


energy saving RIZZI ENGINEERING	Reference: Combustion Air Preheaters	Tech. Spec. 6067 REV1	Comp. RC
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COMBUSTION AIR PREHEATERS

ENG - 6.067



REFERENCE HANDBOOK

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I° GENERALITY

1.1 HEAT RECOVERY

Combustion air preheaters or gas-gas heat exchangers our RAAG patented type find a lot of applications in petrochemical plants and thermal power stations. Gas-air heaters our RAAG patented type are used when there is the need to increase the plant efficiency by means of thermal recovery. The combustion air is heated recovering the sensible heat of the waste gas before to be sent to the burners.

There are also typical applications in the environmental protection systems like DESOX-DENOX plants or incineration plants.

1.2 FIRST INSTALLATION

Our experience in designing and manufacturing combustion air preheaters dates back to 1947 at the period of post-war reconstruction of Italian industry. The first equipment made by cast iron finned elements was realized in that year for the CISA-VISCOVA Company at service of a BREDA TERMOMECCANICA steam boiler.

1.3 CAST IRON FINNED PLATES type AIR PREHEATERS

Afterwards this first installation we've designed and manufactured hundreds of combustion air preheaters realized with cast iron finned plates, provided with external fins gas side and internal fins air side, at service of steam boilers or at service of refinery heaters.

Today cast iron finned elements are obsolete and have been gradually eliminated , also because it is not possible to realize the zero leakage construction –some air is lost to stack instead of reaching the burners-.

1.4 STEEL FINNED PLATES type AIR PREHEATERS

In the meanwhile, since 1982 we started to develop a new type of combustion air preheater made by steel finned plates, finned externally gas side and finned internally air side.

Steel finned plates can be made by carbon steel, alloy steel, stainless steel or COR-TEN (corrosion resistant) steel.

1.5 COMBINATION OF DIFFERENT MATERIALS

Many combustion air preheaters are realized with different materials, for instance one bank cast iron and other ones carbon steel to cope with different temperatures in the different parts of the unit.



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II° EXPERIMENTAL FACILITIES

In order to verify all necessary design parameters, we've realized some full scale experimental plants. The below Combustion Air Preheater is a three pass equipment provided with N° 3 heat transfer modules. Each module can be easily removed and changed to allow the testing of different materials and configurations.




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II° EXPERIMENTAL FACILITIES

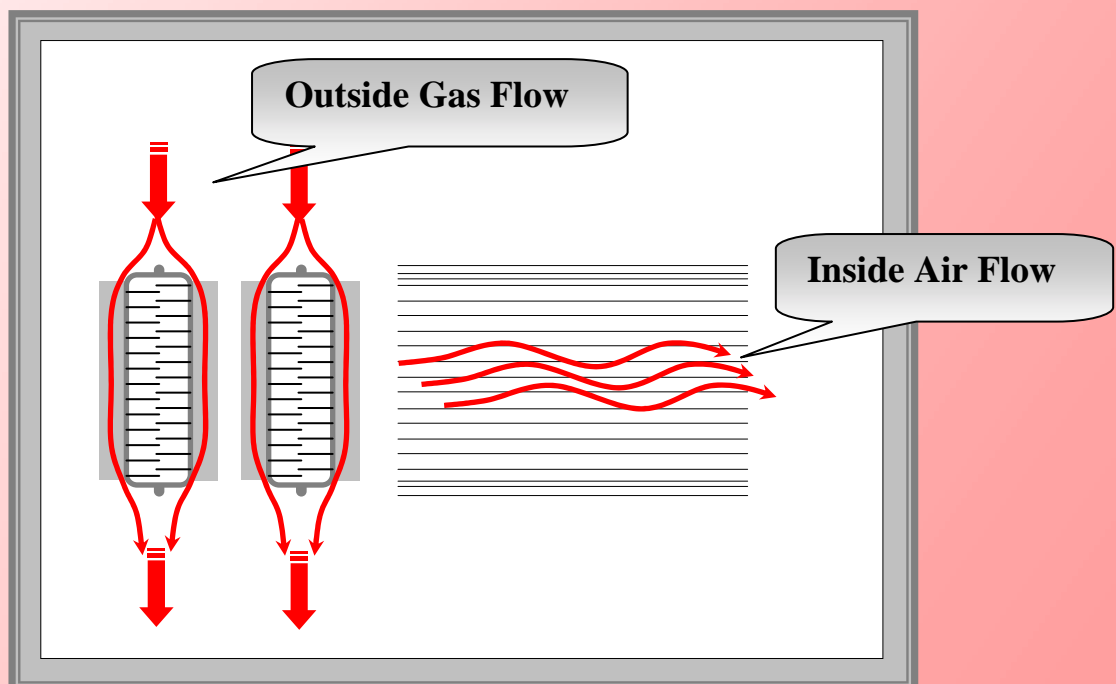
The below picture refers to a Combustion Air Preheater realized by four passes horizontally settled modules.
Each module can be removed and changed to test different parameters.
This arrangement is typical for hydrogen plants.




