



Note 99

Friction-and-Pumping Mean Effective Pressure (FPMEP) for 4-strokes

$$\text{Brake MEP} = \text{Indicated MEP} - \text{FPMEP}$$

The author established in a private study (DST 23 April 1996) that a reasonable correlation for FPMEP for 4-stroke piston engines had the form:-

$$\text{FPMEP} = \text{KF1} + \text{KF2} \times \text{N} \times (\text{MPS})^2.$$

With FPMEP in Bar; N = crank speed RPM; and MPS = Mean Piston Speed in m/s:-then the coefficients of correlation were:-

$$\text{for Touring engines } \text{KF1} = 1; \text{ and } \text{KF2} = 25/10^7.$$

$$\text{for Racing engines } \text{KF1} = \frac{3}{4}; \text{ and } \text{KF2} = 9/10^7.$$

An attached chart 47/dst on P.2* illustrates the data examined for this correlation (data collected up to mid 2001 was about 70% in support). The formulae above have been included in [Appendix 1](#) so as to calculate an Estimated Mechanical Efficiency (EEM, at Line 105) for each CoY example. In these calculations for pre-WW1 engines the values of KF1 and KF2 (shown on Lines 102 & 103) have been chosen as though they were **Touring** units.

The reasons for **Touring** engines having much higher KF coefficients than **Racing** engines are:-

- Longer life required: this demands more material to reduce stresses so that there is more inertia in reciprocating parts, greater piston-cylinder reaction and more oil-shearing area;
- Lower noise required: therefore smaller clearances are required between piston and cylinder so again there is greater oil-shearing loss;
- Lower oil consumption required: Requiring more and higher-radial-pressure piston rings so once more higher oil-shearing loss;
- More Accessories required : self explanatory
- Lower Volumetric Efficiency: *in the past* (see below) the inlet and exhaust systems of **Touring** engines have been much more tortuous than **Racing** engines;
- Lower cost required: **Racing** engines have always had much more labour spent on them to machine parts accurately and fit the parts truly.

The last two factors will be less significant now than in the past because **Touring** engines now have at least "Semi-tuned" inlet and exhaust systems and are produced to a higher quality of machining and assembly.

Racing engines have also had special anti-friction features compared to **Touring** engines, Egs. More ball-and-roller bearings throughout; rollers in valve gear; and more recently low-friction coatings on rubbing parts.

Dimensional Correlation

To obtain an FPMEP correlation with correct dimensions the (N) term should be separate from the (MPS)² term. The former term when multiplied by Oil Viscosity would represent a Pressure. The latter term when multiplied by a Density would also represent a Pressure. The equation would then be balanced dimensionally.

However this desirable separation of terms could not be identified with the data available.

The accuracy of the correlation therefore must be in doubt beyond (N) x (MPS)²
= 90 x 10⁵ (RPM) x (m/s)².

*This chart needs to be enlarged to 200% to be read clearly.

