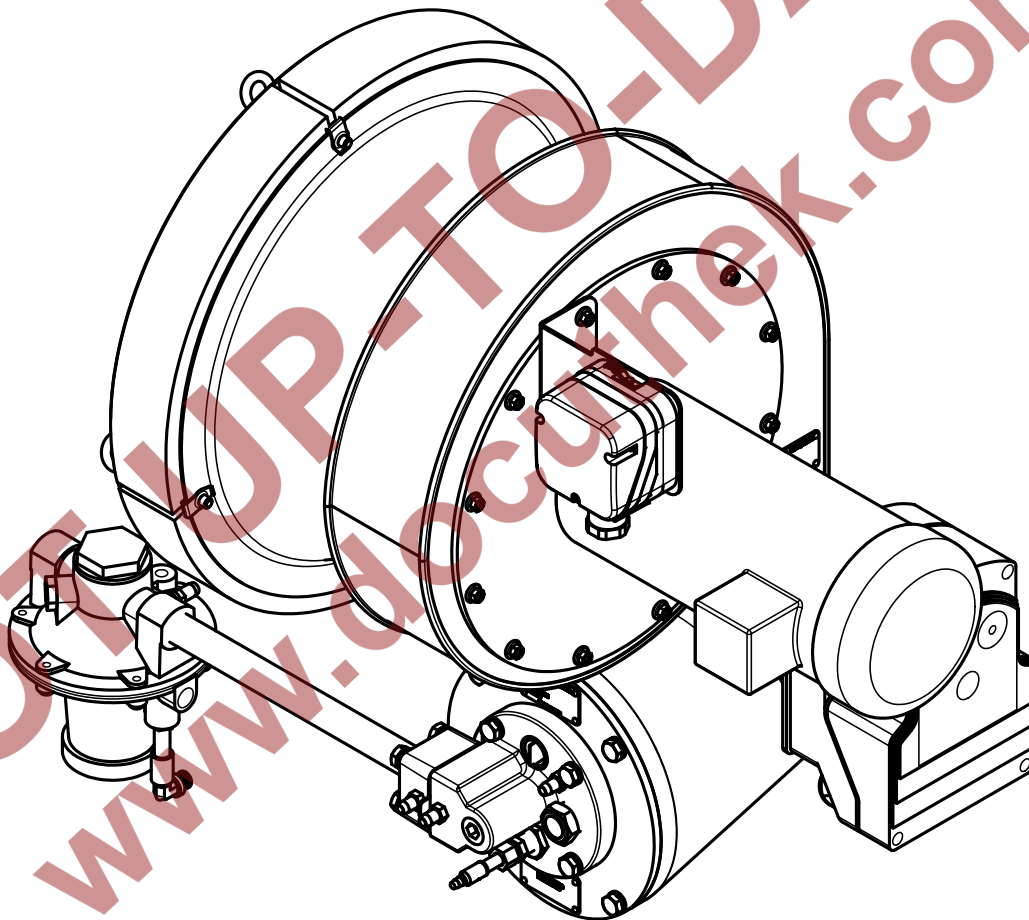


Eclipse ImmersoJet **Burner**

IJ Series

Version 3



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1665 Elmwood Rd.
Rockford, Illinois 61103 U.S.A.
Phone: 815-877-3031
Fax: 815-877-3336
<http://www.eclipsenet.com>

Please be sure to know your equipment's information found on the product label when contacting the factory so we may better serve you.

ECLIPSE® <small>Innovative Thermal Solutions</small>	www.eclipsenet.com
Product Name	
Item #	
S/N	
DD MMM YYYY	



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.



Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Is used to address practices not related to personal injury.

NOTE

Indicates an important part of text. Read thoroughly.

Table of Contents

1 Introduction	4
Product Description	4
Features	4
Audience	4
Purpose	4
ImmersoJet Documents	4
Related Documents	4
2 Safety	5
Warnings	5
Capabilities	5
Operator Training	5
Replacement Parts	5
3 System Design	6
Design	6
Step 1: Burner Model Selection	6
Step 2: Tube Design	7
Step 3: Control System	9
Step 4: Ignition System	10
Step 5: Flame Monitoring System	10
Step 6: Combustion Air System	11
Step 7: Main Gas Shut-Off Valve Train	13
Step 8: Process Temperature Control System	13
Appendix	i
Key to System Schematics	ii-iii
Notes	iv

Introduction

1

Product Description

The ImmersoJet burner is a nozzle-mix, tube-firing burner that is designed to fire at high velocities through small diameter immersion tubes. The standard burner includes a packaged blower, actuator control motor, integral butterfly valve, ratio regulator, burner body, combustion chamber, nozzle (specific to fuel used), rear cover, spark and flame rods, and gas orifice (also specific to fuel used).

