

Laser Ignition in Large-bore Single Cylinder Engine

Argonne's engineers have been successful in demonstrating that natural gas engines can be operated leaner (i.e. lower fuel to air ratio) and hence more environment friendly by replacing conventional spark ignition with laser ignition. Tests were performed in a natural gas fired single cylinder engine at SwRI (Southwest Research Institute) using "Fiber optic coupled laser ignition system" (*cf.* fig.1a) designed and fabricated by ANL team. The same engine was operated using free-space laser ignition (*cf.* fig.1b) and a conventional ignition system (Altronic CD-200) under similar condition to compare the performance and emissions benefits.

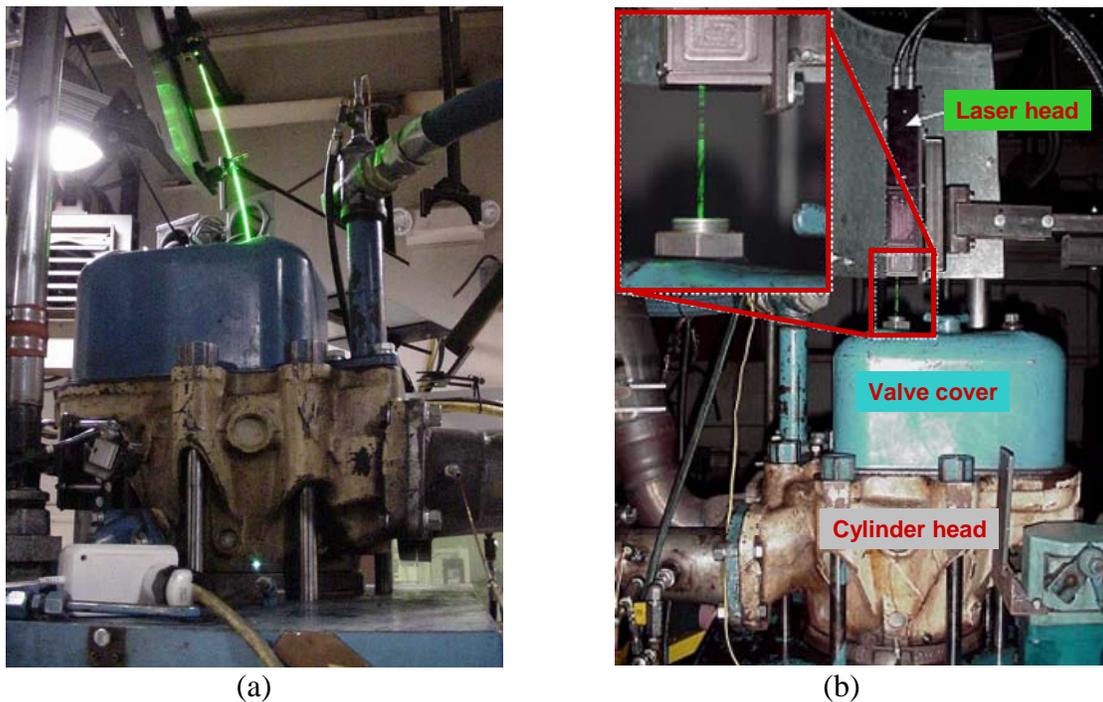


Figure 1. (a) Fiber-coupled laser ignition setup, (b) Free-space laser ignition setup.

These tests showed that the flame spread is accelerated during all phases of combustion in the case of laser ignition. The accelerated flame spread leads to more efficient combustion and thereby reducing the fuel consumption. Additionally, the lean-operation limit (i.e. lowest possible fuel to air ratio for smooth engine operation) could be substantially extended resulting in additional fuel savings. Also with laser ignition COV IMEP (coefficient of variation of indicated mean effective pressure) – a yardstick that industry uses for ignition quality – remained quite low (*cf.* fig. 2). Lower COV IMEP represents more reliable ignition. Most importantly, laser ignition exhibited reductions in NO_x emissions up to 70% for a given efficiency. In other words, for a given level of NO_x emissions, efficiency gains up to 3% are likely (*cf.* fig. 3).

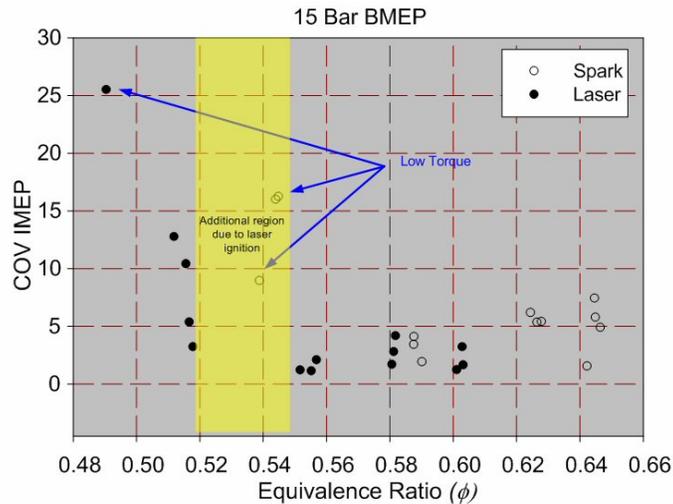


Figure 2. Equivalence ratio vs. COV of IMEP at 15 bar BMEP

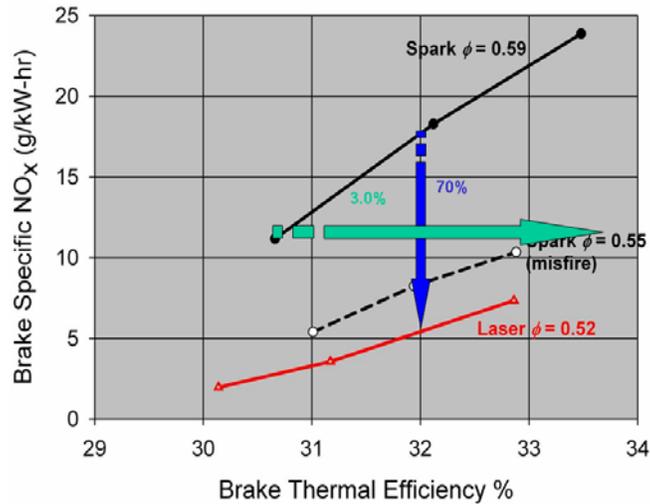


Figure 3. BSNO_x vs. efficiency

Funding agencies: Co funded by DOE-Distributed Energy’s ARES program and California Energy Commission’s ARICE program.

Relevant Publication: Bihari, B., Gupta, S. B., Sekar, R. R., Gingrich, J. and Smith, J., “Development of Advanced Laser Ignition System for Stationary Natural Gas reciprocating engines,” ICEF2005-1325, *ASME-ICE 2005 Fall Technical Conference*, Ottawa, Canada, 2005.

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