Mean Effective Pressure

1. Introduction

After various statements made about BMEP (Brake Mean Effective Pressure) it was thought to be a good idea to explain the concept a bit more detailed. A single cylinder of a 250 GP engine was simulated at 12000 rpm and the results used in the following explanation.

2. Simulation Results

2.1 Abbreviations

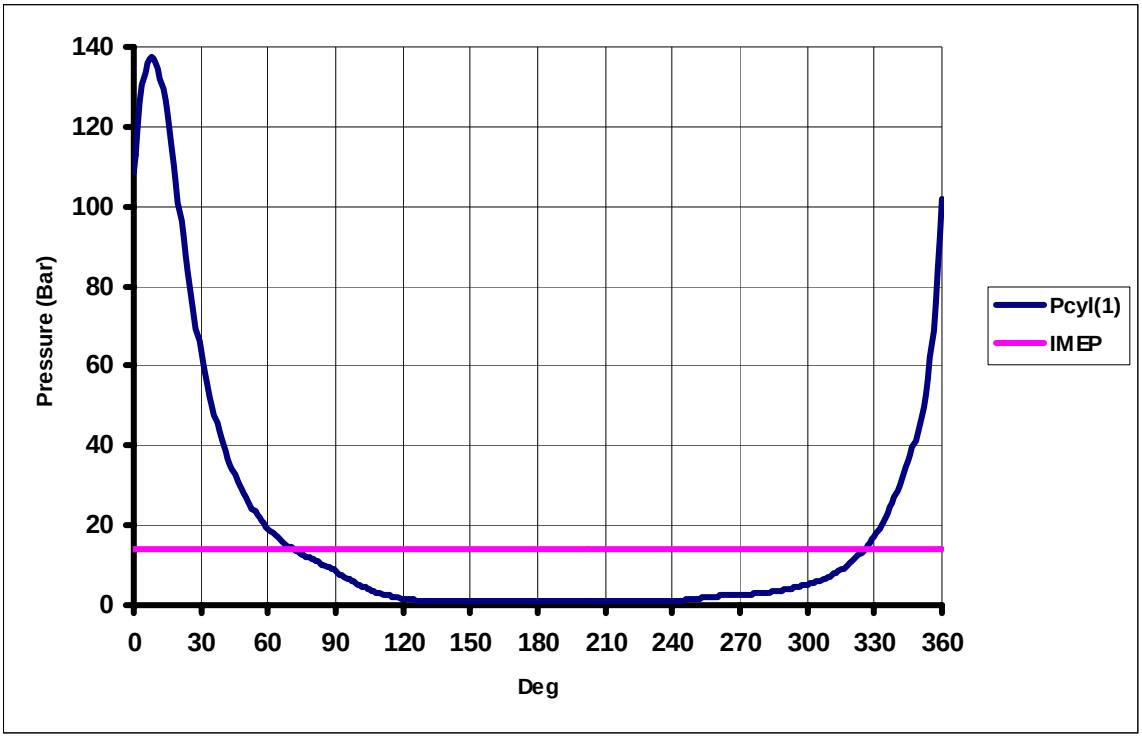
MEP - Mean effective pressure
IMEP - Indicated mean effective pressure
BMEP - Brake mean effective pressure
PMEP - Pumping mean effective pressure
FMEP - Friction mean effective pressure

MEP is the mean pressure that acts on the piston during one revolution for a 2stroke engine and for two revolutions for a 4stroke engine.

2.2 Indicated Mean Effective Pressure

Indicated mean effective pressure (IMEP) is the mean (or average) of the pressure acting on top of the piston crown over 360 degrees of crankshaft rotation. In the early days of the development of the internal combustion engine a special device was used to plot the instantaneous cylinder pressure called an “indicateur”, from there the name “indicated”. Today it is measured using a pressure transducer. It is an indication of how much power an engine can produce if there were no losses.