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III° MAIN FEATURES

- 3.1 We realize all our RAAG patented type heat exchangers with highly efficient finned plates provided with outer fins gas side and inner fins air side. The finned plates are realized by different materials: carbon steel, corten, alloy steel, stainless steel. Cast iron is obsolete and has been gradually eliminated.
- 3.2 If the dimensions are fit for transportation, our equipments are supplied completely preassembled, ready to erection. If the overall dimensions are exceeding the transport capability or the erecting manoeuvrability they are supplied in prefabricated blocks.
- 3.3 Finned plates are normally arranged in line in order to give low pressure drops and better cleaning gas side using soot blowers.
- 3.4 Another important feature of our Combustion air preheaters is the possibility to realize the "ZERO LEAKAGE" manufacturing option. No air leakage into gas zone means lower corrosion problems, no overdesign for air fans, lower maintenance costs.




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IV° GAS-AIR HEAT TRANSFER


- 4.1 The use of static "recuperative type" heat exchangers provided with extended surfaces is very attractive for gas-gas or gas-air heat transfer because can realize very compact heat exchangers avoiding problems connected to excessive dimensions typical of bare tubes units.
- 4.2 In fact film heat transfer for gases is feable and the extension of heat exchanging surface, both side, can considerably increase the overall heat transfer.
The increased heat transfer surface for unit volume of our RAAG patented type heat recovery equipments mean lower installation costs compared to other equipments.



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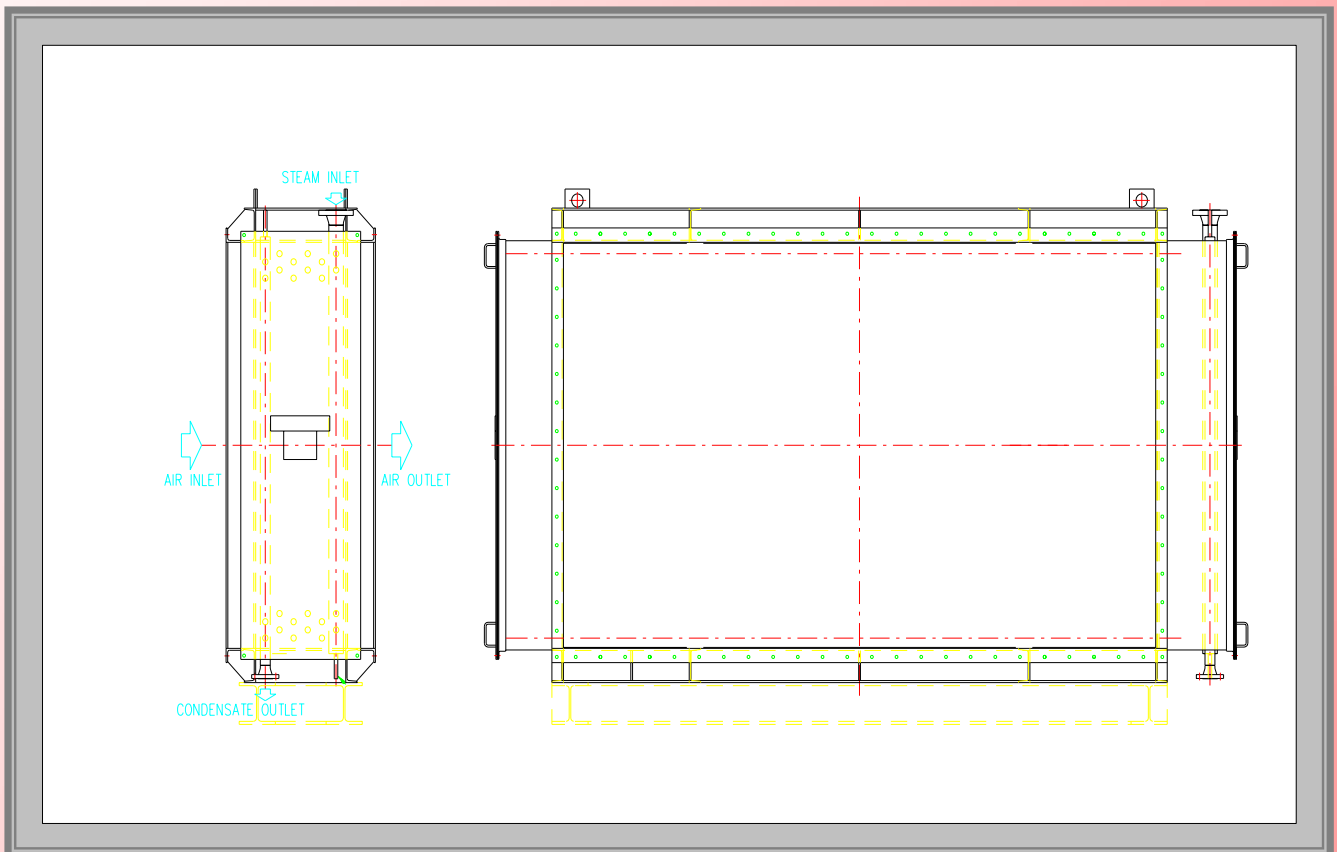
V° SKIN TEMPERATURE CONTROL


