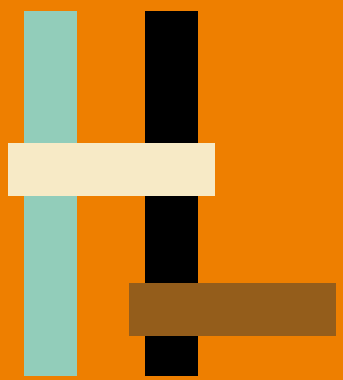


GÖTEBORGS UNIVERSITET

Craft Laboratory
Magasinsgatan 4
PO Box 77, SE-542 21 Mariestad
craftlab@conservation.gu.se
www.craftlab.gu.se

Editorial & graphic design: Sara Hoglund Cover photo:
Christina Persson Press: Ale Press Team AB

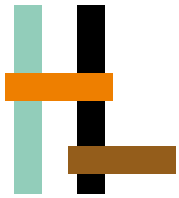
Paper: Cover Trucard 1 Gloss 240 g, inlay Arctic matte 115g

ISBN: 978-91-981883-4-9

Cooperating parties Grevillis
Fund Gothenburg John Hedin
Foundation Cultural Forum

Board Handicraft Council Mariestad
National Heritage Board National
Property Board Swedish Church

Swedish Local Heritage
Federation Västra Götaland



HANTVERKSLABORATORIET

Tar on the wooden roof

A knowledge

Arja Källbom

GÖTEBORGS UNIVERSITET

Borgund stave church from 1180-century in Lærdal, Norway. Several layers of tar has for centuries been deleted on the roof and facade. Photo: Sara Höglund.

Preface

The smell of hot pine tar on a shingled roof is the epitome of tradition, history and genuine craftsmanship. It is a fragrance that has followed man since prehistoric times, and we hope many future generations will experience. The tar has had many uses throughout history, including the churches ever since they began to be built in wood. Tarred church roof, façade, belltower and get gaps is a very important and character creation part of the cultural heritage.

During the 2000s, the Swedish church congregations have invested large sums of maintenance by tjärstrykning, with significant contributions from the state ecclesiastical heritage grant. Meanwhile, Sweden, which was once the world's top exporter of pine tar, completely ceased tjärproduktion in

industrial scale. Instead imported tar from Europe and Asia, the qualities that we do not have the ability and skills enough to check. In addition, making the lack of experienced craftsmen and inadequate guidelines for the clients that the results of tjärstrykningar can vary greatly, and that the necessary underhållsin- intervals are rarely maintained. Purely economic one can say that major

investment risk going to waste if not tar is correct and if the pond is done correctly - if it is done at all. But it is also indispensable antiquarian values at stake. Yet, many lives left in the show that treatment with "real dalbränd tar" is an unambiguous and straightforward process. The need for in-depth knowledge is great. The present study is a compilation of the state today, with flashbacks in history and views mainly to Norway and Finland, where the research done on the subject has been resumed in recent years. Our hope is that this study will contribute to the knowledge of all who work in different ways with these issues. By extension, it should lead on to improved guidelines for maintenance of tar, perhaps even to a resumption of domestic production of cultural care needs. The study was produced by handicraft laboratory in collaboration with the project quality assurance spelling shingle roof, Swedish Church and the National Heritage Board. It has been written by Arja Källbom, Station Ormaryd AB.

Björn Björk, Church engineer at Uppsala pin
Rickard Isaksson, Heritage analyst at Church Office Uppsala
Gunnar north woods, pin curator at Linköping pin


DALBRÄND TJÄRA

"Mikali sauna, viina yes Terva e Auta, on tauti kuolemaksi"

"If neither the sauna, brandy or tar help, the disease is fatal."

Finnish proverb

Tarred church port on the island of Gotland. Photo: Arja Källbom.

CONTENT

SUMMARY

Tar has been produced for more than a thousand years, both small scale and large scale with a large number of methods. Destructive distillation / pyrolysis is one of the oldest pyrotechnic production methods next to metal production. During the seventeenth century, Sweden was the world's largest exporter of tar, which was the country's third largest export product after iron and copper. Tar had a wide range of ships, buildings and folk medicine. They used both hardwood tar and barrträtjära. Around the middle of the 1900s were abandoned Tore tar in favor of other products. It resulted in that we have now broken traditions and a great knowledge loss on domestic manufacturing, quality determination and material characteristics as well as knowledge of the appli cation, then tjärtillverkningen virtually died out. In Finland and Norway, to a greater extent regained more knowledge, which tar has been the subject of research projects and theses about the tarring of the church stavspåntak. Using tjärtyper AND REGULATIONS incidence of job descriptions vary between Sweden, Norway and Finland. There are different views and experiences between the Nordic countries concerning tar possible. pretreatment, pre-heating upon application, the number of deletions and season for application

mm. The tendency is that it is moving towards more similar recom mendations.

In Sweden, mainly imported from ugnstjära inter alia Serbia and China. In our neighboring countries the domestic small pine tar made from primarily direct, autothermal processes. The concept of "genuine dalbränd tar" is a bit misleading in the job descriptions of historical buildings because a large number of parallel direct and indirect production methods have been used historically. Jointly is that pine tar has the highest content of resins and is considered to have the highest quality, ie the longest life. We also know that when törerik raw materials and lower processing temperatures used, produced a more resin-rich tar. When tar produced from inferior materials or when the processing temperatures are higher, produced lighter resins with higher phenolic content which does not have the same film-forming ability.

A first-class tar can simply put likened to a kind of varnish, the resin acids dissolved in turpentine. Tar on e.g. stavspåntak serves as a sacrificial layer, and tar task is to form a resin-rich, fernissa--like surface film that protects the surface from the sun's destructive impact and moisture. Its task is not to give a dark color or to act as a fungi- cid / biocide. The tar darkens for additional coats if they are sufficient. The purpose of tarring is to give a shiny, reflective surface after application. In practice, not tarred roofs, for cost reasons, often enough initially to this film to be built up. Omtjärning occurs

usually within a time span of 5-10 years. The tar on roofs to the south has the shortest life expectancy. We currently lack sufficient knowledge about how the imported tar used in Sweden is produced and under what conditions, what features it has and what methods can be used to assess this. We also lack good specifications for chemical composition and technical characteristics of tar and high quality. Combined gaskromatorgra- and mass spectrometry GC-MS can be used to determine levels of resins, fatty acids and volatile components.

The procedure is used in conjunction with other methods to determine the quality of tar in Norway. In order to answer the demands we should put on the wood tar for the cultural and historical buildings, we still generating some work left to do, and also learn from our neighbors. We also lack the answer to the question how we can ensure sufficient raw materials, production and access to the tar.

In this study, tar material characteristic's history and usage summarized by turkällor literature and interviews with knowledgeable individuals. No practical tests have been carried out. It contains proposals on job descriptions and some self-control. In the current situation remain many unanswered questions.

Many layers of tar form a water-repellent surface on the roof of rod turnings. Borgund stave church from 1180-century in Lærdal, Norway. Photo: Sara Höglund.

1. BACKGROUND AND PROBLEM

What is the purpose tarring and what looks to be a tarred surface have? How, when and how often should tar applied? Tar has extensive use in the Nordic countries, although there was a large loss of knowledge about the tar in the 1900s. Pine tar is used today, including the exterior wood treatment eg roof rod chips and boards (mainly pine) for historical buildings. The treatment is done at nyläggning, repair and maintenance of roofs. The maintenance measures e.g. church roof today require not authorized by the Administrative Board and need not be followed by an antiquarian expert. Without antiquarian or technical discussion also domestic tar was replaced by imported tar with unknown quality and manufacturing method.

There are no domestic or joint production to cover the needs of culturally and historically valuable buildings in Sweden (Swedish National Heritage Board,
2011). In Finland and Norway this. The tar used for churches in Sweden today is imported (Björk, 2011), and the knowledge of how it is produced is deficient. There is a shortage of skills, materials, specifications and work instructions. The finish of the pole chip counts usually as care and maintenance. But tarring can also have an aesthetic dimension. The surface treatment is not always synonymous with tarring with dalbränd tar. It has in different times also used coal tar, creosote, and other chemicals, which may cause adhesion problems during subsequent maintenance. Many roofs have also been replaced. The aim was to provide an overview of the state of knowledge and guidance to county boards, pins, clients, craftsmen and antiquarian participants can benefit in connection with the tarring of stavspåntak. The work was partially carried out within the framework of Crafts Laboratory Project Quality assurance of stavspåntak funded by the heritage grant. We hope that the study will increase the cultural benefit of today tjärstryk-up projects to improve the quality of operations and contribute to improvements in the working methods applied in Sweden today. The study suggests possible further work.

Pine of the species Pinus sylvestris, which is a common raw material for the wood tar. Photo Arja Kallbom.

2. LITE TJÄRTERMINOLOGI

2.1. bituminous hydrocarbons

Vedtjära (and pitches) are mixtures of many different (bituminous) hydrocarbons containing low levels of oxygen, sulfur and nitrogen (Erenmalm, 2013). The described simplified as particles of carbon or carbon compounds with pellicles of light liquid hydrocarbons (rosin acids) floating around freely in an oily medium (terpenes). Resin consists of hundreds of components, and the chemistry is not fully understood despite extensive research (Self-Berg,

2003) (Koskinen, 2003). Tar alternating and complicated chemistry and properties such color and viscosity depends on the species of wood, degree of heating up and processing. The main contents are different kinds of resins (Koskinen, 2003) (Self-Berg,

2003). It has also identified including 5-10% phenols and polycyclic hydrocarbons (PAH) and guaiacol and terpenes.

Resin, resin acids are violated natural way to protect and heal injuries. Terpenes are tree own solvent to the resin and accelerates the oxidation / drying. When the resin rises in the trunk, it must not be too thick, and it will also resinified / solidify when it emerges in such wounds that do not constitute a breeding ground for various microorganisms. Resins which can be brittle, glass-like substances, or be entirely dissolved in oils (Self Berg, 2003). In room temperature tar is light brown to black, with a viscosity between low to high viscosity (Self Berg,

2003) (Koskinen, 2003). There are a number of older, small-scale pre-industrial methods (different types of mild speaker) and newer, industrial methods for the front position of the tar. Vedträtjära typically recovered from pine, spruce and beech (Erenmalm, 2013). Tar prepared by throttled combustion -

pyrolysis, pyrolysis, of various organic materials. It is common to all existing methods are limited combustion (limited air / oxygen supply) of the resin-rich wood, and a drainage system that isolates the tar from the fire (Self-Berg, 2003). Tar is the cultural context in principle synonymous with pine tar. Pine, *Pinus sylvestris,* has higher content of resins than other species. In Nordic tjärproduktion, only *Pinus sylvestris* used, but one can by GC-MS (gas chromatography mass spectrometry) distinguish tar based on e.g. *Pinus halepensis,* which is very similar. Bitumen, asphalt, krosot, carbolineum, stone / brown coal tar, pine tar and pitch, etc. has some chemical and physical similarities

- they are all bituminous hydrocarbons and can be divided into (Self Berg, 2013):

1) Natural products:
    a) bitumen, asphalt
    b) Pyrobitumener: peat, lignin, and carbon
2) Artificial products produced by pyrolysis of wood, charcoal or resin:
    a) Resin (distilled)
    b) Beck (mainly undistilled).

Table 1: Terminology for fossil and non-fossil materials versus natural and industrial products (Self Berg, 2003)

	Natural products and raw materials	Man Made products, technological terms
Fossil raw materials, non-renewable resources	The bitumen and / or asphalt (depending upon definition), charcoal, lignin, crude oil, asphalt / bitumen lakes	Coal tar (distillate) Kolbeck (residue from distillation nest) Petrol (distillate)
Not fossil fuels, renewable sources	Peat, resin and wood	Peat tar and pitch resin tar and pitch Rosin / resin, rosin (residue) tar and pitch

The word tar derived from the Germanic word *Darva* (Lithuanian and Latvian) which in turn derives from the Indo-European Deru. *Deru* means "belonging to the tree," "the tree coming from the liquid" (Dravnieks, 1998). Asphalt and bitumen is Greek / Roman words that describe the same material, and they are still used as synonyms (Self-Berg,

2003). Today they are also the products of the distillation of petroleum. Sometimes tar and asphalt interchangeably. In literature describing the bitumen or asphalt as pigment is also synonymous pitch.

2.2. Isoprene, and terpenoids

Resin is sour natural avsöndringsprodukter of non-cellular and water-insoluble substances which are designed to protect the plant from e.g. micro- organisms and damages (Self Berg, 2003). It is produced in sapwood and channels can be found that brittle glass-like substances or dissolved in oils. A distinction is made *exudates,* that can be excreted naturally from a plant (such as latex, rubber), and *extract eagerness* requiring a solvent to be distinguished from plant (Custom Berg, 2003). Wood contains main components cellulose (40-50%), hemicellulose (20-35%) and lignin (15-35%) and small parts of moisture, resins, gums, starches, sugars and tannins (2-10%) (Self Berg,

2003). Pine contains about 45% cellulose, 20% hemicellulose, 28% lignin and 6% eagerness extract and 0.4% ash and 0.1% nitrogen. Most resins consisting of terpenoids, and consists essentially of C 5 's; isoprene . There are also various other weak acids, phenols and neutral constituents e.g. hydrocarbons. Molecular components of various fatty acids (carboxylic acids), can be analyzed and provide additional information about the origin of the tar. The pine tar abietisk fatty the most important, and it is formed by gentle heating, e.g. at the focal trough the first stage. The fatty acids in pine are well described in the Self's thesis. Natural of- secretions from pine is diterpenoids and birch triterpentoider distinguishable by GC-MS (see

Table 2: Resins of pine (Pinus sylvestris) (Self Berg, 2003).

	terpenoid	Formula	Examples Main constituent
1	monoterpenoid	c 10 compounds, two isoprene	Turpentine oil (also containing 4)
2	diterpenoid	c 20- compounds, four isoprene units	rosin
3	triterpenoid	c 30- compounds six isoprene units	-
4	sesquiterpenoid	c 15 compounds, three isoprene units	-

STRUCTURE OF isoprene

cH 3
IN
cH 2 = CH - C = CH 2 isoprene

section on methods of analysis). Furuhartser consists of a mixture of diterpenoids (usually solid), and mono- and sequiterpenoider (usually liquid). When wood is heated with limited oxygen supply begins extraktiverna evaporated or molten, depending on the temperatures and their respective boiling and melting points (Self Berg, 2003). Decomposition temperatures of the wood cell structures (cellulose and lignin) is about 280-350 ° C, which coincides with the temperature range when the chemically bound water is released. Even holocellulose decomposes in resin rich wood. High temperatures cause the abietisk fatty acid (i.e. decarboxylation carboxyl - COOH cleaved) diterpenoids decomposes (i.e. dehydro generating hydrogen breaks down) and oxidize. Higher temperatures and reducing conditions results in higher proportion of polyaromatic hydrocarbons (PAH) and phenols. Resin also contain substances which pyrocatechol, toluene, xylene, cresol and naptha- xylenes (Koskinen, 2003).

By distilling crude tall oil obtained turpentine oil and the solid residue is rosin (Self Berg, 2003).

A small clarification around the concept of viscosity, which sometimes causes misunderstanding: Viscosity is a physical property of liquids which represents their "Thickness" or internal resistance to flow, and can be seen as a measure of friction. "Thin" liquids of low viscosity and flows readily, while "thick" fluids have a high viscosity and is viscous. The viscosity differs between tjärtyper and various fractions.

2.3. TJÄRTyPER

Vedtjära and other tars

The tar is a large group of materials, with many original shows including the following descriptions of various commodities dictionary.

DEFINITION

"Tar is dark colored, thick, more or less aromatic smelling liquids simultaneously with water, gases, ammonia and other volatile substances formed during destructive distillation of organic substances, especially coal, lignite, wood, peat and various shale species, wherein both the appearance of odor and other characteristics are different depending on the raw material used. "(Meyer, 1952)

DIFFERENT TJÄRTYPER

"Tar called the more or less thick liquid and oily products formed by destructive distillation of organic matter. Collective name tar takes into account only a certain similarity in appearance, but in respect to chemical composition thereof and conditioned practical use tars of the origin of different products. This applies not only to tar of such diverse materials **Stone-**

tar and wood tar but also hardwood tar and pine tar shows large divergent speeds. Of barrvedstjäror is mildalstjära

most typical, and those in the market in recent decades entered kolugnstjärorna are of inferior quality. lignite Tar has no relationship with either coal tar or wood tar. sHALE OIL obtained in the distillation of bituminous shale. "(Kjellin, 1927)

Barrvedstjära is one of the main tjärtyperna of commercial interest (Kjellin, 1927). Tar may either be the main product (tore firing in mild speaker or furnaces) or byproduct (charcoal in charcoal ovens). Mildalstjäran considered superior Stove tar in quality, and for the use of fatty töreved, partly because milan is designed to produce tar, no carbon.

Mildalstjära / daltjära burned in "cottage industry," environmental valleys built on a hillside and consists of a funnel-like bottom (Kjellin, 1927) (Tideström, 1957). It can also be made in tjärkanal (Tideström, 1957). Mainly used pine stumps as raw materials, which stood in the earth so that the sapwood rotted away and heartwood remains (Kjellin, 1927). Mildals- tar has a weight of from 1,037 to 1.067 g / cm 3 (Note that the data Varier in various sources) at 20 ° C and is then brown, yellowish brown or nearly yellow and smells good. When coated on wood leaves mildalstjära a ferniss-like, almost gold shiny coating. Mildalstjära and daltjära can be classified as *fine ordinary* and *bearish* or *prime, secondary* and *tertiary*

(Claesson, 2013), with different uses (National Heritage Board, 2011). *fine pitch* is very light and strong aromatic odor, light liquid and fradgar at the pouring (Kjellin, 1927) (Shenet, 2014).

Secondary thicker and a little grainy. *Heavy tar* tjockfluten and is solid when cold and of granular resin acid crystals. A coarse pitch does not need to have a poor quality of graininess disappears when heated. A good tar sucked into a piece of paper without leaving residue on the surface (Riksantikvarieämbe- tet, 1981).

Tore Tar or stubbvedstjära extracted from Tore, 10-80 years old pine stumps (Tideström, 1957). Stubbveds- tar denotes ugnstjära. Stamvedstjära is designated accession ugnstjära on which the raw material is sapwood of pine trees (spruce, pine), and the resin content is relatively low.

Stove tar / ugnstjära may have large variation of composition due to different materials and different carbonization furnace designs (Kjellin, 1927). Poor tar obtained if granrik ribbved used. The dead weight is reported to be 1.07-1.11, please note that the data varies in different sources. The color is more or less

Table 3: Overview of the various tar products (Shenet, 2014) (Tideström, 1957).

Mother Plant	Synonym	Farmakopénamn	foreign names
birch (*Betula alba* et al)	Birch tar, birch tar, birch oil, Russian oil crucible oil, Lithuanian conditioner	Oleum empyreumaticum epidermidis, Pix liquida betulae, Pix betulae liquida, Pyroleum betulae, oleum betulae, Oleum betulinum, Oleum rusci, betulae pyroleum	Birch takes, birchwood takes (English)
pine (*Pinus sylvestris)* fir (*Picea abies)* larch other conifers	Pine tar, furuträtjära, pine tar, tar, pine tar, pine tar (tar stubble, töre-tar, tar Milad, dalbränd tar, tar-A, B-tar, furnace tar, tar carbon furnace, furnace burnt tar)	Pix liquida, Pyroleum pini, Pix pini (USA)	Pine tar, Stockholm tar (English)
One (***Juniperus communis)***	Eneträdstjära, entjära, enetjära, eneträdsolja, enolja	-	-
Kad (***Juniperus Oxycedrus*** et al)	Kadtjära, entjära, cade oil, cadolja, cadinolja, Spanish cedar oil	Pix liquida juniperi, Pyroleum oxycedri, Oleum cadinum, Pyroleum juniperi, juniperi empyreu maticum	Cade takes, juniper tar / cade oil, oil of cade (English)
Unspecified tar in different languages	Tar, wood tar, wood oil (English) goudron (French), goudron de cade and *goudron de bois, goudron vegetal* (French). catrame (Italian), Betão (Portuguese) *Alquitrán vegetal, alquitrán the Madera (* Spanish) Tjaere (Danish), tjaere (Norwegian), Tretjaere, nåletretjaere (Norwegian), Terva (Finnish) Menen (ancient Egyptian), Rocketeer (German) degenöl, Nadelholzteer (German), Degot, degt (Russian), degguts (Latvian), degùtas (Lithuanian)		

dark brown. Beck content varies depending on the type of oven. Typically Stove tar is a high content of phenolic resin-rich substances that give it both pungent odor and strong darkening after it has dried. It dries worse, and because it is low in resins get the dry surface is not a ferniss-like coating. Phenols are reported to be antiseptic and well in resins for medical use (Own Berg, 2003).

Stove Tar / ugnstjära not suited to the tarring of ropes as the high phenol content makes the sharp and caustic. On the other hand, indicates Kjellin that it is conservative and easily penetrates into the wood than mildalstjära. The water insoluble tar at ugnsbränning deposited as a thick oil layer named A-tar while in tjärvattnet soluble tar called B tar (Tideström, 1957). A tar is most similar dalbränd quality (Custom Berg, 2003). B-tar may be recovered as residue in the distillation of tar water or pyrolignous acid or by passing the gases through kolugns- water (giving 50% B-tar) (Tideström, 1957) (Self Berg, 2003). From A-tar is stripped of water and part of acetic acid and low boiling oils by direct or distillation. From Tore is the replacement of the A-tar about 20-25% of the Tore, stem wood of pine about 7%, from spruce / birch about 5% and the book about 3% of wood dry matter. Yield of B tar switches between 8-13%.

Bokvedstjära is a German product from the manufacture of wood alcohol and acetic acid by dry distillation of beechwood (Kjellin, 1927). It is very dark, thin liquid and is not used for the coating of wood. It has been used for railway sleepers and production of creosote and gujakol.

birch tar is a byproduct of charcoal production (National Heritage Board, 2011) and also called for Russian oil (Kaila, 2007). It is used, among other things for leather tanning. Mainly birch bark used to tjärfram- position and tar could also be used in perfumery (Tideström, 1957) (Shenet, 2014). Birch Oil also called for Russian oil. Birch tar is more viscous than pine tar, almost like pitch, and therefore less suitable for surface treatment (Own Berg, 2003). Can be further distilled to creosote.

