SNCR Urea Dose for NOx Reduction

Urea and urea solution for a selective non-catalytic reduction (SNCR) system from the NOx load and the normalised stoichiometric ratio, with the NOx removed and the reagent utilisation.

Method: Stoichiometry $CO(NH_2)_2 + 2\ NO + ½\ O_2 \rightarrow 2\ N_2 + CO_2 + 2\ H_2O$ (one mole of urea per two of NO); NSR as NH_3 equivalents per mole of NOx

Input parameters

Unit system: SI

Parameter	Value	Unit
Flue gas flow (dry, normal)	100,000	Nm³/h
NOx at the inlet (as NO_2, dry)	400.00	mg/Nm³
NOx reduction wanted	40.000	%
Normalised stoichiometric ratio Moles of NH_3 equivalent per mole of inlet NOx; 1 mol urea = 2 NH_3.	1.8000	
Urea strength of the solution	40.000	%
Solution density About 1110 kg/m³ for 40 % urea at 20 °C; it falls with strength (about 1090 kg/m³ at 32.5 %). Enter the value for your solution.	1,110.0	kg/m³

Calculated results

Parameter	Value	Unit
NOx at the inlet (as NO_2)	40.000	kg/h
NOx removed (as NO_2)	16.000	kg/h
Urea (100 %)	46.995	kg/h
Urea solution	105.85	L/h
Reagent utilisation η/NSR	22.222	%

Notes for this case

- SNCR works only in a temperature window (roughly 850–1100 °C for urea): outside it urea slips as ammonia or burns to NOx.

Formula and method

$$\dot{n}_{NO_x} = \frac{\dot{V}_n c_{NO_x}}{M_{NO_2}}, \quad \dot{m}_u = \dot{n}_{NO_x} \frac{NSR}{2} M_{urea}, \quad \dot{V}_s = \frac{\dot{m}_u}{w \rho_s}$$

Variables

$\dot{V}_n$	Flue gas flow (dry, normal)	Nm³/s
c_{NO_x}	NOx at the inlet (as NO_2, dry)	kg/m³
η	NOx reduction wanted	-
NSR	Normalised stoichiometric ratio	-
w	Urea strength of the solution	-
ρ_s	Solution density	kg/m³
$\dot{m}_{NO_x}$	NOx at the inlet (as NO_2)	kg/s
$\Delta\dot{m}_{NO_x}$	NOx removed (as NO_2)	kg/s
$\dot{m}_u$	Urea (100 %)	kg/s
$\dot{V}_s$	Urea solution	m³/s
u	Reagent utilisation η/NSR	-

Method and standards

Stoichiometry: the urea dose follows from the inlet NOx (as NO_2) and the NSR, at two NH_3 equivalents per mole of urea. The reduction wanted does not change the dose; it gives the NOx removed and the utilisation η/NSR, and a warning appears when that would exceed 100 %.

Assumptions and limits

- Dry, normal basis throughout.
- The solution density is not linked to the strength: change it when you change the strength.

References

• Stoichiometry $CO(NH_2)_2 + 2\ NO + ½\ O_2 \rightarrow 2\ N_2 + CO_2 + 2\ H_2O$ (one mole of urea per two of NO); NSR as NH_3 equivalents per mole of NOx

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/emissions-stacks/sncr-urea-dose

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.