

# Burner Technology

Energy-efficient and maintenance-friendly solutions for industrial heating technology



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## NOXMAT – RELIABILITY AT WORK

### Energy-efficient and service-friendly burner technology Made in Germany

We manufacture industrial burners and radiant tubes as well as fittings relating to the heating technology of industrial thermal processing plants. Our products are sold in over 30 countries around the globe and used in heat treatment plants and facilities for the heating of metals (ferrous and non-ferrous).

Our products are designed and manufactured for maximum reliability and ease of operation.

In cooperation with manufacturers of industrial thermal processing plants and with the operators themselves, we provide optimal solutions for their respective requirements.

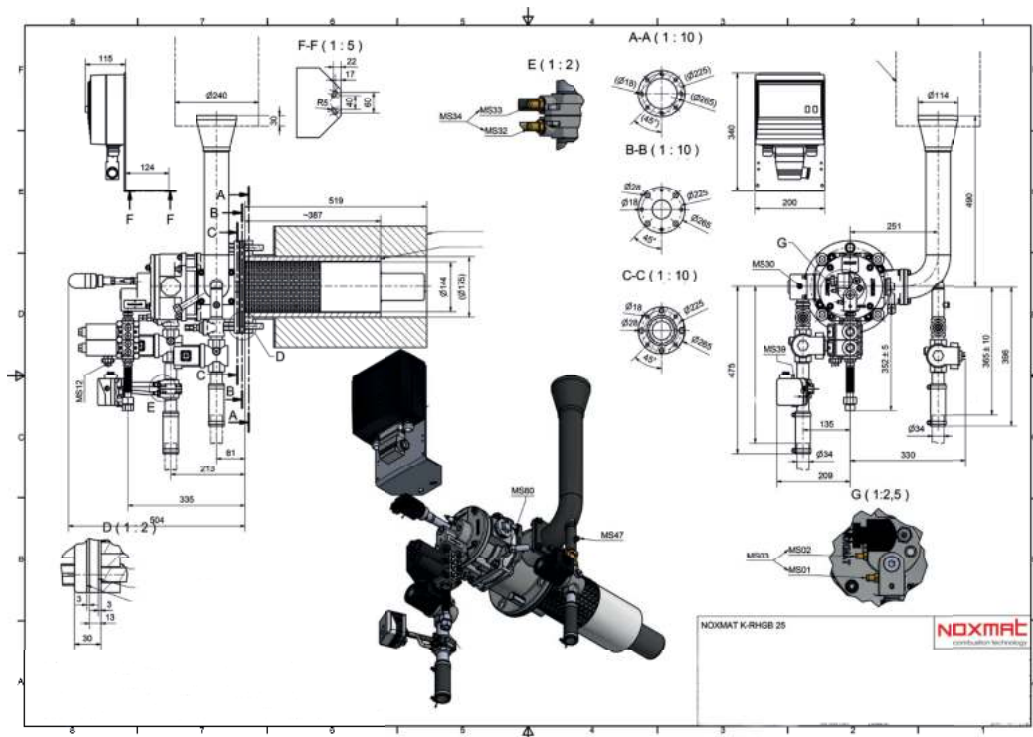
More than 25 years of experience in this field make us a competent partner for you, in all areas of industrial heating technology.



# NOXMAT – RELIABILITY AT WORK

## Planning and design of burner technology in industrial thermal processing plants

NOXMAT will support you right from the start, with planning and designing the heating system for your thermal processing plant. With more than 25 years of experience in the field of industrial burner technology, we are a skilled partner for your project. From simple retrofitting measures to complex new installations - our engineers are by your side to find the optimal choice and top configuration for your plants. Your needs are always at the core of our efforts. Optimal customer benefits, top efficiency, and energy as well as emissions savings.



## Service

At NOXMAT, our competent service team knows all there is to know regarding the heating systems of gas-fired industrial furnaces. Our technicians are the experts for thermal processing plants, and are equipped with all necessary tools for measurement, diagnosis, and service.

Our motto: Best in Class!



## Maintenance

Our service team's objective is always to maintain the mint condition of your plant's heating system or to reset the system to this state, so that your operation can run efficiently and smoothly.

## Optimization

Quite often, a lot of potential for savings lies dormant inside an industrial furnace, which is not always immediately apparent to the operator. This potential can often be revealed with relatively simple measures.



## Retrofit

Retrofitting or modernizing a furnace plant's heating system is a real alternative to a new investment. Considerable savings of up to 30% can thus be achieved quite frequently. An increase in production and product quality may be further results of such retrofit measures.

# BASICS OF COMBUSTION TECHNOLOGY

## Combustion triangle

The combustion triangle represents the necessary conditions for combustion. All conditions must coincide at the same time and in the same place.

The three conditions in the combustion triangle are the following:

- Fuel
- Oxygen
- Heat (mechanical sparks, electricity)



Source: Wikipedia

As the mixing ratio is essential for meeting the three conditions to start the combustion process, it is considered a fourth condition.

## Firing efficiency $\eta_F$

Firing efficiency describes the use of the heat arising from the combustion of a fuel at nominal load. Only the heat loss caused by the cooling of the flue gas down to ambient temperature is considered.

$$\eta_F = 100 \% - q_A \quad (q_A: \text{Flue gas loss } [\%])$$

Approximate calculation using the following formula:

$$q_A = (\vartheta_a - \vartheta_f) \cdot \left( \frac{A_2}{21 - O_2} + B \right)$$

$A_2 = 0,66$  (Natural gas)  
 $B = 0,009$  (Natural gas)  
 $\vartheta_a$  – flue gas temperature [°C]  
 $\vartheta_f$  – Combustion air temperature [°C]  
 $O_2$  – Oxygen level in flue gas [%]

## Air-fuel ratio $\lambda$

The air-fuel ratio  $\lambda$  is the ratio between the amount of supplied air  $l_0$  and the theoretically required amount of air  $l_{0,min}$

$$\lambda = \frac{l_0}{l_{0,min}}$$

$\lambda = 1$  refers to the stoichiometric air-fuel ratio, meaning all fuel molecules react completely with atmospheric oxygen, without creating a lack of oxygen or residual unburned oxygen.

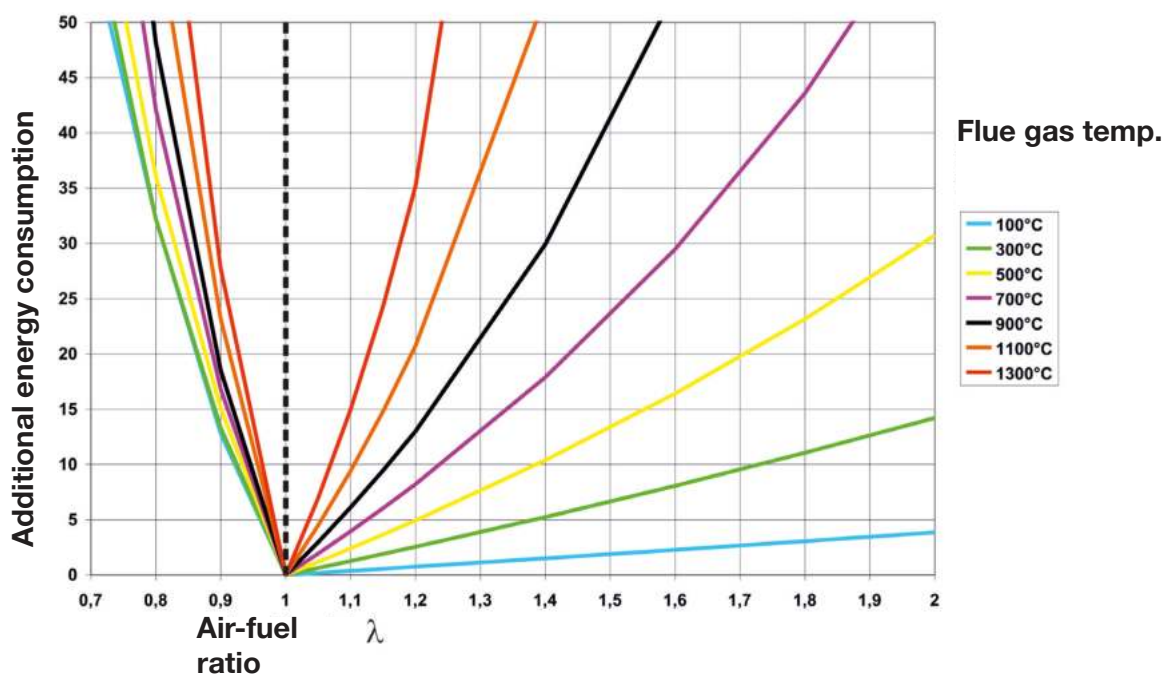
$\lambda < 1$  (i.e. 0.9) means “lack of air”

$\lambda > 1$  (i.e. 1.1) means “surplus of air”

An approximative calculation can be done through the residual oxygen content in the flue gas:

$$\lambda \approx \frac{21}{21 - \kappa_{O_2}}$$

Optimally, the residual amount of oxygen in the flue gas should be between 2.5 and 3.5%. A lambda which is too high leads to an excess consumption of fuel gas, which increases even further at higher application and flue gas temperatures.



# BURNER TECHNOLOGY

## Design features and function of a cold-air burner



The cold-air burner consists of a two-parts burner body, the combustion tube, a gas lance, and an electrode.

Combustion air flows via the connection pipe, through the air part, into the combustion tube and then through the swirl plate into the combustion chamber. The swirl plate swirls the combustion air, leading to intensive mixing with the combustion gas inside the combustion chamber. The combustion gas flows towards the swirl plate through the gas part and the gas lance via the connection pipe. At this point, the gas flow is separated. The main part of the combustion gas flows into the combustion chamber, where it is intensively mixed with the swirled combustion air. The smaller share of the combustion gas is led into the ignition chamber of the swirl plate and then ignited with high-voltage sparks.

Perfectly matched conditions inside the ignition chamber enable easy ignition and starting of the burner (cold start). The flame gases emit from the burner tube at high velocity.

The waste gases emerging from the burner are vented separately.

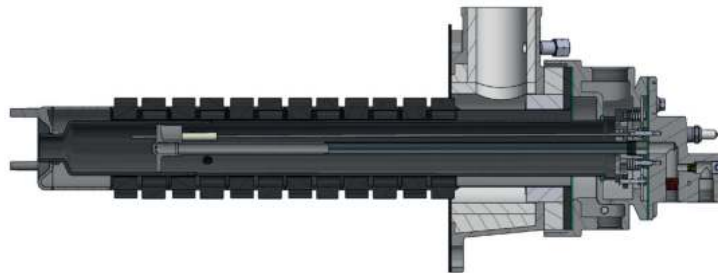
Purge air is added to the combustion gas inside the gas part in metered quantities via a purge air nozzle. This makes for good ignition conditions. Moreover, it flushes the residual combustion gas left in the gas lance when the burner shuts-down, thus avoiding afterburning.

Upon request, NOXMAT high-velocity burners can also be equipped with a cooling air connector. Cooling air flows from the connector through the air part, directly through the combustion tube and into a radiant tube or into the furnace chamber.

Depending on the process, flame monitoring occurs via a flame monitoring current and a UV sensor, or via an ionization current and the electrode, which serves as both an ignition and an ionization electrode.



## Design features and function of a recuperative burner



The recuperative burner is comprised of a three-part burner body, a recuperator, a burner tube, a gas lance, and an electrode, along with various other components.

Combustion air flows via a connected line through the air part and the recuperator and is preheated by utilizing the waste-gas heat. The majority of the combustion air (primary air) flows from the recuperator outlet through holes into the interior of the burner tube and, further, through the swirl plate into the combustion chamber. The smaller portion of combustion air (secondary air) exits the recuperator through the annular gap in the combustion-air chamber mouth and is mixed with the flame gases escaping from the combustion chamber.

The air guide plate splits-up the volumetric combustion-air flow as it enters the air part. Combustion air may flow either completely through the recuperator, or some portion of it may flow directly through the burner tube inside the burner. This is to protect the burner internals from overheating in case of very high thermal loads.

Fuel gas flows via a connected line through the gas part and the gas lance to the swirl plate. At this point, the gas flow is divided. The majority of the fuel gas flows into the combustion chamber, where it mixes with the intensively swirled combustion air. A smaller portion of the fuel gas is siphoned into the ignition chamber of the swirl plate and is ignited there by means of a high-voltage ignition spark. Precise conditions in the ignition chamber ensure successful, repeatable ignition of the burner, even from a cold start.

The flame gases escape with high velocity from the burner tube. They are mixing with secondary air, thus achieving complete combustion. Graded fuel-gas and combustion-air supplies affect a delayed combustion process, entailing a low combustion temperature and, thus, reduced NO<sub>x</sub>-emission.

Waste gas is flowing via the recuperator into the waste-gas part and finally exits the burner from there.

# BURNER TECHNOLOGY

The waste gas conveys a part of its heat to combustion air in the recuperator to preheat the combustion air. Said preheating cycle entails fuel savings.

Purge air is supplied to fuel gas in the gas part through a purge-air nozzle in metered quantities to achieve excellent conditions for ignition. Further, said purge air is purging the gas lance to remove residual fuel gas in case of burner shutdown. So, any afterburning is precluded.

NOXMAT recuperated burners are equipped with a separate cooling-air connection. Cooling air is directly flowing from there through the burner tube into the radiant tube.

Flame monitoring is achieved either via the flame monitoring current of a UV-sensor, or via the ionization current of the electrode, which in this case performs both the ignition and ionization functions.

## Waste gas losses

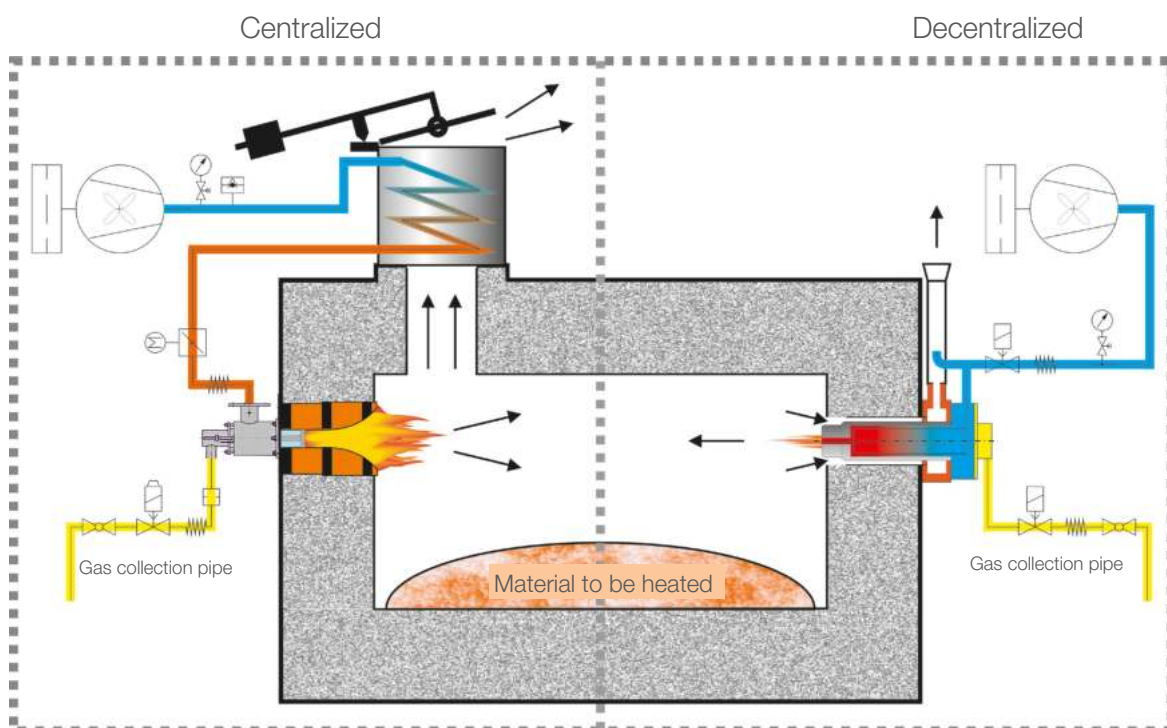
As the name suggests, a cold-air burner is operated without preheating the combustion air. This makes its set-up especially simple. The rising process temperature naturally leads to a rise in waste gas temperature and thus in waste gas loss. At furnace temperatures of 1000°C, the waste gas loss in case of direct heating is almost precisely 50%, meaning that only 50% of the energy supplied by the combustion gas is used for the heating of the furnace/material to be heated; the other 50% exits the furnace chamber completely unused. Firing efficiency thus is also 50%.

