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UV-C PURITEC®
HNS® germicidal lamps

Technical Information

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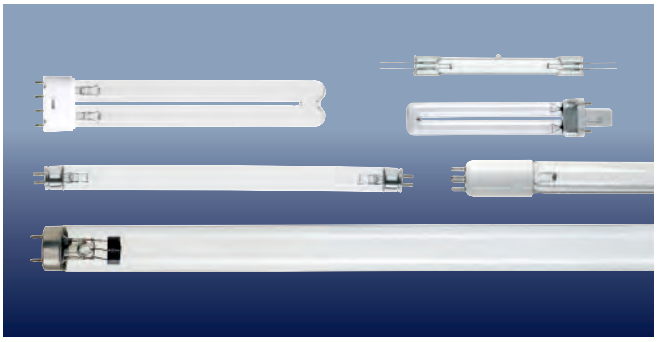


OSRAM PURITEC®
HNS® germicidal lamps

are low-pressure lamps that emit mercury line radiation mainly in the short-wave ultraviolet range. They are the highly promising eco-friendly alternatives to chemical purification processes. OSRAM offers many different lamps for effective disinfection in a wide range of applications. They do not use any chemicals and are environmentally friendly. They are available in different sizes and outputs to suit different requirements.

Key features:
- high UVC irradiance
- long life

The main lines in the spectrum are at 254 nm and 185 nm. Ultraviolet light, which has a wavelength of less than 240 nm, produces ozone. This high-energy radiation can pass through the quartz glass used for ozone-generating lamps. If ozone is not required then special glass or appropriate types of quartz are used. They are transparent for the radiation that kills micro-organisms but do not let ozone-generating radiation through. HNS® lamps are manufactured as undoped lamps and as amalgam-doped lamps. The undoped lamps achieve their optimum wall temperature of 40 °C at an ambient temperature of around 25 °C. The amalgam lamps, on the other hand, typically reach temperatures around 100 °C and are less sensitive to ambient temperature.

Areas of application

Air purification in:
- hospitals
- doctors' practices
- clean rooms
- offices with or without air-conditioning systems
- storage rooms
- rooms with frequent public access
- animal stalls

Water purification and cleansing in:
- private households
- community water works
- mobile stations (camping, outdoor activities)
- swimming pools and aquariums
- ultra-pure water systems
- food processing
- sewage systems

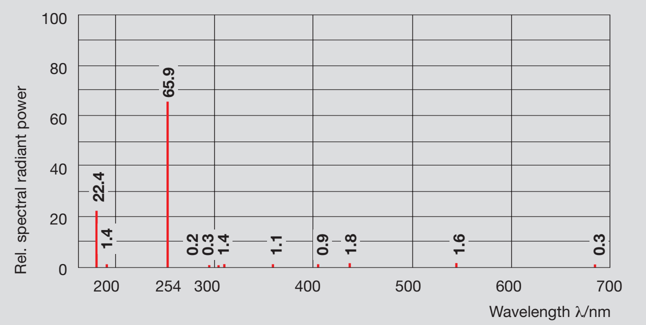
Surface disinfection:
Packaging of pharmaceuticals and food, in aseptic zones and for set of instruments

Odor elimination:
with the aid of the ozone-generating version or air-conditioning systems, storage rooms and extracted air

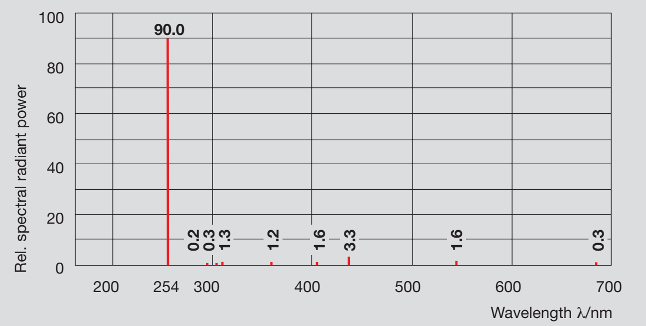
Erasing of Eproms (semiconductor memory):
with the aid of UVC radiation

