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Condensate Recovery in a Plant and its Improvement

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Abstract - Condensate recovery systems help us reduce three tangible costs of producing steam:

- Fuel/energy costs
- Boiler water make-up and sewage treatment
- Boiler water chemical treatment

The amount of steam generated and the condensate recovered was calculated for the plant. These values were used to find out the Condensate Recovery Factor (CRF) which can be defined as the ratio of the amount of condensate recovered to the amount of steam generated. This paper concentrates on the condensate recovery factor calculation of a Distilled Fatty Acid (DFA) Plant and its improvement by suggesting various methods.

Keywords : condensate, DFA, steam.

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Strictly as per the compliance and regulations of :

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I. Introduction

Distilled Fatty Acid Plant consists of the following sections:

- Splitting
- Crude Glycerin Section (CGS)
- Distillation / Fractionation
- Hydrogenation
- Flaking

a) Splitting Section

In this section, the splitting of oil done, following reaction is carried out at 250°C and 50 bar.

Oil + Water ⟶ Fatty Acid + Glycerin

This reaction is carried out in the two Splitting Towers:

1. Lurgi Splitting Tower
2. Jutasama Splitting Tower

b) Crude Glycerine Section

i. *Pre-concentration (PRECON)*

The triple effect evaporators concentrate sweet water from 15% to 35%.

ii. *Treatment*

In this section, the sweet water is subjected to chemical treatment to remove residual fatty acid and other impurities and is filtered by plate and frame filter press.

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iii. *Post-concentration (POSTCON)*

The double effect evaporators concentrate sweet water from 35% to 85%.

iv. *Glycerine Dehydration Unit (GDU)*

The crude glycerine in concentrated from 85% to 92% by flash evaporation.

c) Fractionation / Distillation

Distillation is an operation in which different constituents of a feed material is separated. Different cuts of Fatty Acids are obtained with varying carbon chains.

The distillation/fractionation plant consists of:

- Section 3
- Section 4
- Section 5

d) Hydrogenation Section

The unsaturated fatty acids are hydrogenated batch wise in Loop Reactor to form saturated fatty acid

- Capacity : 60 MT / day
- Feed

1. DLGMFA
2. S PFAD
3. L/E PKO
4. RBDPS

Products:

1. Hyd. DLGMFA
2. Hyd. PFAD
3. Hyd. L/E PKO
4. Hyd. RBDPS
5. P 12

e) Flaking Section

Material which are solid at room temp. are flaked & packed in bags in two flakers.

- Capacity : 65 MT / day
- Grades:

1. Stearic Acid UTSR
2. Stearic Acid DTP 7
3. Stearic Acid P 12
4. Lauric Acid
5. Behenic Acid
6. HPS

The steam that is being generated or consumed can be classified on the basis of pressure into 3 types:

TYPE OF STEAM	PRESSURE
LOW PRESSURE STEAM (LPS)	<5 Kg/cm2
MEDIUM PRESSURE STEAM (MPS)	5-15 Kg/cm2
HIGHPRESSURESTEAM(HPS)	>15 Kg/cm2

Figure 1 : Types of steam based on pressure

f) Calculation of Condensate Recovery Factor

Total LP steam Generated = x

Total condensate Recovered = y

Condensate Recovery Factor (CRF) = y/x

Total CRF =

(y1+y2+y3…+yn) / (x1+x2+x3…+xn)

The steam that can be recovered in the form of condensate is the Low Pressure Steam (LPS).The following diagram shows how the steam is being converted on the basis of different pressures.

