ENERGY SAVING ENDEAVOUR IN RAMZAN SUGAR MILLS

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The Global predicament of energy for us became the inducement to overcome the crunch within the Manufacturing Plant of Ramzan Sugar Mills Chiniot.

For this purpose Falling Film Evaporators, Direct Contact Heaters, Molasses Conditioners, Flash Cigar, Plate Heat Exchanger & Hot Water Radiators have been installed and operated successfully.

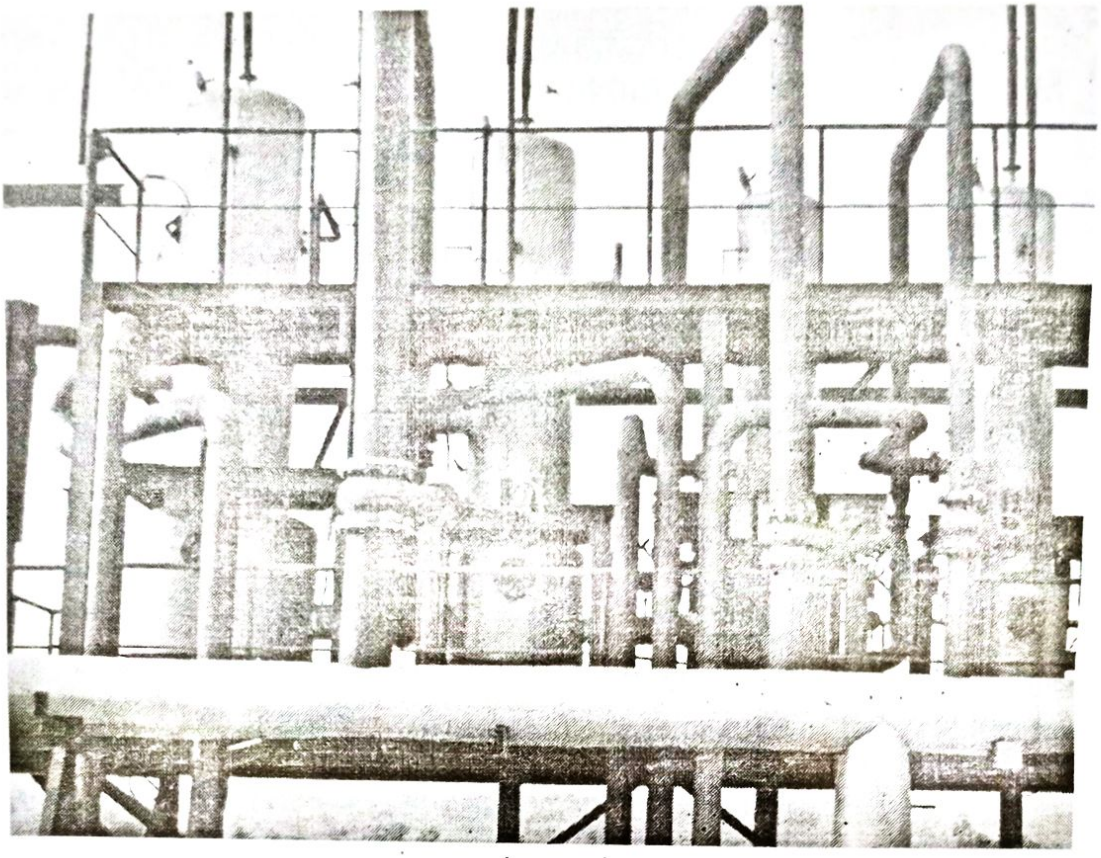
The main redemption in fact, is the function of Falling Film Evaporator employed. It is believed that falling film evaporators provide maximum evaporative execution for the least capital investment.

DIRECT CONTACT HEATERS

Direct Contact (DC) Heaters have high heat transfer coefficient and are an alternative to plate and tubular surface heaters.

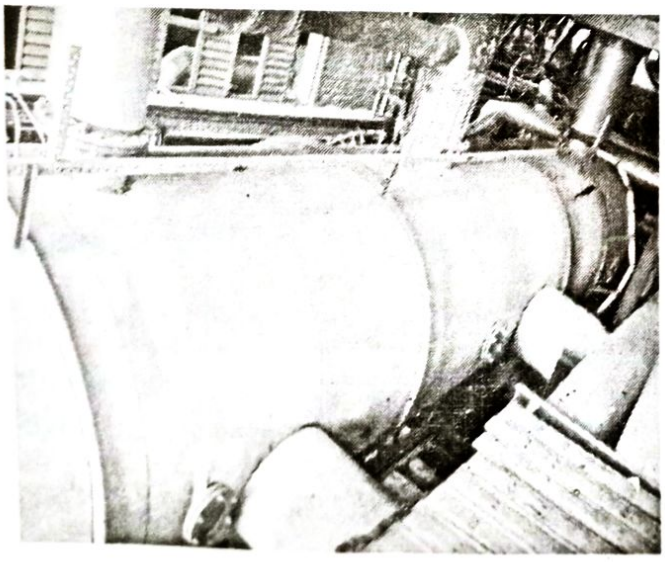
These operate at an approach of around 1°C.

