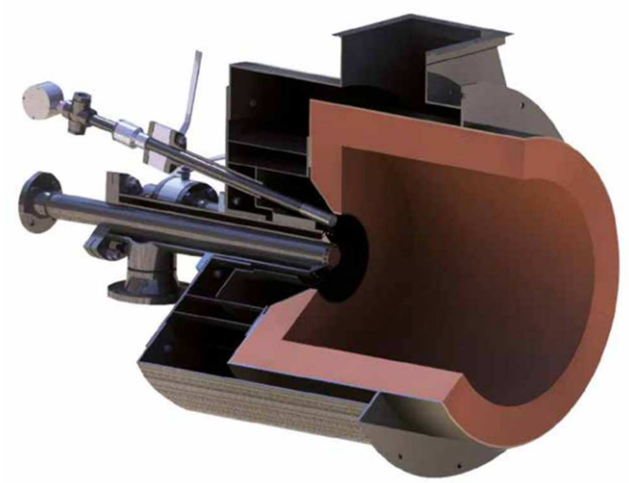
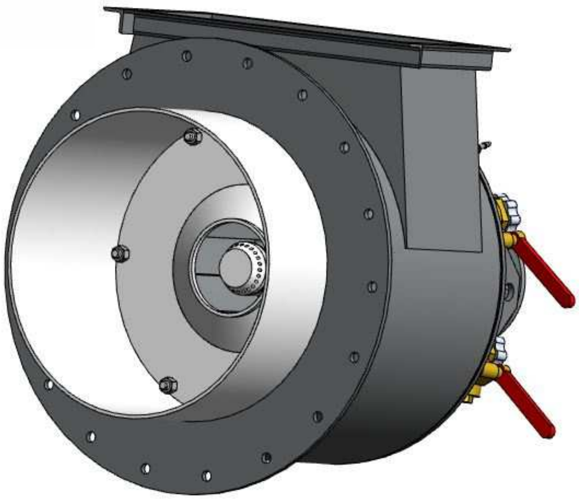
ITAS Intensityflame-gas
Engineering manual

Version May 2020





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- Exceptional events;
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ITAS Intensityflame-gas burner is a “partly completed machinery” and cannot be used without further integration into a combustion system or machine. Fives ITAS S.p.A. liability limits to the product only. Fives ITAS S.p.A. will not be liable for any injury, loss, damage or expense (whether direct or consequential), including but not limited to loss of use, income, or damage to material arising in connection with sale, installation, use of, inability to use or repair or replacement of Fives ITAS S.p.A. products.

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TABLE OF CONTENTS

The information provided on this brochure is for information purposes only and does not constitute any legal obligation or a warranty, expressed or implied, concerning quality, marketability or suitability for a specific purpose.

1. INTRODUCTION

All involved personnel shall carefully read this entire manual before integrating the product into a combustion system. If any part of the information in this manual is not clear, contact Fives ITAS S.p.A. before proceeding.
This manual provides information regarding the design of the burners for their specific design purpose. Do not deviate from any instructions or application limits described herein without written approval from Fives ITAS S.p.A.

1.1 Audience

This manual is intended for engineers having experience with all aspects of combustion. These aspects include, but are not limited to, nozzle-mix burners and its related components such as gas trains, blowers and fans, burner management and air flow design.

1.2 Symbols

⚠WARNING The warning signal used in this document indicates a subject requiring special attention when designing the combustion system. Improper design of the combustion system might result in death or injury when operating the system.

1.3 Assistance

Should the user need any assistance, contact the local Fives ITAS S.p.A. representative or contact the Headquarter:

Fives ITAS S.p.A.
Via Metauro, 5 – 20900 Monza (MB) – Italy
Tel. +39 039 27331

1.4 Related documents

This engineering manual is provided together with, and cannot be used without:

- Technical datasheets of the ITAS Intensityflame-gas burner series. Each burner size has its own datasheet.
- Engineering manual of the ITAS Intensityflame-gas burner series (present document)

1.5 Purpose of this manual

The purpose of this document is to ensure a safe, effective and trouble-free selection of the Intensityflame-gas burner and to support a trouble-free design of the combustion system where burner is to be integrated. This document is not applicable for Intensityflame-oil burners.

