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Overview of materials used for marine industry

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Abstract
Materials used in the maritime industry often work in conditions of great wear resistance; moreover, these details also work in conditions of great corrosion resistance. Therefore, it is imperative to understand and know how to use materials for the ship industry. Selecting and using the right materials will improve the workability of the machine parts. In this article, due to time limitations, the authors present an overview of the metal materials system commonly used in the shipbuilding industry. The main group of materials that the article is intended to be used in is the ship engine.

Keywords: material, marine industry, cast iron, steel

1. Introduction

Each ship or device is designed and manufactured according to a defined process and under certain conditions. Properly exploiting the process, the ship and the equipment to ensure longevity, if exploited improperly, the equipment that is working improperly will soon be damaged. ships or ships used in tropical climates to areas with ice ... make the ship quickly damaged. Parts on the ship such as propeller must work at a speed greater than the design speed for a long time, the propeller will be greatly eroded.

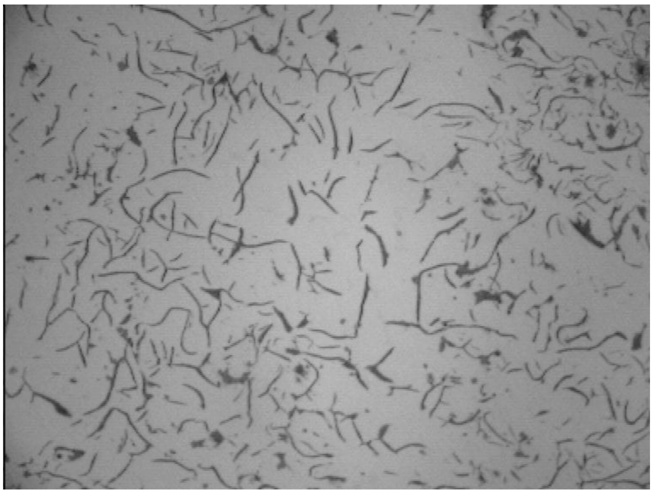
Materials used in ship equipment are technical materials used to manufacture mechanical parts, tools and mechanical load-bearing structures. The details on the ship vary in shape, size and working conditions. They operate with static loads, cyclic loads and impact loads, at low and high temperatures, in different environments. These factors will set specific requirements for materials on working conditions, technology and economy. In order for a machine part or device to work, the structural material needs to have a high structural strength. Structural durability is a collection of properties to ensure reliable and long-term operation of materials in working conditions and environments. Liquid, gas, ionizing environments, radiation affect significantly and are mainly bad to the mechanical properties of the material, reducing the working ability of the details. The working environment can damage the surface due to corrosive cracking, due to oxidation and rust formation; changing the chemical composition of the surface layer due to saturation of unwanted elements (eg hydrogen is brittle). In addition, the material may blister and destroy locally due to ionizing or radioactive radiation. To counteract the working environment, materials need not only mechanical properties but also physico-chemical properties: electrochemical corrosion resistance, thermal stability (antioxidant properties - anti-corrosion properties), radiation resistance, moisture resistance, ability to work in vacuum. The working temperature range of advanced materials is very wide, from -269 to 1000oC, in some cases to 2500ºC. In order to be able to work at high temperatures, the material needs heat resistance, while at low temperatures - cold tolerance.

