

# Hydrogen Combustion and Exhaust Emissions in a Supercharged Gas Engine Ignited with Micro Pilot Diesel Fuel

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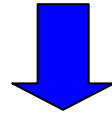
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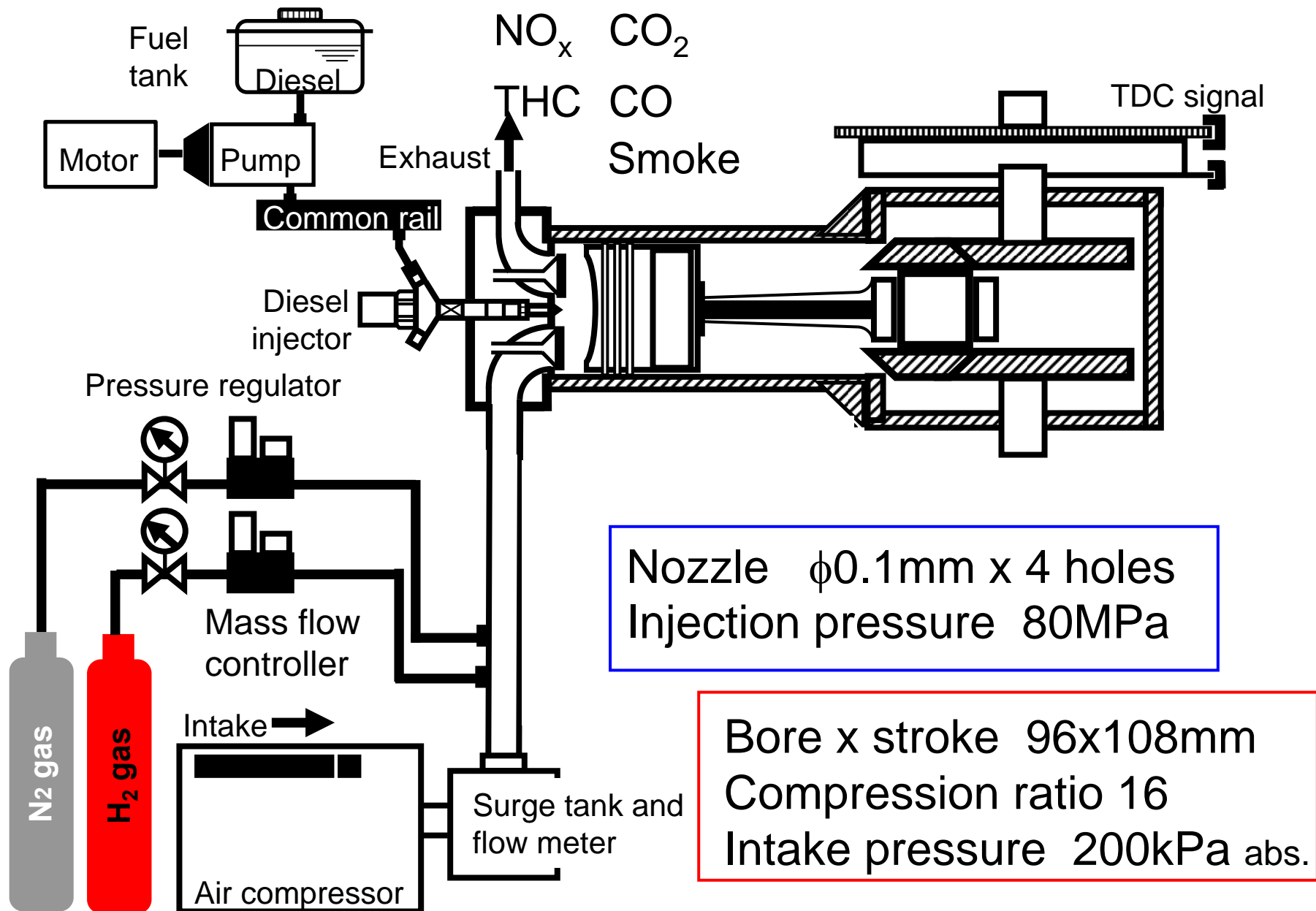
- Dual fuel
  - hydrogen induced from intake port  Lower output
  - + diesel fuel injected with common rail injector
  - (several ignition locations)  Too higher burn rate
- Supercharged  Higher output
- much EGR (simulated EGR=nitrogen dilution)  
control of hydrogen combustion  Moderate burn rate