2. THE PRODUCT

2.1 Description

ITAS Intensityflame-gas burner is a nozzle-mix burner designed for integration into a combustion system or machine. The burner is designed for firing single gas or dual gas with:

- High turndown
- On ratio air- and gas control
- High flame stability
- Simple adjustment

2.2 Intended use

ITAS intensityflame-gas burner is designed for use on a wide range of industrial air-heaters, direct- or indirect-fired. Typical industrial applications are:

- Industrial grass and grain dryers
- Yankee hoods for paper industry
- Base material drying in the minerals industry
- Calcination dryers for Gypsum industry
- Drying applications for food and feed
- Hot gas generators for general drying applications

2.3 Certification

ITAS Intensityflame-gas burner complies with the EN746-2 and the machine directive 2006/42/EC. This can be confirmed by manufacturer's Declaration of incorporation.
ITAS Intensityflame-gas meets the technical specifications of the Eurasian Customs Union (EAC).

2.4 Mechanical construction

The burner is available in twelve (12) different capacity sizes from 1500 kWlhv up to 55000 kWlhv. The mild steel burner body (figure 2.1) houses an alumina air bond refractory or AISI 310 combustor, a mild steel swirling plate and a gas gun. The gas gun comes in 2 options. One for single gas operation and the second for dual gas operation. The gas gun is rotatable in 4 different positions to have the best fit with the incoming gas- and air flanges.

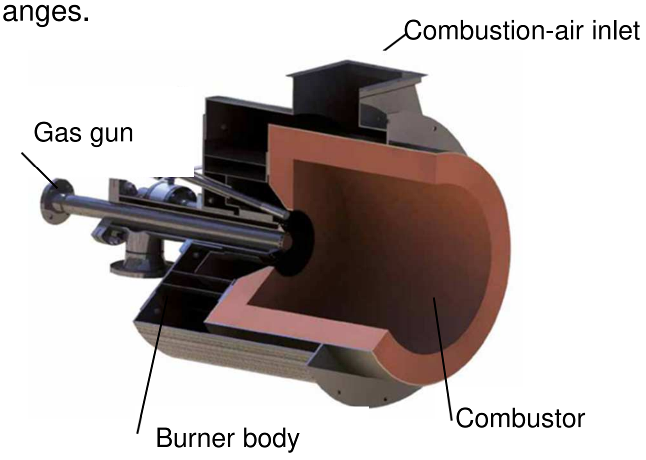

Figure 2.1 - Intensityflame-gas part recognition

2.5 Functioning

After starting the combustion air fan, the burner controller unit shall open the gas supply towards the pilot burner and combustion air towards the burner. At the outlet of the pilot-nozzle, the pilot gas is ignited by the spark rod. Combustion is completed with the oxygen from the combustion air. The burner controller unit opens the main gas(es) supply towards the burner. Main gas and combustion air flow through their separated ways towards the burner's nozzle. The combustible gas/air mixture is produced at the nozzle, downstream of the gas gun, inside of the combustor. The gas-/air mixture is ignited by the pilot flame. A flame is produced, which will be monitored by a flame-sensor. The pilot switches off.

2.6 Control methodology

ITAS Intensityflame-gas burner is designed for on-ratio control with certain levels of air excess. Within the pre-defined limits, the burner offers a wide flexibility in excess air operation (see burner's technical datasheet). During operation, the air- and gas flows are controlled via separate control valves applying the gas and air pressure data at the burner inlet as indicated in the burner data sheet.

3. BURNER SELECTION AND SYSTEM DESIGN

3.1 Burner selection

The burner shall properly fit the heater or application where it is meant to be used on. Use the ITAS Intensityflame-gas technical datasheets when following the selection process. The user shall make sure to be consulting the most recent version of technical datasheets.

Capacity input: A heat balance of the process defines the required heat input from the burner into the heater. Consider all aspects like system efficiencies, preheat temperatures and number of burners to determine the required capacity input from the burner. As far as the capacity data are concerned, it shall be noted that the capacities in kW and energies in kWh/m^3 relate to net heating values (=lhv).

When operating pre-heated combustion air up to 100°C, the maximum capacity input might be considered. When operating combustion air up to 200°C, the maximum burner capacity is reduced to 80% of the datasheet value. When operating combustion air up to 300°C, the maximum burner capacity is reduced to 70% of the datasheet value.

