STEAM MANAGEMENT INC.

BLOWDOWN EFFICIENCY IMPROVEMENT AND HEAT RECOVERY:

Performance Data:

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2 Boilers each 30,000 pounds per hour
Boiler operating pressure 150 psig
B=Boiler water TDS Manual Control (1840 average ppm)
F=Feedwater water TDS (100 ppm)
S=Average steam rate 366,915.5 lb/day
Tmw=Makeup Water Temperature 50 F = 510 R
Tsl = Sewer Temperature Limit 140 F = 600 R
Fuel Cost: #6 Oil $1.33 per Therm
Water Cost: $5/1,000 gallons
BE=Boiler Efficiency 80.5%
HR= Operating Hours = 8760 hr/year

$$S := \frac{366915.5}{24} \cdot \frac{lb}{hr} = 15288\ \frac{lb}{hr}$$

$$T_{MW} := 50\ °F = 510\ R$$

$$T_{SL} := 140\ °F = 600\ R$$

$$FuelCost\$:= \frac{1.33\ \$}{100000 \cdot Btu}$$

$$FuelHV := \frac{152400\ Btu}{gal}$$

$$BE := 0.805 \qquad Water\$:= \frac{5\ \$}{1000 \cdot gal}$$

$$HR := 8760\ hr$$

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Install Electronic Automatic Blowdown Control System:

Existing Condition: Currently blowdown is controlled manually and is blowdown to as high as 2800 TDS maximum. This is done by periodically blowing down boiler to 1840 average TDS.
Proposed Modification: Install an electronic control system to automatically blowdown to more accurately track and maintain the setpoint of 2200 TDS. Savings would be in the ability to maintain the boiler TDS closer to the setpoint of 2200 and is estimated to provide an annual average increase in TDS of 360.

Existing Blowdown:

Blowdown Rate = (FxS)/(B-F)
F=Feed Water TDS (ppm)
S=Steam generation rate (lb/hr)
B=Required boiler water TDS (ppm)

$$F := 100 \qquad B_{Exist} := 1840 \qquad S = 15288\ \frac{lb}{hr}$$

$$BD_{Exist} := \frac{F \cdot S}{B_{Exist} - F}$$

$$BD_{Exist} = 879\ \frac{lb}{hr} \qquad PercBD_{Exist} := \frac{BD_{Exist}}{S} = 5.75\%$$

Proposed Blowdown:

Blowdown Rate = (FxS)/(B-F)
F=Feed Water TDS (ppm)
S=Steam generation rate (lb/hr)
B=Required boiler water TDS (ppm)

$$F = 100 \qquad B_{Prop} := 2200 \qquad S = 15288\ \frac{lb}{hr}$$

$$BD_{Prop} := \frac{F \cdot S}{B_{Prop} - F}$$

$$BD_{Prop} = 728\ \frac{lb}{hr} \qquad PercBD_{Prop} := \frac{BD_{Prop}}{S} = 4.76\%$$

Enthalpy of saturated liquid at 150psig:

$$SH := 338 \cdot \frac{Btu}{lb}$$

$$EnergySavings_{Control} := \frac{(879-728)}{BE} \cdot \frac{lb}{hr} \cdot 339 \cdot \frac{Btu}{lb} \cdot HR$$

$$EnergySavings_{Control} = 557038062\ Btu$$

$$EnergyCostSaved_{Control} := EnergySavings_{Control} \cdot FuelCost\$ = 7409\ \$$$ **$7,409**

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Install Blowdown Heat Recovery System:

Existing Condition: Currently the fuel oil from a back oil pressure control valve (back pressure) surplus oil not being used to the boiler burners goes through a blow down heat exchanger and then returns to the oil storage tanks.

Proposed Modification: All of the available blowdown heat is not being utilized in heating of the fuel oil being returned to the oil storage tanks. Also, this represents a risk of contaminating the fuel with water in the event the heat exchanger would leak. This proposal would be to remove the blowdown water to oil heat exchanger and install a new heat exchanger that would use the available heat in the blowdown water to preheat makeup water to the boiler.