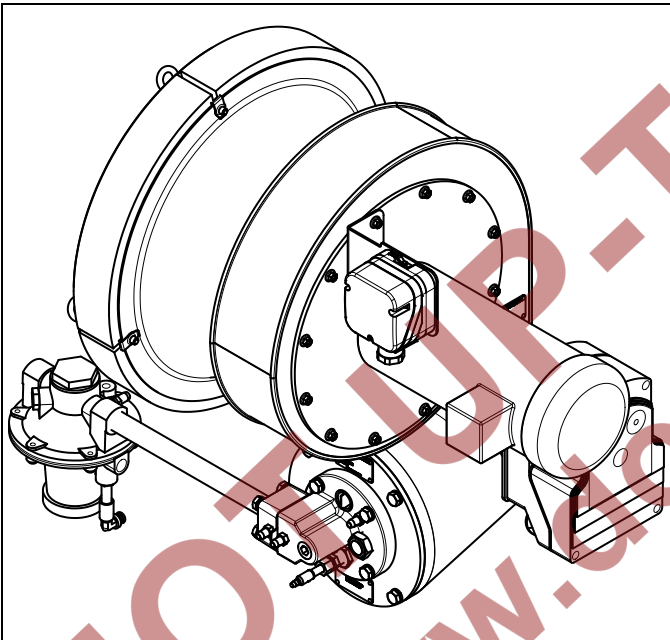


Figure 1.1. Standard ImmersoJet Burner

Features

The combustion gases from the burner scrub the inner tube surface and produce high heat transfer rates. This, in combination with the high velocity flow through the smaller diameter tubes allows for system efficiencies in excess of 80%.

The smaller ImmersoJet tubes also have smaller bends which means less tank space is occupied by the tubes. With a combustion chamber that is integral to the burner body, the new version of the ImmersoJet can sit lower on the tank than previous ImmersoJet models.

Audience

This manual has been written for personnel already familiar with all aspects of an immersion burner and its add-on components, also referred to as the burner system.

These aspects include:

- Design/selection
- Use
- Maintenance

The audience is expected to be qualified and have experience with this type of equipment and its working environment.

Purpose

The purpose of this manual is to ensure that the design of a safe, effective, and trouble-free system is carried out.

ImmersoJet Documents

Design Guide No. 330

- This document

Datasheet Series No. 330

- Required to complete design and selection

Installation Guide No. 330

- Used with datasheet to complete installation

Related Documents

- EFE 825 (Combustion Engineering Guide)
- Eclipse Bulletins and Information Guides: 610, 710, 720, 730, 744, 760, 930

Safety

2

Important notices which help provide safe burner operation will be found in this section. To avoid personal injury and damage to the property or facility, the following warnings must be observed. All involved personnel should read this entire manual carefully before attempting to start or operate this system. If any part of the information in this manual is not understood, contact Eclipse before continuing.

Safety Warnings



DANGER

- The burners covered in this manual are designed to mix fuel with air and burn the resulting mixture. All fuel burning devices are capable of producing fires and explosions when improperly applied, installed, adjusted, controlled or maintained.
- Do not bypass any safety feature; fire or explosion could result.
- Never try to light the burner if it shows signs of damage or malfunction.



WARNING

- The burner is likely to have HOT surfaces. Always wear protective clothing when approaching the burner.
- Eclipse products are designed to minimize the use of materials that contain crystalline silica. Examples of these chemicals are: respirable crystalline silica from bricks, cement or other masonry products and respirable refractory ceramic fibers from insulating blankets, boards, or gaskets. Despite these efforts, dust created by sanding, sawing, grinding, cutting and other construction activities could release crystalline silica. Crystalline silica is known to cause cancer, and health risks from the exposure to these chemicals vary depending on the frequency and length of exposure to these chemicals. To reduce the risk, limit exposure to these chemicals, work in a well-ventilated area and wear approved personal protective safety equipment for these chemicals.

NOTICE

- This manual gives information for the use of these burners for their specific design purpose. Do not deviate from any instructions or application limits in this manual without written advice from Eclipse.

Capabilities

Only qualified personnel, with good mechanical aptitude and experience with combustion equipment, should adjust, maintain, or troubleshoot any mechanical or electrical part of this system.

Operator Training

The best safety precaution is an alert and trained operator. Train new operators thoroughly and have them demonstrate an adequate understanding of the equipment and its operation. A regular retraining schedule should be administered to ensure operators maintain a high degree of proficiency.

Replacement Parts

Order replacement parts from Eclipse only. Any customer-supplied valves or switches should carry UL, FM, CSA, CGA and/or CE approval where applicable.

System Design

3

Design

The design process is divided into the following steps:

1. Burner Model Selection

- Determine net input required for the tank or process
- Select tube efficiency
- Calculate gross input required
- Select burner model

2. Tube Design

3. Control Methodology

4. Ignition System

5. Flame Monitoring System

6. Combustion Air System: blower and air pressure switch

7. Main Gas Shut-Off Valve Train

8. Process Temperature Control System

Step 1: Burner Model Selection

Determine the Net Input Required to the Tank

The net input to the tank is determined from heat balance calculations. These calculations are based on the heatup and steady-state requirements of the process, and take into account surface losses, tank wall losses and tank heat storage. Detailed guidelines for heat balance calculations are in the Eclipse Combustion Engineering Guide (EFE 825).

