Suggestive Improvements in Yankee Internal Design

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Objective

- The objective of this presentation is to indicate the possibility of a modified design Yankee tray for better condensate removal.
- It must be indicated that the design is only for slow speed Yankee cylinders where the condensate behavior is ‘Ponding’.
Design of Conventional Yankee
Conventional Trays

SCALE: 1:10

Scoping Ø8" Pipe half pieces
Present Tray Design

- Currently, the tray is made across the full deckle of the yankee dryer. The concept is to provide exactly same heat transfer conditions throughout the deckle.
Design Limitation

- If we consider condensate is being removed from the drive side, the condensate from the tender side cannot easily reach the drive side due to lack of driving force.
- As a result, sufficient amount of condensate needs to get build up before a part of condensate is removed.
- Let us see this in next slide-
Tray Simulated Schematic

- As clear from the above the level at left side is higher than the right side from where the condensate is removed.
- This way, all condensate cannot go to straw pipe and cannot be fully removed from yankee.
Straw Pipes

- Straw pipes are in spiral shape and connect the tray to the rotary joint condensate connection.
- Their design allows the condensate to flow only in the desired direction.
- Yet, it is interesting to know the quantity of condensate handled by individual straw pipe in one go.
Typical Calculations

- Let us consider a yankee of a 70 TPD machine, steam consumption @1.6T/T, two straw, yankee diameter 4.8M and machine speed of 400mpm.
- Let us make some simple calculations.
- Speed: 400mpm
- Rotational Speed: \(400/(4.8 \times 3.14)\)rpm
- Rotational Speed: 26.5 rev/min.
- Scoop Acting: 53 times per min. (2*26.5)
Calculations:

- Steam Consumption: 112 TPD (70 * 1.6)
- Steam Consumption: 77.8 LPM
- Condensate removed: 1.47 Lit. per cycle.
  
  \[
  \frac{77.8}{53}
  \]

- Looks strange, but scoop needs to handle less than 2 liters of condensate or so at one go.
Flow of Water

- Flow of condensate, water or any other liquid follows a very basic rule. The more is driving force (the head or level difference), the faster will be the flow.
- By keeping the tray horizontal, we are not giving any driving force, and the condensate comes to straw pipe just by the head developed due to accumulated condensate.
Tray Flooding

- As indicated in earlier slides, as the condensate needs to get build up in trays before removal, some condensate always remains in the yankee.
- This condensate creates various operational problems in yankee cylinders.
Effects of Accumulated Condensate

- Due to accumulated condensate, some of the yankee internal surface remains insulated for heat transfer.
- This results in reduced heat transfer and hence reduced production.
- In some cases, condensate is removed all of a sudden by one tray, and the other tray does not get adequate condensate. This looks like unbalanced yankee operation, however, un-identical tray is the main reason for this.
• In some cases, this condensate exerts back pressure on tray, and hence yankee, thus creating a ‘jerk’ on the dryer.
• This can be observed in sudden fluctuation in yankee drive twice in every rotation. If the trays are not identical, the jerk will be more and once in every rotation.
Proposed Tray Design.

- To avoid such problems, it is proposed to use the following alterations in tray design:
  
  1. Use of tilted tray
  2. Use of a condensate collection can
‘TILTED TRAY’

- The proposed tray is slightly tilted for providing additional head so that condensate removal is quicker.
- The degree of tilt can be designed depending on condensate load, yankee diameter, face length and rotational speed.
Variable Tilting

- In fact, such an alteration allows altering angles of tilt with reference to axial position of tray in the Yankee cylinder.
- When the tray is at bottom of Yankee, practically there will be no driving force as the both ends of tray are at same elevation.
Variable Tilting

- But, as the tray reaches at a level of centre line of yankee dryer, the angle will be maximum.
- This allows gradual increase in condensate speed towards the outlet side of tray.
Effect of Tray Position on Tilt Angle

- A graph indicates tentative slope of tray at different positions with reference to vertical downwards.
Result

- No accumulated condensate.
- Improved heat transfer, hence
- Increased production.
- No mechanical jerk.
- Less possibility of tray detachment due to weld breaking.
Condensate Collection Can (CCC)

- In addition to the tray tilting, the next approach is to mount a small pit for collecting condensate.
- When a fluid is allowed to drain from an open chamber through a small opening, flow restriction takes place.
- The conventional tray opening results in a flow that looks like as shown in next slide-
Existing System

- Condensate removal from the existing system is just like the flow through a sudden contraction, where, the flow is restricted as a vortex is formed.
**CCC**

- The purpose of CCC is to allow sufficient space for the condensate to reside before it goes to straw pipe.
- The capacity of CCC is kept according to the quantity of condensate to be handled by the straw pipe in one go.
CCC Shapes

• CCC can be designed in any suitable shape, but essentially, the bottom is a conical one.

• However, a typical inverted milk can design seems sufficient for this purpose.

• The top of the can should be comparable to the tray width.
Advantages of CCC

- CCC allows condensate to collect and transfer gradually to the straw pipe with lesser amount of entrained steam, thereby reducing the need of blow through.
- As the shock load is reduced, the rotary joint seals rings give a longer life, thereby reducing downtime to replace the seals.
Overall Gains

- By installation of ‘tilt tray’ and ‘CCC’, you get-
  - Increased production.
  - Improved condensate removal from yankee.
  - No condensate hammering inside yankee.
  - Better rotary joint seals life.
  - Reduced blow through.
Acknowledgement

- In fact, I was thinking to reserve my IPRs for this work, by applying for a patent or design registration. It was my friend who suggested that if every good work had been patented, think how costly our life would have been. He inspired me to not think of only myself and consider the whole world as “Vaasudhaiv Kutumbakam” (i.e. the whole world is my family). That is why.....
Acknowledgement

I dedicate this presentation to

MOHIT KUMAR SINGHAL
CA, ICWA, CS, LLB, MBA
Thank You.

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