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STONE MARINE
PROPULSION

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Nikalium propeller alloy

Introduction

Nikalium is a nickel aluminium bronze alloy, developed in 1945 from a group of alloys known as complex aluminium bronze alloys. These alloys which had been used widely in wrought form and in small castings, were known to possess a desirable combination of properties for marine propellers. Development work soon demonstrated that the adoption of specialized foundry practices, including electric melting and rigorous metallurgical control, rendered the material eminently suitable for marine propellers. Nikalium has been used to make propellers for all types of vessels including military ones.

Composition

Element	Range	Nominal
Copper	Balance	Balance
Aluminium	8.8 – 9.8	9.3
Nickel	4.0 – 5.5	4.4
Iron	4.0 – 5.5	4.8
Manganese	0.5 – 2.0	1.2
Tin	0.1 max	-
Zinc	1.0 max	-
Lead	0.03 max	-
Silicon	0.15 max	-

Nikalium alloy is supplied to meet the requirements of many navies and Lloyd's, DNV, GL, BV, KR, NKK and ABS.

Mechanical Properties

The mechanical properties of the Nikalium are given in the table below, and are superior to most other copper base alloys used for the manufacture of large marine propellers.

	Nikalium	
Property	Range	Typical
0.2 % proof stress N/mm^2	250 – 290	270
Tensile strength N/mm^2	640 – 710	690
Elongation, % on 5.65$\sqrt{So}$	16 – 32	27
Hardness, Brinell	165 – 190	175
Izod N.m	21.0 – 34.0	27

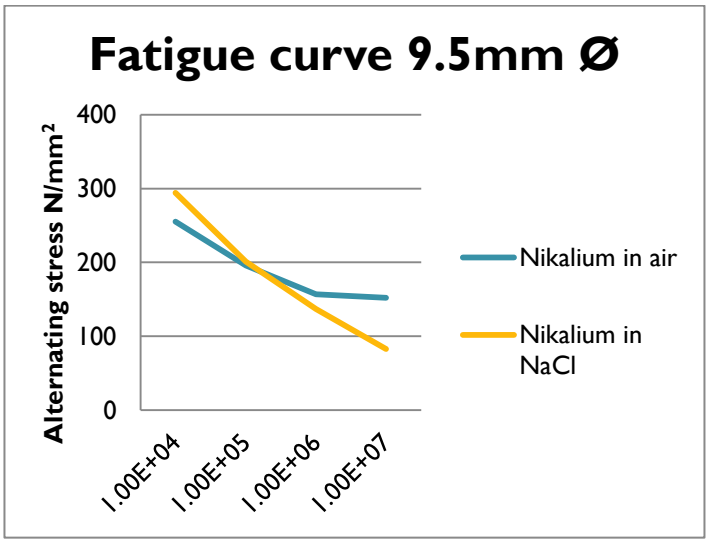
Fatigue Resistance

Fatigue strength is one of the most important properties of a propeller material, particularly when contemplating the use of propellers for high powered or fast vessels, where fluctuating stresses can be very high. Extensive investigations of the fatigue characteristics of Nikalium over a wide

range of conditions has been performed by Stone Manganese Marine, and shows Nikalium to have the highest corrosion fatigue strength of the currently available copper base alloys for propeller manufacture.

The results of Wöhler fatigue tests, using single point loading and 9.5 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.

Fatigue testing has also been carried out on 76 mm diameter specimens cast and slow cooled to simulate boss grain size in large propellers.



Corrosion Resistance

In stagnant seawater the corrosion rate of Nikalium is negligible. In common with other copper base alloys, Nikalium can under certain conditions suffer wastage.

This is a type of impingement attack occurring in regions of high water velocity flow which leads to dissolution of metal. However, Nikalium is three times more resistant to this type of attack than manganese bronze and the metal is left smooth.

Nikalium is not susceptible to stress corrosion cracking in sea water at normal temperatures, and so is immune from boss cracking caused by harsh heating to remove the propeller from the shaft. However, this practice should be condemned since it can give rise to very high residual stresses in blade root areas, encouraging early fatigue failure.

Repair

Repair by welding and straightening presents no difficulty, but several factors should be noted. Nikalium suffers a loss in ductility at about 500°C, heating and cooling should be slow and uniform.

Research has shown that even after heat treatment, welds may have a lower fatigue performance than the propeller casting. If, however, welding is restricted to those areas permitted by classification societies, this operation should not present a problem.

The MIG or TIG processes are preferred for welding Nikalium.

Physical Properties

Property	Unit	Nikalium
Melting range	°C	1055 – 1080
Specific gravity		7.6
Coefficient of thermal expansion	per °C	16.5×10^{-6} (0-100°)
Thermal conductivity At 20°C	W/m°C	33
Electrical conductivity At 20°C	% I.A.C.S	8
Modulus of elasticity	kg/cm^2	1.26×10^4