Fuel Oil Tank Heating Coil Area and Steam

Steam coil area and steam flow to heat a fuel oil storage or day tank in a given time, including the tank's heat loss, from oil mass, temperatures and U values.

Method: IAPWS R7-97(2012) IF97; first law of thermodynamics

Input parameters

Unit system: SI

Parameter	Value	Unit
Oil in the tank	200.00	t
Mean specific heat of the oil	1.9000	kJ/(kg·K)
Oil temperature at start	30.000	°C
Oil temperature wanted	60.000	°C
Heating time	24.000	h
Tank surface area losing heat	300.00	m²
Tank heat-loss coefficient About 1 W/(m²·K) insulated, 5–7 bare; wind raises it.	1.2000	W/(m²·K)
Ambient temperature	25.000	°C
Coil overall heat transfer coefficient Low for viscous oil in natural convection; from the heater maker or plant data.	120.00	W/(m²·K)
Heating steam pressure (saturated) Shown as gauge (bar g, kg/cm² g, psig) as plant headers read; choose an absolute unit to enter absolute pressure.	5.9867	bar g

Calculated results

Parameter	Value	Unit
Coil area needed	9.6666	m²
Steam consumption	242.51	kg/h
Total heat duty	139.14	kW
Heat to raise the oil temperature	131.94	kW
Tank heat loss at mean temperature	7.2000	kW
Steam saturation temperature	164.95	°C

Formula and method

$$\dot{Q}_h = \frac{M c_p (T_2 - T_1)}{t} \qquad \dot{Q}_l = U_t A_t (T_m - T_a),\ T_m = \frac{T_1 + T_2}{2} \qquad \dot{Q} = \dot{Q}_h + \dot{Q}_l$$

$$A_c = \frac{\dot{Q}}{U_c (T_{sat} - T_m)} \qquad \dot{m}_s = \frac{\dot{Q}}{h_{fg}(p_s)}$$

Variables

M	oil in the tank	kg
c_p	mean specific heat of the oil	J/(kg·K)
T_1	oil temperature at start	K
T_2	oil temperature wanted	K
t	heating time	s
A_t	tank surface losing heat	m²

U_t	tank heat-loss coefficient	W/(m²·K)
T_a	ambient temperature	K
U_c	coil overall coefficient	W/(m²·K)
p_s	steam pressure (absolute in SI; shown as gauge)	Pa
A_c	coil area	m²
$\dot{m}_s$	steam consumption	kg/s
$\dot{Q}$	total duty	W
$\dot{Q}_h$	heat to raise the oil	W
$\dot{Q}_l$	tank heat loss	W
T_{sat}	steam saturation temperature	K
T_m	mean oil temperature	K
h_{fg}	latent heat (IF97)	J/kg

Method and standards

Energy balance of the tank over the heating time, with the heat loss at the mean oil temperature; coil area by the steam-to-mean-oil temperature difference; steam latent heat from FireCAD's IAPWS-IF97.

Assumptions and limits

- Well-mixed oil; constant properties; condensate leaves saturated.
- The coil area uses the difference between the steam and the mean oil temperature. The exact batch-heating result, $A = Mc_p \ln[(T_{sat} - T_1)/(T_{sat} - T_2)]/(U_c t)$, is close when the steam is much hotter than the oil but larger as T_{sat} approaches T_2; a note appears within 15 K.
- Below ambient the tank gains heat and the loss is negative, with a note.

References

- IAPWS R7-97(2012) IF97
- first law of thermodynamics

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/boilers-power-plant/fuel-ash-handling/fuel-oil-tank-heating-coil

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Reopens the calculator with the inputs of this report.