Airgon - Preventing inefficiency and reducing energy and CO_2.

The cost of energy has always been important to any organisation especially in the sectors where these businesses are obligated to provide a stable, comfortable, internal temperature and continuous hot water which cannot be compromised.

As more businesses are required to reduce their carbon footprint, the amount of energy used also becomes an area of scrutiny and consideration. Carbon reporting has cost attached to it so anything that improves efficiency and reduces consumption by more than 5% should automatically be considered.

In the early part of 2022, commercial energy prices began to rise significantly and by April the domestic price cap rose by 54%. In August Ofgem confirmed that this will rise again October to a staggering 80%.

Now many businesses are also struggling to cope with the higher rates and no price cap on business energy means that suppliers can increase their out of contract rates to cover their increased costs.

This has seen out of contract rates rise by an average of 102% since August 2021 but some have actually quadrupled

The enormous rise in the cost of energy coupled with the rising cost of living are forcing people to consider the option of eating or heating.

'We are seeing rises of 1,400%': Energy prices are the biggest threat to businesses who risk collapse

Many small and medium sized firms are just recovering from the pandemic but now face even more trouble as energy prices soar

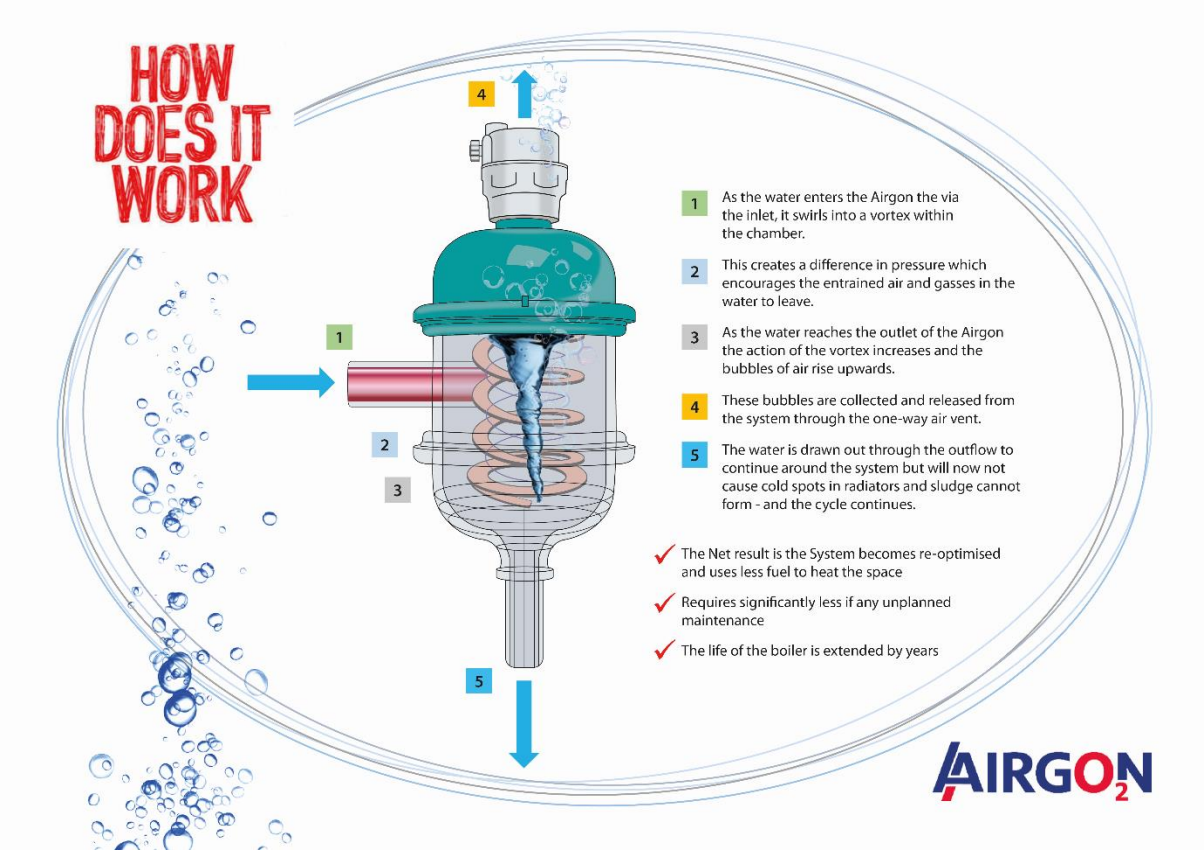
Tony Stein's firm have seen bills rocket by over 1,000% (Photo: John James)

The Government have pledged its help to the public by freezing the cap temporarily to £2,500 but many doubt that this enough.

