

INTRODUCTORY GUIDE

# **KILLING VIRUS AND BACTERIA**

WITH HEAT

# HEAT EFFICIENTLY KILLS BACTERIA AND VIRUSES

The best way to disinfect a room is HEAT. In fact, heat can penetrate deeply into the area, efficiently killing bacteria and deactivating viruses. The effect of heat disinfection in a room can be measured and documented by using Master IMCS.

Heat comes with numerous other benefits:

- Environmentally friendly
- Simple setup procedure
- No subsequently cleaning required
- No risk of chemical pollution and/or allergic reactions
- Much more efficient than any other known alternative

Founded in 1954, Master Climate Solutions is an experienced manufacturer of portable heating solutions for a vast number of industries. Our EKO heaters have been specifically designed to exterminate living organisms quickly and with the highest possible success rate. Experienced industry experts stand ready to ensure efficient and correct usage.

This quick guide provides an overview of typical application areas, a list of temperature and duration requirements along with a short description of our EKO solutions.

## **FOCUS:**

### **VIRUS & BACTERIA HEAT DISINFECTION FOR VEHICLES**

Being frequently used by or in contact with different people, vehicles such as trains, buses, ambulances, trucks and cars are greatly exposed to bacteria and virus contamination. Using chemicals or household cleaning agents for disinfection procedures is risky as it will only do the job where it is applied. In contrast, heating eliminates viruses and bacteria everywhere.

**Give your customers a safe travel experience without risk. Use HEAT.**

## DISINFECTING BY HEAT IS PROVEN BY SCIENCE

Heat has been known to kill pathogens for centuries. In the course of history, scientists have been able to demonstrate how temperature exposure kills or disactivates a wide variety of bacteria and viruses. This is substantiated by the below table:

Species	Temperature	Duration	Author/Scientist
Bacillus coli (E. coli)	60°C	10 minutes	Loeffler (1886)
Bacillus typhosus	56°C	10 minutes	Sternburg (1887)
Dysentery bacilli	60°C	10 minutes	Runge & O'Brien (1924)
Vibrio cholerae	55°C	15 minutes	Kitasato (1889)
Mycobacterium tuberculosis	63°C	3 minutes	North & Park (1925)
Bacillus pestis (Yersinia)	60°C	2 minutes	Gladin (1898)
Staphylococci	62°C	10 minutes	Sternburg (1887)
Streptococci	60°C	30 minutes	Ayers & Johnson (1918)

Source: Hampil, B. (1932): "The Influence of Temperature on the Life Processes and Death of Bacteria", *The Quarterly Review of Biology*, 7(2):172-196

In relation to modern day viruses such as the SARS-CoV Coronavirus, recent studies have found it to be quite stable at low and room temperatures. According to WHO, only a minimal reduction in virus concentration can be detected after 21 days at 4°C and -80°C respectively. At room temperature, even after two days, the virus concentration is reduced by one log only. This strong resistance makes Coronavirus extremely infectious.

However, studies conducted by the Chinese Institute for Viral Disease Control and Prevention (supported by Gerba, 1997; Laude, 1981) demonstrate that the family of Coronaviruses in general is quickly disactivated at higher temperatures. This is illustrated in the below table.

## CORONAVIRUS CAN BE DEACTIVATED WITH HEAT

**THIS TABLE SHOWS THAT CORONAVIRUS IS VERY STABLE AT LOW TEMPERATURES, BUT CAN BE QUICKLY DEACTIVATED AT TEMPERATURES ABOVE 56°C.**

	4°C		20°C		37°C		56°C		67°C		75°C	
15 min	+++	+++	+++	+++	+++	+++	+++	+++	++	++	+	+
30 min	+++	+++	+++	+++	+++	+++	+++	+++	+	+	-	-
60 min	+++	+++	+++	+++	+++	+++	++	++	-	-	-	-
90 min	+++	+++	+++	+++	+++	+++	-	-	-	-	-	-
120 min	+++	+++	+++	+++	+++	+++	-	-	-	-	-	-
Cell control	-	-	-	-	-	-	-	-	-	-	-	-
Virus control	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++

Note: CPE of infected cells was determined 48 h postinfection.

+: less than 25% cells with CPE, ++: 26%-50% cells with CPE, +++: 75% cells with CPE, ±: only few cells with CPE, -: without detectable CPE.