Enetjära / Kadtjära and oil manufactured quite general in Sweden since at least the 1500's and used as a panacea (Shenet, 2014). Cadmium tar produced in Europe by one of them, but sometimes also by pine and spruce.

cOAL TAR (*pyroleum lithantracis)* is a byproduct from the production of town gas and coke (Kjellin, 1927). Today it is mainly a by-product from the destructive distillation of coal into coke for steel production (Chemicals Agency, 2014). Although the production of town gas, household coke and synthetic natural gas provides coal tar. Depending on the manufacturing process, the characteristics vary greatly. It is a black, viscous liquid or semi-solid material weight 1.1-1.3. It has peculiar penetrating odor of naphthalene and burning taste (Kjellin, 1927) (Chemicals Agency, 2014). It has identified more than 450 different substances in coal tar. Coal tar is not water soluble (Kaila, 2007). The composition changes very strongly dependent on the nature of hard coal and the distillation (Meyer, 1952). The higher the temperature, the higher the specific gravity and the tar has the more naphthalene contains (but less of bensoler and anthracenes). Coal tar containing free carbon particulate making the dark (Kjellin, 1927). It also contains ammonia positioned operator makes it alkaline, unlike pine tar is acidic. Coal tar is usually stored for a long time, the suspended gasvatten (also contains ammonia) deposits and can be separated (Meyer, 1952). You can also spin out the water. Distillation of coal tar began in the late 1700s, and also gave plenty of charcoal and karbolitjära (Kaila, 2007). After coal tar purified from, inter alia, Water is used to takstrykning, roofing and roofing felt, carriage lubrication and rust inhibitor. It is today also to fuel, road materials, coating in corrosive environments and electrodes in aluminum / steel (Kemikalieinspektionen, 2014).

lignite Tar prepared by dry distillation of lignite (Kjellin, 1927). It is a brown, odorous liquid, specific gravity of 0.82-0.98 and consisting of liquid

TABLE 4: NAMES OF TJÄRBIPRODUKTER (SHENET, 2014)

Pitch, tar pitch, tar pitch	Tar pitch in English. Pix in Latin. Beck of birch tar (Pix betulinae, betulina Pix) of pine tar pitch (Pix sicca seu navalis, Pix solid, Pix solid sicca, Pix pini (Sweden 1869-1908), Pix navalis, Pix solid, Pix nigra.
Pitch oil, tar oil	Oil, takes oil, rectified takes oil Oleum in Latin. Oleum empyeumaticum Björktjärolja, birch oil, russian oil (Oleum betuale albae, Oleum betuale empyreumaticum, Oleum betuale pyroligneum, Oleum Rusci, Moscoviticum) cade oil, entjärolja (Oleum cadinum, Oleum juniperi empyreumaticum, Pix cadi, Pix juniperi, Pix oxycedri, Pyroleum juniperi, Pyroleum oxycedri): English name: Juniper takes oil, cade oil, oil of cade, cade oil rectified.

and solid hydrocarbons of the methane series. Brown coal tar contains aromatic hydrocarbons and sulfur / nitrogen compounds (Meyer, 1952). The divided into three fractions; light crude oils, paraffin mass and heavy crude oils. The products are used for wax production, solar oil, creosote oil, benzene, impregnation fluids, lubricating oils.

byproducts

By-products obtained mainly when trätjäror vidaredestil- Leras and treated. Beck is considered the main by-product. Other by-products are e.g. terpentinol- oils and other essential oils, resins, rosins, fragrances (musk, vanillin, coumarin and anisalde- hyd). Titles and names shown in Table 4.

Pitch is a residue from the distillation of coal tar or further processed (heated) pine tar (Erenmalm, 2013) (Self Berg, 2003). It is the crowning of tar by-products (Shenet, 2014). Beck is a semi-solid or solid residue after intentional heating (not by natural evaporation of volatile substances). Beck from the same raw materials as tar, in either solid or semi-solid state. Unlike tar pitch is substantially solid at room temperature (Self Berg, 2003). Beck has been used for sealing and impregnation since the Stone Age, when it also used as a gum (Shenet, 2014). Beck used as corrosion protection on larger iron works (Rothstein, 1856). Forging get a black shiny surface when treated with pitch while still hot. Beck also used for the sealing of networking on ships. WAX is a soft pitch manufactured by Tore from tar distilling off turpentine (200 ° C) and other parts of boiling to about 300 ° C (Tideström, 1957). Rotbeck is sulfur yellow, hard and brittle (Shenet, 2014). Often the word pitch also used to describe the remaining, residual, the final distillate.

Tar oils , pitch oils consisting of aromatic hydrocarbons (Miall, 1976). Trätjärans volatiles further refined to tar oils. These include the tin terpene oils. Heavy tar oils have been used insektsbe- control zones in the forest and are highly toxic to plants. Tar oil used for impregnation of the leather, perfumes (e.g., synthetic musk, vanillin, coumarin, anisaldehyde) (Shenet, 2014). Both birch oil and pitch oil has gone under the name of Russian oil.

Beck Oil is a burnt brown strong smelling oil obtained when cooked to tar pitch (Rothstein, 1856). This viscous oil used tinge of timber in the open air, it is said that the "fördrifver mask, and moths." Pitch oil contains up to 1/3 ingredients having boiling point above 300 ° C (Tideström, 1957).

creosote oil obtained in further processing of coal tar. It was first produced in 1756 in England (Kaila, 2003). In connection with the rail expansion increased use of creosote sharply, to impregnate the sleepers. Soon, it replaced the traditional tar for many uses and knowledge of tar disappeared. Creosote is a mix of oil fractions boiling in the range 200-400 ° C, mainly phenols (Self Berg, 2003). The term creosote has also been used for bokträtjära that due to its antiseptic capability used for medical purposes. Creosote oil is referred to in the older literature *Carbolineum (* Rothstein, 1856), also in our neighboring countries. It is, however, a crucial difference in the impregnation of wood with kresot and tarring; tarring will not affect fungal growth which creosote do (Kaila, 2003).

Coal tar can also be further processed to b.la. *light oil, middle oil, heavy oil and anthracene / green oil* (Kjellin, 1927). The products of refining used inter alia to alizarinfärger (aniline).

Continued processing of coal tar was made in large cast iron boilers of 20-30 tons, and it comes out different products (> 270 ° C), the last of which is pitch . For ironing iron coal pitch should be purified from the acid, which is done by the tar boiled and mixed with 2-3% lime (asphalt tar) (Rothstein, 1856). Beck contains various hydrocarbons and benzol, toluene, xylene, naphthalene, anthracene, fenatren, phenols (carbolic acid / carboxylic ylsyra, kreosoler and naftaler) and sulfur compounds (thiophene and carbon disulfide) and nitrogen compounds (pyridine, aniline, quinoline / quinoline, pyrrole, indole and carbazole) (Kjellin, 1927).

wood acids extracted from the tar and consists largely of phenols (Miall, 1976). When the tar is treated with e.g. sodium carbonate sodium phenolate which is obtained purified (Dowprocessen). The phenol is carbolic acid / carboxylic acid ($C_6 hrs_6 O$) and in a fraction of coal tar that is distilled at 190-230 ° C. It is acidic and forms the metal salts. Phenol has a number of technical areas of use. Tjärbrännare differ in brown and black pyrolignous acid in the tar pit. The brown is unusable, the black is used to impregnate wood tools, posts, etc. (Kaila, 2007) pyrolignous acid is synonymous with tjärsyra.

caretaker Sanderi Kautto burning tar in sjöslänt, Niemelä. Unknown photographer. National Board of Antiquities picture collection.

Tjärbrännaren Sverre Opdahl stacks a tar pit of Finnmark in northern Norway 2011. Photo: Mats Johansson.

3. tar PROPERTIES

3.1. GENERALLY

Here are some characteristics of trätjäror, with emphasis on the pine tar.

- Drying tar emit volatile substances and structurally transformed by *polymerization and oxidation (* Self Berg, 2003).
- As with linseed oil and various other oils prepolymer meriserar tar at boiling / simmering because it contains *fatty acids* like for example. Linolenic (Self Berg, 2003). The boiling point of dalbränd pine tar is ca. 200 ° C.
- Tars are thermoplastic and in warm weather, the surface sticking (Fridell-Constants, 2010). Termoplasti- capacity means that the tar can be difficult to apply thin in cold weather conditions (Self Berg, 2003).
- How tar interact with the surface depends on many factors. If the timber is taken out from the subject so that the growth rings are tangentially exposed (along the growth rings) or radial (across the growth rings) are important, as is the proportion of heartwood versus sapwood (Self-Berg 2003).
- Especially the non-absorbing substrate is a 'snake skin "effect on alternate sol (Bonn, 2006).
- Pitches are sensitive to chlorine compounds (Erenmalm, 2013).
- They are not sensitive to frost (Erenmalm, 2013). Pitches have different "hardness", which also affect the viscosity and ductility.
- A tarred surface can not be painted with a color because the tar penetrates through the new paint layer and gives the discoloration, the *effloresces* (Fridell-Constants, 2010).
- Tar is not a biocide, and does not protect against rot (the National Heritage Board, 2011). In 2007, the EU authorities established that tar is not active against organisms that attack wood and therefore should not be classified as a wood preservative (Fridell-users; 2010). Barrvedtjärans task is to *To prevent the wood is moistened* and thereby prevent fungal attack (Kaila, 2003).
- Tar is *water repellent (* Fridell-Constants, 2010) (Riksantikvarieämbetet, 1999) and insoluble in water, e.g. water with hair shampoo (Shenet, 2014).
- Tar replenishes the wood with resins (Ward, 2008).
- Wood tar is acidic (have low pH) and in the reaction with water can surroundings yellow color (Meyer, 1952). This can be observed e.g. in connection with heavy rain and ongoing tarring when taken stained strongly yellow (Björck, 2013).
- Tar may be mixed with vegetable / essential oils, melted with fats / resins / waxes (Shenet, 2014).

Table 5: Some properties of different kinds of resins (Shenet, 2014)

Tjärtyp	Description	density	Chemical solubility water extract 2% Listing of content	
birch tar	Viscous brown black mass; purified varieties are lighter.	1 to 1.09	Moderate to weak acidic (pH 2-6)	Leather smell coming from pyrobetulin.
Pine Tar	Barrträdstjäror is generally stickier than the fatter lövträdstjärorna. The taste is sour and visitors. Kon sistensen should be thick and smooth. Half transparent. the most typical deviations are blaskighet, "tar water" and grittiness of the crystallized resin acids. Tar canned from today's paint shop is brown-black and thick.	1 to 1.10	Moderately acidic (pH 2-4)	Acids (acetic acid, formic acid, fatty acids), turpentine essence, phenols (cresols, pyrosulfate catechin, pyrogallol - in most ugnstjära), esters phenols (cresol, guaiacol), aldehydes, ketones, wood alcohol.
Ene- / kadtjära	Clear and thick liquid, reddish-brown to dark-brown with bitter and burning taste. Making the easy fire.	**0.99**	Acidic (pH 6 and lower).	Phenols, sesquiterpene cadinene.

- It can be emulsified with such egg. This means that the emulsions of eggs, drying oils and tar can be made water-dilutable (Ivarsson, 2015).
- Resins are soluble in 95% alcohol. Tar stains removed with gasoline, kerosene, turpentine, or alcohol (no mineral spirits). Dissolves with essential oils.
- There is conflicting information about tar effect on metallic materials. Some sources claim that it is corrosive, while others talk about its good corrosion protection especially when it warms up (Bonn, 2006). If the tar contains pyrolignous acid is corrosive (Claesson, 2014). Wooden acid settles on the bottom of the barrels and tar, if not purified, seem corrosive.
- Poly-aromatic hydrocarbons (PAH) and gujakol considered carcinogenic and mutagenic resins

(Shenet, 2014) (Koskinen, 2003) (Own Berg, 2003). The fragrances are primarily terpenes, and they can be allergenic (Erenmalm, 2013). Although it is a natural raw material, it contains substances that can be harmful to humans. However, we do not know to what extent (Toivari, 2003). Prolonged contact with skin and indoor use should be avoided. Tar can be absorbed through the skin and thereby damage the kidney (Shenet, 2014). EU scientific committee SCCNFP stated that tar polyaromatis- ka hydrocarbons constitute a risk of skin cancer in cosmetic products (SCCN FP / 0646/03, 2003). There are also many sources indicating that the tar and tar products have been used in folk medicine (Bonn, 2006) (Shenet, 2014).

3.2. Tar sacrificial layer

The main aim of the pine tar on the rod shavings and brädtak is to stop the damage caused by mostly water and UV light does not penetrate the wood (Self Berg, 2003). It seems that the victims layer between the wood and external degradation factors (solar radiation, humidity / weather), so as not to damage the wood. Tar photochemical decomposes thermally, mechanically and washed away by running water (Erenmalm, 2013).

Light short-wave radiation, ultraviolet and blue light, the more energy due to their short wavelengths, and do the most damage to organic materials (Becklén,
1999). It starts photochemical processes at the molecular level, which can make the subject in question reactive with the environment and break down its atomic structure. A dye as readily bleached e.g. organic have such a great reactivity. Varnishes and organic substances may darken, crack, discolour, yellow, slow down and weaken. Besides photodegradation sunlight heats the substrate, which dark areas are extra sensitive to. The long-wave infrared light dries out and shrinks, embrittle and lead to cracking.

Film and film-forming substance can be characterized in various ways. For example. by its ability to form a film, how it dries or sets itself, its strength, adhesion, penetration to the surface, transparency, color, gloss, luster, hardness, flexibility and stability (Self Berg, 2003). Film forming properties of tar appear linked to its total content of resins and fatty acids. Tar is tar even after it is applied and formed a solid. Sometimes called incorrectly pitch.

The film's life also depends on the amount of UV radiation and exposure to sunlight which crystallizes and embrittles the tar in sydlägen. The tar does not chip in any directions, and it is not possible to isolate the layer from the substrate e.g. by bending or twisting. Premature cracking can occur, and they are not entirely consistently opposed to age cracks. Cracking reduces the ability to repel water. Tar coating is somewhat difficult to define, because tar is a solid - rather semisolid (Self Berg, 2003). On the north side is tar more semi-solid or thermoplastic. It is not known in detail how tar acts as a coating, it seems that its 1: solidification (hot liquid solidifies and cools) and 2: drying by evaporation is important. Film forming properties depend on the amount of resin and fatty acids, and tar produced at lower production temperatures is most advantageous and also dries rapidly. It does not penetrate the wood as well as the tar from the later stages of the manufacturing process. A matte surface, after the tar dried, suggesting high penetration, a shinier surface indicates that a film is formed. A good pine tar should preferably be both penetrating and film-forming (Claesson, 2014). Self's work shows that pine tar from early fraction / process provides a more solid and glassy surface compared to the tar out later process, and that there is a difference between mildalstjära and ugnstjära. Söder- roofs last longer with firmer tar earlier fractions. Also so-called simmering / boiling, the tar (so as to have similarities to the pitch) increases the strength. Petroleum and coal tar dissolves the wood's lignin (Erenmalm, 2013), the wood to crack due to its solar energy absorbing capability and is diffusion tight (Kaila, 2007). Coal tar pitch roof on the south side results in long strips when the soft part erodes (Björck, 2013). On the north side, it is typical that the stone kolstjäran formed a thick glaze, with rot under the surface. It can not be seen visually but must be tested with a sharp object. Ceiling treated with coal tar can not tar on the vedträtjära with good results. Wood tar is not absorbed into the substrate if it is treated with coal tar, but may postpone the replacement of such original chip in smaller areas for a time (Olsson, 2015).

Examples of Attmar and Torp church

An example of how the wood tar may act as a sacrificial layer to delay the replacement of coal-tarred stake chips are Attmars Church, outside Sundsvall (Olsson, 2014). Bell tower facade and roof surfaces consist of about a hundred years old rod chips are coated with eg coal tar. Surfaces with creosote will be cleaned up

and replaced. Coals Treated surfaces which are in relatively good condition, will get a treat with pine tar. The tar will serve as a sacrificial layer and delay the replacement of the older chips. Coal treatment prevents tar from penetrate the wood and will have poor adhesion especially on the south side. Omtjärning scheduled for every five years. This action has also been taken on such solbänkarna in Torp's Church, Ånge municipality a few years ago (Olsson, 2015).

The photographs above show's church in Medelpad. Church roof and sun benches are covered with tarred rod turnings. Photo: Julia Cronqvist, Jamtli. The photograph on the right shows the coal tarred rod chips on the belfry at Attmars church. Photo: Tommy Olsson, Arenatum.

Tjärhovet at Toppilas Harbor, Oulu, by the year 1910. Unknown photographer. National Board of Antiquities picture collection.

4. trade

4.1. A several thousand years ARV

Tar production and use has a long history. About 1810 BC Mesopotamians used a torrdestilleringsmetod to extract conditioners and fragrances from, inter alia, cedar and cypress (Koskinen,
2003) (Kaila, 2003). It is known that Egyptians used different wood preservatives including balms to preserve sarcophagi and to preserve mummies. The oldest written sources on tjärtill action stems from makedoniern Theophraustus (371-287 b. Kr.) (Self-Berg, 2003). Plinus Elder (23-79) describe ugnstillverkad tar and the tar can be produced from cedar and pine optionally (Koskinen, 2003). The Bible describes how Noah must build a wooden boat and protect it with pitch (Kaila, 2003).

They have found tar from the Stone Age and the Bronze Age in Northern Europe (Own Berg, 2003). Pine tar and birch tar is known with certainty has been manufactured in the Nordic countries historically because it demonstrated that chemically. The tar can be used as adhesives for utilities. During the Iron Age tjärbehandlade one timber and Nydamsskeppet in Denmark from 300's displays this (Claesson, 2013).

During archaeological excavations in Uppland 2002 found the world so far the oldest places of tjärproduktion (Hennius, 2005). Tarpits derived from the Viking Age, 700's, and production has likely been sold. Although Värmland has found locations for large scale tjärtillverkning, with a plurality of methods (Englund, 1992). When the church building started in Scandinavia used tar for coating (Claesson, 2013). The tradition of using resin-rich roots and stems are joint cooperation in Sweden, Finland and Norway from the Middle Ages onwards (Self-Berg, 2003). Although Icelanders used tar. It was also in Europe eg in Chartes (Kaila, 2003).

Sweden and Finland, which was a kingdom until 1809 was the world's largest producer and exporter of tar in the seventeenth century (Hennius, 2005). The Norwegian tar production never reached as much volume as the Swedish-Finnish made (Custom Berg, 2003). Sweden's strong position in international tjärhandel persisted into the 1800s, when Russia and the North American colonies began producing tar (Erenmalm, 2013). When Umeå had become the largest tjärhamnen in 1880, exports were on the decline (Shenet, 2014).

Tjärbåtarna transporting tar to shipping ports "tjärhoven" could be up to fifteen meters long. Tjärbåtar at Kuhmo rectory on the way to Oulu in the early 1900s. Unknown photographer, National Board of Antiquities picture collection.

4.2. TJÄRHANdEL in Sweden and Finland

In 1368 talks Lübeckian pound customs records that the Hanseatic League was fitted with tar from Stockholm and Gotland (Hennius, 2005). In 1476, there for the first time evidence for shipping tar from Kalmar. In the mid-1500s were loaded tar for export also from Gävle, Öregrund, Söderköping, Vastervik and Kalmar. Tar cash crops began shipped from Finland in the 1500s, and initially from southern Finland (Löytynoja, 2003). Extensive tar and cottage industries are coated in sources since the 1500s in Finland (Wahlgren, 1928).

Prussia had long been dominant in tjärexporten but during the 1600s changed conditions due to shortage of raw materials (Hennius,
2005). During the 1600s increased the Swedish tar importance and became the third most important export product after iron and copper (Villstrand, 1996). During the second half of the 1600s came Sweden, including the Finnish national half, to completely dominate the market. It maintained essentially monopolistic position as exporter of tar (Hennius, 2005). Of the exports, about three-quarters of the tar from Finland (Shenet, 2014). During the 1600s and into the 1700s, organized tar largely through special tjärhandelskompanier in Stockholm and Gothenburg (Hennius, 2005). Tjärhandelskompanierna had a monopoly on the Swedish tar, at prices fixed in advance (Kaila, 2007). Among other things, went the trade of Norrbotten, Västerbotten and Ostrobothnia, Oulu and Stockholm. Colonial powers such as England and Holland förbruka- the large amounts of tar (Löytynoja, 2003). Other large sjönationer was such Spain. In 1715, Sweden lost the big tjärhamnen in Viborg the Gulf of Finland (Shenet, 2014).

In "tjärhoven" (official premises for quality control) sorted and evicted tar (usually with

Tjärdal stacked in Karvi, Finland, 1930. Photo: Eino Nikila, National Board of Antiquities picture collection.

85% yield of the barrel total volume) of a sworn vräkare of 1; separating non-tar i.e. Parma, water and black water, 2; sorting of different grades
for example *prime, second-* and *bearish,* 3; Control of the bin's size and fill (Wahlgren, 1928) (Bonn, 2006). Black tar from the end of the burn were separated and commanded a lower price.

Stockholm Tar was a trade name of the Finnish-Swedish tar exported in the 1600s through Stockholm and other Swedish-Finnish ports (empl mountains, 2003). Several sources refer to any tars that passed the Port of Stockholm, the Stockholm tar, regardless of origin (Bonn, 2006).

Even in Småland in southern Sweden produced tars (Hennius, 2005). A Gotland tjärkompani got trade privileges in 1649, and trade continued until around 1860. In Gotland tjärskatt was paid to the Crown until 1834 (Kaila, 2007). The fine tjärklassen which was reserved for the crown called tax tar as it enabled the payment of taxes in kind (Self Berg, 2003). Skat tar is said to be "white". It emerges not from the sources if one refers to the color, or if it was "legal". The second class was used for trade, and the third for home use. The service areas of the Swedish Svealand used wood instead of charcoal (Hennius, 2005). The southern Finland tar production was moved in 1750 to the Finnish Ostrobothnia (Western Finland), in connection with the war between Sweden and Russia (Löytynoja, 2003). Farmers in Swedish Västerbotten and (now) Finnish Ostrobothnia produced tar in large quantities for the Swedish central government needs (Hennius, 2005).

In 1765 Oulu was given rights to tjärhandel, and was also the main port for the tar. A "court" of tar was established in Toppilansalmi 1781, and there were transferred produced tar tjärbåtar on Oulujoki. A single trip with the boat loaded with 20 liters thins a'125

took 2-3 weeks. In the early 1800s, Oulu one of the world's largest tjärhamnar and competed with the Arkhangelsk port was then the largest. Because the forest ended was moved in the early 1800s tjärproduk- concentration to Kainuu in Kainuu, where it became the dominant manufacturing sector along with agriculture. After many years of famine became tar people's means of survival. In Kainuu forests were public property far in the future (Löytynoja, 2003). Via Vuoksi lake system in northern Finland was transported locally manufactured tar. Tar road, *Tervan Tie,* went from areas around Kuhmo Sotkamo and Kajaani and Oulu via boat, horse and clean (Kaila, 2007). In 1865, it reached its peak Finnish tar production. Tar also transported on the river Iijoki and rentransport (Löytynoja, 2003). The Finnish-Swedish tar produced from relatively young, ring-barked pine trunks (Self Berg, 2003). Ring barking, conducted approximately three to four years before the harvest, were added in the 1600s. Previously used resin-rich stumps and roots. Debarking and katning performed on the forest which was about 40-80 years old (Wahl-mountains, 1958).

Approximately 50,000 barrels / year transported most of Oulu (Cavén, 2003). Around the year 1900 was the issue of 12,717 barrels (Kymäräinen, 2003). When the railway was expanded 1886-1906 took transport straight to Oulu and southern Finnish ports (Löytynoja, 2003). The last tjärbåten rowed in Oulujoki in 1927.