Spectral power distribution

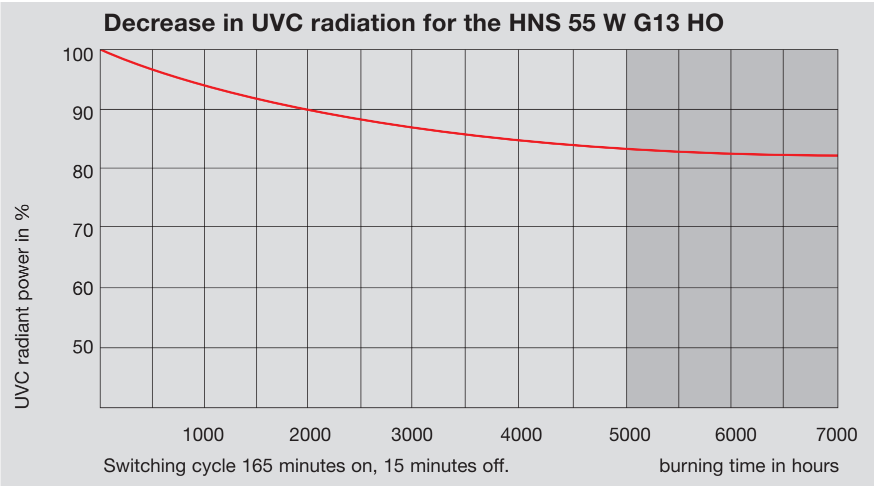
Spectral distribution of ozone-generating lamps



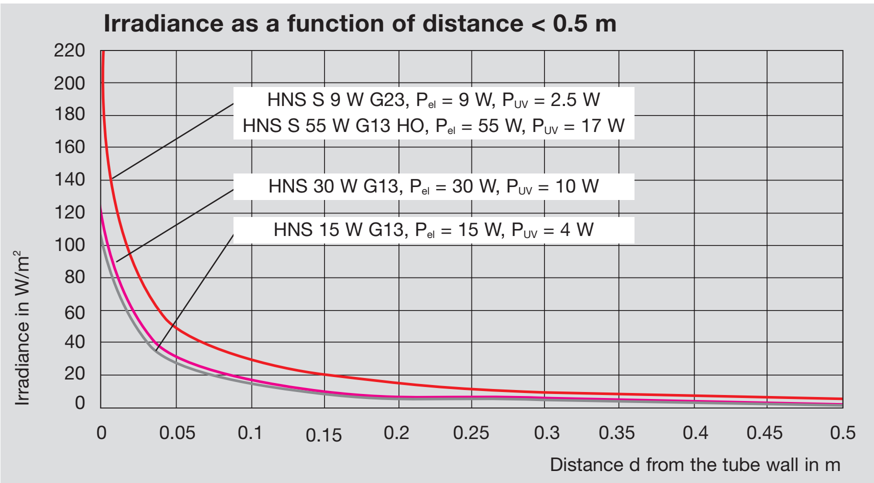
Spectral distribution of ozone-free lamps

