Theoretical Penetration for a Venturi Scrubber

Based on Yung, et. at. "Venturi Scrubber Performance Model" U.S. EPA 600/2-77-172

Enter Values in Highlighted Fields.

Type of Data	Parameter	Symbol	Units	Entered Value	Typical Values
Particle Characteristics	Particle Physical Diameter	d	μm		0.1 to 100
	Density of Particle	ρ_p	gm/cm^3		1 to 3
Gas Stream Characteristics	Gas Flow Rate	Q_g	ACFM		N/A
	Gas Temperature	T	°F		32 to 400
	Moisture Content of Gas	H_2O	%		1 to 50
	Oxygen Content of Gas	O_2	%		< 20.9
	Barometric Pressure	B_p	in. Hg		23.5 to 30.5
	Gas Static Pressure	P_g	in. W.C.		-40 to +120
Liquid Stream Characteristics	Liquid Flow Rate	Q_l	gallons/min		N/A
	Liquid Density	ρ_l	gm/cm^3		1.0 to 1.15
	Droplet Diameter	d_d	cm		0.01 to 0.1
Venturi Characteristics	Venturi Throat Width	w_{vt}	cm		N/A
	Venturi Throat Depth	d_{vt}	cm		N/A

Type of Calculation	Parameter	Symbol	Units	Calculated Value
Particle Characteristics	Aerodynamic Diameter of Particle	d_p	μm	0.00
	Cunningham Slip Correction Factor	C_c	dimensionless	#DIV/0!
Gas Stream	Gas Temperature	T	°K	256
Liquid Stream Characteristics	Liquid-to-Gas Ratio	L/G	gal/(1000 ACF)	#DIV/0!
	Liquid-to-Gas Ratio	L/G	dimensionless	#DIV/0!
	Droplet Diameter	d_d	cm	#DIV/0!
	Droplet Reynolds Number	N_{Red}	dimensionless	#DIV/0!
	Gas Velocity in Throat	v_{gt}	cm/sec	#DIV/0!
	Gas Viscosity	μ_g	gm/cm·sec	0.000153
	Gas Density	ρ_g	gm/cm^3	0.00000
	Drag Coefficient, Liquid at Throat	C_D	dimensionless	#DIV/0!
Collection Eff. Calculations	Parameter B	B	dimensionless	#DIV/0!
	Impaction Parameter at Throat Entrance	K_{po}	dimensionless	#DIV/0!
	Penetration (dp=i)	$P_t(d_p)$	dimensionless	#DIV/0!
	Collection Efficiency (d_p=i)		%	#DIV/0!

Note: Based on infinite throat length. See Yung et. al for assumptions pertaining to the model equations and for limitations of the calculations .

Theoretical Penetration for a Spray Tower Scrubber

Based on Calvert, et. al., "Wet Scrubber Handbook" Section 5.3.5, 1972

Enter values in highlighted fields.

Type of Data	Parameter	Symbol	Units	Entered Value	Typical Range
Particle Characteristics	Particle Physical Diameter	d	μm		> 3
	Particle Density	ρ_p	gm/cm^3		1 to 3
Gas Stream Characteristics	Gas Flow Rate	Q	ACFM		N/A
	Gas Temperature	T	°F		32 to 400
	Moisture Content of Gas	H_2O	%		1 to 50
	Oxygen Content of Gas	O_2	%		1 to 20.9
	Gas Static Pressure	S_p	in. W.C.		-10 to + 10
	Barometric Pressure	P_{BAR}	in. Hg.		23.5 to 30.5
Liquid Stream Characteristics	Liquid Flow Rate	L	gpm		N/A
	Droplet Radius (see nozzle supplier and operating conditions)	r_d	cm		0.005 to 0.05
	Droplet Density	ρ_p	gm/cm^3		1 to 1.15
Scrubber Characteristics	Scrubber Height	Z	cm		N/A
	Gas Superficial Velocity	v_G	cm/sec		50 to 500

Types of Calculations	Parameter	Symbol	Units	Calculated Value
Particle Characteristics	Aerodynamic Particle Diameter	d_p	μm	0.00
	Cunningham Slip Correction Factor	C_c	dimensionless	#DIV/0!
Gas Stream Characteristics	Gas Viscosity	μ_g	$gm/cm \cdot sec$	0.00015
	Gas Density	ρ_g	gm/cm	0.0000
	Gas Temperatuare	T	°K	256
Liquid Stream Characteristics	Liquid Flow Rate	Q_l	ft^3/min	0.00
	Liquid-to-Gas Ratio	L/G	gal/1000 ACF	#DIV/0!
	Liquid-to-Gas Ratio	L/G	dimensionless	#DIV/0!
	Droplet Terminal Settling Velocity	v_t	cm/sec	#DIV/0!
Efficiency Calculations	Impaction Parameter (d_p = i)	K_i	dimensionless	#DIV/0!
	Impaction Parameter η_i	η_i	dimensionless	#DIV/0!
	Penetration (d_p=i)	$P_t(d_p)$	dimensionless	#DIV/0!

	Collection Efficiency (d_p=i)		%	#DIV/0!

Theoretical Penetration for a Packed Tower Scrubber

Based on Calvert, et. al., "Wet Scrubber Handbook" Section 5.3.3, 1972

Enter Values in the highlighted fields.

Type of Data	Parameter	Symbol	Units	Entered Value	Typical Values
Particle Characteristics	Particle Physical Diameter	d	μm		>3
	Particle Density	ρ_p	gm/cm^3		1.0 to 3.0
Gas Stream Characteristics	Gas Temperature	T	°F		32 to 180
	Moisture Content of Gas	H_2O	%		1 to 50
	Oxygen Content of Gas	O_2	%		0 to 20.9
	Actual Gas Flow Rate	Q	ACFM		N/A
Packed Bed Characteristics	Packing Element Width	j	cm		0.16-0.19
	Liquid Hold-Up in Bed	H_d	dimensionless		0
	Packing Diameter	d_c	cm		1 to 5
	Bed Diameter	D	cm		25 to 250
	Bed Porosity	ε	dimensionless		0.57-0.94
	Bed Height	Z	cm		50 to 250

Type of Calculations	Parameter	Symbol	Units	Calculated Value
Particle Characteristics Characteristics	Gas Viscosity	μ_g	gm/cm·sec	0.000153
	Cunningham Slip Correction Factor	C_c	dimensionless	#DIV/0!
	Particle Aerodynamic Diameter	d_p	μm	0.00
Gas stream Characteristics	Superficial Velocity	Vg	cm/sec	#DIV/0!
	Gas Temperature	T	K	256
Efficiency Calculations	Impaction Parameter (d_p = i)	K_i	dimensionless	#DIV/0!
	Penetration (d_p=i)	$P_t(d_p)$	dimensionless	#DIV/0!
	Collection Efficiency (d_p=i)		%	#DIV/0!