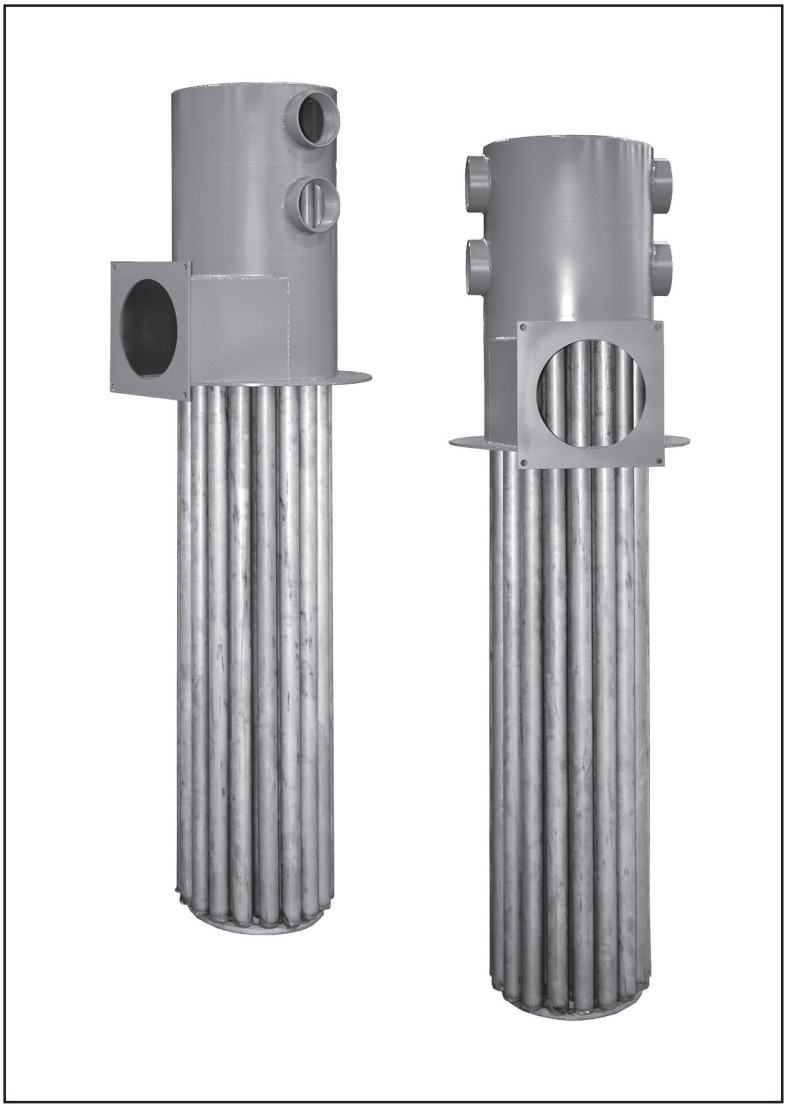
Design Guide
540, 6/6/06

Eclipse Combustion

Extern-A-Therm

Recuperators

Models 300 MA – 2500 MA
Models 300 MB – 2500 MB



ECLIPSE™
Innovative Thermal Solutions

Copyright

Disclaimer Notice

We reserve the right to change the construction and/or configuration of our products at any time without being obliged to adjust earlier supplies accordingly.

The material in this manual is believed adequate for the intended use of the product. If the product, or its individual modules or procedures, are used for purposes other than those specified herein, confirmation of their validity and suitability must be obtained. Eclipse, Inc. warrants that the material itself does not infringe any United States patents. No further warranty is expressed or implied.

We have made every effort to make this manual as accurate and complete as possible. Should you find errors or omissions, please bring them to our attention so that we may correct them. In this way we hope to improve our product documentation for the benefit of our customers. Please send your corrections and comments to our Documentation Manager.

Liability and Warranty

It must be understood that Eclipse's liability for its products, whether due to breach of warranty, negligence, strict liability, or otherwise, is limited to the furnishing of such replacement parts and Eclipse, Inc. will not be liable for any other injury, loss, damage or expenses, whether direct or consequential, including but not limited to loss of use, income of or damage to material arising in connection with the sale, installation, use of, inability to use or the repair or replacement of Eclipse's products.