Select Tube Efficiency

The efficiency of the tube is the net heat input to the tank divided by the heat input to the tube. Efficiency is determined by the effective tube length. The diameter of the tube has little influence on the efficiency. At a given burner input, the net input to the tank is higher for a longer tube than for a relatively short tube.

It is customary to size conventional immersion tubes for 70% efficiency, a reasonable compromise between fuel economy and tube length. Small diameter tubes occupy less tank space than conventional tubes, however, so their length can easily be increased to provide efficiencies of 80% or more.

Calculate the Gross Burner Input

Use this formula to calculate gross burner input in Btu/h:

$$\frac{\text{net output to tank}}{\text{tube efficiency}} = \text{gross burner input}$$

Fuel Type

Table 3.1 Fuel Type

Fuel	Symbol	Gross Heating Value	Specific Gravity	WOBBE Index
Natural Gas	CH ₄ 90%+	1000 Btu/ft ³ (40.1 MJ/m ³)	0.60	1290 Btu/ft ³
Propane	C ₃ H ₈	2525 Btu/ft ³ (101.2 MJ/m ³)	1.55	2028 Btu/ft ³
Butane	C ₄ H ₁₀	3330 Btu/ft ³ (133.7 MJ/m ³)	2.09	2303 Btu/ft ³
Btu/ft ³ at standard conditions (MJ/m ³ at normal conditions)				

If using an alternative fuel supply, contact Eclipse with an accurate breakdown of the fuel components.

Applications Requiring Special Consideration

ImmersoJet burners are used for firing spray wash tanks, dip tanks, and storage tanks such as those used for fire sprinkler systems. Generally, the small bore system can be used wherever conventional immersion burner systems are used, except where high heat flux off the small bore tube can break down the contents of the tank.

Zinc Phosphate Solutions

High heat fluxes break down the phosphate, forming a heavy insulating sludge, which deposits on tube surfaces and causes rapid tube burnout. To reduce early tube failure, make the immersion tube with electro-polished stainless steel, and limit the burner to the capacity shown in the limited capacity portion of Table 3.2 where capacity is based on tube size.

Iron Phosphate Solutions

These are susceptible to the same problem described above for zinc phosphate solutions. To reduce early tube failure, make the immersion tube with stainless steel. Electro-polishing is not required. Limit the burner to the capacity shown in the limited capacity portion of Table 3.2 where capacity is based on tube size.

Cooking Oils

To avoid burning the oil, limit heat flux to 50 Btu/h per in² of the tube area.

Highly Viscous Liquids

All immersion systems depend on natural convection currents to carry heat away from the tube and throughout the tank. Convection is minimal in high viscosity solutions such as asphalt, residual oil or molasses. This can severely overheat the liquid around the tube.



CAUTION

- Do not use the ImmersoJet for highly viscous fluids.

Select Burner Model

Choose a burner model with a maximum capacity greater than the gross burner input calculated previously. Refer to Table 3.2.

Table 3.2 Capacity Guide

Model	Tube Size, in (mm)	Low-Pressure Packaged Blower, Btu/h (kW)	High-Pressure Packaged Blower, Btu/h (kW)	Remote Blower, Btu/h (kW)	Limited Capacity Zinc Phosphate, Btu/h (kW)	Limited Capacity Iron Phosphate, Btu/h (kW)
IJ-2	2 (50)	190,000 (55)	235,000 (69)	370,000 (108)	110,000 (32)	220,000 (64)
IJ-3	3 (80)	440,000 (129)	550,000 (161)	850,000 (249)	250,000 (73)	500,000 (146)
IJ-4	4 (100)	800,000 (234)	1,000,000 (293)	1,800,000 (527)	440,000 (129)	880,000 (258)
IJ-6	6 (150)	2,000,000 (586)	2,400,000 (703)	3,600,000 (1054)	1,000,000 (293)	2,000,000 (586)
IJ-8	8 (200)	3,200,000 (938)	N/A	4,700,000 (1377)	1,800,000 (527)	3,600,000 (1055)

Step 2: Tube Design

Determine Effective Tube Length

Find the required effective tube length using the previously selected tube efficiency, net heat input values, and Figures 3.1 or 3.2. The effective length of a tube is the total centerline length of the tube covered by liquid.

