DESIGN ADVANTAGES FOUND IN AMPCO® ALLOYS

FORMS AND PROPERTIES

The AMPCO® alloys recommended for process applications are essentially aluminium bronzes and nickel- aluminium bronzes. They can be produced in a wide range of forms: sand, centrifugal and shell-mold castings, forgings, rolled sheet and plate, extruded and continuous-cast rod, tube and custom shapes. Through proper selection of alloy and form, and with precise spectrographic control during melting, it is possible to obtain tensile strengths ranging from 60,000 to 110,000 psi, hardness from 70 Rockwell "B" to 35 Rockwell "C" and elongations up to 45%.

CORROSION RESISTANCE

AMPCO® alloys have excellent corrosion resistance to products ranging from SULFURIC ACID, BOILING (up to 50%) to HOT CONCENTRATED CAUSTIC SOLUTIONS and are recommended for such chemicals as phosphoric acid, acetic acid, phthalic anhydride, phenols and furfural.

Although it is customary to think of the copper alloys as having their major field of application in the alkaline or reducing media, AMPCO® alloys demonstrate remarkable tolerance for many corrosive media of the acid or oxidizing type.

In salt water applications, even those so severe as polluted harbor waters and concentrated brine, the highest degree of corrosive resistance is combined with excellent resistance to erosion and cavitation-erosion.

STRESS CORROSION CRACKING

AMPCO® 8 plate is resistant to grain boundary stress corrosion cracking. A small addition of tin in combination with processing developed by AMPCO METAL metallurgists has eliminated the catastrophic failure caused by stress corrosion cracking. Thus, fabrications either too large to stress-relieve or which must be field constructed and welded, can be free from the danger of stress corrosion cracking.

Consequently, the design engineer can take full advantage of the material's strength without fear of exceeding potential stress levels in corrosive environments.

HIGH STRENGTH

The AMPCO® aluminium bronzes recommended for corrosive applications have inherent high strength characteristics. AMPCO® 8 rolled sheet, for example, has roughly 1.5 times the strength of low-carbon steel, and tensile strength and hardness can be further improved by cold working. Several alloys can be heat treated, resulting in minimum tensile of 100,000 psi. Charpy tests conducted at minus 320˚F show AMPCO® 8 plate to have 65 foot-pounds of impact strength, the highest value in the nonferrous field.

At elevated temperatures, AMPCO® alloys retain high tensile strengths and are the most resistant of all cop- per alloys to scaling and exfoliation. They have a mode rate of expansion and are excellent conductors of heat.

WORKABILITY

AMPCO® alloys can be hot-rolled for tube sheets up to 4 inches thick or woven into screens, with individual strands only several thousandths of an inch in diameter. Heads for pressure vessels may be pressed or spun, or they may be welded together from previously formed sheets. Stub ends for Van-Stoning may be formed hot or cold, or fabricated.

Deep-drawn heads of AMPCO® 8 alloy are available in diameters up to 10 feet. Bubble caps for use in fractionating towers are regularly drawn from this alloy on the same dies used for carbon steel.

WEAR RESISTANCE

One of the outstanding characteristics of AMPCO® alloys is their inherent resistance to wear, including erosion, abrasion and cavitation-erosion.

ECONOMY

Several factors ensure real economy in specifying AMPCO® alloys:
(1) a high strength-to-weight ratio which permits thinner, lighter section design;
(2) mode- rate first cost which, combined with extended service life and minimum downtime due to material failure, results in lowest cost per unit of time;
(3) wide selection of forms for design consideration, easily fabricated with the same equipment used on carbon steel.
AMPCO® alloys are "standard materials."

AMPCO® CORROSION RESISTANCE OFTEN XCEEDS THAT OF COMPETITIVE MATERIALS

RESISTANCE TO ACIDS

AMPCO® alloys have a high resistance to corrosion of sulfuric acid from dilute up to 50% solutions in ambient to boiling temperatures. With either sulfuric acid alone or an agglomeration of sludge acid, AMPCO® alloys generally outperform other materials.