## Heat recovery – Energy conservation through pre-heating of the combustion air

A very effective way to improve the efficiency is to preheat the combustion air through recuperated heat recovery from the waste gas. By reducing the waste gas temperature, the temperature of the combustion air is increased, thus directly enhancing firing efficiency.

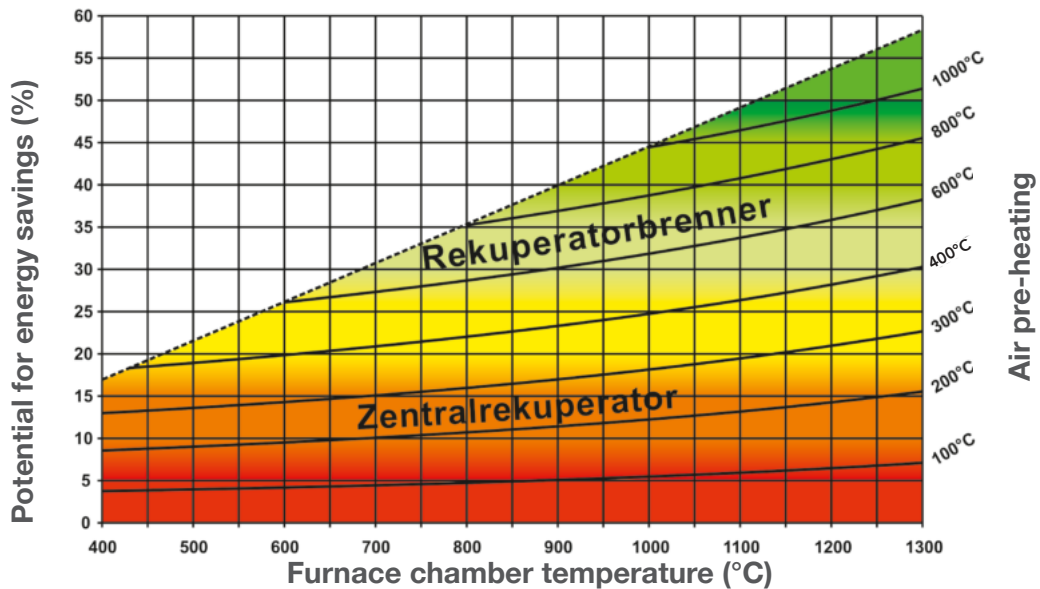
A reduction of the waste gas temperature by 100°C leads to an increase of firing efficiency of almost 6%.

Recuperated heat recovery can be centralized, meaning that the waste gases caused by the individual burners are led through one central heat exchanger (central recuperator); or it can be decentralized, meaning that each burner has its own heat exchanger (recuperator burner).

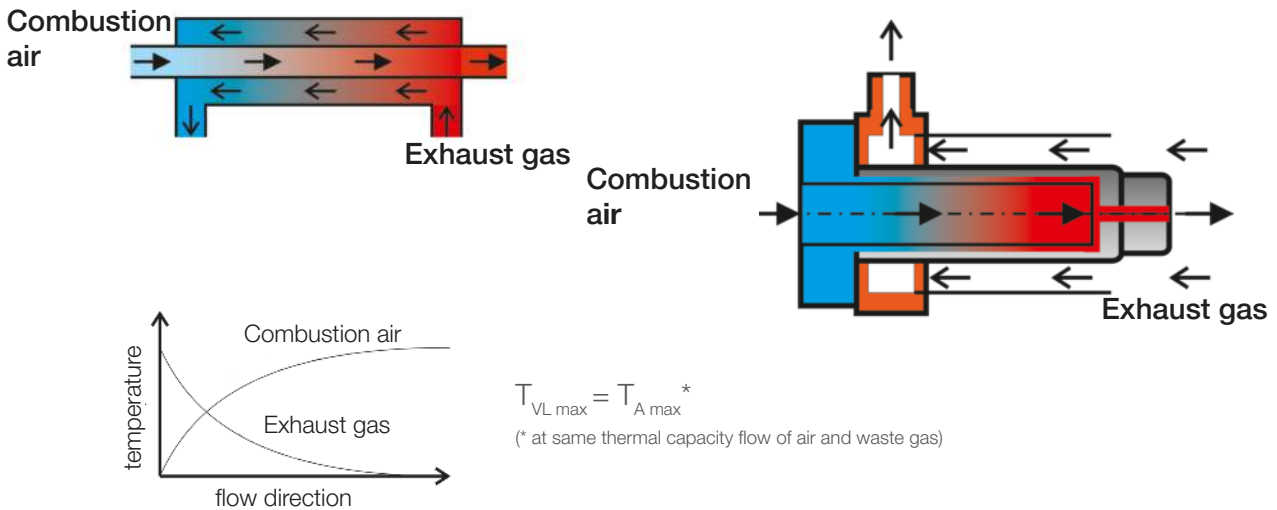


# BURNER TECHNOLOGY

The number of central recuperators in use is quite high, even to this day. This option has several drawbacks, such as the necessity for hot air compensation as well as for a protection system for the recuperator. Moreover, all components of the combustion air supply system must be heat-resistant and designed for larger operating volume flows. Only rarely is this system capable of achieving combustion air temperatures of 400°C at the burner. Air preheating and thus energy savings are usually considerably higher for recuperator burners, as is shown in the following diagram:

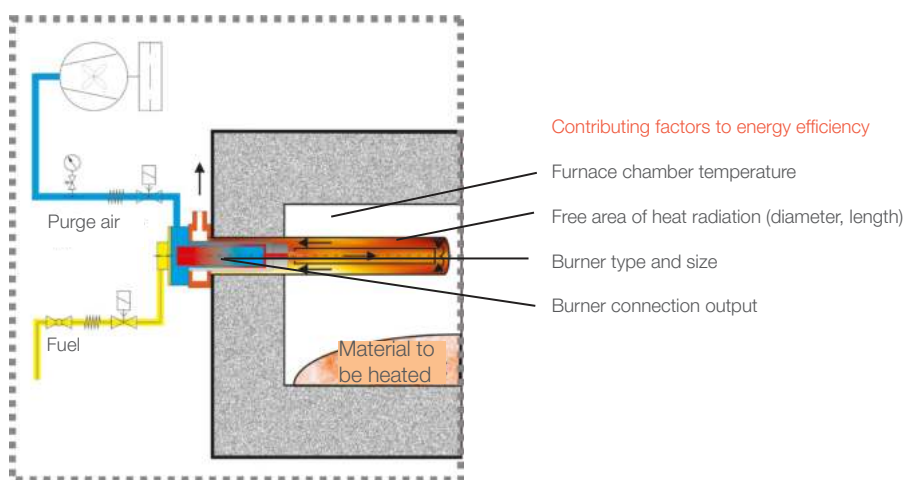


The recuperator burner uses the very effective counter-flow principle, where waste gases transfer the largest possible share of their energy to the combustion air flowing the other way, which increases firing efficiency.



## Factors impacting firing efficiency

In general, the objective for the operation of a burner is the highest possible efficiency in order to reduce fuel consumption and emissions. Firing efficiency, however, is not determined by the burner alone, but may also be impacted to a certain degree by other factors.

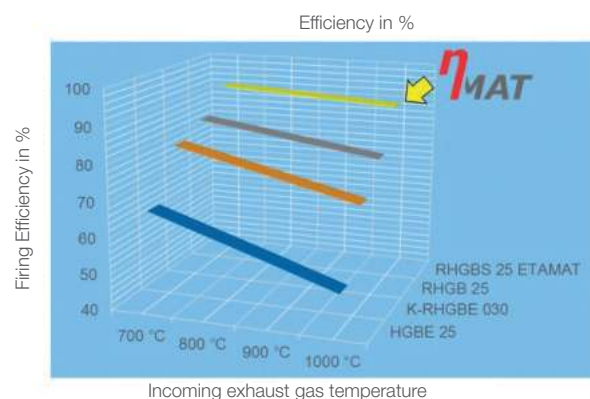


Basically, firing efficiency decreases when the temperature inside the furnace chamber rises. If other parameters remained the same, waste gas temperatures would increase.

A reduction of the burner capacity, while having a positive impact on firing efficiency, reduces the quality of the combustion and can cause higher emissions. Therefore, it is only recommended under certain conditions.

In indirect heating, the free area of heat radiation on the jacket tube is increased, which therefore increases efficiency as the heat transfer inside the furnace chamber improves. As a general rule, jacket tube sizes should be selected accordingly; the jacket tube must be sufficiently large.

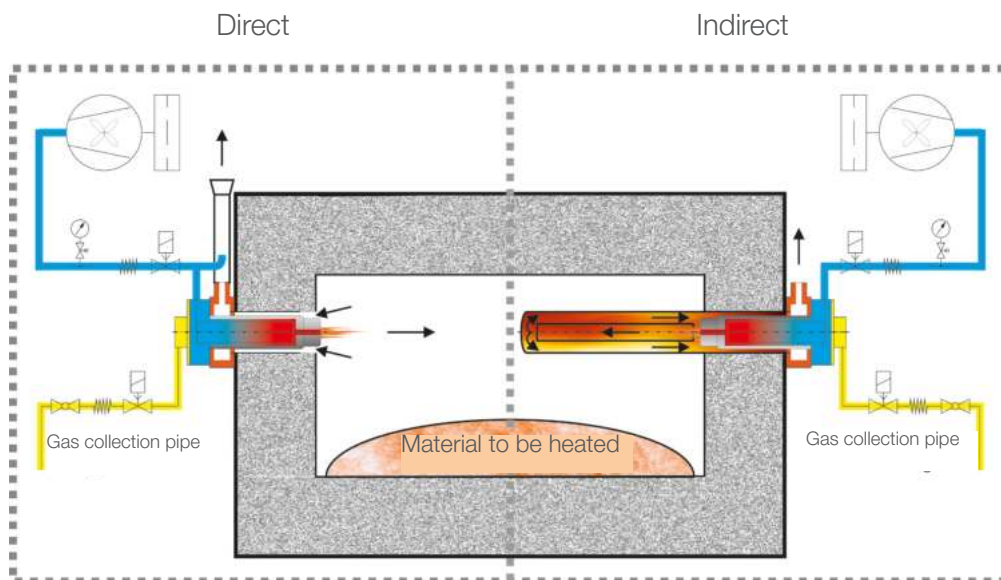
Naturally, the burner itself is of considerable significance. The diagram shows the different efficiencies of the different burner types depending on the waste gas temperature at inlet temperature.



# SELECTION OF THE OPTIMUM HEATING EQUIPMENT

## 1. Direct or indirect heating?

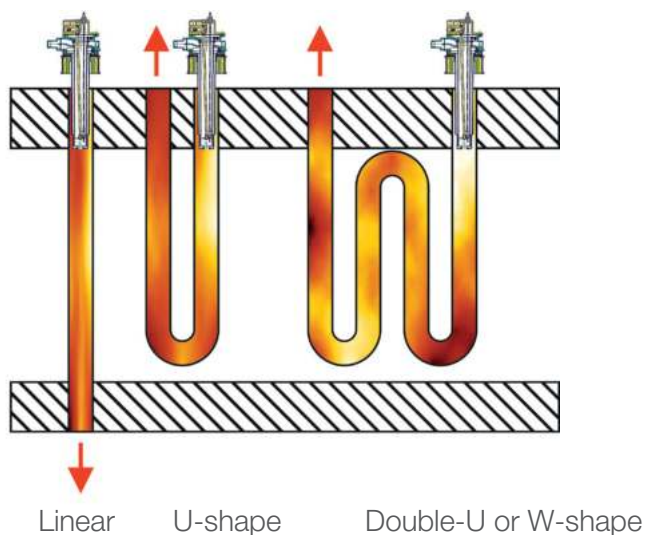
There is a principal distinction between direct and indirect heating. When designing a heat treatment plant, it must first be determined whether indirect heating is required or if direct heating is sufficient for the desired process.



- Direct impact of flame gases on the material to be heated
- High circulation inside the furnace chamber
- Waste gases must be retracted directly (via the ejector)
- i.e. Forging furnaces
- Common burner capacity 50-250 kW

- No direct impact of flame gases on the material to be heated
- No circulation inside the furnace chamber
- Waste gases exit the radiant tube (burner housing) automatically
- i.e. Heat treatment furnaces with protective gas atmosphere
- Common burner capacity 15-80 kW (straight radiant tube) or 120 kW (double p-tube)

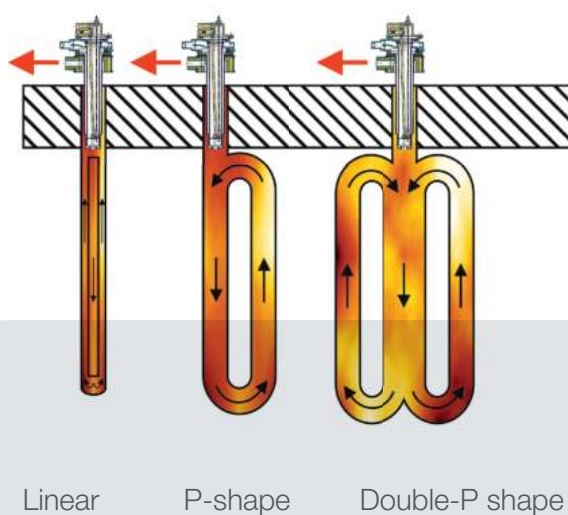
## Radiant tubes without recirculation



### Disadvantages to using radiant tubes without recirculation:

- Heat recovery is zero or is very limited (high waste gas temperature)
- Temperature distribution is not satisfactory

## Radiant tubes with recirculation



### Advantages to using radiant tubes with recirculation:

- Improved heat recovery due to integrated recuperator
- Burner momentum is used for recirculation
- 3- to 5-fold circulation of flue gases inside the radiant tube
- High circulation velocities lead to a temperature equalization and to a cooling of the flame

# SELECTION OF THE OPTIMUM HEATING EQUIPMENT

## 2. Preheated air or cold-air operation?

The next step is to decide whether the plant should be equipped with a comparatively simple cold-air burner or a highly efficient recuperative burner. In principle, either is possible.

As the name suggests, a cold-air burner is operated without preheating the combustion air and with accordingly low efficiency. However, it is considerably more economical to purchase. The preferred use of cold-air burners is for low-temperature plants, where heat recovery is fairly difficult anyway. If a cold-air burner is chosen for indirect heating, only non-recirculating radiant tubes are used.

Preheating the combustion air usually becomes worthwhile once furnace chamber temperatures exceed approx. 500°C. The easiest way to achieve this is by using recuperative burners. They are characterized by their compact shape and high energy efficiency. If used for indirect heating, so-called non-recirculating radiant tubes are installed.

Two-stage combustion is common for recuperative burners, meaning that the air flow volumes separates into primary and secondary air. Firing efficiency is accordingly high and emissions thus accordingly low. The so-called single-stage recuperative burner K-RHGBE is a simplified and economical alternative model. Firing efficiency is still considerably higher than in cold-air burners, but the price is significantly below that of a “conventional” recuperative burner.

## 3. Steel or Ceramic?

The maximum application temperature for steel recuperator burners is 1,150°C.

At higher application temperatures up to 1,300°C, ceramic recuperator burners must be used. In case of direct heating, this is more or less the temperature of the furnace chamber; however, such is not the case for indirect heating, as temperatures inside the radiant tube are often considerable higher than inside the furnace chamber. This distinction must be considered when designing the burner as well as the radiant tubes. In general, the thermal load on the burner and the radiant tube decreases if larger jacket tube surfaces are chosen, while also increasing firing efficiency.

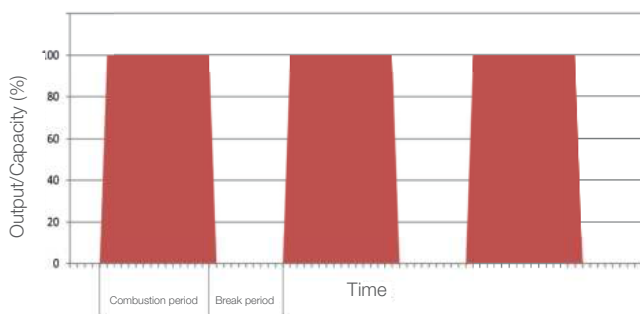


## 4. Mode of operation: On/Off, High/Low, Continuous?

### On/Off control mode

Recuperated burners usually operate in on/off control mode (standard application). This has several advantages:

- Cost-efficient application
- Simple configuration of the burners
- Max. momentum of the burners (temperature equalization)
- Burners always burn at the optimal point of operation
- 



One advantage of the on/off control mode is made clear with the use of quick-release gas and air valves, which allow the burner to rapidly reach high-fire (optimal operation). In the case of direct heating, on/off control can enhance circulation inside the furnace, promoting temperature uniformity. Predictably, on/off firing is only possible for burners which display repeatable, reliable ignition. NOXMAT burners are perfect for on/off control, thanks to their patented ignition chamber. Combustion (on) and break (off) periods may be varied freely by the overarching furnace control system according to the application requirements; however, they should not fall below 15/5 seconds.