4.3. wilderness gold

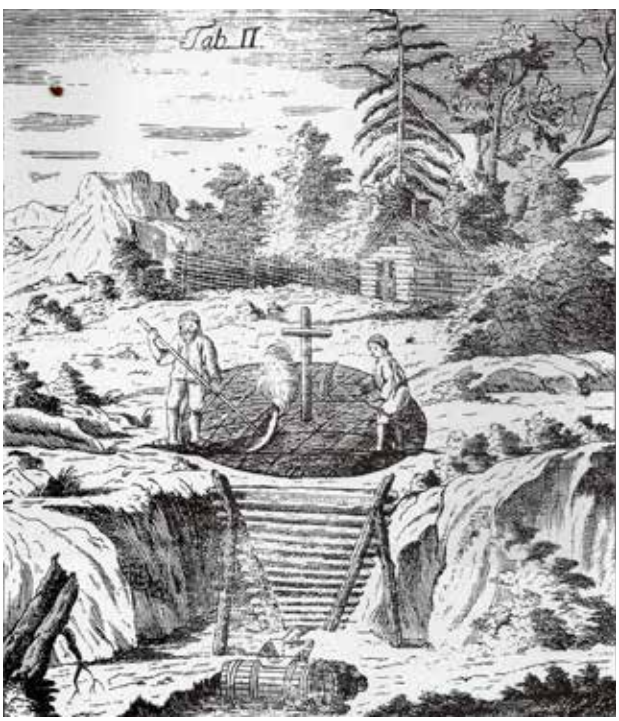
Juvelius describes the Ostrobothnia tjärtill- effects in his dissertation from 1747 (Kaila, 2007) (Wahlgren, 1928). Tar burning was not very profitable, but the lack of other income was a major source of income in the large forest areas and poor wildernesses in both Sweden and Finland. Production of raw materials to the domestic industry occurred primarily during the winter months, when the timber was produced and comminuted. The firing was conducted between floating and hay. It burned mainly in the tar pits, with local variations in performance.

The different steps in tjärframställningen

well suited to do during parts of the year that farmers had a smaller workload (Hennius, 2005).

In the spring when the sap rose prepared trees that would be used by the barking that they would produce more tars (Hennius, 2005). The bark was peeled off except for a strip on the north side which would be about 6-8 cm width to reduce the tree dehydration (Wahlberg, 1958). The first year was katningen to a man's height. Three years later katades tree again and then made annually. The wood continued to live and produce resin that protection until convicted. It was not unusual that the forest could be beaten for 50 years before it was felled because it served as a reserve in case of bad times.

Trees were cut in the fall after Mikkeli (Mikkels- exhibition) at the end of September. Once it has been properly



In the Finnish folklore was avoided calling tar by its name to the surf would be successful. Illustration: Juvelius dissertation 1747th

Tjärmilan lights in Tammela, Hykkilä, in July 1928. Photo: Esko Aaltonen, National Board of Antiquities picture collection.

frozen logs could be transported to Tjärdalen and grovhuggas which was easier when it was very cold. The wood stack was then up in anticipation of the fine cutting and burning that took place in mid-June. Burning of Tjärdalen took only a few days and made up a smaller part of the total work. Tar burning was essentially a man's chore but when the wood was stacked into the valley and at the beginning of firing all participated in the household - men, women, old and young. Studies from Ostrobothnia show that up to 35% of the work performed by women. Approximately 8-10 day labor needed to produce one barrel of tar (Villstrand, 1996).

In Västerbotten, a man could one day overtake break up so many stumps that represented approximately 2 m 3 dissolved measure, when the wood is upphuggen (Wahlberg,
1958). With the so-called Swiss leverage increased volumes to ca. 2.5 m 3rd The lever consisted of a rod with the chains, one of which is secured in the stub and the other anchored to a rock or a tree. If Tjärdalen made where the stumps were broken, there was a rule breaking up, finklyvning and stacking adjacent to the valley. The more chiselled wood, the more effective the drying, uniform firing and greater release of tars. In northern Sweden where, for example, common to Tjärdalen was at home in the village, where it could be easily transported via roads. They wanted to have access to water in case of fire. Clearings could be about five kilometers from the village and the wood was driven into transportable pieces of winter before.

Besides this would tar barrels for storing manufactured during winter (Hennius, 2005). The barrels were made by hand by rätvuxet pine wood, with bent granvidjor to the hoop. An experienced man can

Tar burning in 1898. Photo: IK Inha, National Board of Antiquities picture collection.

produce 4-5 barrels a day (Wahlgren, 1928). The filled tjärtunnorna transported to the cities for sale during the next winter. When the barrels had been so long that tar water / Parma gathered on top of the tar in the barrels could be evicted and replaced with tar. Tar water containing acetic acid and methyl alcohol / methylated spirits (Bolin, 1940). The hard work of producing the tar was also associated with costs. The overseer, "Skursvennen" or "Redesvennen" received an annual salary of 50 crowns, but gladly took bribes not to evict / scrub away some of the delivered tar "aqueous" (Wahlgren, 1928). In northern Skåne and Småland (especially in Kronoberg) paid crofters were fourth or fifth thin to the landowner, as a replacement for the stumps.

The photograph on the right shows how the tar wood katas in Mäkiaho, Saarijärvi, 1908. Photo: A Faltin, National Board of Antiquities picture collection.

Stenkolstjärad and blurred frontage on Pelarne church in Småland. Photo: Arja Källbom.

5. historical use and application

5.1. TAR in Finland

In Finland, the tar has been used for a long time to protect boats, buildings, utilities and health care in medicine for people and animals (Toivari, 2003) (Cavén, 2003). Until the 1880s paid church tax in the form of rod delivered chips to the church roof in Finland (Pihkala,

2009). In Finland, made of tar on farms both trading income and subsistence (Granlund
1979).

exterior wood

The Swedish Royal Academy of Sciences documents from 1742 describe Julius Sahlberg use including vitriol and tar for exterior wood (Kaila, 2007). Many of the recipes describing the production of color that the pigment with tar as a binder, but they are still up here because the recipes show how the tar was used and the types of additives that were made. Rödmull has been used in the tar on the roof since at least the 1700s. It does not impair the protective properties of tar, which also mentions the Dean Gunnar Suolahti 1764 (Pihkala, 1998). Sahlberg describes how buildings painted with a good (red) color can be maintained every second or third time with a mixture consisting of 1/8 pitch oil and possibly some tar. The thoroughly mixed and heated / held hot and hot stone. The tar increases the penetration capability and has a natural red tone that deepened with time. Fresh wood, as lumber and panel, to be dry before ironing. Beck oil should be clear and separated from the water, otherwise the red color black. The same applies to the tar, which should be finished. Is the black and gritty, it has been mixed with carbon black ground or black tar water. The brighter the tar, the redder the color. Sahlberg recommend not only the tar used for painting purposes, as it penetrates the wood bad. He describes how tjärkådan as the tarring settles on the surface are washed away by rain and disappear in the sun - to no avail. If the tar mixed with a little oil thickens and folds on the surface of the wood - but is still sensitive to the sun's influence. The sun makes the surface to crack, and may even damage the wood underneath. "It does not happen if you mix the tar with tar oil."

In Finland, were issued almanacs for farmers (Kaila, 2007). In an almanac from 1781 describes how the farm buildings can be painted with red paint; mixed with tar or tar water, or oil pitch, or salt / vitriolvatten. The wood is protected from decay and moss becomes hard and waterproof - as a shell, and does not need to be repainted more than every 12th or 16th year. Clear, colorless tar used to red coloration of the mansions. Possibly you can use tar and pitch oil 1: 1 or tar oil is lacking with tar water.

maintenance of tjärskiktet long time builds a characteristic pattern, when the substrate is saturated and tar moves with temperature. Photo: Arja Källbom.

Although this source advocates a first pressing of vitriol in warm water kept warm with hot stones. Ironing is made generously and uniformly during a hot summer day. Wood to be painted should be dried at least a year. Although a first ironing with red paint tube in vitriolvatten recommended, followed by a second pressing of only oil pitch or pitch-tar oil mixed with (2: 1).

Although tjärhanteringen was an export product for Finland in the 1700s and 1800s it was used rarely for their own use, it was too expensive and inflammable (Kaila, 2007). Kaila has found some instructions for the tarring of brädtak, from 1845, 1885, 1886, written by *Turku Teknologtidning* and Eugen Jarnefelt. Although these are based on a first reading of vitriol, then tar. Mature måtteneheter have been converted to grams: Three parts of finely divided and sieved charcoal mixed with some finely divided lime. For each 425 grams of carbon-lime mixture is added 110 g alum and two fists finely divided flour. In an iron pot solved so much vitriol in water as it is able to redeem. All the dry ingredients are now mixed into the iron pot and allowed to simmer. To the paste is added sältalg or skraptalg (325 g tallow to 2.6 liters paste). The deletion occurs when the paste is warm and smooth, and it can not cool down. When tjärpastan cooled down on the roof, the surface smooth and "water" resistant. National Board've tried the recipe (with wax instead of tallow), with pretty good results. Järnefelt and Sjostrom also has recipes with tar and mineral oil for outdoor painting and wood flooring including in the barracks, where the mineral oil gives a light brown tone.

In order to improve fire protection were added in the 1820s e.g. copperas, alum and salt to the tar, but it is unclear what effect this had (Pihkala,
2009).

Another Finnish recipes for outdoor painting from *Landthushållningen* 1850 (Kaila, 2007) was used to

containers, tools, floors in buildings, ports, barns and barns mm. A thin tar (125 l), 7.8 l translocation or sältalg / butter and 1,275 g of resin are boiled together. Tar mixture is applied hot. It provides a color that can withstand air and moisture well. You can also cook the red paint with oil pitch or Russian oil. From 1876 mentioned recipes where litharge is added to improve the drying properties of the wood tar, which of course dries slower than coal tar. Shy Leten said to bind tar acetic acid. In recipes 1890s used linseed oil, rödmull and tar color, which are plated cold. In the 1920s, states that carbon black, umbror, red ockror, gulockror suitable for use together with tar. Fine pitch does not need to be heated, it is thinned with lamp oil. Recipes with pitch oil (1 part), classy (3 parts), resin and rödmull that is being spun remains. Although tar water,

In the early 1900s, architects advocating that the houses would be decolorized in more natural colors and expressive than the higher county oil paint (Kaila,
2007). Birger Brunila is one of the architects that describes how nature's colors to use as inspiration. In the 1920s tarred houses with valley burnt tar thinned with tar water, if necessary, as it had a shortage of oil for oil paint. You could make tar more elastic by the addition of animal oil, rock oil or transpiration. Use was also made factory tar; *Patent tar, prepared tar,*

Examples of trade names.

In older sources indicate that the fine tar does not need to be heated during application, if necessary thinned it with lamp oil (petroleum base). A cheap and good color was obtained by boiling the tar oil with rödmull. In a recipe referred to 1 part of tar and 3 parts classy cooked in pan. The ink is dried slowly but becomes so hardy that it can not be removed. In the 1930s and beyond are recipes by half cheap tar and turpentine half, or 25-50% of varnish and 75-50% beckol- yes. The paint dries slowly but becomes resistant to water. A kilo of paint covering 2 m 2 timber wall or 3 m 2 wooden partition. A variant used for both the walls and shingle roofs consisted of equal parts tar and petroleum (or 20% petrol), with the addition of yellow or rödmull (10% mentioned as a numeral). In 10 l tar water could be added rödmull 2-3 kg and 1 liter armor oil (linseed oil modified Tikkurila). Red paint could also be cooked by tar in 10 l water mixing wheat flour and slowly adding 1.7 kg rödmull and let everything simmer. Although Roslag Mahogany used; equal parts tar, varnishes and turpentine (+ possible. pigment). There were varieties of lime. Tjärbland- connections were deleted warm to penetrate the substrate, but not in the sunshine as important topics as the evaporator des. Even litharge could be added tjärblandningarna. The availability of dalbränd tar was big in the 1800s, and coal tar came into use at the end of the century (Kaila, 2007). The color was considered ugly, and the mixing of yellow ocher (linseed oil). You could also mix in paints and varnishes. For painting purposes the pitch, turpentine and resin are processing products and by-products from the distillation (Kaila, 2007). In the 1920s, also came factory-made tjärfärger, probably the base of tar, varnish / linseed oil and turpentine; *Terävä (* Kaila, 2007). They were in various off-white, red, brown, yellow-brown, tan, gray, green colors and could be used on both planed and unplaned wood and stone and cement. In the 1930s, was added birch ash to tar the fire bowl (Pihkala, 2009).

1900s tjärsubstitut made many church roof was destroyed (Pihkala, 2009). The dark coal tar keep warm wood causing it to crack and splitting. Since tar is tight, incoming water can not get out, and the wood is rotting (Kaila, 2007). In some cases, however, they discovered that the addition of substitute materials such as paraffin wax or graphite in creosote tar increased grip on stavspåntak, while paintings and other saturating preparations deterioration same (Pihkala, 2009).

5.2 TAR in Sweden

pANACEA

Tar has been used for boat building, protection for wooden buildings, protection of objects (sleds, fishing nets, casks

and barrels), to lubricate the leather and wheel, making wine and beer (Granlund, 1979). It is used inter alia to repbestrykning, leather, wheel lubrication, pitch preparation (including oil pitch and turpentine were collected) Tar has also been used for medicinal and cosmetic purposes (Svanberg, 1932). Tar, birch tar and pine tar (Russian oil) as well as coal tar, used in addition to ointments, soaps, hair shampoo against eczema, rheumatism and dandruff.

exterior wood

Tar has been mentioned as a preservative since the Middle Ages, the building context to the wooden roof, chips facades, sleepers and other exposed areas such as nodal chains, wind boards, ladders, doors, lining and window shutters (Fridell-Anterselva, 2010) (Erenmalm, 2013) (Bonn,

2006). Tore tar was considered, and are still considered to be the most valuable tar for coating wood. Although pigmented tar e.g. rödtjära has been used since the Middle Ages. Rödtjärning was a regular takbehandlingsmetod until the 1800s. Roslagsbanan mahogany, consisting of equal parts of pine tar, turpentine and linseed oil, has been used to porch floors, stairs, doors etc dependence because it combines the properties of tar and linseed oil; impregnating a surface wiper (Fridell-Constants, 2010). Also mixtures with translocation has been used e.g. to make boats more water repellent (Bonn, 2006). Tar, transport and turpentine used on absorbent surfaces. Tar used as wood against weathering (Rothstein, 1856). To the flavor of papperstak can nice and clean tars used as boiled 5-6 hours, then mixed with slurried pencil (0, 25 kg graphite per liter of tar). Carbon black can be used, but Rothstein states that it does the same benefit. Before tar coated on it can be heated by hot stones or pieces of iron is added in. The higher temperature, lower viscosity and therefore better penetration of the wood. You could also dilute with petroleum for the same purpose.

Rothstein states that "tar should be free of water and soil, clear and amber, not grainy or blackish "(Rothstein, 1856). With a clean wooden stick that is inserted into and pulled out of the barrel examined tar quality.

Heating the tar is beneficial for application mainly in areas already tarred (Bonn, 2006). Bonn warns of repeated heating because the volatile components disappear and tar gradually begins to look like asphalt, and this transformation is not reversible.

Ironworks and charcoal production

The ironworks has for many centuries had charcoal and charcoal burning was conducted in kilns and tar (Wahlberg,
1958). Board of Trade and the Royal Swedish Academy of Sciences wrote already in 1748 about the charcoal ovens and so-called retorts (see page 43) to produce charcoal and tar. Pre-industrial manufactured tar were thus already in the 1700s. Wahlberg says dry that if all those in the world wars put down a lot of effort and money on running tjärugnar, had read the Royal Swedish Academy of Sciences book ' *'S description of Tjäru- and carbon furnaces Establishment (* 1748), they could have spared a lot of effort and resources. "

Industrial tar usage

From the years 1900 to 1948 comprised the majority of the tar production of carbon furnace tar, i.e., a by-product of iron production charcoal (Bergström, 1950). Apart from the two world wars, reduced tar production in Sweden as the steel industry found alternative fuels. Prior to 1900, made virtually no ugnstjära of kolved. Tore tar dominated and were made mainly in the tar pits. Ugnstjäran first produced on a large scale around 1900.

During World War I was a speculative tar Merger be as conditioned high prices because it is used to prepare the lubricating and fuel oils (Wahlberg, 1958). In firing the ugnstjära or when tar obtained as byproduct of the ugnskolning, allowed to by-products not usually obtained at dalbränning; wood alcohol, vinegar and acetic acid.

During the two world wars used Tore tar both in Sweden and Finland for the production of "fairly good lubricating oil" (Tideström, 1957) (Bergstrom, 1941). In Norway this happened. The yield of lubricating oil matched by the tar content of components boiling between 300-370 ° C and the tar may not be superheated so that the retention or carbonized substances are formed. Stamvedstjära from softwood was used during the war as motor fuels including to ignition engines. There are technical specifications on the motor tar in Tideströms reference. Lövvedstjära and B-tar is used as fuel, and also as binder for the briquettes. The sulphate pulp industry, based on the pine wood had a great production of turpentine and resin (Wahlberg, 1958). Was recovered including fatty acids from tall oil, tall oil. From tar water then isolated old acetic acid, methyl alcohol (wood alcohol) and acetone (Tideström, 1957). The exchange is twice as high when using hardwoods than softwoods, and it should also go to the hardwood extracting butyric acid, crotonic and metylfurylketon.

After 1945 ceased almost charring by Tore and kolved in pots (Bergström, 1950). National fuel - the Commission has compiled information on various tar products in different years, and some are in Berg's source. One example given is for the year 1948 the production of carbon furnace tar to 9,000 tons, 1,000 tons of stubble ugnstjära and dalbränd tar to 300 tons. Around 1914, the production of dalbränd tar 2400 tons. Wood tar is used in the rubber industry as additives to rubber, as plasticizer to prevent its aging (Tideström, 1957). Tar is an inhibitor and protects with its content of phenols.

Sojde in Vallstena, June 2014. Coverage with rice and sawdust. Photo: Arja Källbom.

5.3. TAR IN NORWAY

To church

In Norway burned households tar tithe to the church as early as the 1270s (Granlund, 1979). In including *country holidays* from 1274, which was instituted by King Magnus Håkansson, there are laws for the construction and maintenance of churches such as *Frostating Loven (* Self Berg, 2003). Where third winter the farmers tar on his church. IN *Kongespeilet* from the 1300s, stated that the boats should be tarred in the autumn (or spring if it is not possible) and to dry during the winter.

Exact descriptions of how the tar to be applied are not in the medieval sources (Self Berg, 2003). Pans and pans are mentioned, however, in several sources. In later sources indicated that the tar sjuds cooked or, in some cases even to pitch / resin where the volatile components evaporated. The resin is stiff and almost solid when cooled. The Norwegian sources mentioned "pipe-tar", and it was assumed that it is the issue of tar

during byggningsvernskongressen in Oslo in 2014 was made craft experiments with sand on tarred rod turnings. Photo: Christina Persson.

which has been reduced but has a consistency which still is possible to move on. Both pitch and rörtjära get a lower viscosity when heated, allowing for application to wood surfaces. Application of pitch hampered if it is too viscous because it is difficult to work out. On warm summer days, it is better. Simmer was probably a common process until industrialization and early 1900s, both for boats and buildings. Simmer temperature would be about 200 ° C, and does not necessarily a carboxylic degradation and hence reduced content of fatty acids. However reduced volatiles content and concentration of fatty acids therewith. Simmer homosexual geniserar tars. One liter of tar from early fraction decreases about 15% in volume and covering about 2 m 2 provided that the wood is dry and cracked. In 1700s resources (Juvelius 1747) discloses that the early fraction at milbränning are suitable for the manufacture pitch. In Norway seems to methods for applying tar to be similar in the 1600s, 1700s and 1800s (Self Berg, 2003).

In older sources described how the pond insertion process of a newly built tower went to 1686 in Åmot old church in the East Valley (Self Berg, 2003). The newly built tower pretreated twice with rörtjära (six barrels) and then with pitch (eight barrels). Rörtjäran used as a "primer". Rörtjäran boiled and a thin rented (barrels were made of cast iron or copper and exclusive, they begin to be used primarily in the 1600s). Also for Lunner church 1691, 1699 1703, the terms tar, rörtjära and pitch. Sydtak be tarred and rörtjäras and north side beckas. In the latter two instances charcoal is added to the tar. Roros church was finished in 1784 and is Norway's largest church roof at 1300 m 2 (Vegar Os, 2014). The old tjärbeläggningen of shingles in Roros is ca. 1 cm thick in total, at least three layers and is called *armor layer (* Vegar Os, 2014). First layer came to the plant, as a primer. Basic Scaffolding layer is about 0.5 mm and have little penetration into the wood fibers. The chips are not dipped, and tar must have been a tough quality, probably poached. Its function is to protect against moisture in the building process and facilitate drying of the next tjärskikt. The primer also protects the surface of the chips below and in contact with the next layer of sawdust. Second layer contains a lot of fine sand. Practical tests carried out show that the sand strewn on after the tar

applied. If sand is mixed into the tar before applice- ring settles it. In both the second and the surface layer are crushed coal, sieved in a sieve with a 5 mm mesh. According Vegar Os, there are examples that have been mixed into coal, sand or pigments also and elsewhere in the Norway. The causes are probably multiple and assuming that there are both aesthetic, technical and economic reasons. The additives reinforces and stabilizes thick tjärskikt and also extender (it takes less tar). Involvement of red pigment gives a distinctive reddish glow.

It is not known how many entries pond that was needed to build tjärlagren, or the time between tjärningarna. Accounts from 1781 1782 1784 shows a consumption of 17000 liters total tar, corresponding to about 10 liters per square meter of roof area. It is believed most likely that the 1 cm thick tjärlagret, armor layer is constructed during the construction years, not later. Armored layer is dense and after about 240 years have seen the rotting wood in the construction. How chips are produced and taken out of the wooden brick is important. Vegar Os emphasizes the importance of using chips with vertical annual rings and avoid exposure of the medullary rays. The radial cells are important for moisture transport and tar penetration. Märgstrå- gland increases the risk of cracks and pores are so large that the tar is sucked into the timber instead of being left on the surface.

Three years after Heddals stave church restored in 1853, the facade in need of omtjärning (Self Berg, 2003). National Heritage indicates that tarring be carried out in three steps to achieve satisfactory results, 1; deletion tar simmer 2; deletion with tar "cooked", 3; last highlighter with tar "cooked" and almost reduced to the resin.

In older sources reported mentioned that tarring of Churches will take place in winter (Self Berg, 2003). Because of it carried out an attempt on the Gol Stave Church winter 1993. The thermoplastic tar waned sharply during transport to the roof and could not iron thin. When spring came tar ran out and it was concluded that the application should not take place in winter and no satisfactory explanation for the old laws have not been found.

Stav chips with "armor" layer of tar, coal and sand on the Roros church in Norway, is from the 1700s. Photo: Sara Höglund.

They have found the hire of copper vessels in connection with the tarring of several Norwegian churches, and also be able to detect the presence of copper in tar for a number of Norwegian churches (Self Berg, 2003). Copper ions probably functions as biocides / fungicides. There are also indications that the Viking boats tar has elevated copper content. The copper is advantageous for drying and application of linseed oils have demonstrated Lyckman (Lyckman, 2005). This also applies to resins in the same way as linseed composed of various fatty acids. The Norwegian tar production affected by e.g. the introduction of water-powered saws around the year 1500 and transport routes (Self Berg, 2003). The Norwegian tjärtraditionen differs slightly between south and north, and the northern tradition probably originates from Finnish emigrants in the 1600s and 1700's. In the 1850s, began to tar produced in the retorts. During the occupation of Norway during World War II 1940-1945 made extensive efforts to produce domestic fuel and other products from the tar. Development of industrial processes also contributed to the research on such dalbränd tar as consumers reacted to the differences in the properties.

Photo: Christina Persson.

