Termomeccanica Industrial Process

Termomeccanica Group

100 years of Italian technology

1912-2012

Termomeccanica

AMMONIA REMOVAL SYSTEM

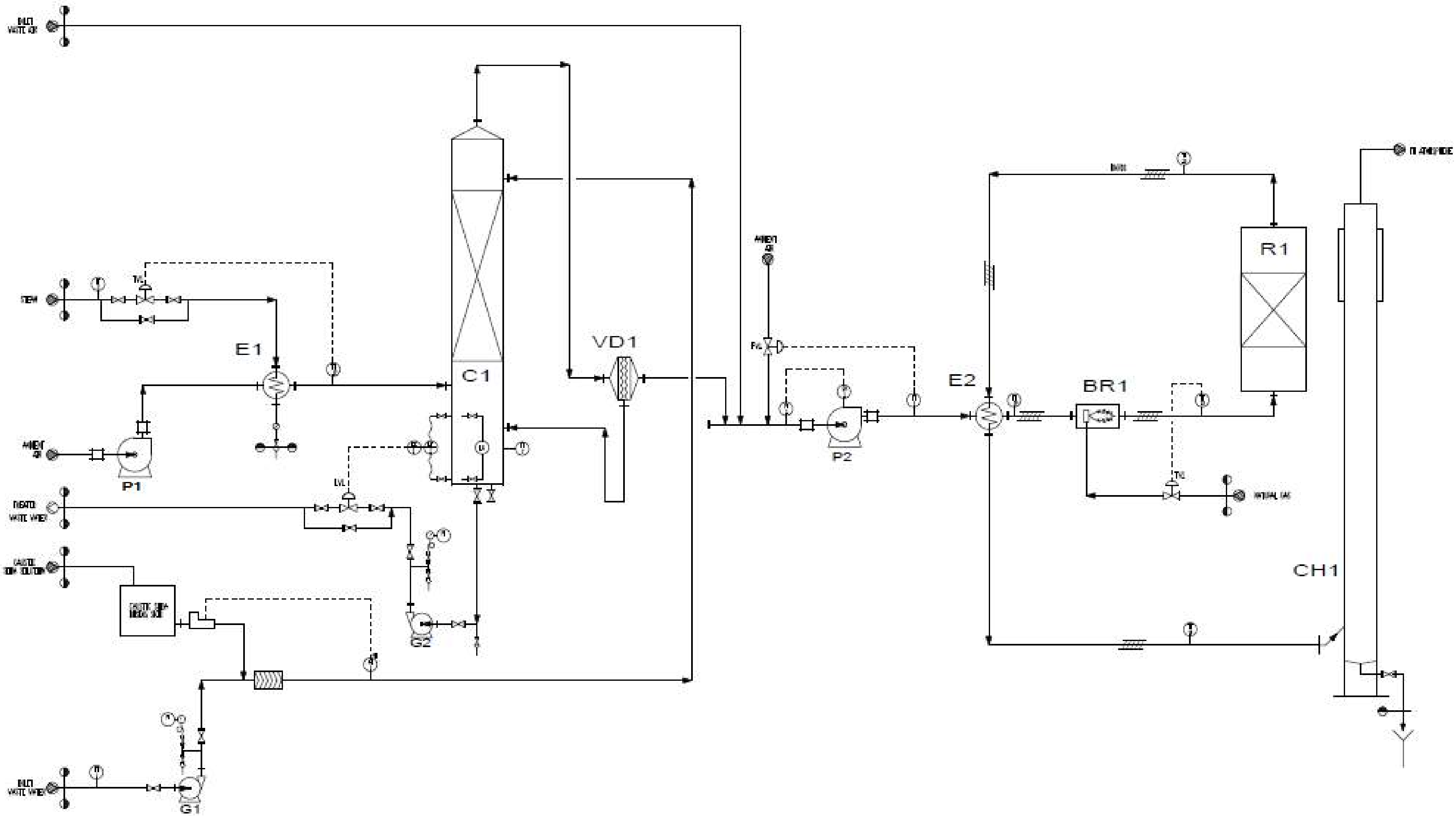
Short project Info

The plant purpose is to remove Ammonia from inlet waste water by using of air stripping technology and then oxidize it in a catalytic reactor to produce nitrogen and water, minimizing nitrogen oxides (NO_x) formation in compliance with the following emission limits:

