PIPELINE CORROSION

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Pipeline Corrosion

When purchasing a center pivot, growers likely have expectations for the lifespan of the equipment. Some center pivot pipelines are still dependable after 25 to 30 years of use; other pipelines show leaks after only 7 to 10 years. Corrosion is a key factor in the breakdown of pivot pipelines, and can cause leaks, cracks, and even structural damage.

While many people may think this has only to do with the quality of the machine equipment, the life expectancy of center pivot pipelines is determined by the number of hours of operation (rather than years) and the water quality running through the pipeline. Since not all water quality is the same in different regions, or even in neighboring regions, not every center pivot will withstand the same amount of hours of operation.

In the past, some growers would purchase a center pivot without taking water quality and hours of operation into consideration and would be disappointed when the life of the pivot would not last as long as expected. There are now water quality tests that can be done before purchasing a center pivot to better help growers estimate the lifespan of the pipeline, and choose a machine that is best for the quality of water running through it.

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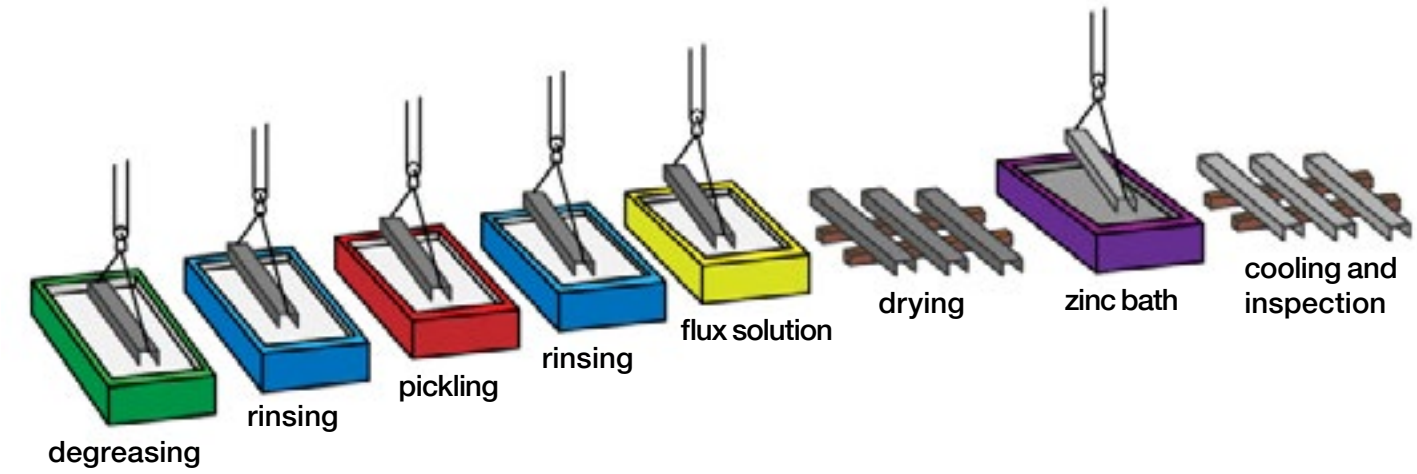
Galvanizing

Galvanizing the pipeline is one solution used to combat corrosion due to poor water quality. Galvanizing began being used as a protective coating in pivot pipelines in the late 1960s. Hot-dip galvanizing submerges pivot parts into a bath of at least 98 percent pure molten zinc maintained at 815 to 850 degrees Fahrenheit. The zinc reacts with the iron in the steel to form a series of bonded zinc-iron alloy layers that seals the underlying steel from contact with its environment.

The part is then slowly removed from the zinc bath and the excess zinc is blown and washed off. The pivot part is then left out in the open air to dry to complete the galvanizing reaction process. When a part first comes out of the zinc bath, it will appear very shiny. Once the galvanizing reaction process is complete and the protective coating has completely formed after sitting out in the open air, the metal will be a dull gray.



The pivot part is now galvanized with a zinc coating that provides a protective layer to prevent rusting. This zinc layer also serves as a sacrificial anode, or a self-healing defensive layer, so even if the coating is scratched the exposed steel will still be protected by the remaining zinc. This has proven to be one of the most effective forms of extending pivot pipeline life. However, severe corrosion issues can still cause a pipeline to breakdown prematurely.

