VALVE MATERIALS FOR DESALINATION PLANTS

B. Todd
B. Todd and Associates, UK

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Contents

Summary

This section describes the types of valve used in desalination processes and their characteristics. Its main concern is with the requirements of materials and linings for these components particularly their corrosion resistance. The effect of valve design on materials selection is described.

1. Introduction

Whilst pumps provide the power to generate flow in desalination processes, valves are needed to control this flow. They are used in two main ways, namely to cut off (or start) flow or to throttle it, i.e. to control flow to a required level.

As the fluids handled in desalination are corrosive to carbon steel and cast iron, two low cost widely used materials, it is necessary to either provide protective coatings to these materials or to use corrosion resistant ones. Because valves often disturb the flow in piping systems where they are fitted, they can generate turbulence, with associated high fluid velocities, within the valves and down stream from them. In some cases cavitation can be generated which can damage the valve and the downstream piping. In selecting valve materials it is therefore necessary to consider their resistance to fast flow and to cavitation. The choice of valve materials is thus very similar to that for pumps except that coatings and linings are used more extensively.

Valves vary in design, as will be considered later, but have three main components. These are the body, valve seats and the shafts or stems.

2. Valve Bodies

The basic low cost valve used in ferrous piping systems has a cast iron or carbon steel body. Depending on design, corrosion rates of several millimeters per year can occur in seawater. In deaerated seawater and brine corrosion rates are generally lower but at high temperature and high turbulence can still be high, Oldfield and Todd (1979). It is usual to coat cast iron and carbon steel valves for service in these environments using either paint systems or rubber linings. Ni Resist alloy cast irons are also used for valve bodies.

Distillate, particularly if aerated, can cause severe corrosion on ferrous materials and protection by coatings or linings is often used. Product water, which has been treated to introduce hardness and raise its pH, is less corrosive but protection is still often used to ensure good resistance and to avoid discoloration of the water.

Upgrading of valve body materials to give higher reliability requires the use of alloys with corrosion resistance to the environment to be handled. Various alloys are used in desalination the most common being nickel aluminium bronze (see the Materials Appendix for details of alloys) for saline systems and stainless steels for distillate and product water and also for reverse osmosis (RO) systems. Corrosion resistance on these materials is given in Table 1 of chapter Pump Materials for Desalination Plants. For piping systems in copper alloys such as 90:10 copper nickel, nickel aluminum bronze is commonly used. This material can also be used in stainless steel systems where the fluid is deaerated seawater or brine. For stainless steel systems, for example in aerated seawater RO systems, valves of similar grade to the piping is advised.

For small valves, in copper alloy systems, alloys based on copper-tin, such as leaded gunmetal (CuSnZnPb 85:5:5:5), are often used e.g. in waterbox drains. These alloys have excellent castability and are less expensive than the aluminum bronzes.

Where cavitation resistance is required, as in the brine discharge valves of RO plants, stainless steels are preferred. Cavitation data are given in Table 2 of chapter Pump Materials for Desalination Plants.

3. Valve Seats

Valve seats, particularly those in throttling service, experience high fluid velocities and data from Table 1 of chapter Pump Materials for Desalination Plants show that materials with high resistance to flow are stainless steels, and nickel base alloys such as nickel-copper Alloy 400. Brass alloys are sometimes used but these have low flow resistance and can suffer dezincification - both of which can lead to early failure.

For product water ferritic grades of stainless steel - based on 12 per cent chromium alloys - are often chosen. These have good resistance to flow but poor resistance to pitting if chlorides are present. They are suitable for the low chloride waters from distillation plants but may pit in RO product water as the chloride content is higher.

As the valve seat is small in area relative to adjacent pipe and body parts, it is good practice to ensure that it is galvanically more noble than these parts. This is to minimize the risk of corrosion on a surface where leakage would result. Thus in a copper alloy valve seats of nickel-copper Alloy 400 are often used. In a stainless steel valve a higher alloy stainless steel or a nickel base alloy is preferred.

4. Valve Stems

Power to operate a valve is applied through a stem or shaft which passes through the valve body. For large valves the load to operate the valve can be high so that high strength materials are preferred. However, these must have adequate corrosion resistance for the fluid being handled. In general, valve stems are made from similar materials to pump shafts and relevant data are given in Table 3 of chapter Pump Materials for Desalination Plants. If a copper alloy body is used then stems of nickel aluminum bronze or nickel-copper Alloy 400 are preferred. Stems are sometimes made in brass alloys such as CuZn 60:40 or Naval Brass but these will suffer dezincification unless receiving cathodic protection - for example from an uncoated cast iron or carbon steel body.

For coated carbon steel or cast iron bodies the usual choice for stems is a stainless steel. For deaerated seawater or brine Type 316 stainless steel is suitable but for aerated seawater and brine this can suffer pitting and crevice corrosion - particularly at seals. The rough surface which this corrosion produces can then damage the seal when the valve is operated causing leakage. Type 316 stainless steel can be used if the valve body is Ni Resist cast iron as this provides cathodic protection - see Table 6 of chapter Pump Materials for Desalination Plants for relevant data.

Product water systems often use 12 per cent chromium (such as Type 410) and 17 per cent chromium (such as Type 430) stainless steels. They have a strength advantage over the austenitic grades such as Type 316 but have lower resistance to chloride pitting. Care is needed when using these grades with RO product waters, which have appreciable chloride contents, and if seawater is used for hydrotesting.

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Bibliography and Suggestions for further study

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