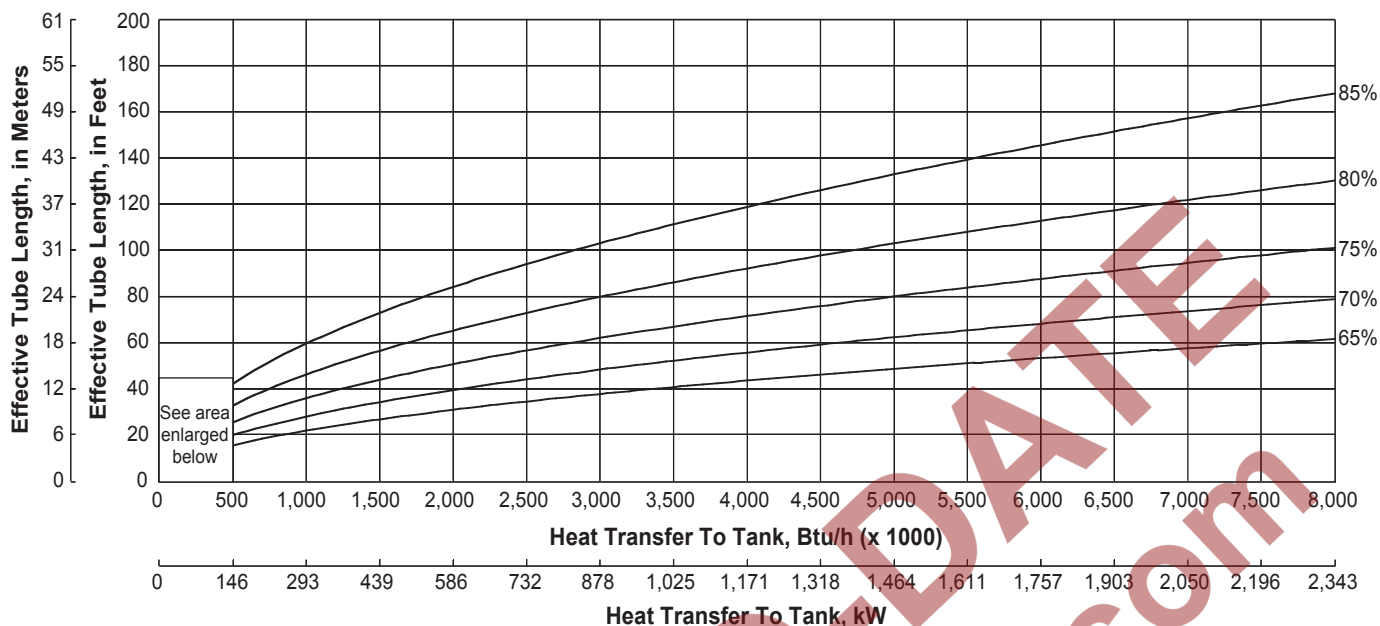


Figure 3.1. Effective Tube Length to 200 ft.

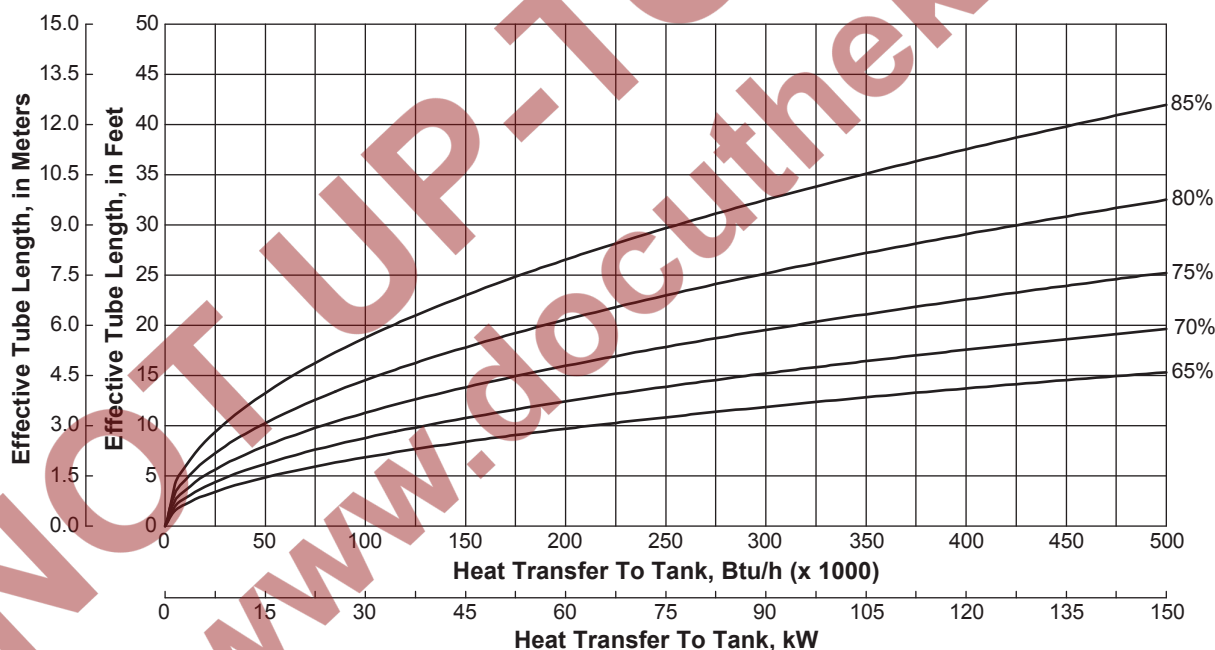


Figure 3.2. Effective Tube Length to 50 ft.

Elbows

- Use standard and sweep elbows only.
- For optimal burner operation and maximum tube life place the first elbow eight tube diameters from the burner.

Stack

- Make sure that the stack is large enough to handle the heated exhaust flow plus the dilution air.

- The stack must be at least one pipe size larger than the tube exhaust.

NOTE: If you use a common stack for more than one burner, then make sure that the stack is large enough to handle the exhaust flow plus any dilution air from all the burners. Detailed guidelines for flue sizing calculations are in the Eclipse Combustion Engineering Guide (EFE 825).