Turndown required: The minimum capacity input is indicated in the burner's technical datasheet.

⚠WARNING Never exceed the maximum and minimum capacities as per product's technical datasheet. This might cause flame instability and unsafe circumstances.

Combustor material: ITAS Intensityflame-gas burner is available with an alloy combustor or with a refractory lined combustor. Make sure the process temperature inside the heater does not exceed the burner's maximum allowable temperature as indicated in the technical datasheet. When using an alloy combustor, the lambda shall be 1,4 or higher to have enough cooling of the steel.

Fuel type: Make sure the fuel is suitable for use on ITAS Intensityflame-gas burner. Natural gas net heating values shall be 8 kWh/Nm^3 or higher.

Fuel supply pressure: The input of the burner is set by the pressure to the gas gun (or differential pressure between gas gun inlet and combustion chamber). Make sure the primary fuel has enough pressure to overcome the pressure drop over the gas gun and the backpressure from the combustion chamber. The gas pressure drop thru the gas gun at maximum gas flow is indicated in the technical datasheet. To calculate a pressure for different inputs, the formula is:

$$p2 = p1 * \frac{Q2}{Q1}$$

p1 = adjustment pressure for reference input [mbar] (from technical datasheet)*
p2 = adjustment pressure for actual input [mbar]
Q1 = reference input [kW] (from technical datasheet)
Q2 = actual input [kW]

* The pressures indicated in the technical datasheet are based on the gases specified in that datasheet. A correction of the gas pressure at the burner when running natural gas with deviating caloric value and/or density may be necessary. The required pressure may be calculated with:

$$p2 = p1 * \frac{\rho 2}{\rho 1} * \frac{hv2}{hv1}$$

p1 = adjustment pressure for reference input [mbar] (from technical datasheet)*
p2 = adjustment pressure for actual input [mbar]
ρ1 = density of reference fuel [kg/Nm³] (from technical datasheet)
ρ2 = density of actual fuel [kg/Nm³]
hv1 = heating value of the reference gas [kWh/m³] (from technical datasheet)
hv2 = heating value of the actual gas [kWh/m³]

In case of dual gas firing, contact Fives ITAS office about flow and pressure sizing.

Ignition system: The Intensityflame-gas burner is provided with a raw gas pilot. Pilot burners shall be fed with gas -flow and -pressure as per technical datasheet. The pilot position in relation to the throat of the burner is adjustable and will be positioned during production of the burner. For proper ignition of the pilot-burner, Fives ITAS S.p.A. recommends using a transformer with secondary voltage of 6 to 8 kVAC and a minimum secondary current of 20 mAmps at full wave output.

Flame swirl direction: Standard Intensityflame-gas burners are supplied with a clockwise swirling flame (when looking into the flame). This swirling is a result of the design of the nozzle where gas and air are coming together. If, for any reason, the process requires a counter clockwise swirling direction, please contact the Fives ITAS representative.

Flame supervision: ITAS Intensityflame-gas burners are supplied with a ¾" connection for UV-scanner or infrared scanner for flame supervision. Two installation ports (figure 3.1) are located near the gas gun and pilot assemblies. When using a burner with a standard clockwise swirling flame, the flame scanner shall be located in the port shown in figure 3.1 to prove both pilot- and main-flame. If a second flame-scanner is preferred, use one of the lower sight glass positions for this.
Make sure the type of flame supervision is compatible with the burner control unit. Also make sure the signal is strong enough and wired separately from other components. For detailed information on flame-scanner installation and connection, refer to the supplier's literature.

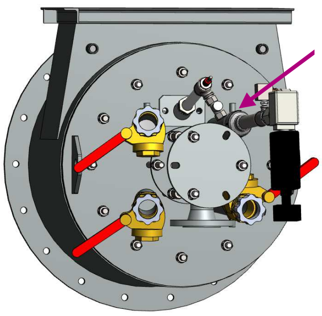

Figure 3.1 – Flame scanner position

Firing position: ITAS Intensityflame-gas burner can fire vertical up or horizontal. Vertical down is also possible but it requires continuous running combustion air. Notice that the functioning of the add on components might be affected by its position. For example, a UV-sensor requires more frequent cleaning when positioned vertical upwards and a pressure regulator functions properly in a horizontal position. Contact Fives ITAS S.p.A. or the supplier of the components for further support.