Source: "Stability of SARS Coronavirus in Human Specimens and Environment and Its Sensitivity to Heating and UV Irradiation", *Biomedical and environmental sciences* 16, 246-255 (October 2003)

# APPLICATIONS

Heat treatments can eliminate bacteria and viruses in a variety of applications, a selection of which have been depicted here.

Common to all is the fact that heat needs to be applied long enough to penetrate the entire application structure for full efficiency. That

requires a source of heat (heater) combined with a device capable of accurately measuring the temperature (digital thermostat) in the coldest area of the application.

*Please contact us for assistance in how to heat treat your application correctly.*

## AIRPLANES



## AMBULANCES



## EMERGENCY TENTS & ARMY BARRACKS



## SPECIAL CLOTHING & TECHNICAL EQUIPMENT





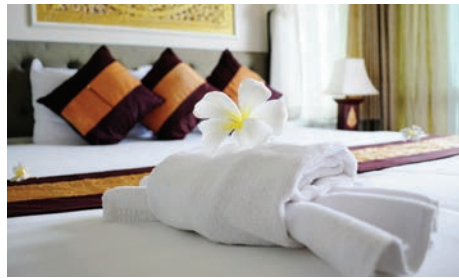
## HOSPITALS

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## HOTELS & HOSTELS

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## POLICE CARS

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## PRISON CELLS

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## PUBLIC TRANSPORT

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## RENTAL CARS

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## TRAIN CARRIAGES

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## FOOD CONTAINERS

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# TEMPERATURES AND DURATION

The following table contains a number of examples from the literature demonstrating how temperature exposure affects different bacteria and viruses.

Please note that the table is for guidance only. Many factors can influence the time required to deactivate bacteria and viruses in different applications. Therefore, all stated figures are indicative and provided as is for guidance only.

## BACTERIA – *indicative temperature and time requirements*

Pathogen/Organism	Death Point	Time req.	Reference/Source*
Acinetobacter baumannii	63°C	15 minutes	Dumalisile, et al., 2005
Aeromonas hydrophila	50°C	3 minutes	Gerba, 1997; Gordon et al., 1992
Bacillus anthracis	140°C	3 hours	Hampil, 1932; Koch, 1881
Bacillus coli (E. coli)	60°C	10 minutes	Hampil, 1932; Loeffler, 1886
Bacillus pestis (Yersinia)	60°C	2 minutes	Hampil, 1932; Gladin, 1898
Bacillus typhosus (Salmonella)	56°C 63°C	10 minutes 4 minutes	Hampil, 1932; Sternburg, 1887 Hampil, 1932; Orskov, 1926
Bacterium tularense	56°C	10 minutes	Hampil, 1932; McCoy, 1912
Brucella abortus	61°C	3 minutes	Jones & Martin, 2003; Golueke, 1982
Brucella abortus	55°C 65°C	60 minutes 3 minutes	Jones & Martin, 2003; Stern, 1974
Brucella abortus or suis	55°C 60°C	60 minutes 3 minutes	Jones & Martin, 2003; Day & Shaw, 2000
Brucella melitensis	55°C 60°C	30 minutes 15 minutes	Hampil, 1932; Zwick & Wedeman, 1913
Burkholderia mallei	55°C	10 minutes	Health Canada, 2007
Campylobacter spp.	75°C	1 minute	Gerba, 1997; Bandres et al., 1988
Chlamydia psittaci	56°C	5 minutes	TIP, 2000; Anderson et al., 1997
Chryseobacterium meningosepticum	63°C	15 minutes	Dumalisile, et al., 2005
Corynebacterium diphtheriae	55°C 70°C	45 minutes 4 minutes	Jones & Martin, 2003; Stern, 1974
Dysentery bacilli (Shigella)	58-60°C	10 minutes	Hampil, 1932; Runge & O'Brien, 1924
Enterococcus faecium	60°C 62.5°C 65°C	<45 minutes <20 minutes <10 minutes	Spelina et al., 2007
Escherichia coli	45°C 60°C 65°C 70°C 75°C	24 hours 105 minutes 45 minutes 45 minutes 15 minutes	Abbott, 2011
Escherichia coli	60°C	45 minutes	Padhye & Doyle, 1992
Escherichia coli	65°C	1 minute	Gerba, 1997; Bandres et al., 1988
Escherichia coli	60°C 70°C	60 minutes 5 minutes	Jones & Martin, 2003; Stern, 1974
Escherichia coli	55°C 60°C	60 minutes 20 minutes	Jones & Martin, 2003; Day & Shaw, 2000

