

# EXPERIENCES OF PLATE FALLING FILM EVAPORATORS AT THE BACK END OF THE EVAPORATOR STATION

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## Introduction:

The plate falling film technology has been established successfully for more than ten years in the sector of thin juice evaporation. In spite of positive results and although there are more than 120 references running in beet and cane sugar nowadays, European sugar producers have had mixed feelings about the operation of plate falling film evaporators at the back end of the evaporator station. However, with the beginning of the recent campaign 08/09 it was accomplished for the first time to use plate falling film evaporators in the 6<sup>th</sup> and 7<sup>th</sup> effect of the evaporator station. The performance data of the plate falling film evaporators after this sugar campaign in 08/09 and the background for the installation of the plate falling film evaporators are described in this paper.

## Evaporator Station (Campaign 2007):

The existing six-effect evaporator station was equipped with Robert-Evaporators, resulting in a total heating surface of 312,500 ft<sup>2</sup> (29.000 m<sup>2</sup>). These evaporators were running without any problems, but due to operating capacities of 2.2 million lb/hr (1000 t/h) thin juice the juice temperature had increased to more than 278 °F (137 °C) in the first effect. Linked to this the build-up of invert sugar increased and white sugar losses of 770 lb/hr (350 kg/h) were determined. The juice colorization was between 600 and 700 IU.

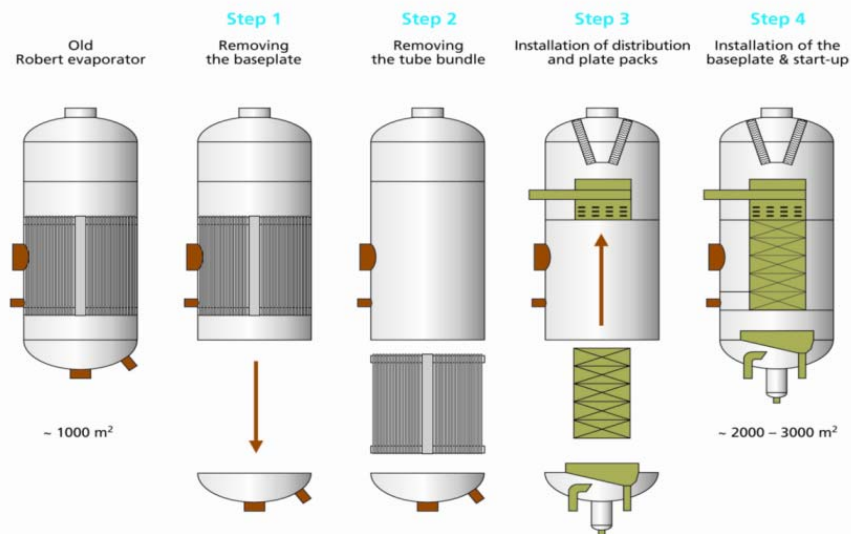


Fig. 1: Retrofit of existing Robert-Evaporators

To achieve energy-savings of 8-10 % the decision was taken to install an additional effect and to review the complete heat balance of the evaporator station at the same time. But the 7-effect evaporation couldn't be realized with an additional Robert-Evaporator, because of the high

temperature differences in the last effects. To lower the effective  $\Delta T$  they decided to retrofit the existing 6<sup>th</sup> effect and an additional Robert-Evaporator in 7<sup>th</sup> effect into plate falling film evaporators. (see Fig. 1)

### **Evaporator Station (Campaign 2008):**

After completion of all structural works the modified evaporator station had a total heating surface of 444,500 ft<sup>2</sup> (41.200 m<sup>2</sup>) and the thin juice was concentrated from 15.8 to 73.3 °Bx. All in all an evaporation capacity of 1.7 million lb/hr (770 t/h) (vapors) was achieved with this seven-effect evaporator station. (see Fig. 2)