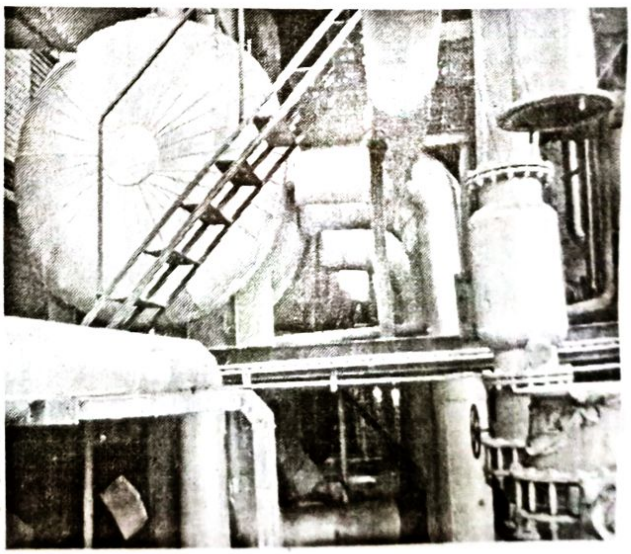
MOLASSES CONDITIONERS



Direct contact molasses conditioners ensure perfect dissolution of crystals without addition of water and by using heat content of low pressure vapour. After molasses conditioning, temperature and brix of molasses is approximately 70 °C and 78–82 ° brix respectively.

FLASH CIGAR





Flash Cigar is a horizontal flash vessel comprising of different flash chambers recovering heat from various condensate streams, where all the chambers operate at different set of pressure conditions.

