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Alloys: Their Need for the Manufacturing of Metal Spare Parts in Nigeria Amadi Steven W.* and Nwala Augustine Onuegbu

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ABSTRACT

The industrial/military power of any nation is attributed to its ability to produce steel. Alloys are as a result of the combination of a base material with other constituent elements. It is therefore interesting to note that for this well researched paper metallic alloys are a combination of a base metal and other constituents. The main constituents here are the carbon. It is the addition of carbon that change metals to an engineering material, thus, various constituents of carbon carbides can be constituted to give different categories of steel alloys which can be used to produce different spare parts. With various production methods, these steel alloys can be better appreciated by what it can be used to accomplish.

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Introduction

Alloys are mixtures containing two or more metallic elements, for instance, non-metallic elements usually fused together or dissolving into each other when molten. There are several types of alloys. They include, alloy cast iron, alloying elements, usually nickel or chromium or copper, to increase the strength or facilitate heat treatment. Also, an iron alloy is cast iron containing similar elements. Alloys steels are characterized and determined by the addition of other elements in addition to carbon. It is therefore of note that alloy is the lowering of value by increasing the base-metal content. When alloyed, the base-metal content is lowered in value. This study is therefore focused identifying the various processes and elements of base metal required for alloying purposes.

Metals

A metal contains or is made up of several chemical elements that are usually shinny solids that conduct heat or electricity and can be found in sheets. According to (Khanna, 1998), metals play a major role in the industrial and everyday life of human beings. As such, metals are composed of hundreds of elements which readily give up electrons to provide a metallic bond and electrical conductivity.

Broadly speaking, pure metals are not useful engineering material. For (Higgins, 1998), pure metals are rarely used for engineering purposes except where electrical conductivity, high ductility or good corrosion resistance are required. Khurmi and Gupta (1981) stated that metals play an important role in the industries of a nation. The metals used in an industry is of two types; ferrous and non-ferrous metals. Thus, it is essential for the Engineer to know the sources and techniques of its production. Further (Khurmi and Gupta 1981), stated that ferrous metals are defined as those metals which contain iron as their main constituent, such as pig iron cast iron, wrought iron, steel and their alloys. Thus, the principal raw material for all ferrous metals is pig iron. The non-ferrous metals are defined as those metals which are metal other than iron as their main constituents such as copper, aluminum, brass, tin, zinc, etc.

The Ferrous Metals

Khanna (1998), stated that ferrous materials contain iron and the one element people use more than the all others is iron. Ferrous materials are the most important metals/alloys in the metallurgical and mechanical industry because of their very extensive use. Ferrous material can be categorized as ferrous: cast iron, gray cast iron, while cast iron, malleable cast iron, ductile cast iron, steel, plain carbon steels, (low carbon steels, medium carbon steels, high carbon steels) low alloy, steels; high alloy steels: pig iron, and wrought iron. **Pig Iron**

The name pig iron originated from the early days of iron ore reduction when the total amount of the blast furnace was sand cast into pigs – a mass of iron, roughly resembling a reclining pig (Khanna, 1998). For (Khurmi and Gupta, (1981), it is the crude form of iron and is used as a raw material for the production of various other ferrous metals, such as cast iron, wrought iron and steel. It is obtained by smelting iron ore in a blast furnace (Kurmi and Gupta, 1981) and the three principal raw materials required in the production of pig iron are iron ore, fuel and flux.

The oldest method of pig casting in sand beds has been largely superseded by pig casing machines, which are (machine cast pigs) much clearer than sand cast pigs and have no adhering sand to contaminate the remote process. Iron ore according to (Khurmi and Gupta, 1981), is any mineral body from which metal can be economically recovered. Khurmi and Gupta (1981) also stated that the iron ores are never found in prime state but are always associated with earthly matter called the 'Gangue' of the ore. The chief gangue minerals associated with iron ore are in the form of oxides as those of silica, alumina, lime, soda, potash, magnesium, manganese. Sulphur is present in the form of sulphates, and phosphorous as phosphates. The fuel, (Khurmi and Gupta, 1981) most commonly used is the hard code in the blast furnace. It serves to provide the required heat for melting the iron ore which combines with oxygen of the ore in order to minimize the same.