**BACTERIA**

Pathogen/Organism	Death Point	Time req.	Reference/Source*
Escherichia coli	55°C 60°C	60 minutes 20 minutes	Jones & Martin, 2003; Golueke, 1982
Escherichia coli	63°C	25 minutes	Dumalisile, et al., 2005
Hemophilus influenzae	62°C	2 minutes	Hampil, 1932; Onorato, 1902
Klebsiella pneumoniae	45°C 60°C 65°C 70°C	24 hour 105 minutes 45 minutes 45 minutes	Abbott, 2011
Legionella	66°C	.45 minutes	Gerba, 1997; Sarden et al., 1989
Legionella pneumophila	60°C	30 minutes	Stout, et al., 1986
Listeria monocytogenes	63°C	30+ minutes	Rowan and Anderson 1998
Listeria monocytogenes	63°C	20 minutes	Dumalisile, et al., 2005
Meningococci	60°C	1 minute	Hampil, 1932; Bettencourt and Franca, 1904
Mycobacterium avium sub. paratuberculosis	62°C 71°C	23 minutes 73 seconds	Sung & Collins, 1998
Mycobacterium diphtheriae	55°C 70°C	45 minutes 4 minutes	Jones & Martin, 2003; Stern, 1974
Mycobacterium spp. M. avium	70°C	2 minutes 2.3 minutes	Gerba, 1997; Robbecke and Buchhottz, 1992
Mycobacterium avium sub .paratuberculosis	72°C	15 seconds	Pearce, 2001
Mycobacterium tuberculosis	63°C	3 minutes	Hampil, 1932; North & Park, 1925
Mycobacterium tuberculosis	70°C	20 minutes	Jones & Martin, 2003; Stern, 1974
Mycobacterium tuberculosis	63°C 72°C	30 minutes 15 seconds	Connor, 2007
Paratyphoid bacilli	60°C 63°C	20 minutes 3 minutes	Hampil, 1932; Krumwiede & Noble, 1921 Hampil, 1932; Orskov, 1926
Pasteurella multocida	56°C 60°C	15 minutes 10 minutes	TIP, 2000; Rimler and Glisson, 1998
Pasteurella spp.	55°C	15 minutes	Health Canada, 2007
Pneumococci	60°C	30 minutes	Hampil, 1932; Baggar, 1926
Pseudomonas aeruginosa	45°C 60°C 65°C 70°C	4 hours 75 minutes 45 minutes 45 minutes	Abbott, 2011
Pseudomonas aeruginosa	60°C	<10 minutes	Spinks, et al., 2003
Pseudomonas putida	63°C	20 minutes	Dumalisile, et al., 2005
Salmonella	60°C	1 hour	Feachem, 1983
Salmonella sp.	65°C	1 minute	Gerba, 1997; Bandres et al., 1988
Salmonella newport	60°C 65°C	40 minutes 30 minutes	Wiley & Westerberg (1969)
Salmonella typhi	60°C 70°C	30 minutes 4 minutes	Jones & Martin, 2003; Stern, 1974
Shigella sp.	50°C	1 hour	Jones & Martin, 2003; Stern, 1974
Shigella sp.	55°C	1 hour	Feachem, 1983
Shigella spp.	65°C	1 minute	Gerba, 1997; Bandres et al., 1988
Staphylococci	62°C	10 minutes	Hampil, 1932; Sternburg, 1887
Staphylococcus aureus	45°C 50°C 60°C 65°C 70°C	96 hours 48 hours 105 minutes 45 minutes 45 minutes	Abbott, 2011
Methicillin Resistant Staphylococcus aureus (MRSA)	50°C 65°C 70°C	24 hours 45 minutes 45 minutes	Abbott, 2011
Staphylococcus aureus	50°C	10 minutes	Jones & Martin, 2003; Golueke, 1982
Staphylococcus aureus	63°C	20 minutes	Dumalisile, et al., 2005
Streptococci	60°C	30 minutes	Hampil, 1932; Ayers & Johnson, 1918
Streptococcus pyogenes	54°C	10 minutes	Jones & Martin, 2003; Golueke, 1982
Streptococcus pyogenes	55°C	10 minutes	Jones & Martin, 2003; Day & Shaw, 2000
Vibrio cholera	55°C	1 minute	Gerba, 1997; Roberts & Gilbert, 1979
Vibrio cholerae	55°C	15 minutes	Hampil, 1932; Kitasato, 1889
Yersinia enterocolitica	60°C	30 minutes	Gerba, 1997; Frazier and Westhoff, 1988
Coxiella burnetii	63°C	30 minutes	Connor, 2007
Coxiella burnetii	63°C	30 minutes	Health Canada, 2007

