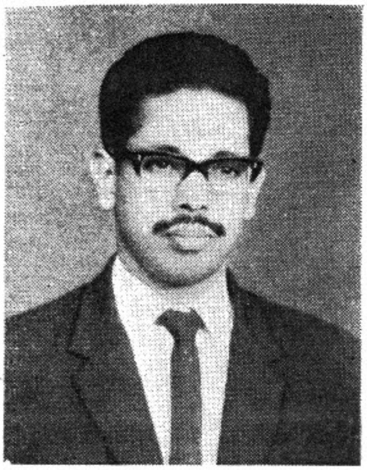
SPHEROIDAL GRAPHITE AUSTENITIC CAST IRON FOR MARINE PROPELLERS



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In recent years due to the technological developments in metallurgy and allied fields the once obsolete cast irons have come into the market in a much improved form as spheroidal austenitic cast iron with a promising future in the marine field. This has been used recently in Europe successfully as a propeller material.

Propellers for fishing boats have hitherto been imported into India with stern gear components along with the marine engines. Of late propellers and stern gears are being manufactured in India.

The propeller is an important integral part of the modern mechanised fishing vessel and as such the required standards for their casting are also rather stringent. The material should have high tensile and proof strength, erosion and corrosion resistance as well as good casting, welding and machining properties. The most common material for casting marine propellers is manganese - bronze besides stainless steel, aluminium - bronze etc.

About 40% of ship repair costs are normally attributable either directly or indirectly to corrosion damage. A marine propeller is exposed to a highly corrosive medium and is in continuous operation for a major part of a year. The cavitation erosion problems, velocity and galvanic effects, cyclic and transitionals stresses and failures associated with stress corrosion cracking, dezincification, graphitisation etc. warrant the use of special types of alloys for casting as propellers for marine use.

The New Material

Austenitic cast irons known under the trade name NI-RESIST constitute a range of irons in which the matrix has been rendered austenitic by adding a sufficient amount of an alloying element mainly nickel. The austenitic matrix in these irons offers good corrosion resistance and toughness than ordinary cast irons. The graphite present in them may be rendered spheriodal which imparts considerable improvement in the tensile strength and elongation properties. Of the various alloy modifications of the cast irons the one which conforms to the grade D2C – ASG3 of IS 2749 – 1964 has been found to be suitable for propeller castings. In the Tables I & II the principal properties of S. G. Irons are summarized. The mechanical properties of S. G. Iron in comparison with manganese bronze used for the production of marine propellers are outlined in Table II. A perusal of the data presented reveals that Ni-Resist is as suitable as manganese bronze for propellers.

Laboratory Tests at the C. I. F. T.

* In collaboration with the International Nickel Company, London through the Nickel Information Bureau, Bombay, samples of Ni-Resist was put to comprehensive laboratory tests recently at the Craft Materials Section of the Central Institute of Fisheries Technology at Cochin. The tests so far conducted have revealed the corrosion resistance of this material which behaved in an encouraging manner when compared with manganese bronze under specially simulated conditions. It is gathered that corrosion rates of 25 — 50 microns/year (0.001″ — 0.002″) and 600 microns (0.024″) per year were reported for S. G. Iron in slow and fast flowing (16 knots) sea water. The corresponding values for manganese bronze and grey cast iron in the latter case are 1.4 mm/year (0.055″) and 4.5 mm/year (0.176″) per year. From this it could be inferred that the performance of S. G. iron is well comparable to that of manganese bronze and is superior to ordinary cast iron.

