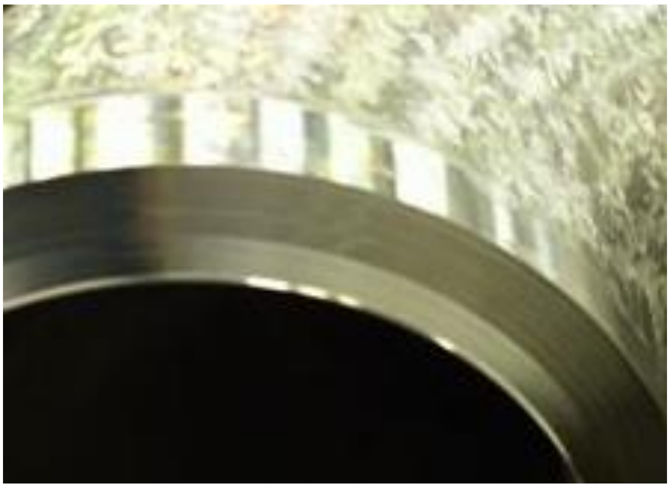
# Technical Bulletin

VECOM

## Pickling Stainless Steel 316 for nuclear applications

Volgnummer: 2010/07



**Introduction**

Stainless steel (SS) has a very broad field of application within industry due to its corrosion-resistant properties. The nuclear energy sector makes a lot of use of stainless steel. There are approximately 480 nuclear power plants that take care of 15% of our total electricity needs on a global scale.

A lot of heat is released under high pressure when producing electricity that is fed through the production system. This technical bulletin discusses in greater depth the pickling of SS 316 pipe sections for the Qinshan Nuclear Power Plant in China.

**The basics of nuclear energy**

To obtain electrical energy, nuclear energy is converted into electricity by using a generator in a nuclear power plant. This process starts in the reactor vessel. Using enriched uranium as fuel, a very high (supercritical) temperature is generated through nuclear fission. This temperature ensures that water can be heated in the reactor. This water is lead through the 'hot leg' from the reactor to the steam generator after heating where steam is generated from another water system without there being direct contact. Due to the fact that water heated up in the reactor comes into direct contact with the enriched uranium (and, therefore, becomes radioactively contaminated), we refer to this as the 'primary loop'.

As already indicated, steam is generated in the steam generator that is under high pressure and that serves as the driving force of a turbine. When the turbine rotates, we arrive at the last step of the production process, that is, the generation of electrical energy or, rather, a current. A generator is linked to the turbine in which an electricity conductor rotates within a magnetic field. According to Faraday's law, an electric field is generated from the magnetic field due to this movement and, therefore, electrical energy is generated.

The fundamental difference between a nuclear power plant and a conventional (coal or gas) power plant only resides in the drive of the turbine with which the generator is driven. The generator itself does not really differ in either method. The above is shown schematically in Figure 1.

**The primary loop of the Qinshan Nuclear Power Plant**

China has been investing heavily in nuclear energy the last few years to ensure it can meet the growing energy need. Currently, there are 11 reactors with a total capacity of more than 9000 MW distributed over 4 sites. One of these sites is the Qinshan Nuclear Power Plant (QNPP) that is currently still being built in the eastern part of China. 5 reactors are now operational at this site.

Recently, our customer Fabricom GDF Suez was granted the contract to build the pipe section of the primary loop for one of the new reactors. This system consists of 20 SS 316 pipe sections with a diameter of 1000 mm, a length of +/- 7500 mm and a wall thickness of no less than 91 mm. Such wall thicknesses are required due to

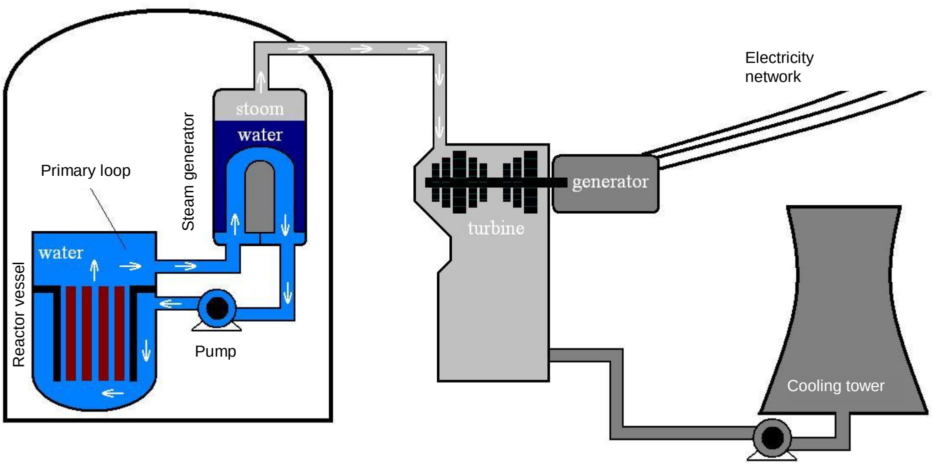



**Fig. 1**: Schematic representation of a nuclear power plant

**Fig. 2**: Qinshan Nuclear Power Plant

safety considerations as a consequence of the operating pressure of 200 bar with which the heated water is pumped through the system.

**Pickling the primary loop**

Due to the corrosion-resisting properties of SS 316, the decision was taken to manufacture the pipe sections from this steel. Although the corrosion resistance of this material is high due to it having higher molybdenum content, the protective chromium oxide skin is, however, damaged by welding, grinding and drilling work. Moreover, stainless steel is also contaminated with a compensating iron contaminant in most cases during the construction phase. Vecom Metal Treatment in Enschede has been given the contract to pickle and passivating the full pipe network before installation to restore the original corrosion resistance of the 316 material and, therefore, also to help guarantee the safety of the nuclear power plant. The pickling shop in Enschede is excellently set up to execute this contract in accordance with the quality specifications due to its clean workshop and large pickling baths.

This pickling process includes the following steps:

1) Degreasing.
   Degreasing takes place first to ensure that the pickling liquid can penetrate everywhere on the surface.
2) High-pressure spraying.
3) Pickling through submersion in Vecinox Pickling Liquid.
   This pickling liquid dissolves the old chromium oxide skin with all its contaminants (welding oxides, mill scaling, compensating iron, etc.).
4) High-pressure spraying.
5) Passivating chemically through submersion in Vecinox Passivating Liquid. This process step ensures that a new, hermetically closed chromium oxide skin forms after the pickling liquids have been rinsed off.
6) Drying.
7) Inspection through a dry wipe test and oxilyser.
   The wipe test is a method to test the purity of the surface. A clean, lint-free cloth is used to wipe the surface to be checked. Next, the cloth is inspected visually for contaminants. The oxyliser is a device which measures the passivity of a stainless steel surface. The operation of the oxilyser and other measuring methods are extensively discussed in our Technical Bulletin - number 2010/03.
8) Packaging and shipment.
   The pipes are fully packaged to ensure that the new chromium oxide skin is fully protected against being contaminated during shipment. They are, next, prepared for shipping to China on wooden frames that have been especially made for this purpose.

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**Fig. 3**: SS 316 pipe section after pickling treatment. You can clearly see the 91 mm wall thickness on this photo.