In-Cylinder Pressure Modeling

Names:

Orientation:
In this activity, you will contrast real and ideal Otto cycle engines from the standpoint of their pressure-volume, pressure-crankangle diagrams, and log pressure vs log volume behavior. This will uncover a clever method for tracking in-cylinder heat release that applies to any engine cycle.

Learning Objectives:

1. Enhance your intuition about real and ideal thermodynamic cycles by relating pressure-volume, pressure-crankangle, and log pressure vs log volume plots.
2. Visualize in-cylinder heat release by analyzing log pressure versus log volume plots.

Targeted Skills:
Diagramming – clarifying relationships through visual representation
Reasoning with theory – explaining data with accepted knowledge
Sharing knowledge – effectively presenting relevant facts and interpretations

1. Sketch an air-standard Otto cycle on a PV diagram. Identify all processes, including ideal intake and exhaust. USE A SOLID LINE. Overlay a PV diagram for a complex fuel-air cycle that includes effects of (a) finite combustion time, (b) wall heat transfer, (c) finite valve opening/closing times, and (d) blowdown before BDC. USE A DASHED LINE.

2. On a separate graph, sketch a pressure-crankangle diagram over 720 degrees for a motored engine with no combustion. Assign top dead center (TDC) at the beginning of the intake stroke to be -360 degrees. This will make TDC at the end of compression to be 0 degrees. USE A DOTTED LINE. On this second graph, overlay a pressure-crankangle diagram for an air-standard Otto cycle. Label the start and end of each process. USE A SOLID LINE. On this second graph, now overlay a pressure-crankangle diagram for a complex fuel-air cycle including the effects listed above. USE A DASHED LINE.

3. Represent compression, combustion, expansion, and heat rejection for this engine to a third graph which displays log pressure versus log volume. Use a SOLID LINE for the air-standard cycle and a DASHED LINE for the complex fuel-air cycle. Clearly identify each process. What is the slope of the polytropes representing compression and expansion?

4. On a fourth graph, sketch the mass burned fraction as a function of crankangle for an air-standard Otto cycle. USE A SOLID LINE. On this graph, overlay the mass burned fraction as a function of crankangle for a complex fuel-air cycle. USE A DASHED LINE. Clearly show the start and end of combustion.

5. How do these graphs change when the mixture is leaned out?

6. How do these graphs change as engine speed is increased?