UV Collimated Beam Dose with Petri, Water and Divergence Factors

Average UV dose delivered to a stirred sample under a collimated beam from radiometer irradiance and time, with the best-estimate uncertainty of the dose.

Method: Collimated-beam dose D = E_s t (1 − R) P_f (1 − 10^(−ad))/(2.303 ad) × L/(L + d) with root-sum-square uncertainty

Input parameters

Unit system: SI

Parameter	Value	Unit
Irradiance at the sample surface centre	0.012000	mW/cm²
Exposure time	25.000	s
Reflection at the water surface	2.5000	%
Petri factor (radiometer map average)	92.000	%
Absorbance coefficient at 254 nm (base 10)	0.080000	1/cm
Sample depth	12.000	mm
Lamp-to-sample-surface distance	0.45000	m
Uncertainty of E_s	5.0000	%
Uncertainty of t	0.30000	s
Uncertainty of P_f	2.0000	%
Uncertainty of a_254	0.005000	1/cm
Uncertainty of d	0.50000	mm
Uncertainty of L	5.0000	mm

Calculated results

Parameter	Value	Unit
Water factor (1 − 10^(−ad))/(2.303 a d)	89.719	%
Divergence factor L/(L + d)	97.403	%
Average UV dose	0.23516	mJ/cm²
Best-estimate uncertainty of the dose	0.013285	mJ/cm²
Relative uncertainty	5.6492	%
Conservative dose	0.22188	mJ/cm²

Notes for this case

- Bolton and Linden's collimated-beam protocol: irradiance corrected for reflection, the Petri factor, absorbance through the depth (water factor) and beam divergence. Uncertainty by root-sum-square of each variable's effect.

Formula and method

$$D_{CB} = E_s\, t\,(1-R)\, P_f\, \frac{1-10^{-a_{254}d}}{2.303\, a_{254} d}\, \frac{L}{L+d}$$

$$U_D = \left[\sum_n \left(\frac{\partial D}{\partial V_n} U_{V_n}\right)^2\right]^{1/2}$$

Variables

E_s	Irradiance at the sample surface centre	W/m²
t	Exposure time	s
R	Reflection at the water surface	-
P_f	Petri factor (radiometer map average)	-
a_{254}	Absorbance coefficient at 254 nm (base 10)	1/m
d	Sample depth	m
L	Lamp-to-sample-surface distance	m
δE_s	Uncertainty of E_s	-
δt	Uncertainty of t	s
δP_f	Uncertainty of P_f	-
δa	Uncertainty of a_254	1/m
δd	Uncertainty of d	m
δL	Uncertainty of L	m
WF	Water factor (1 − 10^(−ad))/(2.303 a d)	-
DF	Divergence factor L/(L + d)	-
D_{CB}	Average UV dose	J/m²
U_D	Best-estimate uncertainty of the dose	J/m²
U_D/D	Relative uncertainty	-
$D - U_D$	Conservative dose	J/m²

Method and standards

Average fluence in a stirred, collimated-beam sample with first-order error propagation.

Assumptions and limits

- Stirred sample; collimated low-pressure lamp at 254 nm.

References

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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/environmental/drinking-water/uv-collimated-beam-dose

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.