6. Manufacture

6.1. dry distillation

Tar traditional use is an umbrella term for materials produced by pyrolysis / carbonisation i.e. slow combustion without or with limited access of air of organic substances such as wood, peat or coal. It uses concepts

destructive distillation , dry distillation and pyrolysis (Self Berg, 2003). Destructive distillation based to the processing of solids. *Pyro* means fire in Greek. Pyrolysis involves chemical decomposition due to high temperatures. Tar and pitch is called pyroligniska substances .

Distillation of liquids include boiling, evaporation and condensation (Self Berg, 2003). A condensation called distillate and the residual nonvolatile that residual . A fractional distillation means separating liquids through evaporation and condensation at different temperatures or boiling points. IN destructive distillation may distillate and residue permanently altered chemical and physical properties. It is not possible that, as in fractional distillation, again combining the distillate and residue to obtain a product similar to the original.

Tar is produced by two main methods (Hennius, 2005):

- *Indirectly* - allothermic method . Process heat is to be formed tars taken from a source other than tjärveden, and no tars burning up. Raw RAN placed in an enclosed space that is heated up by the fires outside the container. The principle is the same for archaic tjärframställning in an inverted cast iron pot in modern retortanläggningar in the chemical industry. In addition to the raw material for tar must also collect fuel for process heat.
- *Directly* - autothermal method . Process heat is taken directly from the timber you want to extract the tar, under controlled oxygen supply. The similarities with charring are obvious and coal is also an important by-product is utilized. In principle, all known major historical tar plants in the Nordic countries applied the direct approach.

Unlike the oven and the retort is that if heat gain förseln is directly referred to it as an oven, and it is indirectly regarded space as a retort (Wahlberg, 1958). There are both horizontal and vertical retorts. The concepts furnace and retorts are often without being aware of the differences. Sometimes the word oven or retortugn retort. Today produced tar primarily industrial in both ovens and retorts.

Stumps and Tore

The best raw material for pine tar is old pine stumps, broken from the sandy and rocky ground. After the tree felled resin begins to accumulate in the stump, and after 10-80 years resin portion constitute a large proportion of the stump weight (Claesson, 2013). The sapwood and decompose a resin-rich core remains. The resin-rich parts oxidizes and stubble "matures" (Wahlberg, 1958).

Tore , tree protection against injuries may also arise from attack by Tore catheter sponge or fire loops (Wahlberg, 1958). Tore is also used to refer to parts of a pine tree that is rich in tar-forming substances. Data for kådhalt in absolutely dry Tore ie mature stump varies in different sources, which may have to do with geographical conditions. Kådhalterna varies between 15-40% of the office's weight (Wahlgren,

1928), (Wahlberg, 1958) (Own Berg, 2003).

Stubbved used for charcoal whether it consists Tore or not (Wahlberg, 1958). Although lowermost part of the stump used. How many years it will take for a stump to mature depends on the soil type, habitat, latitude mm. Besides wood uttor- kas constantly full, is also a degradation of the splints / sapwood resin acids and oxidized (latter with less grainy tar as a result). Dry but nutrient-rich woodlands provide most Tore, and the worst is waterlogged soils (Wahlgren, 1928). The best stumps were on rocky soils in semi-arid sunlit situations, which unfortunately did stumps severe broken (but Tore rich). It broke the stumps with a shovel, hoe, rotyxa, crowbars and levers, or explosives. The quality of the stumps on Gotland was very good, probably because of both rocky and chalky soil. In southern and central Sweden takes approximately 10-20 years, in southern Norrland 15-40 years, central Norrland 30-60 years and Northern Norrland 50-80 years stumps to mature. There are formulas and correlations to determine the exchange of best tjärproduk- Tore and sapwood depending on the stump diameter and ytvedens thickness of Wahlberg's source. Wahlgren gives a numerical example with 15-20% kådhalt dry Tore (Wahlgren, 1928). 1 m 3 scrubbed and

wood quality	tar yield
	kg / m 3 wood
Dried pine heartwood of pine root	30-40
on dried spruce root thinning,	12-17
mixture of pine and spruce splint,	8
splint pine, spruce Birch	5-12
	4-10
	5-6
	10-15

Table 6: wood quality versus tar yield (Self Berg, 2003).

dry Tore may weigh 300 kg, that after the water has evaporated weighs ca. 240 kg (water content about 20%), wood substance 190 kg and 40-50 kg resin. Of the resin is about 20% turpentine oil, the rest are resins and oils. Other information alleges that the pitch content can exceed 30%, and the yield is ca. Tar 30 liters per cubic meter of loose dimensions Tore (Kjellin, 1927). It has also been mentioned, ringbarkat pines for them to start producing resin. Tar yield for different raw materials shown in Table 6.

6.2. Differences between production methods

Traditionally it has been thought that dalbrända tar best quality. It is considered superior to the retort made, and with the ugnsbrända between (Bonn, 2006). Explanations for this are given below. One should remember, however, that opinions also differ greatly. Some claim that one can control the time and temperature in a more controlled manner in industrial processes, especially at lower temperature settings (Bonn, 2006). It is possible that it could not do so at all times. Superior daltjära is prepared at moderate temperature and could be considered as a kind of lacquer consisting of primarily resin acids dissolved in turpentine (oil) (Tideström, 1957). Ugnstjära from Töre is often made

at higher temperatures and in addition contains resin acids also hydrocarbons which dries slowly. Both resin acids and hydrocarbons oxidizes more slowly, the higher temperatures they are formed from.

The quality and quantity of extracted tar depends on the tree content of resin (Self Berg, 2003) (Tideström, 1957). The higher content of resin, the greater the amount of tar formed with high resin and fatty acids. Heartwood contains significantly more resin than splint / sapwood / stem wood. At ugnsproduktion tar is used generally more heterogeneous raw material of various origin, size, moisture and resin content. Stem wood is rich in phenolics (carboxylic acid). It is also more porous than the heartwood and acts as "tjärtjuv", which increases the risk of so-called double charring, thus increasing phenolic content in the distillate, regardless of the production method. It also gave inferior grade of coal.

Both the process temperature and heating rate are important for the final result. The operating temperature is kept lower than at dalbränning ugnsbränning, to prevent ignition. Peat and sawdust are examples of materials used for regulating oxygen supply. At dalbränning kept generally lower temperatures for longer than the burning furnace and resin rich hydrocarbons present in the feedstock is condensed in the early fractions. The lowest quality has last fraction, which distilled at higher temperature.

Early attempts by Clason in the early 1900s linked the qualities fine, ordinary and grainy in mildals and retorts to fractions 1; fine for tem- peratures up to 150 ° C, 2; ordinary temperature of 150-250 ° C and 3; grainy temperature of 250-295 ° C (Self Berg, 2003). The residue was called pitch. Besides the differences in the raw materials for the process types, results third fraction in higher quality, and the residue can be used for further processing in mildalsprocesserna. The residue / pitch from retorts is insoluble and consists of disintegration / krackningsproduk- best, resins and fatty acids to compounds with lower molecular weights due to higher processing temperatures (Self Berg, 2003) (Bolin, 1940). It darkens the tar similar to more neutral oils type creosote (phenols).

Tar produced in kilns have higher levels of resin and fatty acids than those produced in ovens / retorts. The content of volatile constituents is more consistent in milbränd tar, compared with ugnsproducerad. To improve the tar grades from retorts should redistilled according Own Berg (Self Berg, 2003). Various grades extracted from the tar in the temperature range 130-190 ° C can have large differences in quality and thus different applications. Grain arising in the early fractions is not a sign of poor quality because they disappear when heating (Self Berg, 2003), unlike the grain in the last fractions. The late factions penetrates wood easily and absorbed thereby. This indicates lower molecular weights and higher volatility. At the end of the process increases the viscosity, the proportion of volatile elements increases with decreasing content of resin acids. Table 7 on the following page, shows differences in the composition of between kolugnstjäror mil and valley - tars (Kjellin, 1927). Resin acids contained in the fraction is formed above 240 ° C. In the production of kolugns- tars can be mentioned capitalize on products that would otherwise be lost (Bolin, 1940). The 1920s ugnsbrända tar (a by-product from koltillverkning) stated more uneven quality than the dalbrända. (Wahlberg, 1958). Table 8, overleaf, shows differences in the components of various tjärtyper (Tideström, 1957). In the production of kolugns- tars can be mentioned capitalize on products that would otherwise be lost (Bolin, 1940). The 1920s ugnsbrända tar (a by-product from koltillverkning) stated more uneven quality than the dalbrända. (Wahlberg, 1958). Table 8, overleaf, shows differences in the components of various tjärtyper (Tideström, 1957). In the production of kolugns- tars can be mentioned capitalize on products that would otherwise be lost (Bolin, 1940). The 1920s ugnsbrända tar (a by-product from koltillverkning) stated more uneven quality than the dalbrända. (Wahlberg, 1958). Table 8, overleaf, shows differences in the components of various tjärtyper (Tideström, 1957).

Table 7 Differences in percentage fractions vs temperatures kolugnstjäror and mildalstjäror (Kjellin, 1927)

fractions	Kolugnstjäror 1	Kolugnstjäror 2	Mildalstjäror
100-175 ° C	43.8%	33.1%	19.5%
175-240 ° C	24.5%	28.3%	24.1%
Above 240 ° C	21.7%	17.4%	44.7%
Beck / residue	10.7%	20.2%	11.7%
Gases (loss)	1.0%	1.0%	1.6%

distillation in vacuo, the fractions under 100 ° C excluded. Resin acids contained in the fraction is formed above 240 ° C.

Table 8: Components of different tars by distillation under atmospheric pressure (Tideström, 1957)

	daltjära	Stubbugnstjära	Stamvedstjära	Lövvedstjära	B-tar
water %	0.5	3.3	4.9	40.9	34.6
Oil%, boiling point					
below 150 ° C	-	1.1	1.2	1.0	3.3
150-200 ° C	3.5	5.5	3.0	8.2	6.1
200-250 ° C	11.9	11.4	17.4		17.7
250-300 ° C	14.3	11.0	23.0	13.7	12.2
300-350 ° C	12.3	30.7	9.4	3.3	9.2
350-360 ° C	8.9	26.74	-	-	-
Above 360 ° C	42.4		-	-	-
Residue (pitch)%	2.4	7.9	36.9	17.7	12.5
Gases losses%	3.8	2.4	4.2	15.2	4.4
Maximum temperature	380 ° C	370 ° C	305 ° C, pitch	305 ° C, pitch	320 ° C
Other	aqueous layer separated before			Birch	

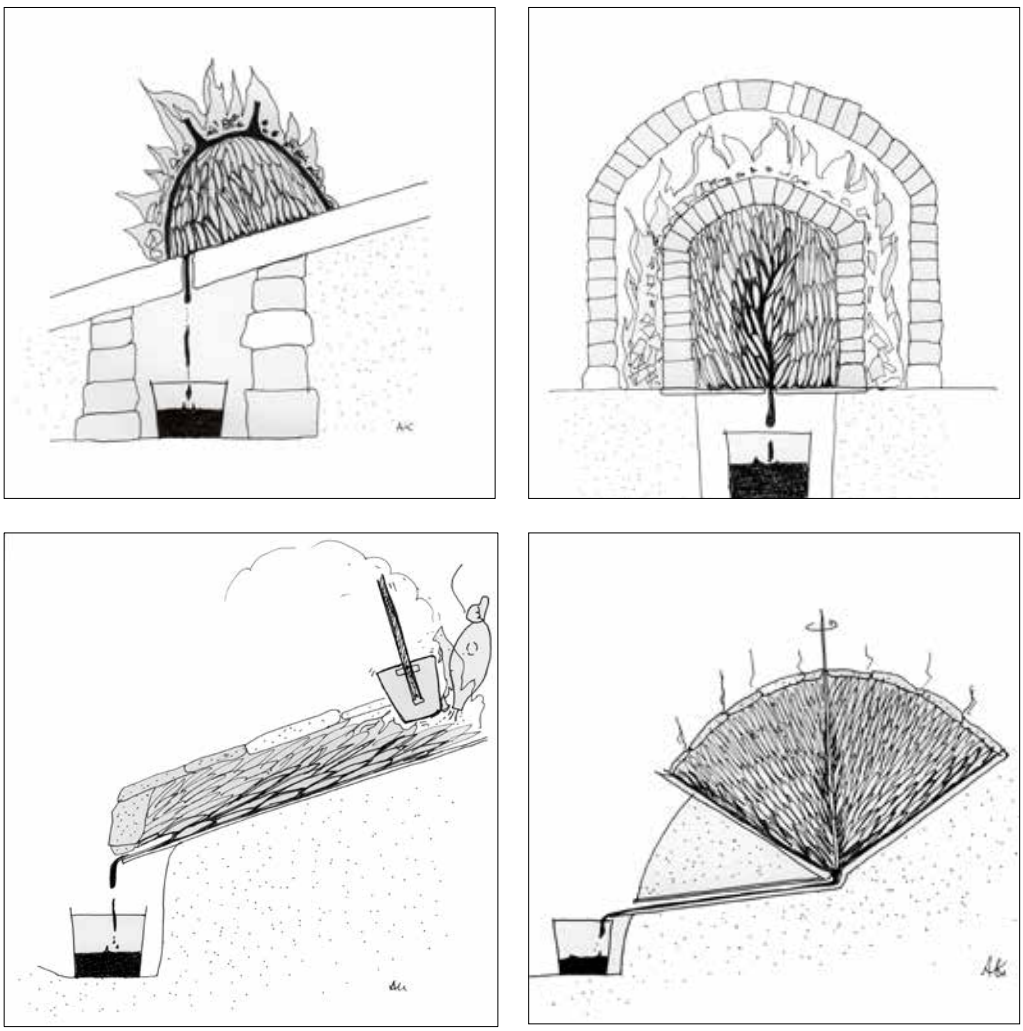
daltjärans water layer separated before distillation. Lövvedstjäran was mainly birch
obtained from trägasgenerator. For " pitch " distillation was stopped when the pitch
formation occurred.

6.3. cottage industries

The pre-industrial tar production in Scandinavia seems to have been similar - ie as heterogeneous (Self Berg, 2003), and that there were **significant local variations (Hennius, 2005). it was conducted *in situ,* a sort** of cottage industries close to raw material.

Names of pre-industrial, autothermal methods vary with like facilities may have different names or where the same name can refer to different types of facilities (Hennius, 2005). Many sources differ on the underground and underground facilities.

Own roller has logged temperature versus time in a number of tar, and seen that material in the bottom of the funnel and affects the temperature gradients in the production cycles (Self Berg, 2003). Wood-ground birch bark in the bottom have larger gradients towards the center of the base than rock sand-clay. Even tjärdalens altitude record. This can affect e.g. plant yield of tar.



Examples of different types of tjärtillverkningsmetoder on slopes, in the Nordic countries: Ö.v: Tjärgryta, height above sea level: Tjärugn, Nv: Tjärgrav / gutter, NH: Tjärhäll. Illustrations: Källbom by Althin 1929 Farbregd 1989. (Own Berg, 2003).

Cottage industries in Finland

There were a large number of pre-industrial methods in Finland and here mention a few. The oldest known method of tjärframställning considered the open tjärrännan (Hennius, 2005). At the end of the Middle Ages was a more advanced method of tjärtillverkning known in Finland, where they dug a funnel-shaped pit with steep sides in dry soil. In the pit stacked one alnslånga tjärvedstycken until a kolmilsliknande stack covered with turf and soil. The tar ran in firing down into the pit where you sometimes could not place a container. Already in the 1500s developed the method to what we today call tar . By placing a gutter in the bottom of the pit could tar drained as the firing continued. Production on a large scale was possible.

A distinction tar produced in covered tjärgravar , masonry tjärugnar and in steel furnaces / retorts (Kaila, 2007). At tjärproduktion obtained tar, tar water / "tjärpiss" (about 30%). Some of the trees water content departs as steam but some remain in the tar. Tar is untied and the water settles to the bottom of the barrel and wood acid to its surface after a year and can be distinguished from tjärtunnan. Tjärvattnet was considered to have no practical use, and discarded. Self-Berg states that it is acid wood that sinks to the bottom and tjärvattnet flowing (Self Berg, 2003). These contradictory data can be because you compare tars with different densities; if the tar have densities below 1 g / cm 3 so floating tar in the water (the differences are due to different raw materials and / or processes are currently not entirely clear). Aqueous tar known wrecks tar (Shenet, 2014). The Finnish farmers called the first fraction *rottjära,* it was thick, white and grainy as Juvelius (Self Berg, 2003). It was particularly suitable for making the pitch of, for example, sealing boats. The fractions in the 1860s were designated as *fine, medium* and *thick.* The fine tar was light brown, oljelik and grain free. The second class could contain some grains but was smooth and homogeneous. Neither pyrolignous acid or tar water was accepted in any of the classes.

Cottage industries in Norway

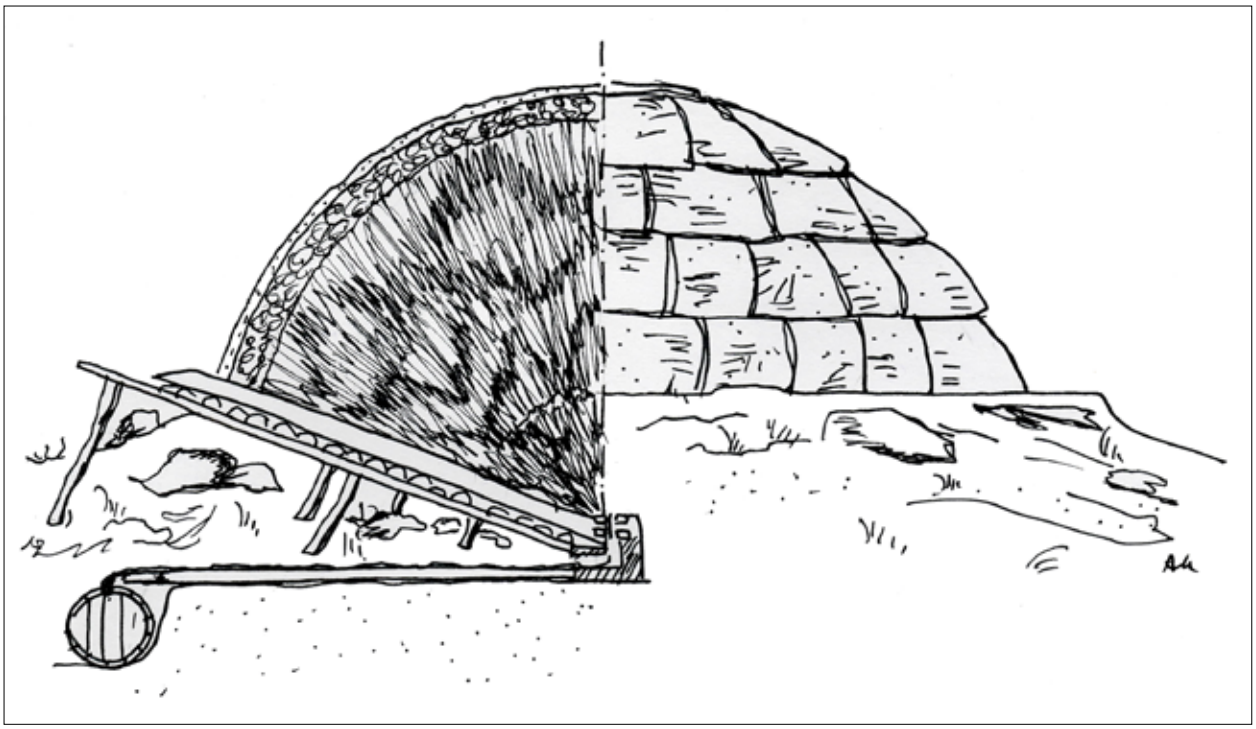
In Norway, various kinds tjärgrytor , ovens , Burial and hobs for home industry. Detailed descriptions of the different types of kilns are designed and work is in Self's thesis. For tar production on a larger scale was used debarked pine trunks that stand, and produce resin for a few years before tjärgraven built (Villstrand, 1996). Wood raw material is chopped up, is cut and dried. Materials of lower quality placed near the periphery of Milan (Self-Berg, 2003). Burning tar requires knowledge and experience in order to, inter alia, assess air supply and temperatures in Milan.

Production of small quantities of tar could be done with a pan (Self Berg, 2003). The boiler is turned upside down with the raw materials and dräningshål inside and open fire on the outside. Similar small-scale manufacturing is today, with an oil barrel without ends (provides about 200 liters). It resembles a retort which has an inner chamber for wood and an external fire. Nearly two identical descriptions are of pitch production in Sweden and Norway, from Keyland 1925 Bruheim 1969 (Self-Berg, 2003). The tar is boiled and stirred continuously. A hood with holes enabling evaporation without ignition. To test whether the pitch was clearly taken a tjärdroppe cooled down in a cup of cold water and pressed against tjärmakarens tooth. It was clear when the pitch does not want to attach to the tooth or give any impression. For sealing boats were preferred pitch production from the dark tar, the sjuds until the smoke is blue and seems pasty.

Cottage industries in Sweden

In Swedish archaeological record is produktionskate- categories: *Tar / Tjärgrop, Tjärmila, Tjärfabrik, Tjärhäll / Tjärsten, Tjärmyrmila, Tjärränna* and *Tjärugn (* Hennius, 2005). You mentioned a few.