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As a coke used, it should be hard, have high caloric value and low ash content, have high density and good porosity, should be free from phosphorous and sulphur and have uniform size. The flux most commonly used in blast furnace is limestone, but dolomite is also sometimes used (Khurmi and Gupta, 1981). This is used for removing impurities such as ash, sulphur and the residues of the burnt fuel. The flux melts and drives away the impurities in the form of slag, leaving pure iron.

Steel

The pure iron (ferrite) is very soft and ductile. The addition of carbon to this iron brings a great change that occurs in its structure and properties. Steel are iron or pig iron with or added to carbon in various percentages. The more carbon is added to the material the harder the materials while the less the carbon content, the less hard or now ductile the steel is. Steel is here defined as an alloy of iron and carbon. Plain carbon steel is an alloy of iron and carbon and it is malleable.

Carbon steels are different from (cast) iron as regards the percentage of carbon. The (carbon steels) contain 0.10 to 1.5% of carbon cast iron possesses from 1.8 to 4.2% carbon. Carbon steel can be classified as low carbon steel (or mild steel), medium carbon steel and high carbon steel. Khanna (1998), enumerated various grades and qualities/compositions of steels as follows:

Mild Steel

Mild steels or low carbon steels may be classified as follows:

Dead mild steel – C0.05 to 0.15%

Dead steel is used for making steel wire sheets, rivets, screws, pipes, nail and chain. It has a tensile stremm² and a hardness of about 115 BHN.

Mild Steel containing 0.15 to 0.20% carbons has a tensile strength of 420 N/mm² and hardness 125 BHN. It is used for making camshafts, sheets and strips for fan blades, welded tubing, forgings, drag lines, etc.

Mild steel containing 0.20 to 0.30% carbon has a tensile strength of 555 N/MM² and a hardness of 140 BHN. It is used for making valves, gears, crankshafts, connecting rods, railway axles, fish plates, small forging, etc.

Medium carbon steels

Medium carbon steels contains carbon from 0.30% to 0.70%

Steels containing 0.35 to 4.5% carbon have a tensile strength of about 750N/mm². They are used for connecting rods, key stock, wires and rods, shift and break levers, spring chips, axles, gear shafts, small and medium forgings of steels containing 0.45 to 0.55% carbon have a tensile strength of about 1000 N/mm² and are used for making parts that are to be subjected to shock and heavy reversal of stress such as railway coach axles, axles, crank pins and heavy machines, spring shafts, cranks shafts, etc.

Steel containing 0/6 to 0.7% carbon have a tensile strength of 1230 N/mm² and a hardness of 400 - 450 BHN. Such steels are used for making drop forging dies, die blocks, clinch discus, plate panel, set screws, self tapping screws, valve springs, cushion springs, thrust washers, etc.

High Carbon Steels

High carbon steels contain carbon from 0.7 to 1.5% steel containing 0.7 to 0.8% carbon have a tensile strength of 1400N/mm² and a hardness of 450 - 500 BHN. These steels are used for making cold chisels, wrenches, jaws for vises, shear blades, hacksaws, pneumatic drill bits, wheel for railway

service, wire for structural work, automatic clutch dishes, beams, etc.

Steels containing 0.8% to 0.9% carbon have a tensile strength of about 660N/mm² and hardness of 500 BHN. Such steels are used for rock drills, railway raik circular saws, machine chisels, punches and dies, clutch dises, leaf springs, music wires, etc.

Steel containing 0.90 to 1.0% carbon (high carbon steels), have a tensile strength of 580 M/mm² and hardness of 550 - 600 BHN. Such steels are used for making punches and dies, springs (leaf and coil) keys, speed discs, pins, shear blades, etc.

Steel containing 1.0 to 1.1% carbon are used for making railway springs, machine tools, mandrels, knives, twist drills, etc.