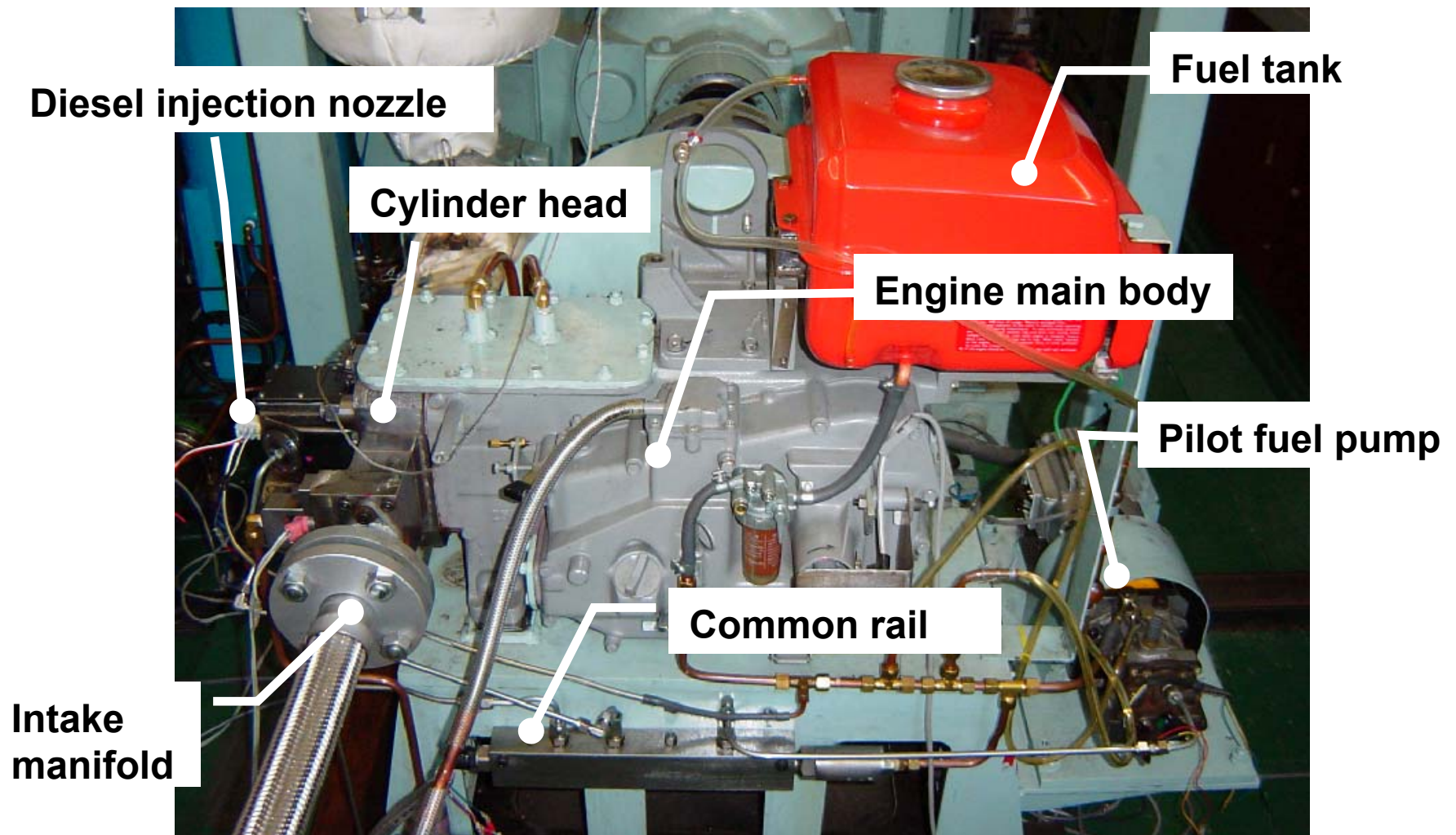
- Stable combustion (several ignition location by diesel fuel)
- Higher output (supercharged)
- Very low NOx (much EGR)

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Purpose of this study



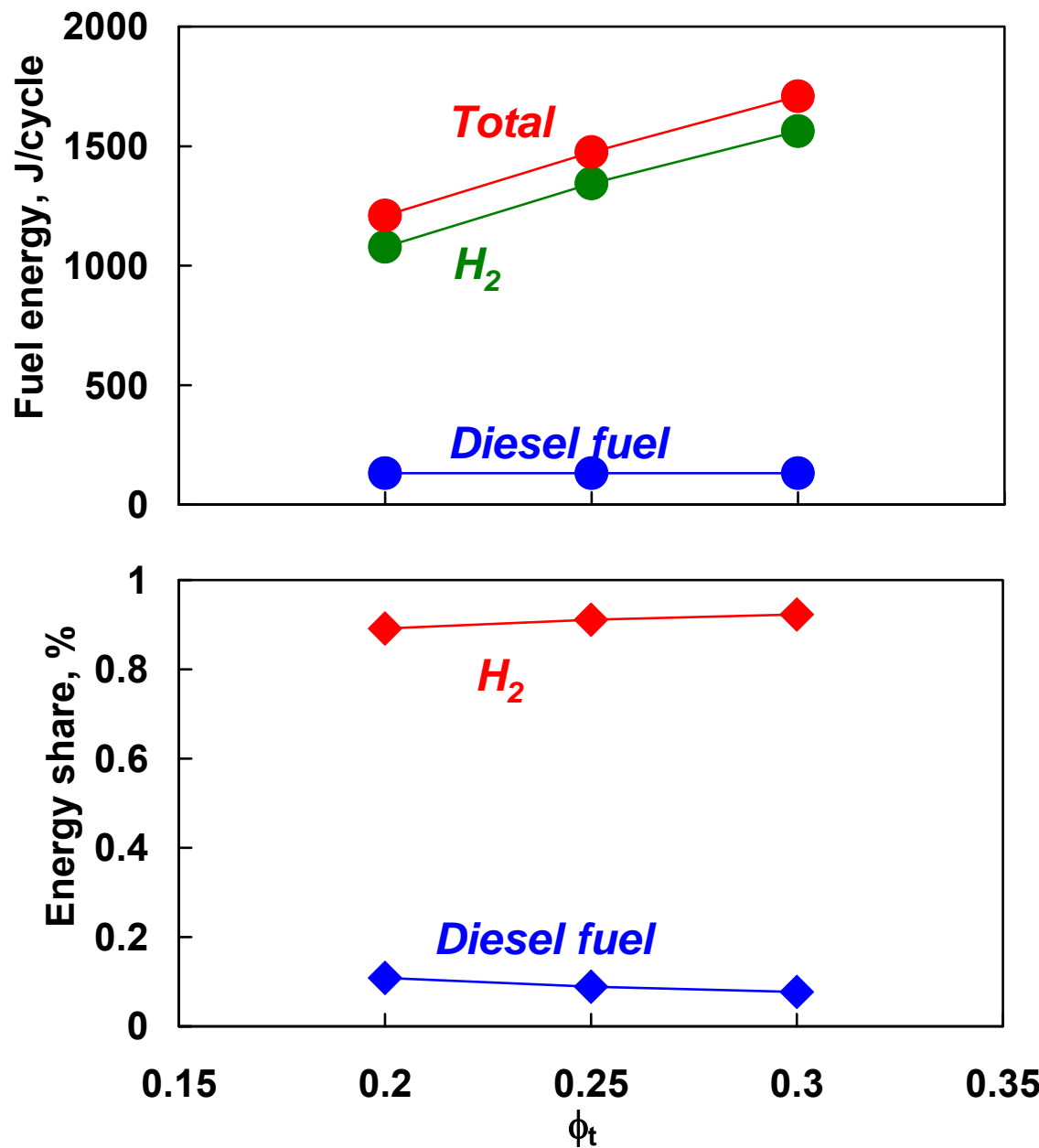
**Schematic diagram of the experimental system**