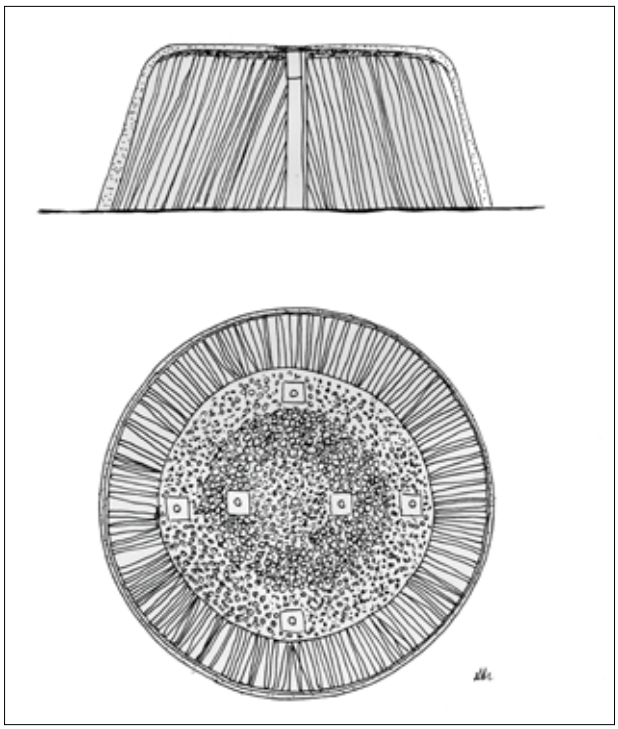
At kolmilning (resmilor or liggmilor) extracted only charcoal, but want to take advantage of the tar by dry distillation, built tar (Bolin, 1940). The tar is collected in Milan's bottom. Efforts to produce tar was demanding both in labor and raw material availability. Types of pits and tjärgravar

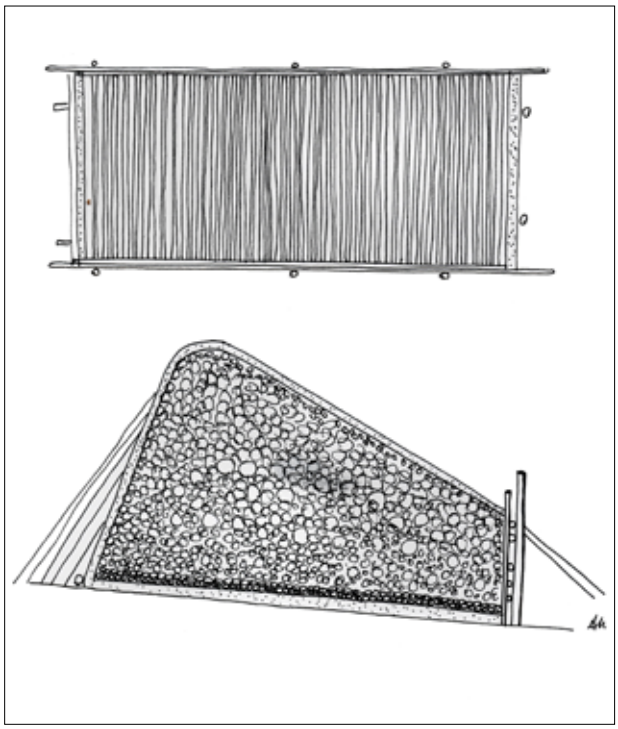


The principle of a tar pit in cross section. Illustration: Källbom after Bolin 1940th

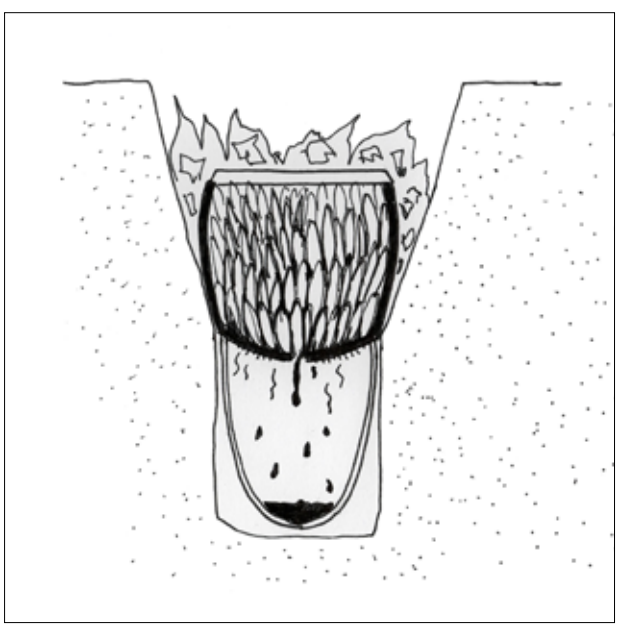
has been used for the burning of firewood (Granlund 1979). They are described in the essay Bergman (Bergman, 1963); *tjärdike, tar, Sojde, tjärmila, tjärgryta* and *tjärugnar*.

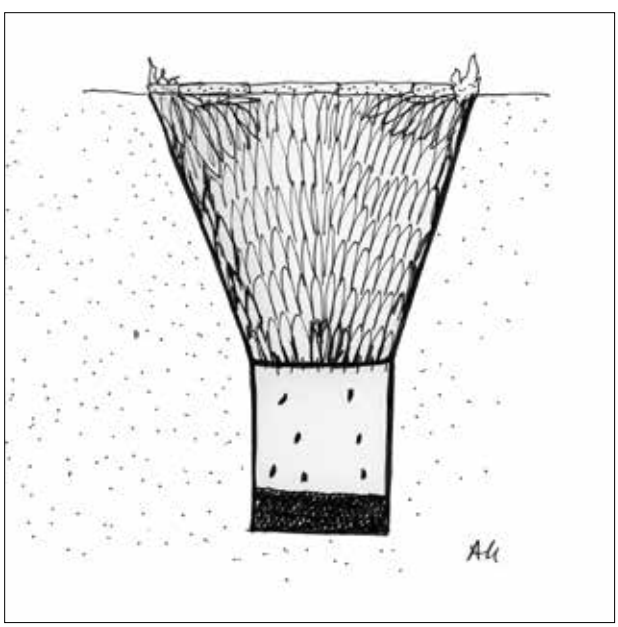
Tjärdalen has a spout that can be constructed with stones and / or wood or buried in the ground - positioned on flat ground or on a slope (Hennius, 2005). The big difference from a tjärmila is a way to stack the customs office of destination in which to build up a milkropp above ground (Althin 1923). It takes 4-6 days of a normal burn tar clear, and work is conducted by combustion master that monitors the firing runs smoothly and quietly (Wahlgren, 1928). Among other things, should the smoke be light, indicating that the temperature is not too high (Self Berg, 2003) (Karlsson, 2012). Dark smoke indicates that tars burning. When burning the tar burning wood from inside to outside, opposite to the conditions prevailing in a charcoal stack. The fire goes from top to bottom like a torch, and char yield is low. The coal maintains however a high quality and is used as such forging school. Rebuilding around 6 hours from the firing started, tar begins to flow through the pin hole. First tjärvattnet containing acetic acid. Then comes *fördroppar- tar* rich in turpentine. Then, the tar of ordinary composition. The careful sorting of raw materials in the tar pit gives higher yield and usually higher quality of the tar. At ugnsbränning, some tar remain in the coals and the retort can tar the chance to decompose. Dalbränd tar sorted in three quality ether; *prime (* fluid, fradgar at pouring, must not be gritty) *-prime (* somewhat thicker, can be gritty) and *tertiary (* rough tar, very grainy). The charcoal production is tar is a byproduct, and the main product is charcoal.





Examples of two types of active charcoal. Illustration: Källbom after Bolin 1940th



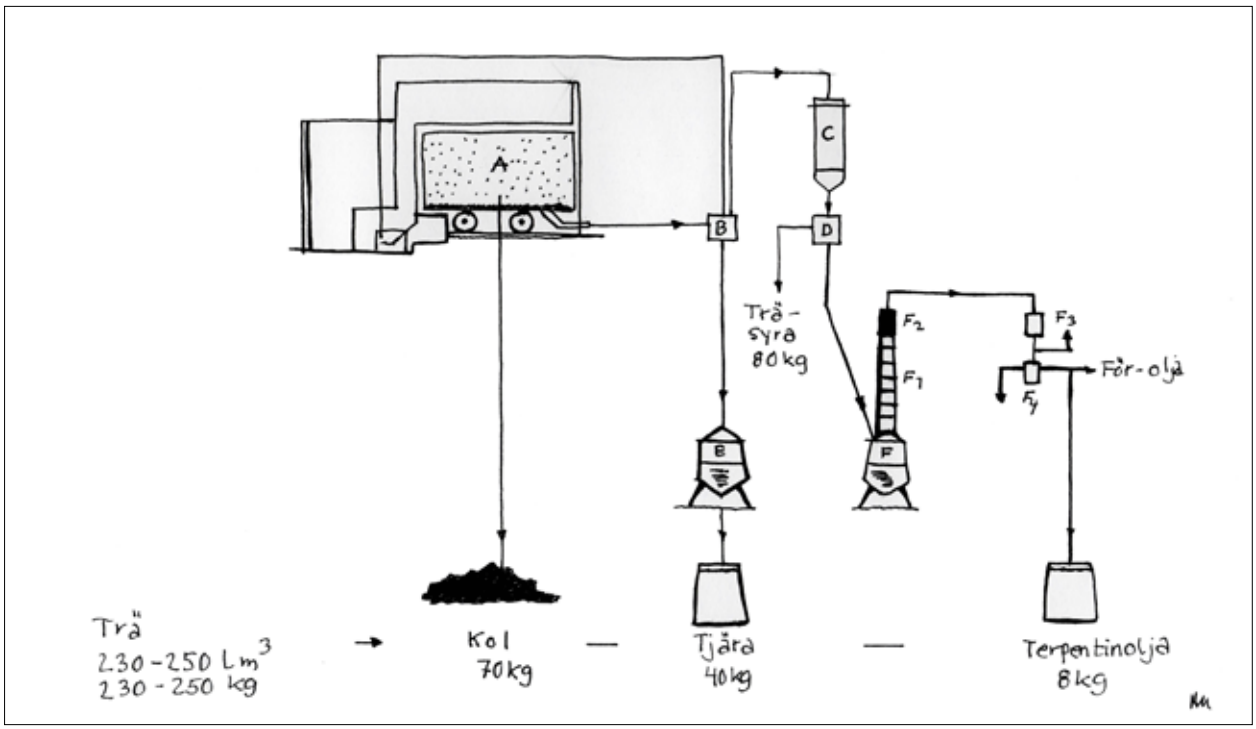


Examples of tjärgropar. Illustration: Källbom after Kurzwell & Todlenhaupt 1981/1989.

The turf-covered Tjärdalen lit throughout, 1930. Photo: Eino Nikila, National Board of Antiquities picture collection.

Tjärgropen has no spout instead collected in the tar pit (Hennius, 2005). Tjärrännan consists of a trench dug into the hillside. The depth can be up to one and a half meters and width can be any more but tapered down towards the bottom, the length varied as required. The trench lowest end dig a pit in which a container is placed. The trench covered with birch bark or bark and the customs office of destination packed into. Combustion takes place from chute highest section and by supplying air to get the valley to burn down the gutter and tar to drain into the vessel. Gutters also called *Burial gear, blow graves, bläxgravar* or *tjärdiken (* Shenet, 2014).

The technology of burning tar in tjärränna has been in use in Scania, Halland, southwestern Småland and west Blekinge well into the 1800s (Hennius, 2005). It is questionable that tjärrännan would have been abandoned in favor of tjärgropar and tar, to increase efficiency. Instead, we should see the techniques traditions that existed in parallel in different areas. Excavations in Uppland partly foiled earlier perceptions of tjärframställningens development of open tjärrännor to the tar pits. On a local were three different production principles combined in the same plant, and the last was a tjärränna. Production is believed to have been sold. The method consisted of a closed funnel-shaped pit was packed with töreved and tar poured into a vessel at the bottom. The tar was produced with a direct method, and as a raw material in production the pine and spruce with an age between 30 and 50 years. The use of snags and tjärstubbar seems to have been very limited. In Norway and in a few places in western Sweden are examples of the so-called tjärmyrmilan (Hennius, 2005). It is a variant of tjärgropen with the difference that it was placed in a bog for tar would drip down into the seepage water. Because the ground is waterlogged sucks almost no tar, which can be collected when Milan burned out and demolished. The tar had better quality due to the rapidly cooled and layered in the water. The water is prevented from tar to catch fire if it would get too much air in Milan at the end of the process.



Process steps in the dry distillation of vagnsretort. A retort B Tjärsluss c: Radiator, D: Separator E: water separator, F1-F2 distillation of turpentine oil, F3: Radiator, F4: Separator. L m = 3 Lösvolym in cubic meters. Illustration Källbom by Bergstrom, 1947 (Self-Berg, 2003).

6.4. Industrial Production Methods

principles

There are numerous types of industrial production. Common to the raw material / biomass is placed in a metallic container / retorts that are not in direct contact with the heat source as in a kiln. There are also ovens, where process heat is taken from the raw material. In industrial production is The relationship procedures controlled and reproducible. When the wood is distilled industrially, all distillates condensed race depending on the boiling point ie turpentine, tjärfrak-organizations and residues pitch. (Self Berg, 2003). A large number of different types of furnaces and retorts user des, with emphasis on the latter.

Characteristic of ugnstjära from Tore (A-tar) is the high content of resin acids, and hydrocarbons with a high boiling point (300-380 ° C) (formed by the decomposition of resin acids) (Tideström, 1957). Upon heating converted to resin acids, abietic acid and other relatively heat resistant resin acids. At ca. 300 ° C split off carbon dioxide and the liquid hydrocarbon abieten, at about 330 ° C, also carbon monoxide and water and liquid abieten. In strong overheating departing hydrocarbons and the solid retention hydrocarbon formed. Reten has a melting point of about 99.5-100 ° C. Reten considered to be an explanation for granularity / "tjärtalg" of the third-class tar decomposition products of resin acids (overheating of as rosin) (Self Berg, 2003). B-tar is water soluble and is formed primarily of wood cellulose and hemicellulose (Tideström, 1957). It contains highly oxygen-containing compounds as aldehydes, acetals, lactones, furan, etc. which is highly reactive and forms on heating water insoluble products.

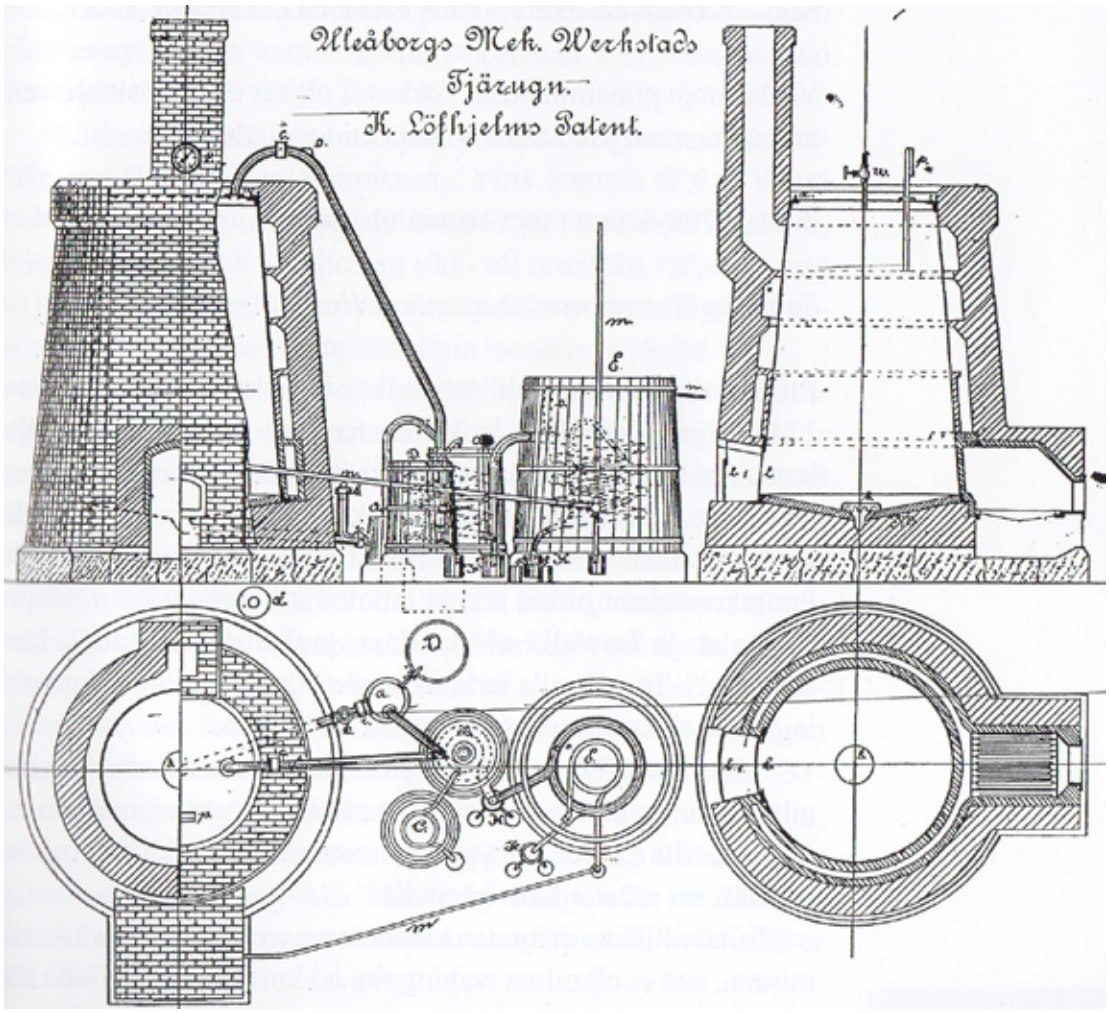
TABLE 9: TYPICAL COMPOSITION OF STUBBUGNSTJÄRA (A-TAR) FROM VAGNRETORT (Tideström, 1957)

Specification	%
Under 300 ° C boiling constituents	
water	2.2
Acetic acid, butyric acid, etc., water-soluble volatile acids	1.7
Trätjärefenoler:	
Pyrokatein, kreosoler et al free phenols	0.2
Gujakol, cresol, etc., acid phenol ethers, bp substantially 200-240 ° C	3.5
Ugnsterpentinfraktion:	
Terpenes, bensolkolväten, neutral phenol ethers etc., bp 150-200 ° C	2.8
Terpineolfraktion, bp substantially 200-250 ° C	1.4
Over 300 ° C boiling constituents	
Unsaponifiable, mainly hydrocarbons such abieten, abietic, retention, hydroretener Resin acids	42.2
	24.8
Fatty acids and other readily esterified oxyacids acids etc. in	7.9
petroleum ether insoluble, acid components lignin-like solid,	8.8
insoluble in ethyl ether and coal char water soluble tar (tar B)	3.9
inorganic constituents (ash)	0.1
	0.4
	0.1

significant differences between the B-tar from softwood or hardwood. It is sometimes mixed A- and B-tar during heating in order to get a good wood coatings. Under unfavorable circumstances could the water is separated into a product similar to one dewatered industrial (Bergström, 1950). Table 9 shows typical composition of stubbugnstjära (A-tar) - of charring - vagnretort from the 1950s (Tideström, 1957). A tar is used primarily for wood protection (Shenet, 2014). Further processing of the wood acid gave 50% B tar, used inter alia to the fuel.

Trätjärefenoler and acid phenol ethers formed primarily from wood lignin / stem wood (Tideström, 1957). Barrvedstjära contains substantially dihydric phenols and their ethers while lövvedstjära further comprise holding trihydric phenols and their ethers. Phenols have disinfectant properties and protects the wood against rot. Some of the phenols prevent the oxidation and resinification, and included, among other things in creosote (Tideström, 1957) (Self Berg, 2003).

Vacuum distillation of wood tar applied lesser extent (Bergström, 1950). You could get the distillate and hard pitch. At vakuumtorr-distillation (distillation VT) prepared by the ICU in 1929 reached 450 ° C and 90% yield. The tar is said to have bright color, high resin acid content and good drying properties. The high overhead fraction (from completely calm tar) is qualitatively Tore tar close. Separation of tar water on a large scale could be



Examples of a masonry tjärugn from Oulu mechanical workshop. from: *The technician magazine,* 1893 (Kaila, 2007).

problematic. The condensate contains many chemical compounds that are soluble in both tar and pyrolignous acid as the advantages in its on uncontrollable way and emulsification (Wahlberg, 1958). They used replacement cut with indirect heating and when filled flows easier tjärsyra and tung additional reservoirs. The digester is heated to about 80 ° C with stirring whereupon tar "sets", i.e. wood acid and tjärvattnet further separated. Tjärvattnet interfering in this process at the bottom due to its higher density (the tar has therefore density below 1). They used tanks with valves at the bottom and at different altitudes. If you still had problems with separation, which could make such if moss stumps or very dry stumps used, were added a salt solution e.g. road salt. You could also clean fractions were too

themselves and confuse the last (Bergström, 1950). Tjärvattenmängden after purification was not to exceed 15%, preferably not 10%. The water purified tar was sold directly to träbestrykningsmedel and called rubber tar.

brick kilns

Engineering Eichinger presented in 1893 a tjärugn as shown above, and stated that the tar, turpentine, pyrolignous acid (acetic acid and wood alcohol) and charcoal extracted in the process (Kaila, 2007). When the temperature in the oven is about 100 ° C released water vapor and turpentine. Turpentine is bright and pleasant, aromatic odor. At 250 ° C, there is a violent reaction in the furnace; of tar and darkens turpentine, water acidity is about 5%. After 270 ° C decreases the acidity of the water. Wooden acid is passed through lime water.

A similar tjärugn in Oulu MV is preserved in Swedish Axmars mill in Sweden (Björk, 2013). It is unfortunately not in good enough condition to be used again. In Fyrilen, Norrlanda Gotland is tjärugnar left, and production ceased in the mid-1900s (Malmros, 2014). In Nivala Museum is a brick oven that can be used as a model for possible. reconstructing tjärugnar (Nylund 2014).

Lingbo furnace used frequently during the 1900's (also called Ramén furnace) and is a further development of Tjärdalen (Wahlberg, 1958) (Bergström, 1950). The furnace used for the large scale production of both charcoal and tar. It is a method of direct heat supply. The yield of 30 kg tar / m 3 stubbved i.e. ca. 2/3 of the yield retort. Turpentine Oil is also obtained from tjärtillverkning retort (Kaila, 2007). In Wahlberg's source are a large number of kilns and retorts described.

Pelarne church vimmerby. Photo:
Arja Källbom.

7. Characterization of TAR

7.1. science analysis methods

Combined gas chromatography and mass spektrometeri (GC-MS) can be used to analyze both historical and fresh substances e.g. tjärproduk- best (Self Berg, 2003). A known composition is a reference sample, a kind fingeravtyck. The method is useful even when very small specimens, quality residually and quantified. It can be difficult to compare solid (historical) and liquid samples with each other. It is possible to determine from which species the tar is produced, and the nature of such pine (Pinus sylvestris). It is possible to distinguish different tar fractions made both in kilns and ovens. If only small amounts of resin acid can be identified and no

called abietisk acid, so it is likely to be the furnace produced tar. Large amounts abietisk acid gives a high probability that there is an early fraction dalbränd tar. Commercial resins may have tillsatter of various drying oils such as linseed oil which can be detected by GC-MS as the levels of fatty acids characteristic when radically increases. The addition is made to shorten the drying time, which of course can be quite long in a whimsical Nordic climate. Spectroscopic methods can also view the metallic elements. Attraction instruments, temperature, temperature range, sample preparation, etc. derivatization may affect the analysis result and it may be difficult to compare samples from different laboratories and occasions. Comparing to different references, "fingerprint"

which must be available even for aged materials if you compare older tests. Initial characteristics can be detected even after väderpåver- can.

On analysis of tars distil often water vapor at standard atmospheric pressure, which divides the tar of the three essential ingredients in the treatment of solvent-1; volatile portion, 2; water soluble portion, 3; their water ug / nonvolatile part (because tar) (Tideström, 1957). In Töre tar tar is due almost entirely soluble in petroleum ether, the stamvedsstjäror softwood partially soluble in petroleum ether, but for the most part soluble in ethyl ether. Because tar from lövvedsstjäror, especially boktjära, is barely soluble even in ethyl ether. Density can be determined by a so-called

Pycnometer (Self Berg, 2003). Viscosity can be measured with special *viscometers*. Determination of volatiles can be done by relative weight measurements at heating in the oven, with well-defined and tar sands. During World War II, did Skoljab (Forest owners Oil AB) some research on coal and tjärproduktion in Sweden (Wahlberg, 1958). It did, among other things Chemical analyzes of raw materials and tar, its purification, oxidation, etc. which is described in Wahlbergs source. There is such test equipment for the determination of moisture and density. They did some research at Lund University, Department of Chemistry (headed by KJ Kärrman). Empirical tests were also produced. For example. viscosity was determined as follows: A beer bottle

was filled with tar, when it was 20 ° C (important) inverted bottle upside down whereupon the time taken in seconds until the tar drained. Time is a measure of the tar viscosity. In Finland, were extensively tjärforskning (Koskinen, 2003).

