CASE STUDIES – CS 5

Segment – Materials of Construction

Topic/ case – Large end suction pump for an Australian project -

Selecting the right materials of construction

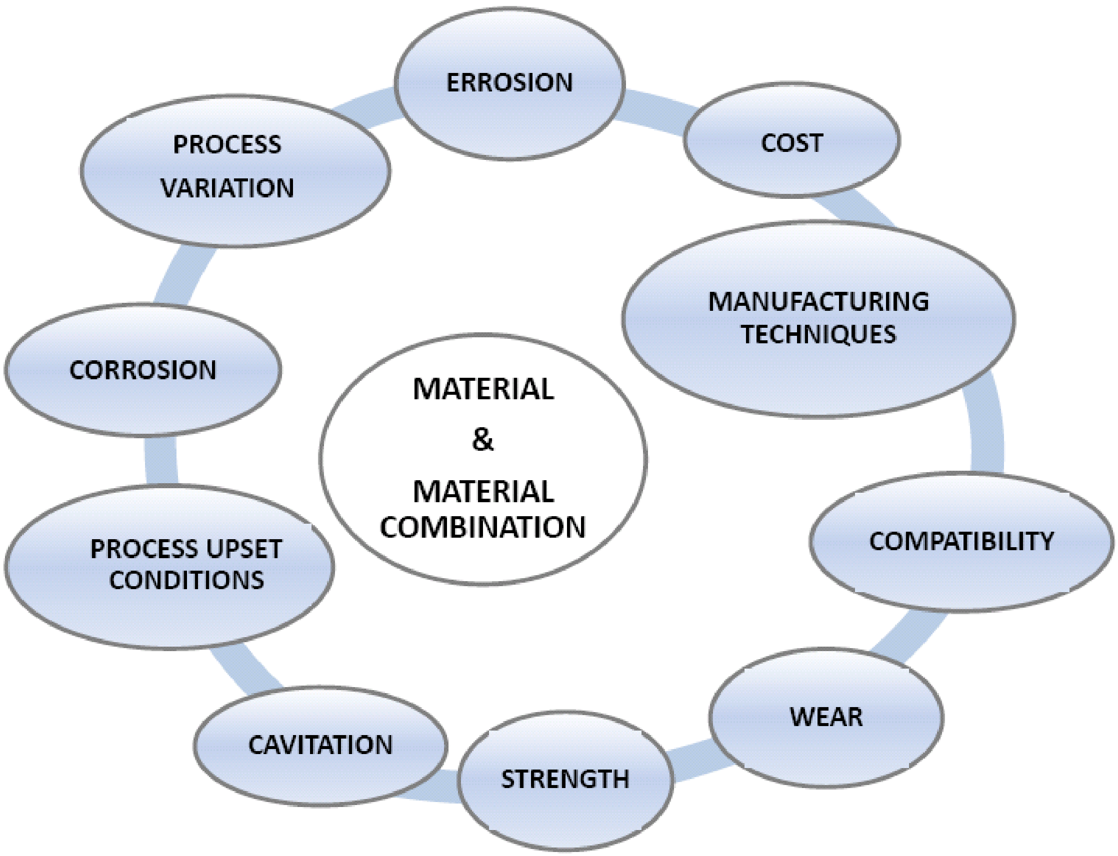
Description of the case – An EPC contractor in Australia has floated an enquiry for large end suction pumps for sea water application. The original material specification indicated by the contractor appears to be of doubtful merit to the pump manufacturer. The manufacturer justifies his recommendations for materials of construction in order to ensure an acceptable working life of the pump.

Question for discussion-

2. What are the key issues to be considered when selecting materials of construction for pumps?
3. What are the sources of recommendations for selecting the right material specification?
4. How do we determine the cost and lead time implications of selecting special materials for pump?
5. For sea water pumps, what are the special considerations in material selection?
6. Is it permissible to coat sea water pump internals with glass-filled epoxy such as Belzona or Corrocoat?

