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Steam System Audit

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Absract - Steam is used to provide process heat and mechanical power. Steam loss in the process, is a major problem faced by industries. A well designed steam distribution system can reduce the losses and improve the efficiency of the steam system thus reducing energy costs. This Steam System Audit provides technical information for steam system operational personnel and plant energy managers on some of the major opportunities available to improve the energy efficiency and productivity of industrial steam systems.

***Keywords*-Steam,Audit,Savings,Flash Steam,Condensate**

I.INTRODUCTION

This Steam System Survey is intended for steam system operational personnel and plant energy managers. Often operations personnel and energy managers are unaware of the opportunities available for energy and productivity savings in their steam systems, or they are unsure of the calculation procedures required to determine the savings opportunities. The purpose of this guide is to assist operations personnel and energy managers in identifying significant opportunities to improve their steam systems.

II. IMPORTANCE OF CONDENSATE RECOVERY AND FLASH STEAM

Generally, the energy resident in the condensate constitutes the majority of the economic impact associated with returning condensate. However, in many locations, the purchase of water and the subsequent wastewater charges associated with the sewer system are significant factors. In most applications, water treatment costs are difficult to establish; however, effort should be made to establish and incorporate these costs to obtain a true representation of condensate worth.

Condensate returned from process heat exchangers typically has an elevated temperature and, therefore, a significant energy value. Energy savings result from the elevated temperature of the returned condensate in comparison with makeup water required to replace the condensate if it is lost from the system.

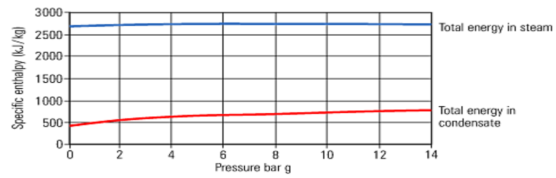


Fig.1 Heat content of steam and condensate at the same pressures

Conventional condensate recovery systems collect condensate from the steam system and feed it back into the boiler feed tank. But as the condensate leaves the steam system and enters the lower pressure environment of the recovery system, up to half of the useful energy it contains can end up being vented as flash steam.

III.CALCULATIONS FOR POTENTIAL SAVINGS

A paint plant has an extensive steam network. The steam is generated at a pressure of 7.5 bar and the condensate is not recovered. The plant management is planning to generate flash steam (from the condensate) for use as low pressure process steam and to recover as much steam condensate practical.

The following data is collected:

- Total enthalpy of steam at 7.5 bars: 660.37 kCal/kg
- Total enthalpy of steam at 3.5 bar: 652.44 kcal/kg
- Condensate quantity: 250 kg/hr
- Condensate pressure: 1 bar
- Cost of steam: Rs.1000/ton
- Annual operating hours: 8000 hr
- Low pressure process steam pressure: 1 bar(Flash steam pressure)
- Sensible heat of condensate at 8 bar: 172.19 kCal/kg
- Sensible heat of condensate at 1 bar: 99.72 kCal/kg

- Latent heat of steam at 1 bar: 539.30 kCal/kg
- Boiler efficiency:75%
- Fuel used in boiler : Natural Gas
- GCV of Natural Gas: 10,200 kCal/kg
- Specific gravity of Natural Gas: 0.65
- Condensate temp. when recovered: 95^{0}C
- Make-up water temperature: 35^{0}C
- Cost of Natural Gas : INR 15000/kiloliter

The following equation is given:
Flash steam generation potential condensate (%) = (S1-S2/L) X 100
Where,
S1 = Sensible heat of condensate at high pressure
S2 = Sensible heat of condensate at low pressure
L = latent heat of steam at low pressure

POTENTIAL OF SAVINGS:

1. Calculate the quantity of flash steam generated (kg) High Pressure
Flash steam generation potential condensate (%) = (S1-S2/L) X 100
Where,
S1 = Sensible heat of condensate at 7.5 bar = 169.41 kCal/kg
S2 = Sensible heat of condensate at 1 bar = 99 kCal/kg
L = latent heat of steam at low pressure = 539.5 kCal/kg
= (166–99) / 539.5
= 0.130 kg / kg of condensate

If plant is using 250 Kg of steam per hour then the flash steam generated will be= 250 * 0.130 kg
= 32.6 kg/hr

2. Calculate the quantity of flash steam generated (kg) Low Pressure
Flash steam generation potential condensate (%) = (S1-S2/L) X 100
Where,
S1 = Sensible heat of condensate at 3.5 bar = 137 kCal/kg
S2 = Sensible heat of condensate at 1 bar = 99 kCal/kg
L = latent heat of steam at low pressure = 539.5 kCal/kg
= (137–99) / 539.5
= 0.07037 kg / kg of condensate
If plant is using 250 Kg of steam per hour then the flash steam generated will be= 250 * 0.130 kg
= 17.59 kg/hr

3. Calculate the annual savings from flash steam recovery in INR

Annual steam savings = (32.6+17.59) kg/hr x 8000 hr/yr / 1000 = 260800 tons/yr
Equivalent annual steam heat savings = (32.6 kg/hr x 660 kCal/kg) = 21516 kCal/hr
Equivalent annual steam heat savings = (17.59 kg/hr x 652.44 kcal/kg)=11478 kcal/hr
Annual monetary savings = (401.52 tons/yr x Rs.1000/ton)= Rs.401520

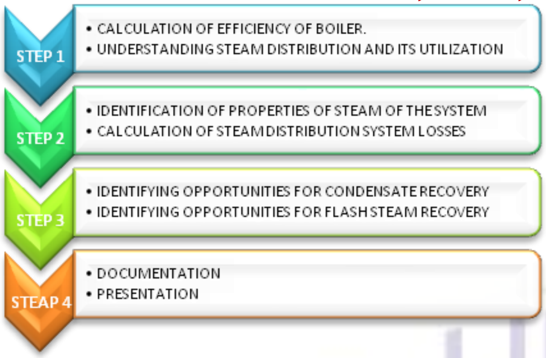
4. Calculate the annual savings from flash steam recovery and condensate recovery in INR
Condensate available for recovery after flash steam = (250 kg/hr – 50.19 kg/hr) = 199.81 kg/hr
Heat recovery potential through condensate recovery
= Mass of condensate x Specific heat of condensate x Temperature difference
= 199.81 kg/hr x 1 x (95-35)
= 11988.6 kCal/hr
Heat savings from flash steam recovery and condensate recovery
= (21516 kCal/hr + 11988.6 kCal/hr + 11478 kCal/hr) = 44982.6 kCal/hr
Annual fuel oil savings
= (heat savings x hours per year) / (boiler efficiency x GCV of fuel)
= (44982.6 kCal/hr x 8000 hr/yr) / (0.75 x 10,200 kCal/kg)
= 47040.2 kg/yr
= 47040.2 / 0.65 =72370.19 SCM
Annual monetary savings
= 72.370 SCM Natural Gas

IV. RECOMMENDATIONS FOR IMPROVEMENT:

- Replace all Steam Trapping System with Thermodynamic Trap / Mechanical Trap
- Installation of Flash Vessel
- Installation of PPPU
- Steam Condensate Recovery Pipe line

V. METHODOLOGY USED

The analysis of steam system has been done through using guidelines of various books. The methodology of steam system audit is as follow..



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