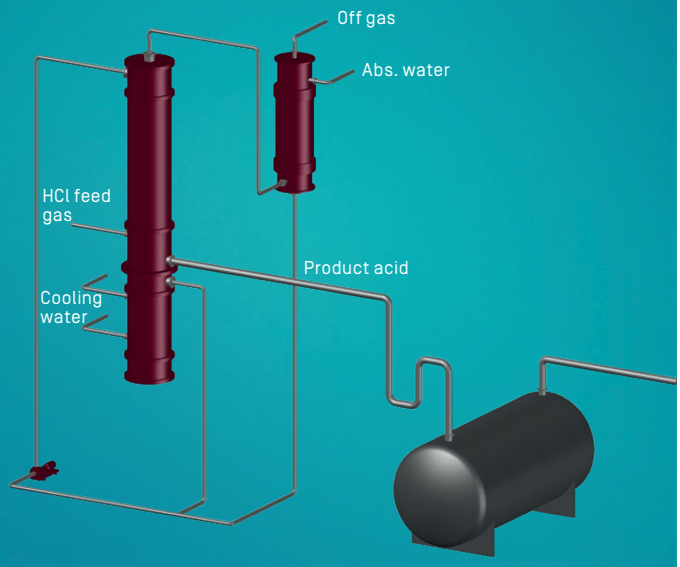
sgl carbon

Absorption of HCl gas

Process Technology – White paper

Compact system including a PTFE lined adiabatic absorption column made of POLYFLURON® that is directly flanged to a cooler made of DIABON® graphite for production of clean hydrochloric acid (33 wt.% HCl).



↑ Absorption of HCl gas containing organics and chlorine applying an external cooler

The requirements for equipment absorbing HCl (hydrogen chloride) gas from off gases are manyfold. For example, in the isocyanate and VCM industries, HCl gas streams with high HCl concentration and organic impurities need to be processed.

In contrast, exhaust gas streams from incineration units typically have high inert gas loads and contain oxidizing impurities. Emergency absorption systems, as another example, need to handle gases with rapidly changing flow rates and gas compositions.

SGL Carbon provides a broad variety of corrosion resistant equipment and process solutions for isothermal and adiabatic HCl absorption that produce pure acid with maximum concentration and clean vent gases. With our knowledge of the complexity of absorption processes, we can also troubleshoot and revamp existing units.

Even though absorption processes generate significant amounts of energy, it is often overlooked that such systems can be designed to at least partially recover the energy released during the absorption process.

Isothermal HCl gas absorption

Isothermal absorption is typically done in a co-current falling-film absorber in which both the gas and absorption liquid are fed to the top of the absorber. A falling film is formed using a special distributor section for absorbing the HCl gas.
The heat released by the absorption of HCl into the rinsing film is effectively removed via cooled graphite surfaces. At the outlet, non-absorbed gases are further processed in a downstream scrubbing system to meet the environmental regulations for HCl emissions.

Isothermal absorbers are specified for producing highly concentrated acids since the boiling point of concentrated hydrochloric acid is rather low. The availability of cooling water with low temperature further supports the economic design of isothermal absorption systems, especially for units producing very high concentrated acid. HCl absorption at low temperatures may result in impurities in the product acid, which are condensed at low temperatures.

As an alternative countercurrent falling-film absorbers may be considered for specific applications. Countercurrent flow of the absorption liquid and HCl gas supports clean off-gas and improves the mass transfer in the sections with high acid concentration. Normally an additional cooling section for the product acid is needed for this sophisticated equipment design.

Isothermal falling-film absorber systems are rather compact and therefore have a minimal space requirement. The complexity of falling-film absorbers for HCl gas is quite often underestimated by simply considering the device as a standalone standard heat exchanger with sufficient exchange area for the heat transfer.

Certainly well-designed absorption systems require not only a sophisticated equipment design but also a comprehensive understanding of all components involved in the process including heat exchanger, vent gas scrubber, layout, instrumentation and piping design.

Adiabatic HCl gas absorption

Absorbing HCl gas adiabatically in a column causes the temperature to increase. The increased temperature typically limits the acid concentration but promotes the stripping of impurities, resulting in a cleaner product acid compared to the isothermal approach. The intense contact between gas and liquid phase in the packing can also promote the conversion of impurities especially for hydrolysis reactions.

Temperature controlled adiabatic absorption columns are operated with external cooler(s) allowing the combination of the advantages of both the isothermal and adiabatic processes. Adiabatic absorption is an economic option for applications no significant temperature increase occurs, e.g. lower product acid concentrations, and should also be considered for special cases, e.g. a specific acid product quality is requested.

Emergency absorption

Processes that handle HCl gas under pressure are typically equipped with an emergency pressure relief device that releases undefined gas streams to an emergency absorber. Such absorbers typically are stand-by mode and must be ready to supply enough absorption media to absorb the released gases at any time.

For proper sizing of such emergency absorption systems, well defined scenarios need to be considered and evaluated with suitable software tools. Often, such emergency absorption units are also used as start-up devices.
Both adiabatic and isothermal absorption systems can be used for this purpose.

Heat recovery options

The heat of absorption generated in HCl absorber is considerable. Hence heat recovery options can be considered for specific applications. Options may range from the production of hot water, low pressure steam or even electricity when combined with an ORC process.

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