Where Different Grades of Stainless Steel Are Used

ACIDS

Hydrochloric acid: Stainless generally is not recommended except when solutions are very dilute and at room temperature.

"Mixed acids": There is usually no appreciable attack on Type 304 or 316 as long as sufficient nitric acid is present.

Nitric acid: Type 304L or 430 is used.

Phosphoric acid: Type 304 is satisfactory for storing cold phosphoric acid up to 85% and for handling concentrations up to 5% in some unit processes of manufacture. Type 316 is more resistant and is generally used for storing and manufacture if the fluorine content is not too high. Type 317 is somewhat more resistant than Type 316. At concentrations up to 85%, the metal temperature should not exceed 212 F (100 C) with Type 316 and slightly higher with Type 317. Oxidizing ions inhibit attack and other inhibitors such as arsenic may be added.

Sulfuric acid: Type 304 can be used at room temperature for concentrations over 80%. Type 316 can be used in contact with sulfuric acid up to 10% at temperatures up to 120 F (50 C) if the solutions are aerated; the attack is greater in airfree solutions. Type 317 may be used at temperatures as high as 150 F (65 C) with up to 5% concentration. The presence of other materials may markedly change the corrosion rate. As little as 500 to 2000 ppm of cupric ions make it possible to use Type 304 in hot solutions of moderate concentration. Other additives may have the opposite effect.

Sulfurous acid: Type 304 may be subject to pitting, particularly if some sulfuric acid is present. Type 316 is usable at moderate concentrations and temperatures.

BASES

Ammonium hydroxide, sodium hydroxide, caustic solutions : Steels in the 300 series generally have good corrosion-resistance at virtually all concentrations and temperatures in weak bases, such as ammonium hydroxide. In stronger bases, such as sodium hydroxide, there may be some attack, cracking or etching in more concentrated solutions and at higher temperatures. Commercial purity caustic solutions may contain chlorides, which will accentuate any attack and may cause pitting of Type 316 as well Type 304.

ORGANICS

Acetic acid: Acetic acid is seldom pure in chemical plants but generally includes numerous and varied minor constituents. Type 304 is used for a wide variety of equipment including stills, base heaters, holding tanks, heat exchangers, pipelines, valves and pumps for concentrations up to 99% at temperatures up to about 120 F (50 C). Type 304 is also satisfactory for contact with 100% acetic acid vapors, and-if small amounts of turbidity or color pickup can be tolerated for room temperature storage of glacial acetic acid. Types 316 and 317 have the broadest range of usefulness, especially if formic acid is also present or if solutions are unaerated. Type 316 is used for fractionating equipment, for 30 to 99% concentrations where Type 304 cannot be used, for storage vessels, pumps and process equipment handling glacial acetic acid, which would be dis-colored by Type 304. Type 316 is likewise applicable for parts having temperatures above 120 F (50 C), for dilute vapors and high pressures. Type 317 has somewhat greater corrosion resistance than Type 316 under severely corrosive conditions. None of the stainless steels has adequate corrosion resistance to glacial acetic acid at the boiling temperature or at superheated vapor temperatures.

Aldehydes: Type 304 is generally satisfactory.

Amines: Type 316 is usually preferred to Type 304.

Cellulose acetate: Type 304 is satisfactory for low temperatures, but Type 316 or Type 317 is needed for high temperatures.

Citric, formic and tartaric acids: Type 304 is generally acceptable at moderate temperatures, - but Type 316 is resistant to all concentrations at temperatures up to boiling.

Esters: From the corrosion standpoint, esters are comparable with organic acids.

Fatty acids: Up to about 300 F (150 C), Type 304 is resistant to fats and fatty acids, but Type 316 is needed at 300 to 500 F (150 to 260 C) and Type 317 at higher temperatures.

Paint vehicles: Type 316 may be needed if exact color and lack of contamination are important.

Phthalic anhydride: Type 316 is usually used for reactors, fractionating columns, traps, baffles, caps and piping.

Soaps: Type 304 is used for parts such as spray towers, but Type 316 may be preferred for spray nozzles and flake-drying belts to minimize off color product.

Synthetic detergents: Type 316 is used for preheat, piping, pumps and reactors in catalytic hydrogenation of fatty acids to give salts of sulfonated high molecular alcohols.

Tall oil (pulp and paper industry): Type 304 has only limited usage in tall-oil distillation service. High-rosin-acid streams can be handled by Type 316L with a minimum molybdenum content of 2.75%. Type 316 can also be used in the more corrosive high-fatty-acid streams at temperatures up to 475(245 C), but Type 317 will probably be required at higher temperatures.

Tar: Tar distillation equipment is almost all Type 316 because coal tar has a high chloride content; Type 304 does not have adequate resistance to pitting.

Urea: Type 316L is generally required.

Pharmaceuticals : Type 316 is usually selected for all parts in contact with the product because of its inherent corrosion resistance and greater assurance of product purity.

Source: Design Guidelines for the selection and use of stainless steel. Specialty Steel Industry of the United States.