Acetic acid is admirably handled by AMPCO® alloys through almost all of its manufacturing processes. AMPCO® alloys are also used with many other acids such as phosphoric, formic, hydrofluoric and propionic in varying concentrations and temperatures.

RESISTANCE TO METAL SALTS

AMPCO® bronzes have proven their value in the production of metal salts throughout the world. Potash re- fining involves corrosion of sodium, potassium, magnesium, chlorides, sulfates and hydroxides from nominal percentages to crystalline slurries and ambient to 240˚F temperatures. AMPCO® alloys resist the corrosion and physical punishment of crushed potash ore and slurry and are specified for heating coils, pumps, piping, valves, thickener tanks and agitators, evaporators, crystallizers and centrifuges.

RESISTANCE TO SEA WATER

Shortage of fresh water has resulted in the rapid in- crease of sea water conversion plants. AMPCO® alloys are regularly used in a number of processes for pumps, valves, pipe fittings, tube sheets and water boxes.

Natural resistance to sea water corrosion plus the high strength of these alloys affords excellent protection from corrosion and erosion due to high velocities.

Brines of varying concentrations and differing temperatures have no detrimental effect on AMPCO® bronzes. Shut-downs or off-stream time are not damaging since the alloys are not subject to pitting or crevice attack.

The demand for fresh water has also increased interest in the use of sea water or brackish estuary water for cooling purposes. The same characteristics and ability to accept widely divergent conditions have made the AMPCO® alloys a favorite choice for plants and utilities in coastal areas.

RESISTANCE TO GALVANIC ACTION

Tests conducted in a number of electrolytes have shown only very minor potentials generated between AMPCO® bronzes and Monel*, nickel, Inconel* and various stainless steels.
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EFFECT OF WELDING ON CORROSION

There is no carbon in the AMPCO® alloys so there is no danger of carbide precipitation as is possible with the ferrous alloys. Also, AMPCO® 8 is a single-phase alloy so the pre-heat or weld heat does not change the metallurgical structure or create a "heat-affected zone" which can be detrimental mechanically or less corrosion resistant. AMPCO-TRODE® weldrods are designed to deposit metal corresponding closely in analysis to the material being welded.

RESISTANCE TO CAVITATION-EROSION

Cavitation-erosion, or damage to a material in contact with a moving liquid, is associated with the formation and collapse of vapor cavities.

Samples of AMPCO® alloys were tested by a prominent manufacturer to determine their relative resistance to cavitation. Included in the test were samples of competitive materials, both ferrous and nonferrous. Results indicated that, in general, the AMPCO® alloys possessed superior resistance to cavitation:

ALLOY	Loss in Weight (mg.)
AMPCO-TRODE® 160 weld on 1010 steel	5.2
AMPCO-TRODE® 160 weld on AMPCO®18	5.9
AMPCOLOY® D4 sand cast	9.9
AMPCO® 18 sand cast	11.6
AMPCO® 8 rolled	12.2
18-8 cast stainless steel	22.0
QQ-S-681b class 2 medium cast steel	88.0
Brass, B-16-42 half-hard (60 Cu, 2.5 Pb, bal. Zn)	166.9

AMPCO® CORROSION RESISTANCE
(chemical agents and applicability table)