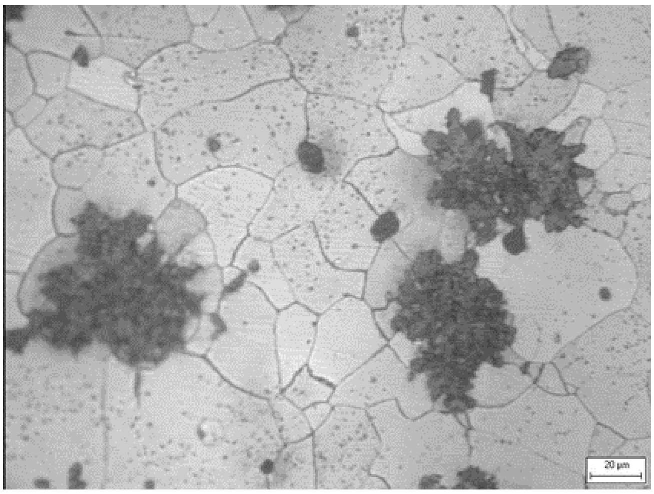
In some cases, certain thermal, electrical and magnetic properties are required; High stability of detail dimensions (especially high precision parts of the tool). In addition to the above requirements, materials must also have good technology to make the cost of manufacturing details and structures at the lowest level. The technology of the material is characterized by machining methods. is evaluated by cutting processing, pressure processing, welding, casting ability, permeability, deformation and cracking tendency when heat treatment ... Technological properties of materials are important because of labor productivity and Quality fabrication details depend on it. Technological and economic requirements are important in mass production. Thus, quality structural materials must satisfy a set of requirements. In addition to ensuring economy, when choosing the most materials, the alloys or containing alloy elements must be based on meeting the working features of balanced parts with the conditions provided and price.

2. Classification of material used for maritime field

A. Cast iron

As previously known, cast iron is an Fe-C alloy with carbon content exceeding 2% (2.14%, right to point E of the Fe-C state diagram). Carbon is an important element in cast iron. From the Fe-C state diagram, it is clear that the high carbon content, the melting temperature of the cast iron is considerably lower than that of the steel, so the fact that cast iron is easier to perform than steel. Do not use cast iron> 5% C. The other two common elements in cast iron with a large amount (0.5 to over 2%) are Mn and Si. These are two factors that govern the formation of graphite, the mechanical properties of cast iron. In the limited cast irons of these two elements change in a relatively wide range.Phosphorus and sulfur are two elements with a low content of 0.05 to 0.5%, in which sulfur is the least harmful element to cast iron. In addition, iron can contain other elements such as alloy elements (Cr, Ni, Mo ...), denatured elements (Mg, Ce ...).





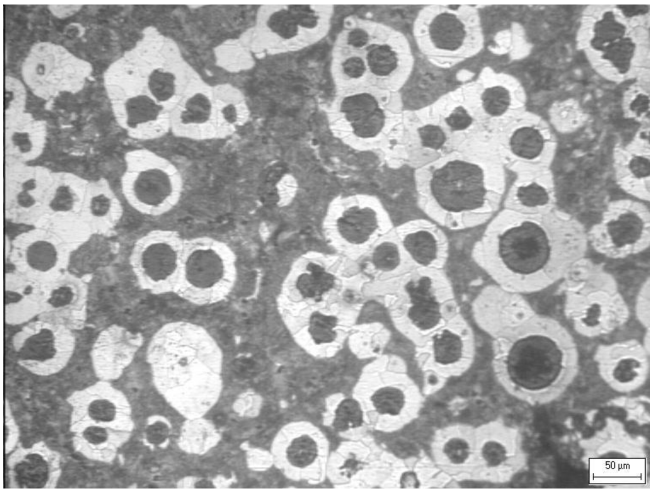


Fig. 1: Cast iron used for marine industry

According to the micro-organism, people are divided into cast iron: white cast iron, gray cast iron, cast iron, plastic cast iron. White cast iron is a cast iron in which all carbon is in the form of a bond in Fe3C Xementite. Thus, the microscopic organization of white pig iron is perfectly suited to the Fe-C state diagram which always contains a mixture of Ledeburite crystals.Gray cast iron, bridges, and plastics are cast iron in which most or all carbon is in free form - graphite with different shapes: plates, bridges, clusters. In the absence of Ledeburit, therefore, the microorganism does not conform to the Fe-C state diagram.The microstructure of graphite cast iron depends on the distribution of carbon in the graphite and cementitious phase. They divide their organization into two parts: the nonmetal part - graphite and the metal base of ferrite and cementite. When all carbon is free, the organization's metal base consists only of ferrite. When carbon is in the link state, the base metal of the organization may be ferrite, pectite, peclitite or peclitite.It is because of the organizational nature of such casts that they have different uses and uses. To achieve a microscopic organization, each type of iron has different elemental constituents.