% Flash Steam = ((SH-SL)/H)*100
SH=Sensible heat in the condensate at the higher pressure before discharge
SL=Sensible heat in the condensate at the lower pressure to which discharge takes place
H=Latent heat in the steam at the lower pressure to which the condensate is discharged
Assuming the blowdown water is released to a flash steam system operating at 30 psig

$$SH = 338\ \frac{Btu}{lb} \qquad SL := 243 \cdot \frac{Btu}{lb} \qquad H := 929 \cdot \frac{Btu}{lb}$$

$$PercentFlashSteam := \left(\frac{SH-SL}{H}\right) = 10.23\%$$

Energy in flash steam (EFS):

$$EFS := PercentFlashSteam \cdot BD_{Prop} \cdot (H) \qquad EFS = 69161\ \frac{Btu}{hr}$$

Energy in condensate (EC):

$$EC := BD_{Prop} \cdot (1 - PercentFlashSteam) \cdot (SL) \qquad EC = 158815 \ \frac{Btu}{hr}$$

Energy Savings with blowdown heat exchanger efficiency of 95%:

$$EnergySavings_{BDHR} := \frac{EFS + (EC \cdot 0.95)}{BE} \cdot HR \qquad EnergySavings_{BDHR} = 2394419473 \ Btu$$

$$EnergyCostSaved_{BDHR} := EnergySavings_{BDHR} \cdot FuelCost\$$$

$EnergyCostSaved_{BDHR} = 31846 \ \$$ **$31,846**

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Water Conserved:

Tempering Water Saved:
To calculated the amount of tempering water saved we use the following relationship to solve for Mtempering, which is the flow of tempering water required in gpm, using the following relationship:

Tdrain * Mdrain = Ttempering * Mtempering + Tbddrain * Mbddrain

Mdrain = Mtempering + Mbddrain

Solving for Mtempering;

Mtempering = Mbddrain * (Tbddrain-Tdrain)/(Tdrain-Ttemp)

This is solved for the original blowdown case. Once the heat recovery unit is implemented, the heat exchanger drain temperature will be low enough so that tempering water is not required. Therefore, all current tempering water is saved.

$$BD_{Exist} = 878.63 \ \frac{lb}{hr} \qquad T_{BDExist} := 212 \ °F = 671.67 \ R$$

$$M_{BDDrain} := BD_{Exist} \cdot (1 - PercentFlashSteam) = 788.78 \ \frac{lb}{hr}$$

$$M_{tempering} := M_{BDDrain} \cdot \left(\frac{(T_{BDExist} - T_{SL})}{(T_{SL} - T_{MW})} \right) = 631.02 \ \frac{lb}{hr}$$

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$$V_{tempering} := M_{tempering} \frac{1}{8.34} \frac{gal}{lb} \frac{hr}{60\ min} = 1.26 \frac{gal}{min}$$

$$V_{TempPerYear} := V_{tempering} \cdot 60 \frac{min}{hr} \cdot HR = 662802\ gal$$

Makeup Water Saved:

The amount of makeup water saved is equal to the reduction in blowdown flow plus the flash steam utilized with the new system.

$$M_{MUSaved} := BD_{Exist} - BD_{Prop} + BD_{Prop} \cdot (PercentFlashSteam) = 225.07 \frac{lb}{hr}$$

$$V_{MUSaved} := M_{MUSaved} \frac{1}{8.34} \frac{gal}{lb} \frac{hr}{60\ min} = 0.45 \frac{gal}{min}$$

$$V_{MUSavedPerYear} := V_{MUSaved} \cdot 60 \frac{min}{hr} \cdot HR = 236403\ gal$$

$$WaterSaved := V_{TempPerYear} + V_{MUSavedPerYear} = 899205\ gal$$

$$WaterCostSaved := WaterSaved \cdot Water\$ = 4496\ \$$$ **$4,496**

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Summary:

$$TotalCostSaved := EnergyCostSaved_{Control} + EnergyCostSaved_{BDHR} + WaterCostSaved = 43750\ \$$$

$$TotalEnergySaved := EnergySavings_{Control} + EnergySavings_{BDHR} = 2951457535\ Btu$$

$$FuelOilSaved := \frac{TotalEnergySaved}{FuelHV} = 19367\ gal$$

$$WaterSaved = 899205\ gal$$