The Discussion On The Influence Of The Form And Content Of Carbon On The Properties Of Carbon Steel And Cast Iron

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【abstract】Carbon steel and cast iron are alloys consisting of iron and carbon. The carbon content and the form of its existence have a great influence on its performance. In this paper, the effects of carbon on the hardness, strength, toughness and plasticity of carbon steel and cast iron are analyzed through the difference of carbon content and existence form.

1. Introduction
Carbon steel and cast iron are widely used in the chemical construction industry. Different equipment, different projects, the demand for carbon steel and cast iron is different. In general, we call ferro-carbon alloys with more than 2.11% carbon content cast iron; Ferro-carbon alloys with less than 2.11% carbon content are called steel. The properties of carbon steel and cast iron are different due to the different content and form of carbon.

2. The form of carbon in iron-carbon alloys
Adding a small amount of carbon into the iron can improve the excellent properties of the iron-carbon alloy and obtain the high quality carbon steel and cast iron. According to its hardness, strength, plasticity and toughness are widely used in the chemical construction industry. In general, the plastic of pure iron is very good, but its hardness and strength are low, so it is rarely used in the chemical construction industry. Iron has a body centered cubic lattice structure below 910 degrees Celsius, known as alpha - iron; above 910 degrees Celsius has a face-centered cubic lattice structure called gamma-iron. Alpha- iron is stable below 910 degrees Celsius and gamma- iron is stable above 910 degrees Celsius. Alpha -iron heating or gamma-iron cooling can transform the iron of the two lattice structures, which form the basis of the properties of Fe-C alloys.

2.1. Carbon dissolves in the iron lattice to form a solid solution
When carbon content is very low, the solid solution formed by carbon dissolved in alpha-iron is called ferrite. In most cases, the dissolved carbon does not exceed 0.02%. The solid solution formed by the dissociation of carbon into -iron is called austenite. Austenite is the high-temperature phase of iron-carbon alloy. Austenite has strong carbon solubility, and the maximum carbon content can reach 2%. Ferrite and austenite can still convert to each other. There is only ferrite but no austenite in the microstructure of steel at room temperature. Carbonaceous ferrite and austenite have good plasticity, which is related to its structure. Because when the carbon atoms squeeze into the lattice of the iron atoms, instead of destroying the lattice structure of the iron atoms, you get a solid solution based on the lattice with a small amount of carbon atoms. It is the basis of...
2.2. Carbon and iron form iron carbide (Fe3C) compound
When the carbon content of Fe-C alloy increases, only part of the carbon will dissolve into ferrite and austenite, and the remaining carbon and iron will form iron carbide. The crystalline structure of this compound is called cementite. This cementite is extremely hard, but has very poor plasticity, almost zero. Generally, the carbon content of carbon steel is between 0.1% and 0.5%. At room temperature, carbon steel is composed of ferrite and cementite. The higher the content of carbon in steel, the higher the cementite particles, the higher the strength and the lower the plasticity. If you want to improve the plasticity of steel, it can be heated to high temperature, so that ferrite and cementite into austenite, so that more carbon into the austenite, into a single austenite with good plasticity, enhance its plastic return, for steel forging and pressing to create a good condition.

2.3. Carbon exists in carbon ferroalloy in the form of graphite
When the carbon content of carbon and iron is bigger (generally more than 2.11%), liquid iron carbon alloy in the process of gradually cool, most of the carbon to graphite forms exist in the carbon body and cementite on the matrix of the equivalent of dug many holes in the iron carbon alloy, destroyed the original iron carbon alloy structure form, lead to the strength of the carbon ferroalloy decline instead, this is cast iron instead of high strength carbon content is lower than steel. However, its machinability and wear resistance increased, the reason is the existence of graphite, lubrication.

3. Influence of carbon content on the properties of Fe-C alloys

3.1 Influence of carbon content on the strength, hardness, plasticity and toughness of carbon Steel
As shown in the figure:

Strength: The strength of steel refers to the deformation and fracture of metal material under the action of external force. With the increase of carbon content, the tensile strength and yield strength of carbon steel increase continuously. When the carbon content reaches 0.9%, the strength reaches the maximum. Subsequently, with the increase of carbon content, the amount of iron carbide increases sharply, and the network is obviously distributed on the austenite crystal interface, leading to the decrease of strength. As shown in figure: $\sigma_b$.

Hardness: the hardness of steel refers to the surface layer local volume resistance to hard objects pressed into the ability to produce plastic deformation. Hardness value is expressed as HB. When carbon content increases, carbon mainly exists in the form of cementite containing iron carbide. Iron carbide is a kind of interstitial compound with metal bond and covalent bond. It belongs to orthogonal crystal and its hardness is stronger than iron. Thus, as carbon content increases, carbon steel becomes harder, but more brittle because carbon is not malleable. Figure: HB.

