Coal Ash Slagging and Fouling Indices (Base/Acid Ratio)

Base-to-acid ratio, slagging index and fouling index of coal ash from the oxide analysis and the sulphur in the coal, with the Attig and Duzy severity bands.

Method: Attig and Duzy (1969); Coal ash deposition studies and application to boiler design; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Silica SiO_2	58.000	%
Alumina Al_2O_3	27.000	%
Titania TiO_2	1.5000	%
Iron oxide Fe_2O_3	5.0000	%
Lime CaO	2.0000	%
Magnesia MgO	1.0000	%
Soda Na_2O	0.30000	%
Potash K_2O	1.2000	%
Sulphur in the coal, dry basis	0.50000	%

Calculated results

Parameter	Value	Unit
Basic oxides Fe_2O_3 + CaO + MgO + Na_2O + K_2O	9.5000	%
Acidic oxides SiO_2 + Al_2O_3 + TiO_2	86.500	%
Base-to-acid ratio	0.10983	
Slagging index (B/A × % sulphur, dry)	0.054913	
Fouling index (B/A × % Na_2O in ash)	0.032948	

Notes for this case

- Slagging tendency low and fouling tendency low on the Attig and Duzy (1969) bands for bituminous-type ash (Fe_2O_3 above CaO + MgO).

Formula and method

$$B = \mathrm{Fe_2O_3} + \mathrm{CaO} + \mathrm{MgO} + \mathrm{Na_2O} + \mathrm{K_2O}, \quad A = \mathrm{SiO_2} + \mathrm{Al_2O_3} + \mathrm{TiO_2}$$

$$R_s = \frac{B}{A} \times S_d\,(\%), \quad R_f = \frac{B}{A} \times \mathrm{Na_2O}\,(\%)$$

Variables

$\mathrm{SiO_2}$	Silica SiO_2	-
$\mathrm{Al_2O_3}$	Alumina Al_2O_3	-
$\mathrm{TiO_2}$	Titania TiO_2	-
$\mathrm{Fe_2O_3}$	Iron oxide Fe_2O_3	-
CaO	Lime CaO	-
MgO	Magnesia MgO	-
$\mathrm{Na_2O}$	Soda Na_2O	-
$\mathrm{K_2O}$	Potash K_2O	-
S_d	Sulphur in the coal, dry basis	-
B	Basic oxides Fe_2O_3 + CaO + MgO + Na_2O + K_2O	-

A	Acidic oxides SiO_2 + Al_2O_3 + TiO_2	-
B/A	Base-to-acid ratio	-
R_s	Slagging index (B/A × % sulphur, dry)	-
R_f	Fouling index (B/A × % Na_2O in ash)	-

Method and standards

The indices of Attig and Duzy (1969, Proceedings of the American Power Conference) combine the fluxing basic oxides and the network-forming acidic oxides of the ash with sulphur (which travels with iron as pyrite) for slagging, and with sodium for convective-pass fouling. The oxides are percentages of the ash; sulphur is on the dry coal.

Assumptions and limits

- Bituminous-type ash; lignitic ash needs other indices (a warning appears when CaO + MgO exceeds Fe_2O_3, but the bituminous forms are still shown).
- An analysis whose oxides add up to less than 85 % gets a warning.
- Empirical bands; ash fusion temperatures should be checked too.

References

• Attig and Duzy (1969)
• Coal ash deposition studies and application to boiler design
• Proceedings of the American Power Conference vol. 31
• Babcock & Wilcox
• Steam (ash indices)

Report details

Report reference	FCC-RCRF-WNRN (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/boilers-power-plant/fuel-ash-handling/ash-slagging-fouling-indices

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.