STRESS RELIEVING OF MG: AN OVERVIEW

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For Students

- The basic aim for this presentation is to share practical real life situations and decision making process for these; with mechanical engineering students.

Stress relieving of MG

- A large drying cylinder for a paper mill needs to be manufactured. Its dimensions are-
  - Face Length: 3200mm
  - Diameter: 4267mm
  - Shell Thickness: 75mm
  - Dish End Thickness: 65mm
  - Tie Rods: 80mm∅ X 12 Nos.
  - Ribs: 8 nos. each side X 42mm thick
  - Journal Diameter: 320mm
  - Weight: Approx. 45-47MT

Some Photographs of the Cylinder

Some Photographs of the Cylinder

Some Photographs of the Cylinder

Stress Relieving

- Stress relieving is needed to eliminate the stresses developed during fabrication of the same.
- For the same, the temperature needs to be increased gradually to 620^0C, and then reduced slowly.
- For this you need a big furnace in which such a huge equipment can be put.

Furnace for SR

- As a huge furnace is required for this big and heavy job, it it available at Vadodara.
- The bed of this furnace is retractable.
- Images shows MG being put on furnace bed.

Retractable Bed

MG Kept on Furnace Bed

Bed Moving inside Furnace

A Typical Furnace in Action

Stress Relieving Process

- Your mill has placed the order to the manufacturer in Ahmedabad, but, the furnace is available at Vadodara.
- The whole manufacturing process is going to be-
  - Fabricate
  - Transport it to Vadodara for SR
  - Get SR Done
  - Transport back to Ahmedabad
  - Get it machined

Costs Involved

- The additional costs involved include-

- Loading & Unloading at two places.
- Transportation to and from
- SR Charges

- Typically, these are nearly 10-15% of equipment cost.

A Cheaper Alternate

- While you are busy with negotiating with transporters, the manufacturer comes up with a simple alternate-
  - The cylinder shall be covered with glass wool
  - From the manhole, HSD shall be injected and fired inside the cylinder.
  - Exhaust gases will come out from manhole and journal steam entry opening.
  - Cost for SR alone shall be nearly the half.
  - However, in place of reaching a temperature of 620^{0}C, it could be around 500^{0}C or so.

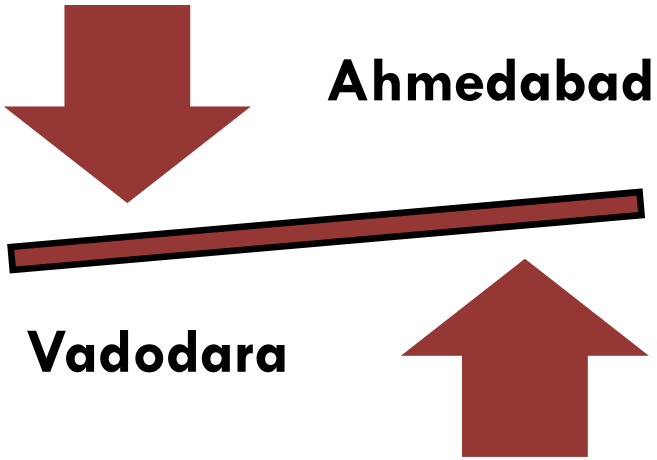
Market Trends

- As per the supplier, only a few mills opt for Vadodara option, as the cylinder has to operate at 170-180^{0}C maximum.
- Most mills follow the same path and save money.
- A few mills had decided not to get the SR done, and use the cylinder after fabrication and machining only.

- Now, **you** have to **decide**! & the choices are…..

The Choices are-

- Get SR done at Vadodara.
  - Typical Cost: 4.0-6.0 L
- Get SR done at Ahmedabad only.
  - Typical Cost: 1.0-1.5 L
- Go ahead without SR.
  - Typical Cost: Free!
- **Your answer?**
  - Why?



Clues

- As you want to decide, you asked the amount of HSD consumed for SR by both process.
- An In-Situ process needs around 500-700 lit., while in furnace, it may need around 1500-1800 lit., as the furnace is really big enough.
- Does HSD consumption figure help you in making a decision?

How to Check Temperature Achieved?

- In both cases, the person doing SR will mount three sensors on the surface of cylinder, and the readings shall be recorded on a plotter.
- He is ready to show you the calibration certificate of sensors and chart recorder also.

- Still, if he can manage to display higher readings on plotter, can you check it? How?

Temperature Cross Checks

- Pyrometer
  - A pyrometer is the simplest method to cross check the temperature.
- Fuel Consumed
  - A too low fuel consumption means the desired temperature cannot be achieved. We shall discuss how to calculate theoretical fuel consumption in later sections.
- TEMPINDIC Crayons
  - Temperature sensitive crayons are available in the market for various ranges. Just make a mark on the metal surface and after the job cools down, observe the mark. If the mark has smeared, the temperature had crossed the limit for that crayon. In case you are targeting 620^{0}C, you may use three different crayons for ranges 550-575, 575-600 and 600-625.

