Gas Well Liquid Loading: Turner Critical Rate

Minimum gas rate to lift liquid droplets out of a gas well (Turner), from pressure, temperature, tubing size, liquid density and surface tension.

Input parameters

Unit system: SI

Parameter	Value	Unit
Flowing pressure at the point checked (absolute)	300.00	psi
Temperature at that point	80.330	°F
Tubing inside diameter	1.9950	in
Liquid density (water about 67, condensate about 45 lb/ft³)	45.000	lb/ft³
Gas-liquid surface tension	20.000	mN/m
Gas gravity (air = 1)	0.70000	

Calculated results

Parameter	Value	Unit
Gas compressibility factor (Hall–Yarborough)	0.94068	
Gas density	1.1156	lb/ft³
Critical (terminal) velocity with Turner's 20 % margin	9.8529	ft/s
Minimum gas rate to unload liquids	387.61	Mscf/d

Notes for this case

- Check at the wellhead and at the bottom of the tubing and use the larger rate. Below the critical rate droplets fall back, liquid accumulates and the well loads up; smaller tubing, a velocity string or plunger lift raise the gas velocity.

Formula and method

$$v_t = 1.912\frac{[\sigma(\rho_L-\rho_g)]^{1/4}}{\rho_g^{1/2}}\ \text{(ft/s)},\quad Q_{min} = \frac{128\,r^2 p\,[\sigma(\rho_L-\rho_g)]^{1/4}}{TZ\sqrt{\rho_g}}\ \text{(Mscf/d; in, psia, °R, dyn/cm, lb/ft}^3\text{)}$$

Variables

p	Flowing pressure at the point checked (absolute)	Pa
T	Temperature at that point	K
d	Tubing inside diameter	m
ρ_L	Liquid density (water about 67, condensate about 45 lb/ft³)	kg/m³
σ	Gas-liquid surface tension	N/m
γ_g	Gas gravity (air = 1)	-
Z	Gas compressibility factor (Hall–Yarborough)	-
ρ_g	Gas density	kg/m³
v_t	Critical (terminal) velocity with Turner's 20 % margin	m/s
Q_{min}	Minimum gas rate to unload liquids	Nm³/s

Method and standards

Turner droplet model with 20 % margin.

Assumptions and limits

- Droplet model; mist flow.

Report details

Report reference	FCC-E5FH-VRJQ (the same inputs always give the same reference)
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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/chemical/oil-gas/gas-well-liquid-loading-turner

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.