

Prediction of evaporators' sucrose losses using their preliminary sizing calculations

Many articles have been written on measurements and calculations regarding inversion losses in operating evaporators. However, there is an alternate way to estimate these losses, either in the project stage of a new installation, or in the expansion stage of an existing one. It is very common to use Robert short vertical tube type evaporators in multiple effect evaporating stations when designed for new mills.

Regardless of the type of evaporators used in a project, a good evaporator station should directly consume almost all the steam produced by the bagasse generated in the milling. This should be accomplished either via the exhaust steam from the turbines or with live steam supplied to said exhaust.

As previously described, the steam is distributed to collateral equipment, such as vacuum pans, concentrators, heaters, and other auxiliaries through the steam extracted from the different evaporators. This makes this station the main managing body for the energy provided by the bagasse.

The extractions and the number of effects are selected by applying Rillieux's principles for multiple effect evaporation.

With the good management of the number of effects and steam extractions made in the upper vessels of a multiple, it is possible to reach a steam consumption of less than 350 kg/h for each ton of milled cane. This generates a surplus of energy that, when converted into electrical energy, is sold to the public network.



The steam extractions made from the upper bodies of the multiple, require very large surfaces in the first 3 effects of the multiple and therefore, the retention time linked to these surfaces is large and of high temperatures (97° - 119° C). This leads to significant losses due to thermal inversion with an increase in color.

Relationship of the average volume and the surface of different types of evaporators

Each type of evaporator has a surface density dictated by the flooding liquid required for it to function. In the case of the Roberts, it is 40 to 50 m²/m³, while for the descending plate type it is 240 m²/m³. The rest of the evaporators have intermediate surface densities.

Taking all of the above into account, a comparative simulation was made for a 600 tons of cane per hour mill using a quintuple with only Robert bodies of (45 m²/m³), compared to the same quintuple whose three initial effects are of the descending plate type (220 m²/m³).

For the quintuple, the following calculations were made:

1. A conventional battery was sized, using 20 psig of exhaust pressure.
2. The average volumes generated by the surfaces calculated in Robert conventional vessels were compared with those generated in the descending plate evaporator effects, both under the same initial and final pressure conditions.
3. A mean inversion reaction was estimated by temperature, time, and pH using the Vukov equations (Peter Rein cap 25, p 590).
4. The inverted sucrose difference was calculated in the first 3 effects for both types of evaporators.



The results are shown below:

PARAMETERS FOR MULTIPLE EFFECT CALCULATION EXAMPLE				
Cane milled per hour (mton/h)	600			
Exhaust steam pressure (psia)	34.7	Clarified juice Brix	13.1	
Syrup Brix	65	Juice purity	84	
Bleed V1	Third step of reheating			
Bleed V2	B Pan, final reheating, second step of reheating			
Bleed V3	B and C Pans, secondary heating, first step of reheating			
Bleed V4	Primary heating of juice previous heated to 150 F with condensates			
Process steam consumption	Less than 35% in cane			
SUCROSE INVERTED IN THREE FIRST STEP				
Effects	1°	2°	3°	Total
Robert kg sucrose/tch	4.68	2.89	0.66	8.24
Plate FF kg sucrose/tch	0.073	0.04	0.01	0.13
Savings kg/tch	4.61	2.85	0.65	8.112
Per 600 mtch, have a savings of available sucrose per hour of		4867.365 kg		
Actual value # 11 N.Y	0.286 \$/kg	Total Value	1392.066 \$/h	

A return of \$1,392.00/h is considerable, especially with the low prices of raw sugar in the surplus market, and we believe that it would be enough to pay for the change of the first three effects in the previously recommended conditions.

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