# SELECTION OF THE OPTIMUM HEATING EQUIPMENT

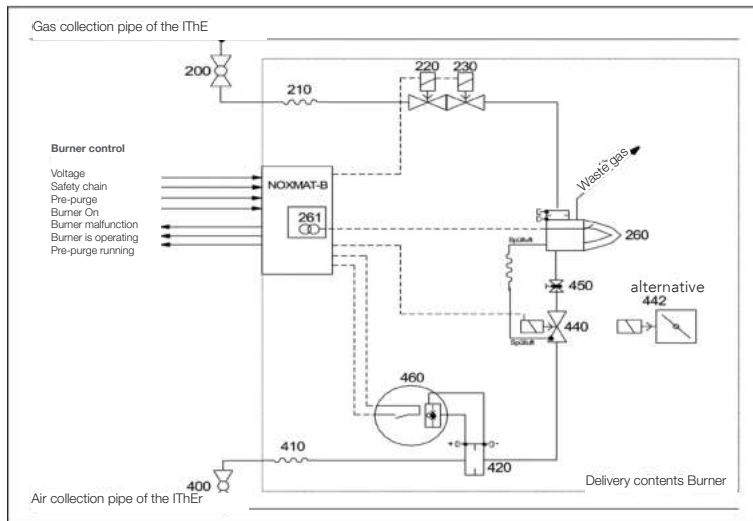


Image: Model process of an on/off control mode of a recuperative burner. The burner output is determined by the built-in gas nozzle.

Key			
Gas		Combustion air	
200	Manual shut-off valve	400	Manual shut-off valve
210	Gas hose	410	Air hose
220	1. Shut-off valve without damping	420	Measuring orifice
230	2. Shut-off valve without damping	440	Air-solenoid valve without damping
260	Burner	alternative 442	Air-solenoid flap without damping
261	Ignition / Flame monitoring	450	Air setting mechanism
		460	Air pressure monitor

## High/Low control mode

High/Low control mode is used relatively rarely these days. In this mode, the burner is usually not shut down at all (permanent operation), but switches between two levels depending on the heat requirements.

This mode used to be popular to guarantee constant positive pressure inside the combustion chamber when using direct heating, or for burners with poor ignition behavior, to reduce the probability of a fault when starting the burner. The over-temperature furnace control only shuts down the burner in case of over-temperature inside the combustion chamber.

This mode of operation may be implemented, for instance, when using two-stage valves.

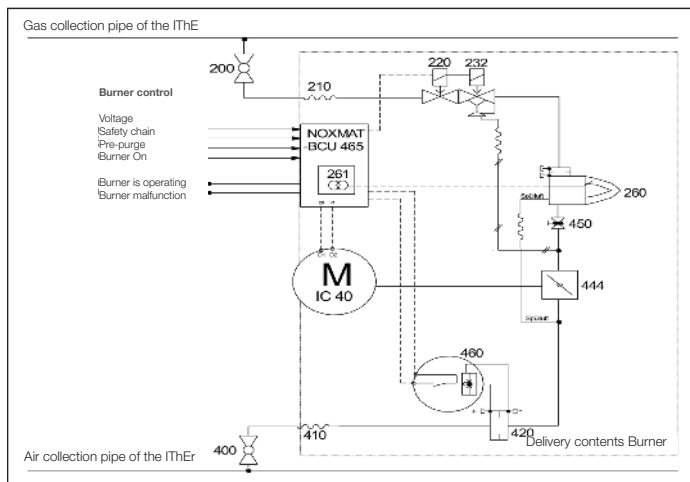
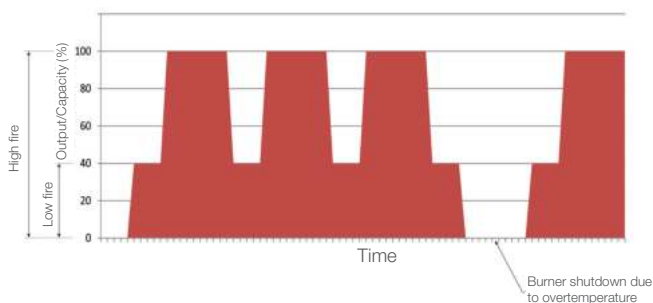


Image: Model process of a high/low control mode of a cold air burner. The burner output is determined by the furnace control.

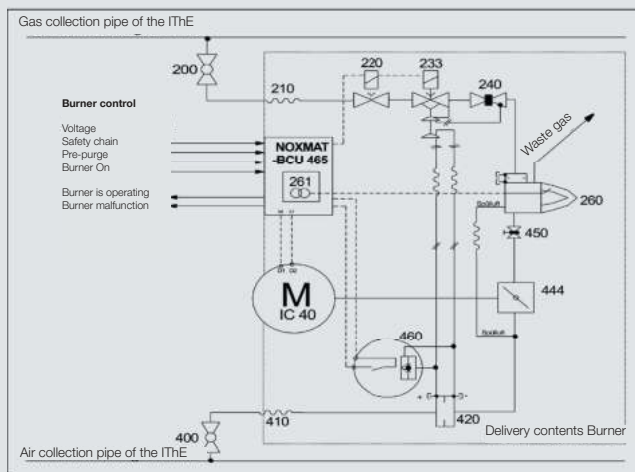
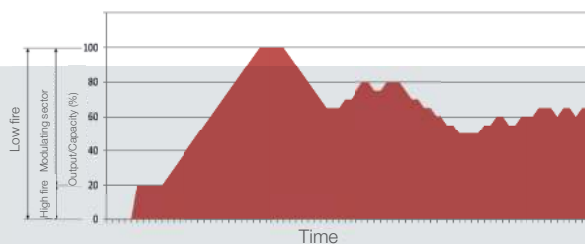
Key			
Gas		Combustion air	
200	Manual shut-off valve	400	Manual shut-off valve
210	Gas hose	410	Air hose
220	1. Shut-off valve without damping	420	Measuring orifice
230	2. Shut-off valve without damping	444	Air regulation valve / Air regulation flap
260	Burner	450	Air setting mechanism
261	Ignition / Flame monitoring	460	Air pressure monitor

# SELECTION OF THE OPTIMUM HEATING EQUIPMENT

## Continuous control mode

Continuous control mode of a burner requires significantly more complex control engineering than on/off control. The burner is usually ignited at low low-fire and can be operated in continuous mode, depending on the heat requirement, at any possible power mode between high and low.

This mode of operation may be implemented by using an air flap whose opening angle can be varied depending on the heat requirement. The air flap must be activated separately by furnace control. The amount of gas is usually adapted automatically in mechanical compound with a ratio or flow volume controller. It ensures that the air-fuel ratio  $\lambda$  remains as constant as possible at each power stage



Model process of a continuous control mode of a recuperated burner. The burner output is determined by the furnace control.

Key			
Gas		Combustion air	
200	Manual shut-off valve	400	Manual shut-off valve
210	Gas hose	410	Air hose
220	1. Shut-off valve without damping	420	Measuring orifice
233	2. Shut-off valve with air/gas ratio control	444	Air regulation valve / Air regulation flap
240	Setting mechanism for air/gas ratio control	450	Air setting mechanism
260	Burner	460	Air pressure monitor
261	Ignition / Flame monitoring		

## PRODUCT OVERVIEW

### **Series RHGBS *ETAMAT***

Recuperated high-velocity burner with metal foam recuperative for the indirect heating of industrial furnaces 15-35 kW



### **Series RHGB**

Recuperated high-velocity burner with steel recuperative for the direct and indirect heating of industrial furnaces 7-250 kW



### **Series K-RHGB**

Recuperated high-velocity burner with ceramic recuperative for the direct and indirect heating of industrial furnaces 9-250 kW



### **Series K-RHGBE**

Recuperated high-velocity burner with ceramic recuperative combustion tube for the direct and indirect heating of industrial furnaces 9-100 kW



### **Series K-RHGB RN *REMAT***

Retrofit recuperated high-velocity burner with ceramic recuperative for the indirect heating of industrial furnaces 13-25 kW



### **Series HGBE**

High-velocity burner for the direct and indirect heating of industrial furnaces 9-160 kW



Steel or ceramic jacket radiant tubes for the indirect heating of industrial furnaces

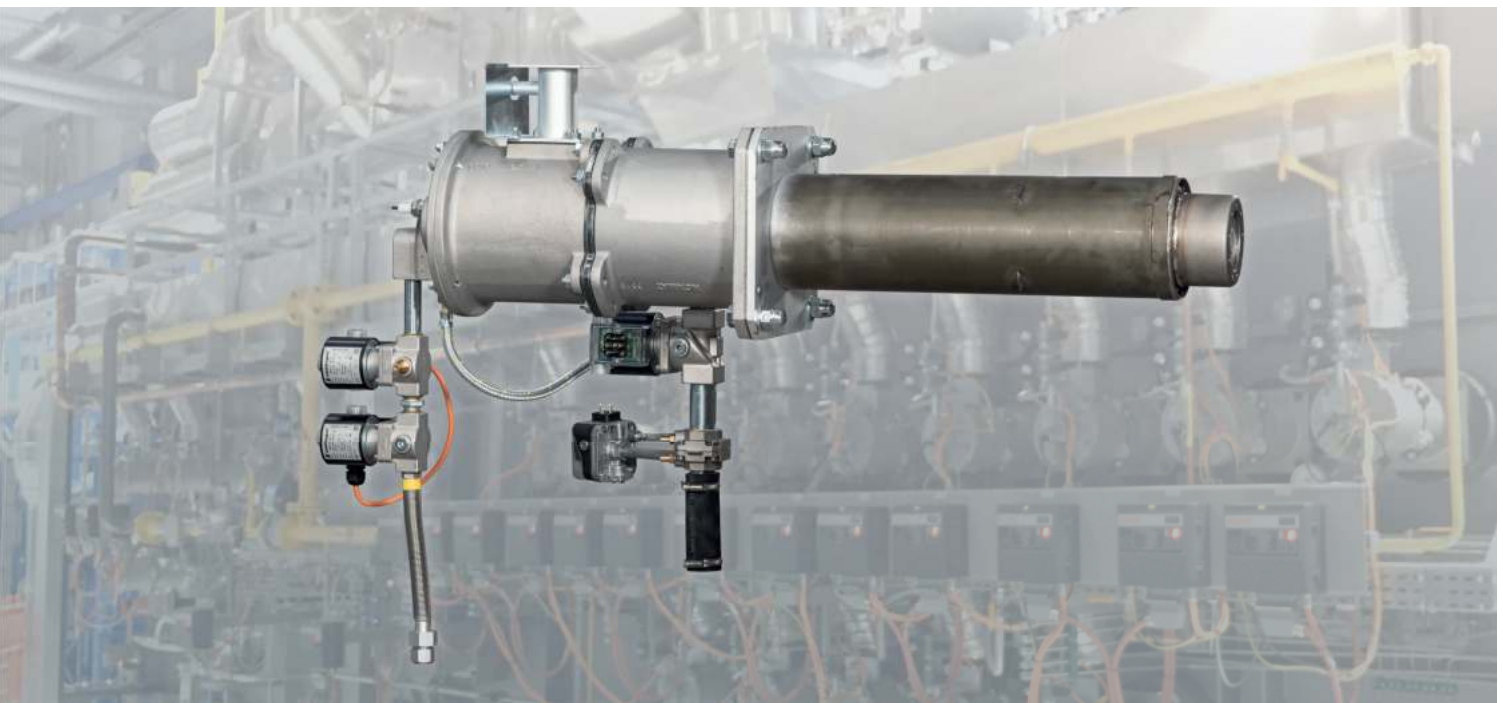


Accessories for industrial heating systems (burner control units, combustion air fans, gas pressure measurement and control systems, etc.)



## SERIES RHGBS *ETAMAT*

Recuperative high-velocity burner with metal foam recuperator for the indirect heating of industrial furnaces 15-35 kW



### Specifications & Advantages

- High-velocity burner with integrated metal foam recuperator for the highest possible heat recovery, for indirect heating
- Power scope from 15 to 35 kW
- Burner efficiency up to 90%
- Low-emission multi-stage combustion
- Excellent temperature distribution due to high burner velocity
- Very low sound pressure level: up to below 50 dB(A)
- Maintenance-friendly, modular set-up
- All media connections can be adjusted at 90° angles
- Direct flame monitoring to ensure maximum safety in all stages of operation
- Separate cooling air connection possible to enable the specific operation of temperature ramps
- Available with basic or complete configuration

## Technical specifications

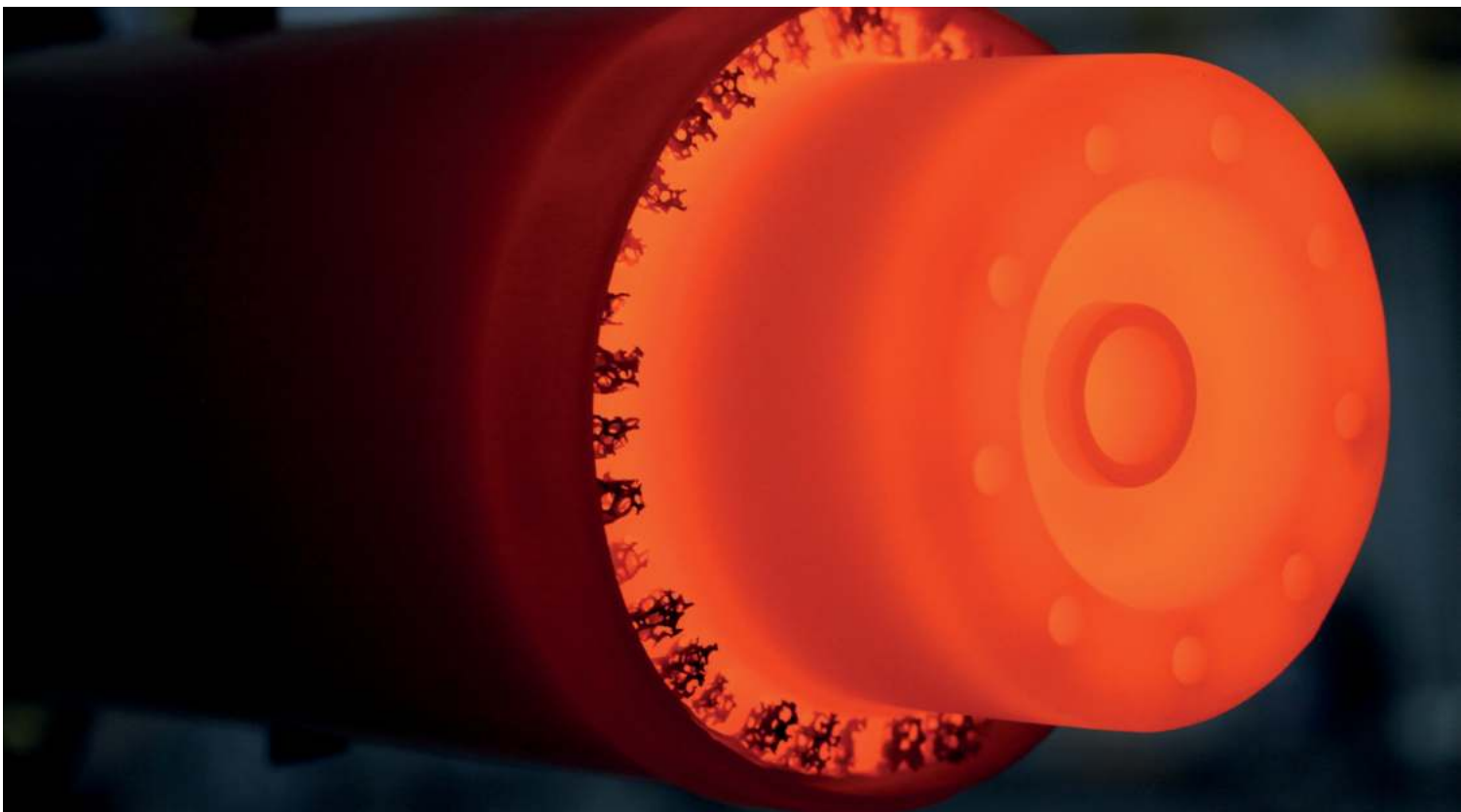


Burner type RHGBS		25
Nominal thermal capacity [1]	kW	35
Nominal thermal capacity [1]	BTU/h	~120000
Minimum thermal capacity [1]	kW	15
Minimum thermal capacity [1]	BTU/h	~51000
Nominal gas connection pressure [2]	mbar	115
Nominal air connection pressure, indirect heating [2]	mbar	100
Maximum recuperator temperature	°C	1050
Nominal diameter of recuperator with waste gas guiding tube	mm	160
Nominal diameter gas connection	DN	15
Nominal diameter combustion air connection	DN	25
Nominal diameter cooling air connection	DN	40
Fuel gas		NG

Subject to technical changes without prior notice.

