

Energy Conservation Through Implementation of Steam Audit Recommendations

1.0 Introduction

In the days of soaring fuel prices the need for energy conservation cannot be over emphasised. Typically in the operation of a refinery fuel consumed for generation of steam varies from 30-40% of total fuel consumption. CRL has got an installed steam generation capacity of 377T/Hr of which 213T/Hr is HP steam at 39Kg/ Cm² and 164 T/Hr MP steam at 18Kg/Cm². The total process steam load for the refinery when operating at full load is around 258 T/Hr. In addition to this 30T/Hr of steam is condensed in STG for power generation. The DHDS facilities with 120T/hr of installed capacity will add another 60T/Hr to the steam load and for the 9MW power additionally required, the condensation in STG will be increased from the present 30T/Hr to 60T/Hr.

An audit of the steam generation and distribution system was conducted to identify the shortfalls within the system and to suggest improvements.

2.0 Scope & Methodology of the Audit

As built P&ID were prepared for the entire HP, MP, LP system, a mass balance was one to check the potential for condensate recovery. A trap survey was conducted to identify the faulty traps using a trap man. Using a test rig an efficiency comparison of TD trap and Balanced Pressure Thermostatic (BPT) trap was made and found that the latter one is more efficient for steam tracing application. The performance of the system was analysed and modifications were suggested to recover condensate and conserve steam in different application.

3.0 Steam and Condensate Balance

Steam generation from utility boilers and waste heat boilers were found from the respective meters. Steam consumption in process units was found from the meters wherever available otherwise it was estimated from the heat load. For turbine drives the consumption figures were estimated from the design data. Wherever meters were not available. Fuel oil atomisation steam requirement is taken as 20% of fuel fired. Steam consumption in steam tracing is equal to no of traps times the average consumption of trap which was found to be 4.5 Kg/Hr for LP steam and 8 Kg/Hr for MP steam. Steam consumption in deaerators was approximated to 8% of the steam generation. Condensate load due to steam distribution is equal to 3% of the total steam generation. The surface temperature for the mains and steam distribution lines were found to be within the tolerable limits of 35-40°C. The line sizing found to be adequate with the steam velocity within the range of 25-30 m/sec.

4.0 Steam Trap Performance Survey

One of the objectives of this survey was to establish the efficiency of Balanced Pressure Thermostatic trap over the Thermodynamic trap in steam tracing application. The tests were conducted on Energy Conservation and Loss Control a test rig formed of 15NB pipes, which would act as radiation surface to give constant heating load. A moisture separator and pressure reducing valve was provided in the upstream of test rig to ensure supply of dry steam at constant pressure. A digital temperature indicator and a high pressure sight glass provided observe the temperature and flooding of condensate upstream of trap.

The Thermodynamic trap discharged 7.5% more condensate than the balanced Pressure Thermostatic trap at a load of 3Kg/Hr and the temperature of condensate was only 1°C below the steam temperature whereas a Balanced Pressure Thermostatic Trap shown a condensate temperature 17°C below the steam temperature.

Accumulation of condensate in the condensate leg was noticed for BPT trap while TD trap did not allow any condensate to get collected at the inlet. The test was repeated at higher pressure and higher load and sub cooling of the condensate was observed while using BPT traps. The BPT trap utilises the sensible heat of the condensate to heat by sub cooling the condensate to 15-20°C under different pressure ranges and thus saves steam. The BPT traps have got excellent air venting capacity and helps in reducing the start up time and are ideal for tracing line applications as its pressure rating is 21 bar and the temperature rating is 285°C.

A steam tap survey was also conducted to check leakage, operation, installation and type of traps in all pressure ranges especially LP (4.5Kg/Cm²), MP (15Kg/Cm²) and HP (38 Kg/Cm²). The list of working traps, cold traps and leaking traps were made. Thermodynamic traps used for condensate removal constituted 17% of trap population and 3% of trap population was in heating coils and heaters. Some of the heating coils identified with TD traps needs to be changed with float type traps. Average heat load for LP steam tracing was found to be 4.5 Kg/Hr and that for MP steam tracing it was 8Kg/Hr.. Leaks thorough traps for the entire refinery area was quantified and found to be around 1.3 T/Hr. Around 3% of steam generated was removed as condensate from the distribution lines.

5.0 Recommendations

The following schemes for conserving energy through better condensate recovery and steam conservation were suggested:-

- Install 1/2" thermostatic trap on open ended copper tube tracing
- Replace thermodynamic trap with more efficient Balanced pressure thermostatic trap to conserve steam in tracing application
- Recover 9.6T/Hr of condensate from Bitumen, VGO tank farms and other process units
- Install Automated blow down system in all boilers to reduce blow down quantity
- Install air vents at high points in steam distribution lines to improve upon the heat transfer rates
- Use of LP steam for offsite tracing instead of medium pressure steam. The pay back calculations for all the above recommendations were made and found to be commercially attractive. One of the proposals for installing a thermo-compressor to recover LP steam was not considered for implementation, as the pay back was unattractive. Similarly installation of density compensated steam flow meter in place of the existing flow meters were not considered, as it was not commercially viable.