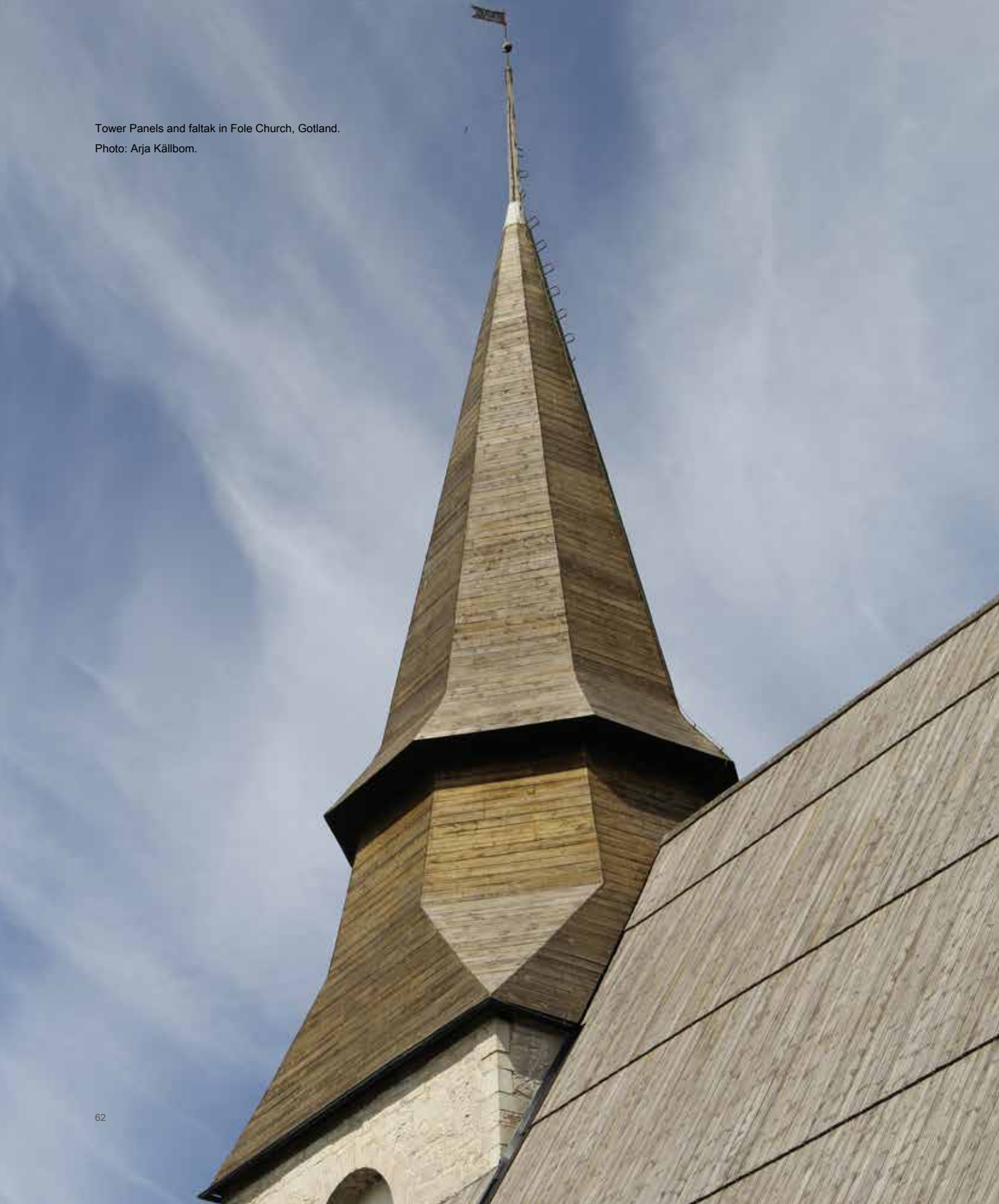
7.2. empirical methods

Today is uppstrykningsprov of tar on wood for assessing color, fragrance, penetration and film forming ability, gloss, drying ability, if necessary. granularity, moisture (Claesson, 2014). See National Heritage ministry publications *Nurture well.*

"Tar extracted from the stems and roots of coniferous trees like pine (pinus sylvestris), Mediterranean pine (Pinus pinaster), spruce (Picea exelsa), Siberian larch (Larix sibirica). A brown-black, viscous and stiff liquid. The thin layer is the transparent, reddish-brown or yellowish-red. Tar has a typical odor and bitter taste. its specific gravity greater than 1. it is dissolved in ethyl alcohol, chloroform, benzene as well as in many volatile and oils. For the most part it is soluble in ether, sprites and kolbisulfid to a minimum dre part soluble in water. When some tar is added to 10 parts of hot water, shaken vigorously for 5 minutes and filtered, then the liquid smell and taste as tar, be light yellow and acidic. it reduces silver nitrate liquid containing ammonium. When a drop järnklorid- weak solution is added, this liquid will be the first brownish green but rapidly converted to maroon. 1 g of tar should be dissolved almost completely in 5 ml of alcohol and filtered liquid obtained should be pinkish yellow and weakly fluorescent. When the vaporized from a glass sheet remains a brown film (coal tar). Combustion ashes of tar should not exceed 1%. "

Characterization of tar in *Pharmacopea Fennica,* State Finnish printing 1937th

Two young women at the burning tar 1898. Photo: IK Inha, National Board of Antiquities picture collection.



Tower Panels and faltak in Fole Church, Gotland.
Photo: Arja Källbom.

8. current situation

8.1. ACTIONS TO RECYCLE knowledge

The Nordic countries have lost the skills and traditions tjärområdet, during a time when such coal tar and creosote was used, at the expense of older tjärtyper. Some knowledge has been withdrawn, for example, by theses in Norway and Finland (Self Roller Pihkala). It has also carried out various projects interventions.

The world's largest tar pit built

Finland has nearly 300 churches and bell towers of tarred rod turnings. Production in Finland ended roughly around 1940, to be resumed in the 1980s (Tjärseminarium 2011). The traditional knowledge in Finland was extinct in 1989 but has regained knowledge and active tjärbrännare through several projects initiated by the National Board of Antiquities (Pihkala, 1998). Between 1997-2000 took place Kainuu tjärprojekt Kainuu to take back the knowledge, boost local manufacturing and use of tar, creating local activities in tourism, handicraft and building traditions (Toivari, 2003) (Cavén, 2003). A tar centers were set up where users can buy controlled, high-quality Finnish tar. The remnants of the country's last tjärfabrik Hyrynsalmi was restored and became a tourist destination.

Kuhmo 100 anniversary in 2000. 45,000 liters produced, be 37 000 liters of prime quality. It went to 1100 m 3 trees (Kymäräinen, 2003). Some were sold to other Nordic countries. The project also resulted in ca. 10 employed in Kainuu now-professional production of tar, either in part or as the main job. As a raw material mainly stumps and trees attacked by rust dare catheter. The acquisition of tar wood is one of the biggest practical problems of tar. Therefore, they develop methods to utilize thinning forests in the forestry industry (Cavén, 2003).

Rebuttal of the EU Biocidal Products Directive

The EU Biodirektiv 98/8 / EC stipulated that all träbevarande funds should be evaluated and taken off the market, including pine tar (Braunschweiler,
2003). It was felt that the pitch was a substance that inhibits fungal growth in the wood, as a biocide and fungicide. The use of tar for example, Ski waxing and condiments were outside the Directive. Finland claimed that trätjärans protective ability depends on its water repellency. To prove that tar works by preventing the wood from absorbing water (by blocking the wood cells), founded in laboratory tests in a climate chamber with mushrooms at VTT in 1982 (Kaila, 2003). The tests showed

Clearly, tarring not affect fungal growth, which creosote do. The layer of tar will be a difference for the life as it prevents the surface breaks down, so it is important to build and maintain a thick layer through the regular application of the new tar.

The oldest Finnish tarred wood fragments derived from the 1400s, and there is no other material can replace tar. In Finland about 300 churches with tarred roof shows a calculation of the costs of replacing the roof with other materials would cost about 160 million Euro.

The EU directive made an exception without time limit the use of pine tar on the cultural and historical buildings and other traditional uses (eg wooden boats), with reference to display the long tradition they have of tar in Finland (Pihkala, 2009). Even in Sweden made successful efforts in order to remove tar from the EU directive's list (Ehrenmalm, 2006), among others in cooperation with the National Heritage Board and the Swedish Chemicals Agency.

Tar Norwegian stave churches

Inger-Marie Self's doctorate in 2003 for tar Norwegian stave churches, and she has extensively researched tjärors qualities. Her tests show that the tar density and water tends to increase at the end of the process (Self Berg, 2003). The viscosity has connection with the production temperature, which varies. Granularity (which disappears during subsequent heating) tends to occur in the first production step when the temperature is low - the boat builders referred to as good tar. Grain, which did not disappear during later heating, resulting in the end of the process as well. It is uneven in particle size and dark. Of tjärbränna-'re called for contaminated or overheated tar. Tar products of different quality and characteristics are taken into different factions during the firing process.

TABLE 10:
EXAMPLES OF HIGH QUALITY NORWEGIAN TAR (own mountain, 2003)

Specification	Unit
Specific Gravity Percent volatile shares	From 1.03 to 1.07 g / ml
Proportion of water-soluble components	8-18% 2-6% 990-9160
viscosity tar should be homogeneous, with no visible content of water	mm^2 / s

Norwegian Society for the Preservation of Ancient Norwegian Monuments administers a tjärbank of cultural and historical buildings to the National Heritage Board, and annually purchases 3000-4000 liters of tar from regular suppliers (Thorne, 2014). The amount is enough for the need to tar the 28 stave churches. New suppliers are tested by NIKU. They have a number of regular suppliers and they sort out the tar in barrels for the Norwegian quality classes. In Norway, there are three grades of tar (Self Berg, 2003). Norwegian standard NSF in 1937 also describes the classes. Class 1 has a low viscosity, light color, is homogeneous without grain, tar water or pyrolignous acid. The second class will be light but can be more viscous (thicker), and grainy. Third and worst class is darker and has a higher viscosity, also known as grain.

Norway has a production stage called boiling down (National Heritage Board, Tjärseminarium,
2011). This refers to simmer near the boiling point. The aim is to homogenize the various tar fractions, increasing the concentration of resins and prepolymerizing the same way as is done with linseed oil. Prima tar need less degree of simmering than the later fractions of tar. Table 11 is compiled by results and observations, mainly from Self's work.

TABLE 11: principle between DALBRÄND tar and UGNSTJÄRA (own roller, 2003)

Dalbränd tar of prime quality	Ugnstjära
brighter	darker
More aromatic fragrance	Less aromatic / sharper scent more
more film forming Dries	penetrating Dries slower
faster	
Hart Richer. May cause graininess	More polyaromatic hydrocarbons, risk of decomposition of carboxylic acids to phenols of process temperature is too high (decomposition products may cause graininess). Although the decomposition of hydrogen. Higher process temperatures Shorter production cycle more heterogeneous raw materials, lower resin content of greater reproducibility and more consistent quality. redistillation
Lower process temperature	
longer production cycle	
For more homogenous feedstock with a higher resin content quality	
varies more with different batches	

Regarding density vs. production, there are no clear answers in the sources.

1. Tar from different fractions / process provides various hot the strength and longevity.

a. Early fractions (viscous and grainy) is more weather-resistant. These fractions occurs about 1/3 into the production cycle (tar). The grains are resin, melting at 40-50 ° C and must also melt when rubbed between the fingers.

b. Early fractions containing high content of abietisk acid, and is most similar to the pure resin, rosin.

c. Depending on the fraction varies properties as viscosity, granularity, water-soluble parts, color, luster, density, volatile substances, high aromatic moieties. Tar is a heterogeneous product both in each production batch and between batches.

2. The boiling / simmering affects the lifetime due to greater viscosity and adhesion of tar thicker.

a. Temperatures below 200 ° C vaporizes the volatile components and concentrating fatty acids and resins, which is positive to form a protective film.

b. Simmer provides higher viscosity. The thicker the film the tar can form the better the life point of view.

3. Träkvaliteteten, stavspånens quality, affecting tar life.

a. High proportion of heartwood film improves weather resistance.

b. Splint is more fibrous and sucks more tar. Simmering can not compensate for poor wood quality. Worst combination is porous surfaces and tar from late fractions.

longtime faltak

What's up today

Gotland has a long tradition of burning tar to use tar to church roof and secular buildings, mainly brädtak called faltak but to some extent also shingled roof with sawn shavings. Information in this section comes from the ancient buildings which are Par Malmros and architect January Utas.

Since 2009, in connection with the extensive tjärstrykningar carried out annually on Gotland church ceilings made practical tests with different pitches and treatment. In the first place, it brädtak as tjärstryks but there are also some shingle roof. Gotland is trying to have a rolling basis so that all the ceilings highlighted in the six-year cycles.

In essence, it is now two types of roofing that tjärstryks on Gotland churches. In the long house, cows and sacristies is faltak. In the tower, the tower panels (boards horizontally mounted in a bearing which is chamfered at the edges so that the water is conducted out of the board).

Tower panels are mainly made in the traditional way without the suspended ceiling and it works well because the slope is so steep. At bottom, however, the tower take on the flatter parts (triangles in the four corners) reinforced with a ceiling because it has been difficult to obtain structures that operate in these areas. Since the 1960s, uses the ecclesiastical buildings a faltakskonstruktion with a layer falor mounted on battens on a tight ceiling with cardboard. The traditional brädtaken is difficult to completely seal and they require regular maintenance to work well. Since there are large interior values to be protected in the churches, and the lack of resources for regular monitoring has chosen this compromise. It uses the best wood going to come by; Winter-felled pine heartwood with life expectancy of 40-60 years - with proper maintenance. The question has come up whether the new, revised design influences roofs and tjärstrykningens life. In cases faltaken the rot is usually in places where the wood is in contact with each other inter alia against the battens. Otherwise, it is primarily ytvedsvirket damaged by rot. It has also seen the north side, where the trees stand close and shadows ceilings, it has an impact with more rot than churches that do not have that relationship. The greatest harm caused sunlight on woodwork, and normally it is more frequent maintenance intervals on the south side.

constructions

Gotland has lost three types of brädtakskonstruktioner (Utas 1984). On the steeple, a tower overhead panel in a warehouse. The boards' edges were traditionally carved carved, today diagonally cut so that the water is led out of the structure. The second type of brädtak is "faltaket". Here, there have been two parallel structures. The first construct, as used initially in kyrktakens nave, cows and sacristies probably dates from early medieval, a combination with the above described panel tower. In the first layer boards, a tower overhead panel nailed to the rafters. The second layer boards mounted above and attached to the bottom layer. There are two church roof preserved with original design and it is in Rute and Fleringe churches. The second design faltak have two coats standing boards plugged into a ridge stock and fixed to the bottom edge with nails or dowels. In the latter case, the boards lie in the tension to be fairly tight, which is not needed in the first case. Possibly faltaket with two layers of boards of bucks a recent construction that could be associated with ramsågens introduction of Gotland during the 1500s and 1600s (Utas 1984). There are several preserved faltak of the recent construction on the island, mainly in secular buildings. Possibly faltaket with two layers of boards of bucks a recent construction that could be associated with ramsågens introduction of Gotland during the 1500s and 1600s (Utas 1984). There are several preserved faltak of the recent construction on the island, mainly in secular buildings. Possibly faltaket with two layers of boards of bucks a recent construction that could be associated with ramsågens introduction of Gotland during the 1500s and 1600s (Utas 1984). There are several preserved faltak of the recent construction on the island, mainly in secular buildings.

tarring

They have tried various methods of application of pine tar on the longtime faltaken; brush, roller and spray. The tower roofs are the main roles used. For long rooftops and kortak used roles and syringe. The tars are heated to about 50 ° C before being taken on. It has also tried to use locally produced

Byggnadshyttans stores in June 2014. Photo: Arja Källbom.

South of roof on Fole parish magazine. Photo: Arja Källbom. Testtak at

detail of the roof of Byggnadshyttans storage. Photo: Arja Källbom.

conditioned dalbrända tars. Since it is difficult to control the process and there are usually local history societies who do the work voluntarily differs kvaliteérna much. To the longtime wood tar used 30-40 years old stumps. A good pitch with high quality is a light tar mainly extracted during the process first half. The first tar of the beginning of the process is light and thin liquid (used for medical purposes) and secondly the lighter, thicker used today to ceiling. The bright thick tar corresponding primary tar. Next comes the somewhat darker and more fluid, and finally, the darkest tar. The tar is not sorted in different classes. Tjärvattnet sink to the bottom and can be drained after about 3 weeks. However, we know nothing about the tar traditionally used to tjärstryka ceilings. There are craftsmen in the island that claims it used tjärvattnet for the treatment of wooden surfaces. There are many opinions on how to do and it is not considered how it was traditionally.

They have also tried the Finnish approach to tjärstryka autumn. It seems to be formed more "paint surface" compared with the conventional method, i.e. tjärstryka during the summer, and Finnish method appears to provide more lasting results. One can also see that a locally produced dalbränd tar, high quality is better than the Chinese tars. On tjärstrykarens initiative has tjärstrukit the most dried-up taken twice with a couple of weeks. It also seems to have given good results. Gotland consumed about 6 m 3 tar annually. It is not possible to local produce as much tar, nor affordable. A locally produced tar costs about three times as much as the Chinese tars.

In the current state paid 60-100 kr per liter, for locally produced tar in tar so it is mainly only possible to extract tar on a voluntary basis by local history societies do it if time and desire. Should a company make a living at it, it is likely that the tar would have cost at least 200 per liter, as in Norway. In the current situation islanders decided to continue with the Chinese tars on roof surfaces as they are some original designs.

However, one strategy is to use a dalbränd Gotland tar on the original designs that door leaf, trävirken the facade mm, provided that they get locally produced tar. The tar is burnt in tar on the island each year (about 2-3 pieces) are already sold before it is manufactured. Each Sojde provide between 300-500 liters tar.

Between 2009 and 2011, started practical tests on takfallen on Fole parish magazine but also a testtak at Byggnadshyttans storage (Malmros, 2009) (Malmros, 2011). While 2010 was conducted two smaller tests both trail the door of the Linde where the tar was applied according to the Finnish recommendations, and the church roof in Othem that role was instead of injected. Faltaket on Fole parish magazine was laid in 2003 and streaked then once with tar. The roof is made of a single layer falor atop a dense boarding and paperboard. On the north and south side was started in 2009 a number full-scale tests with different pitches and the application methods (roller or brush / brush). Southern roof pitch western part shaded during part of the day of the tower and then became a major reference. A reference has been made on both takfallen. They tried tars are

Pine tar TA / TB from forest Carbon (ugnstillverkad), *A Pine Tar* from Claessons tar (ugnstillverkad) and *Gotlandic dalbränd tar.*

Pine tar TA / TB containing 70% pine tar residue lövvedstjära. Pine Tar A and the longtime tar contains furustubbvedsträtjära. During a visit in June 2014 revealed that different application methods are not affected earnings. All south faces look almost equal out, and there are visible traces of tar. It was observed that the twigs and kådanrikningar tar is left indicating that a resinous substrate affects the lifetime. Tars had accumulated that drops at the bottom of it all end grain, which shows that it drained. In the north area are tars remain, even those with drops and growth of lichens. Tests with tar on the path cover on Linde church was made according to the recommendations of the National Board of Antiquities in Finland in autumn 2010 (Malmros, 2003). Gotland dalbränd pine tar brushed and role was on. Briefly, the recommendations to: 1; using dalbränd

pine stump tar of good quality, stored for a year so that tjärvattnet be separated. 2; To tjärstrykning made in the spring before the leaves turned out or in the fall when the leaves have fallen off. 3; Dry basis, tar is heated to 45 ° C maximum (otherwise vaporize some ingredients). 4; Apply braking with roller or spray, but the surface should always brush stressed after application. 5; Intervals of 5 years on the south side, and 10 years on the north side. The roof is not as carefully researched yet, but it is difficult to see any difference on the surfaces, according Malmros. Test roof at Byggnadshyttans storage has a 45 degree slope in full sun in the south. Falorna (6 inch) are mounted on top of dense healed boarding and paperboard (undersides are also tarred). Tars tested is *A Pine Tar* and dalbränd *Tar New (* Claessons pine tar), *Genuine wood tar 850 (* Auson), *dalfärdad the Gotland tar* and *Stig Björklund rödtjära* according Leksandsmo- model, together with reference faces. They also tested pine tar A with 30% of linseed oil. Application methods, roles, spray and brush. The tars has been heated to 60 ° C and application was conducted in June in alternated weather (sunny / cloudy). They also tested the application with Finnish method, with the application of tar in October. Half of the boards is tjärstukna underneath. The reason is that they wanted to examine whether it could reduce rot grips the contact area,

i.e. where falorna are attached to the battens.

During the visit in June 2014 revealed that applicatory methods not affected the results. However, it seems the longtime dalbrända tar have fared somewhat better. There are also signs that the Finnish model is beneficial. One can clearly see that the tar flowed in falornas scoring. Rödfärgspigmenten still remain on the surface. The ridge board, which could show the starting position for all variants, unfortunately, was gone.

Malmros has been in contact with Inger-Marie Self Mountains surrounding the longtime efforts, and she says that it is difficult to compare different makes of tars because the reproducibility varies widely (Malmros, 2011). Imported tar can sometimes called dalbränd, in good faith. Commercial tars can contain added fungicides, solvents and drying oils. She therefore proposes that tested tars also characterized e.g. by GC-MS, measurement of water soluble constituents, volatiles and the specific gravity and viscosity and homogeneity. Such methods have been developed in Norway.

8.2. current materials and access

Norway and Finland are now self-sufficient in tar for their cultural needs (National Heritage Board, 2011). A small production on a voluntary basis is sufficient for the needs, and they are prepared to pay a liter price of 200 NOK. Norway has a materials bank and tjärbrännare. Norwegian Fortidsminnes- compound buys and sells tar to parishes and individuals (Pihkala, 1998). In Finland there are currently several active tjärtillverkningsföretag and about 20-30 m 3 tar produced annually (Braunschweiler, 2003). In Denmark there is no production of tar. In Sweden, small domestic tjärtillverkning of historical buildings. The facilities available are demonstration plants on a voluntary basis (Björk, 2013). Tar of unknown variety and quality are imported from different countries. Just Gotland is the need for tar 6m 3 annually (Riksantikvarieämbetet, 2011). It is estimated that the annual requirement for church ceilings in Sweden is about 22-23 m 3 (Björk, 2013).

In Sweden currently imported a total of 540 tons of tar annually (National Heritage Board, 2011). Claesson's tar tar imports from Europe including from Serbia. It is similar to the Swedish, light and aromatic (Claesson, 2014). The burned by an indirect method, in the oven, and the raw material is old pine stumps. A firing takes a day, and provides a barrel (200 liters). They also import a Chinese pine tar, which burned with a method similar to the tar pit (but taking place in a slope with motvägg). It is not the pine Pinus sylvestris, and it is not as athletic aroma. Claessons also supplies small quantities of Swedish dalbränd pine tar. Other Swedish importers are Auson AB and FC Sweden. It is in the current situation is not known where their tar is produced, and how.

KILN BURNED PINE TAR CBT

CBT is produced according to the old kiln method from stumps of the pine tree Pinus Silvestris. Also known as peasant-made take. CBT has a high resin content (rosin acids and retene), low content of pitch and high purity, ie free from soot and other impurities. CBT is used for wood preservation in Those cases where additional high performance in respect of color and quality is requied. CBT is evan used for vetenary and especially pharmaceutical Purposes.

