Upgrade for a super alloy

Alloy 718 is a high-strength nickel-based super alloy resistant to corrosion, high pressure and extreme temperatures, up to 650°C. For many years, this material has been the best selling nickel alloy worldwide. With VDM® Alloy 718 CTP and powder variants of VDM® Alloy 718 and VDM® Alloy 718 CTP, the High Performance Alloys division of Acerinox has launched some additional innovative solutions aiming to continue this extraordinary success story.

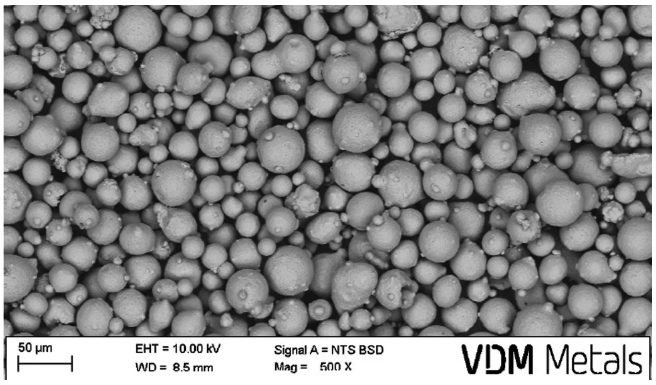
Alloy 718 (UNS N07718) is an age hardenable nickel-chromium-iron-molybdenum alloy. Age hardening is achieved by specific additions of niobium, titanium and aluminium. The sophisticated melting process usually involves two steps: the material is melted under vacuum and afterwards remelted – twice for some aerospace applications.

According to recent market research, the annual demand for Alloy 718 exceeded more than 70 thousand tons prior to the pandemic. This means that the market share of the alloy is more than 20 percent compared to the annual global nickel alloy consumption. The alloy was patented in 1962 by an American company. Today, the alloy is mainly used in two application fields: aircraft turbine engineering and oil and gas exploration – based on its high-temperature resistance up to 650°C, its excellent oxidation and corrosion resistance, and its good workability.

The High Performance Alloys division of Acerinox distributes the material under the brand name VDM® Alloy 718. VDM® Alloy 718 has austenitic microstructure; multiple phases can be precipitated. By means of different heat treatments, graduated mechanical properties of the material can be reached. The excellent mechanical properties of VDM® Alloy 718 result from combination of delta, gamma' and gamma''-formation during the complex heat treatments: solution annealing and precipitation hardening.

Forging of VDM® Alloy bars at VDM Metals site in Unna

Micrograph of VDM®Powder 718



Based on the high chromium and molybdenum concentrations, VDM® Alloy 718 has a good resistance against abrasive and local corrosion such as pitting in many media. By virtue of its high nickel content, VDM® Alloy 718 also features good resistance against stress corrosion cracking.

The alloy was developed and is still used for static and rotating components in aircraft turbines such as housings, mounting elements and turbine disks, where tough requirements apply for creep resistance and fatigue behaviour, in particular for the rotating applications. Virtually no aircraft would fly without Alloy 718.

Due to its advantageous properties, its good workability and efficiency, the material is additionally widely used for static and rotating components in stationary gas turbines, rocket drives, motor vehicle turbo chargers, high-strength screws, springs and mounting elements, and for heat-resistant tools in forgeries, extruders and separating shearers.

The properties of most interest for the oil and gas industry include the overall corrosion resistance, high strength and toughness, resistance against hydrogen embrittlement and stress corrosion cracking. Since the material can be heat-treated according to API or NACE MR specifications to the required strength levels, it is widely used in downhole and surface components.

Ni	Cr	Fe	Mo	Nb	Ti	Al	C
54	19	Balance	3	5.3	1	0.5	≤0.08

Tabla 1: Typical chemical composition; C max. according to ASTM

Good workability

Besides specific material features, the workability of an alloy is always a crucial factor for many of VDM Metals' customers. This is why VDM Metals always keeps an eye on processing characteristics and weldability. Recently, German pipes and components manufacturer BUTTING produced welded pipes made of VDM® Alloy 718 on behalf of VDM Metals.

"We carried out a number of important test procedures on test specimens prior to production of the pipes in pipe size 6" Sch 80S (168.3 x 10.97 mm) and extensively tested the material with regard to forming and heat treatment", explains Tobias Krebiel, Head of Sales Special Pipes at BUTTING.

Welding tests were conducted using Plasma and TIG arc welding processes, using a welding filler metal of the same type. Test specimens were then subjected to a multi-stage heat treatment. This showed that the material VDM® Alloy 718 is easy to process in the solution-annealed state. The non-destructive testing of the joining area by means of visual, dye penetration and radiographic examination confirmed the good weldability.

"The achievable strength properties in the weld area are at a high level and are comparable to those of the parent metal. This means there was nothing preventing us from manufacturing BUTTING pipes using VDM® Alloy 718", sums up Stefan Bartholomäus, Welding Supervisor at BUTTING.

VDM® Alloy 718 CTP for the most demanding oil and gas applications

The material demands in both main applications fields are high – as the related processes take place in very corrosive atmospheres and reliably maintaining mechanical strength over long time periods is absolutely crucial for the materials used. During the past years, VDM Metals developed an additional variant of Alloy 718, called VDM® Alloy 718 CTP, CTP is an abbreviation for Corrosion, Temperature and Pressure, since this grade is particularly designed for the ever more demanding requirements of the oil and gas industry.

VDM® Alloy 718 CTP is characterized by limited levels of carbon and niobium. The purpose of this limitation is to optimise structure and mechanical properties with regard to the intended use, e.g. as pump shafts in electrical submerged pumps for oil and gas production. Even under harsh conditions, the respective components must ensure an efficient and safe oil and gas extraction. With increasing drilling hole depth, pressures and temperatures become ever more critical, and materials must withstand the sour gas environment (H_2S, CO_2, and high chlorides) that is prevalent there. VDM® Alloy 718 CTP has a minimum yield strength of 120 ksi. Further variants are available with minimum yield strengths of up to 150 ksi, which recently have been added to the respective industry standards.

Test in VDM Metals[1] Welding Centre of Excellence

Powder to complete the product range

Besides conventionally manufactured flat and long products, VDM Metals offers its alloys as powders for the use in additive manufacturing processes. VDM® Powder 718 and VDM® Powder 718 CTP are characterized by spherical particles with low level of satellites, high purity and reproducibility level, low oxygen content, small amounts of porosity and good flowability, high apparent and tap density. The materials are aimed at powder -and wire-based Additive Manufacturing applications. This means that they could be used for a wide range of process possibilities, based on better segregation behaviour during the building process, and offer reduced cracking.

According to the requirements of powder based processes, the materials are available in a wide range of particle fractions from 15 to 250 µm. The typical powder atomization yield ranges from 0.1 to 300 µm. After atomization, the powder is sieved and air classified according to customers specifications.