

NICKEL IN PROCESS ENGINEERING

Stainless steels, nickel alloys and other nickel-containing alloys are essential in the chemical, pharmaceutical and petrochemical industries. When selected carefully, for their specific properties, they provide excellent performance in the most demanding conditions.

Corrosion resistance in aqueous, gaseous and high-temperature environments, mechanical properties at extreme temperatures and special physical properties make them invaluable in the most demanding environments. Nickel plating is favoured for specific properties such as hardness and corrosion resistance. And nickel-containing materials are often used as catalysts.

THE SAFE AND COST-EFFICIENT PRODUCTION OF PHARMACEUTICAL COMPOUNDS, FERTILIZERS, PLASTICS, PETROCHEMICALS AND A HOST OF OTHER GOODS RELY ON STAINLESS STEEL AND NICKEL ALLOYS.



Oil and Gas

Nickel-containing materials are widely used to meet the demanding conditions of the oil and gas industries and power generation, including renewable energy.

Though oil itself is not corrosive, its production takes place in highly-corrosive environments. Nickel-containing alloys are essential for providing the long-term corrosion resistance needed in many components exposed to oil and gas production environments. Common components relying on nickel-containing alloys include downhole tubing and safety critical elements, wellhead and Christmas tree components and valves, pipelines, piping, vessels and heat exchangers.

Chemicals and Petrochemicals

The chemical and petrochemical industries pose a unique set of challenges, including cryogenic applications, elevated temperatures, highly corrosive environments, high-pressure handling and the required purity of final products. Stainless steels and nickel alloys have been widely embraced by the chemical

and petrochemical industries because of their ability to withstand highly-corrosive substances over a wide range of temperatures, as well as their impressive mechanical characteristics help to drive high levels of demand.

Pharmaceutical

For all forms of medicine manufacturing, the safety, purity and potency of the products is essential. There are many elements that have to work together to achieve this.

Nickel-containing stainless steel provides machinery and tubing surfaces that are smooth, easy to clean and sanitise and, if necessary, to decontaminate. These surfaces have to be resistant to wear and erosion through contact with ingredients that can be abrasive and aggressive due to their chemical compositions.

For each application materials must be selected on the basis of their corrosion resistance in a specific service environment. Selecting a suitable grade of stainless steel must also consider the cleaning regime and cleansing agents used in the plant.

Appropriate materials

Type 304L (UNS S30400) and Type 316L (UNS S31600) are commonly-used grades. Type 304L is deployed in cryogenic, caustic and oxidizing acid environments. It is suitable for 'non-contact applications' in the pharmaceutical sector. The addition of molybdenum in Type 316L provides superior resistance to chlorides and reducing acids relative to Type 304L. Its enhanced corrosion resistance makes it ideal for 'product contact' applications in the food and pharmaceutical sectors.

In conditions where chlorides exceed the resistance to pitting corrosion of Type 316L, or extreme temperatures promote chloride stress-corrosion cracking, duplex stainless steel such as Type 2205 (UNS S32205), super austenitics (UNS S31254 and UNS N08367) or super duplexes such as Type 2507 (UNS S32750) and Zeron® 100 (UNS S32760), can provide useful resistance.

In intensively corrosive conditions, several types of nickel alloys can be employed. Alloy C-276 (UNS N10276) is the best known, and its derivatives, including UNS N06622, N06059, N06200 and N06686, have been specifically developed to offer increased resistance in specific environments.

SULPHURIC ACID PRODUCTION

Sulphuric acid is produced in larger volumes than any other chemical in the world.

Sulphur is naturally present in all oil and gas deposits, and so, as a result, combustion of these fossil fuels produces sulphur dioxide gas. When this gas is emitted, it reacts in the atmosphere to produce acid rain. In the 1980s, governments started regulating sulphur dioxide emissions. Since then, industry has responded by installing technology made with nickel-containing stainless steel to recover the sulphur during the combustion process, using it to produce sulphuric acid.

The corrosion-resisting properties of nickel-containing stainless steel, particularly at high acid concentrations and high temperatures, makes it essential for the piping, storage and cooling tanks required in this important chemical process. Thanks in part to nickel, sulphur recycling now produces 70% of all sulphur used. And most importantly, emissions of sulphur dioxide have been halved.



COMMON NICKEL-CONTAINING ALLOYS FOR DEMANDING ENVIRONMENTS

Alloy Type	UNS	%Cr	%Ni	%Mo	%Cu	%Fe	
304/304L	S30403	18	8	-	-	bal	Most common stainless steel used for potable water treatment and food contact.
316/316L	S31603	16	10	2.1	-	bal	Addition of Mo provides greater resistance to chlorides and acidic solutions. Used in coastal regions, in water treatment and in the chemical processing industry.
2205	S32205	22	5.7	3.1	-	bal	Even greater corrosion resistance than 316L. Can be used in place of 316L, but its greater strength can mean weight reduction. May be substituted for 316L if it fails in service.
2507	S32750	25	7	4	-	bal	Even greater corrosion resistance than 2205. Useful corrosion resistance to seawater.
Zeron® 100	S32760	25	7	3.5	0.7	bal	
254 SMO®	S31254	20	18	6.1	-	bal	Corrosion resistance similar to 2507, also possessing useful corrosion resistance to seawater.
AL-6XN®	N08367	21	24	6.1	-	bal	
Alloy 20	N08020	20	33	2.1	3.2	bal	Cu bearing stainless steel with useful corrosion resistance to all concentrations of sulphuric acid.
310S	S31008	25	20	-	-	bal	High chromium stainless steel with excellent resistance to high-temperature oxidation.
800H	N08810	20	32	-	-	bal	Stainless steel with excellent high-temperature strength and useful resistance to high-temperature oxidation.
625	N06625	21	bal	9	-	3	Well-known nickel alloy with excellent high-temperature strength and outstanding aqueous corrosion resistance.
C-276	N10276	15	bal	16	-	5	One of the best-known nickel alloys with excellent corrosion resistance to reducing acids.
600	N06600	16	76	-	-	8	Useful resistance to high-temperature corrosion and caustic solutions.
Alloy 400	N04400	-	65	-	32	-	Most common uses are in marine and chemical processing.