Optimisation of LDO during Steam Blowing of 600 MW Units

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I. OBJECTIVE OF COMMISSIONING TEAM

To achieve target with minimum oil consumption, by adopting best commissioning and operation practices.

1.1 Purpose of Blowing

Steam Blowing is a process of removing loose debris, welding slag, loose foreign materials, iron pieces, rust etc. generated during manufacturing, transportation & erection phase from MS, CRH, HRH, HP & LP bypass pipe lines & SH, RH.

1.2 Brief about Blowing

Blowing can be carried out mainly by two media:-
1. Steam.
2. Air

1.3 Steam & Air Blowing

Methods employed:
- Continuous Steam Blowing
- Conventional Steam Blowing
- Air Blowing

1.4 Continuous Steady State Conditions

- Reduced noise level
- Optimised blow duration
- Blowing achieved at low pressure
- Steam flow requirement approximately 30% of maximum capacity

1.5 Conventional (Puffing) Steam Blowing

- Transient steam conditions
- Higher noise level Longer blow duration and high number of blowing cycles
- Higher DF can be achieved. Steam lines subjected to high mechanical forces and thermal stress

1.6 Air Blowing

- Discontinuous
- Air blowing cycles at high pressure (around 35kg/cm²)
- Instantaneously creates high flow rates using a quick opening valve
- High drag forces giving very effective fluidisation of debris
- Considerable reduction of cleaning programme time and commissioning

- Compressed air blows have been used effectively on applications for supercritical boilers, drum-type boilers, and heat recovery steam generators for pre-operational cleaning of main steam lines at power plants with ratings from 35 to 700 MW. The procedure is similar to a steam blow.
- The procedure is similar to a steam blow down except that compressed air is used as the cleaning medium. The system is pressurized using rented compressors or site equipment and depressurized by rapidly opening the temporary valve. The cycle is repeated until the cleanliness criteria have been satisfied. The noise level is similar to steam-blows, and mufflers should be used in populated areas.
- GE’s Power Plant Engineering has historically used air-blows for preoperational cleaning of main steam lines. The recent use of compressed air-blows has confirmed industry experience that this approach is equally effective in cleaning main steam lines.
II. COMPARISON BETWEEN PUFFING & CONTINUOUS METHOD

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<tr>
<th>PUFFING METHOD</th>
<th>CONTINUOUS METHOD</th>
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<tr>
<td>• More time required for complete steam blowing due to stage wise blowing(8-10 days)</td>
<td>• Less time required for completion (3-4 days)</td>
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<td>• More time required for stage wise temporary pipe erection and shifting of blowing device</td>
<td>• Less time required as only valves to be opened for different systems</td>
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<td>• No mill required</td>
<td>• Minimum 02 nos. of mill required</td>
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<tr>
<td>• High oil consumption</td>
<td>• Less oil consumption</td>
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<td>• As per experts opinion this method gives slightly better quality results than continuous blowing.</td>
<td>• Steam velocity or Removal force is the driving force with constant velocity.</td>
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<td>• Thermal shock is the driving force of cleaning with predetermined steam velocity.</td>
<td>• Less thermal stress on tube material</td>
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<td>• More thermal stress on tube material and sudden loading on supports</td>
<td>• Light-up only once in the beginning of the steam blowing</td>
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<td>• Repeated light-up and shutdown</td>
<td>• DM water make-up to the system during steam blowing is a challenge</td>
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<td>• There is a time gap between the blows to make-up DM water</td>
<td>• System normalization time after steam blowing is less.</td>
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<td>• System normalization time after steam blowing is more</td>
<td>• Silencer use is compulsory.</td>
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A. Effect of Blowing Depends on
   1) Thermal shock
   2) Removal/ Cleaning force of steam

• Thermal Shock
   To give a thermal shock to the contour being purged, to dislodge the scale etc.

   Procedure: Raise the boiler pressure to a pre-determined value (50 kg/cm²), shut off firing and at the same time open the quick opening valve (EOTV), thus allowing the steam to escape to atm. (up to 25 kg/cm²) with high velocity carrying with it the loose debris.

• Cleaning Force of Steam
   The necessity to create in the system, the steam velocity greater than that is possible at MCR condition is obvious. These two velocities are expressed as a ratio “Cleaning factor” or “Disturbance factor” or “Cleaning Force Ratio”.

   • Cleaning Force Required (CFR) or Disturbance Factor
     \[
     \text{Disturbance Factor} = \frac{Q_b \times V_b}{Q_{MCR} \times V_{MCR}}
     \]

B. Estimation of Oil Consumption
   As per our unit capacity & condition, BHEL estimated 1700 kL LDO consumption for the completion of entire process and DBPL Commissioning Team further accessed the activity for LDO consumption & estimated 1300 KL, & finally we optimized the entire process in 925 kL.

C. Planning For Steam Blowing ( puffing–Method as per BHEL)
   • Meticulous planning.
   • Brainstorming Meetings in all level.
   • Pre-commissioning checklist.
   • Operation as per standard procedures.
   • Readiness to handle Emergencies.
   • Coordination with all stake-holders.

D. Measures Taken During Steam Blowing
   • Deployment of manpower in all areas.
   • Discussion with manufacturer at all concerns related to steam blowing.
   • Discussion with project team.
   • Discussion with instrumentation and electrical team for automation and healthiness of the related equipment.
   • Day to day meeting for solving past problems and making next day activity plan.