Any operation expressly prohibited in this Guide, any adjustment, or assembly procedures not recommended or authorized in these instructions shall void the warranty.

About this manual

Audience

This manual has been written for people who are already familiar with all aspects of industrial heating equipment design.

These aspects are:

- design/selection
- use
- maintenance.

The audience is expected to have had experience with this kind of equipment.

Cross-Flow Recuperator Documents

Design Guide No. 540

- This document

Data Sheet No. 540-1 through 540-4

- Available for individual Extern-A-Therm models
- Required to complete design calculations in this guide

Related Documents

- EFE 825 (Combustion Engineering Guide)
- Eclipse bulletins and Info Guides:
  610, 710, 720, 730, 742, 744, 760, 930

Purpose

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

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.

Danger:

Indicates hazards or unsafe practices which WILL result in severe personal injury or even death.

Only qualified and well trained personnel are allowed to carry out these instructions or procedures.

Act with great care and follow the instructions.

Warning:

Indicates hazards or unsafe practices which could result in severe personal injury or damage.

Act with great care and follow the instructions.

Caution:

Indicates hazards or unsafe practices which could result in damage to the machine or minor personal injury. Act carefully.

Note:

Indicates an important part of the text. Read thoroughly.

How to get help

If you need help, you can contact your local Eclipse representative.

Table of contents

Introduction

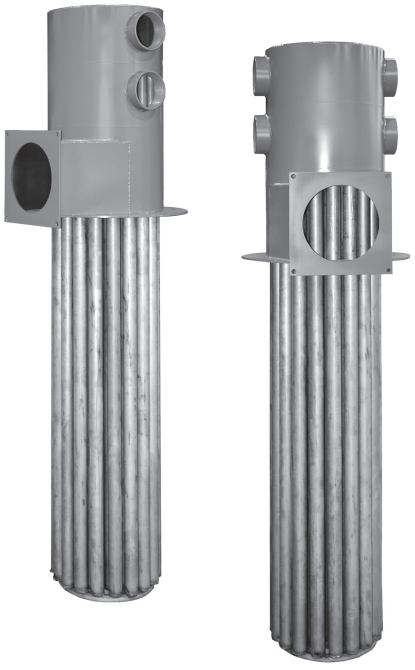
1

Product Description

Eclipse Extern-A-Therm recuperators are compact tubular air-to-air heat exchangers designed to recover the waste heat in industrial exhaust gases. The recovered heat is used to preheat the combustion air for the system's burners, thereby increasing the thermal efficiency. To ensure that all the wasted heat is drawn across the recuperator tubes the recuperator is typically mated with an Eclipse eductor.

The single-ended design of the Extern-A-Therm recuperator allows for free expansion of the recuperator tubes; no expansion joints are required.

The alternative designs of the Extern-A-Therm, housings and eductors ensure ease of installation and efficient use of existing pipe work. The housings are internally insulated; there is no need for additional external insulation.



The Extern-A-Therm Recuperator

Safety

2

Introduction

Important safety notices will be found in this section.

Safety

Warning:

The surface of the recuperator and preheated air pipe work are likely to have HOT surfaces. Always wear protective clothing when approaching the recuperator.

Note:

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

Read this entire manual before attempting to start the system. If any part of the information in this manual is not understood, then contact your local Eclipse representative or Eclipse Inc. before continuing.

Capabilities

Adjustment, maintenance and troubleshooting of this system should be done by qualified personnel with good mechanical aptitude and experience with combustion equipment.

Operator Training

The best safety precaution is an alert and competent operator. Thoroughly instruct new operators so they demonstrate an adequate understanding of the equipment and its operation. Regular retraining must be scheduled to 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

Furnace Temperature Limits

Up to 1800°F – no special safeguards are required to protect the recuperator. See page 10 for aluminum melting or holding applications.