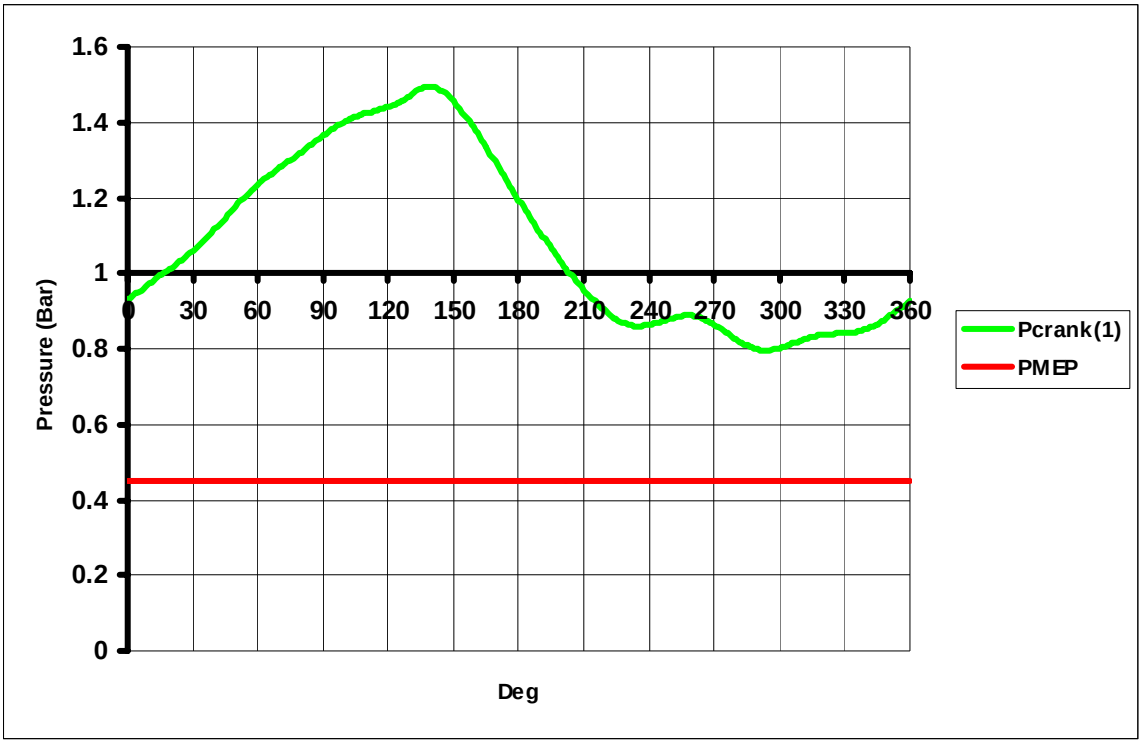
The next figure shows the instantaneous cylinder pressure as a function of crank angle going from TDC to TDC. As can be seen the maximum pressure is almost 140bar (1bar is about 1 atmosphere is about 14.7 psi). Averaging this pressure over the full revolution gives the IMEP shown as the magenta line on the graph and it has a value of 14.119bar.



2.3 Pumping Mean Effective Pressure

Pumping mean effective pressure is the average or mean pressure working underneath the piston (of a 2stroke engine) when the crankcase is used as a scavenge pump. The next graph shows the instantaneous crankcase pressure of the engine.

As before, this pressure is averaged giving the Pumping mean effective pressure (PMEP) with a value of 0.449bar shown as the red line.



2.4 Friction Mean Effective Pressure

Friction mean effective pressure (FMEP) is not a pressure but is the frictional losses; the oil and water pump losses and the alternator losses worked back as a pressure. For our example engine it has a value of 0.608bar.

2.5 Brake Mean Effective Pressure

Brake mean effective pressure is an indication of the netto or usable power an engine produces. It is known as “Brake” mean effective pressure because one way of determining BMEP is to measure the engine power on a brake or a dyno and the calculate the BMEP from the measured power:

Power = PLAN or P = Power/LAN

Where: P is BMEP in Pa
L is stroke in m
A is bore cross sectional area in m^2
N is revolutions per second (rpm/60)
Power is in watts

Also, BMEP can be determined from the following equation:

BMEP = IMEP – PMEP – FMEP

Which for our example engine is:

BMEP = 14.119 – 0.449 – 0.608
= 13.061

And using that we get at 12000rpm:

Power = 13.061E5 x 0.0507 x 0.002463 x 12000/60
= 32619.7 Watt
= 32.6 kW
= 43.49 hp

3. Conclusion

So what an engine produces as a function of all the tuning and scavenging etc. is IMEP and after all the losses we can only use the BMEP part. Using BMEP as a tuning target when designing pipes and porting assumes that all engines have the same losses, which is definitely not true! The porting, pipes, carburetors, reedvalves etc. determine the IMEP and that is what should be used as a tuning aim. Targeting BMEP can only be used if the engines are all very similar as for example single cylinder water-cooled moto-cross engines of the same age.