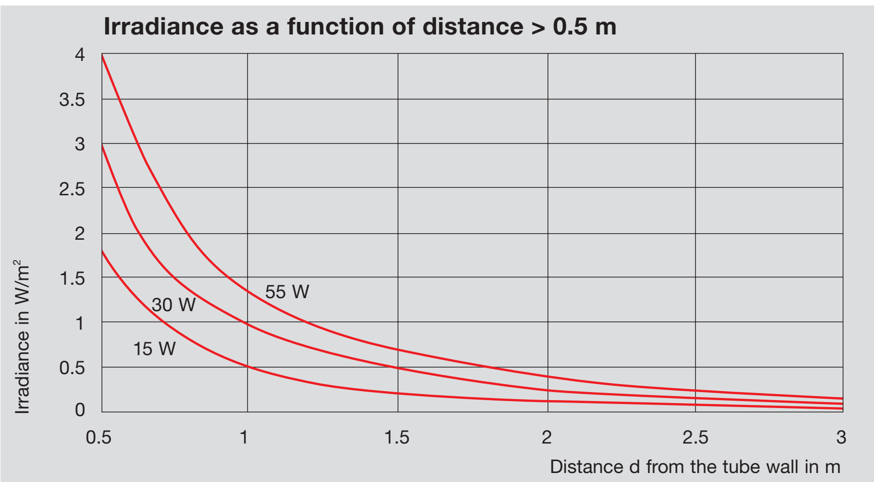


Lifetime radiation behavior



UVC irradiance for tubular PURITEC® HNS® germicidal lamps



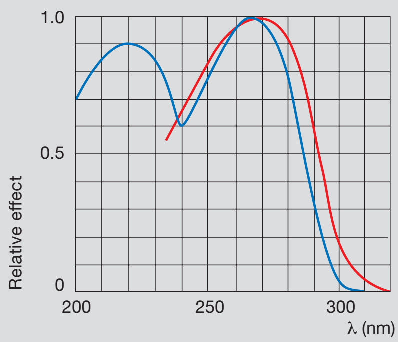


Biological effect

Elimination of bacteria: The anti-bacterial effect of the PURITEC® HNS® lamp is based on the very close match between its maximum radiation at 254 nm and the spectral function $s(\lambda)_{ba,\,rel}$ for killing bacteria. (DIN 5031-10: 2000-03)

Functions

- General elimination of bacteria
- Deactivation of escherichia coli



Warning: The radiation from PURITEC® HNS® lamps poses a health risk. It can cause conjunctivitis and erythema (sunburn) after only brief exposure. The skin and eyes must be protected against direct exposure. Suitable protective clothing must therefore be worn in rooms that do not offer direct protection.

In enclosed rooms, ozone-generating lamps may produce ozone concentrations that are hazardous to health. If germicidal lamps are used to sterilize rooms in which food is kept the relevant food regulations governing the use of germicidal lamps must be followed.

Radiation Doses for Inactivating Various Microorganisms

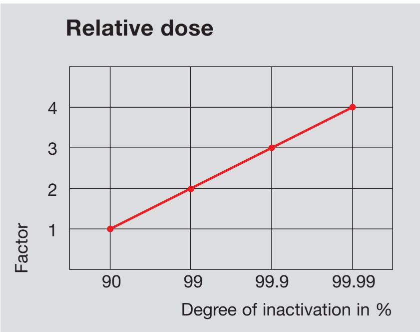
The following values relate to an inactivation rate of 90% at a wavelength of 254 nm, where UV radiation is particularly effective against bacteria. The radiation dose H is defined as UV power x time/irradiated area (Ws/m^2). Values in bold are mean values for the respective families of microbes. Values in brackets show the range of values found in the literature. Additionally, individual examples of the microbe families are listed.