Technical data:

Specific gravity (density) at 20 ° C	1.03 to 1.06
Viscosity at 50 ° C	120-200 cps
odor	Aromatic pine takes
color	dark golden brown
Water content	Max 0.45%
volatile matter	Max 5.6%
Ash content	Max 0.46%
volatile acids (acetic acid)	Max 0.21%
Mechanical impurities	None
PH concentrate	3-4
Boiling point	200-400 ° C
Flashpoint	130 ° C
Reaction with Ca (OH) 2	Positive
solubility	Gum turpentine or ethanol
Transportation Class	No Dangerous Goods
Helth, milieu and fire class	None
CAS No.	8011-48-1
EC	No. 232-374-8
Customs state. no	38070010
Packing	New metal drums 200 kg net
Registration number in REACH	05-2116101461-65-000

Data for the Fc Sweden dalbrända pine tar from their website.

8.3. Job Descriptions

Gulf procedures

Ceiling

In Finland tar to stavspåntak of pine shavings, sometimes aspen, the churches and bell towers (Pihkala, 2009). Ca. 290 religious buildings (churches and bell towers) has been tarred stavspånstak. In Karelia there is a tradition of aspen wafers and today is asp in 50 buildings. Asp gray and similar to silver after a while. The wood, however, has a relatively short life. Since the 1970s, used primarily sawed chips in Finland because it is hard to get hold of Straight-grained resin-rich pine, but trying to gradually move to split shingles.

It also specifies that only birch bark is suitable as a basis, everything else will be too tight. There are also old roof with no ceiling. (Pihkala, 2009). Fyrlagerstäckning tend to be too dense and rots soon as the Finnish experience. The majority of churches have two-layer coverage. It is important to ensure that vegetation does not impede air circulation and drying. Life of stavspånstak quality is about 50 years, and as the best of 200 years. Without tar, it is impossible to achieve these lifetimes.

Artificially dried (oven dry) wood is of unknown cause difficult to tar and similar pressure-treated lumber (Pihkala, 2003). Quickly dried and completely fresh chips tend to be difficult to treat with tar. The particles also tend to crack, thus shortening its life. How much tar consumed by tarring of the pole chip is a measure of the substrate quality (Pihkala, 2009). If consumption exceeds 1 kg / m 2 considered the timber to be of poor quality.

Tar

The Finnish recommendations are only inside the home clean dalbränd pine tar is used (Cavén, 2010). The high-quality tar called "täysterva," or full of tar / heltjära, and its function is to form a protective film on the surface of the wood. Tar function is not considered to only saturate the wood without protecting wood surface against weather exposure and degradation / erosion by film formation. It will prevent the wood moistened and thereby prevent fungal attack. Older buildings often tarred, so that a thick coating was built up on the surface (Kaila, 2003). Protective film characterized by krokodilskinns- like, flaky appearance of the chip and the rod is built up by frequent spring and hösttjärning (Pihkala,

2009). When the film well built can tjärningsinter- embankment increases, especially for the north side. Omtjärnings- interval occurs on the south side every 3-5 year intervals, the north side every 10 years.

It is important to ascertain the tar origin and commodities, because it happens that the burner mix of deciduous trees (Cavén, 2010). It is also important to know if the tar is fresh or stored. pine tar

can be stored / age / thickened by allowing it to stand in an open vessel for at least one year. The Finnish view is that additives such as tar pigments are not considered to serve no purpose. They do not tar keeps better / longer. What lies behind these experiences is currently unknown. Kaila've shown that it has been common. It must not be thinned or diluted with other tars and oils.

In Finland, the experience that ugnstjära not as good as dalbränd tar stavspåntak (Pihkala,
1998). It has resumed way to ring bark of young pine trees to stimulate the resin production.

Season

In Finland, the tradition of the roof should tarred either in the fall when the leaves have fallen off or early spring (Kaila, 2003). The same applies to boats that tarred early spring and where thaw and cool nights allow the tar accumulates in the bottom of the boat. Hot days on the tarred roof makes the wood each cavity is filled with tar, which is thermo-plastically. For each tjärbehandling surface becomes darker and loses its transparency, it resembles mahogany. With yet more layers will tjärytan dark and klumplik. The same treatment as in Sweden called *Roslag Mahogany*

also traditionally made each year by the Finnish sailors. In Tennessee Ostrobothnia tarred roof during the spring period, set at 27.3-20.5 before the leaves come on the trees. Autumn Tarn mixture time is 4.9-30.11, when the leaves have fallen (Cavén, 2010). Consumption during tjärstrykningen of Tennessee church roof calculated to 0.5-1 kg / m 2nd

Application

Kaila recommends annual tarring of the wooden ceiling (empl mountains, 2003). A highlighter with a low viscosity pine tar during the early summer, and a second ironing 2-3 months later with a highly viscous tar. A warehouse full of tar is never enough, you have to repeat the 2-5 deletions in a short time (Pihkala, 1998). A thick tjärlager melts the heat of the sun and fills the wood cracks.

Cavén indicates that the wood surface must be completely dry before tarring, the moisture content below 20% must be applied to the tar and plated by brush (Cavén, 2010).

After rain you have to wait at least a day so that the roof rails. If there is a long shower, you have to wait longer. Or you have to protect the roof from the rain by a tarpaulin. Tarring may not occur during hot weather, as very little of the tar which remains on the roof, but it runs off. Upon application can heat up the tar to 45 ° C, but not after-heater as effective ingredients when vaporized. You have to protect the building at tjärstrykning so that the facade does not discolor. You can use special gutters and downspouts for this.

National Board of tar recommend heating to 40 ° C, coloring occurs spring, or fall at an outside temperature of ca. 10 ° C (National Heritage Board, 2011).

Cavén also states that södertak underlined twice (Caven, 2013). Humidity and temperature is important for the result. Application should preferably be done with a brush, but can be sprayed. It is advantageous to emphasize ceilings early spring with a fresh tar with good penetration and high viscosity. This deletion may also be made at the beginning of August. The warm and sunny weather is not favorable for the result because the key ingredients evaporate and tar oxidizes too quickly. The second coat, with a thick, low viscous tar, takes place in late autumn or next spring. It is important to form a film on the surface of tar tar because the task is not the (only) saturate the wood. Mature crocodile layer develops characteristic pattern on the surface (Pihkala,

1998). When the film is well established, you can tar on less often. Tar not adhere on surfaces previously treated with creosote or coal tar (Pihkala, 2003).

There are examples of how the rod shavings in the early 1800s treated with tar before roofing, (Pihkala, 1998) (Pihkala, 2009). Even in the 1900s delivered some manufacturers tjärdoppade chips. Experience now suggests that tjärdoppning neither improves nor impairs the quality of the chips. New chip is dipped to 2/3 or 3/4 tjärbad in warm (45-60 ° C), and the chips, i.e. top left odoppad stem root end. You still have to pitch despite frequent

dipping. Although wrought spike "disappear" in the curing of tar, which is shown very good corrosion protection and long service life. Some Finnish stavspånstill- manufacturers apply full immersion in closed basins with heated tar especially solid rod turnings, but it has not been shown to shorten the required pond insertion intervals. Rödtjärning sometimes applied, since the early 1900s, to mimic tile roofs, and Kaila believe that the additives thickens and improves tar characteristics. It has not been established, but long experience shows that it either does not degrade tar protection ability. Even sand and graphite have been used to thicken the tar. Rödtjärning of stavspåntak have been made including the Åländska churches; Hyrynsalmi, Jalasjärvi, Kolari, Liminga, Pyhännä and Tornio.

New Finnish experience - Nykarleby shingle roof

Previous recommendations to tjärstryka when it is leafless spring and autumn has basically been abandoned since about 3 years (Nylund, 2014). The tar had a great tendency to run off in the summer. Summer tar is still there after three years on the south side. After 5 years experience gained that everything is gone, regardless avlövningstjärning or summer tar. North sides are almost always fine. In Vammal rebuilt the church after the fire and the first coat was made in 2011, the second coat

2013. It is now starting to brighten the south side. On the south side has tried to stress three times annually for three years, but believes it is too little.

Today tar is heated to about 80-90 ° C with electrical immersion heaters in 200 liter barrels (Nylund, 2014). It warms preferably overnight (at least 5 hours). They see it as beneficial to volatile compounds evaporate and resins concentrated. The construction company Nykarleby shingle roof brush emphasizes and brings 15 liters tin buckets on the roof. A man assists filling device all the time. The tar was kept hot while in the bucket, and the deletion takes about 45 minutes per bucket. Tjärstrykarna follow the sun. The deletion occurs in the summer when it's hot out, for the period

May-Sept. It emphasizes once, but would like to emphasize annually in 5-10 years. That there is a cost issue despite the fact that the life would probably be extended considerably and you would get a surface with more "body". There are requests for testing and recommendation of any independent organization or agency regarding this. One distinguishes three types turnings (Nylund, 2014); 1; ruptured / digested, 2; sawn, 3; sawn and eftertäljd. No one used more in Sweden, while 2 and 3 are used in Finland. He sees that the 1 and 3 have a longer life, and believe that it is for the wood cells and pores closed. The solid rod chips quickly becomes bright again for tarring. It is believed that pre-dip of the chip are advantageous. The chips are greasy and more svårhan- terliga but does not suck as much at penselstryk- up in place and all the edges and bottom tarred too. 3 tar. There is no external pressure is applied, but a kind of gravity when the chips are pushed upwards in the baskets as they want to float up. There are a number tjärtillverkare in Finland including Kuhmo, Saarijärvi and family Hakkalainen (Nylund,

2014). Hakkalainen burned stumps in a valley to a light fragrant tar that is not fractionated. The valley has concrete sides and hood, and it produces ca. 12 m 3 annually.

Swedish procedures

Generally

Decisive for the life of the lake is spåntakens quality and close-grained wood is used, a high proportion of heartwood (Ward, 2008) (Own Berg, 2003). In Sweden, split or sawn rod turnings.

Job Descriptions

General recommendations regarding omtjärnings- range on the south side is often given to five years, but in practice this is often matched by eight years of economic reasons (Björk, 2013). National Heritage Board indicates that the pitch will be emphasized during the summer on well dried wood (see next page).

from General Painting with traditional types of paint (Riksantikvarieämbetet, 1999):

- New rod chips dipped in hot tar and dried thoroughly before they are put up (the National Heritage Board, 1981).
- Ceiling and covering surfaces e.g. the spiers and bell towers have tarred at different intervals, before the wood grain is broken up, wither and grays. Cha-rans resin film leach face fibers and need to be renewed, usually in about five-year intervals - in the south modes may be needed more often.

- Dalbränd tar of good quality should be used, and a liter is enough for about 3 m2 roof.
- Tarring will take place in dry weather in the summer.
- For the tar can be added carbon black or rödfärgs- pigments (give black or reddish tone). Rödtjära can be applied hot or cold. it indicated that the pigments formed into pasta lle turpentine before blending with the tar. For cold application advocates the red dye pigment mixed with the soap in the cold tar.

- Wood tar will be more easy to apply and högpenetre- generating the heated eg in water bath to about 30-50 ° C. A thinner by about 10-15% lacknaf- check / kerosene is acceptable.

- For keeping the tar can be done in such a thin sheet as heated with a gas burner.
- Application is by plafond brush or sprayed.

- On the new material underlined surface liberally 1-2 times and new chips can be dipped in hot tar. The chips will be touch dry before they are posted, and the roof can be tarred again with the chips in place.
- Previous tarred surface checked before omtjärning; tar dissolves easily in white spirit, becomes smeared and smells of tar. it is also possible to remove a piece and ignite. Coal tar is dark, almost black, and smells pungently. it is usually burned into the wood and avfrätt sapwood. Loose debris should be scraped away. the same applies when a tarred surface is brittle, leached or heavily crazed. Lichen, mold and the like scraped off.

The following guidelines have been prepared by the Diocese of Linköping (North Woods, 2008):

- Pine Tar quality should be used.
- The tar can be applied by brushing or spraying. Tar temperature and quality determines the penetrative. To provide good intrusion accession should tar in the application keeping a tem- perature of about 70 ° C.

- Tarn No one should be repeated until full saturation is reached in the wood. This may require up to three applications. An alternative is to pitch more often. the procurement should clarify how many applications the tender.

- If existing chips are colored, any darkening of the tar made by Falun rödfärgs- pigment or carbon black.

- If individual chips need to be replaced, the replacement chips to be as existing chips. This is particularly important if the existing chips are kluv- na, because sawn chips have a shorter lifespan. The chips will be fixed with stainless nails and not harder than they are allowed some movement.

- If larger batches of chips need to be replaced, you should seek consultation with the provincial government to determine if the work is subject to license.

Job Description of Claessons Wood pitch (wood tar Claessons, 2013):

- Entertainment Interval wooden surfaces that are exposed to sun, wind and rain leached at surface and gray, crumbling and cracking. Although tarred surfaces aging in this way. When these events occur, it is time for tjärstrykning. Normal maintenance interval is every 5 years on exposed south and west sides, while the North and ostsidor 10-year interval may be sufficient. In protected mode, longer maintenance intervals occur. Trätjärans resin content replaces the wood's natural resins. Examine the wood quality and possible. damage before tjärstrykningen begins. Possible new wood can advantageously be dipped in hot tar before the set.

- Cleaning Surface cleaned by brushing the surface. Ev. flaking surfaces or surfaces with thick coatings scraped. Pressure washers can be used but require drying of the wood before further treatment. Cleaning tools, brushes, other building components, etc., are made with spirits. White spirit or the like does not solve the wood tar. Pine tar on the skin washed with soap and warm water.

- General Work performed anytime during summer was. surface must be dry. High temperatures, heavy sunshine makes work easier and gives better results. hot tar constant temperature (up to maximum 70 ° C) gives a better result. valley burned pine tar provides better surface protection, dries quickly and provides a more resistant surface than ugnsbrända qualities. An old assessment basis for pine tar is higher quality, the brighter it is. The drying time can vary from one day to several weeks, maybe months, depending on tjärkva- little, external conditions such as temperature, solar, wind, the suction and the layer thickness. usually be tar not be diluted. exceptions can be made for the first coat, then with alcohol or vegetable turpentine, gum turpentine. For better solubility should always be a few percent alcohol added.

- Tjärstrykning normally required 2 coats to obtain consisting surface. Brush gives the best results. Brush should be kind "horns sow", round with relatively long rigid natural fiber bristles. Airless spray can be used but efterstryk- up by brush to be performed. it is always an advantage to work with hot tar. Remember that a tar cools during the work could cause you to gradually emphasize more and more trögfly--making tar, which can provide distinct differences in tone and layer thickness when a new bucket of warm tar begins deleted. Sometimes you can actually see on the surface where it was when the sun rose in clouds. First coat normally go completely into the wood. If the wood is so saturated already the first coat provides a after a few days time remaining surface film, then one coat may be sufficient. Try before starting work. Difference in tar color and viscosity can occur from one emballa- get to the other. Try to continually mix the tar while working to not get big differ- ences in the same area. Shake the cans while the work is in progress. Stir in cans, while Cha-ran is heated and used.

- Materials consumption can be roughly estimated by the following: first coat in dry, absorbent surface, i.e. new dry sawn, or old leached, gives 2-4 m2 / l, the second coat 4-6 m2 / l. Great variation occurs depending on tjärkvali- tea, substrate properties, sawed, planed, weather play, the performance of work, etc.

Norwegian procedures

Today tjärproducenter not distinguish the different grades of tar (Self Berg, 2003). Boat Builders differ, however, on different pitches. The boats are tar from the early stages of production appropriate - as for träbestrykning - called båttjära. Tar must be bold, bright and clear. Grain accepted if the grains are such that they melt when rubbed between the fingers. Grain from late fractions, tar darker and that does not disappear from the fingertips, is disadvantageous and indicates chemical decomposition of components.

New Norwegian experiences

Vegar Os refers to Self's work shows that tar main objective is to stop the damage of water and UV rays do not penetrate the wood. It is now known that early tar fraction gives a firmer and more glassy surface than tar from subsequent process step (Vegar Os, 2014). Södertak last longer with firmer tar earlier fractions. While boiling, so that the tar approaching pitch increases strength. To distinguish between early and late fraction of dalbränd tar seems to work varying in Norway (Os, 2014). Practical experience on Self's recommendations on boiling down / Simmering also indicates that the life was not significantly longer compared to the extra workload and it is now applied in practice. The trend in Norway today is to apply tar later in the fall, so that it hardens and can withstand high summer temperatures. It is also mixed into the carbon layers.

Self's recommendation (Self Berg, 2003):

- Use dalbränd pine tar.
- Make sure tjärtunnan marked with the number X of the total batch, eg No 2/6
- The tar must be boiled or otherwise cooked to a specified degree before application, to about 200 ° C. This production process steps do not happen to the building for safety reasons. For example. 25-30 l tar sjudas in a 60 l boiler, on a plate or a gas flame (4-5 kW).
- Tar must be clean of tar water.
- Wood surfaces should be clean from dirt and dust, loose particles.
- Older, crystallized tar can be left as it will merge with the new applice- conditioned tar and become part of the new The coating one.
- Pine tar is heated in a water bath before applice- ring and applied manually with e.g. brush, cloth, or ladle.
- The weather should be warm, stable and dry during and after the pond no. For cold weather gives insufficient durability. A warm sunny day dry tar on some days, but on the north side, it may take a few weeks.
- Tarn is repeated shortly after sun-lit and weather weathered surfaces. A shiny film will be formed to provide weather protection.

National Heritage indicates that the Norwegian stave churches to be tarred as follows (instruction 1994) (Own Berg, 2003):

- Dalbränd tar is heated in water and applied by brush to clean and dry surface.
- On new wooden surfaces should tarn is repeated twice in the summer, in a period of 4-5 years, or until a surface layer formed. Since tarred surfaces every three years on the south side, and six years on norrsi-day. The three-year interval is derived from the medieval regulations, where farmers under the law would accomplish this.

Remains of rödpigmenterad tar on Frösö church bell tower (built in 1754) Photo: Christina Persson.

9. discussion

Experience from neighboring countries

Clearly, a large part of traditional knowledge regarding tar is lost, even if the skill level seems higher in Norway and Finland. It is interesting that in more detail at how our neighboring countries resolved the issue. It would be valuable to interview such Ing-Marie Self Mountains and Antti Pihkala input to share their rich experiences. It may also be interesting to follow up the practical work on the manufacture and application of tar eg of tjärtillverkare and companies that emphasize church roof. There are new Experience from neighboring countries shows that for various reasons are to abandon a portion of the recovered experience eg concerning simmering tar and tarring of the church roof outside the summer season.

New EU Directive

EU chemicals regulation REACH requires that the pine tar to be registered to get used after 2018 (Claesson, 2015). The problem is that there is no collective force such an industry body that could pay for the surveys and registration fees required. Individual producers or importers are not able to do this. This is a pressing issue that requires a joint Nordic effort.

Genuine dalbränd tar

To enter the "real dalbränd tar will be used" is as wrong as "genuine linseed oil", it shows both the self's and Lyckmans works (Lyckman, 2005). As for tar so has a range of pre-industrial production methods used, with variations in construction, shape and use. Common for the methods is that the raw material was rich in resin, in finely divided and uniform size that was longer production cycle and occurred at lower temperature. This results in resins with many fractions and where the early fractions have a high content of resins and essential fatty acids. Tjärdalen is one of many autothermal production methods in cottage industries used to make larger batches and tar for the open market. Among the industrial methods meant tar retort indirect heating. Its yield is stated to be lower than for tjärugnar. In the mid-1700s were tar industrial furnaces / retorts but ugnstillver- kad tar existed before. Today is comparative, empirical up ironing test. There is contradictory information about primary tar is low or high viscous, most

Table 12: Characteristics for Good Pine Tar (Bonn, 2006) (Tideström, 1957) (own mountain, 2003)

Color	A good pitch should be bright and clear genomsiktlig, regardless of hue and must not darken too much during drying.
fragrance	Resins with a high proportion of terpenes have an aromatic scent. Sharp indicates phenols, which is a sign of high quality film forming tar.
Texture	Primary tar is thick, and can be difficult underlined. The tar is heated in connection with the application.
grittiness	If the grains are lost when the tar is heated or when the grains are rubbed between the fingers is supersaturated resins. If grains does not disappear, it is a sign of overheated tar and thus poor quality.
layering	The tar will not stratify or contain any visible water or pyrolignous acid. the water content should not exceed X%. The tar will not produce / obtain any sediment.
surface	Glanslik, "bold". Forms a fernissliknande surface and dries well.
density	There are various details of the density of a good pitch to have, probably depending on the purpose. Most sources, however, the density from 1.03 to 1.11, Own Berg indicates 1.03 to 1.07.
Beckbildare	When the tar is cooked, it forms a fine pitch, which is solid at room temperature. Suitable for sealing of such boats.

resources indicating that it is thick and viscous (i.e. high viscosity).

tar function

Our notions of tar feature wooden buildings may not always agree with the historical purpose of tjärbehandlingen. Many believe that the tar to protect by impregnation and that it is "strong" in order to keep fungi, etc. gone. At the same time, it is determined that the tar is not a biocide or fungicide. The tar protects by being hydrophobic and the church roof as a sacrificial layer by forming a resin-rich film on the wooden surface that protects it from light radiation and weather, precipitation and erosion. Once we understand the mechanisms for the up building of this layer, we also understand the requirements we will ask the tar characteristics. If the timber is sucked into the tar can not form a film as easily as in a resin rich timber further integrated with the tar by partial dissolution and re-solidification. A chemical basic rule is the "like dissolves like" so it is reasonable to assume that a resin-rich wood, a film with better adhesion tjärfilm and lower consumption. On the north side, it may suffice with a highlighter because there is often residual materials. On the south side should underscore the tar occur until the surface is saturated and a shiny reflective surface occurs, particularly if there is the question of new timber.

Many also expect the tar to give a color to the wood surface eg dark brown / black. It is true sometimes, but not always. There is an expectation that is derived primarily from the use of coal tar (Björck, 2013). The more layers that are deleted, the darker the tar. If using boiled / simmered tar, it has become darker. Tar can also be dark of mixed carbon black. Black roof absorbs energy from sunlight, which is depleting. Otherwise the tar to be relatively light, and many say the best pine tar is light and provides a fernissliknande surface.

tar quality

To get ahead in tjärfrågan needed first and foremost methods to determine the quality of tar in quantifiable ways, with tolerance intervals. Self Berg have shown that the GC-MS can be used for qualitative and quantitative analysis of important components. We need access to reference database and people who can interpret the results. Experience and practice in Norway. One can begin by analyzing a number of batches of Finnish and Norwegian tar to know range / tolerances for components diterpenoids, abietisk fatty acid, linolenic, water, volatiles, polyaromatic hydrocarbons, etc. The measurements should be complemented with other technical measurements such as density, viscosity, boiling / flashpoint and pH. After domestic tars can continue with imported tars.

Tar involves complex organic chemistry, and requires at least a skilled organic chemist to be able to move forward in the establishment / completion of the terms of reference for what constitutes a high quality tar coating of wooden architecture. There is such träkemister at Växjö University, Royal Institute of Technology, Lulea TH possess valuable specialist knowledge.