Flame dimensions: Make sure the burner's flame dimensions fit the heater. The swirler inside the burner gives a clockwise rotation to the flame. On request, a counter clockwise rotation is available.

Combustion air supply: Designed for the available supply voltage, system back pressure and elevation above sea level, ITAS Intensityflame-gas burner system can be equipped with a combustion air blower.

It is also possible to have an external source supplying combustion air to the burner. Make sure the correct amount and flow are delivered (values may be found in the Technical datasheet) and piping is prepared in order to have uniform flows into the burner, see chapter 3.2 for more information.

Combustion air inlet: The burner body can be positioned with the combustion air coming from top, from the left, from the right or coming from the bottom.

3.2 Combustion air system

The values in the Intensityflame technical datasheet are all based on environmental "Nominal Conditions", defined as:

- 20°C (293,15 K)
- 1 atm (1013,25 mbar, 101,325 kN/m², 101,325 kPa)

Deviations on the above might come from pre-heating combustion air, elevation above sea level or different pressure conditions. The maximum burner capacity may be reduced when operating on non-nominal conditions.

Consider the proper volume and pressure of combustion air to have a complete combustion of fuel at maximum input.

The volume of the combustion air supply shall match the burner and air-heater requirements.

Combustion air shall be fresh (20,9 % O2) and free of contaminants.

Fives ITAS strongly recommends the use of a combustion air filter to remove airborne particles. No corrosive fumes or particles shall be supplied to the burner.

ITAS Intensityflame-gas burner has a minimum and maximum lambda of operation. Make sure the required amount of combustion air fits the graph 1 in the burner's technical datasheet (see example in figure 3.2).

The combustion air can be supplied by a blower, connected via piping.

It is important to have uniform flow distribution for combustion air coming into the burner.

1. OPERATION CURVE (AMBIENT COMBUSTION AIR)

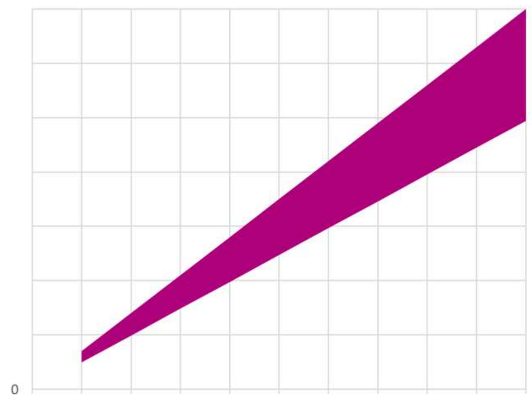

Figure 3.2 – Operation curve from datasheet

⚠WARNING Make sure the external combustion air supply delivers the correct amount and pressure of air to the burner connection flange. (Values may be found in the burner's technical datasheets)

The air pressure drop thru the burner at maximum flow is given in the technical datasheet. To calculate a pressure for different inputs, the formula is:

$$p2 = p1 * \frac{Q2}{Q1}$$

p1 = adjustment pressure for reference input [mbar] (from technical datasheet)*
p2 = adjustment pressure for actual input [mbar]
Q1 = reference input [Nm³/h] (from technical datasheet)
Q2 = actual input [Nm³/h]

* The pressures indicated in the technical datasheet are based on the air temperature specified in that datasheet. A correction of the pressure at the burner when operating preheated combustion air may be necessary. The required pressure may be calculated with:

$$p2 = p1 * \frac{T2}{T1}$$

p1 = adjustment pressure for reference temperature [mbar] (from technical datasheet)*
p2 = adjustment pressure for actual temperature [mbar]
T1 = reference temperature [K] (from technical datasheet)
Q2 = actual temperature [K]

⚠WARNING If the burner shuts off during operation at application temperatures above 100°C, provisions shall be made to provide an adequate cooling of the burner internals.

Install a pipe union or flange in the air-line to the burner. This simplifies installation and removal of the burner during commissioning or for maintenance.

The use of flexible pipes (expansion joints) is recommended to absorb stress due to heat expansion and slight misalignment. Be aware that flexible pipe nipples might cause inaccurate measurements of pressures during commissioning.

