ACGIH®, *Industrial Ventilation: A Manual of Recommended Practice for Design*, 29th Edition
Errata Listing (as of 08/13/2018)

CHAPTER	SECTION	PAGE	DESCRIPTION
13	VS-85-02	13-179	Replace this VS-Plate with attached VS plate as per 28th Edition.

The exhaust flow rate for operating engines connected directly to a tail pipe exhaust system is a function of engine displacement, crankshaft revolutions, tailpipe exhaust temperature and the appropriate conversion factors. The exhaust volume is determined using the following equations, which also include a 20% safety factor.

4-Cycle Engine Exhaust Flow Rate Equations

The engine exhaust flow rate equation may take one of three forms depending on the units of the variables.

Parameters	Abbreviation	Condition/Units of Measure		
		1	**2**	**3**
Exhaust Flow Rate	Q_e	acfm	acfm	am^3/s
Engine Displacement	D_{eng}	in^3/cycle	liters/cycle	liters/cycle
Crankshaft Revolutions per Unit Time	N	rpm	rpm	rpm
Tailpipe Exhaust Temperature	T_{ex}	F	F	C
Standard Temperature	T_s	70 F	70 F	21 C

Where:

- Condition 1 – all parameters in IP units:

$$Q_e = (1.2)(D_{eng})(N)(0.5)(1\ ft^3/1728\ in^3)((460\ F + T_{ex}) / 530\ F)$$

- Condition 2 – engine displacement in SI units; all other parameters in IP units:

$$Q_e = (1.2)(D_{eng})(N)(0.5)(0.0353\ ft^3/liter)((460\ F + T_{ex}) / 530\ F)$$

- Condition 3 – all parameters in SI units:

$$[Q_e = (1.2)(D_{eng})(N)\left(\frac{1\ min}{60\ s}\right)(0.5)(.001\ m^3/liter)((273\ C + T_{ex}) / 294\ C)]$$

Note 1: The above equations do not take into account the engine's volumetric efficiency (VE). VE is a ratio of the volume of fuel and air that actually enters the cylinder during the induction phase to the actual capacity of the cylinder under static conditions. Use of larger valves, multiple valves, cylinder head porting, tuned exhaust systems, variable valve timing, and forced air induction all can improve the VE above that which can be obtained from a normally tuned, naturally aspirated engine. If the VE is known, Q_e can be multiplied by VE to yield a more accurate representation of the exhaust flow.

If VE is unknown, it is assumed to be 100% (or 1.00, as is the case in the above equations). This is a conservative assumption when working with naturally aspirated engines, as VE is less than 100% is such cases.

Note 2: When calculating the exhaust flow rate for a dual exhaust system, divide the engine's exhaust flow rate (acfm) by two (2) to yield the flow rate for each exhaust pipe.

EXAMPLE PROBLEM 1 (5.7 Liter Engine)

A 5.7 liter, normally aspirated gas engine is operated at 1200 rpm. Its tailpipe exhaust gas temperature is 1000 F. What is the exhaust flow rate in acfm? (Condition 2)

$$Q_e = (1.2)(D_{eng})(N)(0.5)(0.0353\ ft^3/liter)((460\ F + T_{ex}) / 530\ F)$$

$$= (1.2)(5.7\ L)(1200\ rpm)(0.5)(0.0353\ ft^3/L)(1460\ F / 530\ F)$$

$$= 400\ acfm$$