X-Ray Studies of Delphi Diesel Injection Systems

Final CRADA Report

Energy Systems Division

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Non Proprietary Final CRADA Report

Date: December 12, 2017

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CRADA Title: X-Ray Studies of Delphi Diesel Injection Systems

CRADA Start/End Date: 5 January 2012 to 5 July 2017

Argonne Dollars: \$700,000

Participant Dollars: \$697,425

Argonne PI: Christopher Powell

Participant(s):

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Summary of Major Accomplishments:

Measurements of the fuel injection process from several injectors provided by Delphi Automotive were conducted. The measurements included high-speed x-ray imaging of the needle valve motion inside the injectors, high-speed x-ray images of the spray emerging from the injector, and quantitative measurements of the near-nozzle fuel distribution. The combination of these measurements gave Delphi a comparison of the performance of the different injector models, and insights into how their designs impact the fuel injection process in engines.

Summary of Major Accomplishments:

Summary of Technology Transfer Benefits to Industry:

This CRADA explored the performance of two different models of Delphi diesel injectors. For each injector, the valve needle motion was imaged from two lines of sight at three different injection pressures to characterize its 3D motion. The needle lift was quite repeatable, and followed the expected trend of faster lift with higher injection pressure. In addition, it was observed that the maximum lift increased with injection pressure, even after the valve reached its mechanical limit, indicating that the increased fuel pressure was causing compression or bending of the needle. The off-axis motion of the needle was found to be significant in both measurement planes, though it was very repeatable from one injection event to the next. The effect of ambient pressure on the needle motion was explored at an injection pressure of 400 bar, with ambient pressure up to 15 bar. No effect of the elevated ambient pressure on the needle lift was observed.

High-speed x-ray imaging of the spray as it first emerges from the injector nozzle was performed in order to characterize the near-nozzle morphology and breakup of the spray. While imaging was successful at low ambient pressure, the contrast of the images was reduced at high ambient pressures, and quantitative measurements of the morphology were precluded.

The near-nozzle fuel distributions were measured using time-resolved x-ray radiography for three injection pressures at an ambient pressure of 33 bar. Increasing injection pressure caused the fuel distribution to narrow, as measured by the Full Width at Half Maximum of the mass distributions. The fuel distributions were quantified for the two injectors at each measurement condition, quantifying the impact that each experimental parameter has on the near-nozzle fuel and air mixture preparation.

Other Information/Results: (Papers, Inventions, Software, etc.)

None to date.

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