Airgon helps the consumer and businesses reduce costs and carbon emissions by ensuring that heating systems operate at their optimum level of efficiency and preventing deterioration from taking place.

Optimising the system can have a substantial impact, reducing the cost of heating and carbon emissions by between 10% and 20% per year.

1. What is Airgon and how does it work?



Airgon is a highly efficient deaeration unit that removes dissolved (entrained) gasses from the water in a closed heating system.

Airgon creates an environment that extracts the dissolved gasses using a vortex. The faster moving liquid at the base creates a pressure differential in the upper part of the chamber, encouraging the air and gases to be released upwards where they are evacuated using an automatic air vent.

This deaeration process has a significant effect on improving system performance and reducing energy usage, which in turn reduces carbon footprint and the cost of heating.

Removing the dissolved oxygen (DO) and other entrained gasses to an inert level (less than 0.5ppm) halts corrosion. Removing the dissolved nitrogen prevents the formation of a thermal barrier lining the pipes and radiators allowing more efficient heat transfer reducing fuel use.

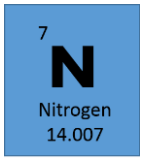
Installing Airgon into a qualifying system results in a measurable difference in system performance resulting in significant benefits.

2. Henrys Law. C=kP

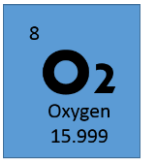
Temperature and pressure have a direct and predictable relationship on the volume of entrained gasses in water. This was discovered in the early 19th century by William Henry and is referred to as Henry's Law or Henry's constant.

What Henry observed is that at a given temperature and pressure the volume of a given gas entrained in a liquid can be accurately calculated. Air is typically approximately 78% Nitrogen by volume and 21% Oxygen. In water these ratios change due to the solubility of Nitrogen and Oxygen.

As the temperature of the water rises these gasses are released and at around 85° Celsius, which is typically the temperature the water reaches as it travels through pipework and into radiators, the majority of the entrained air is forced out of the water. This is an issue because in a closed heating system it is unable to escape with problematic results:



Nitrogen creates a thermal barrier by collecting in heat exchangers/radiators which means more energy is required to overcome the barrier to heat a given environment. This causes 'cold spots' in radiators so they don't heat completely or operate efficiently.



Oxygen combines with iron and the water in the system to cause corrosion. This results in a Ferric Oxide sludge called magnetite which increases the stress on the pumps and heating mechanisms reducing component life, whilst increasing the need for unplanned maintenance calls, and shortening the life of the system by destroying the physical components.

3. Removal of the thermal barrier.

Within a closed wet heating system, the entrained gasses that are released as water temperature increases, have no means of escape and so collect in the nearest available chamber, usually a radiator. This can only be overcome by running the boiler for longer to reach the temperature set by the thermostat.

Air is continually being introduced into the system water from a range of instances including but not limited to;

- Heating and cooling,
- Pin holes
- Leaking seals and valves
- Topping up system water

Air is also generated as the water is circulated making this effect inevitable.

Airgon provides the escape route for these gasses which prevents air pockets and cold spots occurring. Radiators continually operate at maximum efficiency and don't need 'bleeding' as there is no air build up in the system to cause the problem.

4. Investigation of bubble behaviours in wet central heating systems

Ali Shefik [1, a] and Yunting Ge[11] Brunel University, Department of Mechanical Engineering, UB8 3PH,

A study published by Brunel University, Department of Mechanical Engineering, sets out in considerable detail the behaviour of gasses in a closed wet heating system, determining predictable qualities based not only on pressure and temperature but on liquid viscosity and the introduction of impurities and additional gasses. (see attached or click here.)

By understanding gas behaviour, in particular the reabsorption rates back into a liquid medium during periods where the boiler is not used, we can determine how effective the application of a Airgon will be in terms of the amount of impurity addressed and if / how long it will take to achieve an optimum level.