The total investment for all the above proposal is around Rs. 123 lakhs and its implementation saves around 3000 T/Yr. of fuel. The derived pay back is around Rs 243 lakhs/ Year based on the current fuel price at Rs 8100/ Energy conservation Ton making an overall pay back period of only six months. Please see Annexure - 1 for details.

5.1 Installation of "A" BPT

Traps on Open Ended Copper Tracing Tubes Copper tubes of 3mm and 6mm are used for steam tracing of impulse line of flow meters, pressure gauges etc. These tracer lines are left open without steam traps at the end, during survey we have identified around 40 nos. open-ended tubes. It is now recommended to install 1/2" thermostatic traps at these tube ends and can conserve around 1.25T/hr of steam.

5.2 Replacing TD

Traps with BPT Traps Steam traps survey was carried out over the entire refinery using ultrasonic trap tester. The cold traps and the leaking traps were identified and tagged. We have conducted a rig study to establish the efficiency of BPT traps and found that there is a saving of 7.5% for BPT traps with average steam load of 4.5 Kg/hr. Also it was noted that the BPT traps the sensible heat of the condensate to heat which results in savings of 15 to 20 Kcal /Kg of steam. In view of this it was proposed to change from thermodynamic traps to balanced pressure thermostatic traps in all tracer line application in a phased manner.

These traps can operate under different pressure ranges without affecting the performance and can always discharge at 15-20 °C below saturation temperature of steam and also has got excellent air venting capacity and high condensate discharge during start up.

5.3 Condensate Recovery

Of the total steam load of 258 tons/hr we are recovering condensate upto 122 tons/hr. After the steam audit we have identified some more condensate recovery potential in the refinery. The following areas were identified for recovery of condensate:

5.3.1 Recovering condensate Jrom bitumen tank/arm area:

There are 4 bitumen and 3 LSHS tanks in this area. Steam is used in the tank steam coils to keep the bitumen and LSHS at pumpable temperature of 100 °C for bitumen and 85 °C for LSHS. Out of the seven tanks six of them uses Medium Pressure steam at 18 Kg/cm² and one uses Low-pressure steam at 4Kg/cm² for heating. We propose to recover MP condensate from all the 6 tanks, connected MP steam tracer lines and the condensate from nearby plant fuel heater to a flash vessel to generate LP steam at 4.5Kg/cm², which can be used for the tank with LP steam coils. The condensate after flashing is pumped to the deaerators using an MP steam powered pump. This is expected to recover around 8.1 Tons/hr of condensate during normal operation. The steam powered pump works without any electrical connection, switches and mechanical seals. The steam consumption for the pump is approximately 5 Kg per 1000 Kg of condensate.

5.3.2 Scheme for recovering condensate from VGO tanks:

The three VGO tanks in this area are provided with LP steam coils to keep VGO at pumpable temperature. Presently the condensate from these tanks being drained. Now we propose the recover this content into flash vessel to generate flash steam, which can be used for tracing application in the nearby areas. The flashed condensate is pumped back to the deaerator using an MP steam powered pump. This scheme is expected to recover around 0.5 T/hr of condensate.

5.3.3 Scheme for recovering condensate Jrom Process units:

The condensate from a Energy Conservation and Loss Control reboiler and DM water heater is being presently drained. Now we propose to collect this condensate into a vented receiver and pump back to boiler deaerator using a steam-powered pump by it is expected to save 1.0T/hr of condensate.

5.4 Automated Blow Down System

At present in CRL the TDS level in the boiler drum is maintained by manual blow down. The manual blow down and its duration is only a guess work and this guess work costs money when the TDS level falls below the stipulated level.

Now we are planning to install an automated blow down in 7 boilers to optimize upon the blow down quantity by maintaining exactly 300 ppm in the drum. The system consists of a self-cleaning sensor in a chamber followed by a blow down control valve with pneumatic actuator and controller. The controller

periodically opens the blow down valve to start a flow of boiler water past the conductivity sensor. The measured value then compared with the desired TDS set point in the controller. If the measured value is less than the set value the blow down valve is closed and if it has reached the set point the blow down valve remains open until the measured value drops below the set point. This system can be provided as a bypass to the existing continuous blow down valve. A sample cooler is also provided at the upstream of the sensor chamber to draw sample and to check the accuracy of the sensor if required.

5.5 Installation of Air Vents

During the audit it was observed that no provision has been made to remove air from the steam distribution lines. Air entrapped in the distribution lines will be carried to the individual heat transfer surfaces and will lead to poor heat transfer efficiency. It was proposed to provide 50 nos. of thermostatic air vents in steam distribution lines at strategic location like the distribution line where it changes elevation or direction, middle portion of an expansion loop, dead end of the distribution lines, etc.

5.6 Use of LP Steam at Offsite Tracing Applications

Presently MP steam is used for tracing line application in offsite areas whereas LP steam can be effectively used for this requirement and can also help to reduce number of leaks. It was proposed to install restriction orifices in these MP steam lines to offsite for pressure reduction.

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Reference:

http://www.centreforhightechnology.com/Literature/Articles/Steam_Audit_Recommendations.asp