Toxic Dose and Probit: Probability of an Effect

Toxic load from concentration and exposure time ($C^n t$), the probit Y = a + b ln($C^n t$) and the probability of the effect, from user probit constants.

Method: Perry's Chemical Engineers' Handbook; 9th ed. (McGraw-Hill, 2019); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Concentration	50.000	ppm
Exposure time	30.000	min
Probit constant a (for concentration in ppm and time in minutes) The constants must be for C in ppm and t in minutes. Sets fitted to mg/m³ or to seconds have different a values: convert or use a matching set.	-8.2900	
Probit constant b (ppm, minutes)	0.92000	
Concentration exponent n (ppm, minutes)	2.0000	

Calculated results

Parameter	Value	Unit
Haber dose C·t (ppm·min)	1,500.0	
Toxic load (ppm^n·min)	75,000	
Probit	2.0372	
Probability of the effect	0.15244	%

Notes for this case

• Probit constants are substance- and effect-specific: take them from a recognised source (CCPS, TNO Green Book). The defaults are illustrative only. Screening estimate only, not a safety study or a basis for protective design.

Formula and method

$$D = Ct, \quad Y = a + b\ln(C^n t), \quad P = \frac{1}{2}\left[1 + \operatorname{erf}\left(\frac{Y-5}{\sqrt{2}}\right)\right] \quad (C \text{ ppm},\ t \text{ min})$$

Variables

C	Concentration	-
t	Exposure time	s
a	Probit constant a (for concentration in ppm and time in minutes)	-
b	Probit constant b (ppm, minutes)	-
n	Concentration exponent n (ppm, minutes)	-
D	Haber dose C·t (ppm·min)	-
$C^n t$	Toxic load (ppm^n·min)	-
Y	Probit	-
P	Probability of the effect	-

Method and standards

Haber's law and the probit method.

Assumptions and limits

- Constant concentration during the exposure.
- The probit constants must be for concentration in ppm and time in minutes; sets for mg/m³ or seconds need converting.

References

- Perry's Chemical Engineers' Handbook
- 9th ed. (McGraw-Hill, 2019)
- sec. 23
- Eq. (23-15) (Haber dose) and probit methods
- Probit to probability: $P = \frac{1}{2}[1 + \mathrm{erf}((Y - 5)/\sqrt{2})]$

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/chemical/process-safety/toxic-dose-probit

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.