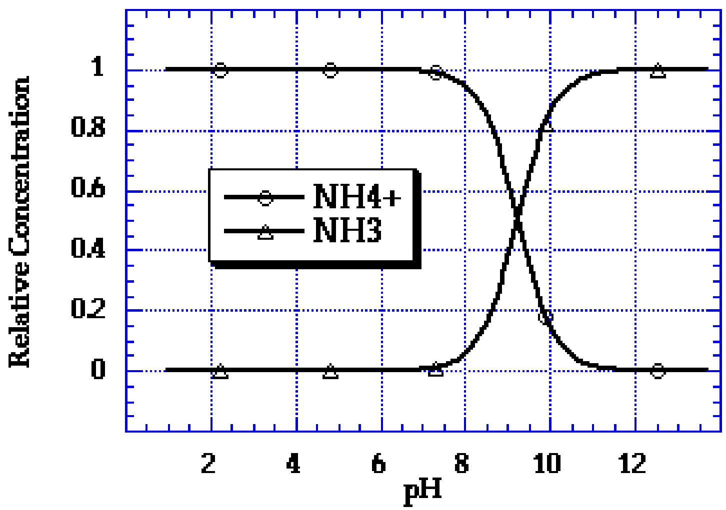
Parameters	**Units**	**Value**
Ammonia (NH_3) in outlet air stream	mg/m^3	250 (concentration measure before stack outlet)
Nitrogen dioxide (NO_2) in outlet air stream	mg/m^3	500 (concentration measure before stack outlet)
Ammonia (NH_3) in stripper liquid effluent	mg/l	10
Catalyst life	years	5 (Minimum)

If needed and depending by the input data is possible to reduce the emissions down to 90 mg/Nm^3 of Ammonia (NH_3) and 40 mg/Nm^3 of Nitrogen Dioxide (NO_2).

Process Scheme



Stripper: pH selection criteria



Our goal is to remove ammoniacal nitrogen (NH_3-N) from the waste water. Ammonia nitrogen exists in aqueous solution as either ammonium ion or ammonia, according to the following equilibrium reaction:

$$NH_4^+ \Leftrightarrow NH_{3(aq)} + H^+$$

According to this reaction, the speciation of ammonia nitrogen (NH_3) will depend on the pH value, the equilibrium being displaced to the right in alkaline water.

The stoichiometric (or apparent) dissociation constant of ammonium includes the value of the various activity coefficients and is defined according to the following equation:

$$K'_{NH_4^+} = \frac{[H^+]\cdot[NH_3]}{[NH_4^+]}$$

The value of the apparent dissociation constant is dependent on temperature. The following equation shows the relationship of the constant with temperature:

$$pK_{NH_4^+}(T) = a_0 + \frac{a_1}{T}$$

$$a_0 = 9{,}0387 \cdot 10^{-2}$$

$$a_1 = 2{,}72933 \cdot 10^{3}$$

The ammonium ion is not stripped from water, so we want all ammonia nitrogen to be as ammonia. To achieve this we have to raise the pH. The following formula indicates the relationship between the pH and the % of ammoniacal nitrogen which is in the ammonia form:

$$\% NH_3 = \frac{10^{pH-pK}}{10^{pH-pK}+1}$$

In our case if the pH is equal or higher than 12, and the temperature 50 ºC, the percentage of ammonia gas will be about 99,9%. As showed in following graph.

