# Enhancing Plant Efficiency by Raising the Degree of Superheat in steam

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Advantages of Higher Degree of Super-heat

a. More energy will be transported through same amount of steam without modifying the pressure of the boiler.

b. Capacity of the Boiler to generate energy with the same overall specifications will enhance.

c. Capacity of turbines to convert energy will increase with out any modification in their structure.

d. Lesser quantity of steam having higher energy will be required for process use.

e. Comparatively smaller size steam handling equipment will be required.

Original Coil Design
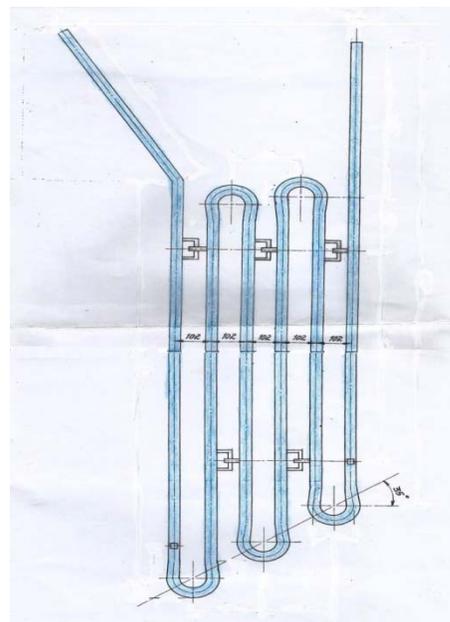
Modified Coil Design
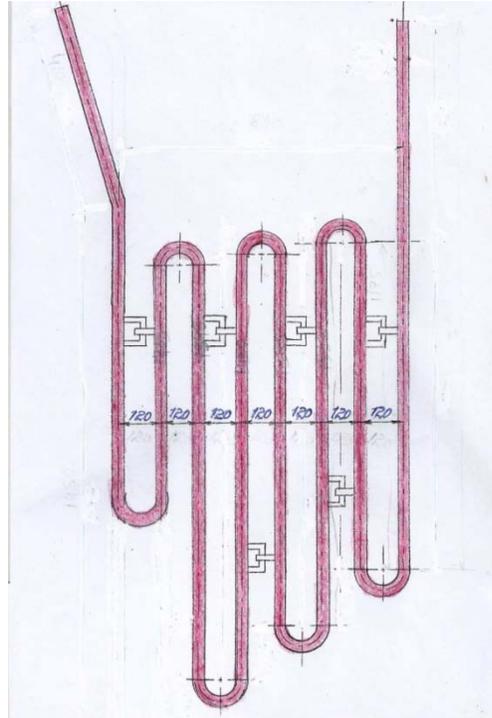
Data from Boiler Specifications

- Rated capacity of Boilers (p)   = 50Tph.

- Working Pressure @325°C   = 24 kg/cm^2

- Surface area of super-heater.   = 76m^2

- Single coil length   = 11m

- No. of super-heater coils.   = 58

- Super-heated steam temp.   = 325°C

- Temperature of gasses entering into the super-heater. (T1)   = 1000°C

Data from Standard Values

All standard values are taken from Huga's Handbook of cane sugar engineering, Molieer Charts, steam tables other references sited & laboratory analysis

- Specific Heat of gasses (C)   = 0.32 kcal/kg/^{o}C

- Mean specific heat of steam (c) = 0.50 kcal/kg^{o}C.

- Moisture in Bagasse (w)   = 52.1%

Data from Standard Values

- Dryness fraction of saturated steam (x)   =   0.96.

- Latent heat of vaporization at boiler press. (r)   =   440 kcal/kg.

- Temp. of saturated steam at boiler press (t)   = 225°C.

- Coefficient of heat transfer (k)   =   65 kcal/m^{2}/hr/^{o}C

- Coefficient of un-burnt losses (∞)   =   0.9.

- Excess air ratio (m)   =   1.5

Data from Calculated values:

- **New Specifications:** Super-heated steam temperature-Required (T)=360°C

- **Weight of Bagasse to be burnt (B):** B = p/2.1 = 50000/2.1 =23,809.5 kg/h

Data from Calculated values:

- **Mass of Gasses:**

Pg   =5.76(1-w) m+1

      = 5.76 (1-0.521) 1.5+1

      =5.138 kg/kg of bagasse

- **Total mass of gasses**

P   = Pg*B

      =5.138*23809.5

      =122,346 kg/h

Data from Calculated values:

- Quantity of heat transmitted by Super-heater

    M=∞*P*C(T1-T2)

    Again M=p(1-x)r + p*c (T-t)

    Thus ∞*P*C(T1-T2)=p(1-x)r + p*c (T-t).

    Putting the values in this expression thus gives: 0.9*122346*0.32(1000-T2)

=50000(1-.96)440+50000 *0.50 (360-225); Finally Temperature of Gasses leaving the super-heater T2=879°C

Data from Calculated values:

- Temperature of gases leaving the Super-heater:T2= 879°C.(This calculation has been shown in previous slide).

Data from Calculated values:

- Heating Surface of the Super-heater. (S)

- = p(1-x)r + p*c(T-t)/[k(T1+T2)/2-(T+t)/2]

- = 50000(1-.96)440 + 50000*0.50(360-225) /65[(1000 + 879)/2 – (360 + 225)/2] = **101m^2**.

- Single coil length = 12.8m.

- No. of coils= 66.

- Tube dia = 38 mm

BAGASSE SAVING.

Description	Season	
	2013-14 (After Change)	2012-13 (Before Change)
Cane Crushed	588,138 tons	533,616 tons
Steam % cane	60.5	61.8
Live Steam temp.	355°C	320°C
Energy in live steam	762 kcal/kg	745 kcal/kg
Exhaust Steam temp.	188°C	175°C
Energy in exhaust Steam	688 kcal/kg	681 kcal/kg
Total energy carried by Steam in the season	$2.4*10^{11}$kcal	$2.2*10^{11}$kcal

Bagasse saving.

- After modification of super-heater, a larger amount of energy is carried by a smaller quantity of steam to cater the needs of process house at a higher crushing rate.

- While calculating the bagasse saving, the effect of higher crushing of this season is nullified by considering crushing of 2012-13. Also, same fiber % is considered.

  Bagasse consumption @ 60.5% steam on cane=161,418tons. Bagasse consumption @61.8% steam on cane= 164,887tons. Bagasse saving due to higher degree of super-heat=3,469tons.

Cost of Project

- **Cost of constructing new super-heaters**:   = Rs: 4,500,000

- Details

Description	Cost (Rs.)
Tubes + Other Material	1,600,000
Labor Charges	2,700,000
Welding Rods & Cutting Gas	50,000
Masonry, Insulation & Electricity	150,000

Return on Investment

- Saving in rupees, bagasse @Rs.2500 per ton. = Rs. 8,672,500

- **Return on Investment.** (Considering 160 days season).

  - Pay back =80 days

  - Subsequent saving= Rs 8.5 Million each year

Thank You