PREN NUMBER

A look at how pitting resistance equivalent numbers (PREN) are determined and what they do -- and do not -- tell you about a material

Pitting corrosion resistance is an essential attribute to consider when choosing components and materials for a piping system.

However, resistance levels change based on metallurgic composition and with the sheer variety of options available today, having a clear idea of corrosion resistance just by name or grade is nearly impossible.

This is where pitting resistance equivalent numbers (PRENs) — also known as pitting resistance equivalent values (PRE-values) can help.

While not absolute figures, PRENs offer a simple way to compare various alloys and their ability to withstand pitting corrosion.

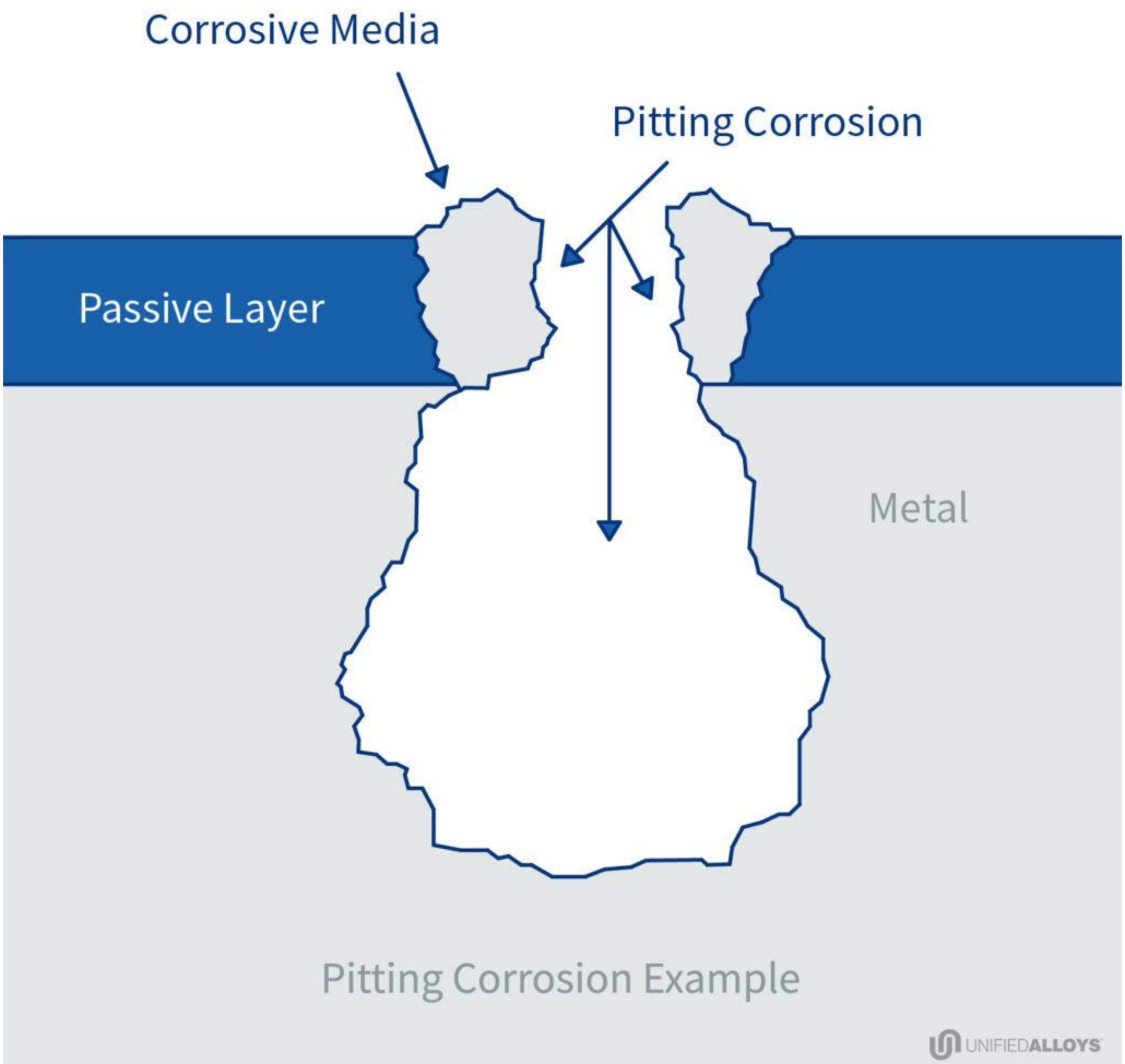
"The PREN (or PRE) numbers are useful for ranking and comparing the different grades, but cannot be used to predict whether a particular grade will be suitable for a given application, where pitting corrosion may be a hazard."