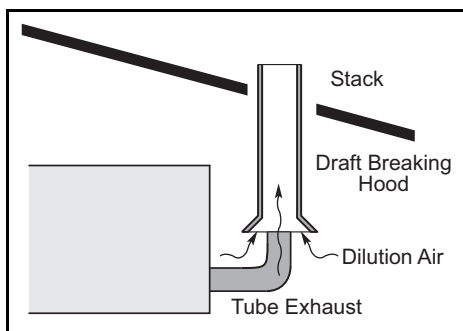


Figure 3.3.

Draft Breaking Hood

A draft breaking hood is an open connection between the heater tube exhaust and the exhaust stack. It allows fresh dilution air to pass into the exhaust and mix with the exhaust gases.

The advantages of a draft hood are:

- the burner operation is less sensitive to atmospheric conditions.
- the temperature of the exhaust gases is lower when they pass through the roof.

NOTE: Leave access between the draft hood and the tube exhaust. Install a damper plate if acoustic feedback occurs in the tube.

Condensate provisions

If the immersion tube will operate at efficiencies less than 80%, the exhaust leg can be raised through the liquid surface. For efficiencies of 80% or higher, locate the exhaust stack outside of the tank and provide a drain. See Figures 3.4 and 3.5.

NOTE: Regardless of the exhaust design, pitch the immersion tube down towards the exhaust so condensate will not collect at the burner.



CAUTION

- At efficiencies of 80% or greater, low exhaust temperatures will cause condensation to form in the tube at start-up or during long idling periods. The higher the efficiency the more condensation will increase.
- To prevent condensation/corrosion from shortening tube life or disrupting burner operation, provide a condensate drain at the exhaust and slope the immersion tube downward, away from the burner.

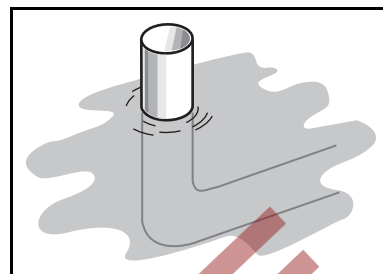


Figure 3.4. Efficiencies less than 80%

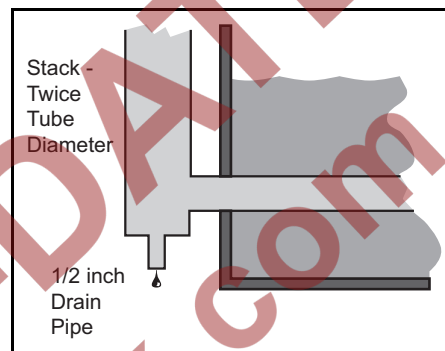


Figure 3.5. Efficiencies 80% or more

Tube placement in tank

The tube placement height in the tank should be high enough to avoid the possibility of sludge build-up on the bottom of the tank; however, it should be low enough to avoid tube exposure due to liquid level variations caused by evaporation or displacement. In the latter case use a liquid level switch to shut down the burner

Step 3: Control System

Control Methodology

ImmersoJet burners use a modulating on-ratio control system as shown in Figure 3.3. To control the heat delivered by the burner, adjust the air flow to the burner. The gas flow will change in proportion to the air flow.

The burner will operate reliably at any input between the low fire and high fire limits stated on the burner's datasheet.

Components

- ❶ Automatic butterfly valve
- ❷ Ratio regulator: varies gas flow to burner in proportion to air flow.
- ❸ Automatic shut-off valve (optional).
- ❹ Manual butterfly valve

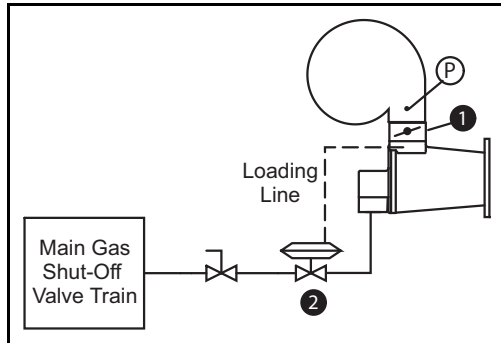


Figure 3.6. Packaged Blower

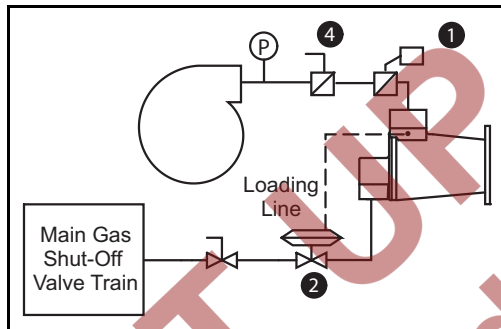


Figure 3.7. Remote Blower with External Air Butterfly Valve

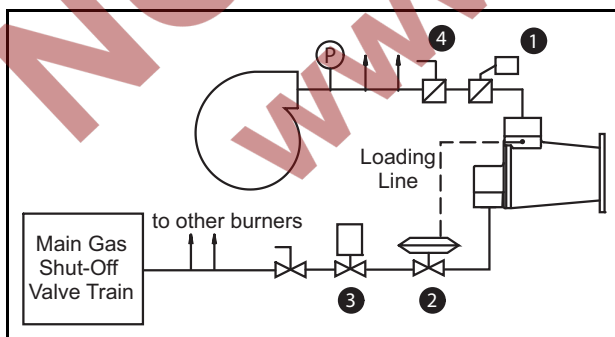


Figure 3.8. Remote Blower with External Air Butterfly Valve for Multiple Burner Zones