Differences in handling

Self's thesis shows clear links around improved film formation properties for "early tar" or förtjäran / rottjäran when sjuds around 180-190 ° C. Although it makes no mention of tar simmered in job descriptions from Sweden or Finland. It has also been shown that the Norwegians seem to deviate from the approach more and more today. Simmer / near boiling, boiling förpolymeriserar resins, concentrating fatty acids, resins and homogenizes the tar. There are parallels to eg boiled linseed oil. As for heating tar to facilitate the application, there are different views. In Finland warned of evaporation of volatile components when heated, while Self's research shows that the evaporation of these phases instead concentrate vital components e.g. resins and fatty acids required for film formation. On the other hand, increases the volatile constituents hot tar flowability and spreadability. It would be possible to use two different pitches in a two-stage treatment that is often mentioned in Finland: 1; A tar that easily penetrates and saturates the wood pores with resin. 2; A tar which easily form an elastic and protective film. A högviskösare, more film-forming tar can be created by allowing the tar to stand uncovered and föroxidera in a year, according to the Finnish recommendations. To store the tar under Finnish practice has probably also been made in Sweden historically (Claesson, 2014). In addition to pre-oxidation and enrichment of resins could also pyrolignous acid and tar water separated in special vats. Interestingly tjärtillverkarna in Serbia has proposed this as practice. It would be possible to use two different pitches in a two-stage treatment that is often mentioned in Finland: 1; A tar that easily penetrates and saturates the wood pores with resin. 2; A tar which easily form an elastic and protective film. A högviskösare, more film-forming tar can be created by allowing the tar to stand uncovered and föroxidera in a year, according to the Finnish recommendations. To store the tar under Finnish practice has probably also been made in Sweden historically (Claesson, 2014). In addition to pre-oxidation and enrichment of resins could also pyrolignous acid and tar water separated in special vats. Interestingly tjärtillverkarna in Serbia has proposed this as practice. It would be possible to use two different pitches in a two-stage treatment that is often mentioned in Finland: 1; A tar that easily penetrates and saturates the wood pores with resin. 2; A tar which easily form an elastic and protective film. A högviskösare, more film-forming tar can be created by allowing the tar to stand uncovered and föroxidera in a year, according to the Finnish rec

Production, demand and supply

Even if we can establish a technical specification tar remains the question of how it can be made. In our neighboring countries the organized volunteers, but tar quality and characteristics vary. Norsk quantity of tjärtillverkning is still small in relation to Swedish needs. Norway has pointed out the buildings with the greatest value and most in need of high-quality tar. They are prepared to pay well for this, which means that you can get suppliers.

Swedish church is probably the country's largest consumer of tar, roughly around 20-25 tonnes / year (Björk, 2013). This is equivalent to about 20-25 m 3rd Just Gotland reported annual need to be 6 m 3rd For it will need to tar brädtak for both secular and ecclesiastical buildings.

There is a great value in a reproducible production of high quality and in large quantities. If you can use the resin-rich raw materials, the same type used in the example tar, control furnace / retort heating rate and holding time in the same manner as is typical in so tar should be able to mimic the conditions obtained in small scale autothermal processes.

A first step would be to differentiate the needs and identify the churches and secular buildings of greatest historical value, and most in need of authentic material for facades, roofs and various parts of the building. For example. medieval wooden churches, buildings originaltak, ports with older tarred layer mm. You can also decide to use high quality wood tar for the slope of the roof facing south, and another tar on the north side. If the cultural environment are willing to pay for domestic tar for high-priority buildings and building components, we would probably be able to get more suppliers and larger quantity (Claesson, 2014).

Access to the resin-rich raw material is a nut to crack because the law restricts access to both mature stumps and katade trees. Maybe you need a dialogue between different agencies such as National Heritage Board and the National Board of Forestry to find a sustainable solution for all parties. Swedish Church also manages large areas of forest. A project by the Finnish concept, which aims to kick-start entrepreneurs (eg carpenters and small forest owners) to small-scale tjärtillverkning could produce tangible results. In literature from charring industry disclosed a large number of ovens and retorts which could be updated again (Wahlberg, 1958). For example. Lingbo-kiln, which is a further development of Tjärdalen. Gotland has an intact oven remains.

It would be important to capture the remaining experiences called on industrially produced tar in Sweden, while the key people are still alive. Forest Carbon in Schmitz Hälsingland ceased industrial tjärtillverkning around 2008 (Björk,

2013). They still produce charcoal, tar was a byproduct which also included lövvedstjära (Malmros,
2014) (Claesson, 2014). Harry Beck Power in Toft Gotland is over 90 years and has valuable knowledge of older tjärtillverkning (Malmros, 2014). Hilding Bergström at Jernkontoret Kolnings- laboratory wrote the 1948 report *Analytical methods for the products of the carbonization of wood,* that can be updated. The report describes how the tar can be classi - sified with respect to physical properties, composition, purity, etc. to develop standards. Tar products classified systematically even with respect to viscosity, density, water content, water-soluble constituents and residues, and even different fatty acids, phenols mm. Berg's methods developed by, among other things NTU in Norway and is the basis for the klassificieringar now being made in Norway (Self Berg, 2003). It is possible that it is possible to further develop empirical methods to evaluate various properties. It is common for a gauge of various types are used for quality control of materials in different contexts. Examples of tests that can be tested, for example, color / luster (etalon), film forming ability (streaking on the glass, as possible. cooled), resin content / ductility (during cooling of the tar), drying / oxidation (streaking on glass), viscosity (there are many types of viscosity meter), solids (freeze-drying). (Blasted) glass sheets tjärats can be tested for five years in South and North positions, that is renewed is 2, 3 and 4 to extend the sample interval. Alternatively, dense MDF or the like used as a basis.

It would be interesting to do an in-depth literature study of such Jernkontoret archives, and Skoljabs and Lund University tests in the 1950s (and of course also the modern chemical international literature.) It is interesting that more detailed follow-up experiments

going on Gotland and also launch more trials after we found ways to characterize tar.

additives

Tar is a thermoplastic material - a mixture of hydrocarbons that dries by oxidation i.e. some fatty / resin binds oxygen molecules (as for linseed oil). There are examples of adding linseed oil to reduce tar dries. It dilutes However, the resins and other fatty acids. There are signs that the metal ions act as catalysts accelerates the drying process (as in linseed oil). It has also historically appointed litharge to tar to improve the drying properties. The presence of copper ions detected in Self's work is believed to be associated with this and the vessels used for heating of the wood tar. So if you want to improve the drying properties can be very small addition of suitable metal ions to be beneficial because it reduces the concentration of resins (should also improve its film-forming properties).

Many sources indicate that they have used tar with additions such as pencil, charcoal, sand, vitriol, carbon black, red ocher mm to various purposes. Roros Church are found to have a centimeter thick "armor layer" from the 1700s. There are Norwegian experiences in this follow up. Data on the sand historically added the tar is interesting from several aspects. It is unclear why, and some sources dismisses intentional additions, while others describe it been common and fulfill different functions. Sand consists mainly of silicon / aluminum / magnesium oxides, all with large refractive index and inertness

- especially quartz. A film with high-index minerals are protected from some of the solar photo-oxidizing and deteriorating effects. This is true both that are transparent and chromophore (color-bearing) minerals. If you want to improve tjärfilmens life, without getting any color or Grang, one might add finely transparent minerals such as more mica (muscovite others).

Other

Oak as a basis for row. tarring has not been dealt with specifically. An inventory of e.g. covered preserved older tarred roof for sampling would be interesting to investigate both additives, metal ions and possible. tjärkarak time characteristic. The cleaning of dirty surfaces can possibly be made with deionized water (Ekofasad), it has been tried in Halland with good results (Björck

2013).

recommendations

In light of the information presented in this study, the following general recommendations can be given.

The tar used to be:

1. Being of high quality. It is missing today in Sweden experience to fix this.
   a. to be dry distillate of Pinus sylvestris or equivalent.
   b. Should include high content of resins and fatty acids (such abietisk acid). It can be analyzed including GC-MS. Abietisk fatty acid similar to the pure resin, rosin.
   c. Be homogeneous and free of pyrolignous acid and tar water.
   d. Being bright and clear.
   e. Particles in the tar disappear between fingertips when rubbed.
   f. Most preferably be boiled / simmered before application of Norwegian experiences or stored / aged under Finnish experiences.
   g. Have good oxidation ability and good drying properties.
   h. Product information should be reported, as well as possible. additives.
2. be film forming and yield a smooth surface. Today there is no useful way to determine this.
3. Be resistant to photochemical degradation. Today there is no useful way to determine this.

4. Be extra careful in the choice of tar in the case of original parts of the building such as ports mm.

The basis

1. Previously treated substrates tested so that it is tar by dissolving it with turpentine. It should be dissolved and smell aromatic tar. The base should be at tarring dry and clean, free of loose material.

2. Previously treated surfaces examined any of the expert before purchasing, to assess the condition and needs.

3. Remains of tar can be retained, it integrates with the next layer.

4. The moisture of the application should not exceed about 15%.

5. The tar will be applied to the timber of high quality that have the large proportion of heartwood. The timber must be crack. The worst combination is bad wood / lot sapwood and tar that easily penetrates the wood (late fractions) and not based film. Good timber can not compensate for poor pitch, but must be from the early fractions. A penetrating tar is better than no tar at all.

Time for maintenance

- South Pages are more exposed than the north sides, and maintenance should be done within eight years under all circumstances or when the timber needs to renew protection. Usually given 5 years for the south side, and 10 years for the north side.
- Ideally omtjärning occur while there is a tjärfilm left.

Application

- It will form a glossy, reflective surface of the tar.
- Application should be made in so many layers to the surface is saturated and stops sucking (so that a surface film can be built up at the forthcoming deletions). A matt surface is that the surface still sucking tar. Request the unit price for additional ironing.

- The weather should be stable and dry during and after the pond no.

- Too cold weather gives insufficient durability. Rain causes adhesion problems. warm

weather provides good penetration and saturation, but is not beneficial to build up a film and tar can run. Repeated tarring can happen after the first coats, later in the summer season / early autumn. 2-5 deletions, within a short time is preferable. This is especially true for the new timber.

- Tar must have time to oxidize before it gets cold.
- Heating the tar takes place according to the manufacturer / importer's instructions.
- Please use water and minimize losses provides temperature before application.
- Application should be made in a way so that the tar pene- trates the surface fibers. Application is with e.g. roller, spray or brush. Brush increases the probability of detecting chips that need to be replaced.

- Protect façade and surroundings from discoloration due to splashing.

Documentation

Please use the form of self-control on the following page. Enclose product data sheet.

Documentation - SELF-MONITORING tarring

Construction		
Byggnadsde l	**the Surface**	**QUARTER**
Protocol established by the	**Date of protocols**	
Entrepreneur	**Date of tarring**	

Relevant maintenance history (date, entrepreneurial, action)

Describe the team's condition pine shavings oak chips

gARNET	cracked	Disrupted / weathered	dry
Old movies are	Yes	No	Partial
film is	Matthew	Smooth	cracked

Number exchanged chip of the mere insertion

moment Moisture at start-up (%) Other

tar brands	**Type of tar**	**Absorbed amount (** kg or liters)

Product data sheets attached Yes No

Safety Data Sheet attached Yes No

Cleaning method / s Heating

Method / s tar heating temperature

Tar application temperature

Application methods / -s (roller, spray, brush, other)

number of strokes

The wood is saturated with tar? Yes No

It has formed a surface film made? Yes No

Description film (matte, gloss, streak, smooth, cracked, etc.)

Other (for example protection against trickle / splash, observations)

Weather History	**Weather (** sun, rain, overcast, alternate, breezy etc.)	**Other (** Observations mm.)
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

CREDENTIALS

Printed sources

Becklén, R. (1999). *The tooth of the time. Preventive Conservation. (* Fjaestad M., Eds.), Malmo: National Heritage Board. ISBN 91-7209-135-5. Bergman, J. (1963). *Various tjärbränningsmetoder.* Rating essay in ethnology, Uppsala. Bergstrom, H. (1941). *Preparation of tars and oils from inhemsktråmaterial.*

Technical magazine, booklet 14. Bergstrom, H. (1950). *Preparation of trätjäror and products therefrom (* Vol. Offprint

IVA No. 1950: 3). Stockholm: The Royal Swedish Academy of Engineering Sciences. Bolin, I. (1940). *The organic chemistry and what it teaches us in practical life*

(Third Ed.). Stockholm: Nature and culture. Bonn, B. (2006). *Tar. To be.* Skelleftea: County Administrative Board of Västerbotten,

Västerbotten Museum, Forest Museum in Lycksele. Braunschweiler, H. (2003). *Is Pine takes under a threat? What is the aim of the biocides*

directive? Turku: The finnish pine takes. Building Heritage Association. ISSN 1458-4174. Cavén, O. (2003). *The Past, Present and Future of pine takes.* Turku: The finnish pine

taking. Building Heritage Association. ISSN 1458-4174. Cavén, O. (May 11, 2010). *A bit of tar. (* By Ulrika Mebus, Gotland Museum

2013-05-20). Finland: Translation of Martti Jokinen. Dravnieks, G. (1998). *The Building words. Meaning, origin, history (* Second ed.).

Stockholm: Swedish Building and K-consultant. ISBN 91-7332-455-8. Edlund, CR (1864). *Anwisning that with good winst tillwerka resin, carbon black, tar,*

turpentine and rosin oil. Turku: CR Edlund's publisher. Ehrenmalm, T. (2006). *The EU and the threat to the wood tar.* Building Culture 6/2006. Self-Berg, IM (2003). *Tarring maintenance of Norwegian stave churches.*

Characterization of pine takes During kiln-production, experimental coating procedures and weathering (Doctoral thesis for the Department of Environmental Science and Conservation ed.). Göteborg: Acta Universitatis Gothoburgensis. ISBN 91-7346-483-X. Englund, LE. (1992). *Archeology Varmland (* Vol. ISSN 1102-5832). Stockholm:

National Heritage Board. Fridell-Constants, Å. S. (2010). *Building of painting colors, materials and use.*

Emmaboda: Arkus. ISBN 978-91-978957-0-5. Granlund, J. (1979). *Kulturhistoriskt dictionary for Nordic Middle Ages.* Allhem publishers. Hennius, A. (2005). *Coal and tar - Archeology northern Uppland woodlands.* The survey

compounds of E4. Vendel, Tierp and Tolfta parishes 2002. The authors Jonas Svensson, Anna Ölund, His Bleicher. Uppsala Uppland Museum. Kaila, P. (2003). *Pine takes as a wood preservative. On the use of pine takes paint.* Turku:

The Finnish pine takes. Building Heritage Association. ISSN 1458-4174. Kaila, P. (2007). *Kevät toi maalarin. Perinteinen ulkomalaus.* Jyväskulä:

Multi Kustannus OY. ISBN 978-952-468-151-3. Karlsson, I. (2012). *Tar burning at Kruse. Såjdebränningg bei Kruse.* Gothenburg:

ISBN 978-91-637-0618. Kjellin. (1927). *Illustrated goods dictionaries for trade and industry.* Stockholm: Åhlén and

Åkerlund Publishers. Koskinen, A. (2003). *The Wonders of taking chemistry.* Turku: The finnish pine takes.

Building Heritage Association. ISSN 1458-4174. Kymäräinen, S. (2003). *The old skills of pine takes burning live on in Kuhmo.* Turku:

The finnish pine takes. Building Heritage Association. ISSN 1458-4174. Källbom, A. (2008). *Back to basics. Jordfärgers characteristics, properties and*

use. Enhanced Project 15 Credits, Gotland University, Visby. Källbom, A. (2008). *Focus on pigmentation.* 15 hp, University of

Gotland, Visby. Lyckman, K. (2005). *Historical oil paints.* Color Archaeologist publishers.

ISBN 91-631-7896-68. Löytynoja, T. (2003). *Pine is - the black gold of of the north. (* TF takes, Ed.) Turku: The finnish pine takes. Building Heritage Association. ISSN 1458-4174. Malmros, P. (2003). *Tjärstrykning of the longtime church roofs.* Visby:

Building Foundry Gotland. Malmros, P. (2009). *Programs tjärstrykningstest Fole parish magazine.* Visby:

County Museum of Gotland. Report AD2009-0109. Dat 2009-02-10. Malmros, P. (2011). *Programs tjärstrykningstest.* Visby Gotland Museum,

2011-05-05. Meyer, K. (1952). *Meyers vending dictionary.* Stockholm: Forum. Miall. (1976). *Dictionary of Chemistry.* Lund: Beta Graphics. ISBN 91-40-03476-3.

Fourth Edition.

Nordanskog, G. (March 18, 2008). *Guidelines for Church antiquarian compensation*

maintenance of the rod-chip. Linköping: Linköping pin, pin board. Nykänen, P. (2003). *The Science of pine takes.* Turku: The finnish pine takes. buiding

Heritage association. ISSN 1458-4174. Olsson, T. (2014). *Attmar Church. Program of exterior restoration of*

Attmars church, bell tower and rose port. Sundsvall Municipality, Tennessee. Sundsvall Arenatum. Pihkala, A. (1998). *Panu yes Pare, tutkimus suomalasisista puukatteista.* Terva yes

korvikeaineet panukattojen suojauksessa. Turku: Turku University. Pihkala, A. (2003). *Shingle roofs are lost withour pine takes.* Turku: The finnish pine

taking. Building Heritage Association. ISSN 1458-4174. Pihkala, A. (2009). *Paanukatot Suomen kirkoissa yes tapuleissa.* Rovaniemi: Oulu

Yliopistu. Doctoral thesis. ISBN 978-951-42-9286-6. Ranta, H. (2008). *New Rörum Church - diversion shingled roof.* Kristianstad:

Regional Museum in Kristianstad.

National Heritage Board. (1981). *Shavings. Recommendations for production, orientation and protection treatment (* Vol. 3). Stockholm: Swedish National Heritage Board. Report 1982: 3rd ISBN 91-7192-512-0. National Heritage Board. (1999). *Building Painting with traditional types of paint.* Stockholm: ISBN 91-7209-153-3. National Heritage Board. (2011). *Tjärseminarium.* Visby: National Heritage Board,

Crafts Laboratory. Rothstein, E. v. (1856) A. *Tutorials in public buildings doctrine with primary for construction art (* Vol. Facsimile 2003. ISBN 91-89622-12-X). Bjärnum: Accent publishers. Svanberg, D. (1932). *Chemical-technical recipes handbook for home and industry.* Stockholm: Wahlstrom and Widstrand. Tideström, SH (1957). *Encyclopedia of commodities and materials.* Stockholm: Nordic Rotogravure. Toivari, P. (2003). *Pine Tar is a party of beeing finnish (* Vol. The finnish pine tar). Turku: The finnish pine takes. Building Heritage Association. ISSN 1458-4174. Utas, J. (4/84 1984). *Ag, boards and chips.* 4/84. ISSN 0346-9077. Cultural heritage management. Wahlberg, H. (1958). *Tore charring and stubbtjäreprodukter.* Lund: Carl Blom boktryckeri. Wahlgren, A. (1928). *Sweden's forests and how we use them.* Stockholm: L Hökerbergs publishing. Ward, S. (2008). *Managing shingle roof - knowledge and experience recovery.* Thesis, unpublished at the University of Gothenburg. Mariestad. Vegar Os, K. (2014). *With tjaere, litter og sand householder kirk roof stand. (* A. Hansen, Ed.) Ostersund: Cultural Heritage crafts. Jamtli publishers. ISBN: 978-91-7948-248-0. Villstrand, NE. (1996). *Tar, bark bread and honey.* Utmarkens people and diverse people. A saving fire. Tar burning in the Swedish Empire from 1500 to 1800. (B. Liljevall, Ed.) Stockholm: Nordic Museum. ISBN: 9171084002nd

interviews

Björk, B. (March 28, 2011). Ecclesiastical Engineering Uppsala diocese. Uppsala. Björck, B. (June 14, 2013). Ormaryd.
Claesson. S (15 December 2014). Architect and owner of Claessons pine tar. Gothenburg. Malmros, P. (May 20, 2013). Bebyggelseantikvarie on Gotland Fornsal. Visby. Malmros, P. (June 26, 2014). Visby.

Malmros, P. (January 2015). Visby. Malmros also interviewed in January Utas. Nylund T. (November 24, 2014). Spåntakläggare. Nykarleby Finland. Olsson, T. (January 13, 2015). Architect on Arenatum. Ostersund. Thorne, ES. (9 December 2014). Eiendom manager in Norwegian Fortidsminnesforeningen. Oslo.
Vegar Os, K. (November 11, 2014). Architectural curator at Røros Museum.

digital sources

Cavén, O. (June 4, 2013). *Terva yes panukatot*. Retrieved from Kainuun Terva: www.kanuunterva.fi.

Cavén, O, Heikkinen, E. (March 5, 2015). *Tjärtillverkningens tradition continues*. The Finnish oak publication "Rakennettu kestämään - Tutki yes OPI", 2003. http://hoforskolare.se/dokument/tjartillverkningens_traditioner_fortsatter.pdf. Claesson, S. (April 2, 2013). *Claesson's pine tar*. Retrieved from Job Description for wood tar: www.claessons.se Claesson, S. (April 3, 2013). *Claessons tar*. Retrieved from Little about tar: www.claessons.se

Erenmalm, T. (April 13, 2013). *Material Guide*. Retrieved from the National Heritage office: http://old.raa.se/cms/materialguiden Heikkinen, E. (2 June 2013). *Kainuun Terva*. Retrieved from www.kanuunterva.fi. Ivarsson, M. (Feb 2015) *Traditional Colors and målerittekniker (* fb).

Chemicals Agency. (December 7, 2014). *If coal tar*. Picked up from www.kemikalieinspektionen.se. Nylund, T. (2014). http: // *www.spantak.fi/*. Retrieved from Nykarleby shingled roof.

Uudenkaarlepyyn paanukatto. 2014-11-18. SCCNFP / 0646/03. (2003). *Opinion of the scinetific Committee on Cosmetic Products and non-food*. Location Unknown: EU.

Shenet. (2014). Retrieved from Tar and tar oils: *www.shenet.se*. Extensive sources:

- Literature: see example Arnborg (1994), Bolin and Gustaver (1960), Gentz and Lindgren (1946), Grimberg volume 3, 6 (1922), Hallbert (1981), Högberg (1969), Jonsson and Simmons (1935), Kalm (1960), Kirkevold and Gjessing (2004), Lagerqvist and Lindqvist (1999), Lindgren (1918), Manniche (1999), Meyer (1952), Nordstrom (1940), Pharmacopoea Svecica I (1775), Pliny book 16: 21 (1968), Svanberg (1948), Swedish Pharmacopoeia VIII (1901), Swedish Pharmacopoeia XI (1946), Theophrastus book 9 (1916), The Hagen (1995), Westman (2006).

- Articles: Torsten Althin: Some tjärbränningsmetoder in western Sweden (Fataburen 1923). Nils Keyland: Some ways to burn tar photos and notes from western Värmland (Fataburen 1925). Nils Erik Willstrand: A fire rescue: tar in the Swedish Empire 1500-1800; Lars-Erik Borgegård: Tjärproduktion in Västerbotten in the 1800s - a variable resource (British Liljewall, red: tar, bark bread and wild honey: utmarkens people and diverse resources; 1996). Ingvar Svanberg and Håkan Tunón: bark, bark and sap (Man and nature: ethnobiology in Sweden, 1, 2001).

- Online publications: Felter and Lloyd (1898, 1900): King's American Dispensatory (2003 12 22). Encyclopedia (2004 04 14). SCCNFP (18 March 2003): Wood tar and wood takes preparations (2006 06 29). Chemicals Agency: Some biocidal revoked . (2006 07 04). Nottingham Co: d-Limonene campuses and Industries (2008 06 14). European Commission: Cosing: Cosmetic Ingredients and Substances (2008 07 07). IFRA Standards (2008 07 07). Pharmacopoeia of Japan IV 1922 (2009 11:23 a.m.).