In general, cast iron is a material with low tensile strength, high brilliance. Xementite is a hard and brittle phase, its presence in large amounts and concentrated in cast iron makes it easy to crack under the effect of pulling load, white cast iron has low tensile strength and high brilliance.

Fig. 2: Crankshaft fabricated by steel

In gray cast iron, cast iron, graphite ganglion holds graphite as holes are available in cast iron, where stress is concentrated, making cast iron unstable. The concentration of stress depends on the graphite shape, the largest in gray cast iron with the smallest graphite graphite in graphite with round-shaped graphite. Thus, ductile cast iron has the highest durability coupled with the best plasticity in cast iron. In addition, the presence of graphite in cast iron has some good mechanical effects such as increased frictional wear resistance (because graphite itself is lubricated, in addition there is a "hole" of graphite that holds lubricating oil, such as when used as a sliding disk), to switch off vibration and resonance oscillations.In terms of technology, cast iron and good machining characteristics: cast irons are commonly used in the semiconductor composition, so the flow temperature is low, so the high water content is one of the important factors. molding, graphite in gray cast iron, plastic and brittle chip to break when cutting (turning, milling, planing ....). In general, cast iron is not as high synthesized as steel, but good castability, easy machining, simpler production (due to low flow temperature, molten iron and cast iron easier than steel) and cheap. Graphite castings are used extensively in mechanical manufacturing.People use cast iron to make a lot of machine parts. For example, in the car cast iron parts can account for up to 40% of the metal mass, in appliances and static machines, up to 50 - 80%. There are many types of products used in large quantities, made of cast iron such as large water pipes. In general, cast iron is used to make static load bearing parts that are less resistant to impact such as machine supports, shells, lids, and less moving parts.There are now good casts with high mechanical strength, which can be used to replace steel in some cases, such as cast iron for crankshaft.

B. Steel

Carbon steel is a steel in the unorganized organization Ledeburite, in addition to carbon and iron there are some impurities Mn, Si, P, S. Manganese and Silicon go into the composition of steel from the following sources:Into the iron ore, so go into the composition of the cast iron and then into the steel. When steel is used, ferosilicon and ferroanganate are used to remove oxygen, so some of these elements also enter the steel.Mn and Si are two beneficial impurities, which enhance the mechanical properties of steel so that it does not matter to remove them during the process. Under normal conditions of metallurgy, they are in steel with the following amount: Mn <0.8%; Si <0.50%.

Phosphorus and sulfur also go into the composition of pig iron due to their existence in iron ore and fuel. For steel, both elements are harmful impurities, so during the process must remove them. P and S depletion are costly, so just reduce their constituents in steel so that the harmful effect is negligible. Generally speaking, most of the steel, the amount of each element is less than 0.05%. So any carbon steel contains the following elements in the following limits:C <2%, Mn <0.8%, Si <0.5%, P, S <0.05%.

Carbon steel is widely used in engineering and even in machine building because of two basic advantages:

Cheap, not expensive alloy elements, easy to work

There is a certain mechanical and good technology: easy to mold, rolling, forging, spinning, and stamping than for alloy steel.

However, carbon steel also has many disadvantages, including the low permeability, so that the heat treatment efficiency is not high, the temperature resistance is high, while the alloy steel outside the following High thermal properties also have some special properties such as corrosion resistance, high temperature resistance, magnetic properties and special electricity.Alloy steels have properties that are superior to carbon steels, in other words steel alloying is in the following aspects:In general, alloy steel generally has a higher durability (limited durability, flow limitation) than carbon steel, which is especially noticeable after tempering me and ram. This advantage is usually expressed in all steel alloys, the better the strength of this alloy is clear. Along with the increase in the level of alloying, the technology of steel will deteriorate.For high temperature resistance, it is found that carbon steel is relatively stable after steeling, but cannot be kept working at temperatures higher than 200^0C because the magnesite is broken down and the aggregate is agglomerated. Alloy elements interfere with the diffusion of carbon so that the magnesium is dissociated and the carbides are agglomerated at higher temperatures, so that the alloy steel retains high mechanical strength of the mine state at temperatures above 200^0C. To achieve this, steel needs to be alloyed by a relatively high number of elements.