Step 4: Ignition System

For the ignition system you should use:

- 6000 VAC transformers
- full wave spark transformers
- one transformer per burner

Do not use:

- 10,000 VAC transformers
- twin outlet transformers
- distributor type transformers
- half wave spark transformers

ImmersoJet burners will ignite reliably at any input within the ignition zone shown in the appropriate burner datasheet, however, it is recommended that low fire start be used. Local safety and insurance requirements demand that you limit the maximum time that a burner takes to ignite. These time limits vary from country to country.

The time that a burner takes to ignite depends on:

- the distance between the gas shut-off valve and the burner
- the air/gas ratio
- the gas flow at start conditions.

In the USA, with a time of 15 seconds to ignition, there should be sufficient time to ignite the burners. It is possible, however, to have the low fire too low to ignite within the time limit. Under these circumstances you must consider the following options:

- start at higher input levels
- resize and/or relocate the gas controls

Step 5: Flame Monitoring System

A flame monitoring system consists of two main parts:

- a flame sensor
- flame monitoring control

Flame sensor

There are two types that you can use for an ImmersoJet burner:

- U.V. scanner
- flame rod

You can find U.V. scanner information in:

- Info Guide 852; 90° U.V. scanner
- Info Guide 854; straight U.V. scanner
- Info Guide 855; Solid State U.V.I.R. scanner
- Info Guide 856; self-check U.V. scanner.

You can find flame rod information in Bulletin 832 and Information Guide 832.

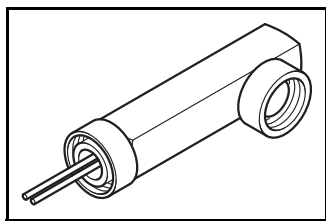


Figure 3.9. UV Scanner

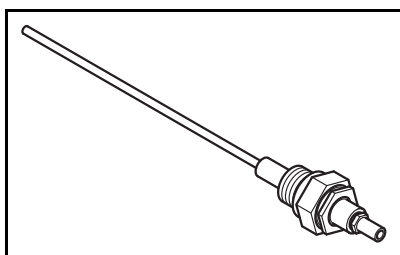


Figure 3.10. Flame Rod

Flame Monitoring Control

The flame monitoring control is the equipment that processes the signal from the flame rod or the U.V. scanner.

For flame monitoring control you may select several options:

- flame monitoring control for each burner: if one burner goes down, only that burner will be shut off
- multiple burner flame monitoring control: if one burner goes down, all burners will be shut off

Other manufacturer's flame monitoring systems can be used with the burner if spark is maintained for a fixed time interval and is not interrupted when a flame signal is detected during trial for ignition

Step 6: Combustion Air System

ImmersoJet burners are sold in these configurations:

- Burner with integral low pressure blower.
- Burner with integral high pressure blower.
- Burner less blower.

NOTE: This section describes how to size a blower for burners purchased without a blower.

Effects of atmospheric conditions

The blower data is based on the International Standard Atmosphere (ISA) at Mean Sea Level (MSL), which means that it is valid for:

- sea level

- 29.92" Hg (1,013 mbar)
- 70°F (21°C)

The make-up of the air is different above sea level or in a hot area. The density of the air decreases, and as a result, the outlet pressure and the flow of the blower decrease. An accurate description of these effects is in the Eclipse Combustion Engineering Guide (EFE 825). The Guide contains tables to calculate the effect of pressure, altitude and temperature on air.

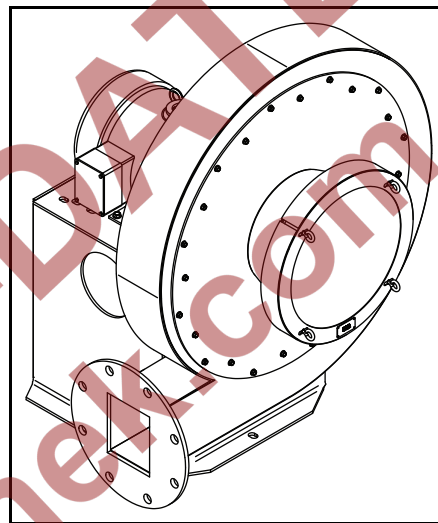


Figure 3.11. SMJ Turbo Blower

Blower

The rating of the blower must match the system requirements. You can find all the blower data in Bulletin 610.

Follow these steps:

1. Calculate the outlet pressure.

When calculating the outlet pressure of the blower, the total of these pressures must be calculated.

