Often, design requires that dissimilar metals come in contact with each other and door and hardware product lines are no exception. Stainless steel/brass/bronze hardware on steel door/frame and a steel fastener in an aluminum weather-strip are common examples.

The whole ‘dissimilar metal’ subject has to do with what is known as galvanic corrosion, often misnamed “electrolysis.” Galvanic corrosion occurs when two dissimilar metals are placed in contact with each other in the presence of an electrolyte (any medium in which an electrical current can flow, e.g. moisture, sea water, rain, etc...), resulting in the unintentional formation of a galvanic cell and concomitant chemical reaction of the metals involved. An electrolytic cell is created and metals form an anode or a cathode depending on their relative position on the Galvanic Series Table (see page 23). The anodic material will be the one to corrode.

For galvanic or dissimilar or electrolytic corrosion to occur, three conditions must exist:

1. **The metal join must be wet with a conductive liquid.**
   The conductive liquid or electrolyte could be rainwater or even water from condensation. Salt or industrial pollution significantly increases the conductivity of water so galvanic effects are normally more severe near the coast or in heavy industrial areas. One complication is that during evaporation, water films become more conductive, so initially benign water may cause quite active galvanic effects as the liquid in the crevice under a bolt or clamp becomes more concentrated.

2. **There must be metal-to-metal contact.**
   Galvanic corrosion can only occur if the dissimilar metals are in electrical contact. The contact may be direct or by an external bolt/screw or wire or pipe.

3. **The metals must have sufficiently different potentials.**
   All metals dissolve to some extent when they are wetted with a
conductive liquid. The degree of dissolution is greatest with active or sacrificial metals such as magnesium and zinc and they have the most negative potential. In contrast, noble or passive metals such as gold or graphite are relatively inert and have a more positive potential. Stainless steel is in the middle although it is nobler than carbon steel. The potential can be measured with a reference electrode and used to construct a galvanic series.

The rate at which galvanic corrosion occurs depends on several factors:

1. **The relative position on the Galvanic Series Table** — the further apart materials are in the Galvanic Series Table, the greater the potential for corrosion of the anodic material.

2. **The amount and concentration of electrolyte present** — an indoor, dry environment will have little or no galvanic corrosion compared to a wet atmosphere.

3. **The relative size of the materials** — a small amount of anodic material in contact with a large cathodic material will result in greater corrosion. Likewise, a large anode in contact with a small cathode will decrease the rate of attack. (Think of a small screw in a large plate).

4. **Non-uniform conditions along the surface of a metal can also cause different energy potentials**.

   For example, the portion of an anchor embedded in concrete typically has lower energy potential than the portion exposed to soil, resulting in the exposed portion affected by galvanic corrosion more than the embedded portion.

In effect, it is impossible to prevent all galvanic corrosion. Minimizing its effects to prevent failure is what needs to be considered.

First, always try to eliminate the cathodic metal by making all parts of a structure out of the same material. When this is not possible, either choose materials that are grouped together, or at least close together, in the Galvanic Series chart, or provide a barrier between the two metals, such as paint, non-metallic washers or gaskets.

Another approach is to make small critical parts out of the more cathodic metal so they will be protected. Avoid connecting small anodes to large cathodes (remember the screw on a large plate, always design the fastener as the cathode so the cathodic area is small as compared to the anodic area).
Galvanic crevice corrosion can result in very high corrosion rates. Because of this it is important to avoid intrusion of liquid or moisture in the contact points between dissimilar materials. This can be done with a joint sealing compound, but it is important that this is non-hygroscopic (does not absorb moisture from air) and does not contain any aggressive ions that can be leached during service.

Periodic cleaning or removal of corrosion product films is not recommended for reducing galvanic corrosion because it usually increases the corrosion rate.

Avoid hot or cold spots in a construction. If a material in a corrosive environment experiences a temperature gradient this may give rise to a so-called thermo-galvanic corrosion. Normally hot areas will be anodic and cold areas cathodic.

Stainless steel, the dominant material in architectural hardware today, is susceptible to its own special form of decay—crevice corrosion, also known as oxygen starvation. Stainless steel contains significant amounts of chromium. When exposed to the atmosphere, the surface oxidizes slightly and a thin film of chromium oxide forms, preventing any further oxidation. If exposed to water, salt or fresh, without the presence of air, this film will not form and the metal will corrode. If the water in question is salt water, the process is accelerated.

Finally, let’s see how we can use galvanic effects to our advantage in preventing corrosion. Suppose the steel member of a structure is being damaged by contact with silicon bronze. That galvanic corrosion can be stopped by connecting both metals to a third metal more anodic than either of them. According to
our Galvanic Series, the third metal in this case could be magnesium, zinc, aluminum, or cadmium. In practice, and for reasons too complex to cover here, zinc works best. The zinc corrodes preferentially to both of the original members of the couple. **The steel is now protected, and the zinc is called a sacrificial anode.** Such anodes are commonly used together with coatings to control galvanic corrosion. Zinc (called galvanizing) and aluminum coatings are used extensively to protect steel in marine atmospheres. Under severe conditions, the rule of thumb is that a heavy, hot-dipped zinc coating will protect steel for about one year per mil thickness of zinc applied. One mil is equal to 0.001 inch or 0.025 millimeter.

As far as how this relates to door hardware, most steel materials are going to have a decorative and/or rust-resisting surface applied, whether that is a zinc plating or a painted surface. Also, most steel doors have a painted coating on them so metal to metal contact is not that great. It will usually happen where they have drilled and tapped holes for attaching hardware. If you attach stainless steel hardware to a steel door or frame, the steel door or frame will corrode first. However, this would be such a slow process that it would take years to notice because the large anode (Steel) is in contact with a small cathode (stainless steel). Also, stainless steel has an inherently effective passive film so the available corrosion current is quite low.

When installing protection plates of dissimilar metals on doors at corrosion prone locations, I prefer using self-adhesive dual-sided tape instead of screws. You may also use special gasket tape (available from some protection plate manufacturers) as a buffer to help prevent tarnishing that may result from electrolytic oxidation between brass plates and steel or stainless steel doors.

Just how frayed, rusty, old or whatever must a piece be for it to be condemned? There are plenty of people out there who can point to a battered, but still-functioning, hinge and its reinforcement and tell you that it’s held up fine and they’d still trust it in a gale. The hinge and its reinforcement will sometimes hold together far longer than anyone could reasonably expect. But the point is to have not just a long-lived door/hardware, but a safe and functioning long-lived door/hardware.

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