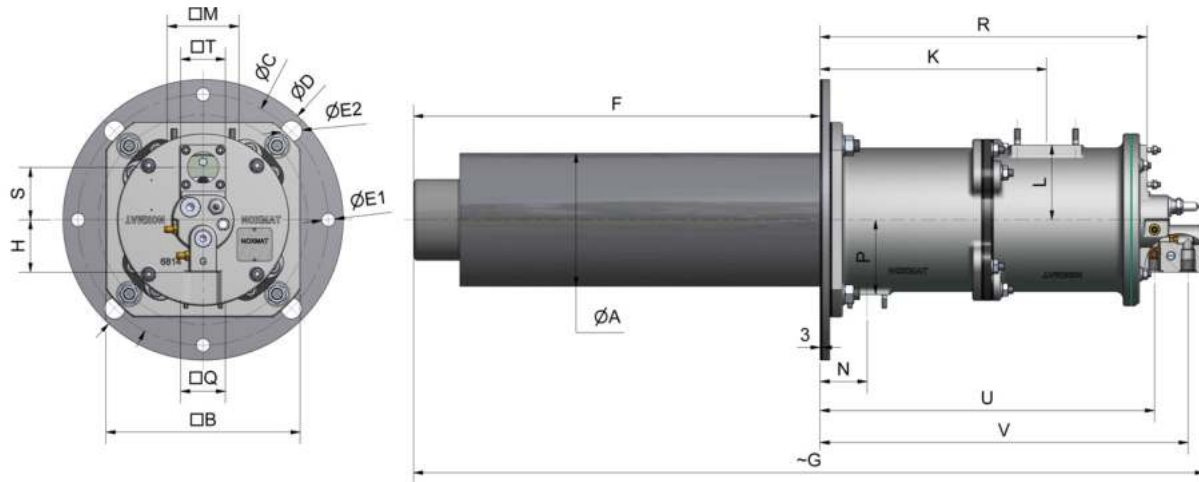
[1] Other thermal capacities available upon request.

[2] Pressure variations should not exceed +/- 5%, this applies also to burners in grouped operation.



# SERIES RHGBS *ETAMAT*

## Principal dimensions / Basic burner



Burner size	Principal dimensions							
	A	B	C	D	E1/E2	F	G	H
	mm							
RHGBS 25	160	252	335	375	18/28	545	1060	70

Burner size	Connection dimensions															
	Waste gas			Combustion air				Cooling air			Purge air	Combustion gas				
	K	L	M	N	P	Q	R	S	T	U	V					
	mm			mm				mm			mm	inch	mm	inch		
RHGBS 25	303	100	96	Ø 75	63	100	60	Ø 50	438	70	60	Ø 42	448	G3/8	493	Rp1/2

## Application

- Use in new plants or as a replacement for existing burners with ribbed-tube recuperators to increase efficiency
- Burner operation modes ON/OFF, HIGH/LOW, and CONTINUOUS
- Replacement of the RHGB 40 with the RHGBS 25

## Comparison with standard Burner RHGB 40

RHGBS 25		RHGB 40
with		with
35 kW		39,5 kW
30 kW		34 kW
25 kW		28,5 kW

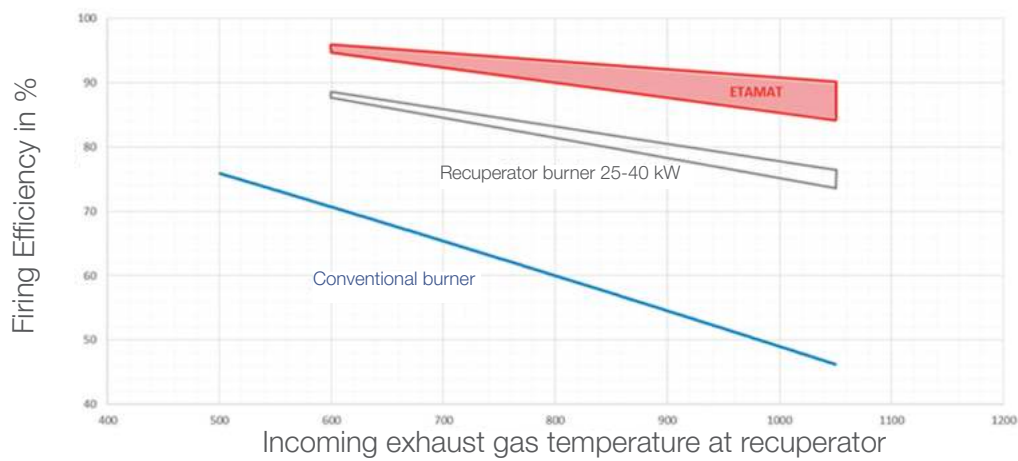




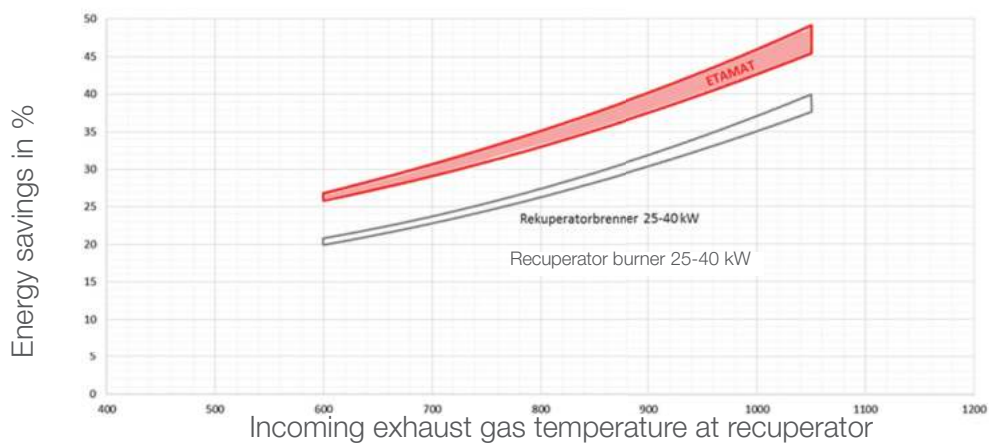
## Energy Savings

The firing efficiency is up to 90% with regard to a flue gas inlet temperature of 1050°C. Depending on the state of operation, this leads to energy savings of another 5 to 10% compared to previous recuperator burners

## Efficiency



## Energieersparnis



## SERIES RHGB

Recuperative high-velocity burner with steel recuperator for the direct and indirect heating of industrial furnaces 7-250 kW



### Specifications & Advantages

- High-velocity burner with integrated steel recuperator for efficient heat recovery, for direct and indirect heating
- Wide power scope, from 7 to 250 kW
- Maximum application temperature up to 1150°C
- High efficiency
- Low-emission multi-stage combustion
- Excellent temperature distribution due to high burner velocity
- Easy direct ignition at high-fire due to patented ignition system
- Particularly maintenance-friendly, modular set-up
- All media connections can be adjusted at 90° angles
- Direct flame monitoring to ensure maximum safety in all stages of operation
- Separate cooling air connection possible to enable the specific operation of temperature ramps

## Technical specifications

Burner type RHGB		15	25	40	80	100	160	250
Nominal thermal capacity [1]	kW	15	25	40	80	100	160	250
Nominal thermal capacity [1]	BTU/h	~51000	~85000	~136000	~273000	~341000	~546000	~853000
Minimum thermal capacity [1]	kW	7	13	25	40	50	80	100
Minimum thermal capacity [1]	BTU/h	~24000	~44000	~85000	~136000	~171000	~273000	~341000
Nominal gas connection pressure [2]	mbar	50	50	50	50	70	50	70
Nominal air connection pressure, indirect heating [2]	mbar	60	60	80	80	90	80	90
Nominal ejector air connection pressure, direct heating [2] [3]	mbar	60	60	80	90	100	90	130
Necessary volumetric ejector air flow [3]	Nm <sup>3</sup> /h	20	20	60	150	190	260	350
Maximum recuperator temperature	°C	1150	1150	1150	1150	1150	1150	1150
Nominal diameter of recuperator	mm	102	130	130	180	180	230	230
Nominal diameter gas connection	DN	15	15	15	15	20	20	25
Nominal diameter combustion air connection	DN	25	25	25	40	40	50	65
Nominal diameter cooling air connection	DN	25	40	40	40	40	50	65
Nominal diameter ejector air connection	DN	25	25	25	40	65	80	80
Fuel gas [4]		NG, LNG, LPG						

Subject to technical changes without prior notice.

[1] Other thermal capacities available upon request.

[2] Pressure variations should not exceed +/- 5%, this applies also to burners in grouped operation.

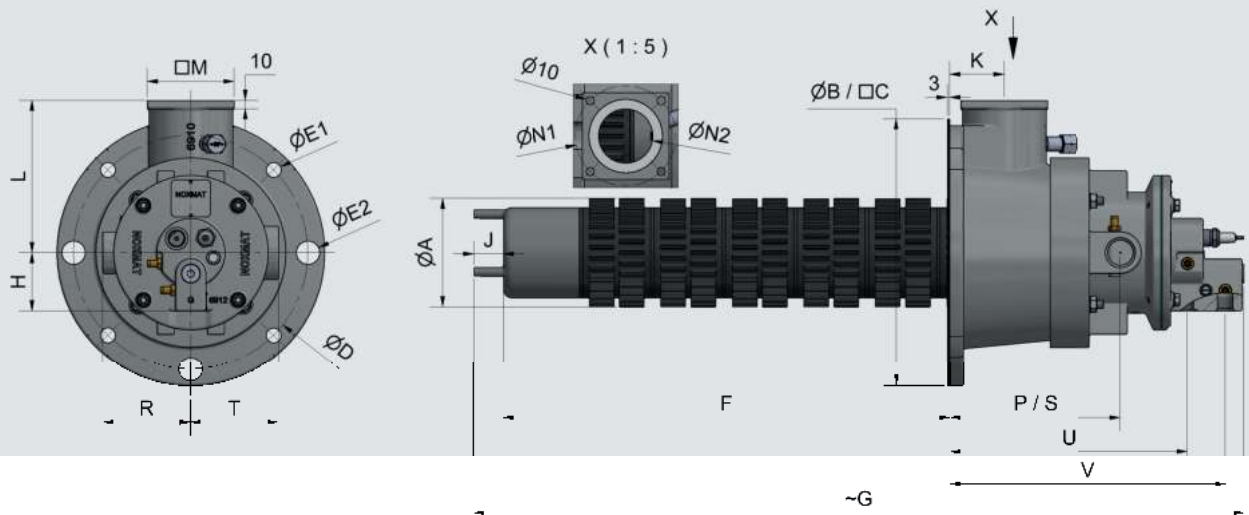
[3] Reference values, based on furnace temperature of 1000°C and 90% waste gas extraction at nominal burner capacity.

[4] Other fuel gas types must be agreed upon with the manufacturer.



# SERIES RHGB

## Principal dimensions / Basic burner

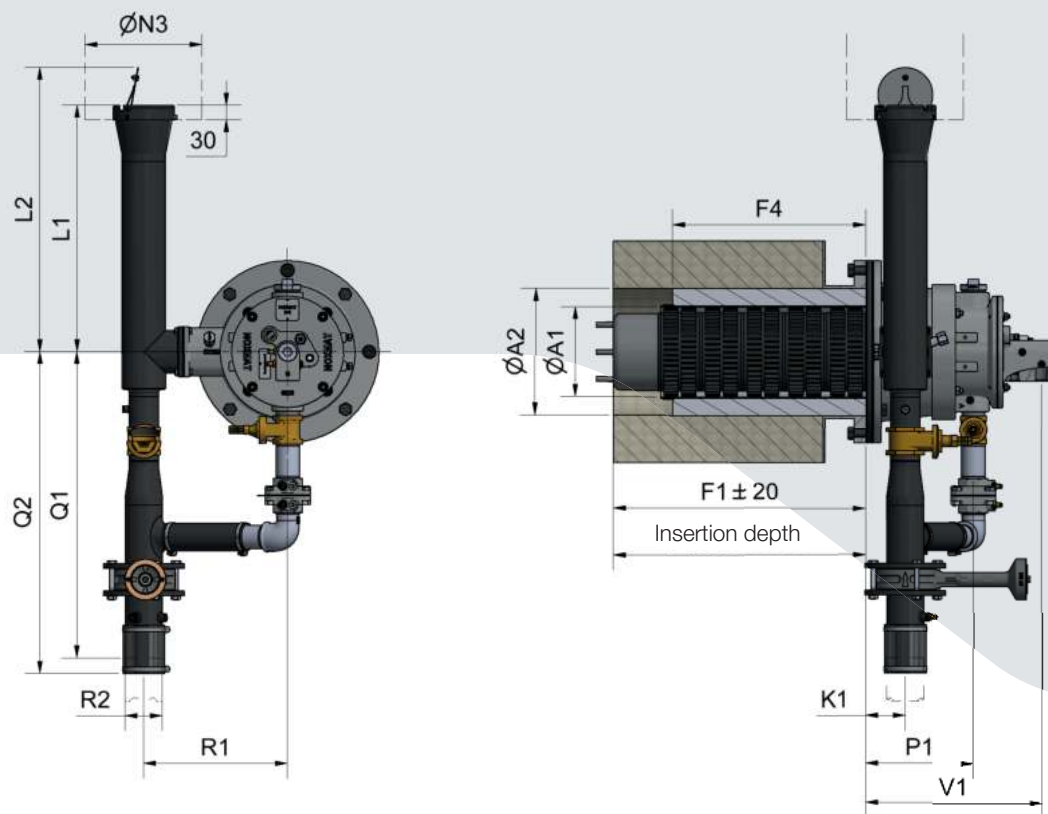


Burner size	Principal dimensions								
	A	B	C	D	E1/E2	F*	G	H	J
	mm								
RHGB 15	102	265	--	225	19/28	535	950	80	20
RHGB 25	130	--	250	280	18/--	535	920	70	35
RHGB 40	130	--	250	280	18/--	535	920	70	35
RHGB 80	180	375	--	335	18/28	535	930	50	35
RHGB 100	180	375	--	335	18/28	535	950	60	35
RHGB 160	230	490	--	445	24/34	535	970	70	10
RHGB 250	230	490	--	445	24/24	535	970	70	10

Burner size	Connection dimensions														
	Waste gas					Combustion air			Cooling air**			Purge air		Combustion	
	K	L	M	N1	N2	P	R	S	T	U	V				
	mm					mm	inch	mm	inch	mm	inch	mm	inch		
RHGB 15	60	150	Ø90	--	55	185	85	G1	185	85	G1	270	G3/8	315	Rp1/2
RHGB 25	65	180	104	120	65	205	105	G1	205	105	G1.1/2	285	G3/8	330	Rp1/2
RHGB 40	65	180	104	120	65	205	105	G1	205	105	G1.1/2	285	G3/8	330	Rp1/2
RHGB 80	65	210	104	120	65	205	123	G1.1/2	205	123	G1.1/2	288	G3/8	330	Rp1/2
RHGB 100	65	210	104	120	65	205	123	G1.1/2	205	123	G1.1/2	288	G3/8	345	Rp3/4
RHGB 160	80	265	134	160	92	240	174	G2	240	175	G2**	342	G3/8	400	Rp3/4
RHGB 250	80	265	134	160	92	240	175	G2.1/2	240	176	G2**	342	G3/8	400	Rp1