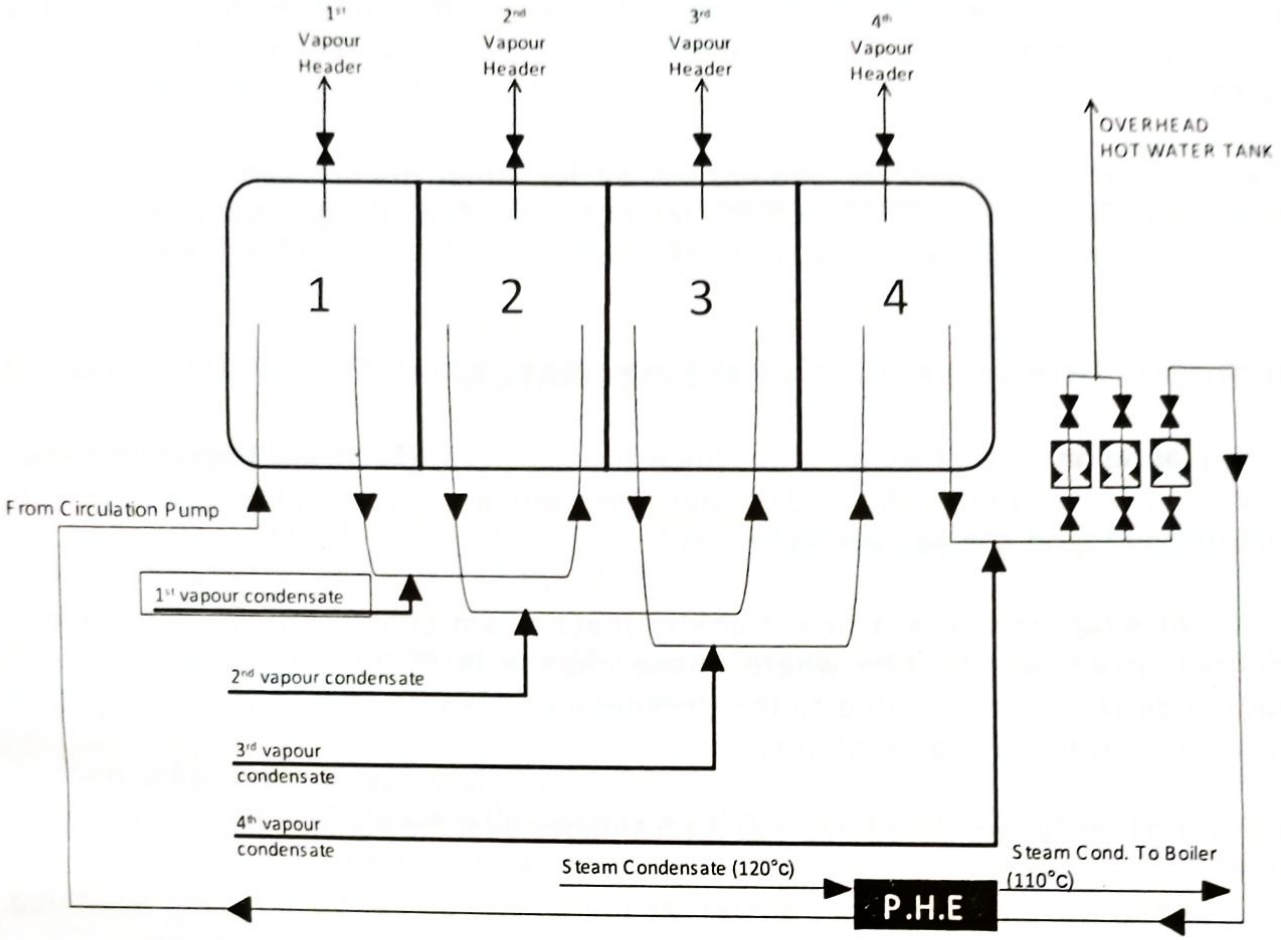
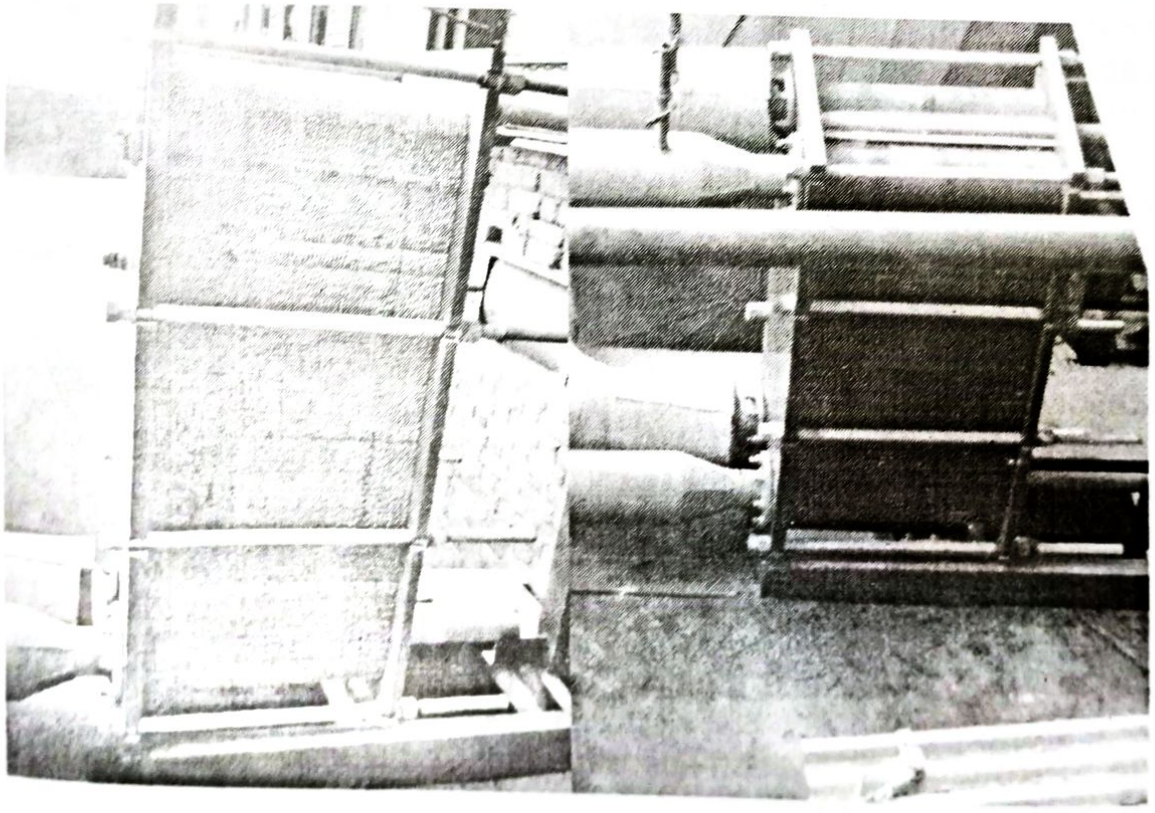


PLATE HEAT EXCHANGER



Low temperature vapour condensate is heated efficiently through plate heat exchanger, utilizing the heat content of steam condensate. The temperature gained is 10 -15 °C.

Radiators are employed for heating the air for sugar drying. Temperature of hot water supplied is 80 – 85 °C and the temperature of hot air gained is 60 to 65 °C, while the dried sugar temperature is 38 – 42 °C.

INTRODUCTION TO FALLING FILM EVAPORATOR

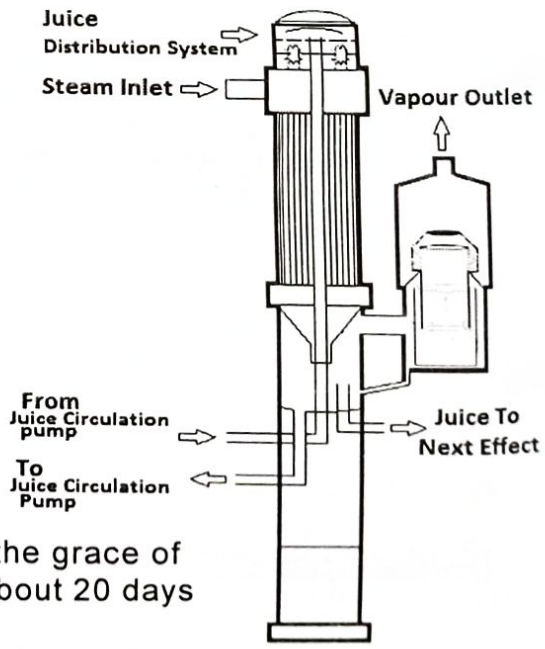
In this popular type of evaporator, juice travels from top to the bottom and as it descends, it takes the entrained vapour along with it to a lower chamber, where the vapour and liquid are separated.

