FAN LAWS

Formulae 1 to 4 can be applied to any fan provided the diameter does not change. If the diameter does not change the fans must be geometrically similar. The units of density, fan rotational speed and diameter are not important as long as both are the same.

In formulae 5 to 8 the units shown in the nomenclature must be used to satisfy the formulae

Volume Flow	$q_{v2} = q_{v1} \times \left(\frac{n_2}{n_1}\right)^1 \times \left(\frac{d_2}{d_1}\right)^3$
Pressure	$p_2 = p_1 \times \left(\frac{n_2}{n_1}\right)^2 \times \left(\frac{d_2}{d_1}\right)^2 \times \left(\frac{\rho_2}{\rho_1}\right)^1$
Absorbed Power	$P_{R2} = P_{R1} \times \left(\frac{n_2}{n_1}\right)^3 \times \left(\frac{d_2}{d_1}\right)^5 \times \left(\frac{\rho_2}{\rho_1}\right)^1$
Sound Power Level	$PWL_2 = PWL_1 \times 70 \log_{10}\left(\frac{d_2}{d_1}\right) + 55 \log_{10}\left(\frac{n_2}{n_1}\right) + 20 \log_{10} \times \left(\frac{c_2}{c_1}\right)$
Density	$\rho_2 = \rho_1 \times \left(\frac{B_2}{B_1}\right) \times \left(\frac{T_1}{T_2}\right)$
Fan Total Efficiency %	$\frac{q_v \times p_1 F}{10\ P_R}$
Fan Total Pressure	$p_t F = p_s F + p_d F$
Fan Static Pressure	$p_s F = p_t F - p_d F$
Velocity Pressure	$p_d = 0.5\ \rho V^2$ $p_d = 0.6\ V^2$ (Standard air, ρ = air 1.2 kg/m³)

Nomenclature for symbols used in this page:-

q_v	Volume flow of air m³/sec
n	Rotational speed of fan
d	Diameter of fan
p	Pressure developed by the fan
ρ	Density of air, kg/m³
P_R	Power absorbed by the fan, kW
B	Barametric pressure (millibars)
T	Absolute temperature, K (K = °C + 273)
P_tF	Fan total pressure, Pa
P_sF	Fan static pressure, Pa
P_dF	Fan dynamic / velocity pressure, Pa
P_d	System dynamic / velocity pressure, Pa
V	Velocity of air, m/sec
PWL	Sound power level

References:
1] F. P. Bleier, Fan Handbook: Selection Application and Design, New York, NY, USA:McGraw-Hill, 1997.
2] M.J. McPherson, Subsurface Ventilation and Environmental Engineering, Chapter 10