1800°F – 2100°F – to ensure that the safe operating temperature of the recuperator tubes is not exceeded, air flow must not fall below the following limits:

Model 300 MA or 300 MB	90 scfh
Model 600 MA or 600 MBA	180 scfh
Model 1500 MA or 1500 MB	450 scfh
Model 2500 MA or 2500 MB	750 scfh

The recuperator must be position so that it will not be exposed to direct radiation from the furnace. This is to protect the recuperator during shutdown or power failure.

CAUTION: When shutting a process down, air must be supplied to the exchanger until the exhaust inlet temperature falls below 1800°F.

2100°F to 2400°F – Dilution air must be introduced to the air stream to maintain exhaust temperature below 2100°F. The amount of dilution air can be determined from the Dilution Air section, page 11. When using dilution air do not operate with excess fuel, either gas or oil. The resulting fire would destroy the recuperator.

A high temperature protection limit switch must be fitted to ensure flue temperatures do not exceed 2100°F.

The recuperator must be position so that it will not be exposed to direct radiation from the furnace. This is to protect the recuperator during shutdown or power failure.

The low flow air requirements listed above must be observed.

CAUTION: When shutting a process down, air must be supplied to the exchanger until the exhaust inlet temperature falls below 1800°F.

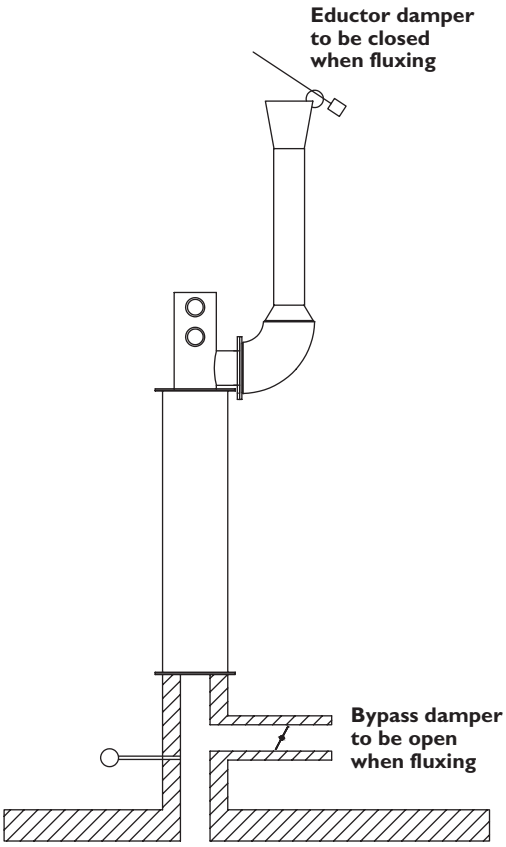


Figure 1

Flue Gas Restrictions:
The recuperator must not be used with any chloride, sulfide, potassium, sodium or lithium salts in the flue gas.

Special precautions for aluminum melting or holding:
If the recuperator is to be used on aluminum melting furnaces where flux is used, special precautions must be taken to protect the recuperator during the fluxing cycle. When flux is being used, the exit of the eductor should be closed off and a by-pass duct opened until the fluxing is complete and no fluxing agents are present in the exhaust. Closing the damper on the eductor will force the eductor air back through the recuperator ensuring that no contaminated exhaust gases enter the recuperator. See Figure 1.
In addition when using the recuperators on aluminum melting or holding furnaces, the exhaust temperature must be diluted to less than 1300°F. This will ensure that any aluminum in the exhaust will condense out before entering the recuperator. Aluminum condensing on the recuperator tubes will cause damage. When in doubt consult Eclipse.

CAUTION: Failure to observe these conditions can destroy the recuperator and will void the warrenty.

Determine the size of recuperator required.
It is assumed that the net Btu requirement is known. The table below is a rough guide for the efficiency with a cross flow recuperator at various furnace temperatures with 10% excess combustion air. This is sufficiently accurate to determine the size of recuperator to use; it should not be used to determine actual gas usage.

Furnace Temp. °F	Efficiency with Extern-A-Therm Recuperator
1500	70%
1600	68.5%
1700	67%
1800	65.7%
1900	64.4%
2000	63%
2100	60.6%
2200	59.3%
2300	58%

Calculate the gross Btu requirement using this efficiency then check the cross flow recuperator capacities in the data sheet to determine the size of recuperator.