Thin film evaporation is a heat transfer mechanism controlled by convection or conduction across the film where phase change is at the interface and whose magnitude is directly related to the thickness of the film. The film normally flows downward under the force of gravity.

The falling film evaporators have many advantages over the conventional evaporators;

- These have better heat transfer, as there is no elevation in boiling point due to hydrostatic pressure
- With an effective juice distribution system and short contact time between juice and steam, the falling film evaporator offers an excellent potential for using high temperature and pressure steam.
- The design of the evaporators is such that, the juice is in contact with the heating surface in a thin layer over the length of the heating surface. So the vapour is entrained with the juice filling the interior of the tube. This avoids the vapour bubble obstruction, which is present in the conventional evaporator.

Falling Film Evaporator provide possibilities of extensive vapour bleeding, with only marginal vapour going to the condenser and with such a system, it is possible to reduce the steam consumption in evaporators.



Falling film evaporators when equipped with a well designed automatic control system they can produce a very consistent concentrated product.

In Ramzan Sugar Mills Limited, Chiniot, we got the opportunity to install a pair of falling film evaporators (3000 M^2 + 3000 M^2) and by the grace of ALMIGHTY ALLAH, had a successful trial of about 20 days at the end of crushing season 2010-2011.

At that short time, a deep study about all of the features of falling film evaporator could not be conducted. In the season 2011-2012 the falling film evaporator made allowance for improving evaporation scheme, giving rise to an export of 3-4 Megawatt electricity per hour.

But sometimes we have to blow steam. To condense excessive steam now a 6 MW condensing/extraction turbine has been installed.

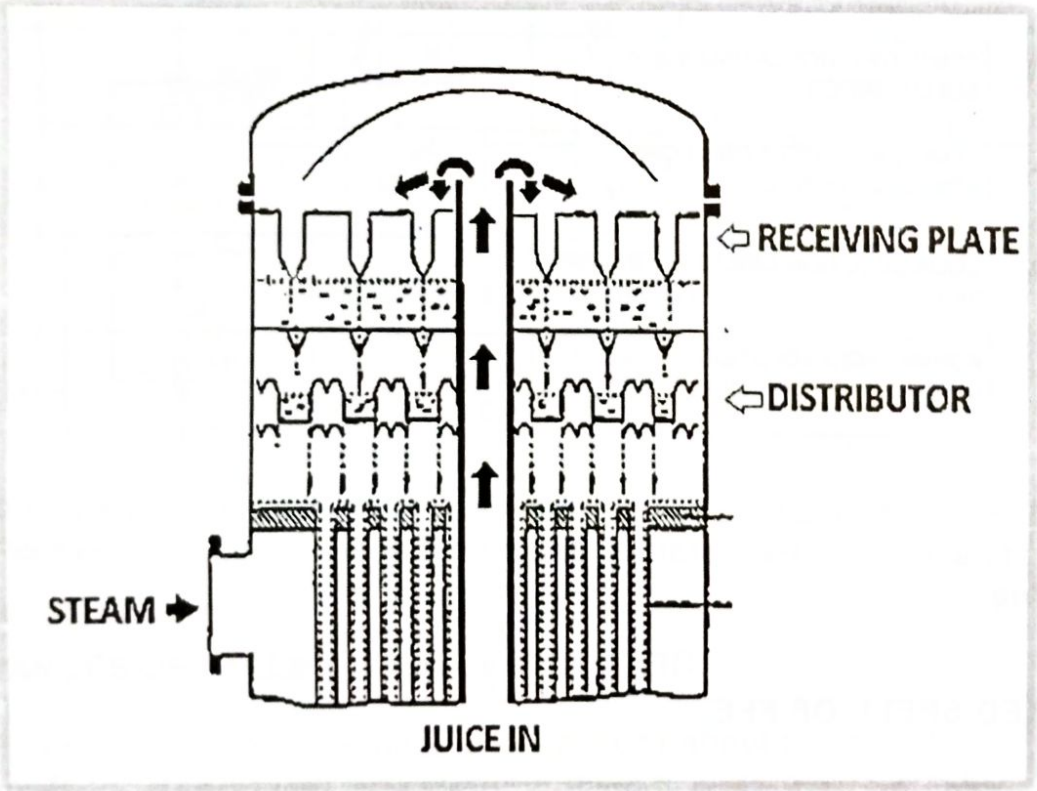
DESIGN FEATURES OF FALLING FILM EVAPORATOR

Juice Distribution System

The juice is pumped from the bottom of the evaporator to the top. The juice is distributed between all tubes in 2 steps:

First step: The inlet pipe covered with wide umbrella, distributes the juice into the receiving plate to make constant flow of juice.