While you should always consult an engineer to ensure your materials meet all requirements, we're going to outline how PRENs are determined and what information this value provides.

kronox
aceros especiales

WHAT IS PITTING CORROSION?

Before you can understand what PREN values might tell you, it's important to know what they're related to — in this case pitting corrosion.



Pitting corrosion occurs on metals with protective films — such as stainless steel.

Often initiated by poor aeration or chemical exposure within the environment, this type of corrosion creates small localized attacks which spread quickly from the protective surface layer to the metal itself.

While sources of pitting corrosion may vary, common causes include exposure to:

- Bromides
- Chlorides
- Fluorides
- Hypochlorites
- Iodides
- Sulfides
- Water

HOW IS THE PREN OF AN ALLOY DETERMINED?

Exact formulas might differ. For this guide, we'll be using two of the most widely accepted modelling formulas to determine resistance to localized pitting corrosion by chlorides.

These formulas determine the rating based upon levels of chromium (%Cr), molybdenum(%Mo), nitrogen(%N), and tungsten (%W) present in the alloy.

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

The first formula is commonly used for stainless and duplex alloys without tungsten while the second adjusts the model to account for the tungsten present in many super duplex stainless alloys.

Common PREN Formulas

Without Tungsten

%Cr + (3.3 x %Mo) + (16 x %N)

With Tungsten

%Cr + 3.3 x (%Mo + 0.5%W) + 16 x %N

%Cr - Chromium
%Mo - Molybdenum
%N - Nitrogen
%W - Tungsten

UNIFIEDALLOYS

For either formula, results typically start around 16 and can reach numbers greater than 40. You can see an example of typical results using data from the BSSA below.

STEEL TYPE	CHROMIUM %	MOLYBDENUM %	NITROGEN %	PREN
Ferritic Steels				
430	16.0-18.0	NS	NS	16.0-18.0
434	16.0-18.0	0.9-1.4	NS	19.0-22.6
441	17.5-18.5	NS	NS	17.5-18.5

444	17.0-20.0	1.8-2.5	0.030 MAX	23.0-28.7
Austenitic Steels				
304	17.5-19.5	NS	0.11 MAX	17.5-20.8
304LN	17.5-19.5	NS	0.12-0.22	19.4-23.0
316/316L	16.5-18.5	2.0-2.5	0.11 MAX	23.1-28.5
316L (2.5% min Mo)	17.0-19.0	2.5-3.2	0.11 MAX	25.3-30.7
316LN	16.5-18.5	2.0-2.5	0.12-0.22	25.0-30.3
904L	19.0-21.0	4.0-5.0	0.15 MAX	32.2-39.9
Sanicro 28	24.0-26.0	3.0-4.0	0.11 MAX	35.9-43.0
254SMO	19.5-20.5	6.0-7.0	0.18-0.25	42.2-47.6
1925hMo	19.0-21.0	6.0-7.0	0.15-0.25	41.2-48.1
4565S	24.0-26.0	4.0-5.0	0.30-0.60	42.0-52.1

Duplex Steels				
2202	22.0	0.4	0.20	26.5
2101LDX	21.0-22.0	0.1-0.8	0.20-0.25	24.5-28.6
SAF 2304	22.0-24.0	0.1-0.6	0.05-0.20	23.1-29.2
SAF 2205	21.0-23.0	2.5-3.5	0.10-0.22	30.8-38.1
SAF 2507	24.0-26.0	3.0-4.0	0.24-0.35	> 40
Zeron 100	24.0-26.0	3.0-4.0	0.20-0.30	> 40
Ferrinox 255	24.0-26.0	3.0-4.0	0.20-0.30	> 40