Pulverised Coal Pipe Velocity and Coal Loading

Transport velocity in a pulverised coal (PF) pipe from the primary air flow, pipe size and mill outlet conditions, with the coal-to-air loading.

Method: Continuity with the ideal-gas law for air

Input parameters

Unit system: SI

Parameter	Value	Unit
Pulverised coal flow per pipe	2,500.0	kg/h
Primary air flow per pipe, dry	5,000.0	kg/h
Pipe inside diameter	350.00	mm
Mill outlet (mixture) temperature	75.000	°C
Pipe pressure (absolute)	1.0433	bar
Primary air humidity, kg water per kg dry air About 0.01 for temperate air, up to 0.02 to 0.03 for humid tropical air.	0.013000	kg/kg
Total moisture of the raw coal	15.000	%
Moisture left in the pulverised coal	2.0000	%

Calculated results

Parameter	Value	Unit
Gas velocity in the pipe (air with its humidity and the evaporated coal moisture)	15.817	m/s
Water vapour in the pipe (air humidity and coal moisture driven off)	447.35	kg/h
Coal loading, kg coal per kg air	0.50000	kg/kg
Air-to-coal ratio	2.0000	kg/kg

Notes for this case

- Check the velocity against the mill and burner maker's minimum (coal settles and pipes can catch fire below it) and maximum (erosion).

Formula and method

$$\dot{m}_v = x_a \dot{m}_a + \dot{m}_c \frac{M_{in} - M_{out}}{1 - M_{in}}$$

$$v = \frac{\dot{m}_a/\rho_a(T,p) + \dot{m}_v/\rho_v(T,p)}{\pi D^2/4} \qquad \mu_c = \frac{\dot{m}_c}{\dot{m}_a} \qquad A/C = \frac{\dot{m}_a}{\dot{m}_c}$$

Variables

$\dot{m}_c$	pulverised coal flow per pipe	kg/s
$\dot{m}_a$	primary air per pipe, dry air	kg/s
D	pipe bore	m
T	mill outlet temperature	K
p	pipe pressure	Pa
x_a	primary air humidity, kg water vapour per kg dry air	kg/kg
M_{in}	total moisture of the raw coal	-
M_{out}	moisture left in the pulverised coal	-

$\dot{m}_v$	water vapour in the pipe	kg/s
$\mathcal{V}$	gas velocity	m/s
μ_c	coal loading	kg/kg
A/C	air-to-coal ratio	kg/kg
ρ_a	dry air density	kg/m³
ρ_v	water vapour density (ideal gas)	kg/m³

Method and standards

The gas in the pipe is the dry primary air, the water vapour its humidity carries, and the moisture driven off the coal in the mill ((M_in − M_out)/(1 − M_in) kg per kg of pulverised coal). Each is taken at the mill outlet temperature and pipe pressure by the ideal-gas law and the volumes are added; the coal's own volume is neglected.

Assumptions and limits

- Gas velocity only (slip of coal particles not modelled). The vapour from the coal and the air humidity add roughly 15 % to the dry-air velocity for 15 % moisture coal dried to 2 % at an air-to-coal ratio of 2; enter zero humidity and moisture to see the dry-air figure.
- The pipe pressure is absolute: add the atmospheric pressure to a gauge reading.

References

- Continuity with the ideal-gas law for air

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/pf-pipe-velocity

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.