Second step: Each V-type distributor fixed in distribution plate, located under the juice receiving plate, distributes the juice to a set of three tubes. This juice distribution system is reliable and provides an even dispersion across the complete heating surface area.



Juice Recirculation System

To ensure good operating conditions, the tubes need to be wetted at a minimum rate. Juice enters in the bottom of the Calandria and flashes which avoids movement of the juice distribution system.

The recirculation box allows mixing a fraction of the outlet juice with the inlet juice in order to have a sufficient flow rate of juice to wet the tubes.

Chemical Cleaning Procedure of Falling Film Evaporator

The recommendations of the supplier regarding chemical cleaning of falling film evaporator during season were followed.

After each chemical cleaning of the falling film evaporators, we always observed their performance by keeping record of the quantity of condensate produced. Our first cleaning was after a month with comparatively low crushing.

With an increase in crushing rate the tube fouling days decreased; 15 days, 12 days and then to 10 days. By practical experience, we revised the amounts of chemicals, solution circulation time, temperature and observed better results.

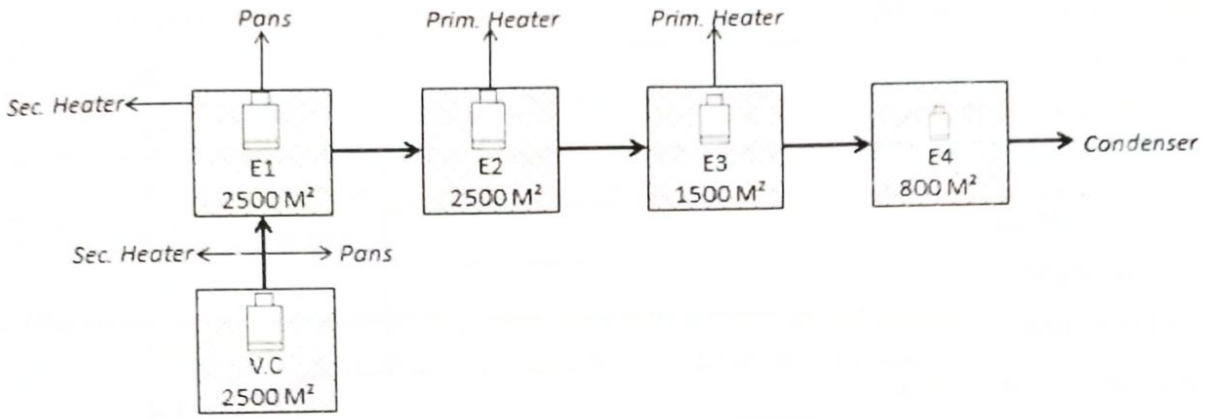
CHEMICAL CLEANING PROCEDURE		
CHEMICAL DOSE	RECOMMENED BY SUPPLIER	ADOPTED BY EXPERIENCE
SODA ASH (%)	3 – 5	3.75
CAUSTIC SODA (%)	1 – 2	3.75
STRENGTH OF FORMIC ACID(%)	3.5	4.5
TEMP. OF CIRCULATING SODA SOLUTION(°C)	70 – 80	90
TEMP. OF CIRCULATING FORMIC ACID SOLUTION(°C)	60 – 70	90
SODA SOLUTION CIRCULATION TIME (hr.)	4	4
FORMIC ACID SOLUTION CIRCULATION TIME (hr.)	3	4

After revision in chemical cleaning procedure, we noticed a remarkable change in cleaning of Falling Film Evaporators, and after that our evaporation system become trouble free.

