Alfa Laval Guideline on water characteristics to avoid corrosion

Brazed plate heat exchangers

Introduction

This document provides guidelines for brazed plate heat exchangers (BHE) in water duties.

Water contains a wide range of dissolved substances, and their amounts vary depending on factors like water type and geographic location. Not all substances affect the corrosion performance of the materials exposed to these waters, and this document aims at presenting the most crucial limits for the effective use of BHE units.

Corrosion resistance of stainless steel and copper

A BHE consists of two materials: stainless steel and copper, each with unique corrosion properties. The corrosion resistance of stainless steel is due to the formation of a protective oxide layer, known as the passive layer. In water installations, crevice corrosion is typically the most serious type of corrosion. The main parameters affecting crevice corrosion are chloride content, pH and temperature. Table 1 and table 2 in the Technical data section show the maximum level of chloride ions depending on pH and temperature which are allowed for BHEs with plates in SS304 and SS316 to avoid crevice corrosion.

Copper is considered a noble metal, but it can dissolve in the presence of oxygen or oxidizing substances in water. It lacks a robust passive layer like stainless steel and depends on specific water constituents for protection. The water composition plays a crucial role in copper's corrosion sensitivity and the interaction between the parameters is complex, which makes it hard to define absolute limits. Table 3 provides general guidelines on water composition for preventing copper corrosion.

In summary, copper limits the overall water composition used in a brazed plate heat exchanger, whereas stainless steel is constrained by the chloride content.

Technical data

Table 1. Maximum level of chloride ion concentration, ppm (mg/l), to avoid crevice corrosion of SS304 at pH 7 and 9. For pH in between use linear interpolation.

BHE / SS304		
Temperatures °C (°F)	pH7 ppm	pH9 ppm
25 (77)	100	300
50 (122)	40	200
80 (176)	20	100

Table 2. Maximum level of chloride ion concentration, ppm (mg/l), to avoid crevice corrosion of SS316 at pH 7 and 9. For pH in between use linear interpolation.

BHE / SS316		
Temperatures °C (°F)	pH7 ppm	pH9 ppm
25 (77)	1000	6000
50 (122)	300	1500
80 (176)	100	600

Table 3. Water composition limits to avoid copper corrosion

Element — Compound — Property	Limit
pH	7.5– 9.0
Total hardness	4.5–8.5 °dH
Free chlorine	<1.0 ppm
Conductitivy	<500 µS/cm
Ammonia (NH_3)	<0.5 ppm
Sulphate (SO_4^{2-})	<100 ppm
Hydrogen carbonate (HCO_{3-})	60–200 ppm
(HCO_{3-})/(SO_4^{2-})	>1.5
(Ca+Mg)/(HCO_{3-})	>0.5

Disclaimer

The assessment assumes moving water. It is important to remember that still or dirty water which can cause fouling or scaling also can harm the corrosion resistance. Enclosed water characteristics should hence not be taken as a guarantee against corrosion but should be viewed as recommendations for minimizing the risk of corrosion. Alfa Laval is not to be held responsible for damaged BHE due to corrosion.

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