Multiple-Effect Evaporator Steam with Vapour Bleeding (Rillieux)

Exhaust steam to an n-effect evaporator and the steam saved by bleeding vapour from the effects, by Rillieux's principles (equal evaporation per kg of steam).

Method: Rillieux's principles of multiple-effect evaporation and vapour bleeding (Hugot, Handbook of Cane Sugar Engineering)

Input parameters

Unit system: SI

Parameter	Value	Unit
Number of effects	5.0000	
Total evaporation	200.00	t/h
Vapour bled from effect 1	40.000	t/h
Vapour bled from effect 2	25.000	t/h
Vapour bled from effect 3	10.000	t/h
Vapour bled from effect 4	0	t/h

Calculated results

Parameter	Value	Unit
Steam with no bleeding (heaters on exhaust)	115.00	t/h
Exhaust steam with bleeding	91.000	t/h
Steam saved by bleeding	24.000	t/h
Evaporation per kg of steam	2.1978	

Notes for this case

- Rillieux's idealisation: 1 kg of steam or vapour evaporates 1 kg in each effect. Real effects give somewhat less.

Formula and method

$$S = \frac{E + \sum_i (n - i)\, B_i}{n}, \quad S_0 = \frac{E}{n} + \sum_i B_i, \quad x = \frac{E - \sum_i i\, B_i}{n} \geq 0$$

Variables

n	Number of effects	-
E	Total evaporation	kg/s
B_1	Vapour bled from effect 1	kg/s
B_2	Vapour bled from effect 2	kg/s
B_3	Vapour bled from effect 3	kg/s
B_4	Vapour bled from effect 4	kg/s
S_0	Steam with no bleeding (heaters on exhaust)	kg/s
S	Exhaust steam with bleeding	kg/s
ΔS	Steam saved by bleeding	kg/s
E/S	Evaporation per kg of steam	-
x	Vapour to the condenser	kg/s

Method and standards

Rillieux's principles.

Assumptions and limits

- Equal evaporation per kg; heat losses ignored.
- The vapour left for the condenser x must not be negative: Σ i B_i may not exceed E.
- With n = 1 (a single effect) bleeding saves its full weight in steam, as Rillieux's i/n = 1.

References

- Rillieux's principles of multiple-effect evaporation and vapour bleeding (Hugot, Handbook of Cane Sugar Engineering)

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/sugar-ethanol/evaporation/rillieux-vapour-bleeding

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.