## VIRUSES – indicative temperature and time requirements

VIRUSES	Pathogen/Organism	Death Point	Time req.	Reference/Source*
	Adenovirus	60°C	20 minutes	Gerba, 1997; Mahnel, 1977
	Avian pneumovirus	56°C	30 minutes	TIP, 2000; Collins, 1986
	Cercopithecine Herpes Virus 1	60°C	30 minutes	Health Canada, 2007
	Coronavirus	55°C	2 minutes	Gerba, 1997; Laude, 1981
	Coxsackievirus	60°C	30 minutes	Health Canada, 2007
	Cytomegalovirus	60°C	30 minutes	Health Canada, 2007
	Ebola virus	60°C	60 minutes	Health Canada, 2007
	Echovirus	50°C	2 hours	Health Canada, 2007
	Enterovirus 70	60°C	30 minutes	Health Canada, 2007
	Enteroviruses, Reoviruses and Adenoviruses (All)	60°C	2 hours	Feachem, 1983
	Epstein-Barr Virus	60°C	30 minutes	Health Canada, 2007
	Hantavirus Pulmonary Syndrome (HPS)	60°C	30 minutes	Health Canada, 2007
	Hepatitis A	70°C	10 minutes	Gerba, 1997; Siegl et al, 1984
	Hepatitis A	70°C	4 minutes	Health Canada, 2007
	Highly Pathogenic Avian Influenza (HPAI)	56°C	15 minutes	TIP, 2000; Blaha, 1989
	Infectious bronchitis	56°C	15 minutes	Otsaki, 1979
	Newcastle Disease Virus (NDV)	60°C 70°C	1 hour 50 seconds	TIP, 2000; Foster & Thompson, 1957
	Norwalk virus	>60°C	>30 minutes	Health Canada, 2007
	Parvoviruses	60°C	30 minutes	TIP, 2000; Gough et al, 1981
	Poliovirus	60°C	25 minutes	Gerba, 1997; Larkin and Fasolitis, 1979
	Poliovirus 1	55°C 60°C	30 minutes 5 minutes	Feachem, 1983, p163; Wiley & Westerberg, 1969
	Poxviruses	60°C	8 minutes	TIP, 2000; Tripathy, 1993
	Reovirus	60°C	20 minutes	Gerba, 1997; Mahnel, 1977
Rotavirus	63°C	30 minutes	Feachem, 1983, p188; G.N. Woode	
Rotavirus	50°C	30 minutes	Gerba, 1997 ; Estes, et al., 1979	
Viruses (Most)	70°C	20 minutes	Jones & Martin, 2003; Day & Shaw, 2000	
Viruses (Most)	70°C	25 minutes	Jones & Martin, 2003; Stern, 1974	

**MOST VIRUSES CAN BE EASILY DEACTIVATED IN LESS THAN 1 HOUR WHEN TREATED WITH TEMPERATURES BETWEEN 55°C AND 70°C.**



# MASTER EKO 3KW ELECTRIC HEATER

An effective disinfection requires high temperatures. But to avoid thermal shock to the room and the objects in it, the temperature needs to be increased smoothly. Master's purpose-built EKO heaters do just that.

Most other heaters on the market are incapable of reaching these high temperatures smoothly and are therefore unfit for thermal disinfection.



## FEATURES

- Compact and lightweight
- EKO 3 delivers 800 m<sup>3</sup>/h of hot air using only 2.8 kW at 240 V (single phase)
- Connection to the external digital remote thermostat THK, specific for this application, included in the package
- Overheat thermostat
- Motor with thermal protection and intervention
- The Master EKO is placed inside the room and recirculates the air increasing the temperature by 15°C at a time
- Compatible with Master IMCS remote monitoring and documentation device

### Included in the box



Remote thermostat THK with probe 4150.137



Master IMCS



Specifications	Units	EKO 3
Heating power	kW	2.8
	Btu/h	11260
	kcal/h	2866
Air flow	m <sup>3</sup> /h	800
Power supply	V/Hz	230/1ph/50
Rated current	A	12.4
Remote thermostat		Digital
Product size (l x w x h)	mm	455 x 440 x 600
Weight	kg	19

### Note:

EKO 3 has a power limited to 2.8 kW.  
EKO 3 alone will not be able to heat a standard room.  
EKO 3 is designed to be used in very small spaces or as a support to an EKO 9

## SMOOTH TEMPERATURE INCREASE

The temperature of the air flowing through is increased in amounts of 15°C each time. 20°C->35°C->50°C- 70°C. The big air flow allows a fast increase and an even temperature distribution. This solution avoids temperature shocks, which would let insects run away.