(\*) Length variable; (\*\*) optional

## Principal dimensions / Connecting dimensions Direct heating

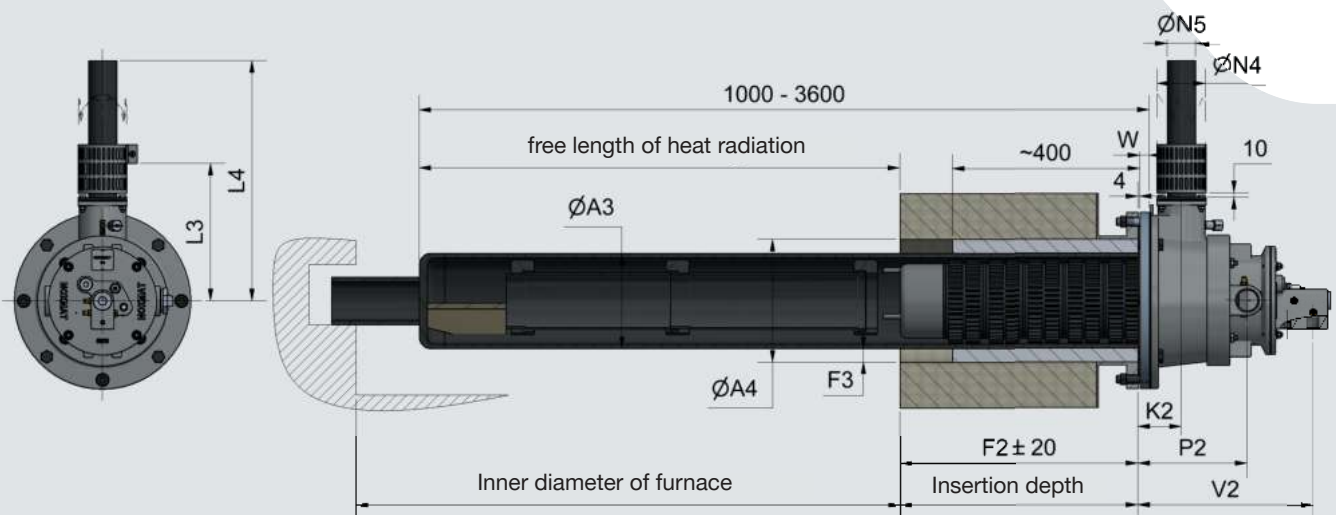


Burner size	Principal dimensions			
	A1	A2	F1	F4
	mm			
RHGB 15	106	160	519	398
RHGB 25	135	200	521	398
RHGB 40	135	200	521	398
RHGB 80	185	260	519	400
RHGB 100	185	260	519	400
RHGB 160	236	300	519	400
RHGB 250	251	300	519	400

# SERIES RHGB

Burner size	Connection dimensions									
	Waste gas				Combustion and Ejector air					Gas
	K1	L1	L2	N3	P2	Q1	Q2	V2	V1	V1
	mm				mm					mm
RHGB 15	76	506	583	240	201	375±10	398	250	34	331
RHGB 25	79	506	583	240	219	375±10	404	281	34	344
RHGB 40	79	506	583	240	219	375±10	404	281	34	344
RHGB 80	81	506	583	240	221	630±10	658	311	76	346
RHGB 100	81	506	583	240	221	690±10	722	311	76	361
RHGB 160	96	1031	1127	280	256	720±10	753	350	89	416
RHGB 250	96	1031	1127	280	256	770±10	800	350	89	416

## Principal dimensions / Connecting dimensions Indirect heating



Burner size	Principal dimensions			
	A3	A4	F2	F3
	mm			
RHGB 15	120	181	513	30
	150	207	495	28
RHGB 25	150	207	508	28
	200	261	497	30
RHGB 40	150	207	508	28
	200	261	497	30
RHGB 80	200	261	508	30
RHGB 100	200	261	508	30
RHGB 160	236**	k.A.	512	k.A.
RHGB 250	251**	k.A.	512	k.A.

Burner size	Connection dimensions							
	Waste gas					CA	Gas	Jacket tube
	K2	L3	L4	N4	N5	P2	V2	W
	mm					mm	mm	mm
RHGB 15	82	229	450	102	42	207	337	15
	100	229	450	102	42	225	355	15
RHGB 25	92	262	480	102	42	232	357	20
	103	262	480	102	42	243	368	20
RHGB 40	92	262	480	102	48	232	357	20
	103	262	480	102	48	243	368	20
RHGB 80	92	292	510	102	60	232	357	20
RHGB 100	92	292	510	102	60	232	372	20
RHGB 160	103	347	565	140	89	263	423	20
RHGB 250	103	347	565	140	89	263	423	20

\*only when using P and double P-nozzles

\*\*required inner diameter of the steel tube

## SERIES K-RHGB

Recuperative high-velocity burner with ceramic recuperator for the direct and indirect heating of industrial furnaces 9-250 kW



### Specifications & Advantages

- High-velocity burner with integrated ceramic recuperator for efficient heat recovery, for direct and indirect heating
- Wide power scope, from 9 to 250 kW
- Maximum application temperature up to 1300°C
- High efficiency
- Low-emission multi-stage combustion
- Excellent temperature distribution due to high burner momentum
- Easy direct ignition at high-fire due to patented ignition system
- Particularly maintenance-friendly, modular set-up
- All media connections can be adjusted at 90° angles
- Direct flame monitoring to ensure maximum safety in all stages of operation
- Separate cooling air connection possible to enable the specific operation of temperature ramps
- Easy and economical basic maintenance
- Available with basic or complete configuration



## Technical specifications

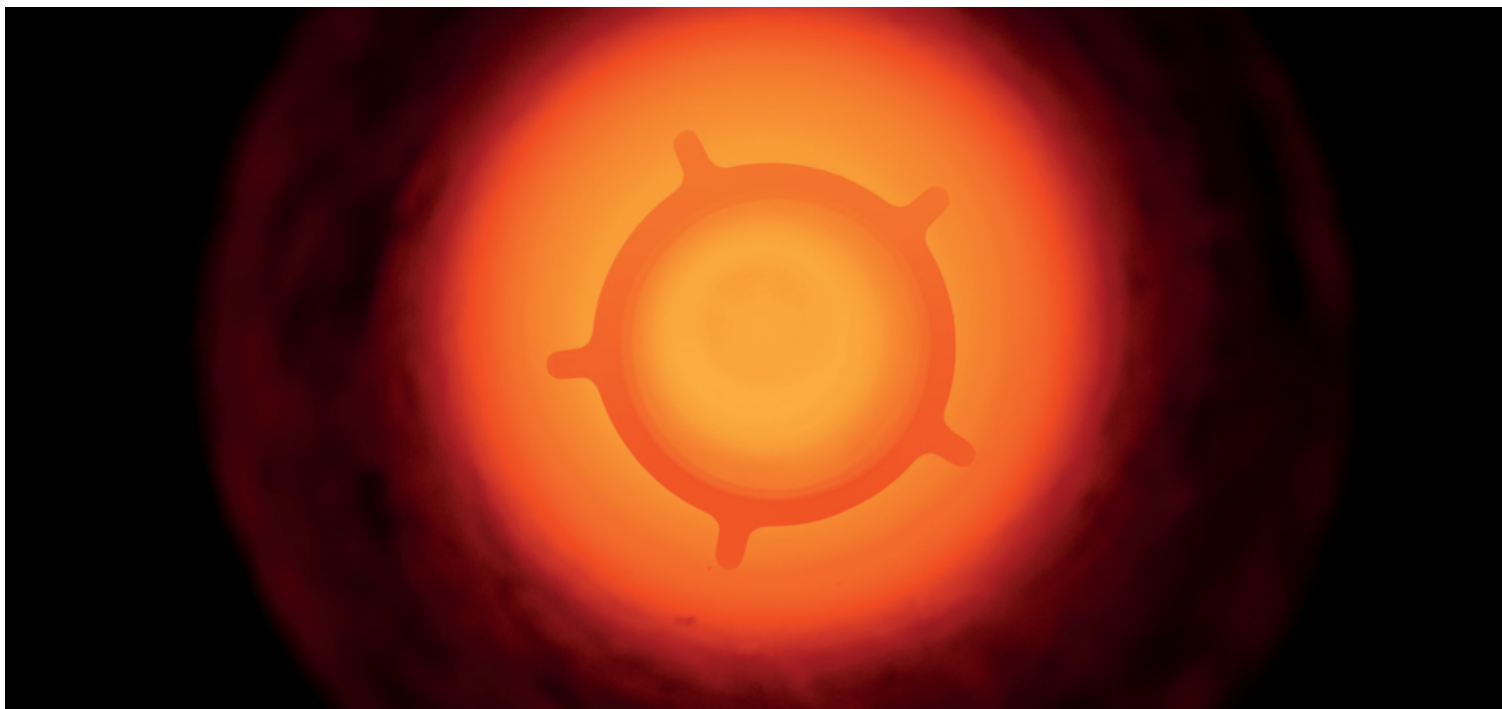
Burner type K-RHGB		15	25	40	80	160	250
Nominal thermal capacity [1]	kW	15	25	40	80	160	250
Nominal thermal capacity [1]	BTU/h	~51000	~85000	~136000	~273000	~546000	~853000
Minimum thermal capacity [1]	kW	9	13	25	40	80	100
Minimum thermal capacity [1]	BTU/h	~31000	~44000	~85000	~136000	~273000	~341000
Nominal gas connection pressure [2]	mbar	50	50	50	50	50	70
Nominal air connection pressure, indirect heating [2]	mbar	60	80	80	80	80	100
Nominal ejector air connection pressure, direct heating [2] [3]	mbar	60	80	90	100	120	130
Necessary volumetric ejector air flow [3]	Nm <sup>3</sup> /h	30	40	100	250	300	370
Maximum recuperator temperature	°C	1300	1300	1300	1300	1300	1300
Nominal diameter of recuperator	mm	85	100	125	150	208	208
Nominal diameter gas connection	DN	15	15	15	15	20	25
Nominal diameter combustion air connection	DN	25	25	40	40	50	65
Nominal diameter cooling air connection	DN	25	40	40	40	50	50
Nominal diameter ejector air connection	DN	25	25	40	65	80	80
Fuel gas [4]	NG, LNG, LPG						

Subject to technical changes without prior notice. [1] Other thermal capacities available upon request.

[2] Pressure variations should not exceed +/- 5%, this applies also to burners in grouped operation.

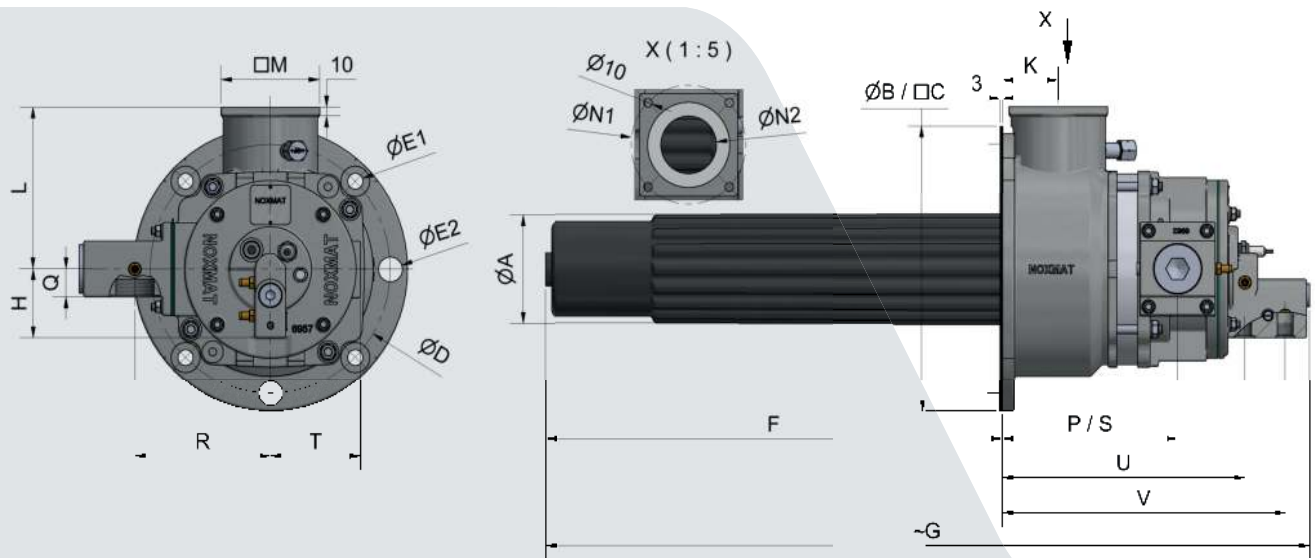
[3] Reference values, based on furnace temperature of 1200°C and 90% waste gas extraction at nominal burner capacity.

[4] Other fuel gas types must be agreed upon with the manufacturer.



# SERIES K-RHGB

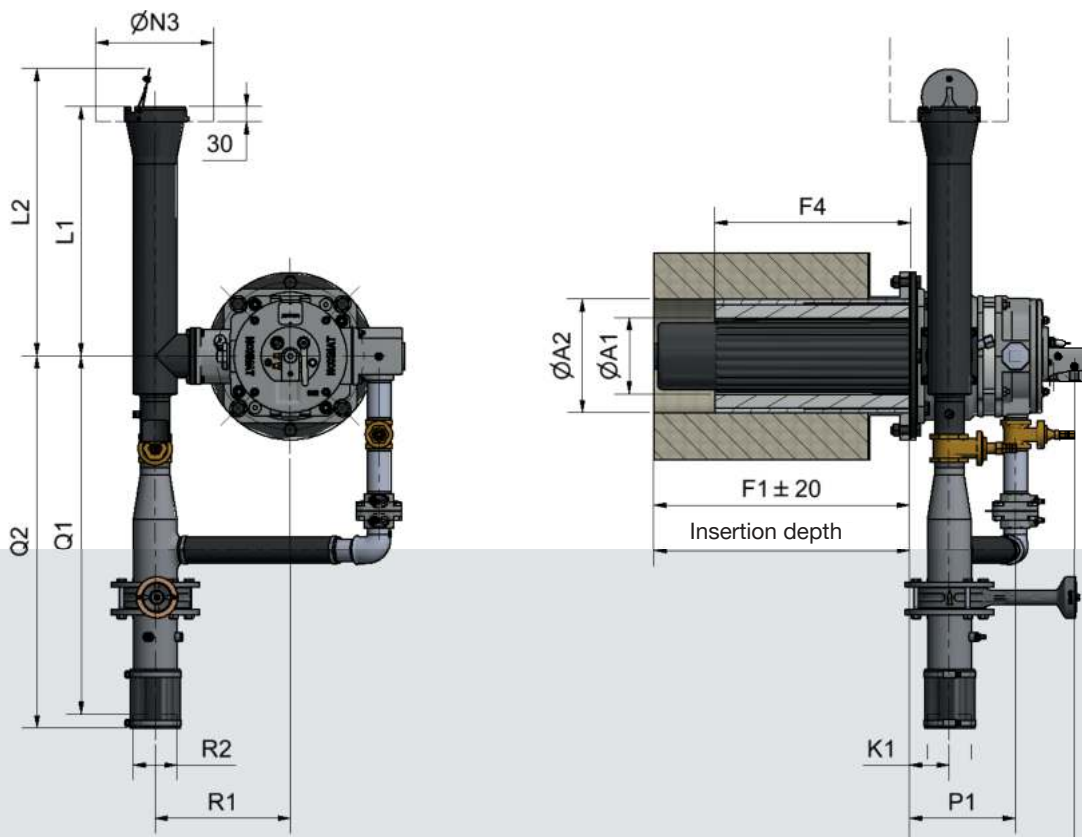
## Principal dimensions / Basic burner



Burner size	Principal dimensions							
	A	B	C	D	E1/E2	F	G	H
	mm							
K-RHGB 15	85	--	180	210	18/--	535	910	80
K-RHGB 25	100	265	--	225	18/28	535	880	70
K-RHGB 40	125	--	252	280	18/--	535	890	77
K-RHGB 80	150	--	272	300	18/--	535	880	50
K-RHGB 160	208	440	--	395	24/34	535	960	70
K-RHGB 250	208	440	--	395	24/34	625	1052	70