On special physical and chemical properties, it is found that carbon steel is rusted in air, corroded in acidic, basic and saline environments, with no special physical characteristics such as magnetic expansion special heat. This requires the use of a variety of alloy steel with a strong chemical composition.It can be seen that alloy elements work very well. Alloy steels are an inexpensive metal material for heavy machinery, tools, thermoelectricity, chemical industry. It is usually made of the most important detail in heavy working condition.Each alloy element used more or less (not even used) in a particular steel group depends on its effect on the properties of the steel. It is common to see that each steel uses only one alloy element at a certain level.For example, for structural steels that require higher durability, they often use elements that enhance the permeability of chromium, manganese, nickel, and silicon, with a content of 1 to 2 percent. High speed machining tools have to use high strengths such as tungsten, cobalt, molybdenum with high content of 5-20%. Steel with special chemical and physical properties also has special characteristics such as stainless steel containing no less than 12.5% Cr, abrasion resistant steel with 13% Mn, steel technical steel with 2-4% Si etc ...Commonly used elements are chromium, manganese, nickel, silicon, tungsten, molybdenum, vanadium, cobalt, titanium, and boron, in which manganese and silicon are the two most abundant elements.

Structural steel is mainly used for making machine parts (axles, gears, power transmission rods, springs, bearings etc.). Compared to conventional steels, they are used in smaller volumes, but are of a higher quality and have more variety and are often subjected to heat treatment to maximize their performance.As used in machine parts, structural steel has to meet the following two basic requirements: good machinability in the machining state (pressure processing and machining) and good synthesis Workability (mainly high impact strength at the core and high surface hardness to prevent abrasion).About the carbon content: To ensure that structural steel is usually low and medium carbon steel, usually within the range of 0.1-0.6% highest not more than 0.65%.Regarding alloying elements: Alloy elements for structural steel mainly enhance the permeability and improve the mechanical properties (ferrous bond strength), but if too much will undermine the technology and raise the price. Thus the alloy elements in structural steel used less often only 1-3%, individual also only 6-7%.

C. Aliminum

Unlike iron with a history of thousands of years, aluminum has a history of over a century, but has a tremendous amount of money because of its large reserves (nearly twice as much iron), light (nearly triple durable metal (highly durable aluminum alloy that has the same strengths as steel structural steel) and high corrosion resistance (higher iron content).Unlike iron, aluminum is a metal with no transformational transformation, it has only one type of crystal lattice structure, centered on the network parameter a = 4.04 atomic diameter of 2.86. Small mass (γ = 2.7 g/cm^3) should be used extensively in aircraft manufacture.High corrosion resistance: Pure aluminum with high purity is highly corrosive and chemically very high, due to its strong affinity for oxygen, so its surface always has a thin and dense oxide layer of Al2O3. tight, highly protective. The lower the cleanliness of aluminum, the less corrosion resistance it has.High conductivity and electrical conductivity: Aluminum conductivity is high, equal to 60% of copper, plus a lightweight, with the same weight, aluminum conductors are better than copper. In electrical engineering has used quite a lot of electric wire from aluminum. The aluminum conductivity is 0.3426 inches / cm.s.0C higher than iron and steel.Low flow temperatures (6600C) can make the process easier, but aluminum alloys do not work at high temperatures. Hiding the heat of crystallization and melting of large aluminum, so the aluminum castings slowly cooled in the liquid state facilitates the process of refining fineness. However, its castability is not high due to high shrinkage (up to 6%).Relatively low strength: Aluminum with high purity after rolling and incubation has σ_b = 60N / mm2; $\sigma_{0.2}$ = 20N / mm2, a hardness of 25HB is only 1/4 to 1/6 of the iron, so almost no pure aluminum makes the machine parts. In machines, the use of aluminum alloys is significantly higher.High flexibility: Pure aluminum is very flexible, δ = 85%, δ = 40% so it is easy to deform in cold state and in hot state, low cutting machinability of aluminum.