- 5.1 In order to avoid the corrosion of heat transfer surfaces, the skin temperatures of combustion air preheaters banks must be kept higher than the dew point of cooled gas in all working conditions.
- 5.2 There are different modalities to realize this requirement and/or different alternatives of construction to reach this goal. Each different solution must be analyzed case by case and adopted when resulting the best one, or the simplest and, last but not least, the most economical one.
- 5.3 The different technical options are the following ones:
- INCREASE AIR INLET TEMPERATURE
by means of a steam preheater as per paragraph VI°
 - USE DIFFERENT FINNING OF GAS OUTLET ZONE
using air side bare plates as per paragraph VII°
 - ADD AIR OUTLET RECIRCULATION
taking back to air fan some quantity of heated air as per paragraph VIII°
- 5.4 Also the use of AIR BY-PASS prevents the possibility of corrosion in some particular or reduced working conditions.
- 5.5 Finally when there is no possibility to keep the skin temperatures over dew point in all working conditions, special materials must be adopted as per paragraph IX°

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VI° STEAM-AIR PREHEATERS

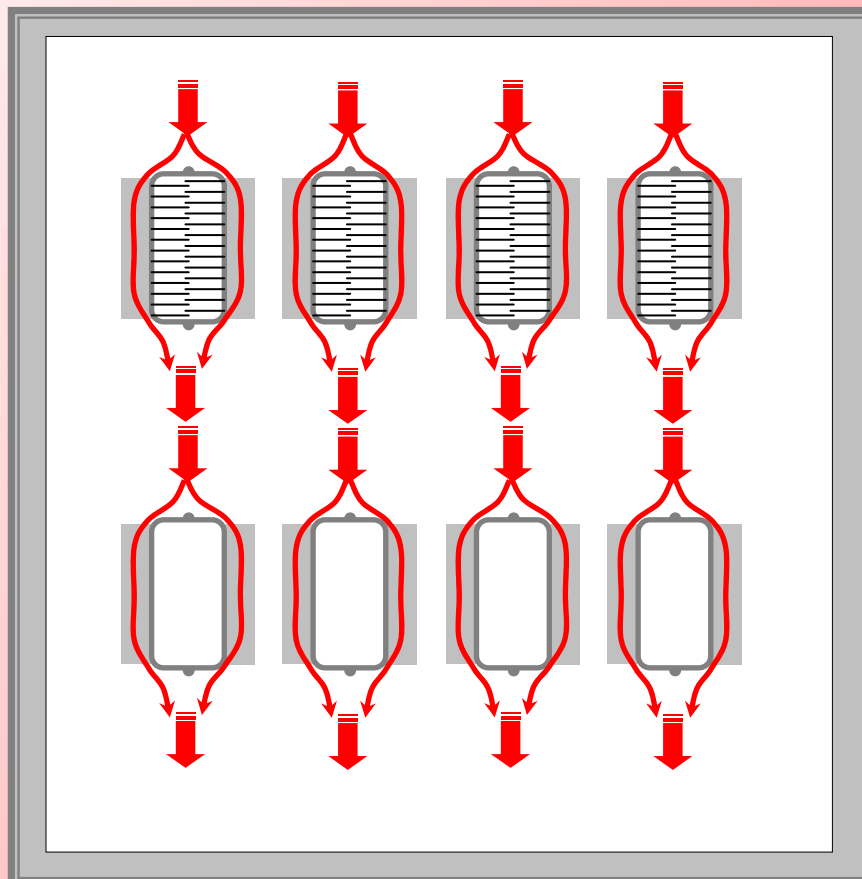
- 6.1 The installation of a steam-air preheater is fit for increasing cold air temperature and consequently skin temperature over dew point. If low pressure steam is available this option can be the most economical.
- 6.2 Our design incorporates an extended surface steam air preheater in a very compact arrangement, directly connected to the air inlet hood of the first bank of the Raag type combustion air heater.
- 6.3 The steam-air preheater, our AIREX type, can be realized with bimetallic aluminium-steel tubes. Finned tubes are manufactured with our G-FIN automatic process. Alternatively steel finned tubes are used.




