Fluidised-Bed Tube Erosion: Effect of Velocity and Ash

Relative maximum erosion of boiler tubes when gas velocity, ash concentration, operating hours or tube material change, by Emax ∝ M τ ρ_a V^3.3 (Basu Eq. 11.1).

Method: Basu; Circulating Fluidized Bed Boilers: Design; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Reference gas velocity	5.0000	m/s
New gas velocity	6.0000	m/s
Ash concentration ratio new/reference	1.0000	
Abrasion coefficient ratio (1 carbon steel, 0.7 alloy steel)	1.0000	
Operating hours ratio	1.0000	

Calculated results

Parameter	Value	Unit
Relative maximum erosion	1.8251	
Velocity giving the reference erosion with the new ash and material	5.0000	m/s

Notes for this case

- A 20 % rise in velocity raises erosion by about 80 %: velocity is the first thing to control.
- V* holds the operating hours equal; it is the velocity giving the reference erosion rate with the new ash and material.

Formula and method

$$E_{max} \propto M\tau\rho_a V_g^{3.3} \Rightarrow \frac{E_2}{E_1} = \frac{M_2}{M_1}\cdot\frac{\tau_2}{\tau_1}\cdot\frac{\rho_{a2}}{\rho_{a1}}\left(\frac{V_2}{V_1}\right)^{3.3}, \quad V^* = V_1\left(\frac{M_2}{M_1}\cdot\frac{\rho_{a2}}{\rho_{a1}}\right)^{-1/3.3}$$

Variables

V_1	Reference gas velocity	m/s
V_2	New gas velocity	m/s
ρ_{a2}/ρ_{a1}	Ash concentration ratio new/reference	-
M_2/M_1	Abrasion coefficient ratio (1 carbon steel, 0.7 alloy steel)	-
τ_2/τ_1	Operating hours ratio	-
E_2/E_1	Relative maximum erosion	-
V^*	Velocity giving the reference erosion with the new ash and material	m/s

Method and standards

Basu's Eq. (11.1) as a ratio between a new and a reference condition. V* is the velocity that gives the reference erosion rate with the new ash and tube material (operating hours taken equal).

Assumptions and limits

- Same particle properties and impact angle.
- The ash concentration ratio must be above zero (at least 0.01): with no ash there is no erosion and V^* is not defined.

References

- Basu
- Circulating Fluidized Bed Boilers: Design
- Operation and Maintenance (Springer, 2015)
- ch. 11

- Eq. (11.1) (Chinese Boiler Thermal Standard 1973, after Finnie)

Report details

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Release checks	2 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/boilers-power-plant/fluidised-bed/tube-erosion-velocity-ratio

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.