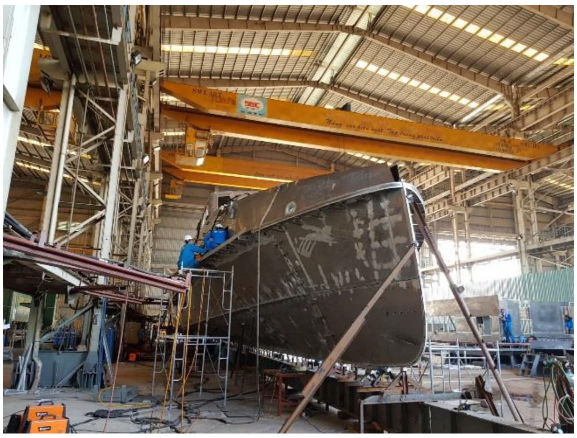


Fig. 3: Aluminum shell ship

Thanks to the higher durability, aluminum is used in the manufacture of alloys.According to technology, aluminum alloys are divided into castings, deformed and sintered.Aluminum alloys and deformed aluminum alloys are produced by melting. The basis for distinguishing the boundary between the two in a given alloy system is the aluminum-alloy state diagram.Deformed aluminum alloys are alloyed aluminum alloys that are within the limits of the solid solution, ie to the left of the C 'point.It is possible that at normal temperature the alloy has not been fully held solid solution (with the second phase added) but when heated to the appropriate temperature (eg higher than the CD) will be held so, very Easily deformed (rolled, forged, stamped) as desired. Alloyed aluminum alloys do not contain the same crystals, which are easily deformed not only at one-phase temperature but also at normal temperatures. Within the range of the aluminum alloy deformation is divided into two groups: thermofiltrate and thermofiltrate. Alloy components on the left side of the D point when heated or cooled have no phase shift and cannot be chemically stable. The alloys at the right of the point D (from D to C '), at normal temperatures outside the solid solution also have a second phase, when heated, this phase is completely dissolved into solid solution when cooled The fast settling of the solid solution is too saturated and becomes unbalanced, releasing dispersed phases for increased durability.Aluminum alloy castings are aluminum alloys with alloying elements so that in their organization they contain essentially identical crystalline castings. In principle, the alloys to the right of the 'C' point in the molding are then co-finned and will be cast aluminum alloys, but in practice they are often used with fairly large components and finally the crystal.It is noted that the alloy aluminum alloy contains a higher amount of alloy elements than aluminum alloy deformation.Sintered aluminum alloys are aluminum alloys made from the original element of supercritical powder and sintered.

D. Copper

Copper is a red metal, so pure copper is technically known as copper. As a non-transforming metal, copper has only one type of crystal lattice structure, centered on a = 3,608A^0, atomic diameter of 2.56A^0.High specific gravity = 8.94 g/cm^3 is three times larger than aluminum. High conductivity and conductivity. In this respect copper is second only to silver so it has very high application in electrical transmission and heat transfer. Good anti-corrosion. Copper has high chemical stability in normal water, seawater, atmospheres and in chemical environments: organic acids, alkalis ...The temperature is relatively high (1083^{0}C), intermediate between iron and aluminum. Copper is strong, so the castings may be porous.Durability is not high but increases when cold deformation occurs. In the cast state the strength of the copper is rather low especially the flow limit σb = 160N / mm2, σ0.2 = 35 N / mm2, HB = 40. In cold deformation state, limited durability and special limited Flow rate is very high σb = 450N / mm2, σ0.2 = 400 N/mm2, HB = 125. Therefore, one of the copper and copper alloys is durable by deformation. The hardness is not high but the corrosion resistance is quite good.The characteristic is copper is very flexible, easy to roll, drawn into thin sheets and fibers are very handy in the technical very handy in engineering, In addition it is very easy to solder. However,