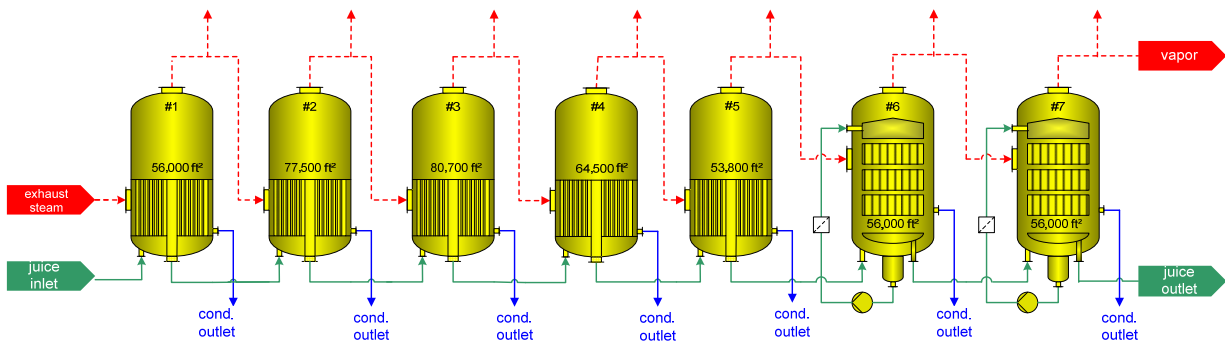


Fig. 2: Flowsheet - 7 effect evaporator station

A heating surface of 56,000 ft<sup>2</sup> (5.200 m<sup>2</sup>) is installed in each plate falling film evaporator. As effect 6 is concentrating juice from 53 to 64 °Bx at an effective  $\Delta T$  of 4.3 K, effect 7 operates at 5.2 K  $\Delta T$  to obtain an end concentration of 73.3 °Bx. The effective  $\Delta T$  over both effects is not higher than 9.5 K.

### **Reliability Issues of Plate Falling Film Evaporators:**

During the engineering process several measures were taken to ensure the reliability of the plate falling film evaporators.

For example the operation of the existing juice softening had a positive effect with regard to the reduction of scaling on the heating surface. Furthermore sufficient recirculation rates made sure that the heating surface is completely wetted. The wetting rate for plate falling film evaporators is designed to reach a minimum of 2.5 l/h\*cm (1.68 gal/hr\*in) in beet sugar. Additionally, redundant strainers of 0.16 inch (4 mm) mesh size were installed in the recirculation piping. Thus no dirt or particles can block the juice distributor. The juice distributor itself is equipped with a level control. It also integrates an overflow-box, which drain-pipe is installed outside of the evaporator with a sightglass.

Furthermore, a special Brix-control-arrangement, as described in Fig. 3, is installed for the two plate falling film evaporators.

