Calculating the Pitting Resistance Equivalent Numbers (PREN)

Please Note:
The formal used by Novametal to calculate a Pitting Resistance Equivalent Number is:
PREN = Cr + 3.3Mo + 16N

Novametal Slickline Products

Grade	Supernova 750	Supernova 700	Supernova 400	Supernova 316	Zeron 100
PREN	46 - 46	42 - 46	31.65 - 37	23.5 - 27	>41

What is a PREN

Pitting resistance equivalent numbers (PREN) are a theoretical way of comparing the pitting corrosion resistance of various types of stainless steels and are based on the chemical compositions and are useful for ranking and comparing the different stainless steel grades.

Actual or specified range compositions can be used and usually involve chromium, molybdenum and nitrogen in the calculations. Tungsten also appears in some versions of the calculation.

It should be noted that it is important to know the formula or formulae being used, in particular the weight being applied to each Alloying Element when more than one PREN is being compared.

They cannot be used to predict whether a particular grade will be suitable for a given application, where pitting corrosion may be a hazard.

If you require a material selection recommendation please get in touch.

The Effect of Alloying Elements on Pitting Resistance

These are 'linear' formulas, where the molybdenum and nitrogen levels are 'weighted' to take account of their strong influence on pitting corrosion resistance.

They typically take the form: **PREN = Cr + m Mo + N**, where 'm' and 'n' are the factors for molybdenum and nitrogen.

The most commonly used version of the formula is **PREN = Cr + 3.3Mo + 16N**

Some formulas weight nitrogen more, with factors of 27 or 30, but as the actual nitrogen levels are quite modest in most stainless steels, this does not have a dramatic effect on ranking.

PREN = Cr + 3.3 (Mo +0.5W) + 16N

Tungsten is also included in the molybdenum-rating factor to acknowledge its effect on pitting resistance in the tungsten bearing super-duplex types, for example 1.4501. A modified formula is then used:

The PREN values will of course lie somewhere between the minimum and maximum Grades with a PREN of 40 or more are known as 'super' austenitics or 'super' duplex types, depending to which basic family they belong.

Nitrogen

Nitrogen ranges are not specified in standards such as BS EN 10088-1 for all but specific grades, such as 1.4311 (304LN), 1.4406 (316LN) austenitics. In contrast all the duplex grades have specified nitrogen ranges. It can then be misleading to use just specified ranges as the residual nitrogen in commercially produced austenitics will benefit the pitting resistance.

Tungsten (W) is known to have an effect on the pitting resistance and for some grades a modified formula is used:

PREN = Cr + 3.3 (Mo +0.5W) + 16N

Exact testing procedures are specified in the ASTM G48 standard. In general: the higher PREN-value is, the more corrosion resistant the steel is.

The PREN-value is calculated using the following formula: PREN = 1 x %Cr + 3.3 x %Mo + 16 x %N (w/w) Steels with PREN-values above 32 are considered seawater (corrosion) resistant.

A PREN-value ≥ 40 for duplex steels is called for in the DIN EN ISO 15156 as well as the American NACE – a standard for use in hydrogen sulphide environments known in the oil and gas extraction industries.

Exception: stainless steels with molybdenum content ≥ 1.5% may have a PREN-value ≥ 30. In these norms the PREN-value takes into account tungsten [W] in the alloy and is defined with the formula:

PREN = 1 - %Cr + 3.3 (%Mo + 0.5 - %W) + 16 - %N