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FERTILISER PRODUCTION

Corrosion Resistant Nickel Alloys

There are many types of primary and compound fertilisers. Primary fertilisers include substances derived from nitrogen, phosphorous and potassium and the extraction process results in aggressively corrosive environments which require the use of nickel-based alloys for production equipment.

Potassium chloride is a primary component of caustic potash. For resistance to caustic corrosion the nickel content of the material is critical. Hence the commercially pure **Nickel 200 and 201** grades are often used and are the best metals for resisting caustic corrosion. **Nickel 201** is a carbon-controlled version of 200 for use at temperatures above 315 °C. **Alloy 400** and **Alloy 600** have high nickel contents and so provide good caustic corrosion resistance and also offer higher strength than Nickel 200/201.

Production of the phosphorous fertiliser component involves the use of both sulphuric and phosphoric acids. Sulphuric acid is one of the most important industrial chemicals. The most common nickel alloys used in sulphuric acid service are the Ni-Cr-Mo and Ni-Mo alloys. At low temperatures and concentrations **Alloy 400, Alloy 825** and **Alloy 625** find application. **Alloy C–276**, a Ni-Cr-Mo alloy, is used in the most aggressive environments (concentrated acid at elevated temperatures) and can be used for pipes, vessels, valves, pumps and structural components. The most commonly used nickel alloy in processes containing pure phosphoric acid is **Alloy 825**. Commercial phosphoric acid, however, usually contains impurities such as fluorides and chlorides that increase its corrosivity. In impure phosphoric acid Alloy 600 can be used at room temperature in all concentrations. In moderate to severe environments **Alloy 625** is often selected and as with sulphuric acid production for the most aggressive, hot phosphoric acid environments the highly alloyed **Alloy C–276** is utilised.

Metal dusting failures have been reported in ammonia and fertilizer plants also in methanol reforming plants and in other industries such as refining and heat treating where carbon-rich process gases are cooled through the temperature range 400-800 °C. This is usually a localised form of attack which is very rapid and unpredictable. Alloys which form a protective alumina scale, such as **Alloy 601**, offer resistance to this type of attack. The alloy also has good mechanical properties at elevated temperatures.

Alloy Properties

	Composition (%)	Key attributes
Nickel 200/201 N02200 2.4060	99.6Ni	Outstanding resistance to caustic environments. 201 used at temperatures above 315°C
Alloy 400 N04400 2.4360	65Ni – 32Cu – 1.6Fe	High strength, excellent corrosion resistance in a range of media including alkalis/caustic solutions and sulphuric acid
Alloy 600 N06600 2.4816	76Ni – 15Cr – 8Fe	Good high temperature strength, resistant to caustic and also phosphoric acid up to 85% concentration at room temperature
Alloy 601 N06601 2.4851	60Ni – 23CR – 14Fe – 1.4 Al	Addition of aluminium for enhanced resistance to carburisation and oxidation. High mechanical properties at elevated temperatures
Alloy 625 N06625 2.4856	61Ni – 21Cr – 2Fe – 9Mo – 3Nb	Resistant to pitting and crevice corrosion in severe environments with high strength up to 815 °C
Alloy 800H / 800HT N08810/N08811 1.4876/1.4959	32Ni – 21Cr – 46Fe – C controlled	A high strength, corrosion resistant alloy with resistance to oxidation, carburisation and high temperature creep
Alloy 825 N08825 2.4856	42Ni – 21Cr – 28 – 3Mo – 0.6Ti	Excellent resistance to sulphuric and phosphoric acids, stress corrosion cracking and pitting
Alloy C-276 N10276 2.4819	57Ni – 16Cr – 5Fe – 16Mo- 4W	Excellent resistance to sulphuric and phosphoric acid – used in hot, aggressive environments