Example:
Net required 1.0mm Btu/hr. with furnace temperature of 1700°F. From the table on page 10, the efficiency = 67%
Therefore, the gross input = 1.0mm/0.67 = 1.49mm Btu/hr. From the data sheets, a 1500 MA or 1500 MB Extern-A-Therm with a capacity of 0.4mm to 1.6mm Btu/hr must be used. If a higher preheat air temperature is required the 2500 MA or MB could be used.

Dilution Air.
If the furnace temperature is above 2100°F dilution air must be introduced to cool the exhaust gases to 2100°F before they enter the recuperator. See Figure 2.
As a guide, the following chart can be used to determine the amount of dilution air required:

		Burner Capacity Btu/hr.				
		100,000	200,000	500,000	1,000,000	2,000,000
Volume scfh Cooling Air	2200°F Furnace	75	150	375	730	1,460
	2300°F Furnace	150	300	750	1,500	3,000
	2400°F Furnace	220	440	1,100	2,200	4,400

Number of Extern-A-Therm Recuperators.
It is recommended that one recuperator be used for each zone of control. This has the advantage that the combustion air flow is controlled on the cold side of the recuperator. All the subsequent instructions and descriptions are written with this assumption. If it is required that a single cross flow recuperator will pre-heat the combustion air for multiple zones, consult Eclipse.

Mounting the Recuperator.
The Extern-A-Therm recuperators are designed for vertical mounting with the recuperator tubes hanging vertically down. If an alternative mounting arrangement is required contact Eclipse.
There are two types of recuperator designs, three types of insulated housing designs and two types of eductor designs. These variations enable the Extern-A-Therm to be positioned and mounted in the optimum location relative to the exhaust flue and burner position.
The recuperator and exhaust housings have sufficient strength to be self supporting from the mounting flange, and can support the eductor if fitted. Eclipse recommends the use of flexibles at the air inlet/outlet and entrainment air connections to accommodate expansion and contraction. See Figure 2 for a typical arrangement.
Do not add additional insulation to the outside of the recuperator.

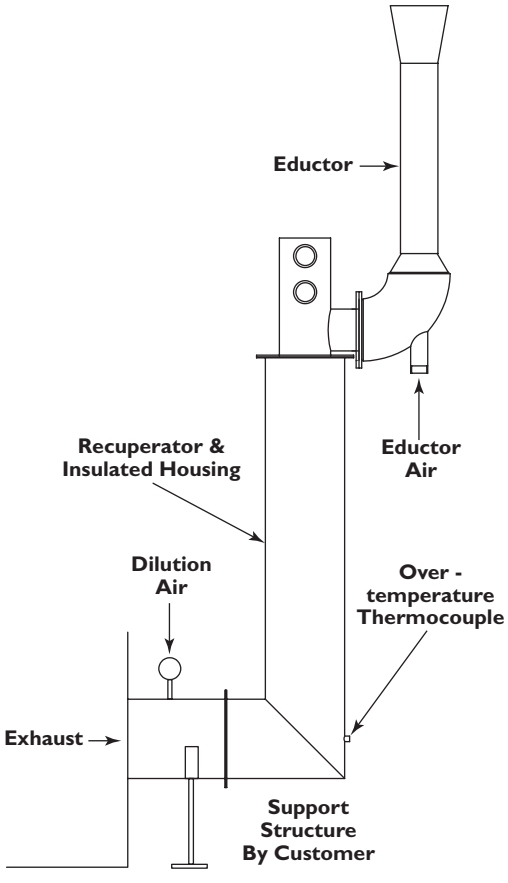


Figure 2

Mounting the Eductor.

The eductor can be mounted directly to the recuperator. The outlet flange on the recuperator is of sufficient strength to support the weight of the eductor; no additional support is required for the eductor.
The standard eductor is designed for vertical mounting, if horizontal mounting is requires consult Eclipse.
No additional exhaust ducting should be connected directly to the eductor.
There should be no restrictions at the eductor outlet; this would affect the eductor performance.
The outside of the eductor should not be insulated.

Typical Air Pipe Work.

