FILMTEC Membranes

System Design: Materials of Construction, Corrosion Control

Materials of Construction, Corrosion Control

From a corrosion point of view, a very harsh environment prevails in an RO water desalination plant. Hence the materials of construction must possess a certain degree of corrosion resistance. This is true for both the exterior parts exposed to spillage and a humid and saline atmosphere as well as for the interior of the system exposed to the wide variety of waters treated.

Although not to be underestimated, the control of exterior corrosion can usually be overcome by using a surface coating (painting, galvanizing, etc.) on materials likely to corrode (mild steel, cast iron, etc.) and by establishing a maintenance program involving periodical flush down and cleaning, repair of leaks, etc.

Selecting materials of construction for the interior wetted system is a far more complicated task. Apart from being compatible with the pressures, vibrations, temperatures, etc., existing in an RO system, the materials must also be able to withstand potential corrosion attacks caused by the high chloride content of the feed water and concentrate stream, the aggressive product water and the chemicals used for applications such as membrane cleaning.

Application of nonmetallic materials such as plastics, fiberglass, etc., are widely used for preventing corrosion and chemical attacks as well in the low-pressure (< 145 psi/10 bar) part of the RO system as in the RO elements and pressure vessels. However, it is usually necessary to use metals for the high-pressure (145–1,000 psi/10–70 bar) parts such as pumps, piping and valves. Carbon and low alloy steels do not have sufficient corrosion resistance, and their corrosion products can foul the membranes.

Lined piping is usually not a realistic alternative because of the often compact piping design and relatively great amount of connections and fittings needed. Al-bronze can be an alternative for pumps etc., but the risk of erosion corrosion and chemical attacks must be taken into account. The most relevant material to be used for the high-pressure parts is stainless steel.

The basic advantage with stainless steel is that it is very resistant to general corrosion and erosion corrosion. Stainless steel is rarely attacked by galvanic corrosion, but it will influence the attack on the other metal in a two-metal couple (e.g. copper, brass, etc.). Stress corrosion cracking of stainless steels in media containing chloride rarely occurs below 158°F (70°C) so it does not need to be considered in an RO desalination plant.

Unfortunately, some stainless steels are prone to pitting and crevice corrosion in the waters occurring in an RO plant. Pitting means localized attacks that result in holes in the metal. Pitting occurs where the passive film formed by chromium oxides breaks and chlorides can attack the bare metal. Crevice corrosion is pitting associated with small volumes of stagnant water caused by holes, gasket surfaces, deposits, and crevices under bolts, etc. In order to avoid pitting and crevice corrosion in the RO water desalination plant the following recommendations can be given:

Form No. 609-02066-604

RO Plants with Concentrate Stream TDS below 7,000 ppm

Stainless steel type AISI 316 L with <0.03% C is the minimum demand for the pipe system because lower grade stainless steels with higher carbon content will suffer from pitting in the welding zones (intergranular corrosion). For non-welded parts, stainless steel type AISI 316 is usually acceptable.

RO Plants with Concentrate Stream TDS higher than 7,000 ppm

Stainless steel type 904 L is recommended for pipes and bends for welding and for similar parts without crevices. Where crevices occur, such as at flange connections, in valves, in pumps, etc., stainless steel type 254 SMO or similar with ≥ 6% Mo is recommended. These two higher alloy stainless steels can be welded together without risking galvanic corrosion. Sensor elements of instruments may be coated or lined. The composition of the named stainless steels is given in Table 3.14.

Table 3.14 Composition of stainless steels

Usual designation	UNS No.	C%	Cr%	Ni%	Mo%	Cu%	N%
AISI 316	S 31600	< 0.08	16.0 - 18.0	10 - 14	2.0 - 3.0	—	—
AISI 316L	S 31603	< 0.03	16.0 - 18.0	10 - 14	2.0 - 3.0	—	—
904 L	N 08904	< 0.02	19.0 - 23.0	23.0 - 28.0	4.0 - 5.0	1.0 - 2.0	—
254 SMO	S 31254	< 0.02	19.5 - 20.5	17.5 - 18.5	6.0 - 6.5	0.5 - 1.0	0.18 - 0.22

Besides the above recommendations, general precautions must be taken during design and construction, such as:

- Design with a minimum of crevices and dead ends.
- Design the piping so that the flow velocity is above 5 ft/s (1.5 m/s). This promotes the forming and maintenance of the passive film.
- Use backing gas when welding in order to avoid the weld oxide film forming a base for crevice corrosion.
- Pickle and passivate the pipe system as this gives the optimum safety against chloride attack.
- Flush the plant with low TDS water before a shutdown period.

FILMTEC™ Membranes
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