Useful Theory, Equations and Notes on Engine Tests

Notation

Item	Symbol	Units	Actual Value
Coefficient of Discharge for the Orifice	C_d		0.6
Calorific Value of Fuel	C_L	$J.kg^{-1}$	See Table 2.
Specific Heat of Air at Constant Pressure	C_P	$J.kg^{-1}$	(1004.5 at low pressure and room temperature)
Orifice Diameter	d	m	(See **'Technical Specifications'** on page 11)
Ambient Pressure	p_A	Pa	
Engine Speed	N	$Rev.min^{-1}$	
Ambient Air Temperature (at inlet)	T_A	°K	
Pressure change	Δp	Pa	
Enthalpy of Air	H_A	W	
Combustion Energy of Fuel	H_F	W	

Mass and Volume Flow

Many of the calculations need the mass flow of a liquid, but the instruments read volume flow. This is because the mass flow depends on the density of the liquid, which can vary with temperature. The relationship between mass and volume of a liquid is:

$$\text{Mass} = \text{Density} \times \text{Volume}$$

So:

$$\text{Mass Flow (in kg.s}^{-1}) = \text{Density (in kg.m}^{-3}) \text{ x (Volume Flow (in L.s}^{-1})/1000)$$

Air Consumption

The Airbox includes an orifice at its inlet. The DPT1 Instrument Module shows the ambient air pressure (before the orifice) and the air pressure in the Airbox (after the orifice). The difference in the pressures (Δp) and the air density (ρ) will give you the basic air flow velocity (U):

$$U = \sqrt{\frac{2\Delta p}{\rho}}$$

To find the mass flow ($\dot{m}_a$) the air flow velocity equation is modified to separate out the factors of density and to include the coefficient of discharge (C_d) for the orifice and the orifice diameter:

$$\dot{m}_a = C_d \frac{\pi d^2}{4} \sqrt{\frac{2 p_A \Delta p}{R T_A}}$$