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VII° DIFFERENT FINNING

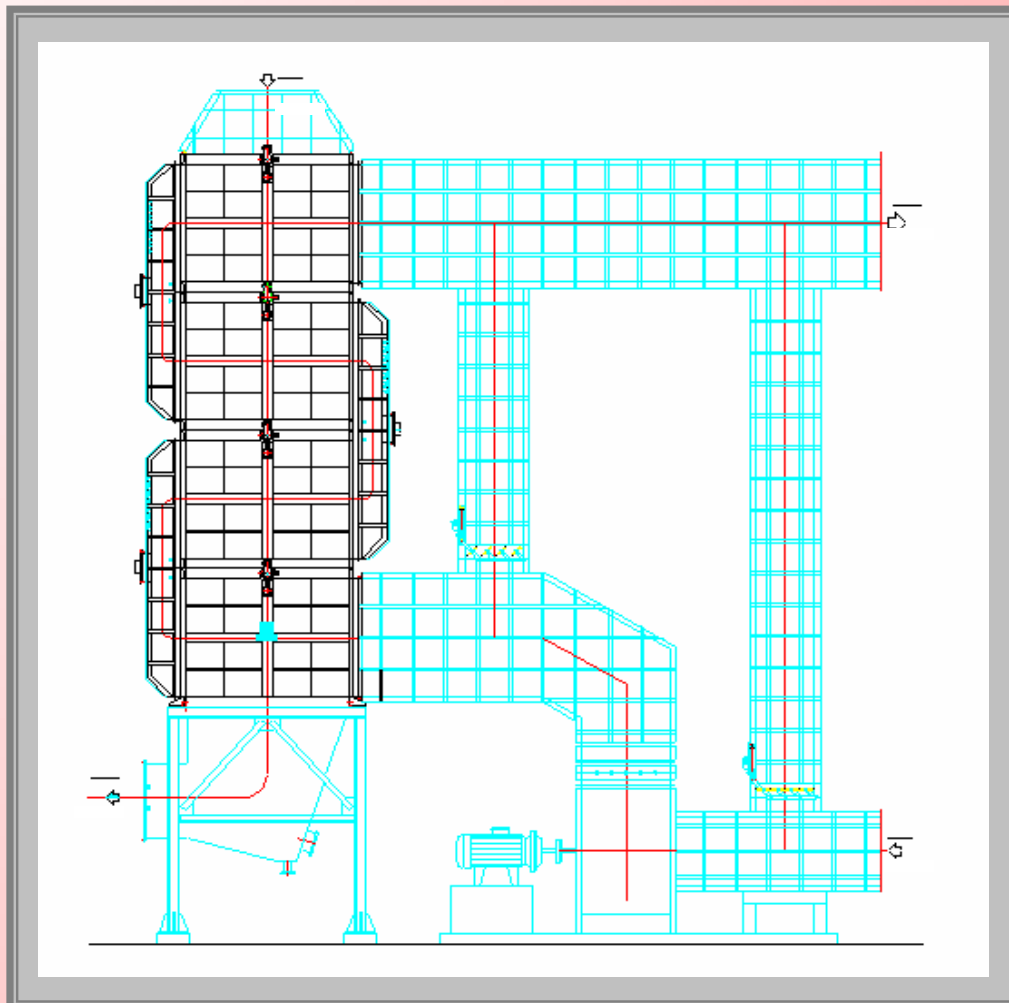
- 7.1 The skin temperature of each part of heat exchanger depends mainly from local film temperature and from convective heat transfer coefficient. Convective film heat transfer coefficient is the controlling coefficient: as much his value is high as much skin temperature approaches film temperature of the fluid.
- 7.2 The way for increasing convective coefficient is the extending of heat transfer surface by finning. Consequently if one side is finned and the other one is bare (unfinned) the skin temperature approaches the finned side film temperature and differs from unfinned side film temperature.
- 7.3 Using this feature at gas outlet zone, corresponding to cold air inlet zone, it is possible to control skin temperature of heat exchanging surface increasing the same over the dew point value.




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VIII° AIR RECIRCULATION

- 8.1 Many plants are equipped with an air recirculation system: some heated air flowrate from 5% up to 15% is sent back to the air intake of forced draft fan to in order to mix with ambient cold air, protecting heat transfer surfaces against corrosion.
- 8.2 The system needs an air recirculation duct provided with insulation, expansion joints and supports and at least one set of dampers. Normally dampers are operated by means of a pneumatic actuator.
- 8.3 In this case the air forced fan must be designed for the overall flowrate - combustion air plus recirculated air. The air preheater must supply sensible heat for combustion air and for the recirculated one.



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IX° LOW TEMPERATURE ZONE SPECIAL MATERIALS

Sometimes it is necessary to increase thermal recovery and to go below gas dew point: in this case we use for the coolest heat transfer bank special materials

9.1 BOROSILICATE GLASS TUBES

The most expensive option is the use of borosilicate glass tubes arranged with horizontal or vertical axis.