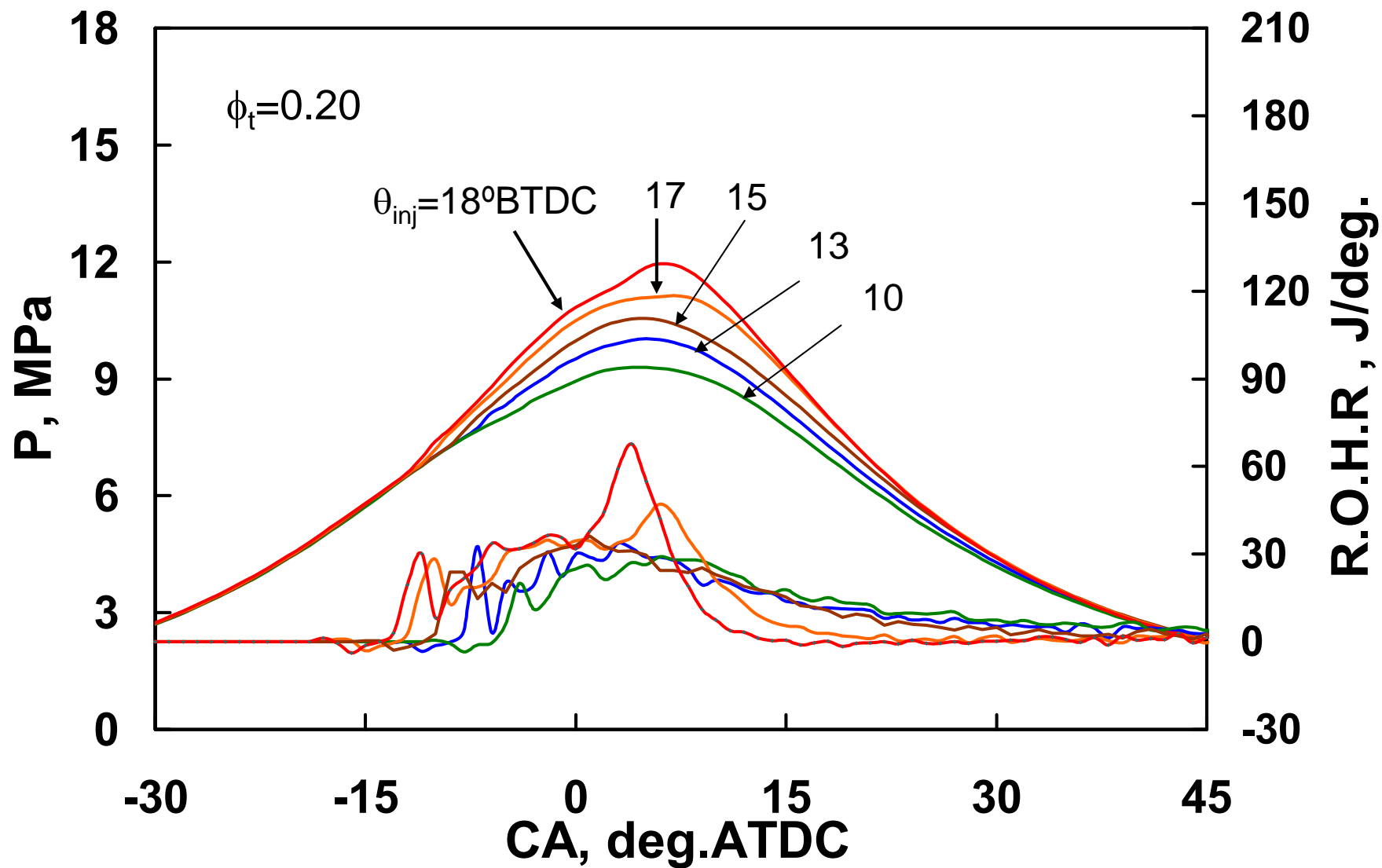
<b>Bore×Stroke</b>	<b>96×108 mm</b>
<b>Swept volume</b>	<b>781.7 cc</b>
<b>Compression ratio</b>	<b>16.0</b>

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Test engine (single cylinder, water-cooled, supercharged)

