Ceramic Heat Exchangers

Efficient use of Energy

HTI 4-Pass
Ceramic Heat Exchanger
# Table of Contents

Ceramic Air-To-Air Heat Exchangers — Overview . . . . . . 1

Applicable Furnaces . . . . . . . . . . . . . . . . . . . . . . . . . 1

Service . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1

Preheated Combustion Air . . . . . . . . . . . . . . . . . . . . . . 1

Size . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

Construction . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

Draft . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

Leakage . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

Maintenance . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2

Cleaning . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

Amortization . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

Turnkey Operations . . . . . . . . . . . . . . . . . . . . . . . . . 3

Installations . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 3

Ceramic Heat Exchanger Design Guide . . . . . . . . . . . . . . 4
Ceramic Air-To-Air Heat Exchangers — Overview

Heat Transfer International offers three styles of all-ceramic, air-to-air heat exchangers. The first is a high temperature, high pressure, shell and tube machine that indirectly heats air up to 2000°F from particulate/acid-laden process gas at temperatures up to 2400°F. The air side can handle air at pressures from one to 13 atmospheres, which makes this exchanger ideal for using clean air to drive a gas turbine and preheat combustion air.

Described herein are two styles of medium to low differential pressure, all ceramic heat exchangers. The units are designed to handle process gas and heat air to the same temperature ranges described above.

The medium differential pressure exchanger is ideally suited for processes that cannot take air leakage into the process, such as in the carbon black industry. The low pressure machine is recommended for processes where a small amount of leakage from the air side to the process side is inconsequential, such as in the aluminum remelt and incineration industries.

Applicable Furnaces

Most industrial furnaces can be modernized to use a heat exchanger. The all-ceramic recuperator lends itself to carbon black reactors, aluminum scrap remelt furnaces, steel soaking pits, forge furnaces, aluminum melting pots, incinerators, dryers and similar equipment that has flue gases at high temperature containing corrosive chemicals or abrasive particulate.

Service

The exchangers are constructed of many different ceramic materials. Heat Transfer International has been testing ceramics in the laboratory since 1975 and has field-tested ceramics in atmospheres containing halogens and metallic slag at temperatures as high as 2400°F. This program has supplied sufficient data to allow Heat Transfer International to select the best materials for each zone according to the severity of the service.

Low temperature - Although ceramic heat exchangers lend themselves to medium and high temperature applications, they can be used in the 500°F to 1400°F range. If the flue gas is corrosive and/or abrasive, the machine is a practical piece of equipment to preheat combustion air for dryers and other similar processes.

Medium temperature - Most ceramic exchangers are designed for the 1400°F to 2200°F range, and Heat Transfer International has several full size exchangers operating successfully in these ranges.

High temperature - Special ceramics can be incorporated into the Heat Transfer International heat exchanger to take temperatures up to 2400°F

There is a wide variety of applications for heat exchangers. By analyzing the process information, Heat Transfer International can design a heat exchanger based on the temperature and chemistry of the waste products. This custom selection of materials assures the customer of long service with minimal maintenance.

Preheated Combustion Air

Most exchangers are used to preheat combustion air up to 1400°F, however, the air can be heated up to 2000°F in other plant processes.

When a waste fume contains oxygen, it is possible to preheat the fume and return the heated waste to the burners, thereby reducing substantially the need for supplemental fuel. In secondary aluminum remelt furnaces, preheated air not needed for combustion can be sent directly to a sow or scrap preheater.

Heat Transfer International will design and supply all the necessary ductwork and valving to handle the preheated air.
Size

Factory-fabricated flange-to-flange units, with all the access doors, thermocouple and pressure taps, connecting flanges, etc., are available from 100,000 to 30,000,000 BTU per hour. They range from a single pass to multiple pass units. Smaller exchangers (up to 5,000,000 BTU per hour average heat recovery) are standard package units. Larger recuperators are designed specifically for each process.

Modular and field-installed units are available from 30,000,000 up to several hundred million BTU per hour. Tube diameter and length, tube spacing, tube materials and zoning are all determined by Heat Transfer International to meet actual plant requirements.

