Start-Up Steam to Vent or Bypass at Minimum Firing

Steam made at minimum stable firing during start-up (IF97) that must go to the start-up vent or bypass, and the heat it carries.

Method: Energy balance with IAPWS-IF97 enthalpies

Input parameters

Unit system: SI

Parameter	Value	Unit
Fuel heat input at minimum stable firing	12.000	MW
Boiler efficiency at that firing	70.000	%
Steam pressure at the vent (absolute)	20.000	bar
Steam temperature	300.00	°C
Feedwater temperature	80.000	°C
Drum (feedwater) pressure (absolute) The feedwater enthalpy is taken at the drum or feed pressure, which can be well above the vent pressure during start-up.	20.000	bar

Calculated results

Parameter	Value	Unit
Steam to vent or bypass	11.251	t/h
Heat in the vented steam	8.4000	MW

Notes for this case

- Size the start-up vent and silencer for this flow; superheaters need it to keep cool before the turbine takes steam.

Formula and method

$$\dot{m}_s = \frac{\eta \dot{Q}_{min}}{h_s - h_{fw}}$$

Variables

$\dot{Q}_{min}$	Fuel heat input at minimum stable firing	W
η	Boiler efficiency at that firing	-
p	Steam pressure at the vent (absolute)	Pa
T_s	Steam temperature	K
T_{fw}	Feedwater temperature	K
p_{fw}	Drum (feedwater) pressure (absolute)	Pa
$h_s$$, $$h_{fw}$	steam enthalpy at the vent (p, T_s) and feedwater enthalpy at (p_fw, T_fw), IF97	J/kg
$\dot{m}_s$	Steam to vent or bypass	kg/s
$\dot{Q}_l$	Heat in the vented steam	W

Method and standards

Energy balance: the heat absorbed at minimum firing (input times efficiency) all goes into raising steam from the feedwater to the vented state, with IAPWS-IF97 enthalpies (steam at the vent conditions, feedwater at the drum pressure).

Assumptions and limits

- Steady minimum firing.
- Feedwater must be liquid at the drum pressure.
- All the absorbed heat is taken to make vented steam. During a real start-up part of it heats the water and metal, so the vent flow found is an upper bound, suitable for sizing the vent and silencer.

References

- Energy balance with IAPWS-IF97 enthalpies

Report details

Report reference	FCC-8T84-M37M (the same inputs always give the same reference)
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Calculator	Start-Up Steam to Vent or Bypass at Minimum Firing
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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/boilers/start-up-steam-to-vent

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.