One of the more significant aspects of the study details the absorption rates of these gasses back into the liquid from which they came. This is significant for Airgon as it illustrates the ongoing efficiency of the apparatus.

Airgon essentially provides a low pressure chamber where gasses released under temperature and pressure would 'choose' to collect. As they do the pressure increases within the chamber causing release via a one-way valve to exit the system thereby reducing the volume of gas present within the closed environment overall.

This means that there is now less gas within the heating system to be reabsorbed when the water temperature cools, so there is less gas present to cause corrosion and create a thermal barrier and reduce the efficiency of the system.

Gasses (air) are continually being reintroduced into the system which continue to collect in radiators and pipework unless the system is 'flushed' and 'bled' periodically. By means of the action thus described, Airgon removes the need for manual intervention to maintain efficiency by preventing the opportunity for thermal barriers and cold spots to arise.

The magnetite residue produced by corrosion due to the presence of oxygen in the heating water is prevented by removing the oxygen, thereby improving pump life, heating element life, and heating system efficiency.

5. No need for magnetic filters or additives.

Magnetic filters are used to help combat corrosion in a wet heating system. The filter uses magnets to attract particles of magnetite which helps reduce the build-up of sludge in the system.

Magnetite, Fe3O4, also known as iron (ll, lll) oxide or ferrous-ferric oxide, is a magnetic naturally occurring mineral.

Magnetic Filters simply remove the product of corrosion but do not stop it from occurring, they also require regular maintenance which includes removing, disposing of and cleaning the devices.

Magnetic filter manufacturers recommend using additives with their Filters. MagnaClean, recommends additives as part of ADEY's Best Practice System they recommend using MC1+ Inhibitor after installation to protect against further system corrosion.

Additives can remove some Oxygen but not to an inert level, most additives typically reduce the DO level to around 20ppm but additives that contain Oxygen scavengers like hydrazine and sodium sulphite can effectively reduce both DO and oxides to maintain water quality.

However, using multifunctional treatments requires a considered regime, combining alkali, phosphate and polymers for all round protection requires effort. Whilst there are advantages to using sulphiteIt is difficult to get the right chemical level (over or under dose very easily)Chemical adds to boiler water Total Dissolved Solids (TDS) increasing blowdown requirements

Multifunctional treatments can also accelerate deterioration and the breakdown of boiler components if correct temperatures or pressures are not maintained.

6. Maintaining and managing dosing

Central heating inhibitor has to be changed regularly usually once a year or so. It will break down over time, meaning minerals and rust build up once more. This requires regulating the system's inhibitor intake ensuring it runs steadily and consistently. (dosing) and you should always replace the inhibitor every time your system is drained.

- In our experience, most dosing pots fitted to commercial systems are not used
- In 4 years of visiting plant rooms to survey and install, our engineers have reported not one dosing pot was operational. It would seem that maintenance either runs out of additive or

simply forgets to use it. This also applies to sites managed by a Facilities management companies

- Magnetic filters are occasionally found in situ but usually don't work or haven't been emptied and even when they are working don't remove the problem

Cost of equipment and refreshing chemicals plus the annual maintenance time and service charges should be considered.

With Airgon installed there is:

- NO requirement for Additives or Magnetic filters.
- The water remains inert –so there is NO product of corrosion because there is NO air or dissolved gasses in the system water.
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7.Toxicity and impact on the environment

Most additives used in heating system water are classified as toxic - cause skin and eye irritation. Ingestion may cause irritation of the gastrointestinal tract and disposal requires consideration although it is usually drained off into soakaways or nearby land drains when changing the system water. This is also not eco-friendly**.**

8. Why are aged systems usually inefficient?

Inefficient energy use in heating systems is often due to maintenance work not being undertaken until there is a system failure or breakdown.

Without a Airgon installed, systems need to be regularly flushed to ensure removal of any magnetite deposits and trapped air so that the system returns to a state of high efficiency. This is expensive and therefore rarely happens.

Flushing a commercial system typically costs around [1.)]£1200 into multiple thousands and so the installation of Airgon considerably reduces the cost of preventative maintenance, replacement radiators and boiler parts.

