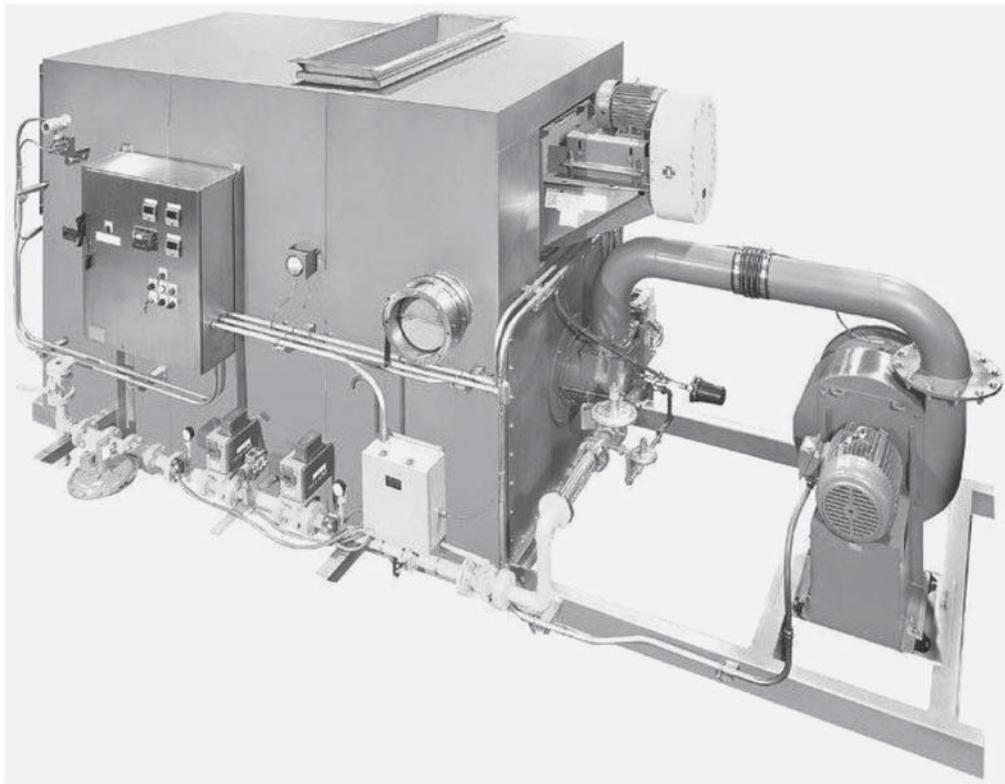

Eclipse ER

Indirect Air Heater

Version 1



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Document Conventions

There are several special symbols in this document. You must know their meaning and importance.

The explanation of these symbols follows below. Please read it thoroughly.



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.



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Introduction

1

Product Description

The ER Indirect Air Heater is a heater for producing clean hot air, free of combustion products. The heater utilizes a sinusoidal heat exchanger to transfer heat from the recirculated hot products of the combustion side to the clean process air side. The use of a recirculation fan on the hot products of combustion side improves the effectiveness of the heat exchanger for fuel efficient operation. Gross thermal efficiencies can exceed 85%.

The ER Indirect Air Heater is a complete skid mounted system and includes the heat exchanger, recirculation fan, combustion chamber, burner, combustion air blower, gas train and control panel. Standard construction includes NEMA 4 environmental rating, a NFPA 86 or EN 746-2 compliant gas train and burner safety system, and a NEMA 68 compliant ventilation system.

Flanged connections are provided for the fuel gas inlet, the process air inlet, process air outlet and burner exhaust outlet.

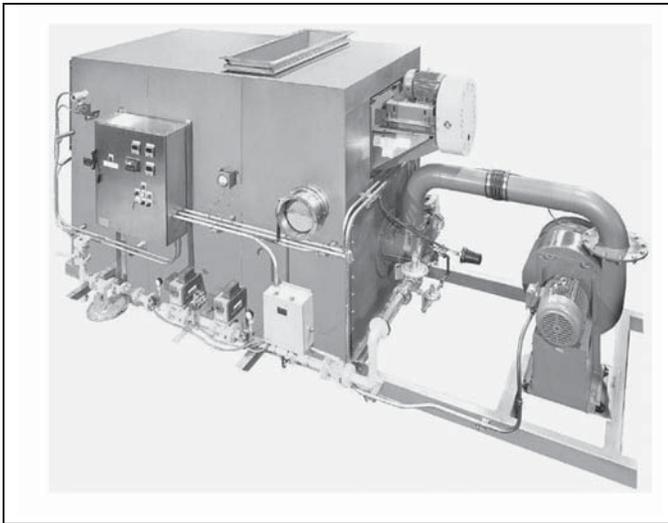


Figure 1.1. Eclipse ER Indirect Air Heater

Audience

This manual has been written for personnel already familiar with all aspects of an indirect air heater and its add-on components.