copper has the disadvantage of poor machining and thinning.
Copper alloys are relatively high in mechanical properties, good in technology and less friction while maintaining the advantages of copper as their thermal conductivity, conductivity and good chemical stability.The alloy elements of copper commonly used are Zn, Sn, Al, Be, Mn, Ni ... they significantly improve the durability but actually do not do bad (in some cases also improve) plasticity in the range of concentration Determination. It can be said that plasticity is a prominent advantage of copper alloy.In terms of technology, the copper alloys are divided: deformed alloys and cast alloys. Thermal treatment is divided into two types: durable and non-chemically stable.In practice the prevailing classification of copper alloys by chemical composition. According to the chemical composition, the copper alloys are divided into two main groups: the fly (Zn alloy) and the copper alloy (Zn alloys).

Fig. 4: Propeller

The general advantage of high-temperature sliding alloys is the high pressure resistance due to their high durability (which can work under high pressure conditions). Usually used in gray and gray hair.
Gray cast iron: It is usually used in high quality gray cast irons with a metal base that is fine peclitite and a large amount of graphite. The organization is of a soft, soft-core type, where the graphite has a near zero durability, leaving the surface exposed to "pits" that contain very good lubricants. The cheap gray cast slides have good compression but low rotational speed because of the friction coefficient of the cast iron pair (though graphite produces a lubricant effect for the slider, but not the coefficient friction of cast iron with low steel as in carbide). It is also possible to use cast iron, cast iron with P-background and austenitic gray cast iron for sliding.
Tin tongue: As stated, the slippery tin is a soft material that is solid and solid. The advantage of tin can is that it undergoes great pressure and has a higher ring speed than the gray cast iron, which often makes important slides. Can be used with the numbers BSn10V1 and BSn8Pb12.In practice it is often used with complex tins to make the lining required to resist abrasion and less friction. For the silver lining of the neck and the neck of the crankshaft, the BSn5Zn5Pb5 (in casting state) and BSn4Zn4Pb2.5 (in the deformed state) are used. Solid particles, in the form of individual particles, reduce friction.

Fig. 5: Bearing of crankshaft based on BSn5Zn5Pb5

Sticky: The lead character is characterized by low friction and high thermal conductivity, in addition to good load resistance and damping and fatigue resistance. Therefore, the lead is used as the important slider, high load and high speed as the slip of the aircraft engine, diesel, tuocbin ....BPb30 is currently most commonly used with about 30% lead. Because Pb is insoluble in Cu in solid state and dissolved in liquid state, therefore, when casting, it has the same geometry. Therefore, in order to avoid the phenomenon of crystallization, it is necessary to crystallize molten metal with fast speed. Simultaneously classify and place small Pb particles evenly distributed on the copper substrate. When working the Pb particles are worn out quickly to form an oil reservoir, while the Cu supports the shaft.The BPb30's mechanical properties are relatively low (σb = 60N / mm2, δ = 4%, 25HB), and mechanical properties are often cast onto steel or tubing, Further alloying with Sn, Ni, Mn will form a solid solution with Cu to improve the strength of the alloy and can be used immediately without the steel trough.When using a lead spatula, attention must be paid to the high stiffness of the shaft to prevent wear of the shaft and the lubrication of the oil must be low acidity.

3. Conclusion
The importance of the maritime industry for some countries to the extent that these countries may not have agriculture and mining industries, there are no light and heavy industries ... without dying. But without the maritime industry, those countries cannot be themselves. Singapore is such a country. In other rich capitalist countries with sea, the maritime industry contributes a very large proportion to the gross domestic product of GDP. For Vietnam is a country with a sea along the geographical length and this sea is adjacent to the world's most important international maritime route, the strong ability of the maritime industry is huge. In terms of population, there are about 30 million people living along this coast. Yet its maritime industry is still poor. Every year, only GDP contribution for the whole country is about 5% while it is expected that this proportion can reach 30%.

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