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Design and development of an extensive vapour bleeding system at the evaporators

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ABSTRACT

The improvement of the co-generation plant in sugar factories and selling additional power to the national grid may be possible. This generates additional revenue in the sugar mills. The steam demand in process can be minimized by secondary power production in the co-generation plant. The secondary power production in the co-generation plant can be achieved in online process by employing extensive vapour bleeding system at the evaporators for secondary heating of cane juice (85-110°C). The annual saving achieved was Rs.11.00 million. This required an investment of Rs.6.50 million, which had an attractive simple payback period of 8 months.

KEYWORDS

High pressure boilers;
Falling film evaporator (FFE);
Co-generation plant;
Vapour bleeding;
Sugar factory.

INTRODUCTION

The sugar industry is a major consumer of thermal energy in the form of steam for the process. The steam consumers in the process are evaporators and juice heaters (mixed juice, sulphited juice and clear juice)[1]. Out of the consumers, the evaporation which concentrate the juice typically from a brix content of 10-11 to about 55-60 brix consume the maximum steam. The evaporators are multiple effect evaporators, with the vapour of one stage can be used as the heating medium in the subsequent stages[3-5].

In the older mills the evaporators are triple or quadruple effect and the vapour from the first effect is used for the vacuum pans and from the second effect for juice heating. The other requirements were met through usage of exhaust steam. Where as in the modern sugar mills efforts have been made to reduce the steam consumption. The following approach has been adopted in the boiling house for reducing the steam consumption[6].

- Increasing the number of evaporator effects, the higher the number of effects the greater will be the steam economy which obeys the Relliux principle.
- Extensive vapour bleeding the extensive use of vapour coming out of different effects of the evaporators are to be used for juice heaters and vacuum pans. The later the effect the better is the steam economy in the system[7,8].

Additionally, the following aspects were also considered in the cane preparation section

- Installation of heavy-duty shredders, to achieve better preparatory index (> 92+ as compared to the conventional 85+) for cane.
- Installation of Grooved Roller Pressure Feeder (GRPF) for pressure feed to the mills. This allows

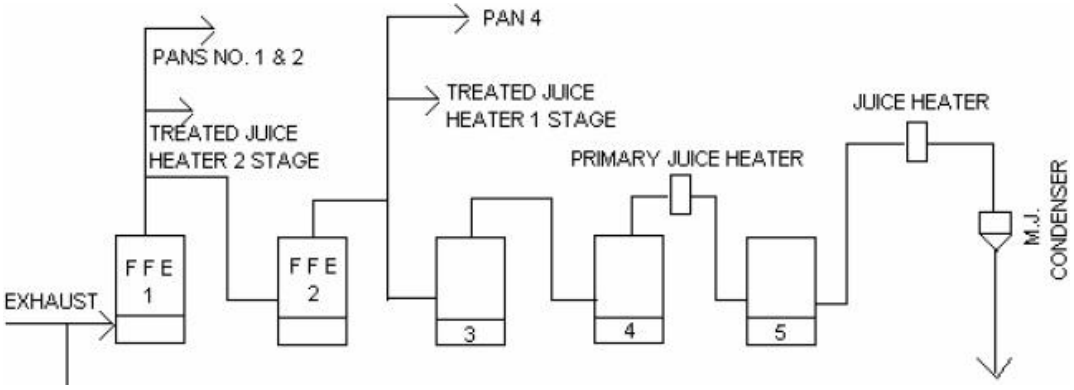

Figure 1 : The multiple effect evaporators

for better juice extraction from the cane.

- Installation of Grooved Roller Pressure Feeder (GRPF) for pressure feed to the mills. This allows for better juice extraction from the cane.
- Lesser imbibitions water addition, on account of the better juice extraction by the GRPF, resulting in reduction of boiling house steam consumption.
- In this present study authors had reported the design and development of an extensive vapour bleeding system at the evaporators.

EXPERIMENTAL

Case study 1

In this case study pertains to a sugar mill of 2500 TCD; where the above approach has been adopted at the design stage itself, resulting in lower steam consumption.