For proper and safe ignition of the pilot, the combustion air piping shall be equipped with a bypass valve over the main air control device (see PID in chapter 3.6). This bypass valve shall be sized to provide a certain amount of air to the burner during the pilot ignition cycle and during low fire operation of the burner. (see figure 3.3)

Burner	Diameter bypass valve*
IF0015-G	DN80
IF0028-G	DN80
IF0045-G	DN100
IF0060-G	DN100
IF0085-G	DN100
IF0115-G	DN100
IF0145-G	Contact Fives ITAS S.p.A.
IF0205-G	Contact Fives ITAS S.p.A.
IF0235-G	Contact Fives ITAS S.p.A.
IF0330-G	Contact Fives ITAS S.p.A.
IF0420-G	Contact Fives ITAS S.p.A.
IF0550-G	Contact Fives ITAS S.p.A.

Figure 3.3 – Sizing of the bypass valve

3.3 Calculation example

An air-heater requires 6900 kW of net heat input, delivered by 3 burners.
The system operates on Russian Natural gas (lhv = 9,97 kWh/m³, stoichiometric air/gas ratio 9,56 m³/m³)
Burner will operate at 40% access of air (=Lambda 1,4)
Combustion air is taken from ambient at 20°C (<200mAsl)

a. Select the most appropriate Intensityflame burner model:
   Qt = total heat input [kW]
   n = number of burners [-]
   Q = heat input burner [kW]

$$Q = \frac{Qt}{n} = \frac{6900}{3} = 2300\ kW\ per\ burner$$

   Select ITAS Intensityflame model IF0028-G based on the required 2300kW

b. Calculate the required gas flow:
   Vgas = Gas flow [m³/h]
   lhv = net heating value of the gas [kWh/m³]

$$Vgas = \frac{Q}{lhv} = \frac{2300}{9{,}97} = 230{,}7\ m^3/h$$

c. Calculate combustion air flow requirement
   Vair = Air flow [m³/h]
   α = stoichiometric air/gas ratio [m³/m³]
   λ = Lambda [-]

$$Vair = a \times Vgas \times \lambda = 9{,}56 \times 230{,}7 \times 1{,}4 = 3092\ \mathrm{m}^3/\mathrm{h}$$

The burner's technical datasheet indicates:

- At 2300 kW, the combustion air shall be between 2700 Nm³/h and 3700 Nm³/h
- For 3092 Nm³/h, 20 mbar pressure is required at the burner's inlet flange

3.4 Gas supply system

The gas valvetrain shall be designed in a proper and safe way to supply the correct amount of fuel gas at the right pressure to the burner. The required gas pressure at the inlet of the burner's gas gun can be read from graph 3 in the technical datasheet (figure 3.4).

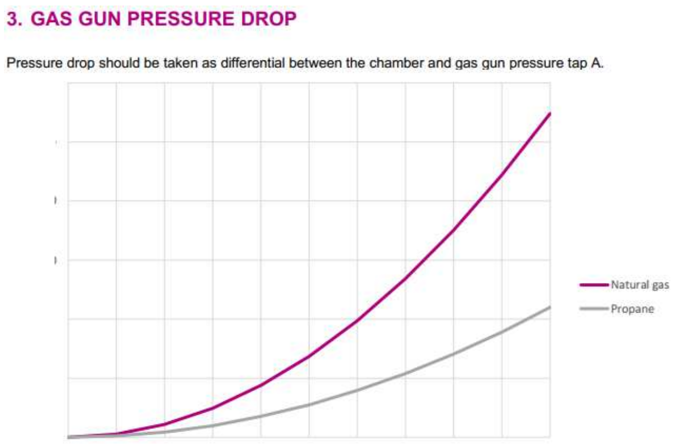

Figure 3.4 – pressure drop over the gas gun

The gas train shall comply with all local safety standards and codes. Regulations shall be, but are not limited to:

- EN 746-2 and machine directive
- NFPA with listing marks from UL, FM, CSA

Make sure you are using high quality safety components and assemble these as per suppliers instructions.

Pipe diameters shall be selected in a correct way. High gas-flow velocities might create noise and high pressure-drops shall be avoided. Fives ITAS S.p.A. can support in the design and delivery of the main gas train for fuel supply to the burner.

⚠WARNING Be sure the burner operates at proper gas- and air ratios. Too low air flow might cause incomplete combustion, emission formation or other unsafe circumstances.