Material Selection – Issues to be considered

Life of a pump largely depends upon proper selection of materials, specially for the aggressive service



Sea Water Pumps – Notes on Material Specification

Materials of construction of the various components of the pump have been suggested based on the following:

a) Pump Service – Continuous Operation – District Cooling Application.

b) Liquid handled by the pump – Sea Water

c) Pump Type and Size – End suction back pull-out alternatively vertical in-line. Relatively high capacity – up to 602 l/s.

The guiding principle in the selection of materials has been to ensure an uninterrupted service life of four years for these pumps without any need for repairs or replacement.

The following general features were considered:

- Corrosion resistance in sea water environment
- Erosion resistance against high flow velocities
- Capacity variations inherent in district cooling application
- Cavitation resistance
- Strength
- Wear resistance
- Galling properties and compatibility
- Ease of manufacture
- Cost

The reasons for selection of materials for individual components are as follows:

1. <u>Impeller</u> – Nickel Al. Bronze (BS1400 AB2)

AB2 aluminum bronze has a very high strength, good wear and corrosion resistance and also has a high resistance to oxidation.

All large pumps on variable duty tend to cavitate, the extent of cavitation erosion depends on the point of operation of the pump (for example, at part flow the damage gets accelerated) and also on the material chosen for the impeller.

Nickel Al Bronze AB2 offers very high resistance to cavitation erosion and this will be seen from the relative cavitation erosion rating chart enclosed.

The following are, therefore, the major reasons for suggesting Nickel Al Bronze as impeller material:

- High resistance to cavitation erosion
- High corrosion and abrasion wear resistance in sea water environment
- Relatively easy to cast and machine
- Yields smooth surface and hence ensures good efficiency
- Does not rust

2. <u>Case Wear Rings</u> – Leaded Bearing Bronze BS1400LB2

These components have a very close clearance with impeller and shaft sleeves respectively – only a few thousandths of an inch. The liquid between the two components is sea water. The lubricating properties of the liquid are poor and contribute little to the avoidance of seizure or galling. To the greatest possible extent, therefore, the materials chosen for these areas should be mutually compatible. This means that they should be capable of rubbing together at high peripheral speed without welding or breaking up.

In addition to possessing this mutual compatibility under rubbing conditions, the material chosen must also be able to withstand the erosive/corrosive environment of the fluid. In leaded tin bronze LB2, the lead content renders the metal almost immune to seizure as it acts as a lubricant under severe condition of rubbing, while the hard tin rich constituent provides a good wearing surface under normal wearing conditions.

In summary, therefore, LB2 has been chosen as a wear ring and stuffing box bush material on following considerations:

a) Galling characteristics (compatibility with AB2)
b) Corrosion resistance
c) Abrasive wear resistance
d) Easily cast and machined

3. <u>Pump Casing</u> – Bronze BS1400 LG2 alternatively Cast Iron BS 1452 FG 260

Pump casings have been offered both in cast iron and LG2 bronze. The criteria used for selecting casing material are:

- Strength – pressure resistance
- Corrosion resistance
- Abrasive wear resistance
- Casting and machining properties
- Weldability for repairs
- Cost

Bronze casting offers an extended life in sea water environment. Leaded Gun Metal (LG2) chosen is the least expensive amongst acceptable bronze casing materials for sea water application. It prevents galvanic corrosion and lead contributes to the pressure tightness of the casing casting.

If sea water is known to be clean and non-aggressive, cast iron FG 260 should be an acceptable casing material. Since the velocities are not too high, CI casing with AB2 impeller can ensure a life of approximately twenty years.

4. <u>Pump Shaft</u> – AISI 316

The criteria for selection of shaft material are:

a) Permissible shear stress at the coupling end of the shaft
b) Endurance limit
c) Corrosion resistance
d) Notch sensitivity

AISI 316 is an austenitic grade stainless steel and offers excellent performance on the above criteria in sea water environment.