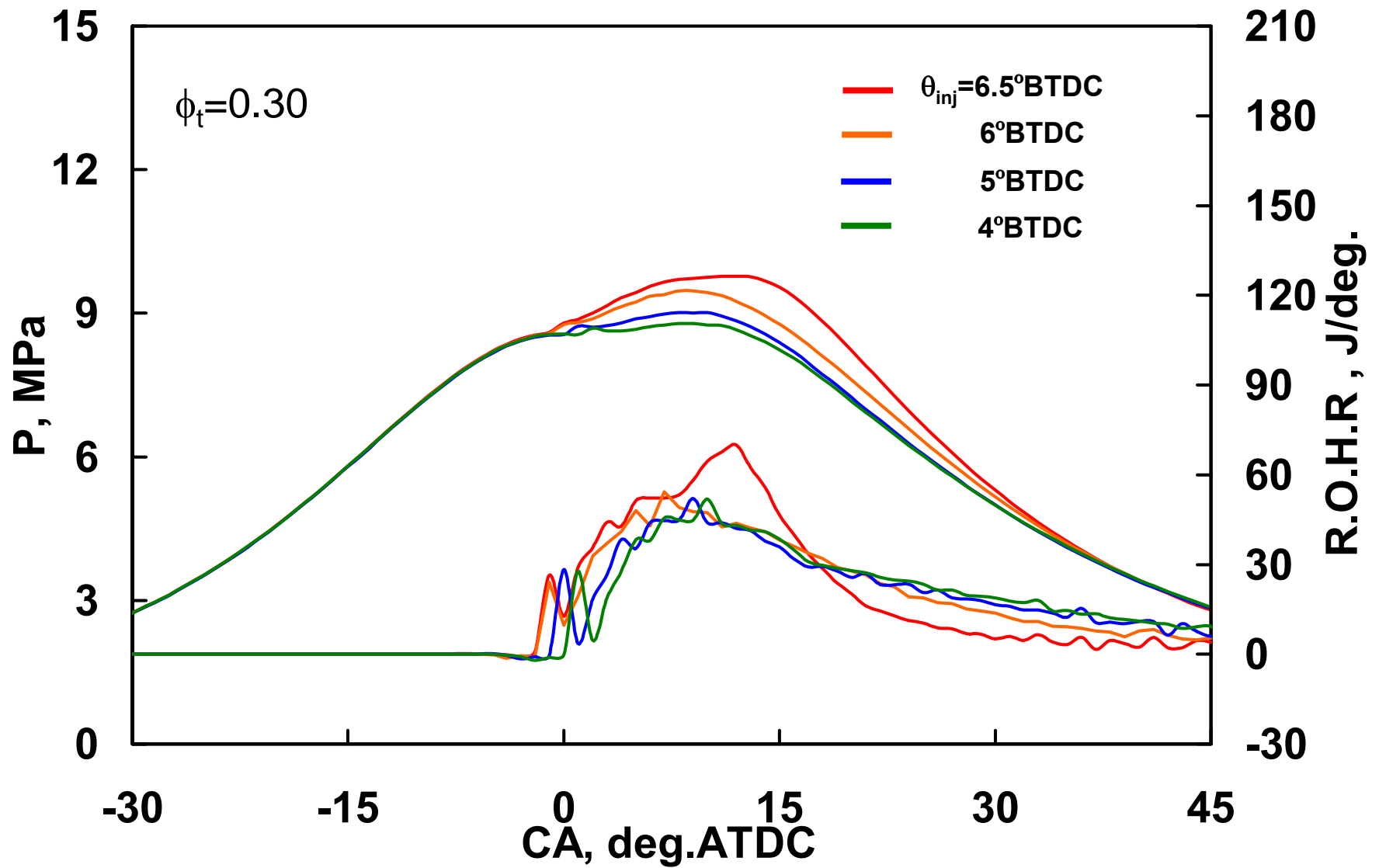


Fuel energy and energy share (hydrogen and diesel fuel)



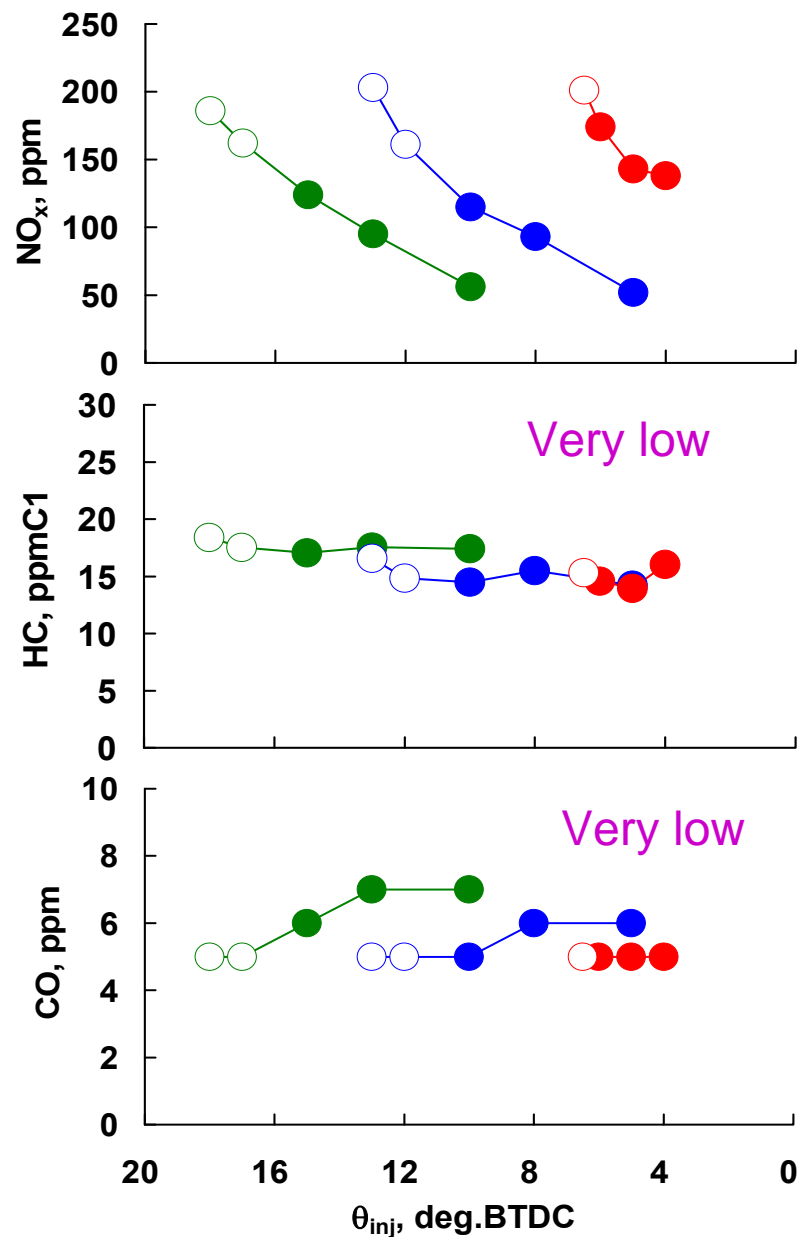
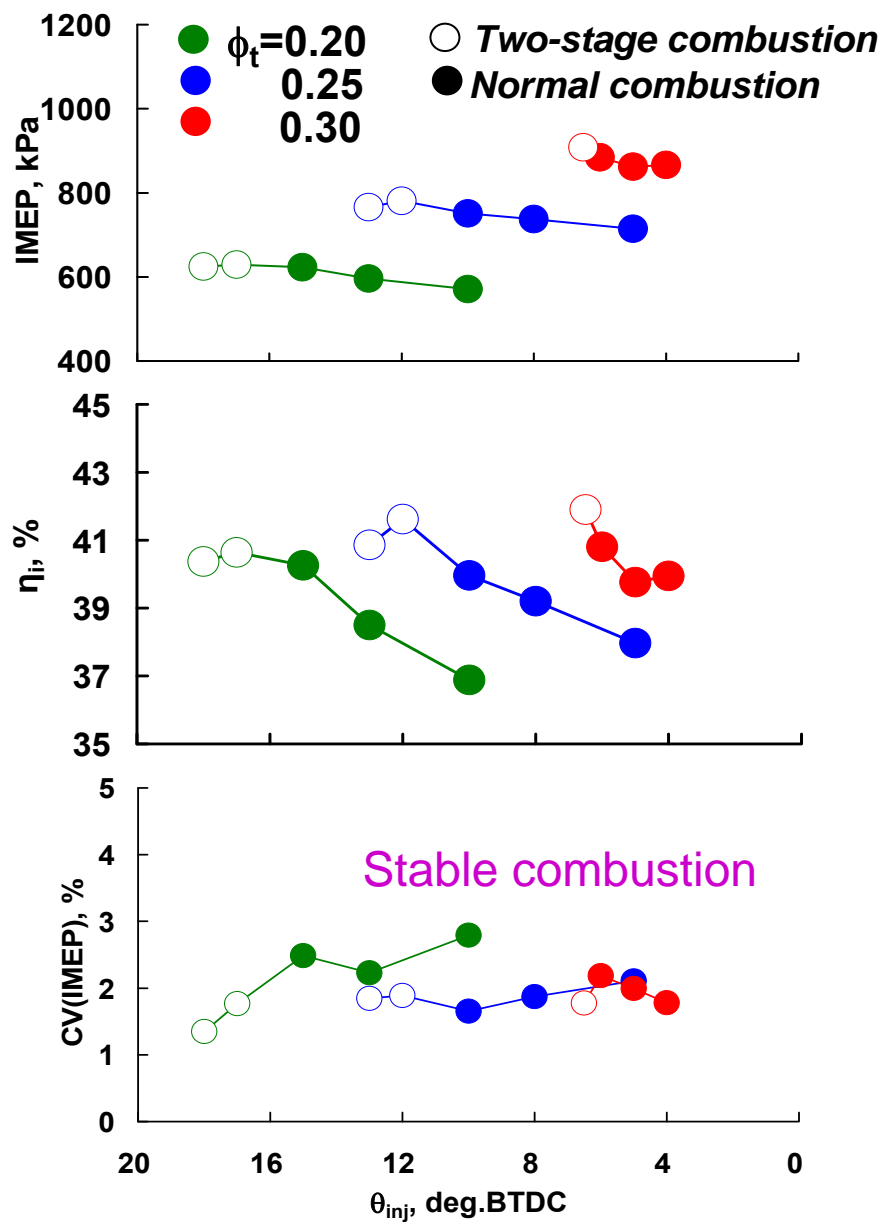
Pressure history and rate of heat release