Temperature Cross Checks

- Use of magnet
  - Long back, I used this idea when I had nothing to use. Pyrometer was out of order, TEMPINDIC Crayons could not be supplied by the supplier in time and No other option was available. I could manage to get four tiny magnets by breaking my mobile belt case. These were stuck at different places on the cylinder. As the temperature increased beyond 320-330^{0}C, these fell off one by one (Magnets loose the magnetism if heated beyond this temperature). The display was showing (almost) the same temperature, so I knew that I am not being cheated. Had the display showed a much higher temperature, it means that there was something wrong!

Additional Questions

- What is the theoretical HSD required for the whole process?
- Can you calculate it?

Calculating HSD Requirements

- Multiply weight of cylinder with specific heat of material (Mild Steel) and with temperature increase.
- This gives you the heat absorbed by the material.
- You need to add some 15, 20, or 25% as compensation for heat loss.
- Now, consider overall combustion efficiency as say 75% or so. (Remember: at 620^{0}C, exhaust will be at a temperature higher than this- Huge heat loss!)
- Now, divide this with the calorific value of HSD.
- Don't forget to convert HSD weight thus calculated into volume.

Calculating Air for Combustion

- As you have calculated the quantity of HSD, you need to multiply it with stoichiometic air requirement for the combustion of HSD.
- It is something around say 10 kg air per kg of HSD.
- Add 15-20% excess air.
- This gives you the air requirement for SR, which you need to supply within 3-4 hours.
- Calculate the volume of the same by dividing the calculated weight by density of air.

Calculating Exhaust Air Volume

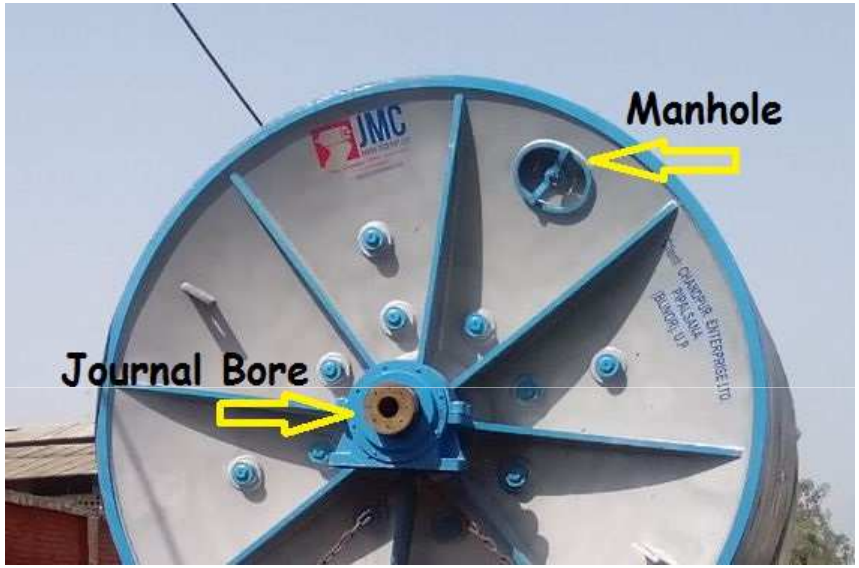
- Against combustion air, exhaust air will be the sum of combustion air and the quantity of HSD consumed.
- Being it at higher temperature, the density will be much lower.
- Find out the density at this temperature and thus the volume.

Internal Firing

- You need nearly three-four hours to increase temperature @100-150^{0}C per hour.
- The cylinder has two openings, first the manhole, and second the 125mm bore inside one of the journal (for steam entry).
- Are these two openings sufficient enough to accommodate the air supply and exhaust gases release from the cylinder?

Handling the Air

- As you know, now the volume of combustion air and the exhaust, and you know the open area available for these (The manhole and a hole in journal), what could be the velocity of air while passing through these openings?
- Are these within acceptable limits or not?



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Thank You.

About

- Born in 1968, **D K Singhal** is B.E., M.E. (Pulp & Paper, 1993) from Dept. of Paper Technology, University of Roorkee (now IIT, Roorkee). Certified Energy Auditor and Chartered Engineer. Contributed nearly 100 publications on energymanagertraining.com, slideshare.net, paperonweb.com, IPPTA and youtube.com. He is also serving IPPTA as a member of Editorial Board. An initiative, a cyber campaign initiated against unjustified targeting of paper industry by "Idea" mobile, in their "**Sirjee**" advertisement campaign, after which this advertisement was taken off air. Moderated a Facebook group, "**PaperTechnology**" with nearly 2000 members from India and abroad to discuss problems related to pulp & paper making for more than 5 years.

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