P. O. Box 5811
Kingwood, Texas 77325

Office: 832 418 9180
Fax:713-8428
SKYPE: 281 968 0727

From the desk of G. A. Aaker, Jr., PE.

CORROSION ALLOWANCE

A corrosion allowance selected based on general corrosion and not localized or pitting corrosion attack neglects the type of corrosion damage most likely to cause a pipeline/flowline failure. Pitting is the major cause pipeline corrosion failure from internal corrosion. However, if a corrosion allowance is based on the pitting penetration rate and the actual aggressiveness of the system it will be too large and uneconomical to include.

A brief literature survey and anecdotal evidence, shows that the term "Corrosion Allowance" appears to have been introduced during the 1950's to address general external wall thinning of buried pipelines due to corrosion. Subsequently, the phrase was incorporated into the design for all piping systems and vessels.

The corrosion allowance appears to have been initially set at some arbitrary value and could range from about 0.100 to 0.500 inches. A value of 0.10-inches was commonly used as the corrosion allowance for carbon-steel and alloy-steel piping in hydrocarbon service.

The following is an example of an equation often used to determine the corrosion allowance:

$$l_t = l_m + (r_i + r_o)\Delta t$$

where

l_t = total design wall thickness
l_m = designed wall thickness for mechanical requirements
r_i = inside anticipated uniform corrosion rate
r_o = outside anticipated uniform corrosion rate
☐t = design project life

The equation identifies the desired inputs but effective tools are not provided to determine the required corrosion rates. Also, the equation does not address pitting or localized corrosion and the corrosion rates are usually described as "general corrosion" rates. Other equations for the corrosion allowance found in the literature only utilize general corrosion rates.

Engineering Services LP
www.engineering-experts.com

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The majority of corrosion related failures is due to pitting and not from uniform or general corrosion. Therefore, for the above equation as well as any other equation used to calculate a corrosion allowance to be applicable to pipe line/flow line design it has to include the rate of wall penetration due to pitting attack.

The design approach used by many companies is to use a corrosion modeling programs such as NORSOK or equations such as DeWaard-Millams to determine an estimated corrosion rate for the produced fluids based on anticipated system conditions. However, these only yield only general corrosion rates and not pitting penetration rates.

Once a general corrosion rate is calculated, then the assumption is made that a corrosion inhibitor will reduce it to a conservative rate of 4 mpy (0.1 mm/yr). Therefore, with no external corrosion, the general corrosion allowance for a 20 year life should be

$$CA = 4 mpy * 20\ yr = 0.080\ in \quad .$$

Therefore, 0.08 inches would be added to the previously determined design wall thickness.

However, since the most common mode of attack is pitting it is essential to determine the pitting penetration rate and not just the general corrosion rate. General and pitting corrosion are related by the “pitting factor”. Literature and laboratory test data show that the pitting factor value ranges from 5 to 100 depending on the system conditions. A statistical analysis of selected laboratory pitting data for carbon dioxide corrosion in brine systems yielded a pitting factor of about 77 $\pm$7.

If, for example, 50 is used for the pitting factor and the general corrosion rate is 4 mpy, then the pitting penetration rate will be 200 mpy. This means the corrosion allowance for the inhibited system designed for 20 year life should be:

$$CA = 200 mpy * 20 yr = 0.400\ in \quad .$$

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This would mean for a 0.500 in design wall thickness, 0.400 inch would have to be added for the corrosion allowance to adequately allow for the pitting penetration rate.