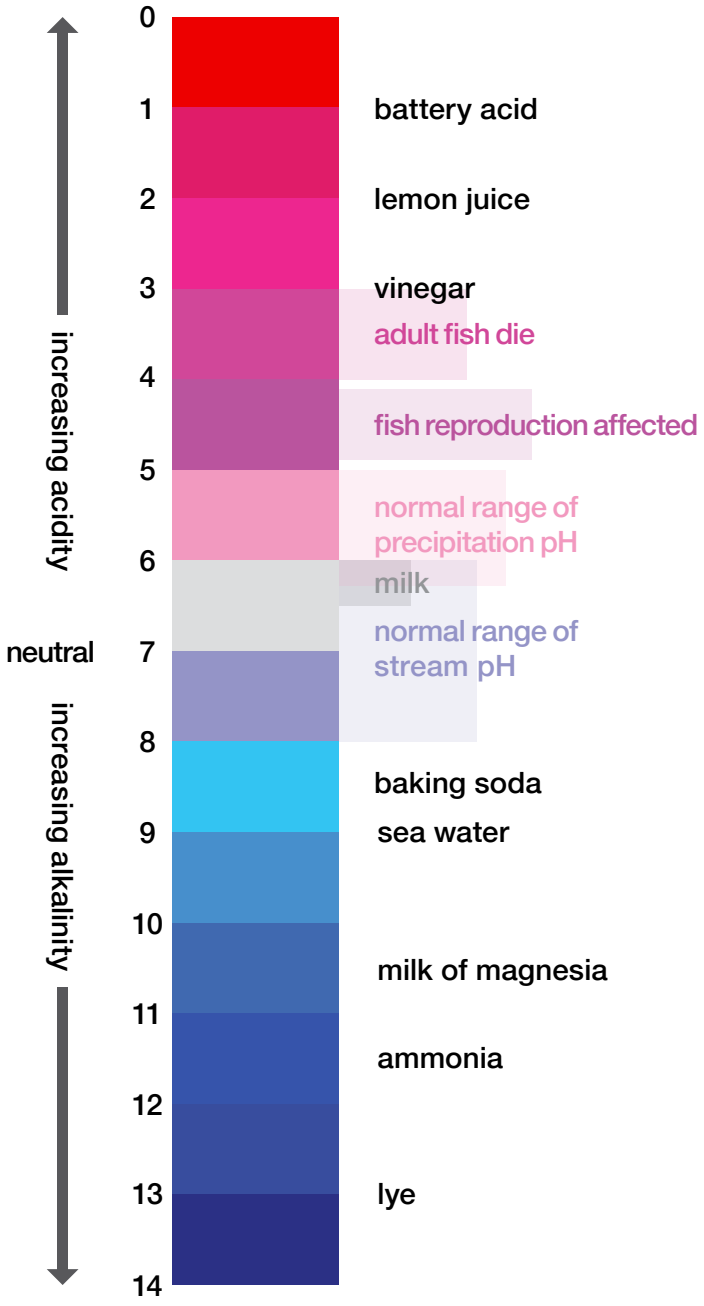
Factors Affecting Galvanized Pipeline Life

Information on the challenges pipelines face started to be documented in the Middle East during the 1980s. Growers in Saudi Arabia were encountering issues with their pipelines with problems ranging from significant leaks at 2,000 hours of operation, to structural failures and cracks at anywhere from 5,000 to 15,000 hours of operation.

Hydro-geologists had discovered that the aquifers in areas of the Middle East contained unusually high levels of chlorides and sulfates. They came to the conclusion that there was a strong correlation between the pH, chloride, sulfate, and the lifespan of a pivot pipeline.

pH is a measure of how acidic or basic water is. The range goes from 0 to 14, with 7 being neutral. A pH of less than 7 indicates acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water with extremely high or low pH levels can contain substances that can be aggressive toward the breakdown of zinc.

High levels of chloride and sulfate can also break down the galvanized pipeline coating. Problems with pipeline coating seem to develop at chloride levels above 500 milligrams per liter, and sulfate levels higher than 250 milligrams per liter. Of all anions, chloride is the most corrosive. In chloride levels higher than 500 milligrams per liter, the water will become more acidic and can begin to cause leaks in a pivot pipeline. With high levels of sulfate in the water, the sulfate ions will begin to undergo hydrolysis, which is a chemical breakdown of a compound due to reaction with water. This can be catastrophic to pivot pipeline coatings.



