

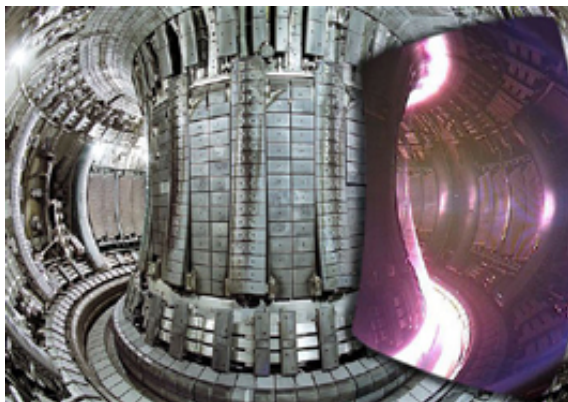
50 GRADES OF STAINLESS STEEL



The BSSA has selected 50 Grades of Stainless Steel as its theme for 2014. Each week throughout the year, we will showcase one grade and illustrate the variety of corrosion resistant, mechanical and physical properties which determine its suitability for a wide range of applications.

#39

**316L plus Mo 317L 316LN 317LMN
1.4432/1.4435/1.4438/1.4429/1.4439**



316LN Nuclear Fusion Research



Pulp and Paper Plant

Taking 316L (1.4404) as a basis, it is possible to construct a series of grades by adding molybdenum and nitrogen for increased corrosion resistance and nickel for achieving the correct austenitic balance. Other properties, notably magnetic permeability are also affected.

Approximate Compositions:

EN Grade	Common Grade	UNS	C	Cr	Mo	Ni	N
1.4404	316L	S31603	0.030	17.0	2.0	10.0	0.04
1.4432	316L + Mo	S31603	0.030	17.0	2.5	10.5	0.04
1.4435	316L + Mo + Ni	S31603	0.030	17.5	2.5	13.0	0.04
1.4429	316LN	S31653	0.030	17.0	2.5	11.0	0.15
1.4438	317L	S31703	0.030	18.0	3.0	13.0	0.04
1.4439	317LMN	S31726	0.030	17.0	4.0	13.0	0.15

These grades combine the following characteristics:

- Increasing pitting and crevice corrosion resistance. PREN up to 34 for 1.4439

- Increasing stress corrosion cracking resistance
- Increasing strength due to increased alloy content especially nitrogen. 0.2% PS of 290 MPa for 1.4439 compared to 240 MPa for 1.4404
- High nitrogen grades like 1.4429 have very low magnetic permeability
- Increasing tendency for sigma phase formation at elevated temperatures
- Increasing difficulty in hot and cold rolling
- Increased difficulty in forming
- Increasing care required in welding

These grades show the significant effect of adding molybdenum and nitrogen to increase the corrosion resistance of austenitic stainless steels. This effect is measured by the pitting resistance equivalent (PREN):

$$\text{PREN} = \%Cr + 3.3x\%Mo + 16x\%N$$

This series of grades spans a range of 23-34 from 1.4404 to 1.4439. The top end is about the same as the 2205 duplex grade 1.4462.

As the Cr and Mo contents increase, the Ni content has to increase to maintain the correct amount of austenite in the steel. In one special case, the grade 1.4435 has an even higher nickel content than the minimum specified at about 14%. This guarantees a maximum ferrite content of 0.5% which is vital in certain chemical and pharmaceutical processes.

The increased alloy content, in particular nitrogen, reduces the tendency for magnetic martensite to form on cold working and/or sub-zero temperatures. Grades such as 1.4429 are therefore used for low magnetic permeability applications notably in nuclear fusion research.

Applications which illustrate these features include:

Chemical, pharmaceutical, oil and gas, nuclear fusion, cryogenics, surgical implants.

[Find out more about the 50 Grades of Stainless Steel campaign](#) →

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