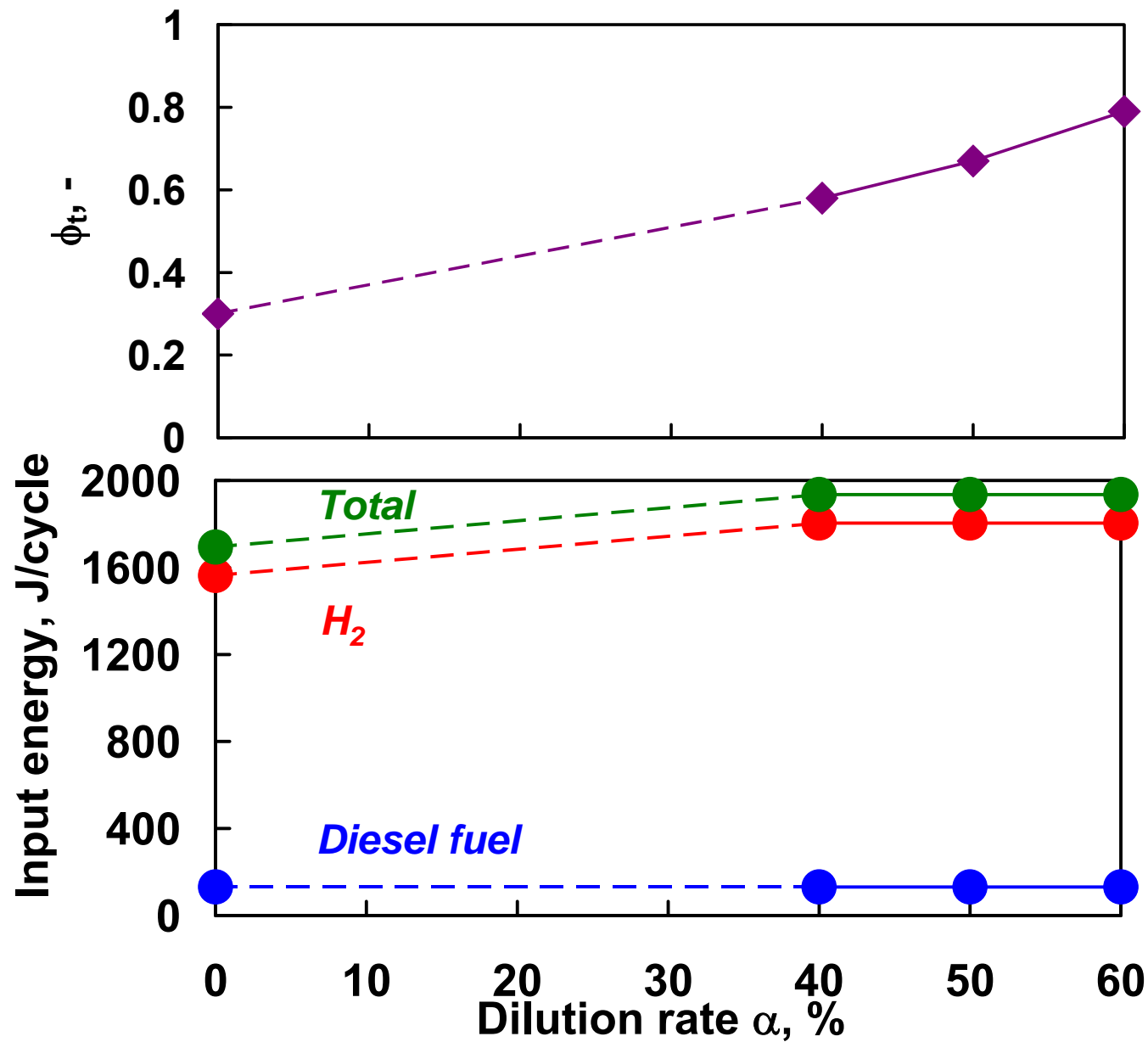


Pressure history and rate of heat release

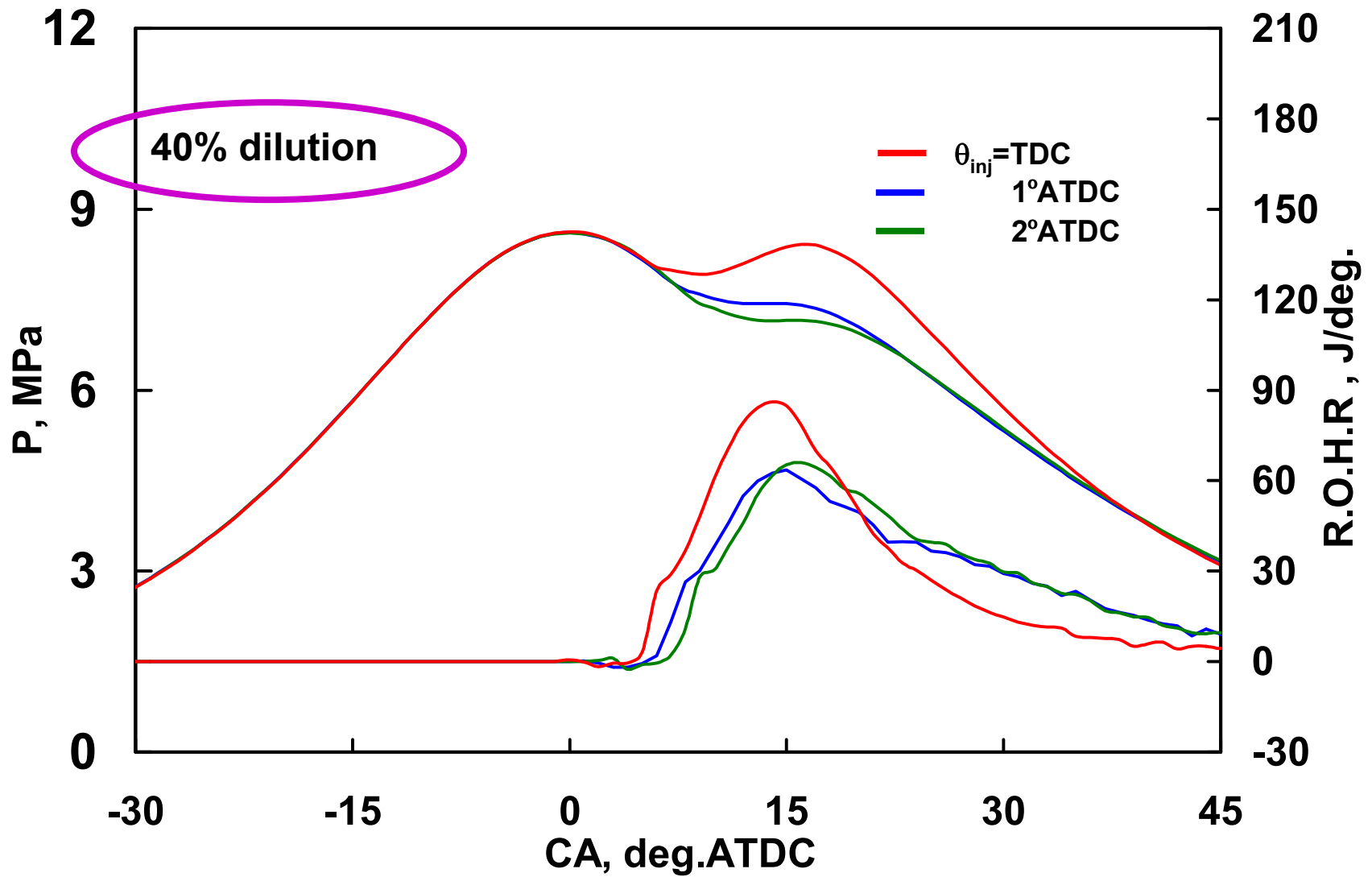