- **Selective oxidation of ammonia to nitrogen.**

$$2\ NH_3 + 3/2\ O_2 \rightarrow N_2 + 3\ H_2O$$

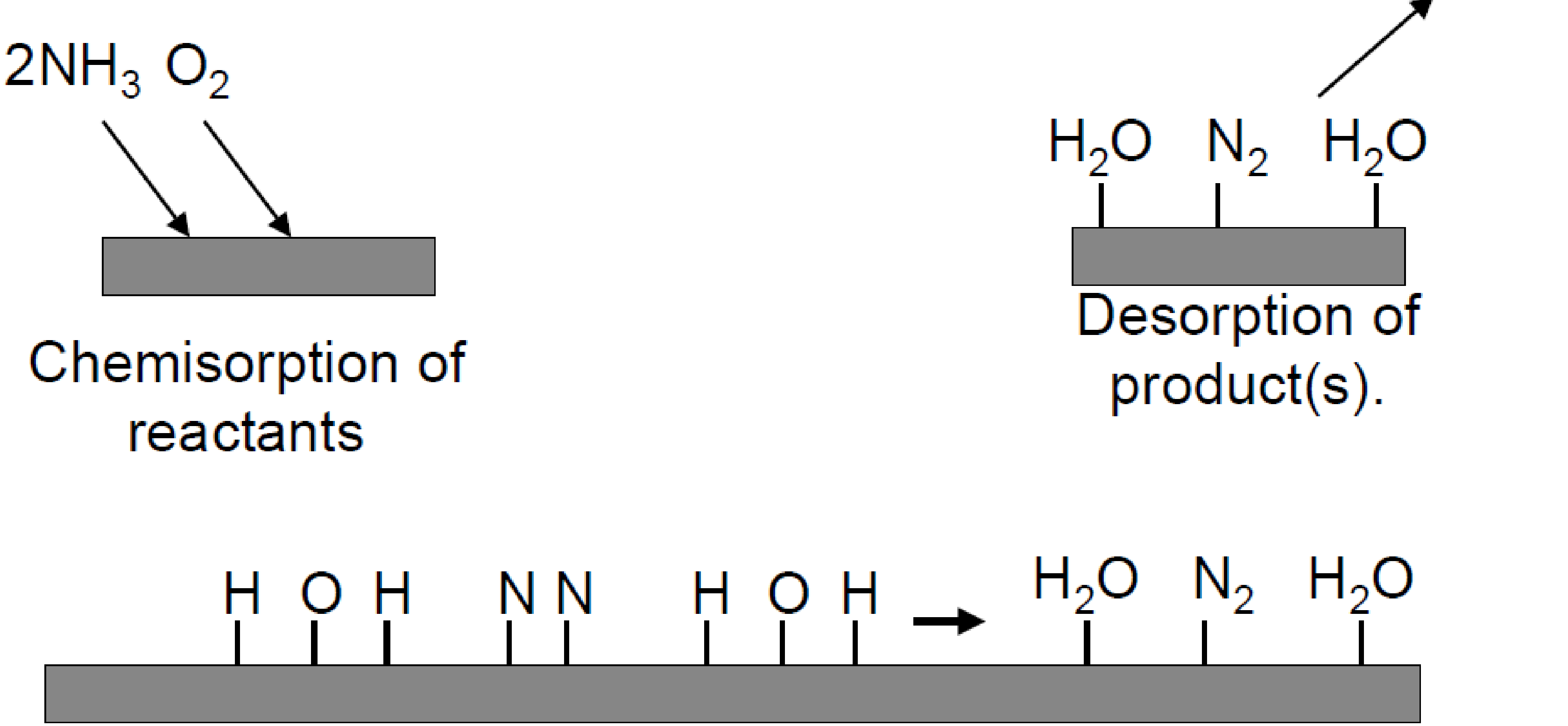
- **Oxidation of ammonia can also produce NO and NO_2.**

