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Modeling a DISI Engine Using GT-Power

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1. Motivation

- New fuels are being developed as energy carriers to power vehicles. Engines must be designed to robustly utilize a variety of fuels
- A Direct Injection Spark Ignition (DISI) engine allows for stratified combustion which increases thermal efficiency
- However, the efficiency gain depends on the type of fuel used
- To increase fuel economy the underlying mechanisms for these differences must be understood

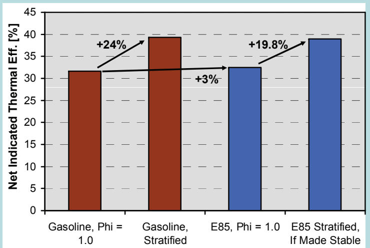


Figure 1: Stratified combustion increases thermal efficiency but the efficiency increase is different for each fuel

- Models provide insights that are hard to measure, for example, charge temperature during various parts of the cycle

2. Engine Set-Up

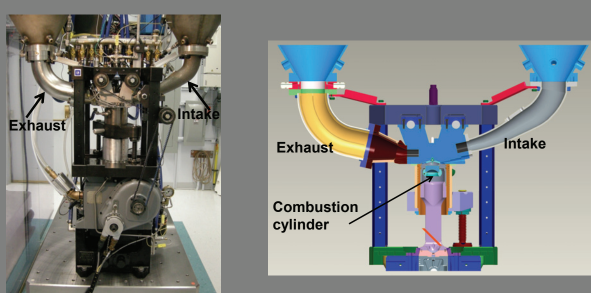


Figure 2: On left the DISI engine used to run experiments is shown. The schematic on the right provides a better view of the internal components of the engine.

3. GT-Power Model

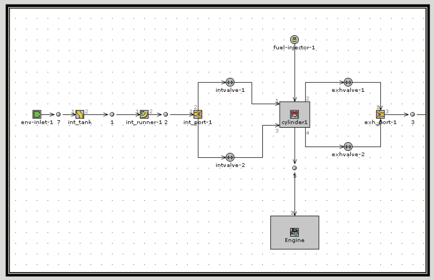
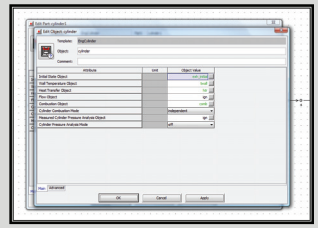


Figure 3: GT-Power User-Interface to create model



- GT-Power solves the Navier-Stokes equations in 1-D by breaking up each component into sub-volumes
- The user must build a model by choosing different components of an engine

Initial Results

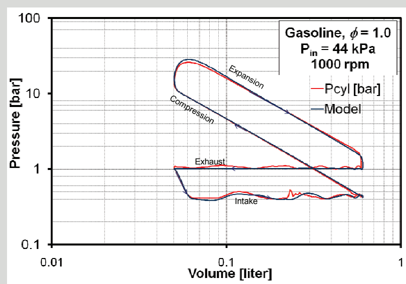


Figure 4: Model results are compared to the experimental data for Gasoline with phi=1 and injection CA of -310 degree.

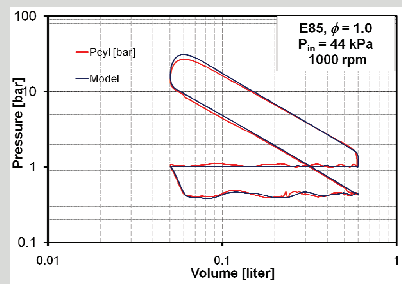


Figure 5: Model results are compared to the experimental data for E85 with phi=1 and injection CA of -300 degree.

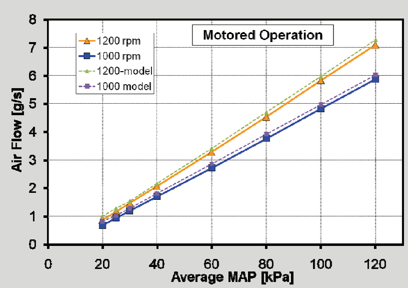


Figure 6: Air flow at intake for several different intake pressures shown for the experimental and model data.

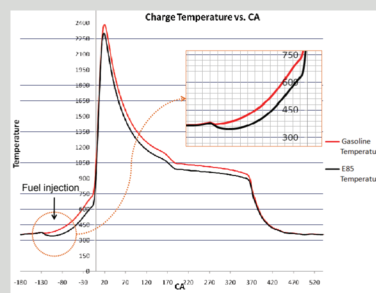
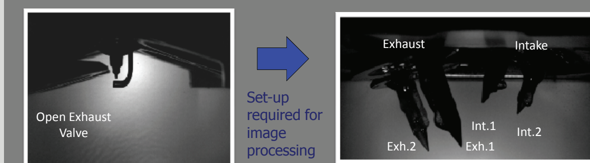


Figure 7: Cooling of the cylinder gases is observed when E85 is injected into the cylinder

4. Current Work

Image Processing of Valve Lift



- High speed camera captures images every CA 2°
- Each image is then analyzed to see how many pixels it has moved relative to the first image

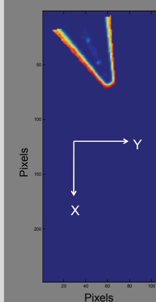


Figure 9: Sample picture of mask around spike attached to valve

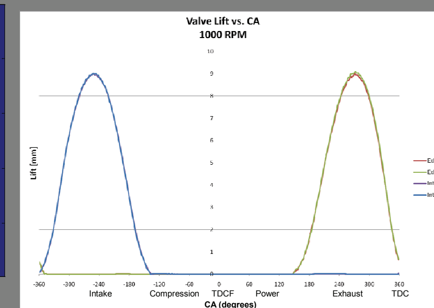


Figure 10: Intake and Exhaust Valve Lift versus crank angle

5. Future Work

- Continue image processing of the valves at different engine speeds
- Use the valve lift data as input into GT-Power to further tune the model
- Further study vaporization cooling effect on thermal efficiency
- Acquire validation data at various coolant temperatures to ensure model correctly captures the effects of changing wall temperature

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