- the static air pressure required at the burner
- the total pressure drop in the piping
- the total of the pressure drops across the valves
- the pressure in the immersion tube
- recommend a minimum safety margin of 10%

2. Calculate the required flow

The blower output is the air flow delivered under standard atmospheric conditions. It must be enough to feed all the burners in the system at high fire.

Combustion air blowers are normally rated in terms of standard cubic feet per hour (scfh) of air.

An example calculation follows the information tables below:

Required Calculation Information

Table 3.3 Fuel Type

Description	Unit of Measure	Formula Symbol
Total system heat input	Btu/h	Q
Number of burners	-	-
Type of fuel	-	-
Gross heating value of fuel	Btu/ft ³	q
Desired excess air percentage (Typical excess air percentage @ high fire is 15%)	percent	%
Air/Gas ratio (Fuel specific, see table below)	-	α
Air flow	scfh	V _{air}
Gas flow	scfh	V _{gas}

Fuel Gas Heating Values

Table 3.4 Fuel Type

Fuel Gas	Stoichiometric* Air/Gas Ratio α (ft ³ _{air} /ft ³ _{gas})	Gross Heating Value q (Btu/ft ³)
Natural Gas (Birmingham, AL)	9.41/1	1002
Propane	23.82/1	2572
Butane	30.47/1	3225

*Stoichiometric: No excess air: The precise amount of air and gas are present for complete combustion.

Application example:

A designer of a spray washer has determined the heat input for the water tank requires 857,500 Btu/h. Based on the size of his tank, he has selected a tube efficiency of 70% which results in a gross burner input of 1,225,000 Btu/h.

Calculation example to determine the air flow requirement:

a. Decide which ImmersoJet model is appropriate:

- From the capacity table, either the 4" with a remote blower (1,800,000 Btu/h), or the 6" with the low pressure packaged blower (2,000,000

Btu/h) have sufficient capacity. For this example, the designer selects the 4" tube because his tank size limits the amount of the larger 6" tube that will fit.

- Select an IJ004, 4" diameter tube ImmersoJet burner with a remote blower for a maximum firing rate of 1,225,000 Btu/h.

b. Calculate the required gas flow:

$$V_{\text{gas}} = Q/q = 1,225,000 \text{ Btu/h} / 1,002 \text{ Btu/ft}^3 = 1,223 \text{ ft}^3/\text{h}$$

- Gas flow of 1,223 ft³/h is required.

c. Calculate the required stoichiometric air flow:

$$V_{\text{air-stoichiometric}} = \alpha (\text{air/gas ratio}) \times V_{\text{gas}} = 9.41 \times 1,223 \text{ ft}^3/\text{h} = 11,508 \text{ ft}^3/\text{h}$$

- Stoichiometric air flow of 11,508 scfh required

d. Calculate the final blower air flow requirement based on 15% excess air at high fire:

$$V_{\text{air}} = (1 + \text{excess air \%}) \times V_{\text{air-stoichiometric}} = (1 + 0.15) \times 11,508 \text{ ft}^3/\text{h} = 13,234 \text{ ft}^3/\text{h}$$

- For this example, final blower air flow requirement is 13,234 scfh at 15% excess air.

NOTE: It is common practice to add an additional 10% to the final blower air flow requirement as a safety margin.

3. Find the blower model number and motor horsepower (hp).

With the output pressure and the specific flow, you can find the blower catalog number and the motor hp in Bulletin 610.

4. Select the other parameters:

- inlet filter or inlet grille
- inlet size (frame size)
- voltage, number of phases, frequency
- blower outlet location, and rotation direction Clockwise (CW) or Counter Clockwise (CCW)

NOTE: The use of an inlet air filter is strongly recommended. The system will perform longer and the settings will be more stable.

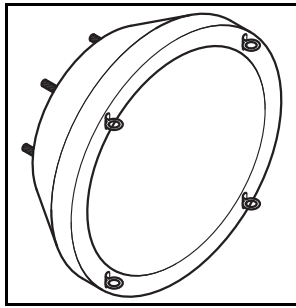


Figure 3.12. Inlet filter with replaceable filter element

NOTE: When selecting a 60 Hz blower for use on 50 Hz, a pressure and capacity calculation is required. See Eclipse Combustion Engineering Guide (EFE 825).

The total selection information you should now have:

- blower model number
- motor hp
- motor enclosure (TEFC)
- voltage, number of phases, frequency
- rotation direction (CW or CCW).

Air pressure switch

The air pressure switch gives a signal to the monitoring system when there is not enough air pressure from the blower.

You can find more information on pressure switches in Blower Bulletin 610.

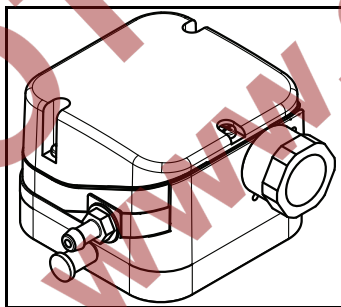


Figure 3.13. Air Pressure Switch



WARNING

- Eclipse Combustion supports NFPA regulations, which require the use of an air pressure switch in conjunction with other safety components, as a minimum standard for main gas safety shut-off systems.