- Vapour bleeding from 11- or 111- effect for heating (from 35°C to 70°C) in the raw (or dynamic) juice heaters.
- Vapour bleeding from 1- effect for heating (from 65°C to 90 0c) in the first stage of the sulphited juice heater.
- Exhaust steam for heating (from 90°C to 105°C) in the second stage of the sulphited Juice heater.
- Exhaust steam for heating (from 94°C to 105 0c) in the clear juice heaters.
- Exhaust steam for heating in the vacuum pans (C - pans).

The specific steam consumption with such a system for a 2500 TCD sugar mill is about 45-53 % on cane, depending on the crushing rate. However, maximum steam economy is achieved, if the vapour from the last two effects can be effectively utilized in the process, as the vapour would be otherwise lost. Also, the load on the evaporator condenser will reduce drastically.

Case study 2

In a 2500 TCD sugar mill, the extensive use of vapour bleeding at evaporators was adopted at the design stage itself. The plant has a quintuple-effect evaporator system. This system comprises of:

- Vapour bleeding from the V-effect, for heating (from 30°C to 45°C) in the first stage of the raw juice heater.
- Vapour bleeding from the IV-effect, for heating (from 45°C to 70°C) in the second stage of the raw juice heater.
- Vapour bleeding from the II-effect, for heating in the A-pans, B-pans and first stage sulphited juice heater.
- Vapour bleeding from the 1-effect, for heating in the C-pans, graining pan and second stage of sulphited juice heater.
- Exhaust steam for heating in the clear Juice heater.

However, to ensure the efficient and stable operation of such a system the exhaust steam pressure has to be maintained uniformly at an average of 1.2-1.4 ksc.

In this particular plant, this was being achieved, through an electronic governor control system for the turbo-alternator sets, in closed loop with the exhaust steam pressure. Whenever, the exhaust steam pressure decreases, the control system will send a signal to the alternator, to reduce the speed. This will reduce the power export to the grid and help achieve steady exhaust pressure and vice-versa.

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RESULTS AND DISCUSSION

Many energy efficient sugar mills, especially those having commercial cogeneration system, have adopted this practice and achieved tremendous benefits. The reduced steam consumption in the process can result in additional power generation, which can be exported to the grid.

Benefits achieved

At 2500-2700 TCD: 41% on cane
At 2700-2800 TCD: 40% on cane
At 2800-3000 TCD: 39% on cane
At 3100 TDC and above: 38% on cane

Thus, the specific steam consumption (% on cane) is lower by at least 7%. This means a saving of 3.5% of bagasse percent cane (or 35 kg of bagasse per ton of cane crushed).

Financial analysis

The annual benefit on account of sale of bagasse (@ Rs.350/- per ton of bagasse and 120 days of operation) works out to Rs.4.50 million. This project was installed at the design stage itself. The actual incremental investment over the conventional system was not available.

In another sugar mill of 5000 TCD, the same project was implemented. The annual saving achieved was Rs.11.00 million. This required an investment of Rs.6.50 million, which had an attractive simple payback period of 8 months.

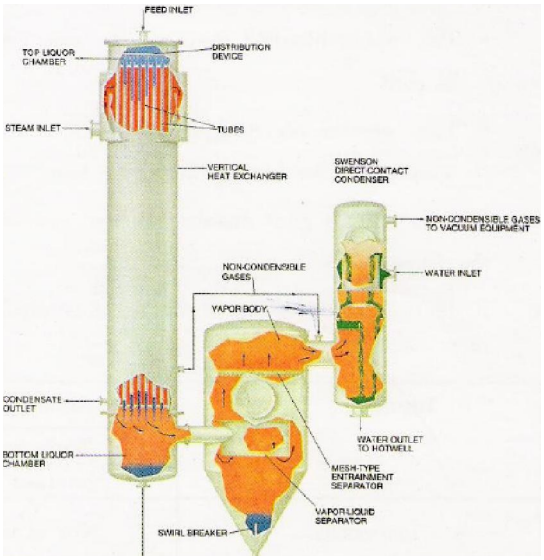

Figure 2 : The falling film evaporators

CONCLUSION

This is one of the methods to reduced steam consumption in the process can result in additional power generation, which can be exported to the grid. This method was implemented in a sugar mill of 2500 TCD and the annual saving achieved was Rs.4.50 million. The same project was also implemented in another sugar mill of 5000 TCD and the annual saving achieved was Rs.11.00 million. This required an investment of Rs.6.50 million, which had an attractive simple payback period of 8 months.

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