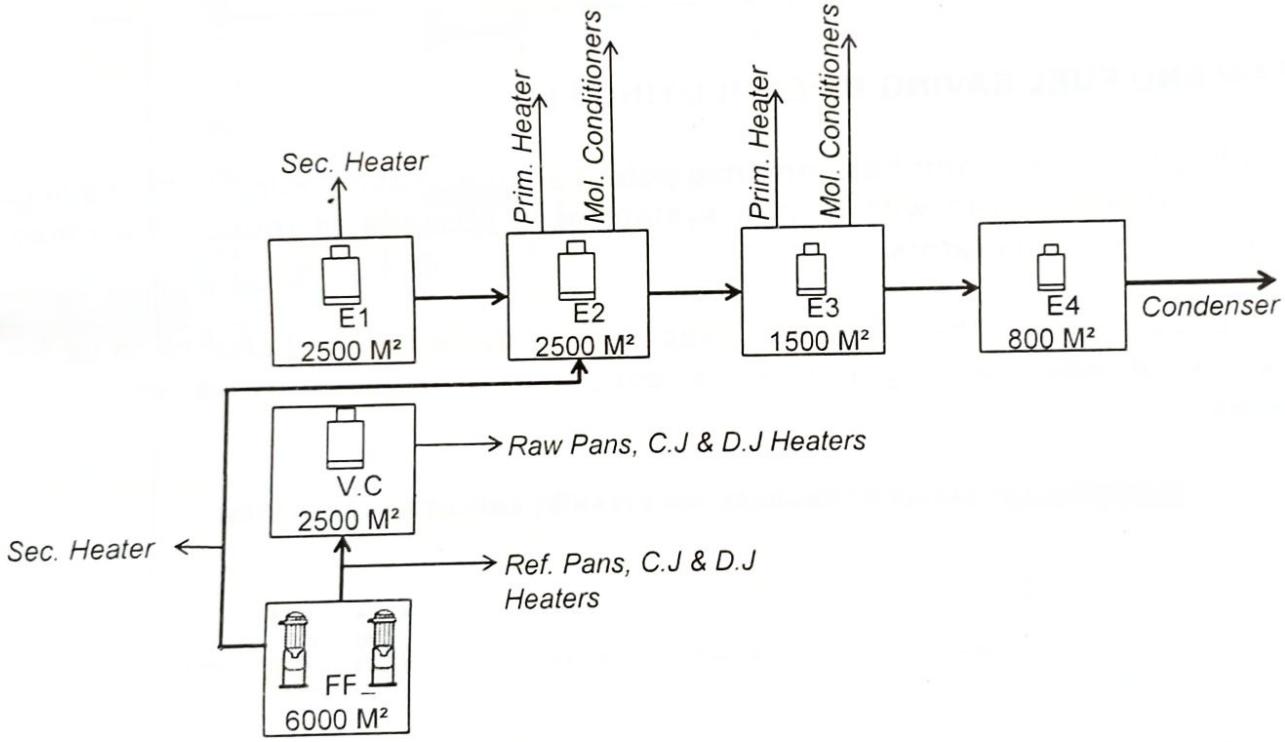
PROVOKED SPELL OF FFE

After the addition of Falling Film Evaporator to the traditional Robert Type Evaporators (Quad Set up), we improved evaporation system to Quint set up.

PREVIOUS SETUP



NEW SETUP



PERFORMANCES OF FALLING FILM EVAPORATOR

In crushing season 2011-12, we made a deep study about performance of Falling Film Evaporator and observed that all the operating parameters are excellent in comparison with Robert Type Evaporators. The following table explains our meticulously made calculations.

PARAMETER	CALCULATED VALUE
Evaporation Coefficient (Kg/hr.M2)	22.8
Evaporation Rate (T/Hr.)	360.10
Heat Transfer Coefficient (W/M2.K)	4646
Flow Rate in Tube (Kg/Sec. M)	0.4341
Thickness of Film (mm)	0.38
Average Film Velocity (M/Sec)	1.141
Residence Time (Sec)	8.8
Vapour velocity (M/Sec)	10.22
Wetting Rate (Kg/Min)	26
Pressure Drop (Kpa)	0.0091
Exhaust Steam Pressure (Bar)	1.2
Exhaust Steam Temperature (°C)	120
Vapour Pressure (Bar)	0.6
Vapour Temperature (°C)	114

STEAM AND FUEL SAVING BY EMPLOYING FFE

The falling film evaporator has immense potential for achieving substantial savings in steam. It is believed with such a system, it is possible to reduce the steam consumption in evaporators.

In this phase, in fact, the falling film evaporator provided a good chance to us for 6% to 7% of steam saving and hence redeeming of a considerable amount of bagasse.

SIGNIFICANT SAVING OF BAGGASE AND STEAM BY EMPLOYING FFE SYSTEM.