Bacteria	
Bacillus (vegetative)	**32 (13-58)**
Bac. anthracis	45
Bac. Megatherium	13
Bac. paratyphosus	32
Bac. subtilis	58
Bacillus (spore)	**118 (11-365)**
Bac. Megatherium	27
Bac. subtilis	120
Bac. anthracis	45
Bac. subtilis (ATCC6633)	365
Bacillus subtilis	11
Bac. subt. spore ATCC6633	152
Campylobacter jejuni	**29**
Clostridium tetani	**130**
Coryneb. diphteria	**34**
Citrob. freundii (ATCC8090)	**42**
Enterob. cloaca (ATCC13047)	**64**
Escherichia coli:	**45 (7-58)**
Escherichia coli	30
Escherichia coli (in air)	7
Escherichia coli (in water)	54
Escherichia coli ATCC 11229	25
Escherichia coli ATCC 25922	30
Escherichia coli K 12 AB 1157	58
Escherichia coli B/r ATCC 12407	53
Klebsi. pneumon. ATCC4352	**42**
Legionella	**15 (4-26)**
Legionella dumoffi	24
Legionella gormanii	26
Legionella micdadei	15
Legionella longbeachae 1	12
Legionella longbeachae 2	10
Legionella oakridgensis	22
Legionella micdadei	18
Legionella jordanis	11
Legionella wadsworthii	4
Legionella pneumophila	25
Legionella bozemanii	20
Leptospira	**20 (8-28)**
Leptrospira biflexa	23
Leptrospira illini	8
Leptrospira interrogans	28
Micrococcus	**80 (61-100)**
Micrococcus candidus	61
Microc. sphaeroides	100
Neisseria catarrhalis	**44**
Pseudomonas aerug.	**35 (15-55)**
Pseudomonas aeruginosa	55
Salmonella	**43 (21-80)**
Salm. typhimurium	80
Salm. enteritidis	40
Salmonella typhi	21
Serratia marcescens	**32 (7-85)**
Shigella paradysenteriae	**17**
Staph	**44 (18-110)**
Staph. albus	18
Staph. aureus	26
Staph. epidermis	110
Strep.	**36 (18-65)**
Strep. hemolyticus	22
Strep. lactis	62
Strep. viridans	20
Strep. feacalis (ATCC29212)	65
Strep. faecalis	55
Strep. pyogenes	22
Strep. salivarius	20
Strep. albus	18
Vibrio	**24 (8-39)**
Yersinia enterecolitica	**15**
DNA-Viruses	
Parvovirus	**35 (30-40)**
Bov. parvovirus	40
Kilham rat virus	30
HCC (Dog hepat. Adenov)	**265**
Herpes virus	**57 (15-165)**
Pseudorabies virus	70
Herpes simplex MP str.	67
Herpes simplex MP str.	15
Herpes simplex, type 1	165
Vaccinia	**18**
RNA-Viruses	
Picornavirus	**72 (36-186)**
Poliovirus	110
Poliov type 1 Mahoney	67
Poliov	133
Poliov type 1	36
Poliov Mahoney	45
ECBO	80
Coxsackiev	186
Reovirus	**102 (48-163)**
Reovirus type 1	48
Reov type 1 (Lang str)	163
Rotav	159
Rotav SA11	65
Paramyxovirus	**35 (15-55)**
Sindbis virus	55
Newcastle Disease	15
Orthomyxovirus	**35**
Influenza	35
HIV (Lentiv)	**1438 (600-2400)**
HIV (HTLVIII)	600
HIV (Sup T1)	1450
HIV (H9)	2400
HIV (PHA-stim. PBL)	1300
Phages	
Bacteriophage	**152 (65-310)**
Bac. subt. phage SP02c12	150
Bac. subt. phage SPP1	195
Bac. subt. phage Ø 29	70
Bacteriophage F specific	292
Coliphage f2	310
Staph. phage A994	65
Yeasts	**59 (23-100)**
Oospora lactis	50
Saccharomyces cerevisiae (baking yeast, brewing yeast)	33-100
Saccharomyces ellipsoideus	60
Saccharomyces sp.	80
Torula sphaerica (in milk and cream)	23
Fungi	**713 (130-3000)**
Aspergillus glaucus	440
Aspergillus flavus	600
Aspergillus niger	1320
Aspergillus niger (pasta)	1500
Aspergillus amstelodami (meat)	700
Candida paraposilosis	220
Cladospor. herbarum (cold stores)	500
Mucor racemosus	170
Mucor mucedo (meat, bread, fat)	600
Oospora lactis	50
Penicillium chrysogenum (fruit)	500
Penicillium roquefortii	130
Penicillium expansum	130
Penicillum digitatum	440
Rhisopus nigricans	1100
Rhizopus nigricans (cheese)	1100
Scopulariopsis brevicaulis (cheese)	800
Protozoa	**600-1000**
Algae	**3000-6000**
Green algae, blue algae, diatoms	

Radiation doses for deactivating various micro-organisms
The table shows that the radiation dose increases as the organisms become more complex. A greater degree of deactivation calls for a higher dose. The total dose required is the product of the value in the table for 90% deactivation and the value for the relative dose.

