Reaction Force at an Open Pipe Discharge

Reaction thrust at an open pipe end or vent discharging gas or liquid, from mass flow, exit area and exit pressure (momentum plus pressure terms).

Method: Momentum balance at an open discharge

Input parameters

Unit system: SI

Parameter	Value	Unit
Fluid at exit	Gas (ideal gas at exit)	
Mass flow	36,000	kg/h
Exit inside diameter	100.00	mm
Static pressure at exit (absolute)	4.8000	bar
Ambient pressure	101.33	kPa
Gas temperature at exit	126.85	°C
Gas molar mass	18.015	kg/kmol
Liquid density	1,000.0	kg/m³

Calculated results

Parameter	Value	Unit
Exit density	2.6000	kg/m³
Exit velocity	489.70	m/s
Momentum term	4.8970	kN
Pressure term	2.9741	kN
Reaction force	7.8711	kN

Notes for this case

• F = ṁv_e + (p_e − p_a)A_e acting opposite to the discharge. For a choked gas exit, p_e is the critical pressure and T_e the critical temperature. Supports near safety valve and blowdown outlets must carry this force; transient opening loads can be up to twice it.

Formula and method

$$F = \dot{m} v_e + (p_e - p_a) A_e, \quad v_e = \frac{\dot{m}}{\rho_e A_e}, \quad \rho_e = \frac{p_e M}{R T_e}$$

Variables

fluid	Fluid at exit	-
$\dot{m}$	Mass flow	kg/s
D_e	Exit inside diameter	m
p_e	Static pressure at exit (absolute)	Pa
p_a	Ambient pressure	Pa
T_e	Gas temperature at exit	K
M	Gas molar mass	kg/kmol
ρ_l	Liquid density	kg/m³
ρ_e	Exit density	kg/m³
v_e	Exit velocity	m/s
$\dot{m} v_e$	Momentum term	N

$(p_e - p_a)A_e$	Pressure term	N
F	Reaction force	N

Method and standards

Discharge thrust.

Assumptions and limits

- Steady discharge; uniform exit flow; ideal gas.

References

Momentum balance at an open discharge

Report details

Report reference	FCC-100W-ZGG3 (the same inputs always give the same reference)
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Calculator	Reaction Force at an Open Pipe Discharge
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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/mechanical/piping/open-discharge-reaction-force

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.