Disinfection Contactor Dispersion: Pipeline and Serpentine Basin

Pipeline contactor diameter and dispersion number (Taylor and Sjenitzer) and serpentine basin dispersion and t10/τ from the length-to-width ratio.

Input parameters

Unit system: SI

Parameter	Value	Unit
Flow	2,000.0	m³/d
Hydraulic residence time	20.000	min
Pipeline length	300.00	m
Darcy friction factor of the pipeline	0.022000	
Serpentine basin length-to-width ratio (flow path)	6.0000	
Coefficient of ideality (3 good design, 7.1 typical older basin)	7.1000	

Calculated results

Parameter	Value	Unit
Pipeline diameter for the residence time	343.35	mm
Pipeline velocity	0.25000	m/s
Dispersion number, Taylor 5.05(D/L)(f/8)^½	3.0310e-04	
Dispersion number, Sjenitzer 89,500 f^3.6 (D/L)^0.859	2.8701e-04	
Serpentine basin dispersion number 0.14 C_i/(L/W)	0.16567	
Basin baffling factor 0.198 ln(L/W) − 0.002	35.277	%

Notes for this case

• Sjenitzer's field correlation fits measured pipeline dispersion better than Taylor's theory; both assume a long straight pipe. A dispersion number below about 0.006 keeps 4-log inactivation within 5 % of plug flow.

Formula and method

$$D = \sqrt{\frac{4Q\tau}{\pi L}}, \quad d_{Taylor} = 5.05\frac{D}{L}\sqrt{\frac{f}{8}}, \quad d_{Sjenitzer} = 89\,500 f^{3.6}\left(\frac{D}{L}\right)^{0.859}$$

$$d_{basin} = \frac{0.14 C_i}{L/W}, \quad \frac{t_{10}}{\tau} = 0.198\ln\left(\frac{L}{W}\right) - 0.002$$

Variables

Q	Flow	m³/s
τ	Hydraulic residence time	s
L	Pipeline length	m
f	Darcy friction factor of the pipeline	-
L/W	Serpentine basin length-to-width ratio (flow path)	-
C_i	Coefficient of ideality (3 good design, 7.1 typical older basin)	-
D	Pipeline diameter for the residence time	m
v	Pipeline velocity	m/s
d_{Taylor}	Dispersion number, Taylor 5.05(D/L)(f/8)^½	-

$d_{Sjenitzer}$	Dispersion number, Sjenitzer 89,500 f^3.6 (D/L)^0.859	-
d_{basin}	Serpentine basin dispersion number 0.14 C_i/(L/W)	-
t_{10}/τ	Basin baffling factor 0.198 ln(L/W) − 0.002	-

Method and standards

Axial dispersion correlations for pipes and baffled channels used as disinfection contactors.

Assumptions and limits

- Long straight pipelines; baffled rectangular basins with H/W of 1 to 3.

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/chlorine-contactor-dispersion

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Reopens the calculator with the inputs of this report.