All aged heating systems are in different states of inefficiency, the contribution seen by installing a Airgon can vary but we expect between a 15-20 percent differences.

As systems are used, the benefits of the Airgon become increasingly pronounced over time. Typically, the difference between systems where dissolved gasses are removed reduces energy consumption by around 17% as the energy requirement to bring an environment to a given temperature is reduced, and 'boiler run-ons' are cut reducing energy wastage further.

1.) typical cost for flushing is £25 per radiator. 70 bed care home x 1.5 radiators per room £2,625.

9. Carbon Reduction

If you are reducing consumption you are saving Carbon, it is possible to calculate the carbon savings provided by a Airgon in an environment as follows:

Variables:

- 1 Metric ton of CO2= 5379 kW/h gas burned

- Boutique Hotel (20 bedrooms) with restaurant typical usage 860,000 kW/h per year of which approx. 50% is heating system use
- Airgon installation and usage reduces prior energy consumption by 17%

Based on the above the expected CO2 reduction can be calculated:

17% of 430,000kW/h = 73,100 kW/h,

= approx. Saving of 13.67MT CO2 (16,670kg) per annum.

10. Measuring Improvement in System Performance

There are many ways to measure the impact a device has on boiler and heating system performance. Most require installing sub-meters on the heating fuel (Gas) supply. Monitoring the flow and return, installing thermostats in rooms and on radiators and factoring external weather compensation.

These types of test require stringent clinical parameters, Energy Management Software and remote monitoring using specific data collection and data-logging equipment to get the level of accuracy required by, for example The BRE (Building Research Establishment).

To achieve a SAP (Standard Assessment Procedure**)** rating requires a comprehensive report. However, the difficulty with these tests is especially with aged heating systems is that they are all specific to the particular heating system and the building they heat.

Importantly, we are not improving boiler performance. We need to measure Airgon performance. The impact that Airgon has on heating fuel consumption and CO2 in a given system varies because each system is unique.

Systems degenerate at different rates and over different periods of time. As a result, Airgon's effect is determined by the level of system deterioration being corrected. The net result is similar, the boiler uses less fuel and the heat transfer is improved at lower cost.

11. Will Airgon work on a New System?

Yes. In these instances a system which has not yet experienced significant deterioration or the corrosive effects of dissolved gasses will not see the significant uplift we observe in older systems. Thel benefit of installing a Airgon in a new system is that it will immediately begin removing nitrogen and oxygen from the environment maintaining optimum performance levels. This extends the life of the system and prevents energy wastage from occurring as the system ages.

There haven't been any long term studies completed on new systems yet because of the time required to monitor two identical systems in the same environment over an extended period (4-5 years), one with Airgon installed and one without. There is little doubt however that there would be a significant difference if one system was fitted with Airgon and one wasn't.

- Airgon doesn't directly reduce the amount of energy a boiler uses but as boilers age and systems degrade they become inefficient.
- Air, dissolved gasses, especially Nitrogen builds up in the pipes and radiators causing decay and air pockets.

- Ferric oxide becomes Magnetite sludge which settles in the lower parts of the system and creates blockages

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Airgon restores a system to it's optimum performance capabilities and prevents deterioration. This means that Airgon saves energy through ensuring wastage is prevented, and significantly reduces maintenance costs and breakdowns.

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12. Measuring results (degree day methodology)

Heating energy consumption depends in part on external (weather-related) temperatures.

Therefore, we use heating degree days which are a measure of how much (in degrees), and for how long (in days), the outside air temperature was below 15.5°C to analyse the energy consumption pre and post Airgon installation.

1	2	3	4	5	6
Month	Degree days (hWh)	Actual consumption (kWh)	Predicted consumption (kWh)	Difference (kWh)	CSUM
	From published or self-calculated values	From meter readings	Slope x Column 2 + intercept	Column 3 minus Column 4	Cumulative sum of figures from Column 5

The base temperature of 15.5°C is used because at this temperature most UK buildings do not need supplementary heating.