## HIGH AIR FLOW

The high air flow quickly mixes the air in the room allowing to heat everywhere.

# MASTER EKO 9KW ELECTRIC HEATER

An effective disinfection requires high temperatures. But to avoid thermal shock to the room and the objects in it, the temperature needs to be increased smoothly. Master's purpose-built EKO heaters do just that.

Most other heaters on the market are incapable of reaching these high temperatures smoothly and are therefore unfit for thermal disinfection.



## FEATURES

- EKO 9 delivers 1400 m<sup>3</sup>/h of hot air using only 9 kW at 380 V (three phase)
- Connection to an external digital remote thermostat THK, specific for this application, included in the package
- Overheat thermostat
- Motor with thermal protection and intervention
- The Master EKO is placed inside the room and recirculates the air increasing the temperature by 15°C at a time
- Compatible with Master IMCS remote monitoring and documentation device

### Included in the box



Remote thermostat THK with probe 4150.137



Master IMCS



### Optional accessories



Extension cord  
16A, 5m  
16A, 10m

## SMOOTH TEMPERATURE INCREASE

The temperature of the air flowing through is increased in amounts of 15°C each time. 20°C->35°C ->50°C- 70°C. The big air flow allows a fast increase and an even temperature distribution. This solution avoids temperature shocks, which would let insects run away.

## HIGH AIR FLOW

The high air flow quickly mixes the air in the room allowing to heat everywhere.

Specifications	Units	EKO 9
Heating power	kW	9
	Btu/h	30709
	kcal/h	7740
Air flow	m <sup>3</sup> /h	1400
Power supply	V/Hz	400/3ph/50
Rated current	A	13.8
Remote thermostat		Digital
Product size (l x w x h)	mm	550 x 606 x 921
Weight	kg	35

# MASTER EKO 150 DIESEL HEATER 150KW

An effective disinfection requires high temperatures. But to avoid thermal shock to the room and the objects in it, the temperature needs to be increased smoothly. Master's purpose-built EKO heaters do just that.

Most other heaters on the market are incapable of reaching these high temperatures smoothly and are therefore unfit for thermal disinfection.



**BIG POWER FOR BIG ROOMS!**

## FEATURES

- The MASTER EKO 150 is an extremely powerful heater which is able to treat large spaces, ie. chicken farms, pig farms
- It delivers 12,800 m<sup>3</sup>/h of hot air
- It uses only 2.8kW of electric power at 220-240V
- Connection to an external digital remote thermostat THK, specific for this application, included in the package
- Connection to flexible tubes to disperse heat in critical points
- High air pressure, allowing the use of long flex tubes
- Air recirculation, allowing the heater to be placed outside the room being treated
- Compatible with Master IMCS remote monitoring and documentation device

### Included in the box



**Remote thermostat THK with probe 4150.137**



**Master IMCS**

## SMOOTH TEMPERATURE INCREASE

The temperature of the air flowing through is increased in amounts of 15°C each time. 20°C->35°C->55°C- 70°C. The big air flow allows a fast increase and an even temperature distribution. This solution avoids temperature shocks, which would let insects run away.

## HIGH AIR FLOW

The high air flow quickly mixes the air in the room allowing to heat everywhere.



Specifications	Units	EKO 150
Heating power	kW	150
	Btu/h	512,000
	kcal/h	129,000
Total air pressure	Pa	250
Air flow	m <sup>3</sup> /h	12,800
Flex tube	cm	1 tube Ø 70cm,
		2 tubes Ø 51cm or
		4 tubes Ø 34cm
Power supply	V/Hz	220-240/1ph/50
Rated current	A	12.6
Remote thermostat		Digital
Summer ventilation		Yes
Fan		Axial
Flue tube	mm	200
Electronic box protection		IP 55
Product size (l x w x h)	mm	2200 x 985 x 1620
Weight	kg	380

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