E. Preconditions
   • Chemical cleaning should be completed
   • All safety valve disc installed after removing hydrostatic plug in drum(sub-critical), super heaters and Reheater
   • Adequate communication between control room, boiler and TG area ensured.

\[ g \text{ = Acceleration due to gravity} = \text{m/Sec}^2 \]

K = Constant = 1.3,

P = Pressure at the exit pipe

\[ V_b = \text{Sp. Volume} \]

= Kg/Sq.cm

= Cu.m/Kg
• Flow nozzle, control valves and NRV flaps wherever applicable should be not erected before steam blowing and suitable spool pieces are erected. Strainers in the path should be removed.
• Required number of Target Plates and holder made available.

F. Time Management Planning
• Light up at the scheduled time.
• Strictly maintained the time interval between consecutive blows.
• Rotation of gun at regular time interval.
• APH soot blowing after every 90mins.
• Taking APH in service after achieving exit gas temperature.

G. Boiler Light-Up before Steam Blowing Activity
• Chemical preparation of feed water to boiler.
• SADC and instruments are ready.
• After attaining drum pressure each section header draining done 15-20 minutes each according to the flow path.
• SH roof inlet header 𝛥BP lower front& rear header 𝛥Divisional panel inlet header 𝛥SH platen inlet header this was done to avoid loose material carryover to super heater coils and thermal shock up to 8 kg/cm² & boiler box-up.

H. Using Economic Oil Spray Nozzle
Economic oil gun nozzle tip was used at higher elevations in combination with design nozzle tip. We got recommended steam temperature with less oil consumption.

I. Optimization of Air
• Design air flow for boiler light-up is 30% to 40%.
• We operated boiler during oil firing in 30% of design air flow (by this we saved approx. 0.5kL LDO/hour).
• Controlled air by checking physical appearance of stack emission.
• As SADC was commissioned and as per logic it was auto operate 60% of corresponding gun to control flame healthiness.
• Also by physical appearance of flame.
• By regulating oil pressure and flow.

J. Achieved Blowing Parameters
• Drum pressure = 50-25 Kg/cm²
• MS temp = 340-300°C
• HRH temp = 350-310°C
• Steam flow = approx 70 tons/blow
• Higher sp. Volume of steam can make higher DF which is achieved by using economic spray oil tip (higher blowing steam temperature).

K. As per Recommended Thermal Shock (ΔT< =40°C)
• At 50 kg/cm² saturation temp = 262.73
• At 25 kg/cm² saturation temp = 222.92
• ΔT = 39.81°C

L. Summary of Steam Blowing
Stage-I- Total blow given 36, Oil consumption 505.62kl
Stage1A- SH, MSL, ESV, temporary lines from ESV to EOTV, EOTV to CRH line and CRH lines up to boiler end before attemperators with temporary exhaust pipe. Tap off lines from CRH for Deaerator, TDBFPs, auxiliary PRDS, HP heater 6a & 6b, gland sealing, etc. shall be remain closed/isolated. Stage 1A end point will be concluded by observing the indents on the target plate.

Stage 1B – SH, MSL, HP bypass inter connection, EOTV valve mounted in place of HP bypass valve and CRH lines up to Boiler end with temporary exhaust piping. In this stage 6 to 8 blows shall be given through HP bypass to ensure cleanliness of the limb.

• Stage-2- Total blow given 32. Oil consumption 420kl
• Stage 2A - 1a plus Reheater, HRH Line, IV and temporary pipe. CRH line along with attemperator shall be welded with Reheater before start of stage 2a. LP bypass lines shall be blanked during stage 2a. Stage 2a end point will be concluded by observing the indents on target plates. In this stage 40 blows are expected.

• Stage 2B – 1a plus Reheater, HRH Line, LP bypass lines with temporary exhaust pipe. LP Bypass blanks shall be removed for stage 2b.Dummy shall be provided in the temporary piping at O/L of IP (SV). 6 to 8 blows will be given through HP bypass line to ensure cleanliness of the limbs.

M. Steam Blowing Completion Criteria
• At least 2 continuous target plates should not have ORIFICE GRANULARITY larger than 0.5 mm.
• DF should be 1.25 to 1.4.
• No. of orifice granularity shall not surpass 05 nos.

N. Oil Savings Pattern
• By air flow trimming: 0.5kl/hour
• Economic oil spray tip:1kl/hour
• Optimum number of effective blowing reduces oil consumption 25 kl/day
• Average oil consumption /blow (925/68)=13.60 kl

III. CONCLUSION
For reducing the oil consumption during steam blowing the following areas to be considered:-
• Emergency planning and short meetings should be organized to discuss with all stake holders and readiness of the system.
• Chemical parameter in feed water should be strictly maintained as per design.
• Superheater draining should be done in a planned manner in sequence with flow path after attaining drum pressure above 2kg/cm² in first boiler light-up..
• Depending on the status of the plant coal can be used off let in some of the units during steam blowing activity keeping an eye on reheater metal temperature.
• Use of economic oil spray tip combination with design oil tip can be beneficial.
• Air flow in boiler during the activity should be around 30% or design lower side.
• Strict observation on rate of rise of pressure and temperature.
• Strictly maintain time gap between consecutive blows.
• APH soot-blowing should be done in regular interval of time.

• Disturbance factor should be monitored in every blow.
• Plan number of blows per day would be within 8 or 9.
• APH should be taken in service after achieving flue gas exit temperature.

We also recommend that our Indian makers should introduce systems in which we can use air blowing instead of steam blowing so that precious oil can be saved & boiler life can be increased.

Fig. 1: Steam Blowing Scheme for Stage 1a and 1b

Fig. 2 Steam Blowing Scheme for Stage 2a and 2b

ABOUT THE AUTHOR

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