Metal Processing: Acid & Caustic Recovery

Metal surfaces can contain impurities that may affect whether the product is used for further processing like plating with metal or painting. In various steelmaking processes for example, the stainless steel is dipped into a vat of pickle liquor (an acid solution; typically sulfuric, hydrochloric, phosphoric, nitric or hydrofluoric acids) to descale, clean and remove impurities and to modify the surface for further treatment. The pickling bath consists of a ratio between acid and metal ions to create an even metal surface.

Aluminum (and a few other metals) on the other hand, is often etched in solutions of caustic soda (NaOH) for a matte finish prior to being anodized (anodizing is an electrochemical process that converts the metal surface into a decorative, durable and corrosion-resistant finish). Aircraft manufacturers for example, use caustic soda to chemically etch aircraft parts to a specific thickness in order to save weight.

Due to the time-consuming and labor-intensive maintenance of the pickling bath, companies are looking for ways to run the pickling process continuously by removing impurities from the pickling liquor. Membrane technology has allowed these companies to run continuous pickling baths and reduce maintenance time.

ACID & CAUSTIC PICKLING BATH CHARACTERISTICS

The acid pickling bath used for stainless steel is typically a mixture of 150 g/L nitric acid (HNO_3) and 50 g/L hydrofluoric acid (HF). The temperature for this process is typically set between 25 and 40°C (77 and 104°F) and the pH is below zero. In some cases, sulfuric acid (H_2SO_4) or hydrogen peroxide (H_2O_2) may be used.

Unalloyed steel is typically processed using sulfuric or hydrochloric (HCl) acid pickling baths, also with a temperature between 25 and 40°C (77 and 104°F) and pH below zero.

Caustic soda (NaOH) is mainly used for the caustic pickling or etching of aluminum. Due to the chemical etching, sodium aluminate ($NaAlO_2$) dissolves in the sodium hydroxide solution. The process temperature of chemical etching is commonly done at 80°C (176°F).

ACID & CAUSTIC RECOVERY PROCESS & PARAMETERS

The concentration of suspended solids and heavy metal ions increases in the bath throughout the pickling process. The increasing presence of solids and heavy metal ions quickly decreases the pickling liquor's efficacy and pickling speed. By removing the solids and heavy metals from the bath in a two-step membrane filtration process, the pickling speed may be stabilized, improving the economics and the lifetime of the bath.

The spent pickling liquor is processed in two filtration cycles. Microfiltration (MF) is used in the first step to treat and remove particles and oils from the pickling liquor. The filtrate from the MF step is then fed to a nanofiltration (NF) system to further treat the spent pickling liquor. The filtrate of the NF step is recycled back to the pickling bath and the concentrate is disposed.

Pickling of Steel (Acid Solution)

1. SEPRODYN® tubular microfiltration modules may be used to retain solids, oils and silica. This stage is primarily used to remove any suspended particles that may damage the NF elements in the second stage of the filtration process. The solution should be cooled down to at least 60°C (140°F). These modules can handle pH 0-14.
2. SPIRA-CEL® OY NP030 nanofiltration elements may be used in the second stage of the filtration process. The maximum process temperature is 80°C (176°F). These elements can handle pH 0-12.

MANN+HUMMEL

Pickling of Aluminum (Caustic Solution)

1. SEPRODYN® tubular microfiltration modules may be used to retain solids, oils and silica. This stage is primarily used to remove any suspended particles that may damage the NF elements in the second stage of the filtration process. The solution should be cooled down to at least 60°C (140°F). These modules can handle pH 0-14.
2. SPIRA-CEL® OX NP030 nanofiltration elements may be used in the second stage of this filtration process. The maximum process temperature is 80°C (176°F). These elements can handle pH 2-14.

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