Metallurgical Composition & Physical Properties of Materials of Construction

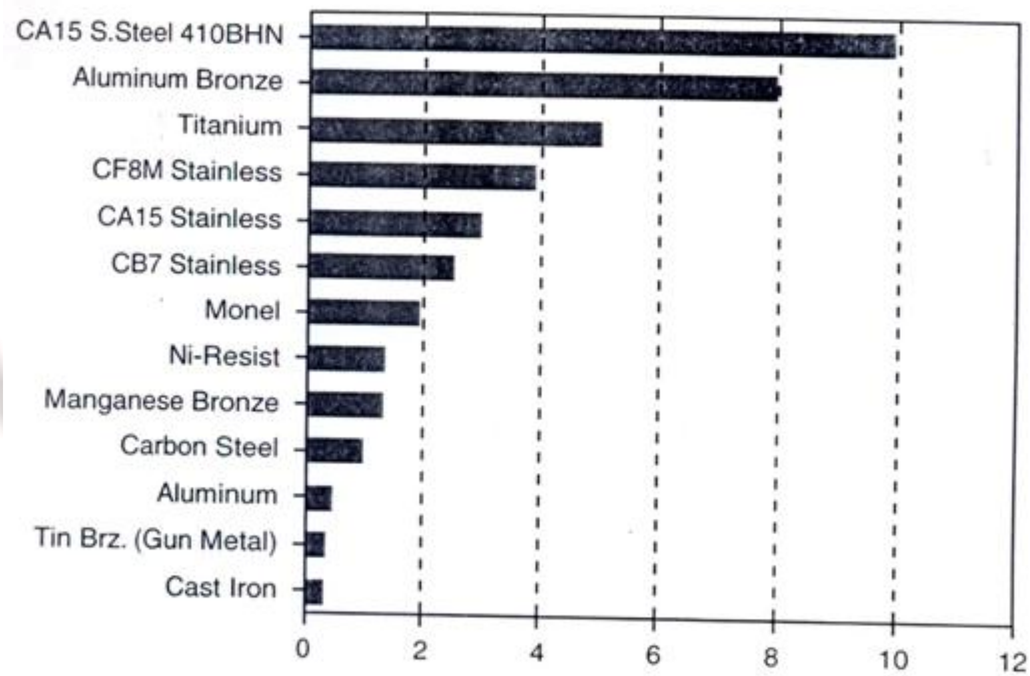
Chemical Composition	Ni-Al Bronze AB2	Leaded Gunmetal LG2	Leaded Bronze LB2
Copper	Remainder	Remainder	Remainder
Tin	0.1% max.	4.0-6.0% max.	9.0-11.0% max.
Zinc	0.5% max.	4.0-6.0% max.	0.1% max.
Lead	0.3% max.	4.0-6.0% max.	8.5-11% max.
Phosphorus	-	-	0.1% max.
Nickel	4.0-5.5%	2.0% max.	2.0% max.
Iron	4.0-5.5%	-	0.15% max.
Aluminium	8.8-10.0%	0.01% max.	0.01% max.
Manganese	3.0% max.	-	0.20% max.
Total Impurities	0.30%	0.80%	0.5%

Physical Properties	Ni-Al Bronze AB2	Leaded Gunmetal LG2	Leaded Bronze LB2
Tensile Strength (N/mm^2)	640-700	200-270	190-270
0.2% Proof Stress (N/mm^2)	250-300	100-130.	80-130
Elongation (%)	13-20	13-25	5-15
Hardness (HB)	140-180	65-75	65-85

Chemical Composition of Cast Iron(FG 260)		Chemical Composition of AISI 316	
Carbon	3.3%	Carbon	0.04-0.08%
Silicon	1.5%	Silicon	0.43%
Manganese	0.75%	Manganese	1.37-2%
Sulphur	0.05%	Nickel	10.43%
Phosphorus	0.5%	Phosphorus	0.04%
Iron	Remainder	Chromium	17.21%
Physical Properties of Cast Iron(Grade FG 260)		**Physical Properties of AISI 316**	
Tensile Strength (N/mm^2)	250-260	Tensile Strength (N/mm^2)	570
Elongation (%)	5-22%	Elongation (%)	51%
Hardness (HB)	180-230	Hardness (HB)	216

Cavitation Resistance of Materials

General Ranking of Cavitation Erosion resistance of Common Cast Metals When Pumping Clear Water at Ambient Temparature



Galvanic Corrosion