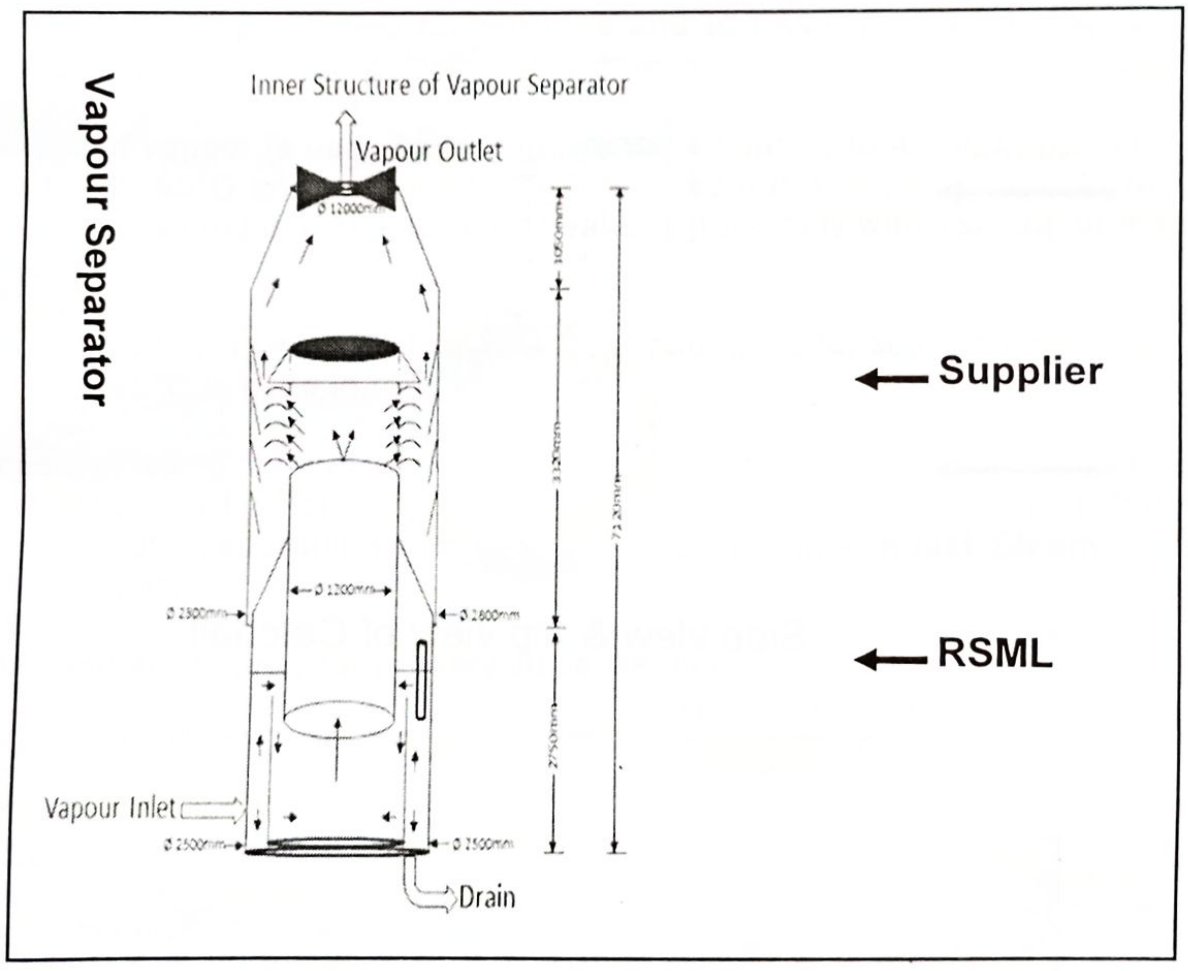
Evaporator Setup	Bagasse Produced (T/D)	Bagasse Consumed (T/D)	Bagasse Saved (T/D)	Steam On Cane
ROBERT TYPE	2700	2557.90	142.10	54%
FFE SYSTEM	2700	2226.32	473.68	47%

ENTRAINMENT CONTROL THROUGH VAPOUR SEPARATOR

During 2010-11 when falling film evaporator was initially taken in operation, the major problem faced was the entrainment of juice on large scale. The vapour separator provided by the supplier failed completely to control the escaping droplets of juice. To resolve this problem, a modification in vapour separator was suggested by us.

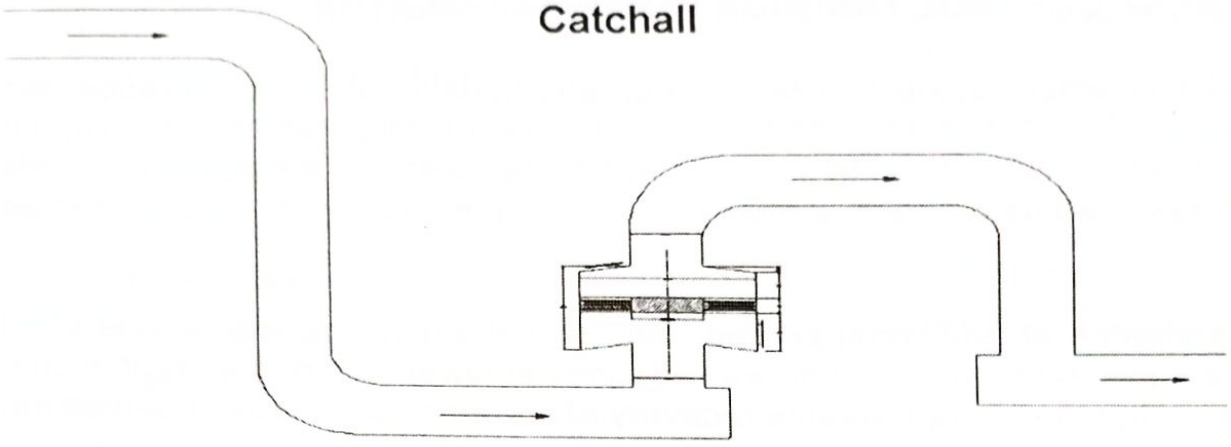
For the installation of additional portion, the original vapour separator was lifted upward and newly fabricated portion was attached at lower side of the original one. After this modification , a remarkable recovery of entrained juice was observed but with very light traces.

The following image and figure show the external / internal views of the original and additional vapour separators together in different colours.



