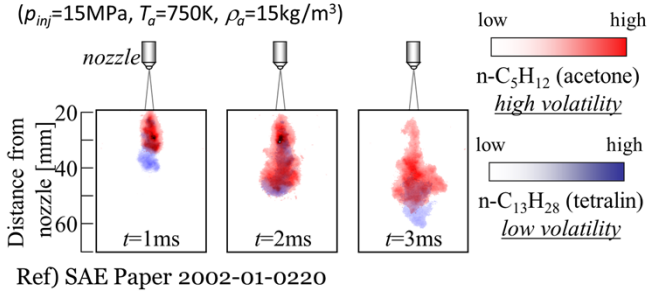
Simultaneous Reduction of Pressure Rise Rate and Emissions in a CI Engine using Binary Fuel Blends

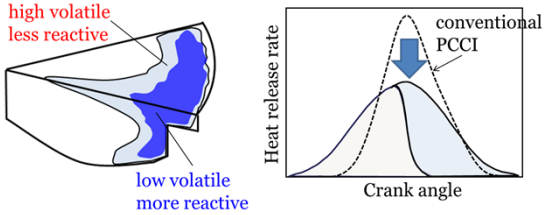
Background

- Premixed charge compression ignition (PCCI) using early DI suffers from high pressure rise rate
- As demonstrated by LIF images shown below, a binary fuel blend can provide a mixture in which two components are stratified
- Binary fuel blends have a potential to suppress pressure rise rate in PCCI operation

LIF of binary fuel blend spray
(p_{inj}=15MPa, T_a=750K, ρ_a=15kg/m³)



Ref) SAE Paper 2002-01-0220



Objective

- Evaluate the effect of binary fuel blends on pressure rise rate and emissions in PCCI operation
- Develop an understanding of pressure rise reduction mechanism of binary fuel blends

Experimental Condition

- The experiments were performed in a single cylinder CI engine equipped with common-rail system
- Oxygen concentration and direct injection timing were set as experimental parameters
- Fuels tested were binary fuel blends of i-octane and n-tridecane and mixing fractions were changed

Fuel	Boiling point [K]	Density [kg/m³]	Cetane No.	Octane No.	
i-octane (i-C_8H_{18})	372	688	12	100	high volatility less reactive
n-tridecane (n-$C_{13}H_{28}$)	510	756	88	-	low volatility more reactive

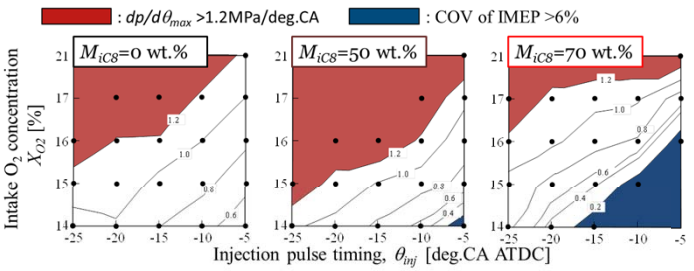
Multi-component Model

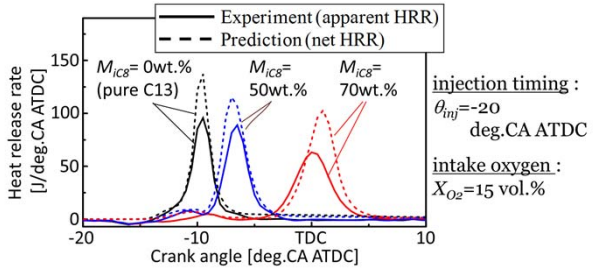
- developed in Doshisha Univ. based on KIVA3V (SAE Paper 2003-01-1838)
- employed Peng-Robinson EOS to estimate equilibrium phase composition with taking into account high pressure effect and ambient air dissolved into droplets
- employed a combination of SHELL ignition model and single-step oxidation reaction

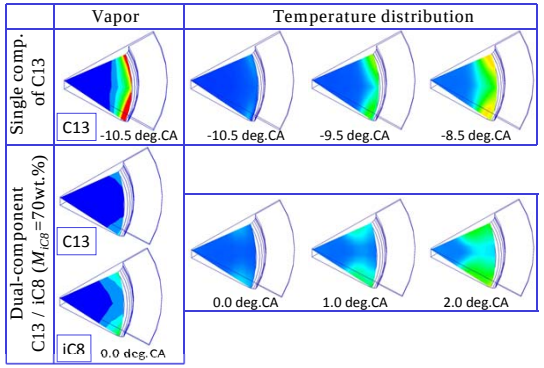
Results

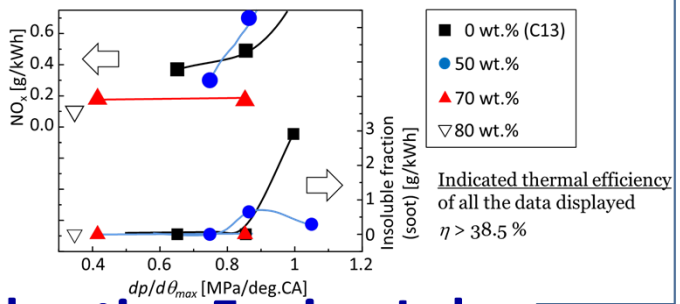
- The $(dp/d\theta)_{max}$ of binary fuel blend is lower than that of pure component if compared at same condition
- The reduction of the $(dp/d\theta)_{max}$ can be attributed to the fact that the two components have different local vapor concentration, causing spatial-temporal difference in combustion phasing
- Binary fuel blends are capable of reducing emissions while keeping the lower $(dp/d\theta)_{max}$.

Contour map of maximum pressure rise rate $(dp/d\theta)_{max}$









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