Install a pipe union or flange in the gas-line to the burner. This simplifies installation and removal of the burner during commissioning or maintenance.

During commissioning or maintenance of the burner, it may be necessary to move the gas gun or pilot to reposition it for proper operation. The use of a flexible connection to the gas gun and pilot allows such movement. The use of flexible pipes (expansion joints) are also recommended to absorb stress due to heat expansion and slight misalignment.

Be aware that flexible pipe nipples might cause inaccurate measurements of pressures during commissioning.

3.5 Burner Management

The combustion system shall be equipped with a management system. The management system shall apply to local regulations and shall be equipped with, but not limited to, burner relay, temperature safeguarding and pressure alarms. It is strongly recommended to control gas- and air via an electronically ratio control system. Contact Fives ITAS S.p.A. in case of questions or doubts.

3.6 Typical schematic for ITAS Intensityflame-gas

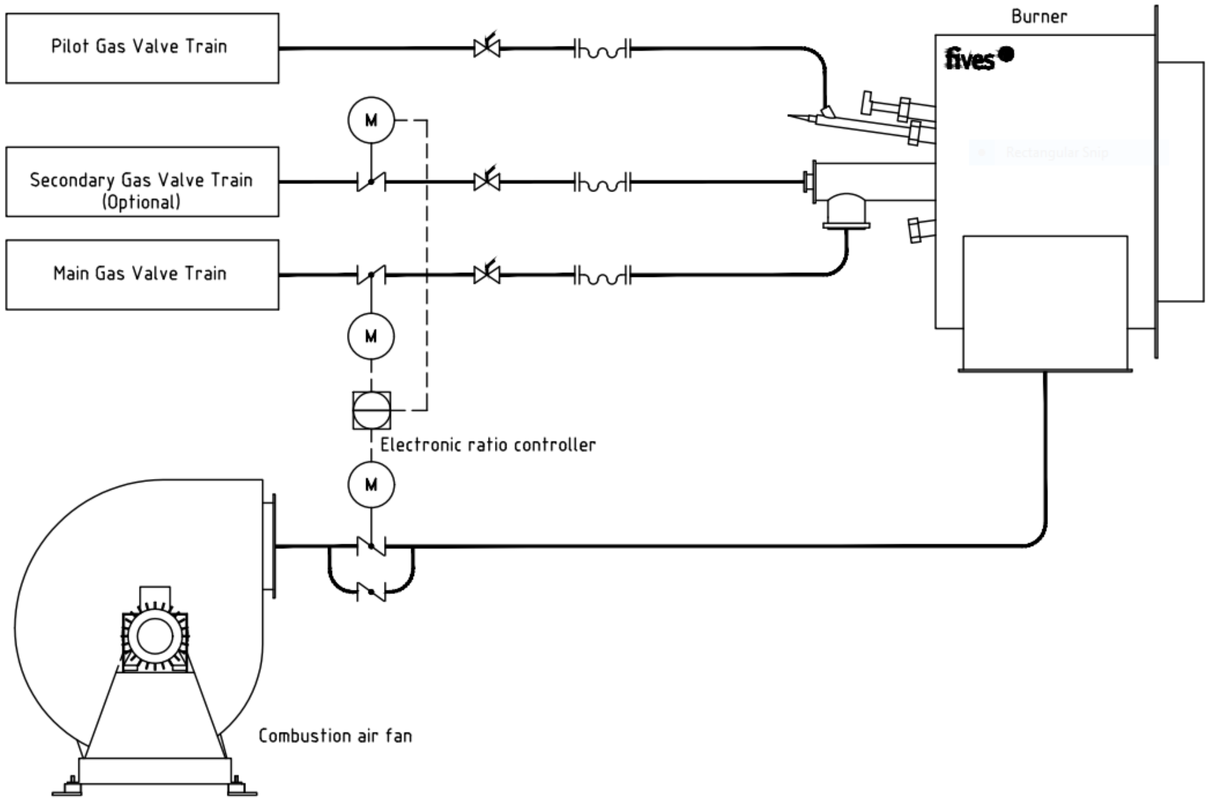

Figure 3.5 – PID dual gas burner

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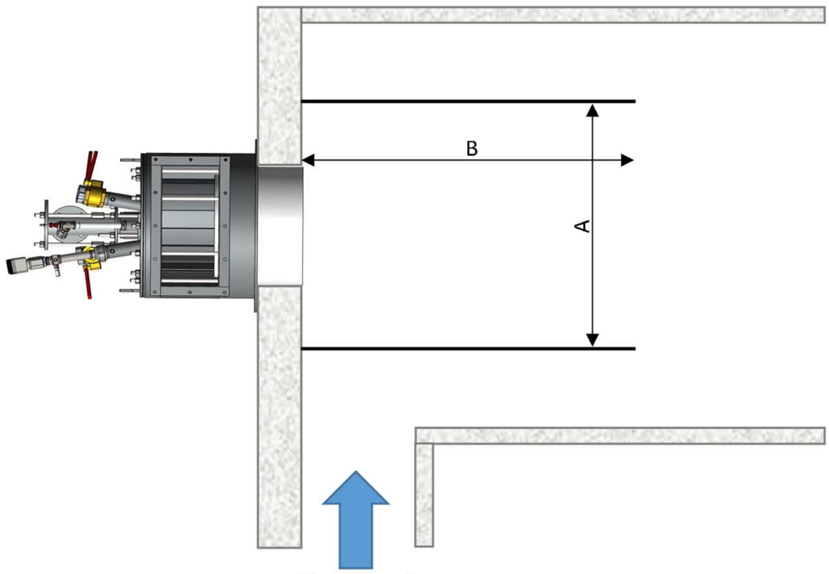
3.7 Combustion chamber design and flame covering

In order prevent flame instability and additional formation of emissions, the incoming process air shall not flow directionally across the face of the burner. In case of concern, a shield may be added around the flame. The diameter of the shield shall be about 200 mm larger than the flame diameter mentioned in the technical