Burner size	Connection dimensions															
	Waste gas					Combustion air				Cooling air			Purge air		Combustion gas	
	K	L	M	N1	N2	P	Q	R	S	T	U		V			
	mm					mm			inch	mm		inch	mm	inch	mm	inch
K-RHGB 15	60	130	96	110	35	185	30	125	G3/4	185	85	G3/4	259	G3/8	304	Rp1/2
K-RHGB 25	65	150	104	120	50	197	37	135	G1	197	98	G1.1/2	274	G3/8	319	Rp1/2
K-RHGB 40	65	180	115	134	65	205	30	158	G1.1/2	205	105	G1.1/2	283	G3/8	328	Rp1/2
K-RHGB 80	65	190	115	134	75	200	48	180	G1.1/2	200	123	G1.1/2	277	G3/8	319	Rp1/2
K-RHGB 160	85	245	134	160	82	240	41	234	G2	240	175	G2	332	G3/8	390	Rp3/4
K-RHGB 250	85	245	134	160	82	240	63	300	G2.1/2	240	175	G2	332	G3/8	390	Rp1

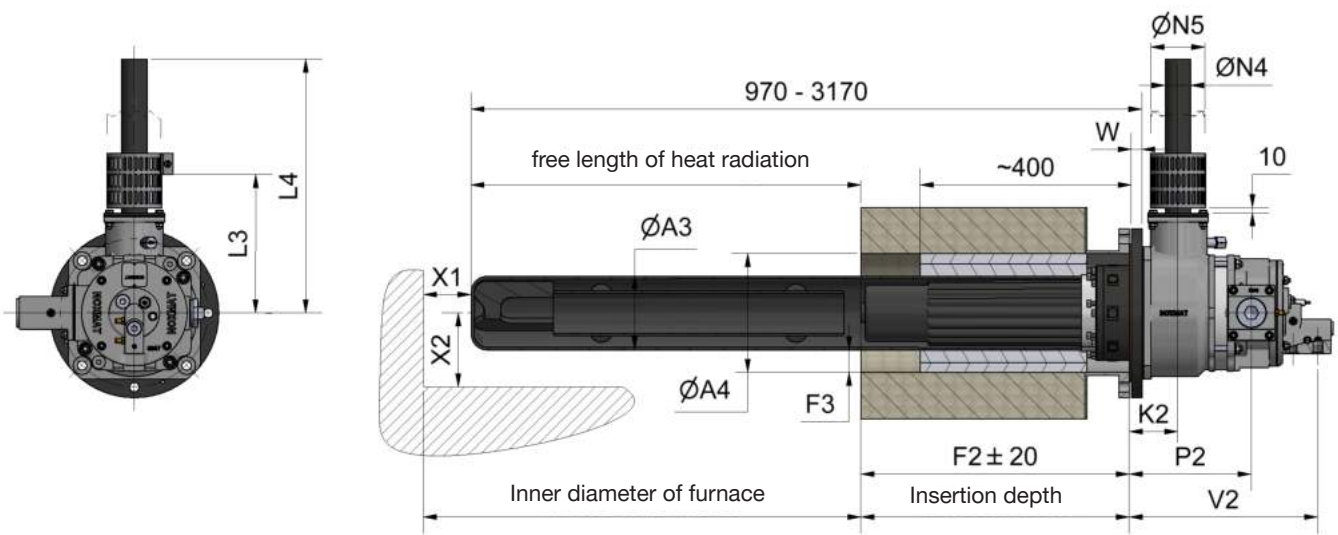
## Principal dimensions / Connecting dimensions Direct heating



Burner size	Principal dimensions				Connection dimensions									
					Waste gas				Combustion and Ejector air					Gas
	A1	A2	F1	F4	K1	L1	L2	N3	P1	Q1	Q2	R1	R2	V1
	mm				mm				mm					mm
K-RHGB 15	90	150	535	418	76	506	583	240	201	365±10	396	231	34	320
K-RHGB 25	105	175	535	387	81	506	583	240	213	365±10	396	251	34	335
K-RHGB 40	130	200	535	395	81	506	583	240	221	365±10	396	281	34	346
K-RHGB 80	155	230	535	398	81	506	583	240	216	730±10	758	275	89	335
K-RHGB 160	216	300	535	389	99	1031	1131	280	254	720±10	751	330	89	404
K-RHGB 250	230	315	625	482	99	1031	1131	280	254	700±10	730	330	89	404

# SERIES K-RHGB

## Principal dimensions / Connecting dimensions Indirect heating



Burner size	Principal dimensions				Connection dimensions									
					Waste gas					CA	Gas	Jacket tube		
	A3	A4	F2	F3	K2	L3	L4	N4	N5	P2	V2	W	X1	X2
	mm				mm					mm	mm	mm	mm	mm
K-RHGB 15	100	160	513	30	82	212	430	42	102	207	326	15	90	100
	115	175	500	30	95	212	430	42	102	220	339	15	90	115
K-RHGB 25	115	175	513	31	87	232	450	42	102	219	341	15	90	115
	140	225	508	42	92	232	450	42	102	224	346	20	90	140
K-RHGB 40	140	225	508	42	92	262	480	48	102	231	357	20	90	140
	165	250	508	43	92	262	480	48	102	231	357	20	105	165
K-RHGB 80	165	250	508	43	92	262	480	60	102	227	346	20	105	165
	200	285	495	43	105	272	490	60	102	240	359	20	120	200

## SERIES K-RHGBE

Recuperative high-velocity burner with ceramic recuperator burner tube for the direct and indirect heating of industrial furnaces 9-100 kW



### Specifications & Advantages

- Cost-efficient high-velocity burner with integrated recuperator combustion tube for heat recovery
- Power scope from 9 to 100 kW
- Maximum application temperature up to 1300°C
- High efficiency
- Low-emission single-stage combustion
- Excellent temperature distribution due to high burner velocity
- Easy direct ignition at high-fire due to patented ignition system
- Particularly maintenance-friendly, modular set-up
- All media connections can be adjusted at 90° angles
- Direct flame monitoring to ensure maximum safety in all stages of operation
- Separate cooling air connection possible to enable the specific operation of temperature ramps

# SERIES K-RHGBE

## Technical specifications

Brennertyp K-RHGBE		15	30	50	100
Nominal thermal capacity [1]	kW	15	30	50	100
Nominal thermal capacity [1]	BTU/h	~51000	~102000	~171000	~341000
Minimum thermal capacity [1]	kW	9	15	25	50
Minimum thermal capacity [1]	BTU/h	~31000	~51000	~85000	~171000
Nominal gas connection pressure [2]	mbar	50	50	50	70
Nominal air connection pressure, indirect heating [2]	mbar	60	80	80	80
Nominal ejector air connection pressure, direct heating [2] [3]	mbar	n/a	80	90	110
Necessary volumetric ejector air flow [3]	Nm <sup>3</sup> /h	n/a	50	120	300
Maximum recuperator temperature	°C	1300	1300	1300	1300
Nominal diameter of recuperator	mm	63	100	125	150
Nominal diameter gas connection	DN	15	15	15	20
Nominal diameter combustion air connection	DN	20	25	40	40
Nominal diameter cooling air connection	DN	20	40	40	40
Nominal diameter ejector air connection	DN	25	25	50	80
Fuel gas [4]	NG, LNG, LPG				

Subject to technical modifications. [1] Values deviating from the burner capacity are possible upon request.

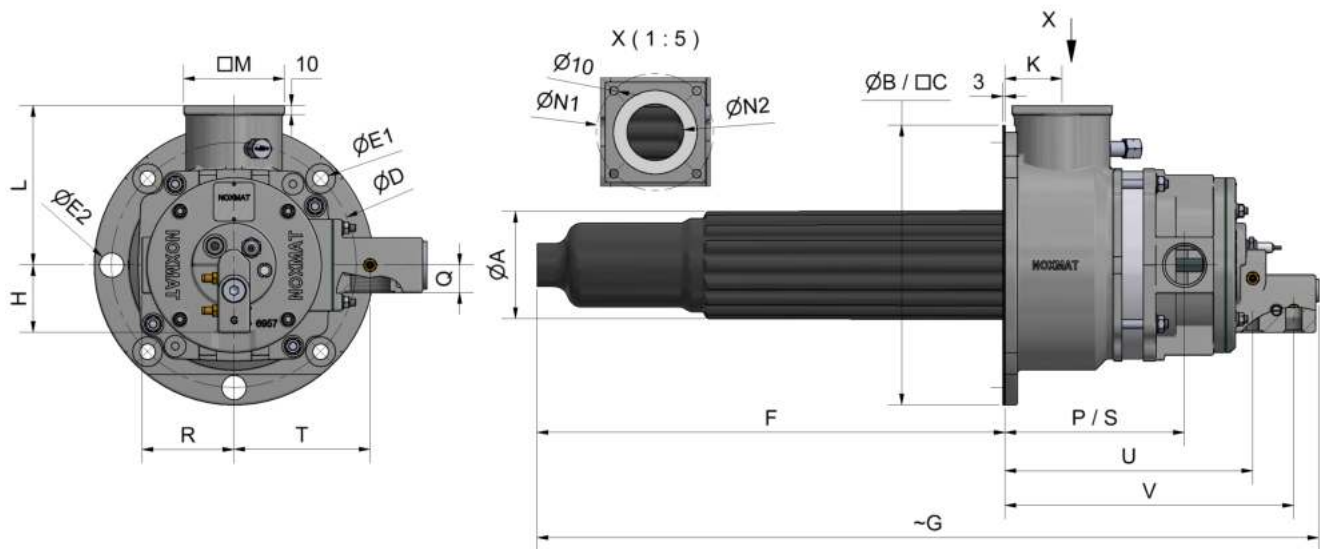
[2] Pressure fluctuations must not exceed +/- 5%; this also applies to the operation of the burners in groups.

[4] Reference values, based on a furnace temperature of 1200°C and 90% waste gas retraction at nominal burner capacity.

[5] Other combustion gases must be coordinated with Noxmat in advance.



## Principal dimensions / Basic burner

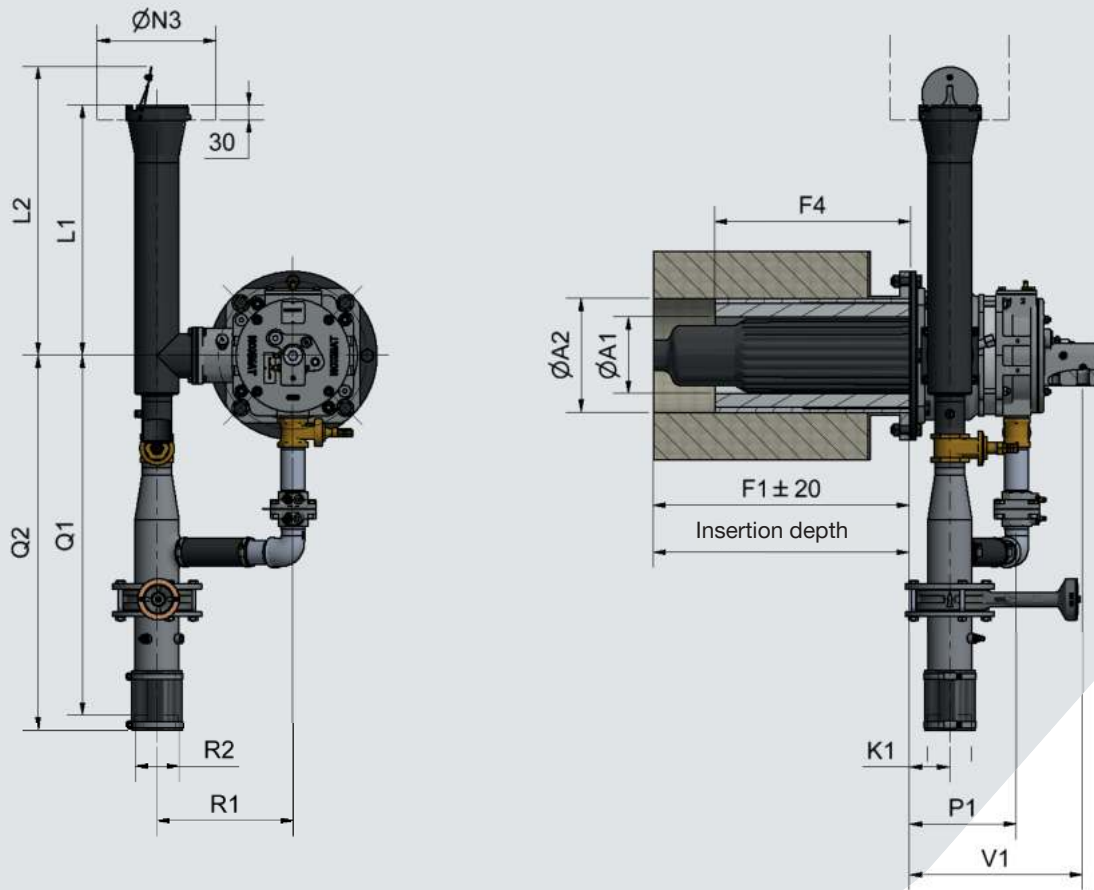


Burner size	Principal dimensions							
	A	B	C	D	E1/E2	F	G	H
	mm							
K-RHGBE 15	60	--	180	210	18/--	535	910	80
K-RHGBE 30	100	265	--	225	18/28	535	880	70
K-RHGBE 50	125	--	252	280	18/--	535	895	77
K-RHGBE 100	150	--	272	300	18/--	535	905	50

Burner size	Connection dimensions															
	Waste gas					Combustion air			Cooling air**			Purge air		Combustion gas		
	K	L	M	N1	N2	P	R	S	Q	T	U	V				
	mm					mm	inch	mm		inch	mm	inch	mm	inch		
K-RHGBE 15	60	130	96	110	35	185	125	G3/4	185	30	125	G3/4	259	G3/8	304	Rp1/2
K-RHGBE 30	65	150	104	120	50	197	135	G1	197	37	135	G1.1/2	274	G3/8	319	Rp1/2
K-RHGBE 50	65	180	115	134	65	205	158	G1.1/2	205	30	158	G1.1/2	283	G3/8	328	Rp1/2
K-RHGBE 100	65	190	115	134	75	200	180	G1.1/2	200	48	180	G1.1/2	279	G3/8	334	Rp3/4

# SERIES K-RHGBE

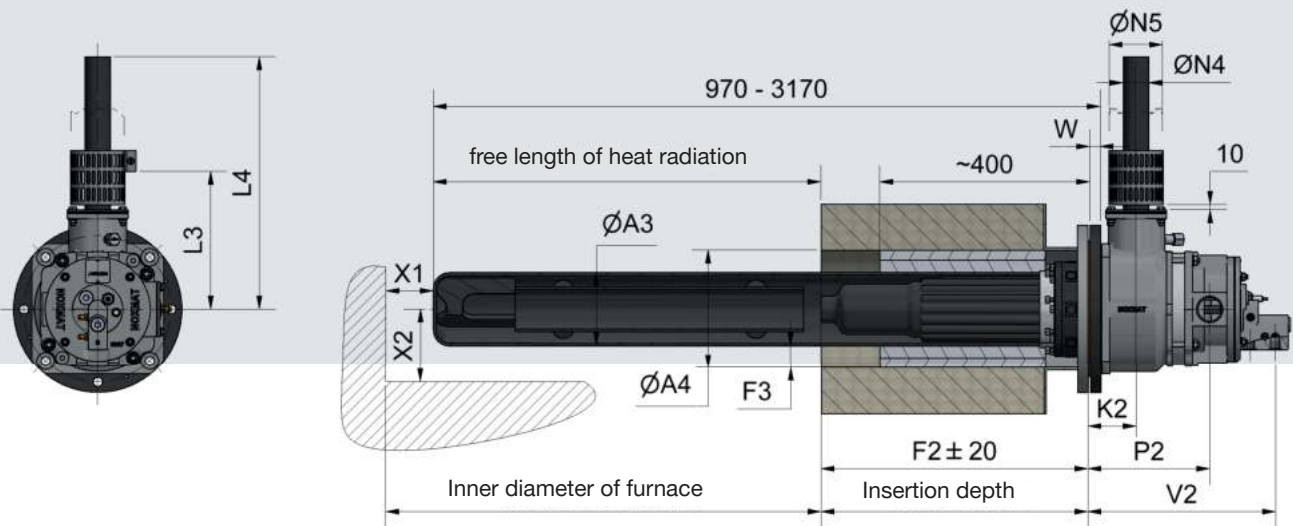
## Principal dimensions / Connecting dimensions Direct heating