These aspects include:

- Design / Selection
- Use
- Maintenance
- Safety

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 a safe, effective, and trouble-free air heater design.

Related Documents

Design Guide No. 121

- This document

Datasheet No. 121

- Required to complete design and selection

Other Documents

- EFE 825 (Combustion Engineering Guide)
- Eclipse Bulletins and Info Guides: 111, 158.

Safety

2

Important notices for safe operation of the air heater system will be found in this section. To avoid personal injury, damage to property or the facility, the following warnings must be observed. Read this entire manual before attempting to start the system. If any part of the information in this manual is not understood, contact Eclipse before continuing.

Safety Warnings



DANGER

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



WARNING

- **The burner and duct sections are likely to have HOT surfaces. Always wear protective clothing when approaching the burner.**

NOTICE

- **This manual provides information in the use of the air heater for its specific design purpose. Do not deviate from any instructions or application limits**

described herein 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 approvals where applicable.

System Design

3

Sizing and Selection Procedure

The ER Indirect Air Heater is a natural gas fired system which heats a clean process air stream to a specified temperature. The heat from the natural gas combustion products is transferred to the process air stream by a heat exchanger, keeping the process air free of any contamination.

The ER Indirect Air Heater has the following primary options that affect heater size selection:

- There are eight ER Heater standard sizes to choose from.
- Each ER Heater size is available with two different types of heat exchanger:
 - a standard performance exchanger with 1/2" plate spacing.
 - a high performance exchanger with 3/8" plate spacing. The 3/8" plate spacing version will provide more effective heat transfer, has lower fuel requirements, will result in higher process air pressure drop, and might result in a smaller heater size as compared to the standard 1/2" exchanger.
- Each ER Heater size is available with two different size burners to economically cover the full range of each ER Heater size. Burner sizes are selected from "Table 1. Burner Options" shown in the datasheet.
 - Large
 - Small
- Each ER Heater is available with 2 different burner types.
 - The Winnox burner product line is good for emission levels down to about 20 ppm NO_x (@ 3% O₂) at rated capacity. If emissions requirements are below 20 ppm NO_x (@ 3% O₂), the Minnox burner is required. Winnox is available with package blower.
 - The Minnox burner product line is good for emission levels down to about 5 ppm NO_x (@3% O₂) at rated capacity. Minnox burners are not available with a package blower.

ER Heater Selection

The procedure below will identify a proper ER Heater size using both 1/2" and 3/8" exchangers.

The performance curves used in the selection process (see Datasheet 121) were made using the following assumptions:

- Fuel is natural gas
- Burners are operated at 50% excess air
- System elevation is at sea level
- Process air enters ER Heater at 70°F (21°C), dry
- Combustion chamber temperature is 900°F (482°C)

NOTE: Contact Eclipse if you have special conditions or questions.

ER Heater Size Selection

1. Note the required process air operating conditions:
 - a. Flow rate
 - b. Inlet and outlet temperatures
 - c. Allowable pressure drop
 - d. Emissions requirements
2. Identify the ER Heater Size using a 1/2" exchanger:
 - a. Identify the operating point on "Process Air Outlet Temperature vs. Process Air Flow Rate, 1/2" Exchanger Plate Spacing" chart.
 - b. Select the ER Heater size by drawing a line straight up from the operating point. The first temperature curve to be crossed identifies the First Curve heater size. The curves assume a process air inlet temperature of 70°F (21°C). If the actual inlet temperature is different than 70°F (21°C), correct the curve values of process air outlet temperature according to "Process Air Outlet Temperature Correction Factor vs. Point Number" chart.
 - c. Note the pressure drop for the same size heater at the same flow rate on "Process Air Pressure Drop vs. Process Air Flow Rate, 1/2" Exchanger Plate Spacing". Consider the pressure drop correction according to "Process Air ΔP Correction Factor vs. Inlet Temp". If the exchanger pressure drop satisfies (is lower than) the requirement, then:

Yes - select the First Curve heater size.

No - go to the next size up (Second Curve) heater. Repeat steps b and c of this section using the Second Curve heater.

d.If the Second Curve heater selection has an excessive pressure drop compared to what is required, then the requirement cannot be economically met with the standard ER Heater design. Please consult Eclipse for a custom ER Heater design, or reconsider the pressure drop requirements.

