Trickling Filter Forced Ventilation: Air Flow, Pressure Drop and Draft

Oxygen supply and air flow for a trickling filter from the BOD loading, corrected for temperature and altitude, packing pressure drop and natural draft.

Input parameters

Unit system: SI

Parameter	Value	Unit
Wastewater flow	8,000.0	m³/d
Primary effluent BOD	120.00	mg/L
BOD loading (kg/m³·d)	0.40000	
Organic peaking factor	1.3000	
Nitrogen oxidised per BOD (0 for BOD removal only)	0.25000	
Warmest air temperature	25.000	°C
Wastewater temperature	18.000	°C
Site atmospheric pressure	0.93758	atm
Tower diameter	15.000	m
Number of towers	2.0000	
Packing depth	6.0000	m
Packing correction (1.3 cross-flow, 2.0 rock)	1.3000	
Inlet and minor loss factor	1.5000	

Calculated results

Parameter	Value	Unit
Oxygen supply (kg O_2 per kg BOD applied)	119.23	
Air at 20 °C and 1 atm	284.57	m³/min
Design air flow	347.86	m³/min
Liquid loading per tower	943.14	kg/(m²·h)
Velocity heads	122.42	
Pressure drop through the tower	0.018284	Pa
Natural draft	0.84409	Pa

Notes for this case

• Air flow (3.58 m³ of air per kg O_2, plus 1 % per °C above 20 °C). The pressure drop is per tower using that tower's share of the flow. Natural draft reverses when the air and water temperatures cross, which is why forced ventilation is used.

Formula and method

$$R_o = 20\left(0.80e^{-9L_B} + 1.2e^{-0.17L_B}\right)PF, \quad AR_{20} = \frac{R_o Q S_o (3.58)}{10^3 (1440)}, \quad AR = AR_{20}\frac{273.15 + T_a}{273.15}\frac{P_a}{P_b}\left(1 + \frac{T_a - 20}{100}\right)$$

$$N_p = f_m f_p\, 10.33\, Ze^{1.36\times10^{-5}L/A}, \quad \Delta P = N_p\frac{\rho v^2}{2}, \quad D_{air} = 353\left(\frac{1}{T_c} - \frac{1}{T_m}\right)Z$$

Variables

Q	Wastewater flow	m³/s

S_o	Primary effluent BOD	kg/m³
L_B	BOD loading (kg/m³·d)	-
PF	Organic peaking factor	-
N_{ox}/BOD	Nitrogen oxidised per BOD (0 for BOD removal only)	-
T_a	Warmest air temperature	K
T_w	Wastewater temperature	K
P_b	Site atmospheric pressure	Pa
D_t	Tower diameter	m
n	Number of towers	-
Z	Packing depth	m
f_p	Packing correction (1.3 cross-flow, 2.0 rock)	-
f_m	Inlet and minor loss factor	-
R_o	Oxygen supply (kg O_2 per kg BOD applied)	-
AR_{20}	Air at 20 °C and 1 atm	m³/s
AR	Design air flow	m³/s
L/A	Liquid loading per tower	kg/(m²·s)
N_p	Velocity heads	-
ΔP	Pressure drop through the tower	Pa
D_{air}	Natural draft	Pa

Method and standards

Trickling filter ventilation.

Assumptions and limits

- Empirical oxygen-supply relation; vertical packing correlation with factors.

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/environmental/wastewater/trickling-filter-ventilation

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Reopens the calculator with the inputs of this report.