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Stainless Steel Pump Stations

Not Always the Best Choice for Salt-Tolerant Golf Course Turf

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Current Issue

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In the wake of increasingly limited fresh water availability, golf courses are using paspalum and other types of salt-tolerant turfs, which tolerate irrigation with brackish and/or salt water.

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However, pump stations commonly used to pump fresh water do not hold up very well when pumping brackish or salt water. Equipped with carbon steel pipes and manifolds, most pump stations will deteriorate quickly under the harsh, corrosive environment brought on by the water's high chloride content.

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Industry News

To address these powerful corrosive forces, some golf courses consider paying five to six times the price of a normal pump station to buy one made using stainless steel. However, stainless steel pump stations aren't always the best answer for these particularly challenging applications.

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Stainless steel is a steel alloy that contains an element called chromium, which is the key to its corrosion resistance. Chromium combines with oxygen to form a passive oxide layer that protects stainless steel from corrosion.) Because of its corrosion resistance, stainless steel often fetches premium prices.

Industry Links

The two most common types of stainless steel are categorized as 304 and 316 (abbreviated as 304SS and 316SS). 304SS is used in many consumer applications and is sometimes referred to as 18/8 stainless steel. A higher grade of stainless steel, 316SS, also referred to as marine grade stainless steel, is the most common type of stainless steel used for brackish water applications.

However, 316SS has its limitations. In addition to being very expensive, this type of stainless steel is susceptible to a type of corrosion called "stress corrosion cracking," or SCC. Three conditions are required for SCC to occur:

- 1) Chlorides: Brackish water and salt water typically contain high amounts of chlorides. Brackish water has a high concentration of dissolved solids. Since chlorides occur quite often throughout our environment—usually as sodium chloride (NaCl), potassium chloride (KCl) and calcium chloride (CaCl₂)—a high dissolved solids concentration also indicates a high chloride concentration. And if you are pumping salt water, Chloride concentrations can run 19,000-20,000ppm.
- 2) Dissolved Oxygen: All water exposed to air contains dissolved oxygen. Unless you can completely seal off your irrigation water source from air, your irrigation water is going to contain dissolved oxygen.
- 3) Tensile Stress: On stainless steel pump stations, it's common for welds to be under tensile stress. These welds are prime targets for corrosion.

In addition to the three conditions required for SCC, there are a couple of additional aggravating factors. One is temperature. Higher temperature irrigation water is more likely to initiate this type of corrosion.

Welds throughout the pump are the second factor. Welding stainless steel results in an uneven distribution of chromium at the weld site. While chromium is what makes stainless steel stainless, an uneven distribution of chromium leads to uneven corrosion resistance at the weld sites—the same places most likely to be under tensile stress.

In order for a weld to possess the same level of corrosion resistance as the rest of the pump station, it has to be "cleaned," a euphemism for dipping the welded component in nitric acid and quench annealing it.

Quench annealing is a technical term for heating the welded stainless steel component to 1960°F and then dipping it in water to cool it. Typically, this process is only performed for nuclear and aerospace grade components and is outside the budgets of most irrigation customers.

Given the limitations imposed on stainless steel in the welding process and the high cost of correcting those limitations (cleaning and quench annealing), anyone using brackish or salt water for irrigation may



want to consider a pump station built with High Density Polyethylene (HDPE) piping and manifolds.

What is HDPE?

High Density Polyethylene (HDPE) is a thermoplastic material first invented in 1953. Other thermoplastics include ABS, PVC, and polypropylene. The first HDPE pipe was produced in 1955, offering engineers a robust material for addressing challenging conditions.

Why is HDPE a good solution for brackish/salt water applications?

At a price tag significantly lower than that of 316SS, HDPE pipe can easily handle irrigation system pressures up to 200PSI and higher. It resists aggressive chemicals better than all of the other thermoplastics, and it can tolerate a wide pH range (1.5 to 14).

HDPE pipe is also fusion-welded; resulting in a monolithic assembly (monolithic is a tech term meaning that the welds are as strong as the parent material). Because of HDPE's strength and high chemical / corrosion resistance and low cost, it has been used in applications where corrosion resistance and durability are top priorities.

An example of this is the use of HDPE corrosion protection liners for sewage systems. Sewage systems can see a variety of different chemical and corrosive agents, and the corrosion resistance of HDPE best addresses this variability.

What are HDPE disadvantages?

There really are no disadvantages from an irrigation perspective. If the piping will be located outside, an argument may be made that stainless steel is more durable when exposed to sunlight; however, UV-resistant HDPE fares just as well under those conditions.

HDPE does not fare as well as stainless steel in applications that exceed HDPE's maximum temperature tolerance of 248°F. However, given that water boils at 212°F, one is hard-pressed to imagine an application where irrigation water will ever exceed 248°F!

HDPE Pump Station Construction

On an HDPE pump station, HDPE replaces the components on a stainless steel station that requiring welding in the fabrication process—the piping and manifolds. Because the welds on a stainless steel component are susceptible to stress corrosion, removing the welded components and replacing them with HDPE components will greatly reduce the potential for SCC.

The remainder of the pump station (valves, pumps, etc) usually consists of materials like 316SS or Navy G bronze. These are cast components that do not have welded surfaces, and hence, are not susceptible to the same corrosion problems.

Bottom Line

For golf courses that are addressing limited fresh water supplies by planting salt tolerant turf grass and irrigating with brackish or salt water, HDPE offers a good, cost-effective solution. Less expensive than a 316SS and not susceptible to SCC, HDPE allows a golf course to buy a pump station that can pump salt water while delivering a satisfactory service life.

1- The U.S. Environmental Protection Agency defines water with less than 1000ppm dissolved solids as freshwater and defines brackish as a mix of fresh and salt water.
(<http://www.epa.gov/safewater/pubs/gloss2.html#B>)

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