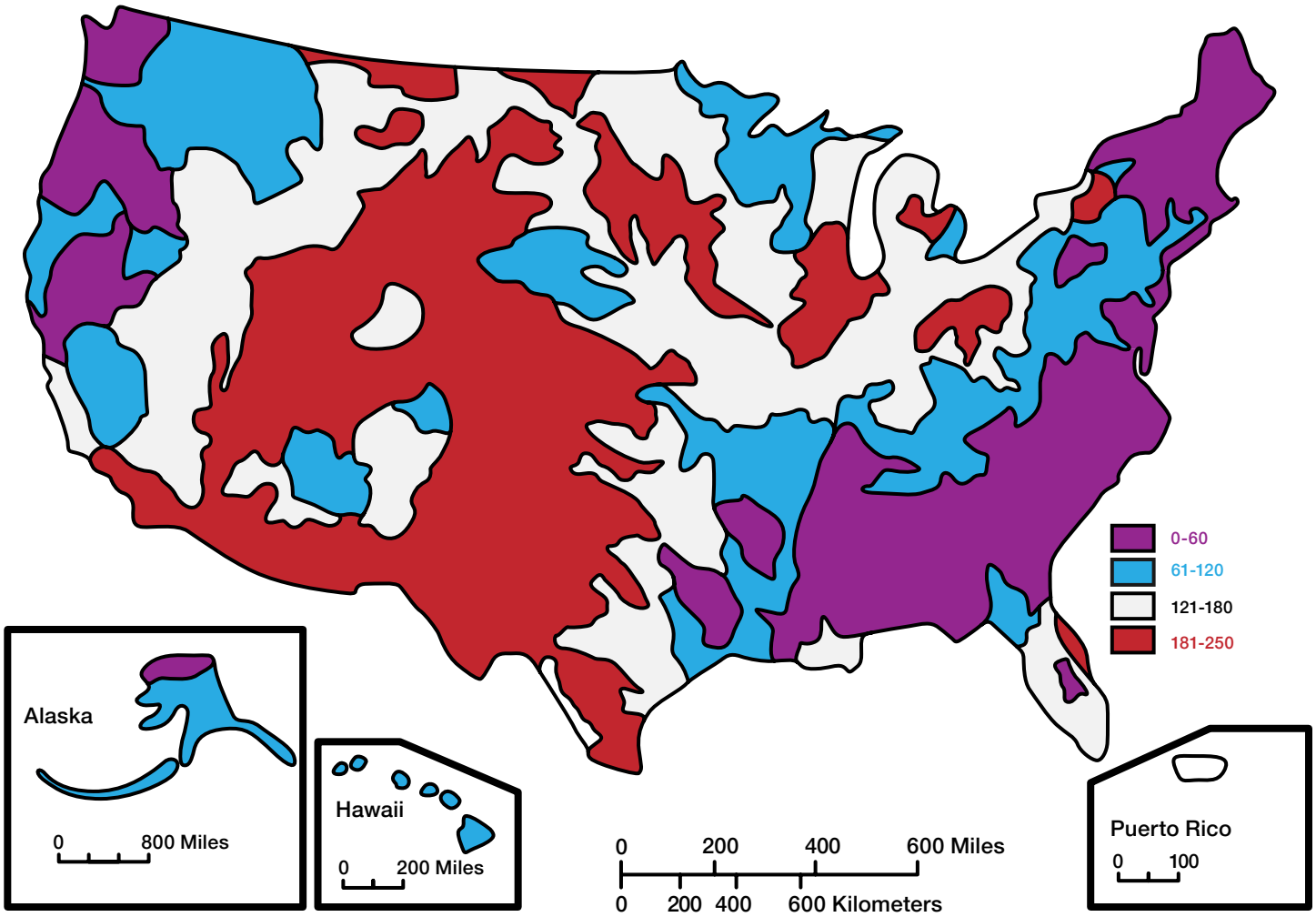
Hardness and softness of water can also have an impact on pipeline coatings. Hard water is water that contains an appreciable quantity of dissolved minerals like calcium and magnesium. Calcium and magnesium will build up and stick to galvanized pipes if large amounts of these minerals are running through the pipe. According to the United States Geological Survey (USGS) research, hard water was found in most streams throughout the Midwest, with extremely hard water found in parts of Texas, New Mexico, Kansas, Arizona, and southern California.

