Ringelmann Number and Smoke Opacity Converter

Converts a Ringelmann smoke number to opacity and an opacity reading to its Ringelmann number, with transmittance and optical density.

Method: Ringelmann smoke chart (U.S. Bureau of Mines IC 8333): each number is 20 % black

Input parameters

Unit system: SI

Parameter	Value	Unit
Ringelmann number (0–5)	1.0000	
Opacity reading (opacity meter)	20.000	%

Calculated results

Parameter	Value	Unit
Opacity of the Ringelmann number	20.000	%
Ringelmann number of the reading	1.0000	
Transmittance of the reading	80.000	%
Optical density of the reading	0.096910	

Formula and method

$$O_N = 0.20\,N \qquad N_O = \frac{O}{0.20} \qquad \tau = 1 - O \qquad D = -\log_{10}(1 - O)$$

Variables

N	Ringelmann number	–
O	opacity reading	–
O_N	opacity of the Ringelmann number	–
N_O	Ringelmann number of the reading	–
τ	transmittance	–
D	optical density	–

Method and standards

The Ringelmann chart defines each number as 20 % blackness; opacity, transmittance and optical density follow from their definitions.

Assumptions and limits

- Opacity at the stack exit path length; no path-length correction.
- Ringelmann numbers are read by an observer against a printed chart of blackness; equating each number with 20 % instrument opacity is a convention. Observer readings and transmissometer opacity can differ, especially for coloured smoke or in poor light.
- The two conversions are independent: the Ringelmann number gives only O_N, and the opacity reading gives N_O, τ and D.

References

- Ringelmann smoke chart (U.S. Bureau of Mines IC 8333): each number is 20 % black

Report details

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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/emissions-stacks/chimney-smoke-ringelmann

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.