Fuel Oil Ring Main: Circulation Flow, Pipe Size and Pressure Drop

Circulating flow, velocity, Reynolds number, pressure drop and pump power of a fuel oil ring main from burner use, circulation factor and oil properties.

Method: Darcy–Weisbach with laminar and Colebrook friction (FireCAD engine) and circulation balance (definitions)

Input parameters

Unit system: SI

Parameter	Value	Unit
Total burner consumption	2,000.0	kg/h
Circulation factor (flow / consumption)	2.5000	
Oil density at line temperature	920.00	kg/m³
Kinematic viscosity at line temperature	40.000	cSt
Pipe inside diameter	40.900	mm
Equivalent ring length	300.00	m
Pressure to hold at the burners	25.000	bar
Pump efficiency	50.000	%

Calculated results

Parameter	Value	Unit
Circulating flow	5.4348	m³/h
Velocity	1.1491	m/s
Reynolds number	1,174.9	
Ring friction drop	2.4267	bar
Pump differential	27.427	bar
Pump power	8.2810	kW

Formula and method

$$Q = \frac{k\dot{m}_b}{\rho}, \quad Re = \frac{Vd}{\nu}, \quad \Delta p_f = f_D \frac{L_e}{d}\frac{\rho V^2}{2}, \quad P = \frac{Q\Delta p}{\eta}$$

$$V = \frac{4Q}{\pi d^2}, \quad f_D = \frac{64}{Re}\ (Re < 2300), \quad \frac{1}{\sqrt{f_D}} = -2\log_{10}\left(\frac{\varepsilon/d}{3.7} + \frac{2.51}{Re\sqrt{f_D}}\right)\ \text{otherwise}, \quad \Delta p = \Delta p_f + \Delta p_b$$

Variables

$\dot{m}_b$	Total burner consumption	kg/s
k	Circulation factor (flow / consumption)	-
ρ	Oil density at line temperature	kg/m³
ν	Kinematic viscosity at line temperature	m²/s
d	Pipe inside diameter	m
L_e	Equivalent ring length	m
Δp_b	Pressure to hold at the burners	Pa
η	Pump efficiency	-
Q	Circulating flow	m³/s

V	Velocity	m/s
Re	Reynolds number	-
Δp_f	Ring friction drop	Pa
Δp	Pump differential	Pa
P	Pump power	W
f_D	Darcy friction factor	-
$\mathcal{E}$	pipe roughness, 0.045 mm (commercial steel)	m

Method and standards

Darcy–Weisbach pipe friction with the laminar factor 64/Re below Re 2300 and Colebrook above, for commercial steel pipe (roughness 0.045 mm).

Assumptions and limits

- Isothermal line.
- The full circulating flow is taken along the whole equivalent length; burner off-takes along the ring, static head and filter and heater drops are not included.
- In the transition range (Re 2300–4000) a note appears.

References

- Darcy–Weisbach with laminar and Colebrook friction (FireCAD engine) and circulation balance (definitions)

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-ring-main

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Reopens the calculator with the inputs of this report.