$$2\ NH_3 + 5/2\ O_2 \rightarrow 2\ NO + 3\ H_2O$$

$$2\ NH_3 + 7/2\ O_2 \rightarrow 2\ NO_2 + 3\ H_2O$$

Steps of Ammonia Oxidation

$$\boxed{2\ NH_3 + 3/2\ O_2 \rightarrow N_2 + 3\ H_2O}$$



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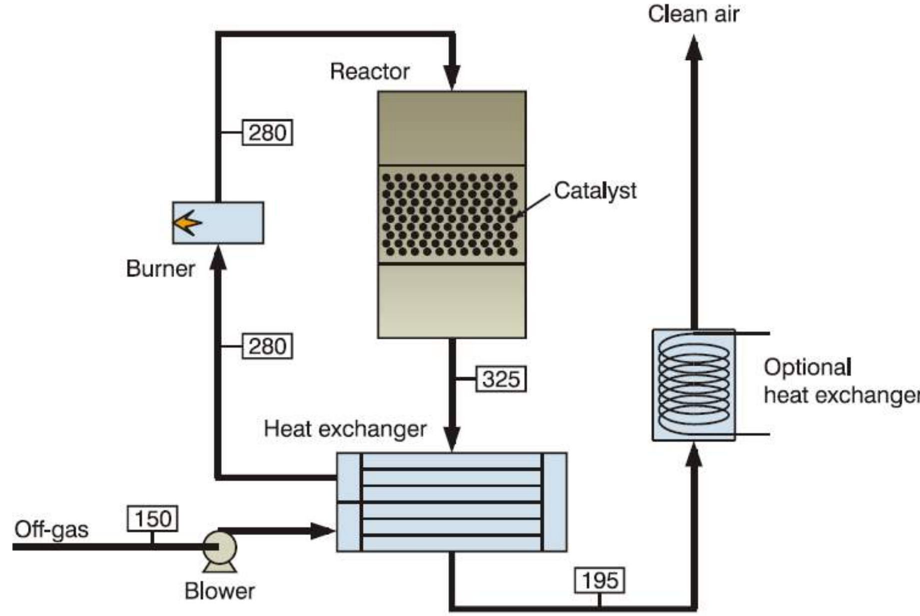
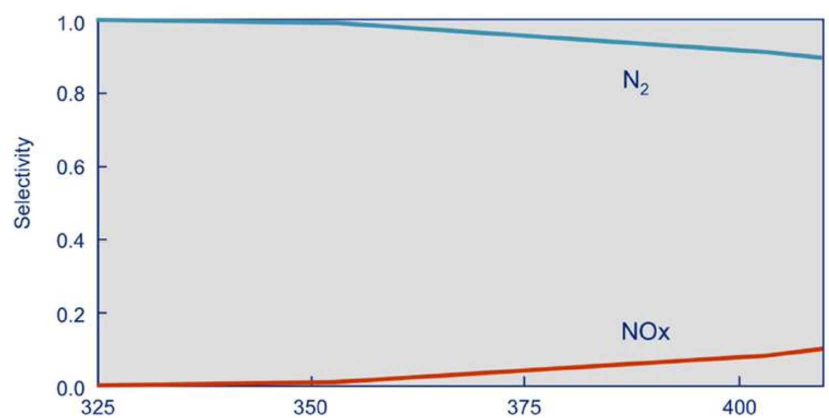
Catalytic Oxidation



Ammonia oxidation and selectivity



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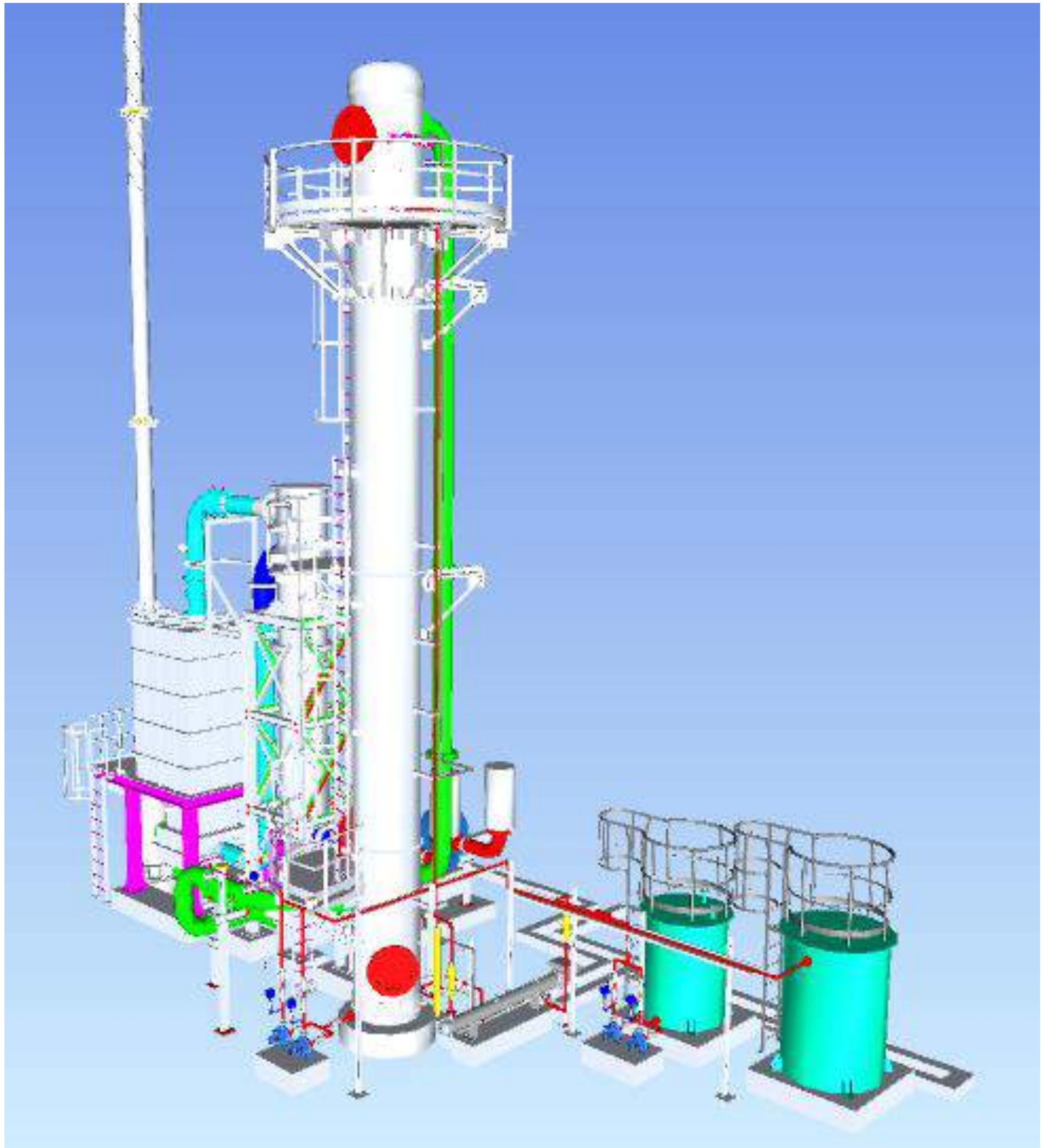

