



### **Anode Rods, Cathodic Protection and the Porcelain (glass) Lining**

Corrosion can be defined as the destructive attack of a metal by an electrochemical reaction with its environment. Steel exposed to moisture and oxygen will rust and corrode. Corrosion is defined as the 'eating away' of metal by electrochemical means. There are four main factors affecting water's ability to corrode:

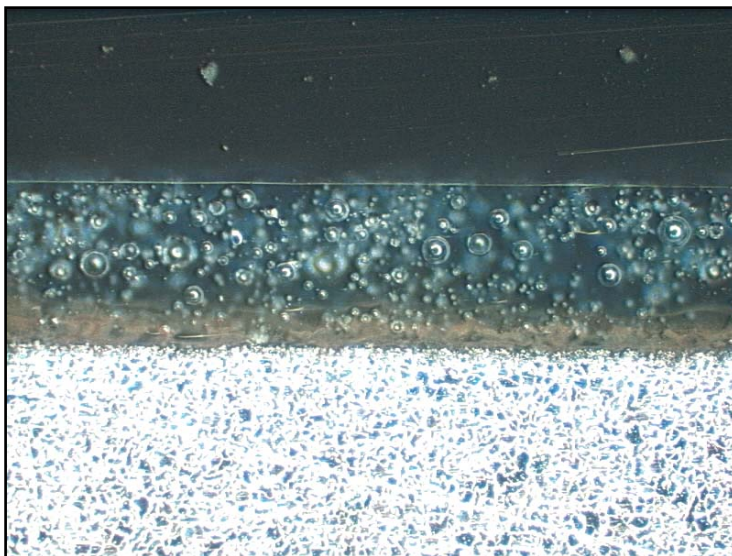
1. Acidity - Water is made acidic by naturally occurring dissolved gases such as carbon dioxide.
2. Temperature - Higher temperatures speeds up the corrosive process.
3. Amount of dissolved oxygen - Free oxygen dissolved in the water promotes corrosion.
4. Electrical conductivity - The more dissolved mineral solids in the water, the greater its ability to carry electrical current. When dissimilar metals are in the water:
  - Electrical current flows between metals
  - One of the metals gradually corrodes faster than the other

Dissimilar metals are present in the interior steel tank surfaces of all water heaters in several forms such as the drain nipples, heating elements, inlet and outlet nipples, and immersion thermostats. These metals, and others present in the water itself, combined with the oxygen content of the water and heat, establish an environment conducive to corrosion. The dissimilar metals create a corrosion cell that is enhanced by the conductivity of the water. The anode is installed to overcome (neutralize) the corrosive cell.

#### ***The Porcelain (glass) Lining***

In a water heater, corrosion is protected by a glass (actually a porcelain enamel) lining in the steel tank, and the use of auxiliary anode rods. Porcelain enamel begins as a blend of minerals mixed in a manner to form liquid slurry. This slurry, resembling a thin mud, is sprayed onto the inner surfaces of the water heaters. During the manufacturing process, the inside water tank and both the top and bottom heads are sprayed with a slurry of glass material. After the tanks are sprayed, they are fired at very high temperatures - generally ranging from 1500 to 1600 degrees Fahrenheit. While in the furnace the porcelain bonds with the metal to create more than a coating. It forms an inseparable compound merging the chemical makeup of the porcelain glass lining and metal resulting in a new, chemically unique finish. This glass provides a long life to the steel tank; otherwise, the tank would fail or corrode in a relatively short time. Every glass lined water tank, no matter how carefully it is manufactured, has some microscopic bare metal areas exposed to the water inside the tank. There is a chance that a crack or chip in the porcelain lining will allow the water to come in contact with the steel tank. Over time, water, a universal solvent that becomes more aggressive with temperature, slowly dissolves the interior tank lining. This will create conditions for corrosion, pinholes in the tank and finally tank failure.

(Microscopic view of steel and porcelain lining after firing)





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### Cathodic protection

(Partially sacrificed anode rod)

Cathodic protection is accomplished in the glass lined water heater by using an auxiliary magnesium anode. Due to the relative position of magnesium to steel in the electromotive series of metals, magnesium will corrode, producing an abundance of electrons which flow (much the same an electrical current) to the exposed steel surface and maintaining it in the electro-negative state. As current flow takes place, the anode rod reacts chemically to corrode at a rate faster than the steel inner tank. This process stops tank corrosion by substituting the sacrificial magnesium anode rod in place of the steel tank. As long as the magnesium anode rod remains in the tank, in an active state, there will be no corrosion of the minute areas of exposed steel inside the tank.



### Anode Rods

(Depleted anode rod)



The life of the anode, in turn, depends on water temperature, amount of water used, and the quality of the glass lining. However, the most important factor in the life of the anode rod is the water chemistry, the hardness or softness of the water. Water softeners contribute to the change in water chemistry. Indirectly, softened water acts to reduce the service life of the anode, since its current demand becomes drastically higher. Also, check the manufacture and installation date of the water heater.

Do not remove the anode rod from the water heater's tank, except for inspection and/or replacement, as operation with the anode rod removed will greatly shorten the life of the glass lined tank and will exclude warranty coverage. The anode rod should be removed from the water heater's tank annually for inspection and replaced when more than 6" of core wire is exposed at either end of the rod.

From time to time, questions are raised as to the use of the R-tech and magnesium anode rods. Generally, these questions are raised in areas where some unusual water problems occur with resultant odors. For many years, the regular magnesium anode was and is the standard anode for use in water heaters tanks. In general, it is a very good anode; however, the performance is dependent on water chemistry. In waters where the conductivity is low, the anode operates at a very low current level. This means not much cathodic protection. Conversely, where the water conductivity is high, an excessive amount of current is produced with inefficient operation. This will sacrifice the anode sooner than predicted and require more frequent replacement.