Construction

The ceramic exchangers are supplied with a patented tube-to-tube sheet construction. The unique internal tube seal with an optional removable plug allows for fast, easy, individual tube replacement. There are no moving parts, such as springs or wheels. There is no sponge-like design to get plugged and no metal to be attacked by acids.

Metal exchangers and ceramic exchangers with metal parts are subject to severe acid attack and rapid oxidation in the event there is a power failure or during heat-up and cool-down when the exchangers are below the dew point. When springs are used they lose their resiliency as the exchanger ages because of heat conducted through the tube sheet.

Leakage

By controlling the draft differential between the heated air and the waste fume, it is possible to maintain a minimal leakage from the air to waste fume. This feature ensures no contamination of the heated air due to leakage. Also, the tubes used in the Heat Transfer International exchanger are impervious so there is no contamination through the tube walls. The design incorporates a special tube sheet that holds the tubes in place on one end and allows the tubes to grow into the second tube sheet, so, as the exchanger comes to temperature, the seals tighten and actually get more efficient with higher temperature.

Maintenance

Access panels are constructed into each pass on both air and flue gas sides. After the panels are removed it takes less than fifteen minutes to change a tube with optional plug design.

The chart below indicates the reduction of natural gas usage as a percentage using preheated combustion air.

<table>
<thead>
<tr>
<th>Furnace Exhaust Temperature, °F</th>
<th>Preheated Air Temperature, °F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>600</td>
</tr>
<tr>
<td>1,000</td>
<td>13</td>
</tr>
<tr>
<td>1,200</td>
<td>14</td>
</tr>
<tr>
<td>1,400</td>
<td>15</td>
</tr>
<tr>
<td>1,600</td>
<td>17</td>
</tr>
<tr>
<td>1,800</td>
<td>18</td>
</tr>
<tr>
<td>2,000</td>
<td>19</td>
</tr>
<tr>
<td>2,200</td>
<td>20</td>
</tr>
<tr>
<td>2,400</td>
<td>21</td>
</tr>
</tbody>
</table>

Feed: Natural gas at 10% excess air. Source: IEA Combustion Technology Manual (see Resources).
Cleaning
Particulate build-up can be removed by soot blowing, steam or air, soot blowers can be added easily. Tube cleaning is possible without process interruption.

Amortization
With proper equipment selection, amortization of the exchanger in many cases can be as short as six months. If new controls, burners and ducts are supplied, amortization of the entire retrofit may still be less than one year.

Turnkey Operations
Heat Transfer International will take full responsibility for modernizing existing industrial furnaces to accept a heat exchanger, including revamping the controls, burners, valve trains, ducts, and fans. This one-source responsibility assures the customer of integration of the heat exchanger into his process with minimum down-time.

Installations
Ceramic exchangers have been installed on secondary aluminum scrap remelt, titanium oxide, aluminum dry hearth melting, investment casting, and copper scrap remelt furnaces. As diverse as the applications may be, they all have in common unique tube sealing and high efficiency heat transfer. Maintenance has been minimal. Customers are saving from 350,000 BTU per hour up to 14,000,000 BTU per hour.
Ceramic Heat Exchanger Design Guide

Please supply HTI with the following information so we can select/size the correct HTI Ceramic Heat Exchanger for your application:

**Waste Gas/Air A**

- **lbs/hr**

**Chemical composition of Waste Gas/Air A**

- ______________ in lbs/hr or %

**Inlet Temperature**

- **T1** ________________

**Outlet Temperature**

- **T2** ________________
  - or energy ________________ BTU/hr

  *Or leave blank and we will determine T2 for optimal design of CHX

**Inlet Pressure**

- ________________ in/ H2O or PSIG

**Outlet Pressure, if required**

- ________________ in H2O or PSIG

**Waste Gas/Air B**

- ________________ lbs/hr

**Chemical composition of Waste Gas/Air B**

- ________________ in lbs/hr or %

**Inlet Temperature**

- **T3** ________________

**Outlet Temperature**

- **T4** ________________
  - or energy ________________ BTU/hr

**Inlet Pressure**

- ________________ in/ H2O or PSIG

**Outlet Pressure, if required**

- ________________ in H2O or PSIG