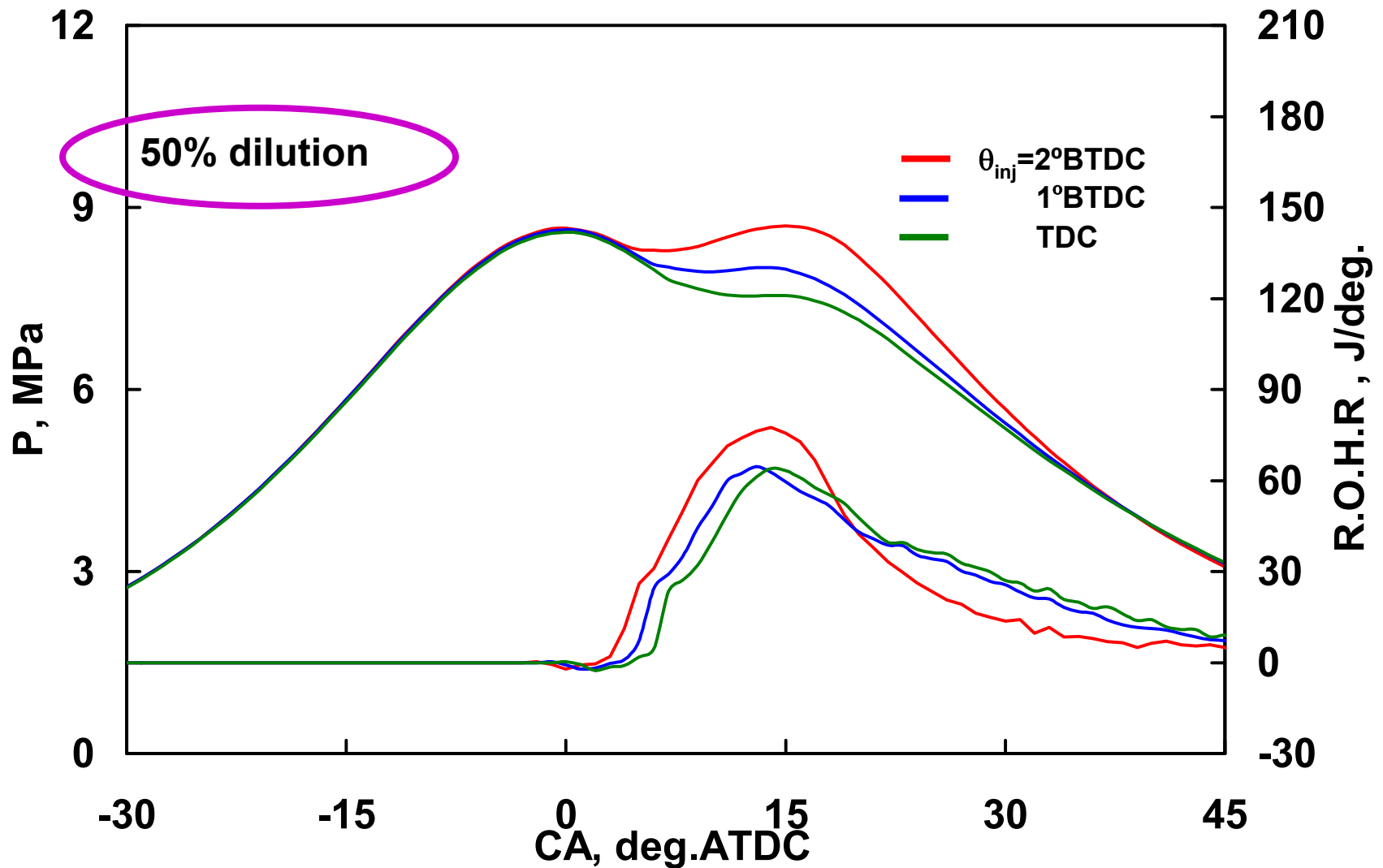
Engine performance and exhaust emissions