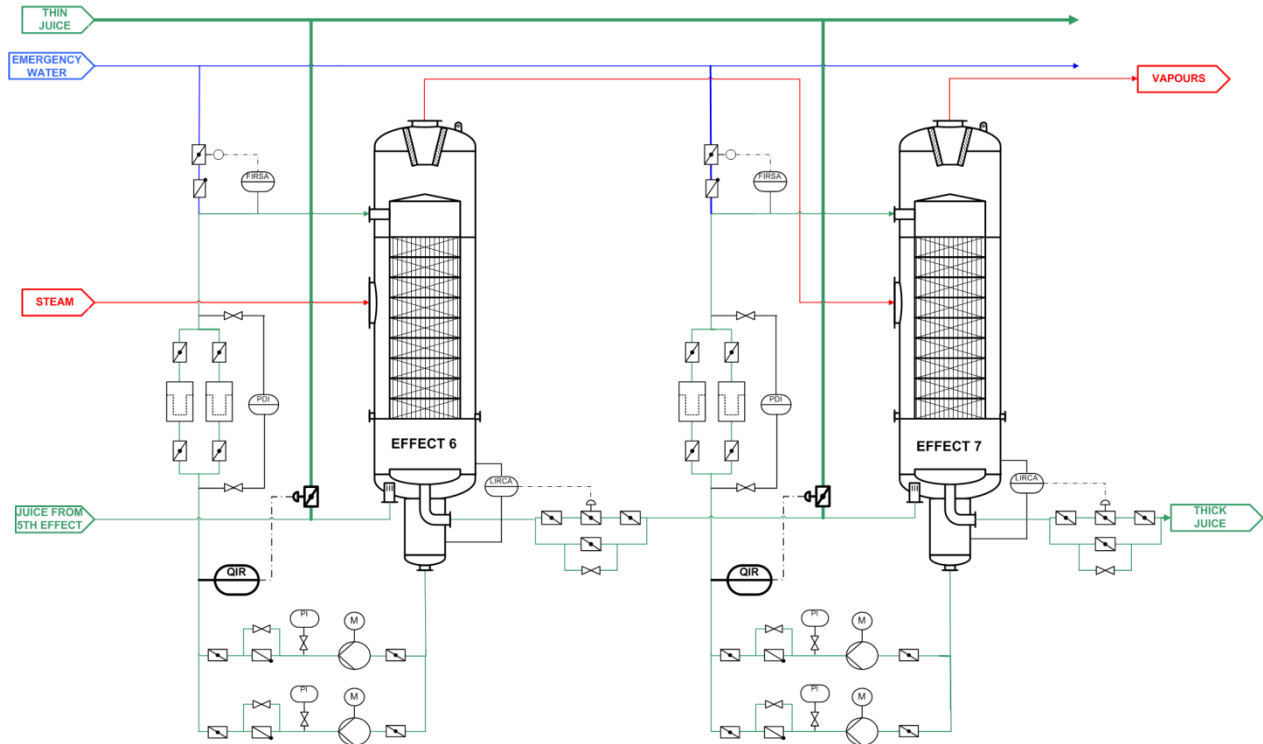


Fig. 3: Brix- control-arrangement

The Brix-measurement in the recirculation pipe is recorded continuously. If the Brix rises to high, thin juice is added to the juice inlet of the respective effect to dilute the juice concentration. This additional control arrangement helps to keep the designed juice concentrations, which is especially important for the last effect.

### **Results:**

The measured u-values of effect 6 and 7 were better than designed and expected. The graphs in Fig. 4 are showing the u-values for both effects from the beginning of the campaign in September 2008 until mid of November. The average u-value of effect 6 is 390 BTU/ft<sup>2</sup>\*hr\*°F (2.200 W/m<sup>2</sup>\*K) and of effect 7 it is 185 BTU/ft<sup>2</sup>\*hr\*°F (1.000 W/m<sup>2</sup>\*K). Originally effect 6 was designed with 246 BTU/ft<sup>2</sup>\*hr\*°F (1.400 W/m<sup>2</sup>\*K) and effect 7 with 88 BTU/ft<sup>2</sup>\*hr\*°F (600 W/m<sup>2</sup>\*K).

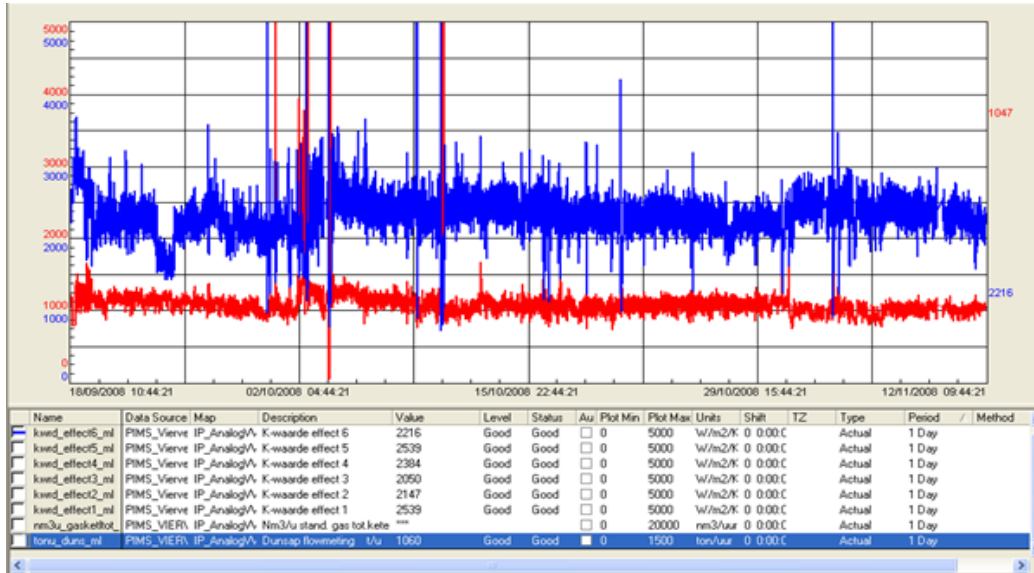


Fig. 4: U-Values of effect 6 and 7

In Tab. 1 the juice colorization and the specific sugar loss o.b. are compared before and after the modifications on the evaporator station.

The color measurement of the thin juices in two consecutive campaigns show no big difference, but it is astonishing to realize that the color of the thick juice was substantially reduced, although an additional effect had been installed.

Campaign	2007	2008
Sugar losses	0.05% o.b.	0.04% o.b.
Thin juice	852 IU	801 IU
Thick Juice	1422 IU	1272 IU
Δ	570 IU	471 IU

Tab. 1: Comparison of Juice Colorization

### **Conclusion:**

This reduction is achieved due to less retention time of the juice within the plate falling film evaporators. In Summary the installation of the plate falling film evaporators was very successful. All parameters could be achieved and the specified energy savings of 10% could be realized.

### **Acknowledgements:**

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