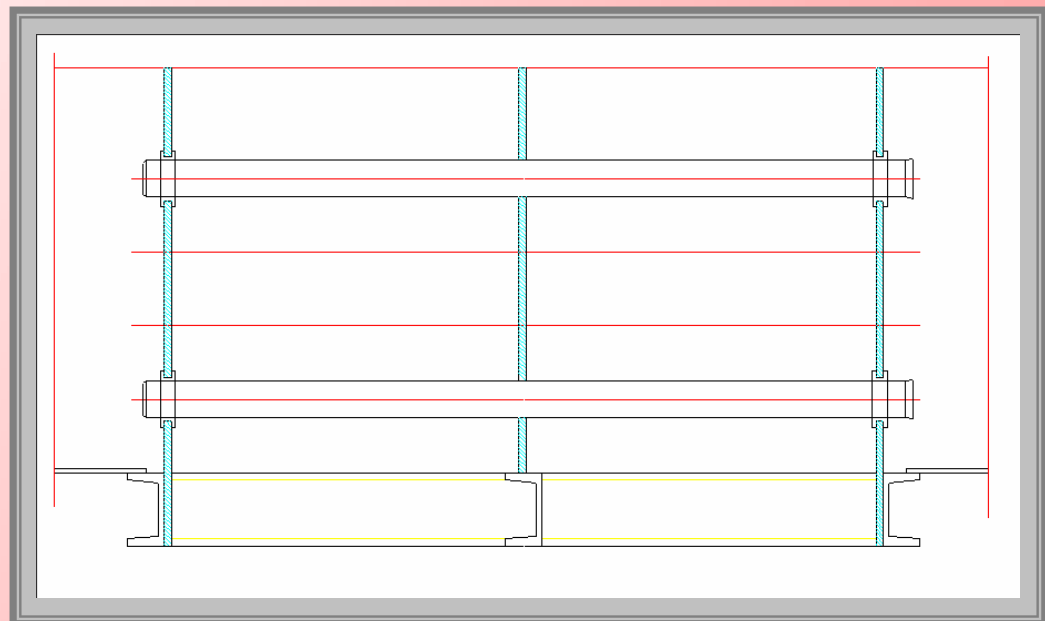
The borosilicate tubes do not suffer of any corrosion, but their fragility can cause problems during erection or if some vibration is induced by air or gas flow. To allow free thermal expansion glass tubes are packed with PTFE special rings.


The support tube plates of glass tubes are particularly designed and can be protected with PTFE in order to avoid corrosion also to this part of the equipment.

9.2 COR-TEN (CORROSION RESISTENT) STEEL

More economically it is possible to fight the corrosion using special alloy steel added with Cr and Cu in low percentages.

This corrosion resistant steel has a very low corrosion velocity if compared with carbon steel and can be successfully applied in many cases. Also support plates will be made by corrosion resistant steel.



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X° **CLEANING SYSTEM**

10.1 THE FOULING PROBLEM

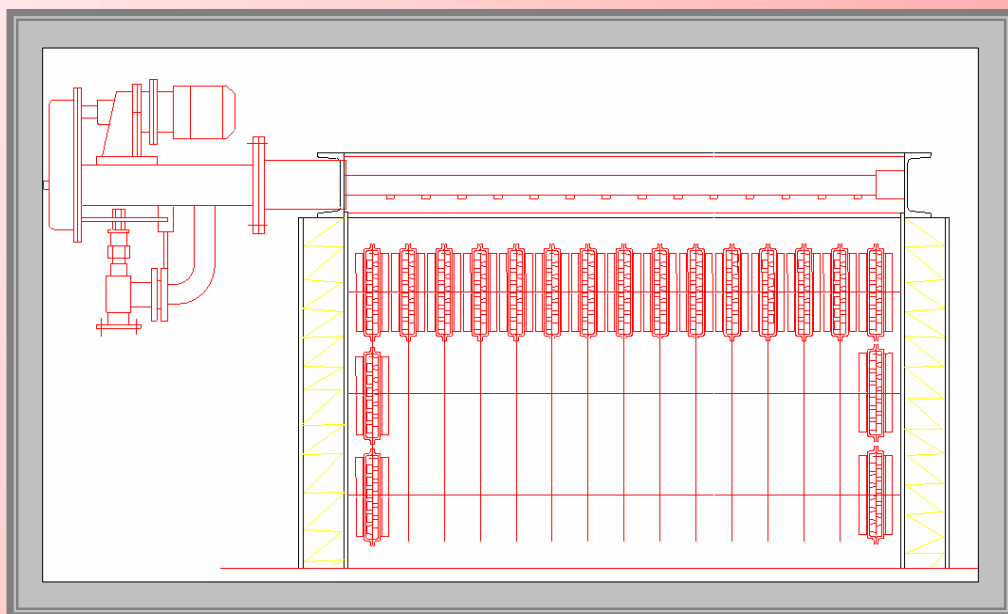
The cleaning systems of the combustion-air heaters or gas-gas heat exchangers are very important in order to install reliable and long lasting equipments, avoiding fouling problems that means increased pressure drops, lower heat recovery and/or corrosions.

10.2 SOOT BLOWERS

The cleaning system is provided with rotary lance or travelling lance soot blowers. The cleaning media are steam or compressed air. The soot blowers our BLOWMATIC type are usually arranged on the upper part of each bank and are provided with special multiple nozzles. The soot blowers can be driven with electrical or pneumatic motors.