The schematic on page 13 (Figure 3) shows a typical air control scheme. This uses one control valve to control the combustion air, eductor air and dilution air. As the burners turn down, the eductor air turns down to reduce the suction and keep the furnace at the desired pressure. If dilution air is fitted, this will also turn down, so as not to excessively cool the exhaust gas.
A more sophisticated control is shown on page 13 (Figure 4). This assumes that more critical furnace pressure control is required. The eductor air has a separate control valve driven by the furnace pressure control.
More details of the combustion circuits and methods of controlling the air and gas can be found in Design Guide 206 covering ThermJet Burners for Preheated Combustion Air.

Eductor Air Flow

Eductors are designed to overcome the exhaust gas pressure drop through the recuperator. The eductor airflows given in the data sheet are the flows required to overcome the exhaust pressure drop at the maximum rating of the recuperator and an inlet exhaust temperature of 1900°F. The entrainment air flow required will be different at other capacities or exhaust temperatures.

Cleaning the Recuperator.

Dirt or other substances in the exhaust can accumulate on the outside of the recuperator tubes. Units can be cleaned with steam, compressed air, or or any other method that accomplishes the task without damaging the insulation.

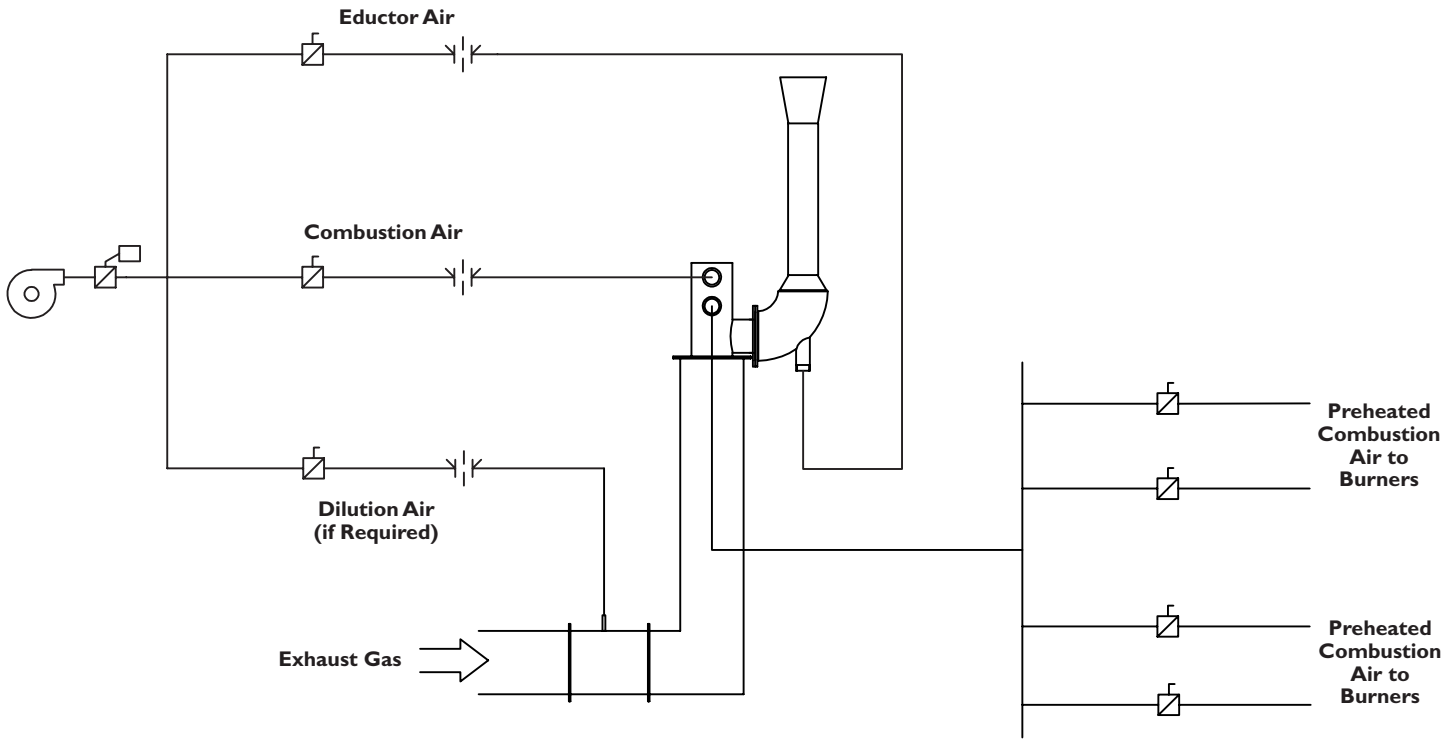


Figure 3

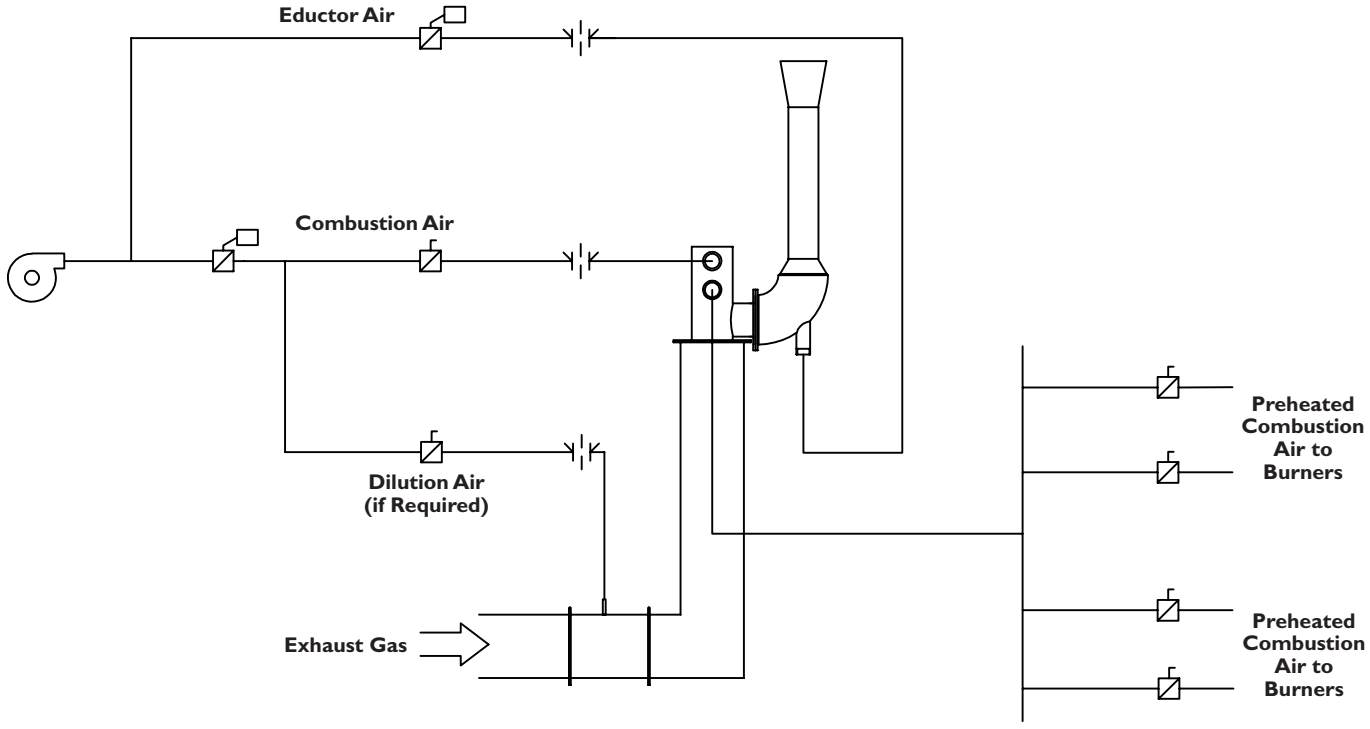


Figure 4

Offered By:
Power Equipment Company
2011 Williamsburg Road
Richmond, VA 23231
Phone: 804-236-3800 Fax: 804-236-3882

www.peconet.com