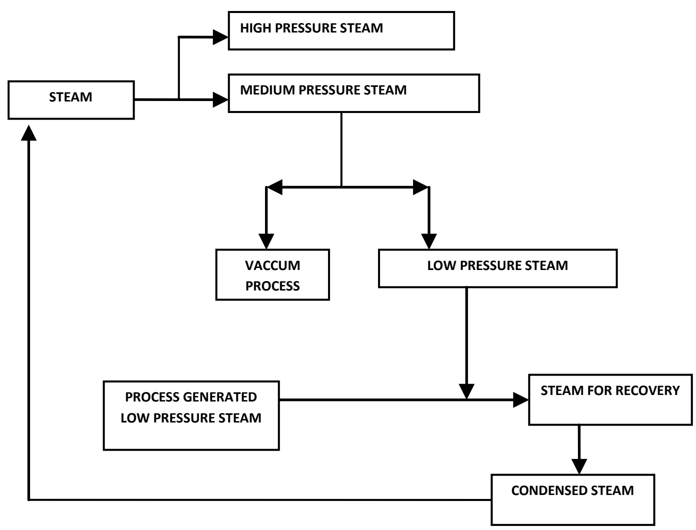

Figure 1 : Steam flow diagram

The steam that is being generated gets converted into high pressure steam (HPS) and medium pressure steam (MPS).The high pressure steam (HPS) cannot be further converted into recoverable form and gets used in various processes. The medium pressure steam can either go into the vacuum processes or else get treated and get converted into low pressure steam (LPS).Our main aim is to obtain the amount of low pressure steam (LPS) as this is the only steam that can be converted to condensate and can be recovered. Low pressure steam (LPS) is also generated from various processes. This LPS undergoes condensation which is eventually used to generate the initial steam. Thus more the condensate recovered better is the Condensate Recovery Factor (CRF), better is the efficiency and lesser the costs of generating steam.

The LP steam network in DFA Plant can be seen as follows:

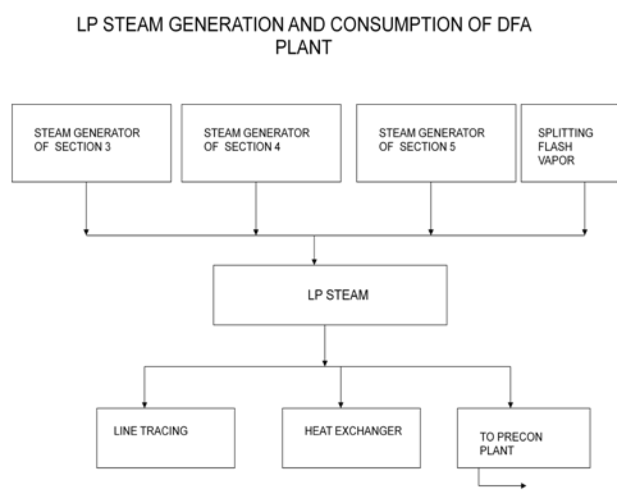

Figure 2 : LP steam generation and consumption in DFA PLANT

In order to calculate the LPS generated, heat balance at steady state has been applied across the system.

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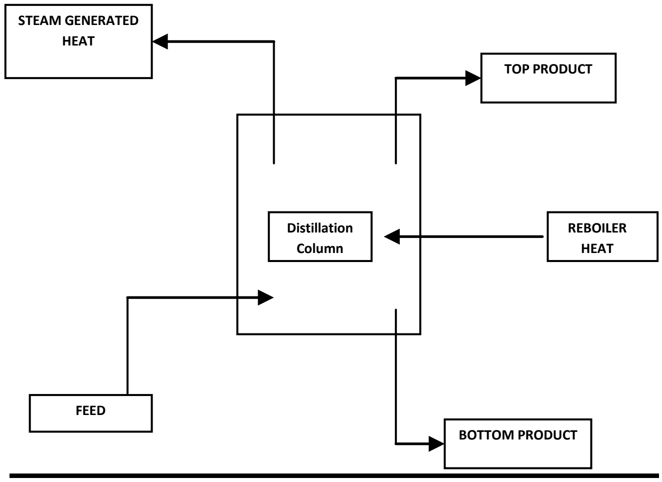

Figure 3 : Heat Balance across the System

g) Condensate Recovery Improvement

There are various reasons due to which the steam that gets converted to condensate is not able to be recovered to a large extent.

