Deaerator Heating Steam Consumption

Heating steam a deaerator needs to bring feedwater to saturation at its operating pressure, from a mass and energy balance with vent loss (IAPWS-IF97).

Method: IAPWS R7-97(2012) IF97

Input parameters

Unit system: SI

Parameter	Value	Unit
Deaerated feedwater outlet flow	50,000	kg/h
Deaerator pressure (absolute) Absolute; choose a gauge unit to enter, for example, 0.2 bar g.	1.2132	bar
Vent steam flow Saturated steam lost through the vent with the gases; 0 to ignore.	0	kg/h
Inlet water temperature (condensate and make-up, mixed)	80.000	°C
Heating steam pressure (absolute)	3.0000	bar
Heating steam condition	Dry saturated	
Heating steam temperature (superheated only)	250.00	°C

Calculated results

Parameter	Value	Unit
Heating steam flow	2,210.0	kg/h
Inlet water flow	47,790	kg/h
Steam per kg of feedwater	4.4200	%
Deaerator (saturation) temperature	105.10	°C
Inlet water enthalpy	335.01	kJ/kg
Heating steam enthalpy	2,724.9	kJ/kg
Outlet feedwater enthalpy (saturated liquid)	440.64	kJ/kg
Vent steam enthalpy (saturated vapour)	2,683.5	kJ/kg

Formula and method

$$\dot{m}_w + \dot{m}_s = \dot{m}_{out} + \dot{m}_v$$

$$\dot{m}_w h_w + \dot{m}_s h_s = \dot{m}_{out} h_{f,d} + \dot{m}_v h_{g,d}$$

$$\dot{m}_s = \frac{\dot{m}_{out}\,(h_{f,d} - h_w) + \dot{m}_v\,(h_{g,d} - h_w)}{h_s - h_w}$$

Variables

$\dot{m}_{out}$	deaerated feedwater outlet flow	kg/s
p_d	deaerator absolute pressure	Pa
$\dot{m}_v$	vent steam flow	kg/s
T_w	mixed inlet water temperature	K
p_s	heating steam absolute pressure	Pa
state	dry saturated, or superheated at T_s	–
T_s	heating steam temperature when superheated	K
$\dot{m}_s$	heating steam flow	kg/s

$\dot{m}_w$	inlet water flow	kg/s
$\dot{m}_s/\dot{m}_{out}$	steam per kg of feedwater	–
T_d	deaerator saturation temperature	K
h_w	inlet water enthalpy	J/kg
h_s	heating steam enthalpy	J/kg
$h_{f,d}$	saturated liquid enthalpy at p_d	J/kg
$h_{g,d}$	saturated vapour enthalpy at p_d	J/kg

Method and standards

First-law balance on a direct-contact heater, enthalpies from FireCAD's IAPWS-IF97 implementation. Steam throttled from p_s to p_d keeps its enthalpy.

Assumptions and limits

- No heat loss from the deaerator shell.
- Inlet streams (condensate, make-up, flash steam returns) are entered as one mixed water stream; add other steam inputs to the heating steam or work them out separately.
- Outlet water leaves saturated at deaerator pressure.
- The inlet water enthalpy is taken at the deaerator pressure, not its own line pressure; for liquid water the difference is negligible.
- The heating steam pressure must be at least the deaerator pressure.

References

• IAPWS R7-97(2012) 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/deaerator-steam

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Reopens the calculator with the inputs of this report.