10.3 SEQUENCE CONTROL PANEL

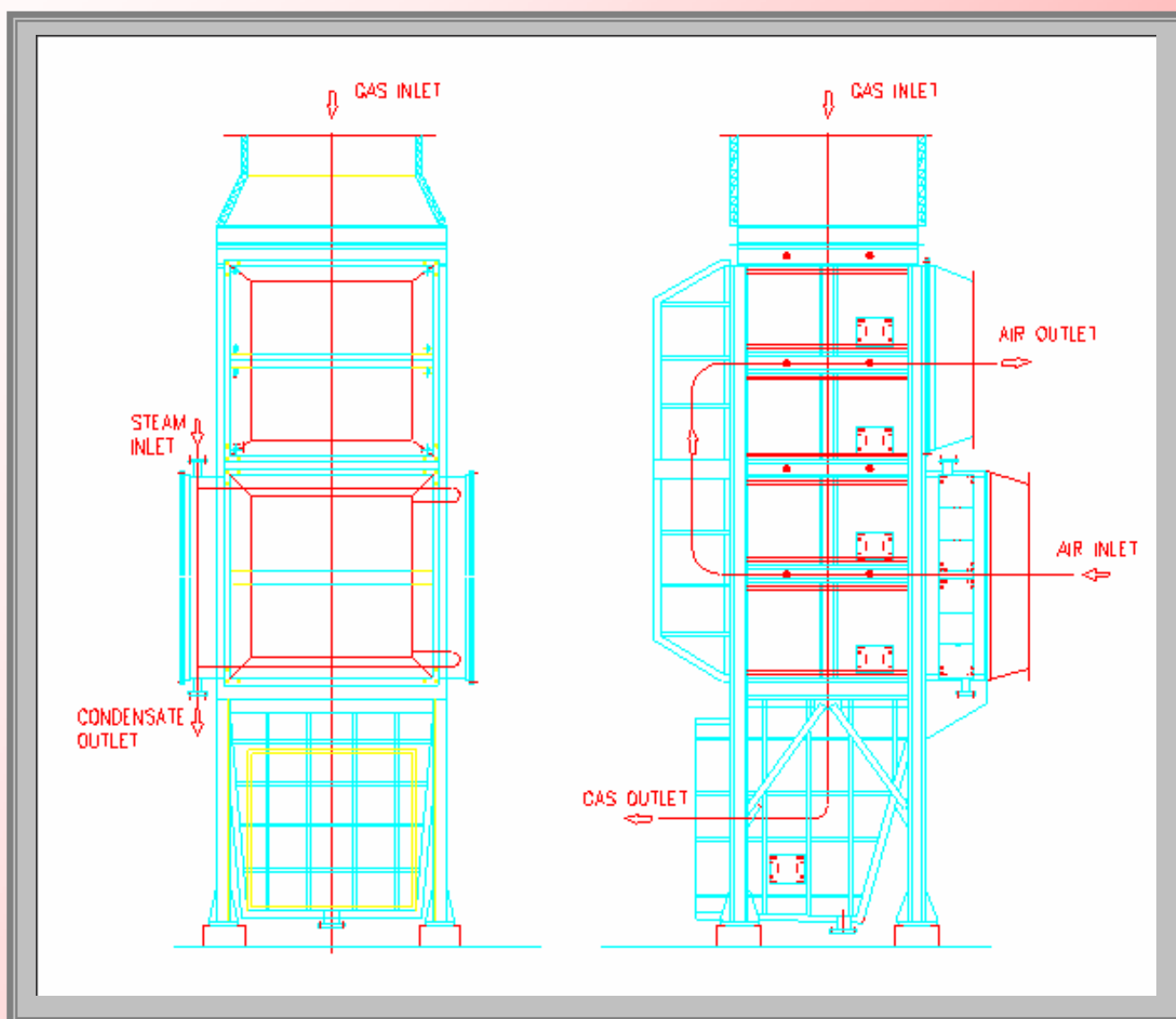
Normally all soot blowers are driven in sequence using a control panel board. The blowing must be done automatically and continuously every 8 hours of continuous running. The blowing time for each soot blower is controlled by the panel board. Sequences and time can be changed as necessary.



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XI° TYPICAL ARRANGEMENTS

- 11.1 Typical combustion air preheater realized in two banks fit for installation at service of refinery furnace, provided also with steam air preheater.