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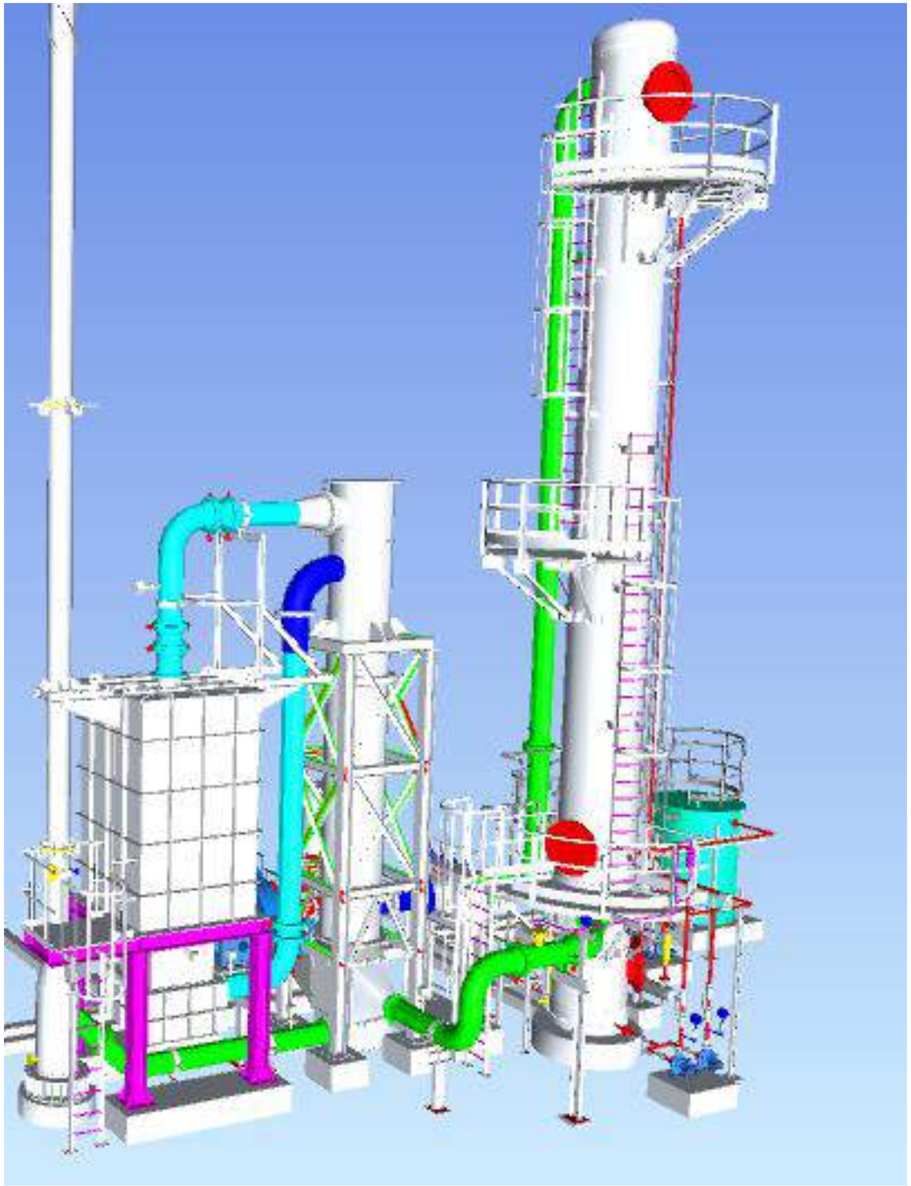