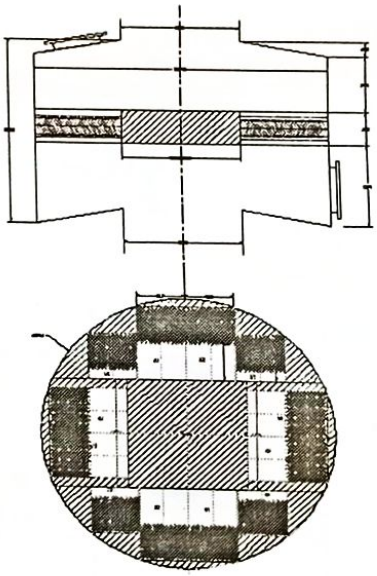
For the best quality of condensate water, an efficient zigzag plate arrester type Catchall was installed in the main 1st vapour line later on. After installation of Catchall, our system became entrainment-free.

Catchall



Diameter of vapour inlet/outlet header = 1500mm
Diameter of Catchall = 3700mm
Height of Catchall = 2300mm

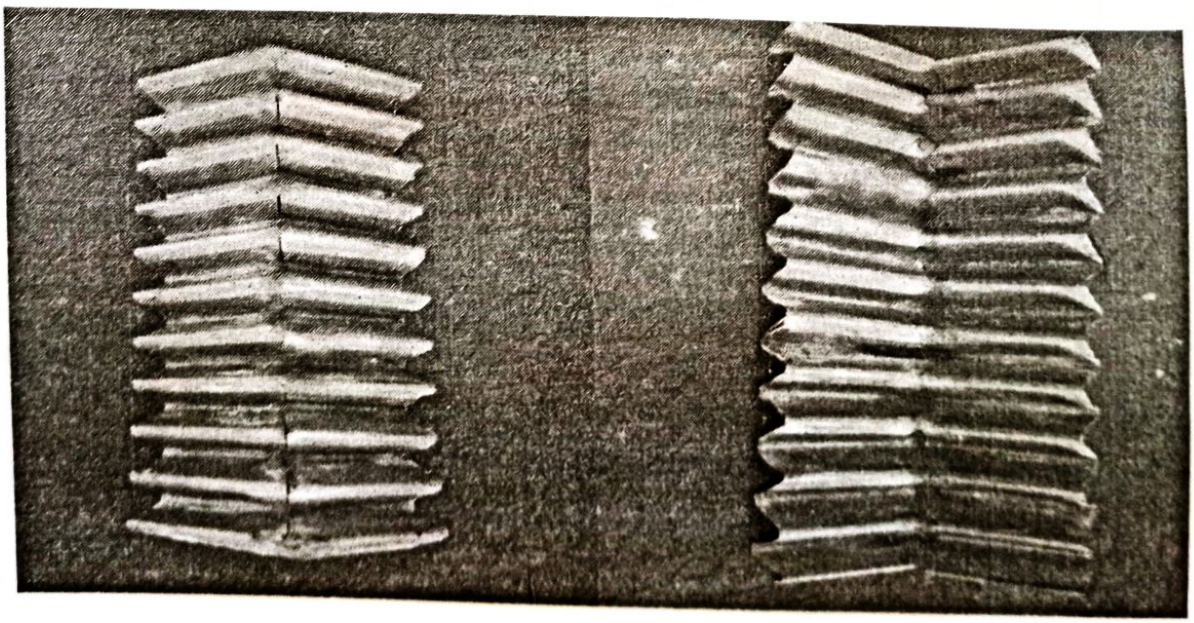
Side view



Top view

Side view & top view of Catchall

ZIGZAG PLATE



GENERAL DISCUSSION AND CONCLUSIONS

Falling film units typically utilize small temperature differences and avoid nucleate boiling so that fouling associated with this type of boiling is kept away. Thermally sensitive liquids are also frequently evaporated in this way.

The falling film evaporator have the specific advantages of compactness, easy erection and installation, no hydrostatic head elevation of the juice, minimum retention time, reduced colour formation, a high heat transfer coefficient and low temperature difference and are easily cleaned with chemicals.

However the arrogant superseding success of the falling film evaporator technology is the ability to optimize the thermal balance of the cane sugar factory and to save the energy.

Usually primary juice heating is carried out with 3rd and 4th vapour. With tubular heater we gain 55°C to 58°C temperature and to raise it upto 60 - 65°C, high temperature vapour is used at D.C. heater.

Similarly, 2nd vapour is used for secondary juice heating to attain temperature of juice upto 92- 95°C and partial heating is carried out with 1st vapour to raise it to104°C. Pre heating in Direct Contact heater is done only with 1st vapour instead of exhaust steam.

Molasses conditioning is carried out with 3rd vapour while for sugar drying, overhead hot water of 85°C is used in radiators.

The vapour of falling film evaporator has high temperature and pressure as compared to those produced by Robert type evaporator. Therefore, at our project, the first effect (FFE) of evaporator setup is supplied only with exhaust Steam and we proficiently utilize;

- 3rd and 4th Vapour for primary Juice Heating.
- 2nd vapour for secondary heating and 1st vapour for temperature make up.
- 2nd vapour for total pan boiling.
- 1st vapour for partial Refine pan boiling.

Of course, these struggles result in plant efficiency with decrease in fuel consumption. A huge saving in bagasse, consequently, encourages for power generation, to resolve energy crises in the country and to enhance the asset value of the project too.

In the next stage we are trying to decrease the steam consumption to a remarkable level. For this purpose the planning is being executed.