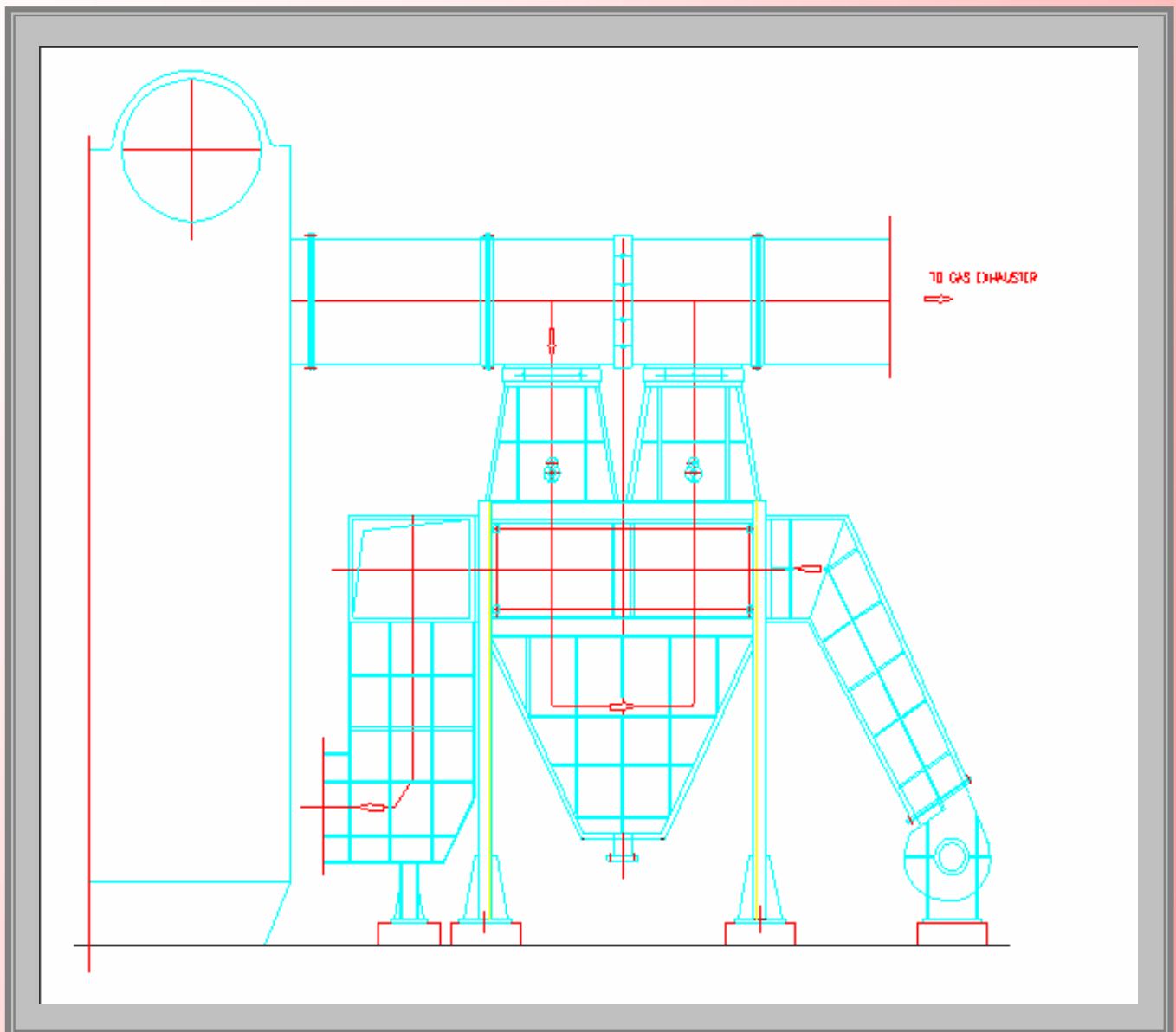




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XI° TYPICAL ARRANGEMENTS

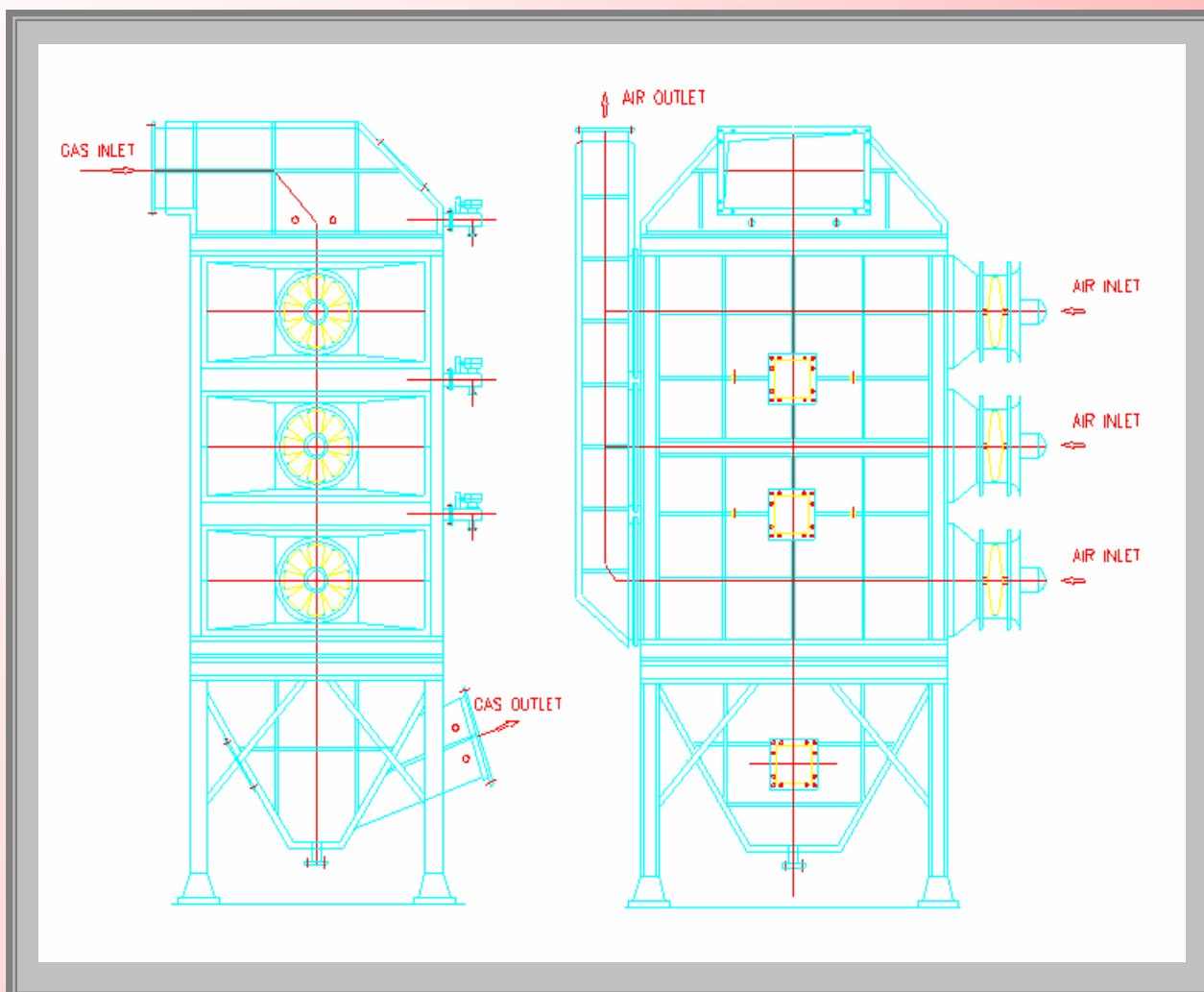
- 11.2 Typical gas air heater at service of a steam generator: generally also in these heat recovery systems a steam air preheater can be added.