Burner size	Principal dimensions				Connection dimensions									
					Waste gas				Combustion and Ejector air				Gas	
	A1	A2	F1	F4	K1	L1	L2	N3	P1	Q1	Q2	R1	R2	V1
mm				mm				mm				mm		
K-RHGBE 15	66	125	535	418	76	506	583	240	201	365±10	396	231	34	320
K-RHGBE 30	105	175	535	387	81	506	583	240	213	365±10	396	251	34	335
K-RHGBE 50	130	200	535	395	81	506	595	240	221	565±10	595	281	60	346
K-RHGBE 100	155	230	535	398	81	506	583	240	216	730±10	758	275	89	350



## Principal dimensions / Connecting dimensions Indirect heating



Burner size	Principal dimensions				Connection dimensions									
					Waste gas					CA	Gas	Jacket tube		
	A3	A4	F2	F3	K2	L3	L4	N4	N5	P2	V2	W	X1	X2
	mm				mm					mm	mm	mm	mm	mm
K-RHGBE 15	80	151	513	36	82	212	430	42	102	207	326	15	90	80
	100	160	513	30	82	212	430	42	102	207	326	15	90	100
K-RHGBE 30	115	175	513	31	87	232	450	42	102	219	341	15	90	115
	140 a	225	508	42	92	232	450	42	102	224	346	20	90	140
K-RHGBE 50	140 a	225	508	42	92	262	480	48	102	231	357	20	90	140
	165 a	250	508	43	92	262	480	48	102	231	357	20	105	165
K-RHGBE 100	165 a	250	508	43	92	262	480	60	102	227	361	20	105	165
	200 a	285	495	43	105	272	490	60	102	240	374	20	120	200

## SERIES K-RHGB-RN *REMAT*

Retrofit recuperative high-velocity burner with ceramic recuperator for the indirect heating of industrial furnaces 13-25 kW



### Specifications & Advantages

- High-velocity burner with integrated ceramic recuperator for efficient heat recovery, for indirect heating
- Especially suitable when modernizing chamber furnaces that are heated with protective gas
- All media connections are suitable for existing systems
- Easy direct ignition at high-fire due to patented ignition system, even at cold start
- Direct flame monitoring to ensure maximum safety in all stages of operation
- Power scope from 13 to 25 kW
- Maximum application temperature at the recuperator up to 1250°C
- Higher energy efficiency due to improved heat recovery compared to existing burners
- Low-emission multi-stage combustion
- Excellent temperature distribution due to high burner velocity
- Easy and economical basic maintenance
- Wear is considerably reduced due to ceramic components

## Technical specifications

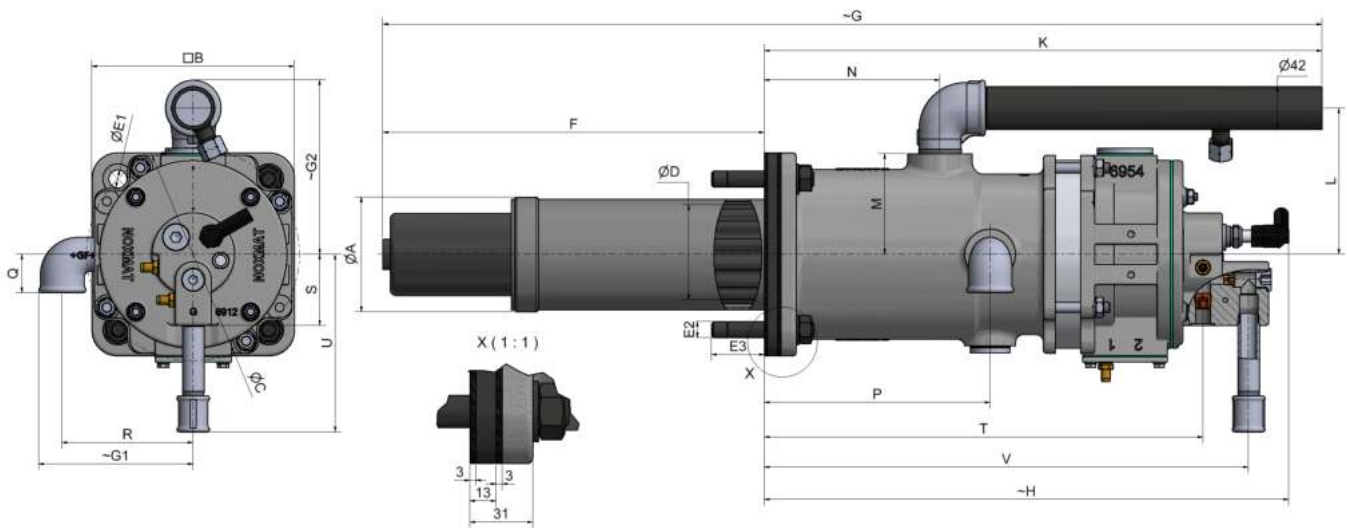
Burner type K-RHGB RN		25
Nominal thermal capacity [1]	kW	25
Nominal thermal capacity [1]	BTU/h	~85000
Minimum thermal capacity [1]	kW	13
Minimum thermal capacity [1]	BTU/h	~44000
Nominal gas connection pressure [2]	mbar	50
Nominal air connection pressure, indirect heating [2]	mbar	80
Maximum recuperator temperature	°C	1250
Nominal diameter of recuperator	mm	98
Nominal diameter gas connection	DN	15
Nominal diameter combustion air connection	DN	25
Nominal diameter cooling air connection	DN	40
Fuel gas [3]		NG, LNG, LPG

Subject to technical modifications. [1] Values deviating from the burner capacity are possible upon request.  
 [2] Pressure fluctuations must not exceed +/- 5%; this also applies to the operation of the burners in groups.  
 [3] Other combustion gases must be coordinated with Noxmat in advance



# SERIES K-RHGB-RN *REMAT*

## Principal dimensions / Basic burner



Burner size	Principal dimensions									
	A	B	C	D	E1/E2/E3	F	G	G1	G2	H
	mm									
K-RHGB 25-380 RN	113	200	210	98	18/M16/52	377	930	152	172	520
K-RHGB 25-560 RN	113	200	210	98	18/M16/52	557	1110	152	172	520

Burner size	Connection dimensions														
	Waste gas				Combustion air				Purge air		Combustion gas				
	K	L	M	N	P	Q	R	S	T	U	V				
	mm				mm			inch	mm		inch	mm		inch	
K-RHGB 25-380 RN	550	144	99	173	G1.1/4	223	38	129	G1	70	433	G3/8	175	478	Rp1/2
K-RHGB 25-560 RN	550	144	99	173	G1.1/4	223	38	129	G1	70	433	G3/8	175	478	Rp1/2

## SERIES HGBE

High-velocity burner for the direct and indirect heating of industrial furnaces 9-160 kW



### Specifications & Advantages

- Especially cost-efficient high-velocity burner
- Power scope from 9 to 160 kW
- Maximum application temperature up to 1300°C
- Suitable for operation with cold and hot air (up to 400°C air pre-heating)
- Low-emission single-stage combustion
- Excellent temperature distribution due to high burner velocity
- Easy direct ignition at full load due to patented ignition system
- Particularly maintenance-friendly, modular set-up
- All media connections can be adjusted at 90° angles
- Direct flame monitoring to ensure maximum safety in all stages of operation
- Separate cooling air connection possible to enable the specific operation of temperature ramps
- Easy and economical basic maintenance
- Available with basic or complete configuration

# SERIES HGBE

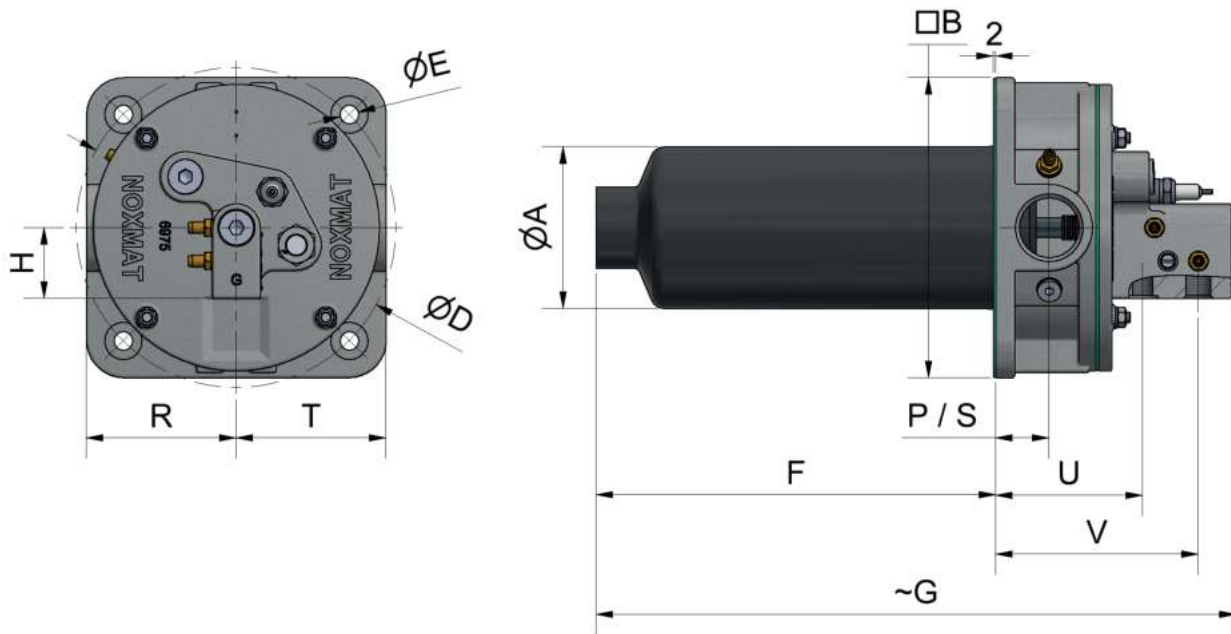
## Technical specifications

Burner type HGBE		15	25	50	100	200
Nominal thermal capacity [1]	kW	15	25	50	100	160
Nominal thermal capacity [1]	BTU/h	~51000	~85000	~171000	~341000	~546000
Minimum thermal capacity [1]	kW	9	13	25	50	80
Minimum thermal capacity [1]	BTU/h	~31000	~44000	~85000	~171000	~273000
Nominal gas connection pressure [2]	mbar	50	50	50	50	50
Nominal air connection pressure [2]	mbar	60	60	60	60	80
Maximum temperature at burner head	°C	1300	1300	1300	1300	1300
Nominal diameter of burner tube	mm	59	71	94	121	171
Nominal diameter gas connection	DN	15	15	15	15	20
Nominal diameter combustion air connection	DN	20	25	40	40	50
Nominal diameter cooling air connection	DN	20	40	40	40	50
Fuel gas [3]		NG, LNG, LPG				

Subject to technical modifications. [1] Values deviating from the burner capacity are possible upon request.  
 [2] Pressure fluctuations must not exceed +/- 5%; this also applies to the operation of the burners in groups.  
 [5] Other combustion gases must be coordinated with Noxmat in advance.



## Principal dimensions / Basic burner



Burner size	Principal dimensions						
	A	B	D	E	F (1)	G (3)	H
	mm						
HGBE 15	59	160	170	14	200/250/300/400	600	72.5
HGBE 25	71	175	190	14	200/250/300/400	560	77
HGBE 50	94	195	210	14	200/250/300/400/500/600	580	77
HGBE 100	121	225	240	14	200/250/300/400/500/600	580	53
HGBE 200	171	285	310	14	300/400/500	650	70

Burner size	Connection dimensions									
	Waste gas			Combustion air			Purge air		Combustion gas	
	P	R		S	T(2)		U		V	
	mm	mm	inch	mm	mm	inch	mm	inch	mm	inch
HGBE 15	34	80	G3/4	34	80	G3/4	87	G3/8	132	Rp1/2
HGBE 25	34	87.5	G1	34	87.5	G1.1/2	92	G3/8	137	Rp1/2
HGBE 50	40	97.5	G1.1/2	40	97.5	G1.1/2	107	G3/8	152	Rp1/2
HGBE 100	40	112.5	G1.1/2	40	112.5	G1.1/2	110	G3/8	152	Rp1/2
HGBE 200	56	142.5	G1.1/2	56	142.5	G2.1/2	157	G3/8	215	Rp3/4

(1)deviating length is possible; (2) drilling optional; (3) reference: installed length of F= 40 mm

# JACKET RADIANT TUBES (K TYPE)

Ceramic radiant tubes for the indirect heating of industrial furnaces

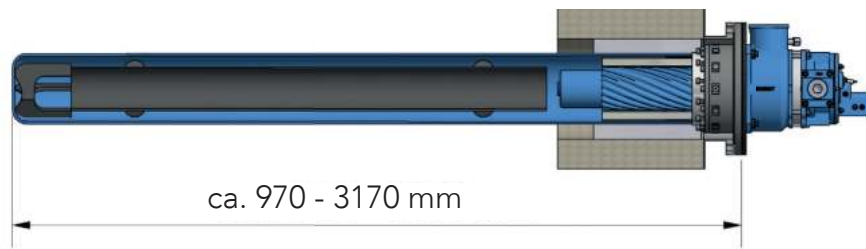


## Specifications & Advantages

- Especially high oxidation and corrosion resistance (no scaling)
- Suitable for horizontal or vertical installation
- Heating tube, flame tube, and spacers are designed in SiSiC ceramic, for thermal stability of up to 1300°C
- Extremely high density even at application temperature
- Constant mechanical rigidity
- Wide selection of different sizes for diverse applications
- Compatibility with other systems
- Especially maintenance-friendly, modular set-up with reusable components
- Numerous possible combinations with burners in ceramic and steel design



## Possible combinations with ceramic burners



Burner size	Outer casing diameter [mm]							
	80	90	100	115	140	145	165	200
K-RHGBE 15								
K-RHGB 15								
K-RHGBE 30/ K-RHGB 25								
K-RHGBE 50/ K-RHGB 40								
K-RHGBE 100/ K-RHGB 80								

not combinable
  with waste gas guiding tube
  without waste gas guiding tube

## with steel burners



Burner size	Outer casing diameter [mm]			
	140	145	165	200
RHGB 15				
RHGB 25				
RHGB 40				

not combinable
  with waste gas guiding tube

# JACKET RADIANT TUBES (STEEL)

Steel radiant tubes for the indirect heating of industrial furnaces



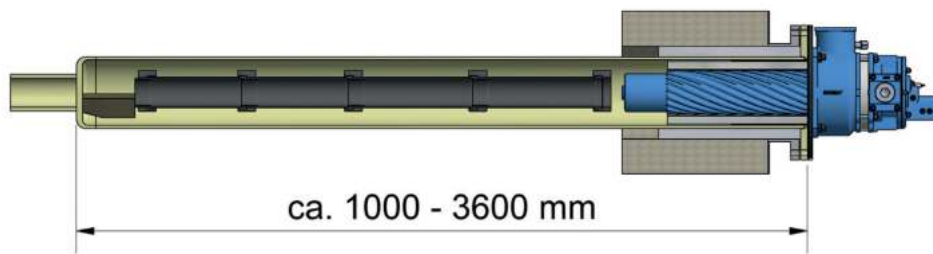
## Specifications & Advantages

- Suitable for horizontal and vertical installation
- Particularly mechanically robust
- Wide selection of different sizes for diverse applications
- Numerous designs (p-, double-p, u-tubes, etc.)
- High power input due to large surface (i.e. double-p tube)
- Extremely high density even at application temperature (depending on material)
- Very compatible with other systems
- Combinable with burners in ceramic and steel design



Example of use P shapes,  
implementation on request

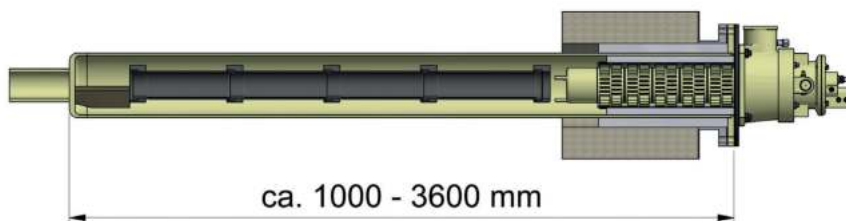
## Possible combinations with ceramic burners



Burner size	Mantelrohrdurchmesser (mm)				
	100	120	150	200	300
K-RHGBE 15					
K-RHGB 15					
K-RHGBE 30/ K-RHGB 25					
K-RHGBE 50/ K-RHGB 40					
K-RHGBE 100/ K-RHGB 80					
K-RHGB 160					

not combinable    
  with waste gas guiding tube    
  without waste gas guiding tube

## with steel burners



Burner size	Mantelrohrdurchmesser (mm)			
	120	150	200	300
RHGB 15				
RHGB 25				
RHGB 40				
RHGB 80				
RHGB 100				
RHGB 160				
RHGB 250				

not combinable    
  with waste gas guiding tube    
  without waste gas guiding tube

# ACCESSORIES

## Burner control units (BCUs)

Decentralized burner controls by NOXMAT have integrated automatic burner control and ignition transformers to ensure safe ignition and control of the burner. The customized function software is tailored to NOXMAT's operation and its burners, and it offers a variety of parameterization and diagnostics possibilities.