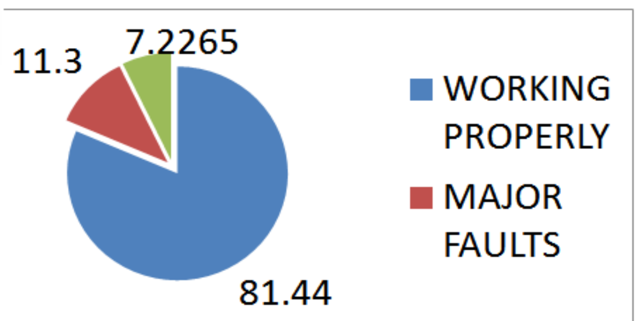

Figure 4 : Total steam and Condensate drains in Working Condition

ISSUE	TYPE OF LEAKAGE	REASON
Leakage of steam from c-402 to e-423 on 7th floor of DFA	Minor	gap between the flanges
Loss of steam as condensate via sampling point on 5th floor of DFA	Minor	bypass completely open
Vent condensate loss via 5th floor of DFA	Minor	hole in pipe
Steam loss while going to 4th floor header of DFA (P 304 A/B)	Minor	bypass completely open
Loss of steam on 2nd floor of DFA by P-352	Major	hand wheel broken and bypass is open.
Overflow of condensate in the vertical drum	Major	pumping not taking place properly
Overflow of condensate in the storage tank	Major	possible backflow and cavitation
Leakage at header leading to old boiler house	Minor	gap between flanges
Leakage at header where Sm-30 and Sm-50 produce steam to FA plant	Minor	gap between flanges
Loss of steam while coming from the Captive Power Plant (CPP)	Major	hand wheel broken and bypass is open.

Figure 5 : Leakages and losses in DFA Plant

h) Improvements

There are two ways in which improvement can be done:

1. Improving the condensate recovery in the existing system
2. Increasing the condensate in the system

In order to improve the condensate in the existing system, the steam traps play a very important role. The type of steam trap also plays an important role. If the steam traps function to their fullest ability then there will be an increase of condensate recovery by approximately 10%.

A steam trap is a device used to discharge condensate and non condensable gases with a negligible consumption or loss of live steam. The three important functions of steam traps are:

- Discharge condensate as soon as it is formed.
- Have negligible steam consumption.
- Have the capability of discharging air and other non-condensable gases.

i) Steam Trap Failure

Steam traps will typically fail in two different ways.

- The trap can stick in the closed position, which causes condensate to back up into the steam system.
- The trap can also stick in the open position, allowing live steam to discharge into the condensate system.

j) Maintenance of Steam Traps

- Visual
  - Visual inspection depends on a release valve situated downstream of certain traps.

These valves can be released, and checked to see if condensate or steam is released

- Acoustic
  - Involves listening to the steam trap operation, while ignoring any ambient sounds. Devices that can be used include stethoscopes, and ultrasonic leak detectors.
  - Ultrasonic devices are typically the best and most accurate choice. These instruments are basically

electronic stethoscopes with acoustic filtering allowing them to be sensitive to high frequency sounds.

- Thermal

Involves observing upstream/downstream temperature variations in the steam traps. This method is most effective when used in conjunction with an ultrasonic leak detector.

- There was overflow of condensate observed in the storage tank due to which a lot of condensate was getting wasted. This was due to the ineffective working of the pump (due to cavitation) due to which the condensate was not able to be pumped to the Old Boiler House and was backflowing into the tank due to which it was getting wasted. In order to stop this the following methods can be followed:

1. Instead of a centrifugal pump, a mechanical pump should be used or a centrifugal pump with an ejector must be used such that there is no cavitation taking place. Hence there will be no loss of condensate and there will be improvement in condensate recovery by about 10%.
2. The second method is diverting the path of the condensate. Instead of making the liquid flow into the condensate tank where it overflows and gets wasted, the condensate should directly be directed to the deaerator so that the pump does not come into the picture. This not only improves the condensate recovery factor but also saves the pumping costs. The condensate recovery factor will improve by about 10 %.
3. All the leaks and losses due to poor functioning of the steam traps and broken valves and flanges should be fixed. Proper connection of steam traps and condensate line with condensate header in order to prevent any loss of steam and hence condensate. This will help improve the efficiency by about 8 to 10 %.
4. Finally all the condensate that comes out of the steam traps and gets drained in order to move the steam forward should be diverted directly to a storage tank or directly to the de-aerator to prevent condensate loss. This will increase the condensate recovery factor by about 10 %

II. Conclusion

This paper focuses on the steam condensate recovery of a DFA Plant and also proposes various suggestions and methods for the improvement of the condensate recovery factor.

III. Acknowledgement

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