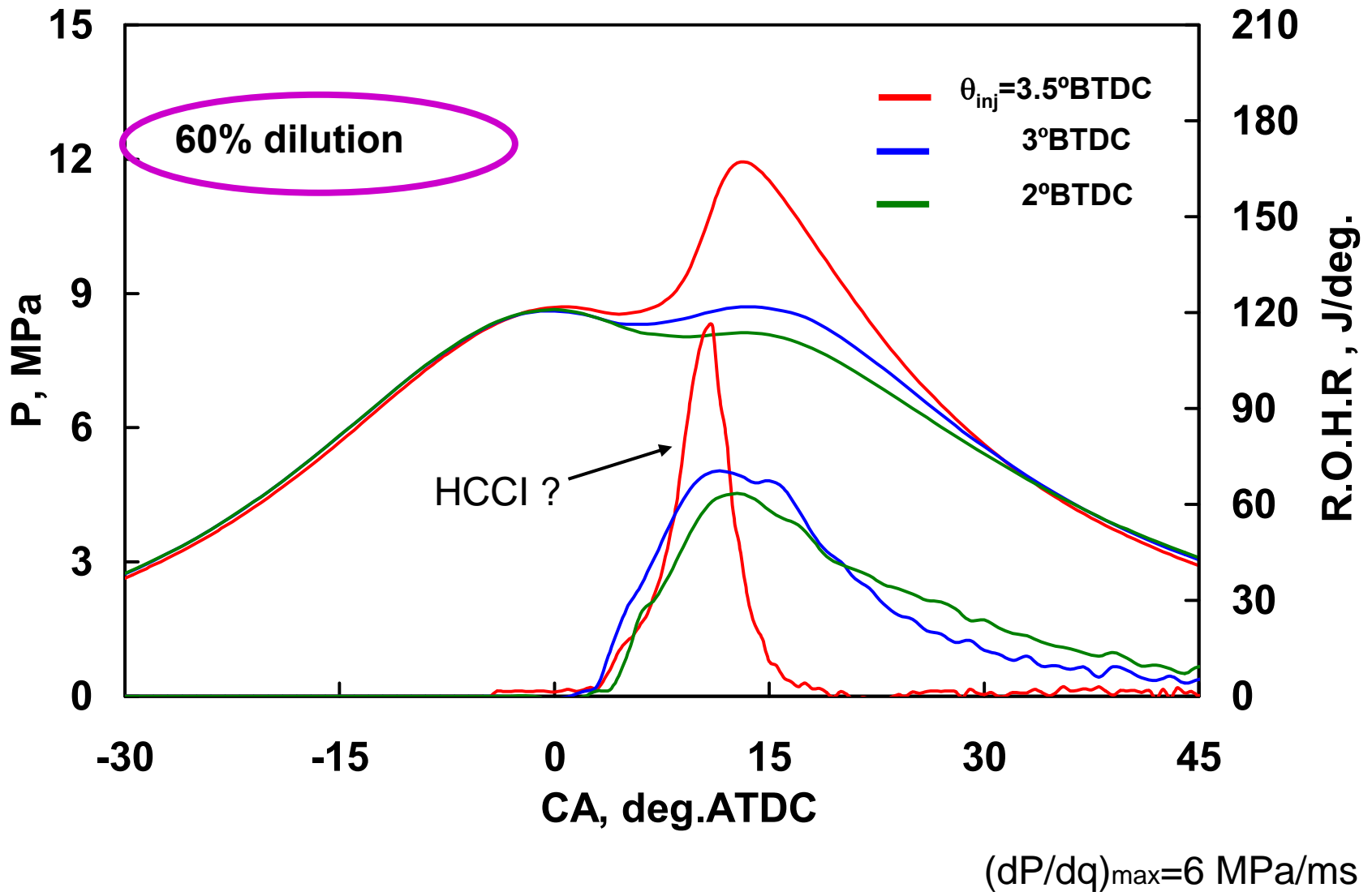
Effect of nitrogen dilution on heat value per cycle