20
Ca
Calcium

12
Mg
Magnesium

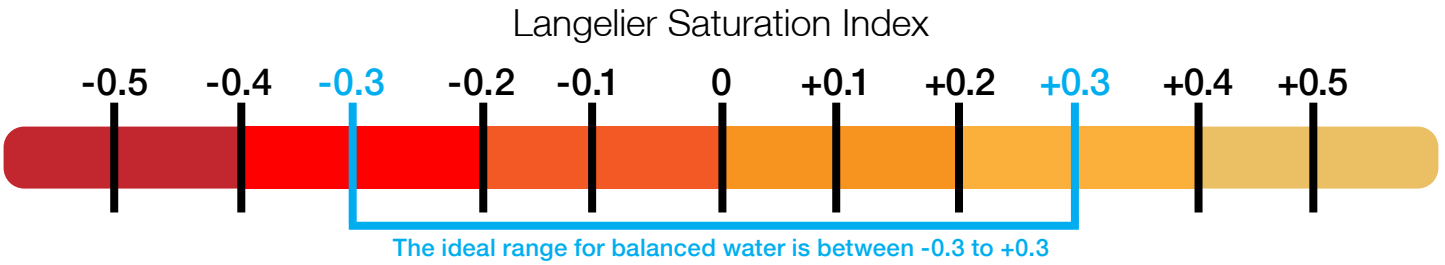
Soft water is water that has a low amount of ions, with particularly low amounts of calcium and magnesium. Soft water occurs naturally as rainwater and is usually preferred in most homes, but can be particularly damaging to pivot pipelines. The zinc oxide film necessary for long galvanized pipeline life does not form if the water running through it is very soft. Soft waters are found throughout most of New England, the South Atlantic-Gulf States, the Pacific Northwest, and Hawaii, according to the USGS.

Concentration of Hardness as Calcium Carbonate, in Milligrams per Liter



Researchers concluded that problems with corrosion in galvanized pipelines can begin to develop with a water pH below 6.2, chloride levels above 500 milligrams per liter, sulfate levels above 250 milligrams per liter, and low calcium and manganese levels (soft water). Knowing the quality of the water that will be used to irrigate before purchasing a pivot can help a grower make a more informed decision when choosing a pipeline coating, and can give a better estimation of the pipeline lifespan.

Valley Irrigation offers a free water test for those who want to know the quality from the water source that will be used for irrigation. Using the Valley Water Review Model, measurements are taken from a water sample using chemistry information on pH, bicarbonate, chloride, sulfate, calcium, and magnesium. These levels of the different water chemistry components are determined by various labs. Then this information is used in the water review model to determine the various indicators.



$$SI = pH + Tf + Cf + Af - TDSf$$

The Langelier Saturation Index

The Langelier Index was developed by Dr. Wilfred Langelier, a civil engineer in the 1930s, to determine how corrosive water might affect pipes in the swimming pool industry. It is widely used in various industries today. This index is an approximate indicator of the degree of saturation of calcium carbonate in water. It is calculated using the pH, alkalinity, calcium concentration, total dissolved solids, and water temperature of a water sample collected at the tap. When using this index, the primary factor affecting long term corrosion that water testers look at is whether a water sample does or does not form scale on the pivot pipeline. If the sample reads greater than 1.0, it is scale forming. If the sample reads less than 1.0, there is no scale forming, which will lead to a loss of galvanizing.

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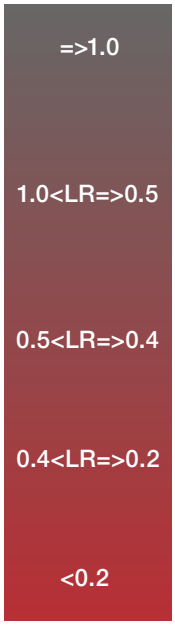
The Ryznar Stability Index

The Ryznar stability index evaluates water temperature, total dissolved solids, and total hardness and alkalinity. This index, developed by chemist John Ryznar in 1944, uses a more sensitive scale than the Langelier index. In water samples reading less than 6.0, it is considered to be definitely scale forming; water samples within 6.0 and 7.0 may form some scale; and samples reading greater than 7.5 will have no scale formation, which leads to a loss of galvanizing.