Steels containing 1.2 to 1.3% can be used for making files, metal cutting tools reamers, etc. Steel containing 1.3 to 1.5% carbon are used for wire drawing, metal cutting saws, paper knives, metal cutting saws, tools, for turning chilled iron, etc.

Manufacturing Processes

There are several manufacturing processes that can be employed in the production of fabrication of spare parts. These include but not limited to the following: casting, forming, machining and welding casting. Casting according to (Parmar 2003) is perhaps the oldest form of giving shapes to metals and alloys. As it is found suitable, it is the shortest route from ore to the end product and usually the most economical. Though there may be techniques that may be developed not to make materials to be casted, but grey cast iron retains its superior casting properties.

The ability of a material to be casted depends on a number of these factors; fluidity, shrinkages, porosity, stress and segregation properties. Parmar (2003), stated that the castability of a material is high if it has high fluidity, low shrinkage, low affinity to absorbing gases, low stress and uniform strength. Further (Parmar, 2003), these characteristics are found to occur mainly in prime metals and eutectics which have, at least the theoretically, definite melting point. However, mainly, alloys are cast for most of the actual application, as pure metals have usually low strength.

Forming

Forming is the next process that follows casting. These alloys are given desired change by the application of pressure, either by sudden impact as in the case of hammer blows or by slow nealing action as in hydraulic process (Parmar, 2003). Cold forming is also a mechanical working of a metal below its recrystallisation temperature while hot work is accomplished above this temperature. These two, both hot and cold working (or forming) is practiced extensively in industries. However, most materials can be forged or formed. Parmar, (2003), stated that as a rule, the materials which are best suited for casting have poor forming qualities, while the materials best suited for forming are those who have mushy range during solidification.

Machining

Parmar (2003) describes this as a process of giving the desired shape to a given material by cutting the extra unwanted material or by cutting in the form of chips. In this case, the cutting material is harder and stronger than the material to be cut by necessity. Turning, milling, drilling, shaping, planning, reaming, boring, are the machining processes commonly employed. Parmar (2003),

stated that almost all materials can be machined though not by the same ease. Further, Parmar (2003), posits that as a rule, harder materials with high tensile strength are more troublesome to machine as seizure occurs between the work material and the tool. Finally (Parmar, 2003), concludes that there is specific hardness range above and below when the machining efficiency decreases.

Welding

Welding is a process by which spare parts manufacture can be fabricated, although the blacksmith process of forging to join metal pieces together has been practiced before Christ. Parmar (2003), stated that welding is a process of joining two or more parts of materials together. This thus, provides a permanent joint but does not normally affect the metallurgy of components. Many materials can be fabricated by one process or the other, the most widely used of them are mainly classified into oxy-acetylene and arc welding process.

Conclusion

Having critically examined metallic alloys from its basic dominate elements, or metals to its alloyed from pig iron to steel, and finally the process for which it can be put to use in form of spare parts, this paper hereby gives the problems for the production of spare parts in Nigeria, according to Wai and Lilly, (2003) as:

1. Unstable government of the economy.

2. Lack of confidence in Nigerian Engineers that leads to the craze for foreign or imported goods.

3. Lack of political will by Nigerian political leaders.

Recommendations

After a careful analytical study of this project, this paper is therefore making some recommendations which will in turn lift Nigeria from the dumping ground for imports spare parts to one of the industrialized nations in the 2020. Nigerian leaders should through a strong political will direct the production of stocks alloys for the manufacture of spare parts in the country. Nigerians should also, have confidence in their Engineers, Technologists, Technicians, Craftsmen, And Artisan to achieve technological growth.

Nigeria should redirect its industrial location policies. According to (Nwala, 2005), the main factor determining the location of an industry is the easy access to building materials, power supplies, skilled labour, proximity to major markets and transport advantages. The government should formulate economic policies which will encourage industries to be located at a place where they will derive benefits from the presence of others. Nwala, (2003) adds that such policies will lead to increased specialization of processes and availability of subsidiary industries providing for the main industries.

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