Evaporator Heat Losses and the Evaporation They Cost

Heat lost from the walls of each evaporator vessel, the vapour it condenses, and the evaporation lost in the later effects by Hugot's place weighting (ch. 32).

Method: Hugot; Handbook of Cane Sugar Engineering; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Number of effects	4.0000	
Exposed surface of each vessel	80.000	m²
Loss coefficient (surface to air) Hugot (Sandera): about 1.6 kcal/(m²·h·°C) for vessels lagged with 60 mm; bare metal several times more.	1.8608	W/(m²·K)
Ambient temperature	30.000	°C
Temperature of vessel 1	104.00	°C
Temperature of vessel 2	94.000	°C
Temperature of vessel 3	80.000	°C
Temperature of vessel 4	55.000	°C
Temperature of vessel 5	55.000	°C

Calculated results

Parameter	Value	Unit
Total heat loss	31.708	kW
Vapour condensed by the losses	50.016	kg/h
Evaporation lost in later effects	94.773	kg/h

Notes for this case

- A loss in the first vessel costs most: the vapour it condenses would have evaporated again in every later effect (Hugot's weighting n − i).

Formula and method

$$\dot{Q}_i = UA(T_i - T_a), \quad \dot{m}_i = \frac{\dot{Q}_i}{h_{fg}(T_i)}, \quad \text{evaporation lost} = \sum (n-i)\dot{m}_i$$

Variables

n	Number of effects	-
A	Exposed surface of each vessel	m²
U	Loss coefficient (surface to air)	W/(m²·K)
T_a	Ambient temperature	K
T_1	Temperature of vessel 1	K
T_2	Temperature of vessel 2	K
T_3	Temperature of vessel 3	K
T_4	Temperature of vessel 4	K
T_5	Temperature of vessel 5	K
$\dot{Q}$	Total heat loss	W
$\Sigma\dot{m}_i$	Vapour condensed by the losses	kg/s

$\Sigma(n-i)\dot{m}_i$	Evaporation lost in later effects	kg/s

Method and standards

Wall losses and Hugot's place weighting.

Assumptions and limits

- Uniform surface temperature.
- The cost is expressed as evaporation lost, not money or fuel. Vessel temperatures must fall along the set.

References

• Hugot
• Handbook of Cane Sugar Engineering
• 3rd ed. (Elsevier, 1986)
• ch. 32
• heat losses (Sandera, Kerr and Webre)
• pp. 543–545
• Latent heat from IAPWS-IF97

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/evaporator-heat-loss

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.