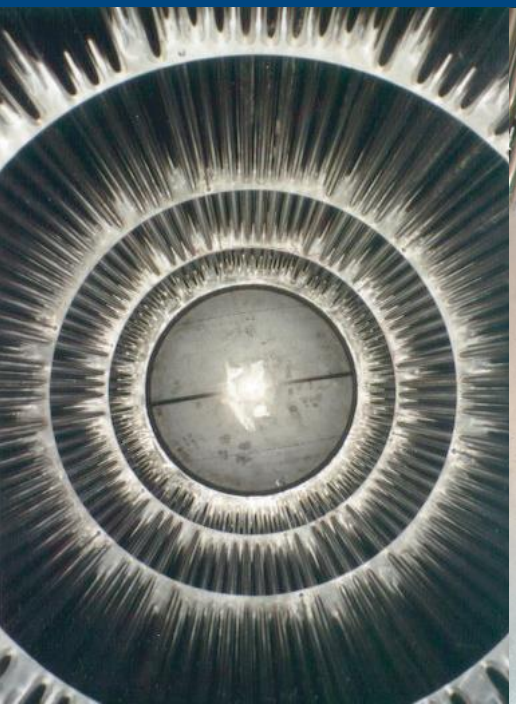
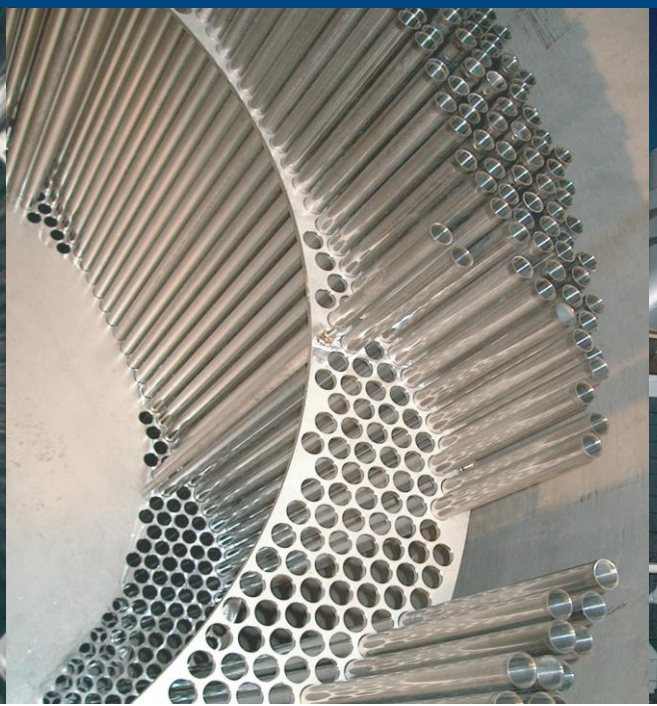
NORAM

SULFURIC ACID

Products and Services

RF™ RADIAL FLOW GAS HEAT EXCHANGERS





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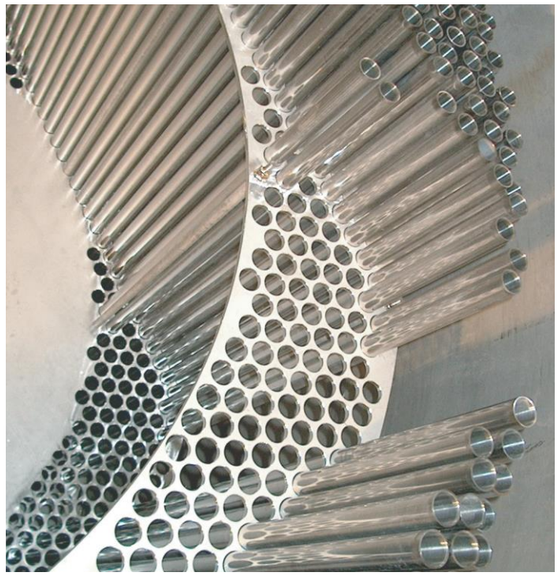
RF™ RADIAL FLOW GAS HEAT EXCHANGERS

The **NORAM RF™ Radial Flow Gas Heat Exchanger** offers a fundamental improvement in gas heat exchanger performance over designs traditionally used in the sulfuric acid industry.

The RF™ design far surpasses existing single-segmental and double-segmental heat exchanger designs in heat transfer rates, at a significantly lower pressure loss. The single-segmental gas exchanger has the disadvantage that pressure drop on the shell side increases in proportion to the number of tube rows the gas has to cross. This design causes the pressure drop to rise with the size of an acid plant as the size of the exchanger grows. A further disadvantage of this design is the poor utilization of tubes in zones where gas flow is parallel to the tubes. This is because heat transfer rates in parallel flow are much lower than in the cross flow arrangement.



The double-segmental exchanger supplied by some contractors addresses the problem of high shell side pressure drop through the introduction of gas from two sides through a bustle arrangement. However in this design, the gas velocity past the tubes in the core region on the shell side is essentially zero. This reduces heat transfer and creates hot or cold zones.

On the tube side, however, the gas flow is not affected. In double-segmental Cold Exchangers, tubes in the core domain will invariably reach the dew point temperature, causing acid condensation and sulfate formation. At the same time, tubes in the core do not contribute significantly to the heat transfer because of the low local heat transfer rates.

