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Investigating the Heat Release from a Single-Cylinder Diesel Engine

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INVESTIGATING THE HEAT RELEASE OF A SINGLE-CYLINDER DIESEL ENGINE

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UNIVERSITY OF SOUTHERN MAINE

Abstract:

- The Diesel cycle is a process in which combustion occurs due to compression-ignition
- Thermal analysis along with investigation of the heat release of the fuel can be used to draw numerous conclusions about engine and fuel set performance

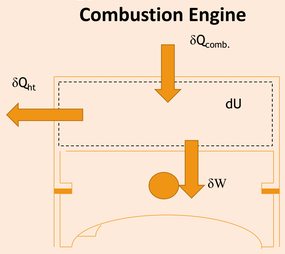
Objectives:

- Using the graphical programming software LabVIEW, code was developed to use dynamic measurement processes and filtering techniques in order to calculate these engine parameters with a high-speed data acquisition system
- Volumetric efficiency of the Kohler Diesel Model KD440 was improved through implementation of a newly designed air intake adapter

Methods of Engine Performance Measurement

- Single-cylinder, 3600 RPM, 7.7 kW diesel engine

Energy Balance in an Internal Combustion Engine



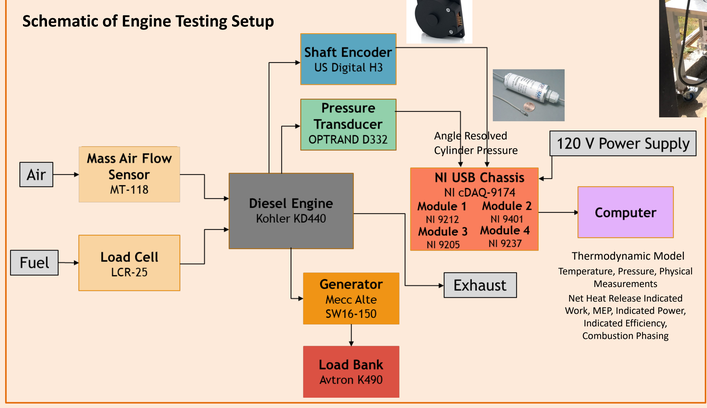
Applying the 1st law for a control volume:

$\delta Q_{comb.} = dU + \delta W - \delta Qht$

Applying the ideal gas law:

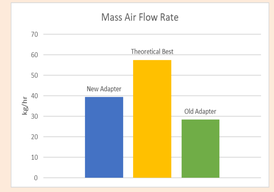
$$\frac{dQ_{comb.}}{d\theta} = \frac{V(\theta)\frac{dP(\theta)}{d\theta} + \gamma(\theta)P(\theta)\frac{dV(\theta)}{d\theta}}{\gamma(\theta)-1} - \frac{dQ(\theta)_{ht}}{d\theta}$$

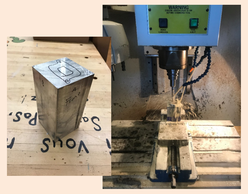
Schematic of Engine Testing Setup

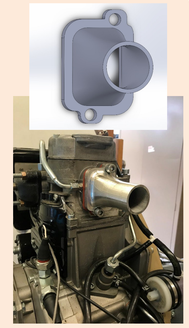


Intake Adapter

- Objective: new design minimized air flow restriction and promoted maximum mass air flow
- Machined final design using Al 60-61 and the Bridgeport VMC 2216
- Volumetric efficiency increased from 50% to 69% with an improvement of 39%

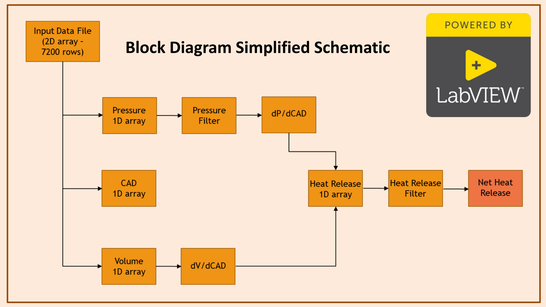


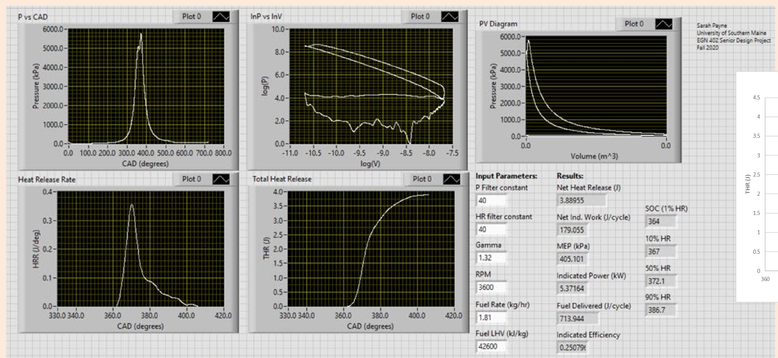


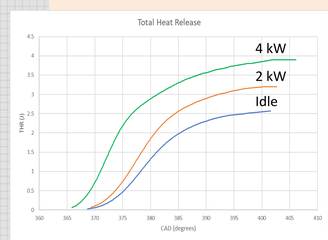


LabVIEW Program

- Customizable user interface capable of acquiring high rates of analog information and mathematical programming
- Objective: calculate the heat release rate and net heat release – amount of fuel chemical energy released during combustion
- Final designed program additionally analyzes indicated work, MEP, power, efficiency, and combustion phasing

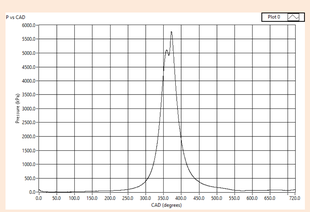


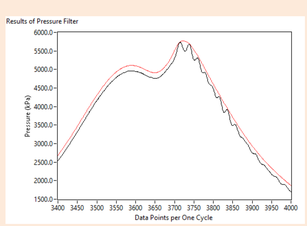




Pressure Trace

- Measurement of the instantaneous in-cylinder pressure as a function of the instantaneous crank angle is fundamental in internal engine combustion analysis
- Using engine geometry specifications, the CAD can be converter to in-cylinder volume
- Engine indicating system included:
  - pressure transducer mounted inside the engine cylinder head
  - shaft encoder coupled to the crankshaft
- Inverse Chebyshev filter used to fit the pressure signal and remove noise





Acknowledgements

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References

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2. S.J. Eaton, *Internal Combustion Engine Cycle Analysis* **2010**, 4-5 (Handout).