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XI° TYPICAL ARRANGEMENTS

- 11.3 Typical gas air heat exchanger arrangement for installation in a steel mill. In many cases the equipment can work only as a gas cooler.





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X° CAPH FIELD ASSEMBLING PICTURES



Iran, combustion air preheater assembling (SNAM PROGETTI ITALY)



India, combustion air preheater assembling (Larsen & Toubro INDIA)

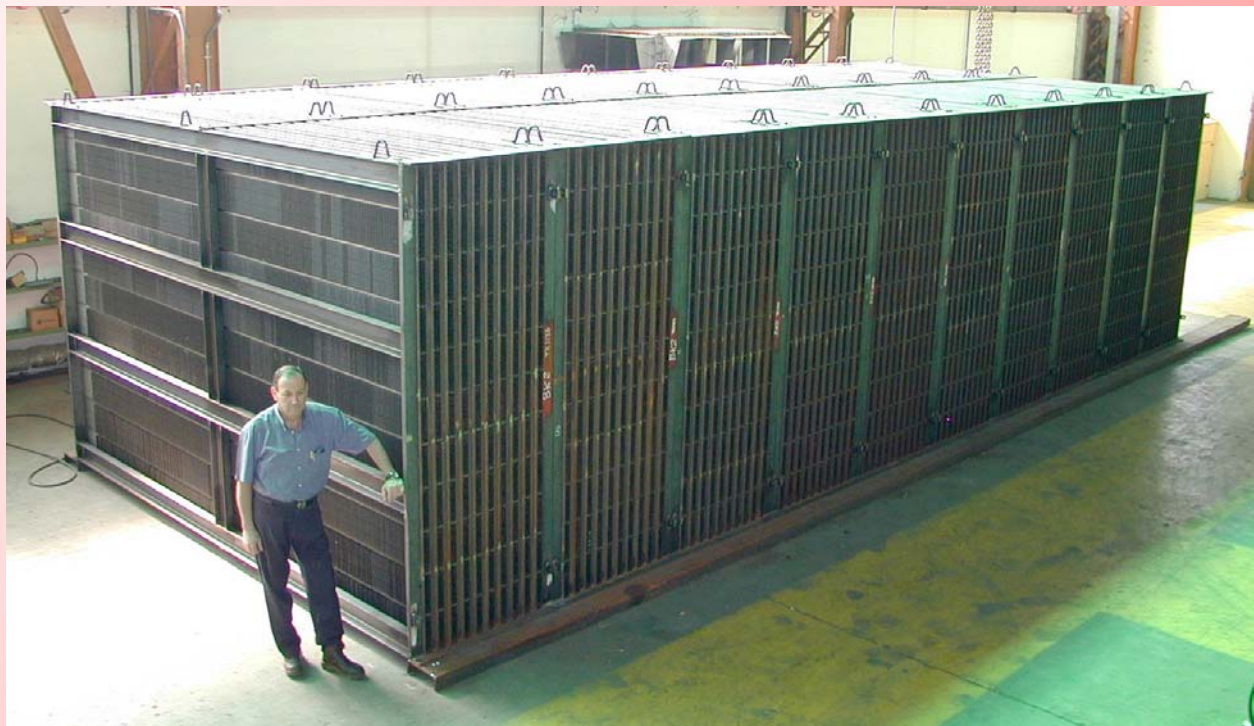


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X° CAPH FIELD ASSEMBLING PICTURES



Venezuela, combustion air preheater assembled (SUPERMETHANOL)



Combustion air preheater, heat exchange modules preassembling in Rizzi Energy SpA workshop