3. Identify the burner for ER Heater using the 1/2" exchanger:

a.Refer to "Burner Firing Rate vs. Process Air Flow Rate, 1/2" Exchange Plate Spacing" and locate the operating point using the process air flow rate.

b.Note the burner firing rate of the operating point.

c.Given the emissions requirements, burner NO_x specifications from page 6, and burner firing rate, select either the large or small burner from "Table 1. Burner Options" shown in the datasheet.

4. Identify ER Heater Size using 3/8" exchanger:

a.Identify the operating point on the "Process Air Outlet Temp vs. Process Air Flow Rate, 3/8" Exchanger Plate Spacing" chart.

b.Select the ER Heater size by drawing a line straight up from the operating point. The first temperature curve to be crossed identifies the First Curve heater size. The curves assume a process air inlet temperature of 70°F (21°C). If the actual inlet temperature is different than 70°F (21°C), correct the curve values of process air outlet temperature according to "Process Air Outlet Temperature Correction Factor vs. Point Number" chart.

c.Note the pressure drop for the same size heater at the same flow rate on "Process Air Pressure Drop vs. Process Air Flow Rate, 3/8" Exchanger Plate Spacing". Consider the pressure drop correction according to "Process Air Δp Correction Factor vs. Inlet Temperature". If the exchanger pressure drop satisfies (is less than) the requirement, then:

Yes - select the First Curve heater size.

No - go to the next size up (Second Curve) heater. Repeat steps b and c of this section using the Second Curve heater.

d.If the Second Curve heater selection has an excessive pressure drop compared to what is required, then the requirements cannot be economically met with the standard ER Heater design. Please consult Eclipse for a custom ER Heater design, or reconsider the pressure drop requirement.

5. Identify the burner for ER Heater using the 3/8" exchanger:

a.Refer to "Burner Firing Rate vs. Process Air Flow Rate, 3/8" Exchanger Plate Spacing" and locate operating point using the process air flow rate.

b.Note the burner firing rate of the operating point.

c.Given the emissions requirements, burner NO_x specifications from page 6, and burner firing rate, select either the large or small burner from "Table 1. Burner Options" shown in the datasheet.

We have now selected 2 properly sized ER Heater / burner systems, one for 1/2" and the other for 3/8" heat exchangers. These two systems will have different capital and operating costs. The 1/2" system will likely have lower capital costs but higher operating costs compared to the 3/8" system.

Example Heater Sizing Calculation:

An indirect heater is required to warm 12,000 SCFM of air from -20°F to 500°F. Pressure drop is not to exceed 3" water column. Burner emissions are not to exceed 30 ppm NO_x at 3% O₂.

Calculation Example:

1. Define Process Air conditions:

a.Flow: 12,000 SCFM

b.-20°F Inlet Temperature 500°F Desired Outlet Temperature.

c.Pressure drop: 3" w.c.

d.Emission Requirement: 30 ppm NO_x.

2. Determine required heater size:

a.Referencing the Process Air Outlet Temperature vs. Process Air Outlet Flow Rate chart for the 1/2" Plate Spacing Exchanger the size 6 heater is required for inlet temperature of 70°F. Note the position where the flow intersects the size 6 curve, in this case it is midway between positions 2 and 3 on the curve.

b.Calculate the actual outlet temperature for -20°F inlet using Process Air Outlet Temperature Correction Factor vs. Point Number chart. Draw a line from midway between 2 and 3 on the horizontal axis up to the 1/2" curve to determine correction factor from the vertical axis. Calculate the actual outlet temperature as follows:

$$T_{co} \text{ actual} = T_{co} \text{ curve} + Ft \times (T_{ci} \text{ actual} - 70^\circ\text{F})$$

$$T_{co} \text{ actual} = 520^\circ\text{F} + .53 \times (-20^\circ\text{F} - 70^\circ\text{F})$$

$$T_{co} \text{ actual} = 472^\circ\text{F}$$

3. Since the Process Air Temperature did not achieve the target. Either go up to the next size, 1/2" unit (size 7) or investigate the more efficient 3/8" unit.

