Preliminary Study on Heat Treatment Problems in Pressure Vessel Design

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Abstract: Pressure vessels have been applied in various industries, but there are many problems in their application, which seriously affect the development of various tasks. The article briefly describes the entry point of heat treatment technology, analyzes the heat treatment problem in pressure vessel design, and puts forward the specific way of post-weld heat treatment, in order to improve the efficiency of pressure vessel use.

1. Introduction

Pressure vessels are commonly used in industrial production. They are mainly used to hold liquids or gases, with a performance of withstanding certain pressures, they have been widely used in various industries. Pressure vessel heat treatment is mainly heated by the use of some media, and then the pressure vessel is insulated and cooled. The internal structure of the pressure vessel changes under the condition that the external shape is sTable. After the heat treatment of the pressure vessel, the performance of the pressure vessel material can be improved, thereby improving the overall performance of the pressure vessel.

2. Overview of heat treatment technology

The essence of heat treatment technology is the process of heating, heat preservation and cooling. The stability of temperature is the most important, and temperature is also the most important parameter. It has a direct influence on the setting of temperature value of heating of pressure vessel and the control of heating range. [1] The manufacture of pressure vessels is basically made of metal materials, so the temperature value needs to be set before heating. Only when the temperature is normal, the performance of the metal material can be guaranteed to be the best. In addition, the pressure vessel needs to be cooled after the heating is completed. It should be noted that the pressure vessel has different materials depending on the state of use, so the speed is different during the cooling process. According to research and analysis, the pressure vessel cooling method and rate are also different. In the control of the cooling rate, attention should be paid to the main methods: slower annealing and faster normalizing.

3. Post-weld heat treatment of pressure vessel and its purpose

The dimensions and conditions in the design of the pressure vessel are determined according to the requirements and need to be fully considered for manufacturing and overhaul. The material of each original of the pressure vessel is determined by analyzing the load, then selecting the appropriate structural pattern, and then determining the dimensions of each component. If the operating environment requirements are high, some parts of the pressure vessel will be damaged after a long time of work, resulting in the complete operation of the whole set of equipment, which will cause serious damage [2].The safety factor of a pressure vessel in an application is primarily affected by the material. The performance of metal materials is mainly affected by factors such as chemical composition, and is also affected by the overall state of heat treatment. Therefore, heat treatment of pressure vessels should be strengthened. Only by ensuring good heat treatment effect of pressure vessels can product quality be guaranteed.

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4. The heat treatment problem after welding

4.1 Austenitic stainless steel as a metal material for the heat treatment of the pressure vessel

Principles of Heating Processing: By heating at a high temperature, the deformation index of the austenitic stainless steel metal material is lowered, and at this time, if the stress position of the pressure vessel is high, flow deformation occurs. After the welding work is completed, the residual stress can also be eliminated, so that the toughness of the pressure vessel can be improved. This method is mainly applied to the heat treatment of a cubic crystal structure container in which a metal material is used as a body center. The austenitic stainless steel metal material belongs to the face-centered cubic structure. Compared with the body-centered cubic crystal structure, the face-centered cube has many slip surfaces, which can improve the toughness of the pressure vessel. Austenitic stainless steel is made of metal material. The pressure vessel can meet the temperature requirement of the preservative. The wall is thin, and the plasticity is high. The residual stress is also small. Even if the cooling is performed, the hardening effect of the material is very low. Therefore, fundamentally no heat treatment is required [3]. At the same time, if the stress is to be eliminated, the heat treatment technology should control the temperature between 600 ℃ and 620 ℃, and the temperature of the austenitic stainless steel material should be between 400 ℃ and 850 ℃. After cooling, the material structure will be corroded. Allergic stainless steel. Therefore, in the heat treatment of the pressure vessel, the temperature requirement is high, and the temperature must be controlled in an appropriate manner to ensure the normal performance of the vessel.

4.2 Heat treatment after welding of composite plate pressure vessel

In the heat treatment process, the composite plate type pressure vessel needs to be further analyzed. Generally, some materials constituting the composite plate need to be heat treated during welding, and the pressure vessel to be fabricated also needs heat treatment even need to select the same heat treatment technology. It should be noted that in the heat treatment, it is necessary to consider the possible reactions of some physical materials to avoid causing a large impact. The main reason is that in the heat processing the composite materials and the welded parts are very easy to be carbonized, which is able to lead to the lower using competence [5].