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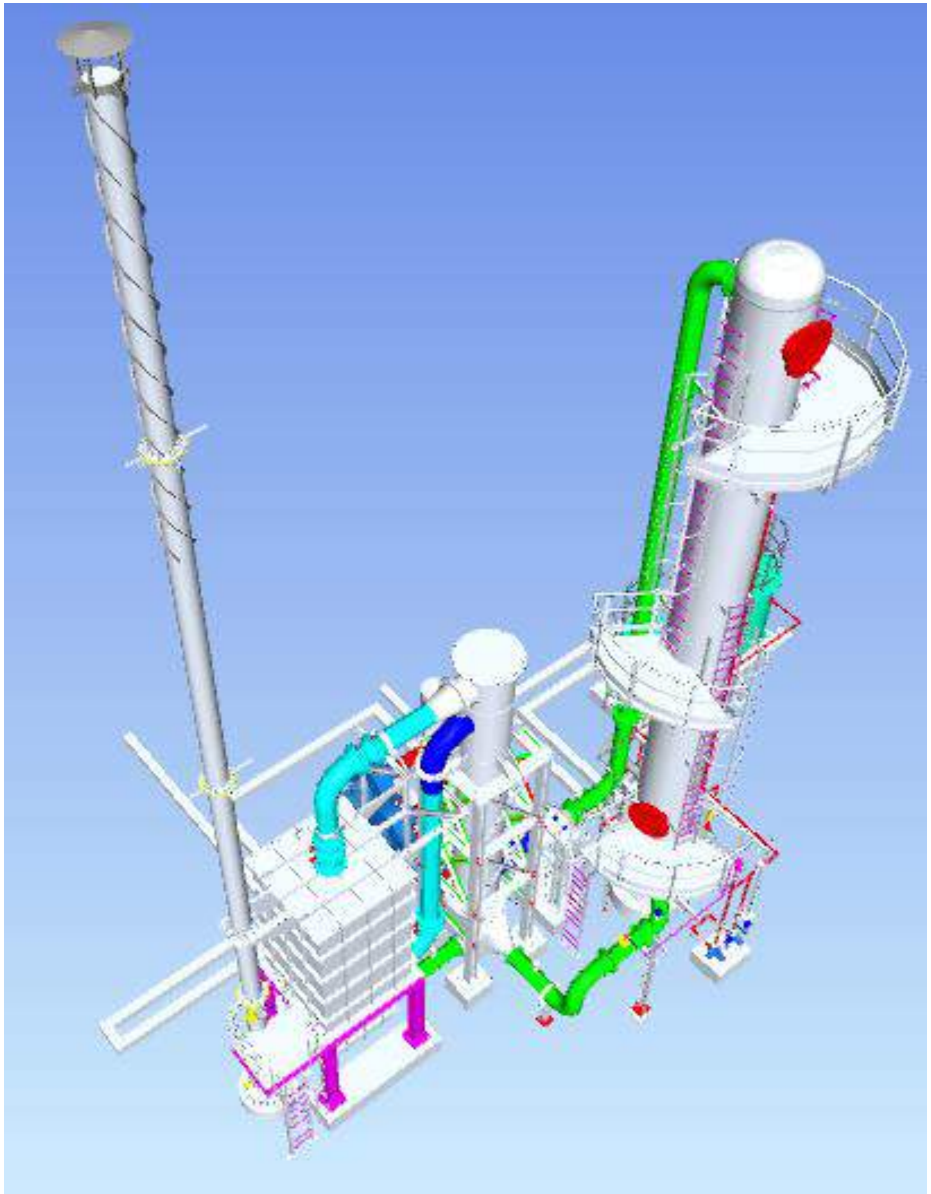

Columns Pictures



Catalytic Oxidizer Pictures

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