Dryer Steam Consumption per kg of Water Evaporated

Water evaporated in a steam-heated dryer from wet feed and moisture in and out, the heat and steam it needs, and steam per kg of water removed (IAPWS-IF97).

Method: Solids and energy balance; IAPWS R7-97 IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Wet product feed	10,000	kg/h
Moisture in, wet basis	55.000	%
Moisture out, wet basis	8.0000	%
Product (water) temperature in	50.000	°C
Evaporation temperature (wet-bulb or boiling)	80.000	°C
Dryer thermal efficiency Share of the steam heat that evaporates water; the rest heats air, product and losses.	60.000	%
Heating steam pressure (absolute, saturated)	4.0000	bar

Calculated results

Parameter	Value	Unit
Steam consumption	9,712.9	kg/h
Water evaporated	5,108.7	kg/h
Steam per kg of water evaporated	1.9013	kg/kg
Heat supplied	5,755.8	kW

Formula and method

$$\dot{W} = \dot{m}_1 - \dot{m}_1 \frac{1 - x_1}{1 - x_2} \qquad \dot{Q} = \frac{\dot{W}[h_g(T_{ev}) - h_l(T_1)]}{\eta_d} \qquad \dot{m}_s = \frac{\dot{Q}}{h_{fg}(p_s)}$$

Variables

$\dot{m}_1$	wet feed	kg/s
x_1	moisture in, wet basis	–
x_2	moisture out, wet basis	–
T_1	water temperature in; $h_l(T_1)$ is taken at 101.325 kPa	K
T_{ev}	evaporation temperature	K
η_d	dryer thermal efficiency	–
p_s	steam pressure	Pa
$\dot{m}_s$	steam consumption	kg/s
$\dot{W}$	water evaporated	kg/s
$\dot{m}_s/\dot{W}$	steam per kg water	kg/kg
$\dot{Q}$	heat supplied	W
h_g, h_l, h_{fg}	water and steam enthalpies (IF97)	J/kg

Method and standards

Solids balance for the water removed; heat to warm and evaporate it divided by a dryer efficiency; steam latent heat from FireCAD's IAPWS-IF97.

Assumptions and limits

- Steady operation; efficiency covers air, product and losses. The sensible heat of the dry solids is not calculated separately; it is inside the efficiency.
- The steam gives up only its latent heat: the condensate leaves saturated at the steam pressure, and flash or condensate heat recovery is not credited.
- The water in the feed is liquid at atmospheric pressure, so its temperature in must be below 100 °C.

References

- Solids and energy balance
- IAPWS R7-97 IF97

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

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

This calculator online

https://calc.firecad.com/boilers-power-plant/steam/dryer-steam-consumption

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.