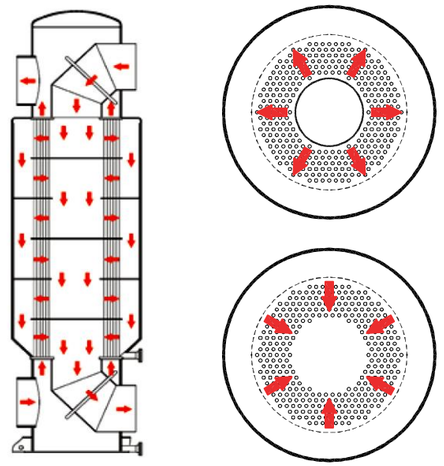
The cross flow exchanger is a single pass exchanger commonly used in hot service between the first and second bed of a converter. Its mechanical weakness comes from the difference in the thermal expansion of the cold and the hot tubes on opposite sides of the exchanger. This often causes tubes being pulled from the tubesheets or failure of expansion joints.

In the RF™ Gas Exchanger, tubes are arranged in an annular pattern using disk and donut baffles. Flow is directed from an inner core outward across the tube bundle and from an outer annulus inward across the tube bundle. The gas turns in the inner core and outer annulus are not restricted by tubes so that pressure losses are minimized. The flow resistance across the tube bundle is uniform, resulting in uniform flow and low pressure losses due to minimal gas acceleration and deceleration. Also, the radial design minimizes the number of tube rows which have to be crossed by the gas, resulting in a low shell side pressure drop. Steps are taken in the design to maintain uniform velocity through the core, the bundle, and the annulus to minimize overall flow resistance.

Heat transfer rates in the RF™ Gas Exchanger are maximized because all the heat transfer surface is fully utilized. Shell gas flow is always perpendicular to the tubes providing the largest film coefficients.

Tube Layout

The RF™ design makes effective use of the heat transfer surface by placing tubes only in areas of cross flow. The gas flows radially across the tube bundle between an open core and open outer annulus, directed by disc and donut baffles. All tubes are located in an annular domain between the core and the outer annulus.



Polygonal Tube Pitch

NORAM's patented Polygonal Tube Pitch radial flow design provides a tube layout which reduces tube surface area and pressure drop compared to conventional radial flow pitches.

Compact Tube Bundles

Due to superior heat transfer characteristics, RF™ Exchangers typically require 25 percent less heat transfer area than traditional exchangers. This results in a smaller exchanger, which usually can be shop fabricated, offering the benefit of better quality.

Freedom of Nozzle Orientation

The disc and donut baffle arrangement permits complete freedom of angular nozzle orientation on the shell side and on the tube side. This facilitates layout of ducting.

Options in Nozzle Connections

RF™ Exchangers offer several options for shell side nozzle connection. These are shell entry, shell exit, core entry and core exit—in any combination.

Low Pressure Drop

RF™ exchangers are purposely designed to maintain steady and uniform gas velocities through the core, the tube bundle and the annulus. This minimizes pressure losses from acceleration and deceleration of the gas. In addition, in the RF™ geometry the gas has to cross only a relatively small number of tube rows, which results in low pressure drop.

Low Nozzle Losses

Through the use of CFD (Computational Fluid Dynamics), design techniques have been developed through which nozzle head losses can be minimized. In NORAM RF™ Gas Exchangers, the nozzles have become an integral part of the exchanger design.

Accurate Prediction of Overall Pressure Drop

Through the use of CFD techniques, accurate prediction of overall exchanger pressure drop is achieved. Field measurements have fully substantiated NORAM's design techniques.

Accurate Thermal Rating

NORAM has developed accurate thermal rating programs for RF™ Exchangers which have been verified through field data in many installations.

Temperature Contours

Through CFD techniques, detailed temperature contours on the shell side and tube side of RF™ Exchangers have been established. Criteria have been developed to integrate dew point calculations and thermal rating programs to avoid acid condensation, which will result in corrosion.

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- NORAM/CPPE HYBRID SULFURIC ACID PROCESS (HSAP)
- NORAM CLEAN START™ PROCESS
- NORAM PLANT PREHEATING SYSTEMS
- NORAM'S TURBOSCRUBBER FOR GAS SCRUBBING
- NORAM STAINLESS STEEL CATALYTIC CONVERTERS
- NORAM RF™ RADIAL FLOW GAS-TO-GAS HEAT EXCHANGERS
- NORAM SF™ SPLIT FLOW GAS-TO-GAS HEAT EXCHANGERS
- NORAM BRICK-LINED ACID TOWERS
- NORAM SULFUR & SPENT ACID BURNERS
- NORAM CELLCHEM SULFUR BURNERS
- NORAM ANODICALLY PROTECTED ACID COOLERS
- NORAM SX® ACID COOLERS
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- NORAM TROUGH ACID DISTRIBUTORS FOR ACID TOWERS
- NORAM SX® CHIPGUARD CG™ ACID STRAINER
- NORAM ENTRAINMENT MITIGATION DEVICE (EMD)
- NORAM ACID DILUTION SYSTEMS
- NORAM SX® MATERIAL
- NORAM SX® ACID DISTRIBUTORS
- NORAM SX® PIPING
- NORAM SX® VALVES
- NORAM GAS DUCTING
- NORAM DAMPER
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