Thus, when it comes to the heat processing work of composite board style pressure containers, it is necessary to make the considerations about the negative effects of the materials. In order to avoid the considerable lost during the work. Meanwhile, in the processing to produce the pressure containers made by the composite materials, the following requests should be contained that :

(1) The thickness of carbon steel is greater than 3% of the inner diameter of the cylinder in use. (2) If other alloy steel is used in the manufacturing process, the thickness is greater than 2.5% of the inner diameter of the cylinder.

4.3 The heat processing issues of pressure containers based on liquid ammonia

Whether the pressure vessel based on liquid ammonia needs heat treatment, the staff only has to check whether the container is corroded. Corrosion of the container requires the following conditions: (1) The water vapor content of the container should not exceed 0.2%, and there is no carbon dioxide or oxygen. (2) The ambient temperature needs to be controlled above 5 ℃. If a tube-and-plate heat ex-changer is used and liquid nitrogen is the shell-side medium, heat treatment is required and a stepwise form is required. During the heat treatment, the welding between the first outer casing, the rear outer casing and the tube sheet, and finally the local heat treatment ring.

4.4 The heat processing notice issues of pressure containers' design

(1) In the design of the pressure vessel, the heat treatment can be performed after the component is welded. (2) When the pressure vessel is manufactured, technical inspection, heat treatment, etc. can be performed after the welding work is completely completed. (3) The tube-and-plate structural container needs to be in heat treatment technology after the stress, and does not include the use of stainless steel as the material container. (4) The side of the pipe box with low carbon steel or carbon steel is used. If the opening is larger than 1/3 of the inner diameter of the cylinder, heat treatment

for stress relief after welding is required [5]. (5) Because of the different methods and types of solder joints, it is necessary to determine the heat treatment according to the actual conditions to determine whether it needs to be heat treated. (6) After the welding is completed, the coal burning furnace cannot be used for the heat treatment.

5. The post-welding heat processing methods

There are various methods in terms of heat processing, as well as the classify patterns. The heat processing after welding the components and pressure containers mainly includes the followings:

In-furnace heat treatment, sectional furnace heat treatment, local heat treatment, and on-site heat treatment. In pressure vessel design, the overall heat treatment in the furnace is the best choice under known environmental conditions. This method mainly involves placing the whole work piece in the furnace for heating, ensuring uniform heating of the work piece, and controlling the temperature change, and the heat treatment effect is good. The heat treatment in the segmented furnace is mainly due to the large size of the work piece, which is limited in size during the heating process, and can only be heat treated in a segmented manner. In the heat treatment, it is necessary to pay attention to (1) the length of repeated heating of the work piece - to determine the length of the heating to be greater than 1500 mm. (2) Reasonable insulation measures should be taken for the exposed parts of the work piece to prevent large temperature differences between the inside and outside of the furnace. The focus of local heat treatment is on the power of the heat treatment device, the accuracy of temperature control, the heating width, and the insulation measures to meet the actual needs. The on-site heat treatment was also called the post-weld heat treatment of the overall furnace. Pressure vessels require on-site welding during manufacturing or transportation, such as high towers, spherical tanks, etc. The post-weld heat treatment of the whole furnace is mainly to treat the pressure vessel shell as the furnace body of the high-temperature heating furnace. When the interior of the vessel shell is heated, reasonable insulation measures should be taken outside the casing. At this stage, this method is widely used, but it is easily affected by the environment. Rain, snow and strong winds will have a greater impact on the heat treatment effect.

6. Summary

To sum up, there is a wide usage scope of the pressure containers, which are very common in the energy and construction industries. It is a kind of very paramount equipment. The pressure vessel can realize heat conduction and medium separation in the application, but the pressure vessel is complicated and difficult to design. If damage occurs, it will cause more serious consequences. Therefore, in the manufacture of pressure vessels, it is necessary to select a suiTable heat treatment method according to the actual conditions of the materials in order to maximize the performance of the pressure vessel and ensure the stability, reliability and safety of the pressure vessel with high quality.

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