Acetate solvents	
pure	E
crude	G
Acetic Acid	
crude	E
vapors	E
Acetic Anhydride	G
Acetone	E
Acetylene	NR
Alcohols	E
Aluminium Fluoride	G
Aluminium Sulfate	G
Aluminium Hydroxide	E
Ammonia Gas	
Dry	G
Wet	NR
Ammonium Chloride	NR
Ammonium Hydroxide	NR
Ammonium Nitrate	F
Ammonium Phosphate	F
Ammonium Sulfate	F
Amyl Chloride	E
Asphalt	E
Barium Chloride	G
Beet Sugar Liquors	E
Benzene or Benzol	E
Borax	E
Boric Acid	E
Brine	E
Butane, Butylene	E
Butadiene	E
Butyric Acid	E
Calcium Bisulfite	G
Calcium Hydroxide	G
Calcium Hypochlorite	F
Carbolic Acid	E
Carbon Dioxide Dry	
Wet	E
Carbon Disulfide	G
	F
Carbon Tetrachloride	E
Chlorine	
Dry	G
Wet	NR
Chloroform	E
Chromic Acid	NR
Citric Acid	E
Copper Sulfate	NR
Esters	E
Ethers	E
Ethylene Glycol	E
Ethyl Sulfate	E
Ferric Chloride	NR
Ferric Sulfate	NR
Formaldehyde	E
Formic Acid	E
Freon	E
Furfural	E
Gasoline	E
Gelatine	E
Glucose	E
Glycerine	E
Hydrocarbon Gases	E
Hydrochloric Acid	
to 5%	G
to 10%	F
(see Muriatic) Hydrocyanic Acid	NR
Hydrofluoric Acid	G
Hydrogen Fluoride (Dry)	E
Hydrogen	E
Hydrogen Peroxide	F
Hydrogen Sulfide	
Dry	F
Wet	NR
Lacquers and Lacquer Solvents	E
Lactic Acid	E
Magnesium Chloride	G
Magnesium Hydroxide	E
Magnesium Sulfate	E
Malt Beverages	E
Mercuric Chloride	NR
Mine Water(Sulfate)	E
Molasses	E
Monochlorobenzene	E
Muriatic - Cold, Commercial	G
Naptha	E
Naphtha	E
Natural Gas	E
Nickel Chloride	F
Nickel Sulfate	G
Nitric Acid	NR
Nitrogen (Dry)	E
Oleic Acid	E
Oxygen	E
Paint Vehicles (Except Soya-Oil)	G
Palmitic Acid	E
Petroleum Oils	
Sour	G
Refined	G
Phenol	E
Phosphoric Acid	E
Pickling Acid (except Nitric Chromic)	E
Potassium Chloride	E
Potassium Cyanide	NR
Potassium Hydroxide	F
Potassium Sulfate	E
Propane	E
Shellac	E
Soaps	E
Soda Ash (Sodium Carbonate)	G
Sodium Bicarbonate	E
Sodium Bisulfate	E
Sodium Carbonate	E
Sodium Chloride	E
Sodium Cyanide	NR
Sodium Hydroxide	E
Sodium Nitrate	G
Sodium Perborate	E
Sodium Peroxide	F
Sodium Phosphate	
Alkaline	E
Neutral	E
Acid	G
Sodium Silicate	E
Sodium Sulfate	
(Soda Cake)	E
Sodium Sulfide	NR
Sulfur	F
Sulfur Chloride	NR
Sulfur Dioxide	
Dry	G
Wet	G
Sulfuric Acid	
5%	E
10%	E
25% (up to boiling)	E
35%	E
50%	E
Sulfurous Acid	G
Tannic Acid	G
Tartaric Acid	E
Toluene or Toluol	E
Tri Chloroethylene	E
Tri Sodium Phosphate	E
Turpentine	E
Varnish	E
Vegetable Oils	E
Water	
Fresh	E
Salt (incl. polluted harbor)	E
Xylene	E
Zinc Chloride	G
Zinc Sulfate	E

These ratings may usually be interpreted as follows:

E	Excellent	(IPY penetration less than 0.006“)
G	Good	(IPY penetration less than 0.016“)
F	Fair	(IPY penetration less than 0.050“)
NR	Not Recommended	(IPY penetration over 0.050“)

N.B. In using this data, it should be understood that these are results of specific tests and are indicative of those conditions under which the tests were run, and are a basis for recommendation, but not for guarantee.