Since the 1/2" size 7 would certainly work, lets investigate a 3/8" unit.

a. Referencing the Process Air Outlet Temperature vs. Process Air Outlet Flow Rate chart for the 3/8" Plate Spacing Exchanger the size 6 heater is required for inlet temperature of 70°F. Note the position where the flow intersects the size 6 curve, in this case it is midway between positions 2 and 3 on the curve.

b. Calculate the actual outlet temperature for -20°F inlet using Process Air Outlet Temperature Correction Factor vs. Point Number chart. Draw a line from midway between 2 and 3 on the horizontal axis up to the 3/8" curve to determine correction factor from the vertical axis. Calculate the actual outlet temperature as follows:

$$T_{co} \text{ actual} = T_{co} \text{ curve} + Ft \times (T_{ci} \text{ actual} - 70^\circ\text{F})$$

$$T_{co} \text{ actual} = 560^\circ\text{F} + .48 \times (-20^\circ\text{F} - 70^\circ\text{F})$$

$$T_{co} \text{ actual} = 517^\circ\text{F}$$

So, the thermal requirements would be satisfied with either a size 6 with the 3/8" exchanger, or a size 7 with the 1/2" exchanger. Since the size 6 would be more economical, determine if the size 6 with 3/8" exchanger can satisfy the pressure drop requirement.

4. Referencing the Process Air Pressure Drop vs. Process Air Outlet Flow Rate chart for the 3/8" Plate Spacing Exchanger the size 6 heater has a pressure drop of 2.6" wc for inlet temperature of 70°F. Using the Process Air p Correction Factor vs. Inlet Temp chart, calculate the actual pressure drop for -20°F inlet.

$$dP_{\text{actual}} = F_{dp} \times dP_{\text{curve}}$$

$$dP_{\text{actual}} = 0.83 \times 2.6" \text{ wc}$$

$$dP_{\text{actual}} = 2.16" \text{ wc}$$

Pressure drop is acceptable.

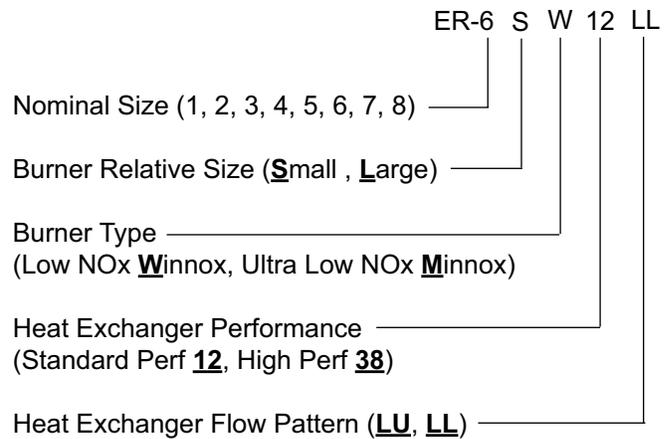
5. Select the Burner Size:

a. Referencing the Burner Firing Rate vs. Process Air Outlet Flow Rate chart for the 3/8" Plate Spacing Exchanger, find the burner firing rate for the size 6 heater at 12,000 SCFM. In this case the firing rate is 7.7 mm BTU/hr.

b. Using Table 1, the smaller burner for size 6 should be chosen to achieve the burner requirement.

c. Referencing the burner emission information provided on page 6, the Winnox burner would be acceptable for this application.

6. ER Heater Model Numbers are specified as follows:



7. ER Heater Standard Equipment Options

a. Burner Options

- Burner Size (Small, Large)
- Burner Type (Winnox, Minnox)

b. Heat Exchanger Options

- Plate Spacing (1/2", 3/8")
- Flow Pattern (LU - process air enters the top and exits the top, LL - process air enters the top and exits the end)

c. Gas Train Options

- Flow Orientation (Left to Right, or Right to Left)
- Make of blocking valves (Siemens standard, others on request)
- Make of combustion air modulating valve actuator (Siemens SQM5 standard, others on request)

d. Transition Options

- Process Air Inlet Transition (Up, Lateral, Longitudinal)
- Process Air Outlet Transition (Up, Lateral, Longitudinal)
- Burner Exhaust Transition (Up, Lateral, Longitudinal)



Appendix

Conversion Factors

Metric to English

From	To	Multiply By
actual cubic meter/hr (am ³ /h)	actual cubic foot/hr (acfh)	35.31
normal cubic meter/hr (Nm ³ /h)	standard cubic foot /hr (scfh)	38.04
degrees Celsius (°C)	degrees Fahrenheit (°F)	(°C x 9/5) + 32
kilogram (kg)	pound (lb)	2.205
kilowatt (kW)	BTU/hr	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/hr (acfh)	actual cubic meter/hr (am ³ /h)	2.832 x 10 ⁻²
standard cubic foot /hr (scfh)	normal cubic meter/hr (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/hr	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



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