Manganese bronze alloy

Introduction

Manganese bronze or high tensile brass propellers have been used for more than 100 years. The alloy is essentially 60-40 brass in which strength and corrosion resistance has been improved by substituting alloys elements such as manganese, aluminium and tin for some of the zinc.

Stone Manganese Marine (SMM) as was, developed two commercial bronzes Turbiston M and Stone's bronze.

Composition

	Stone's bronze %	Turbiston M %
Copper	56.0 min	59.0 min
Aluminium	0.5 – 2.5	1.5 – 2.5
Tin	0.2 – 0.8	0.4 – 0.6
Manganese	0.5 – 2.5	0.8 – 2.0
Iron	0.7 – 1.5	0.8 – 1.5
Nickel	1.0 max	-
Lead	0.5 max	0.05 max
Silicon	0.1 max	0.05 max
Zinc	Balance	Balance

Stone's bronze is supplied to meet the requirements of Lloyd's, DNV, GL, BV and ABS.

Mechanical Properties

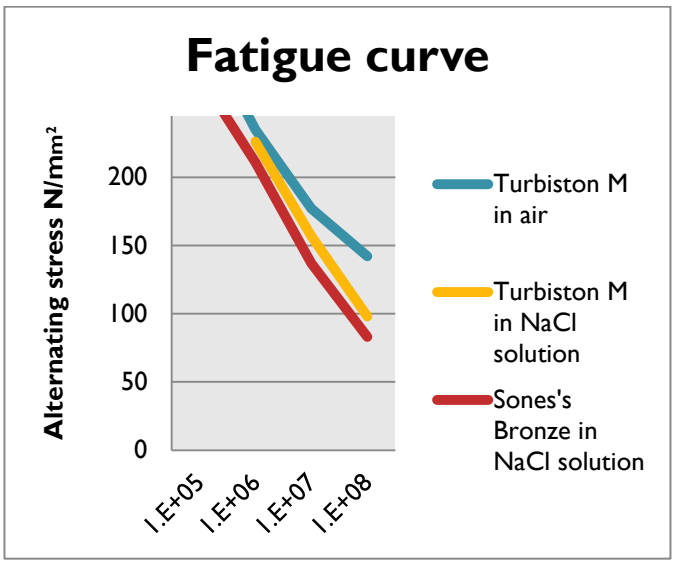
The tensile properties of the manganese bronzes are given in the table below, and are superior to cast iron and cast mild steel and are similar to cast austenitic stainless steels.

	Stone's Bronze		Turbiston M	
Property	Range	Typical	Range	Typical
0.2 % proof stress N/mm2	170 – 216	186	230 – 275	255
Tensile strength N/mm2	480 – 525	510	525 – 588	559
Elongation, % on 5.65√So	18 – 33	26	18 – 31	25
Hardness, Brinell	125 – 165	145	125 – 165	145
Izod N.m	20.6 – 27.5	24.5	27.5 – 34.3	31.4

Fatigue Resistance

It is important that propellers should resist the fluctuating stresses imposed on the rotating blades by the varying wake of the ship across the propeller disc, and this is one of the limiting factors of design stress.

The results of Wöhler fatigue tests, using single point loading and 9.3 mm diameter specimens spinning at 3000 rpm produced the following SN curve. The tests were also carried out in 3% sodium chloride solution spray to simulate sea water. Test bars cut from propeller root sections of several propellers gave endurance values of 70% of the values found in test bars.



Corrosion Resistance

Manganese bronze has been shown by the experience of many years to have satisfactory resistance to corrosion in rapidly moving, turbulent sea water for most propeller applications. The wastage to which these conditions lead is a type of impingement corrosion, known sometimes as corrosion-erosion.

Tests have shown the attack to be electrochemical in nature so that although the manganese bronzes are less resistant then special alloys such as Nikalium and Novoston, the attack can be suppressed by suitable cathodic protection.

Manganese bronze is cathodic to zinc, aluminium alloys and mild steel, anodic to nickel base alloys and slightly anodic to most stainless steels.

Although the types of manganese bronze in present use are less liable to suffer from stress corrosion cracking in service than the alloy with one per cent tin, some cracking does occur from time to time. In most instances it has been possible to show that this has resulted from residual stresses left in the propeller after intense local heating. The cracking has usually been caused by welding without subsequent heat treatment or by local heating of the boss to assist propeller removal.

Repair

Repair is relatively simple and the main point to watch is that no residual stresses are left in the propeller such as could lead to stress corrosion cracking in subsequent service. Such stresses can be avoided by making certain that temperature gradients are shallow, by cooling slowly after hot straightening, by using only gentle heating to assist propeller fitting and removal, and by heat treating welds.

Physical Properties

Property	Unit	Stone's Bronze	Turbiston M
Melting range	°C	860 – 880	860 – 880
Specific gravity		8.25	8.2
Coefficient of thermal expansion	per °C	18.0×10^{-6} (0-100°)	21.0×10^{-6} (0-100°)
Thermal conductivity At 20°C	Cal/cm^2 /cm/sec /°C	0.17	0.23
Electrical conductivity At 20°C	% I.A.C.S	15	22
Modulus of elasticity	kg/cm^2	1.1×10^6	1.1×10^6