Example of 99.9% deactivation of escherichia coli:

Table value 90%:	30 Ws/m²
Factor:	3
Total dose:	90 Ws/m²



Air purification
PURITEC® HNS® lamps efficiently destroy harmful micro-organisms in the air, such as bacteria, viruses, spores, yeasts, algae, protozoa and fungi. Direct or indirect disinfection is used depending on the personal protection requirements.

Indirect disinfection: The disinfection effect in a room is achieved by using convection to move the micro-organisms in the air into the range of the radiation, where they are then deactivated. In the case of indirect disinfection an appropriate aluminum fitting must be provided to ensure that the radiation is shielded at the bottom and reflected up to the ceiling. UV-absorbent ceiling and wall coating is required. People in the room are then not exposed to any danger. Forced circulation of the air in the room can accelerate the disinfection rate.

Indirect disinfection is also used in air recycling, air-conditioning and humidifying equipment. In ventilation ducts it is best to position the lamps beyond the dust filter in the direction of air flow. For air conditioning and ventilation systems it makes sense to install the lamps in radiation chambers.

Direct disinfection: Direct disinfection is possible in rooms in which there are no animals and no people, unless they are wearing appropriate protective clothing. No additional reflectors are needed for direct disinfection. It is best however to provide the walls with highly reflective finishes.

UV reflectance of various materials

Material	Reflectance %
AL: untreated surface	40-60
AL: polished surface	60-89
AL: deposited on glass	75-85
Anodized aluminum	65-75
Stainless steel	25-30
Tinplate	25-30
Chrome plate	35-40
White oil-based paint	3-10
White emulsion paint	10-35
Aluminum paint	40-75
Zinc oxide paint	4-5
Black glaze	5
White glaze	5-10
White plaster, lime	40-60
Magnesium oxide	75-88
Calcium carbonate	70-80
Canvas	15-20
Wallpaper, ivory, glossy	30
Wallpaper, white	20-30

Water purification
PURITEC® HNS® germicidal lamps are the chemical-free alternatives for purifying water in domestic and public settings. They are used in large permanent installations, for example in public water works, and as mobile equipment for example in motorhomes. They are also used for disinfecting swimming pools and waste water.

Wherever possible, the lamps should be installed in the flow of water.

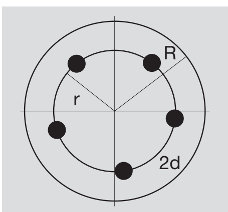
Their effectiveness depends on the composition of the liquid. Salts, organic matter and other ingredients greatly reduce the depth of penetration of UV radiation. This must be taken into consideration in the geometrical design of water purification systems.

For information: For distilled water, UV irradiance reduces to 10% of the initial value at a distance of approx. 3 m. OSRAM offers assistance with calculations.

Project planning example: The number of PURITEC® HNS® lamps required can be determined by answering the following four questions:

- Which micro-organisms are involved?
- What is the required degree of deactivation?
- What is the flow rate?
- What are the dimensions of the vessel?

Calculation method:
- The answers to the first two questions and the relative dose from the diagram on page 5 give the irradiation dose H in Ws/m^2.
- The minimum irradiance E is given as $E = H \times \Phi / (3.14 \times R^2 \times L)$ where the flow rate Φ is in m^3/s, R is the radius and L the length of the irradiation area in m (for cylindrical volumes).
- The maximum distance d between the material to be irradiated and the nearest lamp is given in the "UVC irradiance" diagrams on page 3.
- The lamps are arranged on the circumference of a circle with radius $r = R – d$.
- The distance between two adjacent lamps on the circumference of the circle is 2d.
- The number n of lamps on the circumference of the circle is $n = 3.14 \times (R – d) / d$.



Sample calculation for water purification

Micro-organism:
Escherichia coli in water
Degree of deactivation: 99.9%

Irradiation dose:
$H = 3 \times 54\ Ws/m^2 = 162\ Ws/m^2$

Flow rate:
$\Phi = 270\ m^3/h = 0.075\ m^3/s$

Dimensions of the irradiation area:
R = 0.5 m; L = 0.9 m

Minimum irradiance:
$E = H \times \Phi / (3.14 \times R^2 \times L)$
$E = 17\ W/m^2$

The distance is given by the irradiance diagram on page 3:
d = 0.12 m (HNS 30 W)

Number of lamps:
n = 3.14 x (0.5 – 0.12) / 0.12
n = 10 (HNS 30 W), which have to be arranged uniformly along the circumference of a circle with radius r = R – d = 0.38 m.

