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THERMAL ANALYSIS AND OPTIMISATION OF CERAMIC HEATING PADS FOR SMALL TUBES BY IMPROVED DESIGN OF CERAMIC BEADS

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Abstract - *An FCHP (Flexible Ceramic Heating Pads) are used for stress relieving (SR) process for reaching higher temperatures with uniform heat transfer for about 1000˚C over the welded joints. Ceramic heating pads are made up of Ni-Chrome wire and ceramic beads (alumina). Ceramic beads have high alumina content of about 95% which is capable of producing high thermal conductivity of about 28 W/mk. At this rate, the temperature rise can be brought up to 750˚c which is optimum for stress relieving process. These ceramic heating pads are used for SR process over pipes of diameter 500-1000 mm. When it is to be used in case of tubes of 30-100 mm diameter, the FCHP will not be completely wrapped around the tubes because of the flat surface of ceramic beads. When the ceramic beads are produced in curved shape the wrapping becomes easier and allows complete heat transfer. This enables the user to wrap the pad over tubes having very low pitch distance between two consequent tubes. Thus the ceramic heating pads of curved form can be able to produce much heat transfer. This project finds major application high pressure parts welding and parts subjected high pressure conditions.*

Key Words: Stress Relieving, Flexible Ceramic Heating Pads, Ceramic Beads.

1. INTRODUCTION

Welds are often stress relieved to minimize the internal stresses. The weld is uniformly heated to temperature above 600°C depending on the material and maintained at the same temperature for same time period (called soaking time) depending on the thickness of material and cooled slowly to the room temperature.

1.1 CONSTRUCTION

Ceramic heating pads are made up of Ni-Chrome heating wire surrounded by Ceramic Beads. Ni-Chrome is capable of producing heat energy required for the stress relieving process. Ceramic Beads are used to produce uniform distribution of heat energy with good insulation of electricity. Ceramic Beads of thickness 10.5 mm are used to have good insulation of electricity.

1.2 WORKING

Stress Relieving process is done by, steels are subjected to 680-720°c for about minimum 3 hours (soaking time). Upto 300°C at a faster rate the current flows with the help of energy controller keeping the energy controller at maximum position. After reaching 300°C the heating rate shall be followed strictly. High alloy steel are stress relieved at a heating rate of 100°C per hour. Upto 720°C heating is carried out with the said rate. Then the heating is to be maintained at the same temperature for the Soaking. After achieving the soaking period cooling shall be followed at the same rate. The energy controller is to be manipulated such that the heating, soaking and cooling temperature rates are maintained. Temperature recorder's graph (time vs temperature graph) is the reference for the manipulation. The cooling upto 300°C shall be carried out by manipulation. After reaching the cooling temperature 300°C the Machine is to be switched OFF. The stress relieved joint is kept in still air so that natural cooling will occur. To ensure the stress relieving hardness tester is used to measure the hardness value of the weld joint.

When Ceramic Beads of flat surfaces are used in small tubes it does not wrap completely. So shape of ceramic beads is made curved so as to produce complete heat transfer and easy wrapping of the tubes. These Ceramic Beads are manufactured by die casting process. So it is important to change the shape of die to adapt the requirements in the design.

Works done by the Curved Ceramic Beads are,

- Produces complete heat transfer
- Produces uniform distribution of temperature all over the tube
- Avoids electrical contact
- Reduce strain of wrapping
- Required rate of stress relieving is obtained

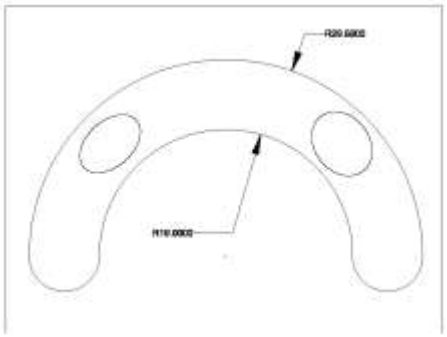

Fig.1 typical example of curved ceramic bead over a tube of 38 mm diameter

1.3 CALCULATION

Calculation of number of tubes that can be wrapped by FCHP if following are the requirements,

Outer Diameter (OD) = 38 mm

Inner Diameter (ID) = 31 mm

Thickness (T) = 7 mm

Circumference = π×OD

= π×38 = 120 mm

Actual pad length = 1200 mm

Actual pad width = 75 mm

No. of tube covered = 1200/200 (minimum pad length required for 2 tubes at a vertical pitch of 80 mm)

= 6 tubes

No. of beads used to wrap one tube is

$$= \frac{circumference\ of\ tube}{bead\ length}$$

$$= \frac{120}{25.5}$$

$$= 4.67 \approx 5\ beads$$

Since the diameter of the tube is considered to be 38 mm, then the radius of curvature is also the same with 5 tubes covering each tube completely.

2. THERMAL ANALYSIS

Thermal analysis of the ceramic beads tells about the temperature distribution in and around the ceramic beads. This enhances clear understanding of the stress relieving process. The temperature at the inner most part of ceramic bead is 1200 k and produce about 950 k around the outer part. So the required thermal distribution can be obtained.

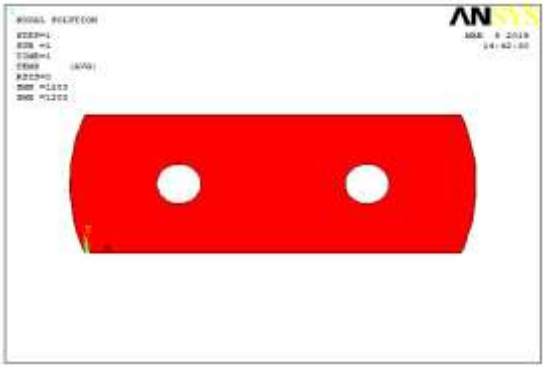

Fig 2 Thermal Analysis of Ceramic Beads with temperature distribution

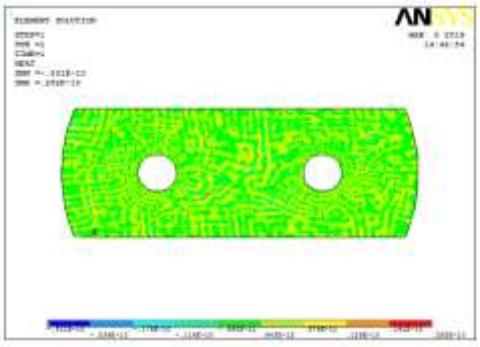

Fig 3 Temperature Distribution of ceramic beads for element solution

3. CONCLUSION

This method will show much better results by improved performance and efficient heat transfer in a minimum time with easier operation. It enables accurate setting of temperatures and in turn required heat output can be obtained. This curved heating pad also avoids continuous manipulation and intervention of the operator. It provides precise control of temperatures for preheating, interpass temperature, PWHT Heating, soaking & Cooling temperatures.

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