

Summarizing Engine Operating Conditions via Mean Effective Pressures

Orientation:

In this activity, you will use PV diagrams to demonstrate your understanding of mean effective pressure. You will test your understanding by analyzing how mean effective pressure changes under throttled and under supercharged conditions for a 4-stroke Otto cycle engine. As a result of this exercise, you will establish a relationship between gross mean effective pressure, pumping mean effective pressure, and indicated (net) mean effective pressure. Characterizing engine cycles by mean effective pressures allows engine designers to efficiently communicate complicated changes in engine combustion and fluid mechanics.

Learning Objectives:

1. Determine mean effective pressures from PV diagrams.
2. Explain impacts of throttling and supercharging on net cycle work.
3. Establish a relation between imep, gmep, and pmep.

Targeted Skills:

Diagramming – clarifying relationships through visual representation

Integrating – combining parts into a new whole

Persisting – continuing despite difficulties

1. Draw an 4-stroke Otto cycle on a PV diagram, including ideal intake and exhaust strokes. Assume compression from 1 atm to 8 atm over a volume ratio of 5:1 prior to combustion.
2. Shade the net work of the cycle on your PV diagram.
3. Next to your unthrottled PV diagram, sketch a qualitatively correct mean effective pressure that gives the same cycle work across the displaced volume. This is the gross indicated effective pressure (gmep).
4. Draw another 4-stroke Otto cycle on a separate PV diagram, assuming the same conditions as before, except for intake throttling down to $\frac{1}{2}$ atm. Shade the area that represents pumping work. What sign is this? What impact does throttling have on the rest of the cycle?
5. Draw yet another 4-stroke Otto cycle on another PV diagram, assuming the same conditions as before, except for supercharging to 1.5 atm absolute. Shade the area that represents pumping work in this case. What sign is this? What impact does supercharging have on the rest of the cycle)?
6. What is the mathematical relationship between gross (gmep), pumping (pmep), and indicated mean effective pressure (imep) for a throttled engine cycle? Imep accounts for PV effects across an entire engine cycle. Gmep accounts for PV effects only from the beginning of compression to the end of expansion.
7. How could you obtain an estimate indicated mean effective pressure from in-cylinder pressure data?