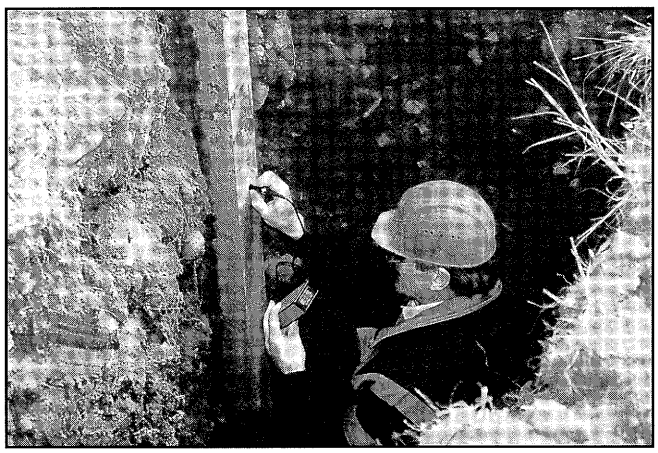
Ask Dr. Galv

Q **I have a customer who wants to hot-dip galvanize some lamp posts that are going to be partially buried in soil. How does soil affect the corrosion rate of zinc?**

A You raise a very difficult question to answer in general. Due to varying physical and chemical characteristics of soil, it is difficult to predict underground corrosion rates. Even in very close proximity, soil content conditions can have significant variations. In order to predict the performance of hot-dip galvanized steel in soil, you must first try and classify the soil to which the galvanized steel will be exposed. The properties of soil that have the most affect on the corrosion rate are aeration, moisture content (or time of wetness), pH, temperature and resistivity.



One of the easiest ways to begin soil classification is color. Red, yellow or brown soil indicates a certain extent of oxidized iron, which corresponds to soil that is well aerated. Soils that are gray indicate the presence of reduced iron or soil that is poorly aerated. Poorly aerated soils are generally more corrosive to zinc.

Particle size plays a large role in determining if hot-dip galvanized steel is suitable for use in a particular soil. Particle size will dictate the amount of aeration, as well as the time of wetness for contacting galvanized steel. Soil particle sizes are generally divided into three categories: sand (0.07mm to 2 mm), silt (0.005 mm to 0.07) and clay (<0.005 mm). In sandy soils, the larger particle size allows for air to enter between the particles and promote aeration of the soil. At the same time, aerated soils allow moisture that remains in the soil from rainfall or other sources to evaporate at a much faster rate than non-aerated soils of smaller particle size. This resulting aeration and shorter time of wetness correlates to a lower zinc corrosion rate.

High levels of bacteria in the soil tend to consume any oxygen present, making the soil poorly aerated. Hot-dip galvanized steel will not perform as well in soils containing large amounts of organic bacteria.

Soils also have a wide variety of chemical properties as well as physical properties that make it difficult to predict corrosion rates of zinc. Studies have shown that the pH of soils can vary from 2.6 to 10.2. As with galvanized steel in contact with solutions, the pH has a dramatic affect on the corrosion rate of zinc. Hot-dip galvanized steel performs the best in soils that are neutral or slightly basic. Extreme corrosion rates and deep pitting are associated with soils having very low pH (highly acidic).

Plentiful rainfall typically translates into soils that are more acidic and are more corrosive to zinc. Also, rainfall affects the time of wetness for the soil and the contacting galvanized parts. The longer that the galvanized steel remains wet, the higher the corrosion rate.

Temperature also plays a role in the rate at which corrosion of galvanized steel in soil occurs. One study has shown that the corrosion rate doubles in samples when the temperature was raised 40 F to 68 F (4 C to 20 C). The higher temperature results in a lower resistivity of the soil. Some studies have shown corrosion rates are higher in soils with low resistivities.

Generally speaking, sandy, well-aerated soils with a neutral or slightly basic pH are likely to cause only limited corrosion, most likely below 10 microns/year (0.4 mil/year). Determining whether galvanized steel is suitable for applications in soil is challenging. Following the aforementioned guidelines should provide you with a basic understanding of the corrosion of zinc in soils.