## Gas-pressure control, measuring, and safety systems (GDRMS)

NOXMAT's gas-pressure control systems are manufactured according to DIN EN 746-2 and are specially tailored to the optimal operation of gas burners in industrial thermal processing plants. The minimal pressure fluctuations enable an optimal and particularly energy-efficient operation of the burners.



## Combustion air fans



NOXMAT's combustion air fans have especially flat characteristics and can be equipped with a frequency converter to further increase efficiency. In line with the NOXMAT gas control systems, they are specially tailored to the optimal operation of gas burners in industrial thermal processing plants. The minimal pressure fluctuations enable an optimal and particularly energy-efficient operation of the burners.

## Measuring orifices (MB)

NOXMAT measuring orifices enable a twofold differential-pressure measurement during operation of the burner. Combined with a differential pressure switch, they are especially suited for the dynamic control of combustion air according to DIN EN 746-2.



## Spare and wear parts

All spare and wear parts for our burner systems are stocked in sufficient quantities. NOXMAT is an EU-licensed consignor of air-freight shipments, thus guaranteeing especially speedy worldwide shipment.



# UNITS

## Energy, Quantity of heat

Unit symbol	Designation of unit	J=Nm	kWs	kWh	kcal	R.deg C	BTU
1 J = Nm	Joule= Newton meter	1	0,001	$2,7778 \cdot 10^{-7}$	$2,3885 \cdot 10^{-4}$	0,12028	0,00095
1 kWs	kilowatt second	1000	1	$2,7778 \cdot 10^{-4}$	0,238846	120,276	$3,7251 \cdot 10^{-4}$
1 kWh	kilowatt hour	3 000 000	3600	1	859,845	432 991	3412,14
1 kcal	Int. Steam table calorie	4186,8	4,1868	0,001163	1	503,575	3,96381
1 R . grd	Gas constant	8,3142	0,00831	$2,3095 \cdot 10^{-4}$	0,001986	1	0,00788
1 BTU	British thermal unit	1055,06	1,05506	0,000293	0,251995	126,963	1

## Specific heat

Unit symbol	Designation of unit	J/kg deg C	kcal/kg	J/kg deg C	BTU/lb deg F
1 J/kg grd	Joule per kilogram per degree Celsius	1	$2,38844 \cdot 10^{-4}$	$2,77778 \cdot 10^{-7}$	$2,38844 \cdot 10^{-4}$
1 kcal/kg grd	kilocalorie per kilogram per degree Celsius	4186,8	1	$1,163 \cdot 10^{-3}$	1
1 kWh/kg grd	Kilowatt hour per kilogram per degree Celsius	$3,6 \cdot 10^6$	859,845	1	859,845
1 BTU/lb deg F	British thermal unit per pound per degree Fahrenheit	4186,8	1	$1,163 \cdot 10^{-3}$	1

## Power

Unit symbol	Designation of unit	J/s = 1 W	kW	kcal/h	BTU/s	BTU/min	PS
1 J/s = 1 W	1 Joule per second = 1 Watt	1	0,001	0,86	$0,948 \cdot 10^{-3}$	0,0569	$1,36 \cdot 10^{-3}$
1 kW	kilowatt hour	1000	1	860	0,948	56,869	1,359
1 kcal/h	kilocalorie per hour	1,163	$1,163 \cdot 10^{-3}$	1	$1,10 \cdot 10^{-3}$	0,066	$1,58 \cdot 10^{-3}$
1 BTU/s	British thermal unit per second	1060	1,06	0,252	1	60	1,43
1 BTU/min	British thermal unit per minute	17,58	0,01758	15,13	0,01667	1	0,0239
PS	Horsepower	735,48	0,735	0,176	0,697	41,827	1

## Volume

Unit symbol	Designation of unit	cm <sup>3</sup>	dm <sup>3</sup> = 1 l	m <sup>3</sup>	in <sup>3</sup>	ft <sup>3</sup>	gal (US)
1 cm <sup>3</sup>	Cubic centimeters	1	0,001	$1 \cdot 10^{-6}$	0,061102	-	0,00026
1 dm <sup>3</sup> = 1 l	Cubic decimeter = liter	1000	1	$1 \cdot 10^{-3}$	61,0237	0,03531	0,26417
1 m <sup>3</sup>	cubic meter	$1 \cdot 10^6$	1000	1	61023,7	35,31	264,17
1 in <sup>3</sup>	cubic inch	16,3871	0,01639	$16,39 \cdot 10^{-6}$	1	0,00058	0,00433
1 ft <sup>3</sup>	cubic foot	28316,8	28,3186	0,02832	17,28	1	7,48047
1 gal (US)	gallon (US)	3785,43	3,78543	$3,785 \cdot 10^{-3}$	231	0,13368	1

## Area

Unit-symbol	Designation of unit	mm <sup>2</sup>	cm <sup>2</sup>	m <sup>2</sup>	a	ha	km <sup>2</sup>	in <sup>2</sup>	ft <sup>2</sup>	sq. Mile
1 mm <sup>2</sup>	square millimeter	1	0,01	1*10 <sup>-6</sup>	-	-	-	1,55*10 <sup>-3</sup>	1,08*10 <sup>-5</sup>	-
1 cm <sup>2</sup>	square centimeter	10	1	0,001	-	-	-	0,155	0,00108	-
1 m <sup>2</sup>	square meter	1*10 <sup>6</sup>	10 000	1	0,01	0,0001	-	1550	10,7639	-
1 a	Ar	-	-	100	1	0,01	0,001	0,001	-	119,599
1 ha	hectar	-	-	10 000	100	1	0,01	-	107 639	0,00386
1 km <sup>2</sup>	square kilometer	-	-	-	10 000	100	1	-	-	0,3861
1 in <sup>2</sup>	square inch	6,45*10 <sup>2</sup>	6,4516	-	-	-	-	1	0,00694	-
1 ft <sup>2</sup>	square foot	9,29*10 <sup>4</sup>	929,03	0,0929	0,00093	-	-	144	1	-
1 sq. mile	square mile	-	-	25899,9	258,999	2,58999	-	-	-	1

## Length

Unit-symbol	Designation of unit	mm	cm	dm	m	km	in	ft	yd	mile
1 mm	millimeter	1	0,1	0,01	0,001	-	0,03937	0,00328	-	-
1 cm	centimeter	10	1	0,1	0,01	-	0,3937	0,03281	-	-
1 dm	decimeter	100	10	1	0,1	-	3,937	0,3281	0,109362	-
1 m	meter	1000	100	10	1	0,001	39,37	3,28084	1,09362	-
1 km	kilometer	-	100 000	10 000	1000	1	39 370	3280,84	1093,62	0,62137
1 in	inch	25,4	2,54	0,254	0,0254	-	1	0,08333	0,0277778	0,07778
1 ft	foot	304,8	30,48	3,048	0,3048	-	12	1	0,33333	-
1 yd (UK)	yard (UK)	914,398	91,4398		0,914398	-	36	3	1	-
1 mile	statute mile	-	-	16 093,4	1609,34	1,609	63360	5280	1760	1

## Weight, mass

Unit-symbol	Designation of unit	g	kg	t	oz	lb
1 g	gram	1	0,001	-	0,03527	0,0022
1 kg	kilogram	1000	1	0,001	35,274	2,20462
1 t	ton	-	1000	1	35274	2204,62
1 oz	ounce	28,3495	0,02835	-	1	0,0625
1 lb	pound	453,592	0,045359	0,00045	16	1

# UNITS

## Pressure

Unit symbol	Designation of unit	Pa= N/m <sup>2</sup>	h Pa= mbar	bar	mH <sub>2</sub> O	kgf/ m <sup>2</sup> =at	atm	lbf/in <sup>2</sup> (psi)	lbf/ft <sup>2</sup> (psf)
1 Pa=1 N/m <sup>2</sup>	Pascal	1	0,01	0,00001	0,0001	0,00001	-	0,00014	0,02089
1 mbar	millibar	100	1	0,001	0,0102	0,001	-	0,0145	-
1 bar	bar	100 000	1000	1	10,1972	1,01972	0,98692	14,5037	2088,54
1 m WS	Centimeter of water	9806,65	98,07	0,09807	1	0,1	0,09678	1,42233	204,816
1 kp/m <sup>2</sup> =1 at	Technical atmosphere	98066,5	980,67	0,098067	10	1	0,96784	14,2233	2048,16
1 atm	Standard Atmosphere	101325	1013,25	1,01325	10,3323	1,03323	1	14,696	2116,22
1 lbf/in <sup>2</sup> (psi)	pound-force per square inch	6894,76	69,95	0,06895	0,70307	0,07031	0,06805	1	144
1 lbf/ft <sup>2</sup> (psf)	pound-force per square foot	47,8803	0,48	0,00048	0,00488	0,00048	0,00047	0,00694	1

## Pipe sizing table (DIN 2440)

Nominal size		Outer diameter	Wall thickness	Inner diameter	Free cross-section	Volume	Surface	Weight of the smooth pipe
inch	mm	da≈mm	s mm	di≈mm	AF≈cm <sup>2</sup>	V≈l/m	Ao≈m <sup>2</sup> /m	≈kg/m
1/8"	6	10,2	2	6,2	0,3	0,03	0,0032	0,407
1/4"	8	13,5	2,35	8,8	0,61	0,061	0,042	0,65
3/8"	10	17,2	2,35	12,5	1,23	0,123	0,054	0,853
1/2"	15	21,25	2,65	15,75	2,02	0,202	0,067	1,22
3/4"	20	26,75	2,65	21,25	3,66	0,366	0,084	1,58
1"	25	33,5	3,25	27	5,8	0,58	0,106	2,44
1 1/4"	32	42,25	3,25	35,75	10,12	1,012	0,133	3,14
1 1/2"	40	48,25	3,25	41,25	13,72	1,372	0,152	3,61
2"	50	50	3,65	42,5	22,06	2,206	0,189	5,1



# CONVERSIONS

Temperature	θ ° Celsius	T Kelvin	t ° Fahrenheit
Degrees Celsius °C	θ	T-273,16	5/9(t-32)
Degrees Kelvin K	θ+273,16	T	5/9(t-455,67)
Degrees Fahrenheit °F	9/5*θ+32	9/5*T-459,67	t

Temperature	°C	T	°F
1 °C	1	273.16	33.8
1K	-273.16	1	-239.36
1°F	-17.22	255.93	1

Density	1 g/cm <sup>3</sup>	lb/cu. inch	lb/cu. foot
1 g/cm <sup>3</sup>	1	0.03613	62.428
1 pound/cubic inch	27.68	1	1728
1 pound/cubic foot	0.01602	5,79*10 <sup>-4</sup>	1

c	N	kN	MN
1 N	1	10 <sup>-3</sup>	10 <sup>-6</sup>
1 kN	10 <sup>3</sup>	1	10 <sup>-3</sup>
1 MN	10 <sup>6</sup>	10 <sup>3</sup>	1

Time	s	ns	µs	ms	min
1 s	1	10 <sup>9</sup>	10 <sup>6</sup>	10 <sup>3</sup>	16,66*10 <sup>-3</sup>
1 ns	10 <sup>-9</sup>	1	10 <sup>-3</sup>	10 <sup>-6</sup>	16,66*10 <sup>-12</sup>
1 µs	10 <sup>-6</sup>	10 <sup>3</sup>	1	10 <sup>-3</sup>	16,66*10 <sup>-9</sup>
1 ms	10 <sup>-3</sup>	10 <sup>6</sup>	10 <sup>3</sup>	1	16,66*10 <sup>-6</sup>
1 min	60	60*10 <sup>9</sup>	6*10 <sup>6</sup>	6*10 <sup>3</sup>	1

# GENERAL INFORMATION

Atmospheric pressure	Pressure	
Meters above sea level m	Torr	mbar = h Pa
0	760	1013
200	742	989
400	724	966
600	707	943
800	690	921
1000	673	899
1200	657	876
1400	641	854
1600	626	835
1800	611	851
2000	596	795
2200	581	775
2400	567	756
2600	553	737
2800	539	719
3000	525	701
3500	493	657
4000	463	616
5000	405	540
10 000	198	264
20 000	41	55

Temperature		
K	°C	°F
0	-273	-460
	0.01602	5,79*10-4
273	0	32
373	100	212
673	400	752
873	600	1112
1073	800	1472
1173	900	1652
1223	950	1742
1273	1000	1832
1323	1050	1922
1373	1100	2012
1423	1150	2102
1473	1200	2192
1523	1250	2282
1573	1300	2372

## NOx values in different elements

Waste gas - Volume				Energy (Natural gas H)		
ppm at 3% O2	ppm at 5% O2	mg/m <sup>3</sup> at 3% O2	mg/m <sup>3</sup> at 5% O2	mg/kWh	mg/MJ	#/MMBTU
10	9	21	18	20	6	0.01
20	18	41	36	41	11	0.03
30	27	62	55	61	17	0.04
40	36	82	73	81	23	0.05
50	44	103	91	102	28	0.07
60	53	123	109	122	34	0.08
70	62	144	128	142	40	0.09
80	71	164	146	163	45	0.11
90	80	185	164	183	51	0.12
100	89	205	182	204	57	0.13
120	107	246	219	244	68	0.16
140	124	287	255	285	79	0.18
160	142	328	292	326	90	0.21
180	160	369	328	366	102	0.24
200	178	410	364	407	113	0.26
250	222	513	456	509	141	0.33
300	267	615	547	611	170	0.39
350	311	718	638	712	198	0.46
400	356	820	729	814	226	0.53
450	400	923	820	916	254	0.59
500	444	1025	911	1018	283	0.66
600	533	1230	1093	1221	339	0.79
700	622	1435	1276	1425	396	0.92
800	711	1640	1458	1628	452	1.05





# CUSTOMER QUESTIONNAIRE

Burner request							
0	Company						
	Project / Operator						
	Furnace type						
1	Operation temperature						
		min:		°C	max:		°C
2	Gas type						
		Natural gas (NG):		Liquefied petroleum gas		Other:	
3	Burner type						
	Burner quantity	Amount / Pieces:		Burner connection value:			kW
	Mounting position of the burner			horizontal:		vertical:	
	Cooling air connection at the burner			with:		without:	
4	Burner control	Yes:		No:			
	Profibus	Yes:		No:			
	Profinet	Yes:		No:			
	Mode of operation:	On / Off:		High / Low:		Continuous:	
5	Magnet valves / flaps		Keine Vorgabe:		Manufacturer:		
6	Radiant tube heating		Ja:		No:		
	Radiant tube type:	Straight:		P-type:		Double-P-type:	
		U-type:		Other:			
	Radiant tube must be included	Yes:		No:			
	Outer diameter	mm					
	Inner diameter	mm					
	Total length	mm					
	Free length of heat radiation:	mm					
	Flame tube must be included	Yes:		No:			
7	Comments						
8	Customer:	Date:					
		Company:					
		Name:					

## HISTORY

- 1992 Founding of the independent company under the leadership of Rudolf Distl & Dr Wolfgang Harbeck
- 1993 The company and six new employees move to a new office building with assembly hall, as first investor in the new business park of Oederan
- 1994 Environmental award of the Freiberg district
- 1996 Certification according to ISO 9001
- 1998 Tests of first burners with ceramic design
- 2000 Development of ceramic jacket tubes
- 2006 New sales office with warehouse opens in Hagen (North Rhine-Westphalia)
- 2007 Expansion: new office building with modern production hall, including R&D and administration building
- 2011 Founding of NOXMAT Technique Beijing Co. Ltd in China
- 2012 Acquisition of WAC company strengthens the NOXMAT service team
- 2013 Celebratory farewell to long-time CEO Dr Wolfgang Harbeck. His successor, Matthias Wolf, brings international experience that allows NOXMAT to tap into new markets
- 2016 Certificate for predictive energy management
- 2017 *ETAMAT* - a new generation of burners with top energy efficiency enters the market in time for the company's 25-year anniversary
- 2018 Most successful year in the history of the company so far, with a record turnover
- 2019 Certification according to new standard ISO 9001:2015



# NOXMAT

combustion technology

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