Plasticity: The shaping of steel is the ability of the steel under external forces to steadily produce permanent deformation without destroying its integrity (without breaking or breaking). Plasticity is related to the chemical composition and structure of steel. As carbon content of carbon steel increases, its plasticity decreases. As shown in figure: $\psi$.

Toughness: the toughness of steel refers to the index reflecting strength and plasticity. It is the ability to absorb plastic deformation function and fracture work under impact load. It is directly related to the carbon content of steel. As carbon content increases, its toughness decreases. As shown in figure: $ak$.

Weldability: weldability of steel refers to the degree of consistency between the properties of the weld and the base material after welding. The main index of weldability of steel is the tendency to crack and brittleness in welding area. The main factors affecting weldability are chemical composition and content. With the increase of carbon content, the welding performance decreases, especially when the carbon content exceeds 0.3%, the brittle fracture tendency of steel is large, the weldability is poor, and the performance decreases significantly.

In addition, with the increase of carbon content, the cold bending performance of steel decreases, the cold brittleness and aging sensitivity of steel increases, and the resistance to atmospheric corrosion.

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3.2. Manufacturing process of carbon steel
Due to its low carbon content and good comprehensive performance, carbon steel can be used for casting, forging, welding, cutting and other forms of cold and hot processing, which greatly improves the technological performance of steel manufacturing.

3.3. Corrosion resistance of carbon steel
The corrosion resistance of carbon steel is poor, in acidic conditions (except for concentrated sulfuric acid, because carbon steel and concentrated sulfuric acid contact, will occur on the surface of carbon steel passivation phenomenon, reduce the speed of metal dissolution, has a certain protective effect on steel. Chemical corrosion is easy to occur, so carbon steel can not be directly in contact with acidic medium, otherwise, chemical corrosion will occur, reduce the performance of steel, causing a huge safety hazard; In alkaline condition, carbon steel and alkaline media in direct contact, will produce iron hydroxide and ferrous hydroxide on the surface of steel, attached to the surface of carbon steel, forming a layer of protective film, therefore, at room temperature carbon steel and alkaline chemical medium contact, has a certain corrosion resistance; Steel placed in the air for a long time is prone to electrochemical corrosion. As carbon steel contains carbon, carbon and iron form a galvanic cell with carbon as the positive pole and iron as the negative pole in the air, resulting in the corrosion of iron in steel and affecting the performance of steel. Therefore, can be coated on the surface of iron and steel with a layer of anticorrosive materials, or in the ferrite lattice into manganese, cobalt, nickel, chromium and other metal elements, the formation of alloy steel, can effectively improve the strength of ferrite, can also enhance its anti-corrosion performance.

3.4. Influence of carbon content on the performance of white cast iron
The iron-carbon alloy with carbon content of 2.11-4.3% is called sibeutectic iron. Iron-carbon alloys with a carbon content of more than 4.3% are called eutectic iron. Because of the high carbon content in cast iron, there is hard and brittle cabbage, it is difficult to be machined. So it is generally used as cast iron.

4. Classification of carbon steel
Carbon steel can be classified into three types according to its carbon content. Low carbon steel; Medium carbon steel; High carbon steel. Generally, the steel with carbon content less than 0.3% is called low carbon steel. Low carbon steel has low strength and hardness, but it has good plasticity and weldability. It can be used to manufacture some small load parts and vessels with strong weldability. The steel with carbon content between 0.3% and 0.6% is called medium carbon steel with moderate...
hardness, strength plasticity, toughness and comprehensive performance. Carbon content in the above 0.6% known as high carbon steel. Its hardness and strength are higher, plasticity is poor, suitable for making springs, steel wire and so on.

5. Application of materials
The form and content of carbon affect the properties of ferro-carbon alloys regularly, which provides a reliable basis for the selection of materials in the chemical construction industry. For example: the required steel hardness, strength, plasticity and toughness to be good material, we should choose a good comprehensive performance of medium carbon steel; to choose good plasticity, toughness, weldability, cold formability of good steel, we should choose low carbon steel; to choose high hardness, good corrosion resistance of steel, we should choose white cast iron.

6. Conclusions
To sum up, it can be seen that carbon exists in different forms and contents, and its performance is also different. Therefore, in the process of factory construction in the chemical construction industry, different types of steel must be selected according to different needs to give full play to their due performance, improve the quality of the project, and control the cost of the project construction process.

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