Many of the propeller materials undergo selective corrosion such as graphitisation, dezincification, dealuminification etc. The brasses and bronzes containing more than 15% zinc are susceptible to dezincification as is seen in fig. 1. if not inhibited with arsenic, antimony etc. Ordinary cast iron similarly undergoes graphitisation but the spheroidal graphite irons are not prone to this type of attack. It is also free from stress corrosion cracking in sea water a phenomenon which is usually encountered with copper base alloys. In the galvanic series of metals and alloys the position of Ni-Resist is above that of manganese bronze

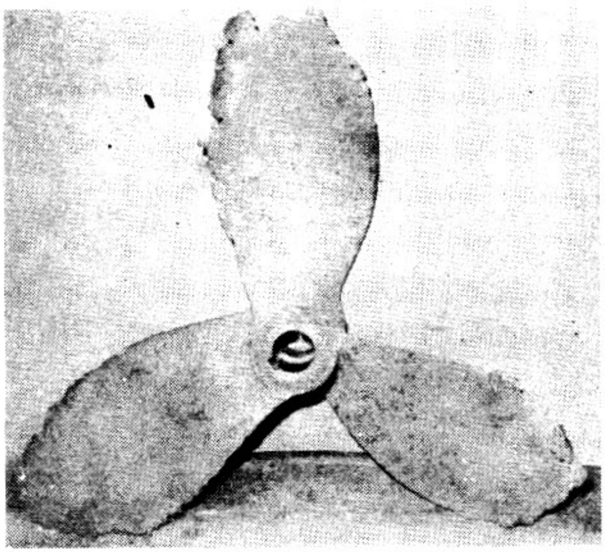

FIG. I — *A typical case of dezincification in a manganese bronze propeller.*

* The authors are much thankful to M/s. International Nickel Company, London and the Nickel Information Bureau, Bombay.

and therefore the electrode potential of the former is less noble than that of manganese bronze. This is particularly advantageous when we rccommend S. G. Iron for an aluminium sheathed wooden fishing vessel as the sheathing would then be subjected to less galvanicc orrosion than by the use of a bronze propeller. However, it has to be noted that the electrode potential of S. G. Iron becomes more noble with time but in view of the favourable area relationship between the propeller and the sheathing, galvanic corrosion will be very meagre.

Founding of Marine Propellers

Some foundries in India have been licensed to import the required quantity of nickel to produce the Ni-Resist. A close control over the melting operations and advance method of castings have helped to produce quality castings. In the foundry of S. G. Iron propellers, due allowance should be given for the shrinkage which is about 1.56 cm./metre. This creates no additional difficulties by virtue of the peculiar geometry of the propeller blades.

Repairs

The ease and ability with a damaged propeller can be repaired is of prime importance and the alloy specially selected for the casting should yield to this requirement. A deformed S. G. Iron propeller can be bent back to the original shape without breaking because of the high elongation of the alloy. Minor repairs by welding can also be carried out.

Economics

As this material is a recent introduction in the Indian market particularly in the field of castings for marine use precise evaluation of the cost appears to be difficult at this stage. However, the performance of Ni-Resist marine propellers are expected to last for a longer period free from all the troubles associated with copper alloys. As against an import of about 60% copper required for the casting of conventional manganese bronze propeller only 20 to 24% of nickel requires to be imported at present for this special cast iron propellers. A saving of about 25 to 30% for each propeller is anticipated, if S. G. Iron is used for the castings for the proposed 8,000 fishing boats. Then the anticipated saving would be appreciable. Comprehensive field trials with prototype propeller castings of Ni-Resist Cast Iron are being planned for further evaluation.

TABLE — I

CHEMICAL COMPOSITION

S. G. Iron Grade D2C — ASG 3	
Carbon	3.0% max.
Silicon	1.0 to 2.8%
Manganese	1.8 to 2.4%
Nickel	21.0 to 24.0%
Chromium	0.5% max.
Phosphorus	0.8% max.
Typical Manganese Bronze	
Copper	55— 60%
Manganese	1.5%
Aluminium	0.5 — 1.5%
Tin	1%
Iron	0.4 to 2%
Lead	0.4%
Zinc	rest

TABLE — II

Typical mechanical properties of S. I. Iron ASG 3 and Manganese bronze

Material	Specific gravity	0.1% proof stress kg/mm2	Tensile strength kg/mm2	Elongation %	Elastic modulus kg/cm2x10^6	Izod impact value kg/cm2	Brinell hardness No.
Austenitic S. G. Iron	7.3	23.5	44	25	1.1	4.8	150
Manganese bronze	8.3	19	52	28	1.1	3.1	145