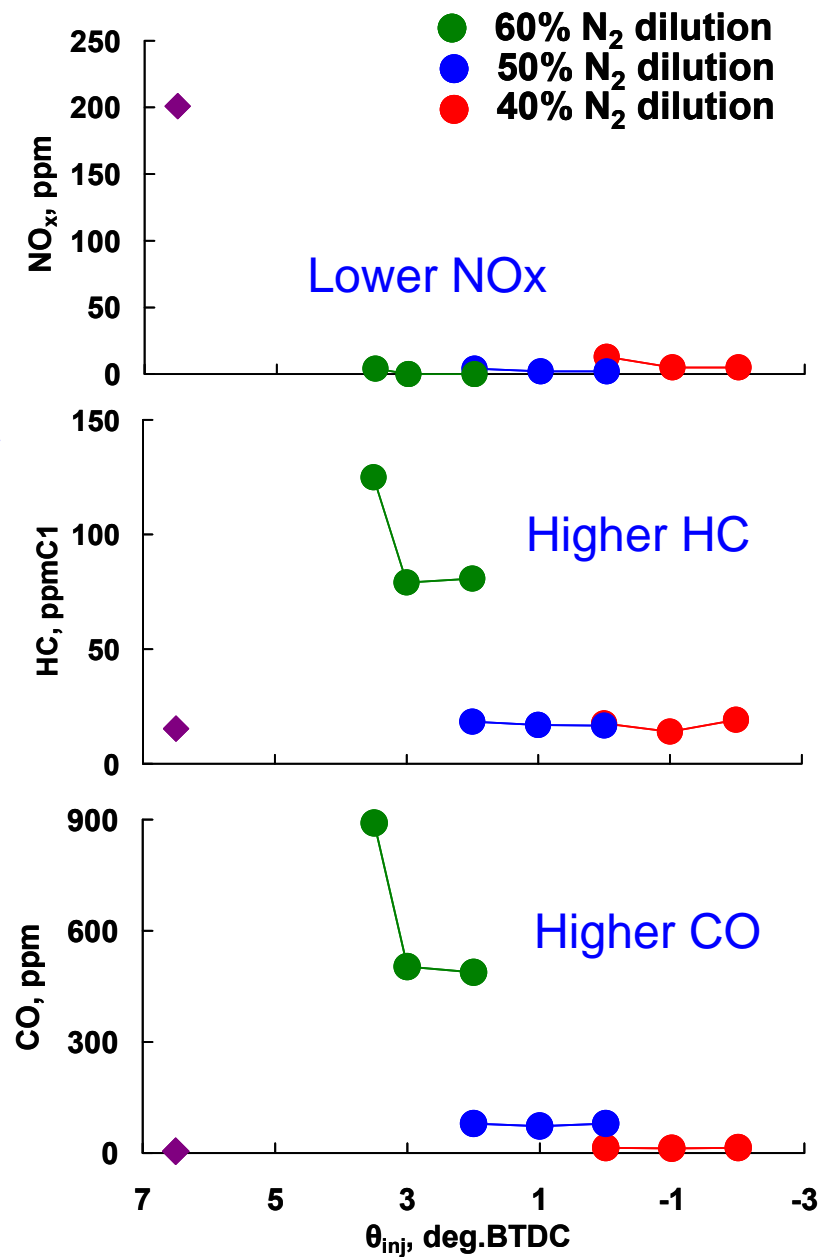
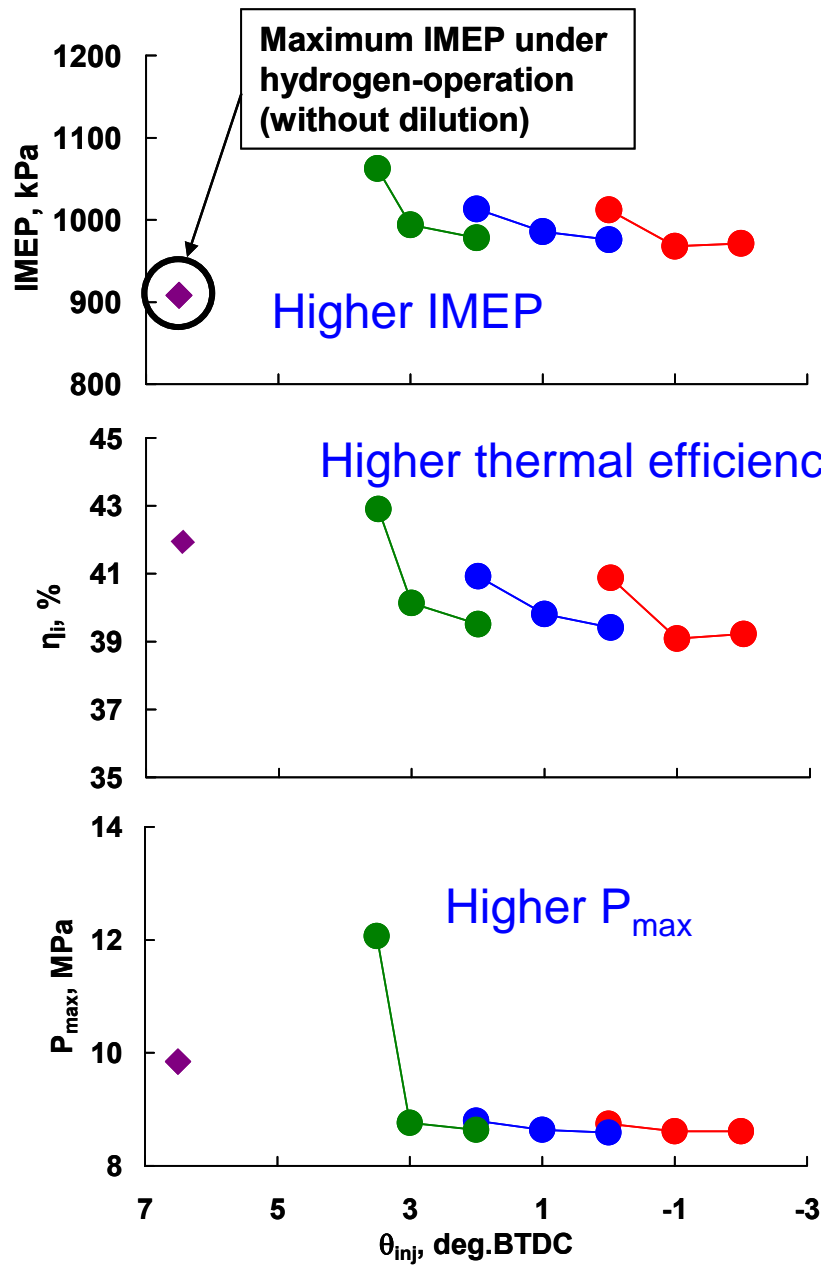
Effect of N<sub>2</sub> dilution on pressure history and rate of heat release



Pressure history and rate of heat release



Pressure history and rate of heat release



Engine performance and exhaust emissions

- 1) Smooth and knock-free engine operation resulted from the use of hydrogen in a supercharged dual-fuel engine for leaner fuel-air equivalence ratios maintaining high thermal efficiency. It was possible to attain more than 90% hydrogen-energy substitution to the diesel fuel with zero smoke emissions.
- 2) The hydrogen-operation produced the maximum IMEP of about 900 kPa and a thermal efficiency about 42% with the highest fuel-air equivalence ratio of 0.3. There were hardly any CO and HC emissions. However, the NO<sub>x</sub> emissions were high.

- 3) The two-stage combustion was found as a condition of higher engine power and a precursor of knocking combustion. The main combustion at the maximum IMEP conditions (with strong two-stage combustions) was found much faster than that of the normal combustions at other IMEP conditions.
- 4) EGR in hydrogen engine was appeared as an excellent method of reducing engine NOx to the zero ppm level.