In addition, some of these waters have excessive sulfate content along with various strains of sulfate reducing bacteria (see Document 1206). These bacteria, harmless to health, will grow in the presence of the highly active magnesium anode rod and using the hydrogen ion from the anode-cathode reaction, will produce hydrogen sulfide gas. The gas smells like rotten eggs. The greater the activity of the anode, the more hydrogen ions are produced – and the more hydrogen sulfide (smelly) gas. These bacteria can be killed with adequate additions of chlorine, such as with an automatic chlorine feeder.

The R-tech anode rod was developed to operate in a broad range of waters without the sensitivity to the various water conditions. This anode or a variation there of, has been used over 15 years in gas water heaters with minimal problems with odors. With the invention of the resistored electric heating element, Rheem now uses the R-tech anode rod in electric water heaters. In doing this, we are now able to efficiently utilize the R-tech anode in all type of water conditions.



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### How to Replace an Anode Rod

**! CAUTION:** *Draining your water heater for this procedure may put you at risk of being scalded by hot water. Please be careful when working on your water heater. If you are not comfortable with this procedure, call the services of a licensed plumbing contractor. Certain portions of this procedure may need to be performed to local codes. If you are not familiar with those codes, call the services of a licensed plumbing contractor.*

The anode rod on some water heaters are not accessible. They include the heat pump water heater, point of use water heaters of 20 gallons or less, residential direct vent water heaters and the DVX models made for manufactured housing. If you are not sure if the anode rod on your water heater is accessible, please call technical support at 800-432-8373.

These instructions will walk you thru the replacement of an anode rod in a residential gas or electric water heater. **Make sure you turn off all power to the water heater before you start the procedure.** Once completed, make sure you check for leaks at the anode rod threads; and check again 24 hours later.

You will need the following tools:

- 1-1/16 inch socket
- Ratchet
- 24" cheater bar or pipe
- Flat Blade Screwdriver
- Teflon tape or pipe dope



If you need assistance anytime during this repair, call our dedicated technical support line at 800-432-8373 M-F 8 am to 5 pm central time.

1. Turn water heater off at the circuit breaker or gas supply.

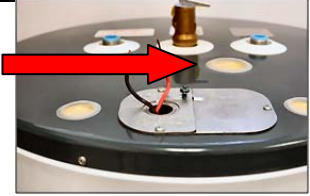
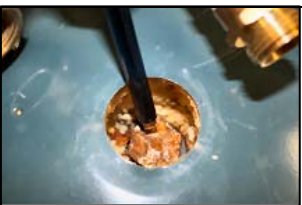


2. Turn off the cold water inlet valve or isolation valve.



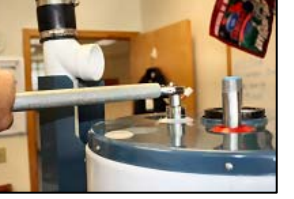
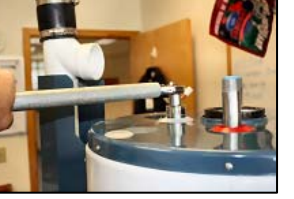
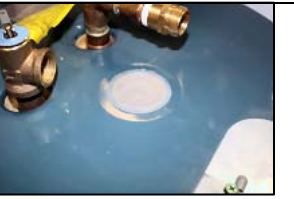


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| <p>3. Open a hot water faucet to relieve system pressure inside the tank.</p>                                                                                                       |    |
| <p>4. Drain approximately 2 gallons of water from the water heater's drain valve.</p>                                                                                               |    |
| <p>5. Locate the anode rod position on the center top of the tank. It will be underneath one of the plastic caps in the top pan. On older models, the anode rod may be exposed.</p> |    |
| <p>6. On some PowerVent models, you will need to remove the blower motor.</p>                                                                                                       |   |
| <p>7. Remove the plastic cap to expose the anode rod.</p>                                                                                                                           |  |
| <p>8. If not clearly visible down to the tank shell, take a flat blade screwdriver and carefully remove the insulation and expose the anode rod head.</p>                           |  |
| <p>9. Next, you will need a 1 1/16 inch socket.</p>                                                                                                                                 |  |



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| <p>10. Using a 1-1/16 inch socket, remove the anode rod by turning it counterclockwise. (Have a rag handy because there will be some seepage of water from the anode rod location.)</p>             |    |
| <p>11. In most cases, you will need a long cheater bar to break the initial seal on the anode rod.</p>                                                                                              |    |
| <p>12. Lift the anode rod out of the tank. <b>CAUTION: Anode rod may be hot!</b></p> <p>It will probably show some signs of deterioration. Something like a half dissolved alka seltzer.</p>        |    |
| <p>13. Prepare the replacement anode rod with pipe dope or Teflon tape. Reseat the anode into the tank and start to tighten.</p>                                                                    |   |
| <p>14. Tighten the anode rod completely with the 1-1/16 in socket. (Remember, lefty loosy; righty tighty)</p>                                                                                       |  |
| <p>15. Turn cold water supply back on; purge the tank thru the open faucet for @ 1 minute; then close the faucet and check for leaks around the anode rod. Turn gas or circuit breaker back on.</p> |  |
| <p>16. If there are no leaks, replace the plastic cap on the top pan if removed; replace the blower motor if removed. Check for leaks again in 24 hours.</p>                                        |  |