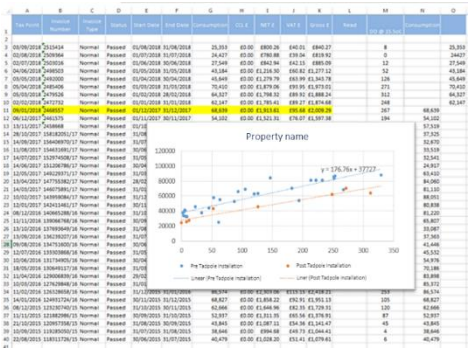
By using Degree-day analysis,we factor in the outside temperature. Degree days are not specific to the building being monitored only the postcode but it is the best and only way of measuring before and after without the precise temperature data of an external and internal temperature logger. Therefore, using weather compensation improves the accuracy of the measurement if we are to make a baseline and measure historical consumption against new.

The other consideration is the energy data month on month by year is never constant because no measured day is exactly the same. However, where consistent supply exists it is possible to create normalisation and a baseline. For example; in Private Care home and NHS sites there is a requirement for a consistent space temperature and constant DHW because of these factors there is usually parity on monthly and annualised consumption.

Private Care home and hospitals, offices and most commercial environments have similar heating demands year on year, this is outlined in the next paragraph.

13. Methodology

Step 1 - Collection and processing of energy and degree day data. We plot the monthly gas consumption (kWh) against monthly degree days over a 2-3 years' period before each Airgon device was installed.



Step 2 - Obtaining a pre-installation performance line.

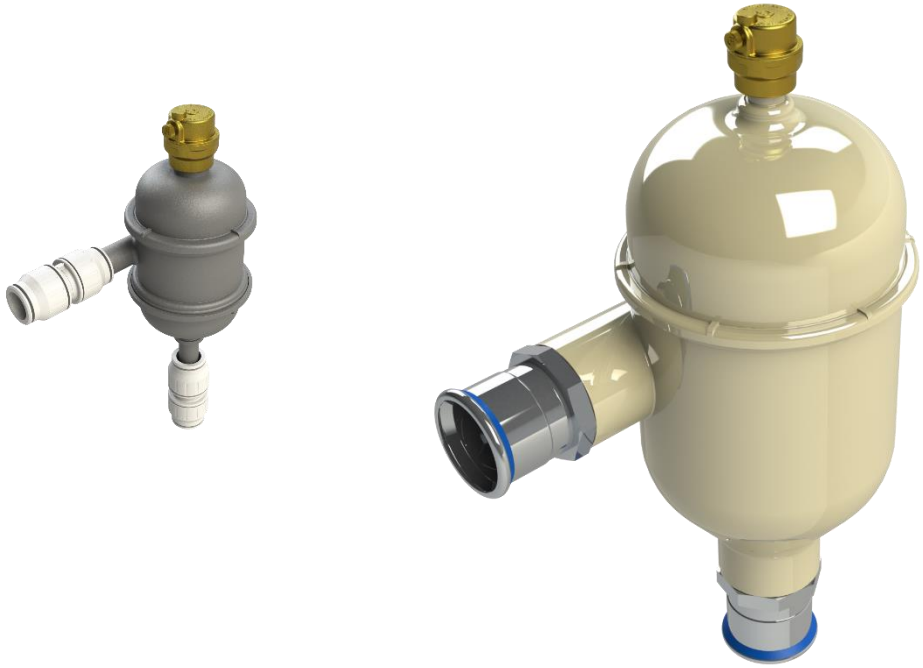
The graph of space-heating energy consumption against degree days shows a relationship between two. We then generate a performance (trend) line and its equation which is an expression of how much the

energy the building can be expected to use for a given number of degree days.

Step 3 - Calculating post installation cumulative savings against the pre-installation performance line equation.

14.Specification

Airgon comes in two domestic sizes 22mm and a commercial sizes 54mm and 100mm. which can



usually be installed in to most commercial systems even when the pipe diameter is larger.

Our Products are guaranteed for a period of 20-years from the date of purchase, subject to registration on the Website using the unique serial number and the required registration criteria being fulfilled.It also has a lifetime replacement Guarantee

15. Minimum Performance Guarantee

Both devices come with a minimum performance guarantee that if 10% energy savings are not achieved over a full 12 months from installation of the Airgon device then the cost of the product will be refunded immediately, subject to Terms.

For information or to receive a quotation Please contact Alexandra Stone on 0161 820 1305 or email alexandra.stone@airgon.co.uk