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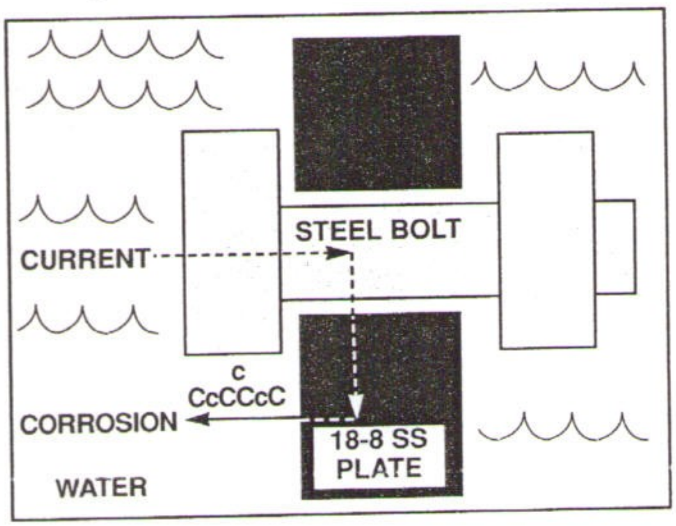
"COMBATING CORROSION IN THE MARINE ENVIROMENT"

The waters of the world offer a challenging contest between the forces of corrosion and the fasteners used in building ships and boats. The reliability of these craft is the most important factor in today's maritime economy. And, corrosion resistance is the single most important aspect of reliability. Without the careful selection of the fastener; corrosion would be the clear winner in this contest.

In the marine environment the type of corrosion encountered is called **Galvanic Corrosion.** In this type two different metals touch each other in the presence of an electrolyte*, a battery is created and current flows. As the current flows one metal will corrode. Much like ash is the result of wood burning. Water is an electrolyte. Saltwater is a far better electrolyte than fresh water.



The diagram above shows the relationship between two dissimilar metals in the presence of an electrolyte. The current generated flows through the steel bolt to the stainless plate. Since the steel bolt's electrical potential is higher than the stainless steel plate the steel bolt corrodes.

All metals have an electrical potential. The metal with the higher electrical potential is the one corroded. The metal with the lower electrical potential is actually protected from corrosion. The closer the electrical potentials the less likely galvanic corrosion will occur. Size is also an important factor in the equation. For example, if the 18-8 SS plate had been relatively small in comparison to the steel fastener the corrosion would have been minimal. This is due to the fact that the amount of flow is the important factor not the voltage of the metal. The larger the material the greater the current flow. The fastener alloy, if it is not the same as the material being joined, should be lower in the galvanic series than the material being joined.

E	f	(+)	MAGNESIUM
L	l		ZINC
E	o		ALUMINUM 1100
C	w		CADMIUM
T	s		ALUMINUM 2024
R			STEEL, IRON, CAST IRON
I	f		CHROMIUM IRON (ACTIVE)
C	r		NI - RESIST
A	o		T 304, T 316 STAINLESS (ACTIVE)
L	m		LEAD, TIN
			NICKEL, INCONEL (ACTIVE)
C	+		BRASS, COPPER, BRONZE, or
			NICKEL-COPPER
U			SILVER SOLDER
R	t		NICKEL, INCONEL (PASSIVE)
R	o		CHROMIUM IRON (PASSIVE)
E			T 304, T 316 STAINLESS (PASSIVE)
N			SILVER
T			TITANIUM
		(-)	GRAPHITE, GOLD, and PLATINUM

For example, if the hull is made from 18-8 stainless steel. A bolt made from 18-8 or a material below it on the above chart would be the best choice for fastening.

The location of the fastener is also an important consideration. The area below the waterline is much more severe, than that area well above the waterline. However, the most corrosive area is the intermediate area known as the splash zone. This constant wetting and drying creates particularly difficult corrosion problems.

CHARACTERISTICS OF DIFFERENT FASTENER MATERIALS

A common misconception is that Brass is t!:e standard material for all marine fasteners. It is in reality a poor choice. A Nickel-Copper alloy or 300 series Stainless Steel alloy out performs Brass.

ALUMINUM - Limited to joining aluminum parts such as riveting aluminum hulls. Poor resistance to seawater.

BRASS - A copper and zinc alloy. Combines strength, toughness, and corrosion resistance.(except in seawater) It is nonmagnetic.

NAVAL BRONZE - Similar to brass with the addition of tin. Preforms better in seawater. Nonmagnetic

NICKEL - COPPER ALLOY - 2/3's nickel to 1/3 copper. The preferred material for marine fasteners.

NYLON(PLASTICS) - Corrosion resistance is excellent. Material absorbs moisture and increases in size. Nylon insert locknuts preform better, but bolts will be harder to remove as the threads swell in size.

SILICON BRONZE - A copper and silicon alloy. Stronger than mild steel and good preformance in seawater.

STAINLESS STEEL(18-8) - A chromium-nickel steel. Superior to brass, naval bronze and aluminum. T-316, an 18-8 type with the addition of molybdenum has even greater corrosion resistance.

TITANIUM - used where strength to weight considerations are important. Seawater resistance is excellent. The high cost of the material must be considered.

FASTENER MATERIALS RATED IN ORDER OF PERFORMANCE

1. **NICKEL-COPPER ALLOY**
2. **T-316 STAINLESS STEEL**
3. **SILICON BRONZE**
4. **18-8 STAINLESS STEEL**
5. **PLATED BRASS**
6. **NAVAL BRONZE**
7. **BRASS**
8. **ALUMINUM**
9. **NYLON**

EFFECTS OF CORROSIVE ACTION ON FASTENER ALLOYS

1. **NICKEL-COPPER ALLOY-** Develops grey/green film
2. **STAINLESS STEEL-** Develops light brown film
3. **BRONZE AND BRASS-** Develops green/brown film
4. **Aluminum-** Develops white powdery film w/pits

TENSILE STRENGTHS OF FASTENER MATERIALS

ALUMINUM 2024T4	48,000 PSI
BRASS	68,000 PSI
NAVAL BRONZE	60,000 PSI
NICKEL-COPPER	97,000 PSI
NYLON	12,000 PSI
SILICON BRONZE	80,000 PSI
TYPE 18-8 SS	80,000 PSI
TYPE 316 SS	90,000 PSI
TITANIUM	100,000 PSI

In the construction or repair process there are four factors to take into consideration when selecting the fastener. First, the material of the item being attached. ie. Hull and trim composition. Second, relative size of the item to the fasteners. ie. a large number of small fasteners is better than a small number of large fasteners. Third, the electrical potentials of metals. ie. the metal with the higher electrical potential will corrode first. And fourth, the location of the fastener. ie. the splash zone, the waterline, or the marine atmosphere. Very often the fasteners in the marine environment must be taken apart. In these cases stainless steel and non-corrosive fasteners assume their greatest economic advantage. It hardly needs stating that a bolt frozen by corrosion is much more expensive to remove and replace, than the intitial cost of the stainless steel or non-corrosive fastener that would not have become frozen. Your **Ideal** representative is trained to assist you in the decisions you make each day in buying fasteners. They stand ready at your nearest branch to help you solve your fastener dilemma.

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