The Larson-Skold Index

The Larson-Skold index was originally used for the Illinois State Water Survey. Dr. Thurston E. Larson and Ronald Skold conducted laboratory studies for Illinois State relating mineral quality of water to corrosion of steel and cast iron in the early 1950s. The Larson-Skold index was adapted by Valley Water researchers for specific information on pipeline corrosion for non-soft water. This index evaluates the chlorides, sulfates, bicarbonate and carbonate levels in a water sample, and determines if the water has an abnormal potential for corrosion. If the sample reads less than 0.8, there will likely be a natural corrosion rate. In readings between 0.8 and 1.2, there will likely be some potential for corrosion. Readings greater than 1.2 will likely have a strong potential for corrosion on galvanized pipelines, and growers may want to consider an alternative pipeline coating.



Depending on these readings, the Valley Water Review Model will estimate a final output to advise the customer how corrosive the water from the sample will be. Recommendations will be given on the best type of pivot pipeline for the water that will be running through the pipeline, as well as the number of hours the pivot will be operating. Operating hours will play a key role on the rate of corrosion. A pivot running for 8,760 hours a year versus an identical pivot running for 1,500 hours a year will likely show problems with corrosion much earlier, simply due to the fact that it will be putting in more hours of operation. While galvanized pipelines are now an industry standard for pivot pipeline coatings, there are some cases in which growers may need to consider an alternative option to maximize pivot life.

Valley® PolySpan® Pipelines

Valley engineers developed a permanent solution to pipeline corrosion issues in 1992 with their PolySpan product line. Valley PolySpan irrigation pipes protect irrigation pipelines from any corrosive components in poor quality water, ensuring a long life for the irrigation machine. PolySpan is a polyethylene liner that is installed inside a span pipe, which then protects the metals against the effects of acidic, alkaline, corrosive, and saline water. Unlike other corrosion resistant-pipe, PolySpan resists all corrosive elements in irrigation water. This pipeline may be ideal for growers with corrosive water issues, or who are planning to use crop production products such as fertilizers, pesticides, and soil/water remediation products.

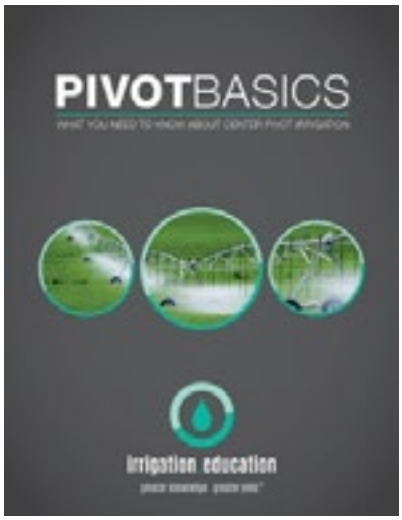
How PolySpan is Added to Pipelines

The PolySpan liner is sized, pulled, and fitted to a wide range of pipe sizes. PolySpan is one complete piece that lines the entire pipe and is formed into the flange. The liner is cut and pulled through the pipe by a winch. The ends are then heated and formed into the flange locking holes. Poly liner expands and contracts slightly as temperatures change, so Valley uses an exclusive hot-forming process to lock the liner into retention holes in the flange. This linear acts as a seal against the galvanized steel, so corrosive water is unable to damage the underlying metal.

When it comes to corrosion, galvanized pivot pipelines are likely the best economical option for growers using water with a natural corrosion rate. To successfully meet pipeline expectations, a machine must be matched with the right pipeline based on the water and products running through it.

To learn more about protection against corrosion, log in to irrigation.education and take the How to Overcome Corrosive Water course.

Download our Previous Guidebook:



In this guide, you will learn:

- **What parts make up a center pivot irrigation machine**
- **How the components of a center pivot work together**
- **How a center pivot moves around a field**

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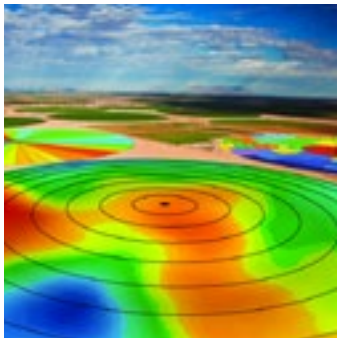

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