Surface disinfection

For packaging pharmaceuticals and food, in aseptic zones in hospitals and for surface disinfection of equipment the infected objects are exposed directly to UV radiation. The efficiency of the radiation can be increased considerably by reflectors (white Teflon or polished aluminum).

Project planning example Conveyor belt application

Questions:

- Which micro-organisms are involved?
- What is the required degree of deactivation?
- What is the distance between the lamp and the material to be irradiated?
- What is the length and speed of the conveyor belt?

Method:

- The answers to the first two questions and the relative dose from the diagram on page 5 give the irradiation dose H in Ws/m^2.
- The distance between the material to be irradiated and the PURITEC® HNS® lamps gives the irradiance E that can be achieved with a lamp in accordance with the diagrams on page 3.
- The conveyor belt length and speed gives the dwell time per lamp segment. The required number of segments is the conveyor belt length divided by the lamp length (approx. 1 m for HNS® 30 W and 55 W).
- The irradiation dose H_{seg} per lamp segment is the irradiation dose divided by the number of lamp segments.
- The required radiation dose H_{seg} per segment divided by the irradiation time per segment gives the required irradiance per segment E_{seg}.

This number of lamps multiplied by the number of segments gives the total number of lamps required.

Sample calculation for surface disinfection

Micro-organism:
Penicillum chrysogenum (mold)
Degree of deactivation: 99%

Irradiation dose:
H = 2 x 500 Ws/m^2 = 1000 Ws/m^2
Planned distance between the lamps and the material to be irradiated 0.2 m

Irradiance:
(HNS 55 W, page 3)
E = 17 W/m^2
With suitable reflectors it is possible to almost double the irradiance in the direction of the material to be irradiated, i.e. approx. 35 W/m^2.

Conveyor belt length to be irradiated:
4 m (lamp length approx. 1 m, therefore 4 lamp segments.)

Speed of the conveyor belt:
0.5 m/s

Dwell time of the material per lamp segment:
2 s

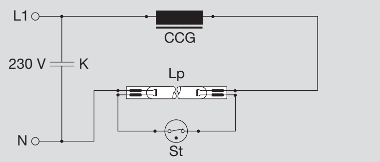
Irradiation dose per lamp segment:
H_{seg} = 1000 Ws/m^2/4 = 250 Ws/m^2

Irradiance per segment:
E_{seg} = 250 Ws/m^2/25 = 125 W/m^2

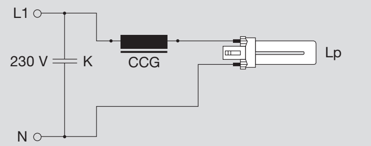
Number of lamps:
n = 125 Ws/m^2/35 W/m^2
n = 4 lamps
per segment
For 4 segments the total number of lamps is 16 x PURITEC® HNS® 55 W.

Wiring

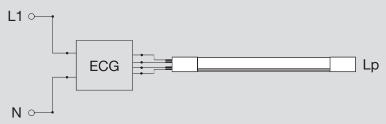
PURITEC® HNS®



PURITEC® HNS® S G23



PURITEC® HNS® CONSTANT



CCG: Conventional control gear;
ECG: Electronic control gear;
Lp: Lamp;
N: Neutral conductor;
L1: Phase;
St: Starter;
K: PF correction capacitor

Operating instructions: In the case of PURITEC® HNS® S G23, the starter for ignition on line voltage is integrated in the base. ECG operation is recommended for amalgam lamps.

Note: The calculations are intended only to highlight the physics involved.

Separate calculations and tests are required for each project.

Global presence.

OSRAM supplies customers in around 150 countries.
- 73 companies and sales offices for 111 countries
- 38 countries served by local agents or OSRAM GmbH, Munich

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