datasheet of the burner. To improve flame stability the shield shall be at least 30% the length of the flame, but not less than the inlet dimension of the process air. In case of any concern that the process flow will quench the flame and produce CO, the flame shield shall cover the entire length of the flame.



Burner	Diameter "A"	Length “B” [mm] 30% flame coverage	Length “B” [mm] 100% flame coverage
IF0015-G	950	540	1800
IF0028-G	1000	630	2100
IF0045-G	1100	720	2400
IF0060-G	1200	810	2700
IF0085-G	1300	960	3200
IF0115-G	1400	1110	3700
IF0145-G	1500	1200	4000
IF0205-G	1600	1380	4600
IF0235-G	1700	1470	4900
IF0330-G	2000	1650	5500
IF0420-G	2100	1830	6100
IF0550-G	2300	2190	7300

Figure 3.6 – Flame shield design

3.8 Burner connection to the heater/ combustion chamber

Use the burner's assembling flange to connect the burner to the heater.

- Make sure the heater wall is strong enough to carry the weight of the burner. If necessary, put supports under the burner. The burner's weight is specified in the technical datasheet.
- The opening in the heater wall shall be 60 mm larger in diameter compared to the burner. This allows installing 30mm fibre lining between the burner's combustor and the heater wall. (Figure 3.7)
- Install a gasket between the burner flange and the heater wall. Make sure the gasket does not leak, especially when the heater is on over-pressure.
- Make sure the flame is covered with the proper designed flame shield (see chapter 3.6)

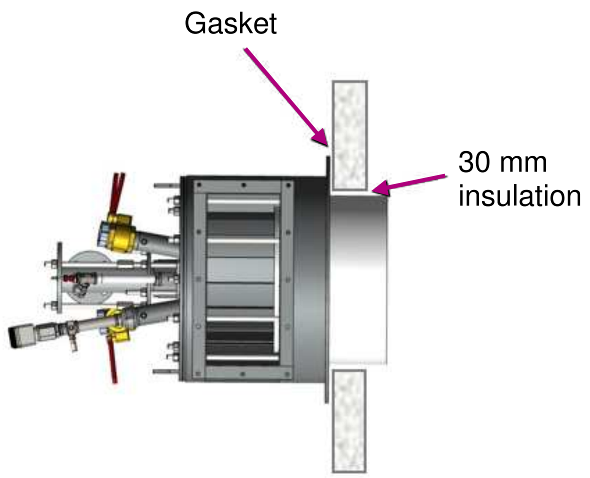


Figure 3.7 – Burner installation on heater

4. NOTES

On this page personal engineering notes may be taken.