Step 7: Main Gas Shut-Off Valve Train

Consult Eclipse

Eclipse can help you design and obtain a main gas shut-off valve train that complies with the current safety standards.

The shut-off valve train must comply with all the local safety standards set by the authorities that have jurisdiction.

For details, please contact your local Eclipse Combustion representative or Eclipse Combustion.

NOTE: Eclipse Combustion supports NFPA regulations (two shut-off valves) as a minimum standard for main gas safety shut-off systems.



Step 8: Process Temperature Control System

Consult Eclipse

The process temperature control system is used to control and monitor the temperature of the system. There is a wide variety of control and measuring equipment available.

For details, please contact your local Eclipse Combustion representative or Eclipse Combustion.

Appendix

Conversion Factors

Metric to English

From	To	Multiply By
actual cubic meter/h (am ³ /h)	actual cubic foot/h (acfh)	35.31
normal cubic meter/h (Nm ³ /h)	standard cubic foot /h (scfh)	38.04
degrees Celsius (°C)	degrees Fahrenheit (°F)	(°C x 9/5) + 32
kilogram (kg)	pound (lb)	2.205
kilowatt (kW)	Btu/h	3415
meter (m)	foot (ft)	3.281
millibar (mbar)	inches water column ("w.c.)	0.402
millibar (mbar)	pounds/sq in (psi)	14.5 x 10 ⁻³
millimeter (mm)	inch (in)	3.94 x 10 ⁻²
MJ/Nm ³	Btu/ft ³ (standard)	26.86


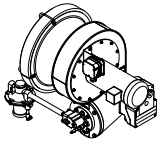
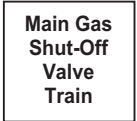

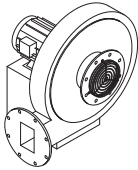



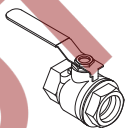
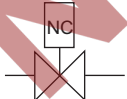
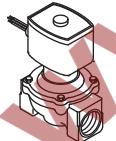
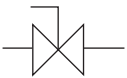
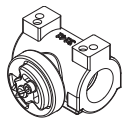

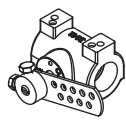
Metric to Metric


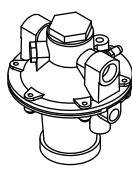
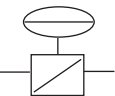


From	To	Multiply By
kiloPascals (kPa)	millibar (mbar)	10
meter (m)	millimeter (mm)	1000
millibar (mbar)	kiloPascals (kPa)	0.1
millimeter (mm)	meter (m)	0.001

English to Metric

From	To	Multiply By
actual cubic foot/h (acfh)	actual cubic meter/h (am ³ /h)	2.832 x 10 ⁻²
standard cubic foot /h (scfh)	normal cubic meter/h (Nm ³ /h)	2.629 x 10 ⁻²
degrees Fahrenheit (°F)	degrees Celsius (°C)	(°F - 32) x 5/9
pound (lb)	kilogram (kg)	0.454
Btu/h	kilowatt (kW)	0.293 x 10 ⁻³
foot (ft)	meter (m)	0.3048
inches water column ("w.c.)	millibar (mbar)	2.489
pounds/sq in (psi)	millibar (mbar)	68.95
inch (in)	millimeter (mm)	25.4
Btu/ft ³ (standard)	MJ/Nm ³	37.2 x 10 ⁻³

System Schematics

Symbol	Appearance	Name	Remarks	Bulletin/ Info Guide
		ImmersoJet burner		
		Main Gas Shut-Off Valve Train	Eclipse Combustion, Inc. strongly endorses NFPA as a minimum.	756
		Combustion air blower	The combustion air blower provides the combustion air to the burner(s).	610
		Pressure Switch	A switch activated by rise or fall in pressure. A manual reset version requires pushing a button to transfer the contacts when the pressure set point is satisfied.	610 I-354
		Gas Cock	Gas cocks are used to manually shut off the gas supply.	710
		Solenoid valve (normally closed)	Solenoid valves are used to automatically shut off the gas supply on a bypass gas system or on small capacity burner systems.	760
		Manual Butterfly Valve	Manual butterfly valves are used to balance the air or gas flow at each burner.	720
		Automatic Butterfly Valve	Automatic butterfly valves are typically used to set the output of the system.	720

Symbol	Appearance	Name	Remarks	Bulletin/ Info Guide
		Ratio Regulator	<p>A ratio regulator is used to control the air/gas ratio. The ratio regulator is a sealed unit that adjusts the gas flow in ratio with the air flow. To do this, it measures the air pressure with a pressure sensing line, the impulse line. This impulse line is connected between the top of the ratio regulator and the air supply line.</p> <p>The cap must stay on the ratio regulator after adjustment.</p>	742
		CRS Valve	<p>A CRS valve is used in a high/low time-proportional control system to quickly open and close the air supply.</p>	744
		Pressure Taps	<p>Pressure taps measure static pressure.</p> <p>The schematics show the advised positions of the pressure taps.</p>	
		Impulse Line	<p>The impulse line connects the ratios regulator to the air supply line.</p>	

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