# Particulate emissions from aromatic containing fuels

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## Introduction

Reduced Sulphur limits in SECA region [1]. Interest to study the effect of aromatics.

Previous experiments showed a decrease in PM emission (mass and number) when adding aromatics (contrary to expectations) [2]. Why?

Hypothesis: More premixing => less PM formation


## Objectives

- To explain findings from previous results (multi-cylinder) [3]
  - Using single cylinder research engine (Euro IV calibration) and pressure trace analysis
  - Using ignition improver to further isolate the effect of aromatics in the fuel
- To increase understanding of PM emissions (= formation – oxidation )
  - Variation in pre-mixing by varying rail pressure and EGR

Figure 1. Comparison Low Load (A25)

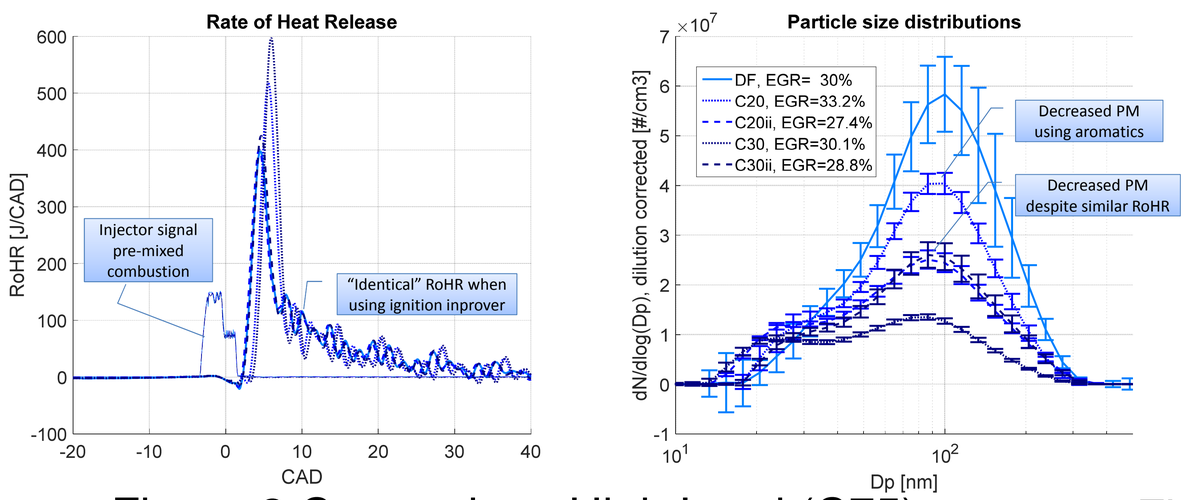



Figure 2.Comparison High Load (C75)

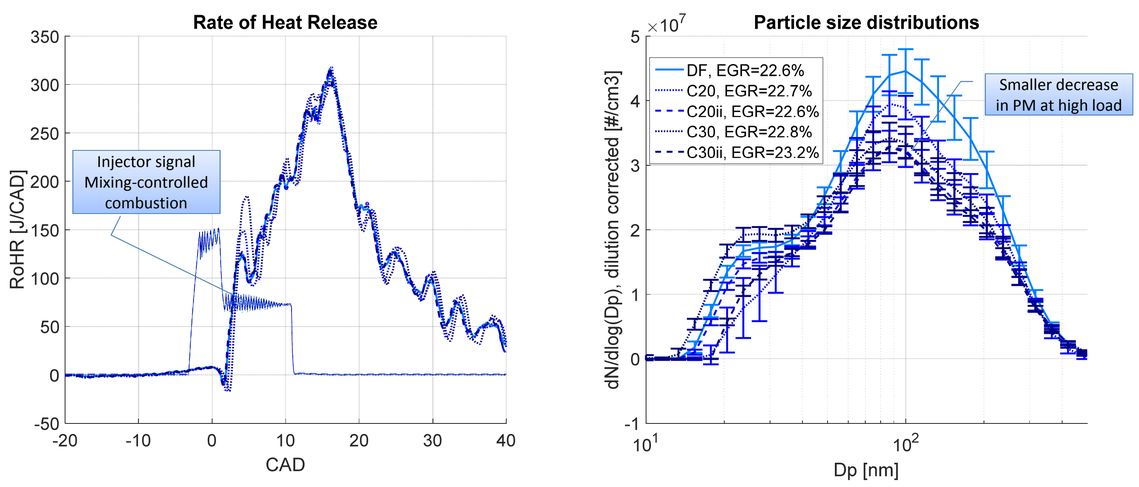



Figure 3.Variation in $P_{inj}$ **with** EGR (Medium Load, B50)

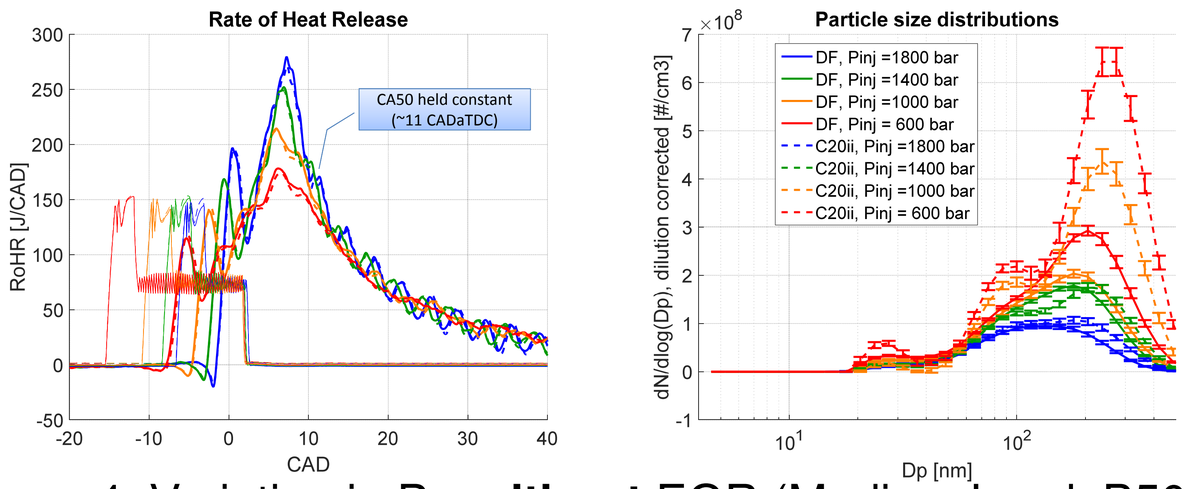



Figure 4. Variation in $P_{inj}$ **without** EGR (Medium Load, B50)

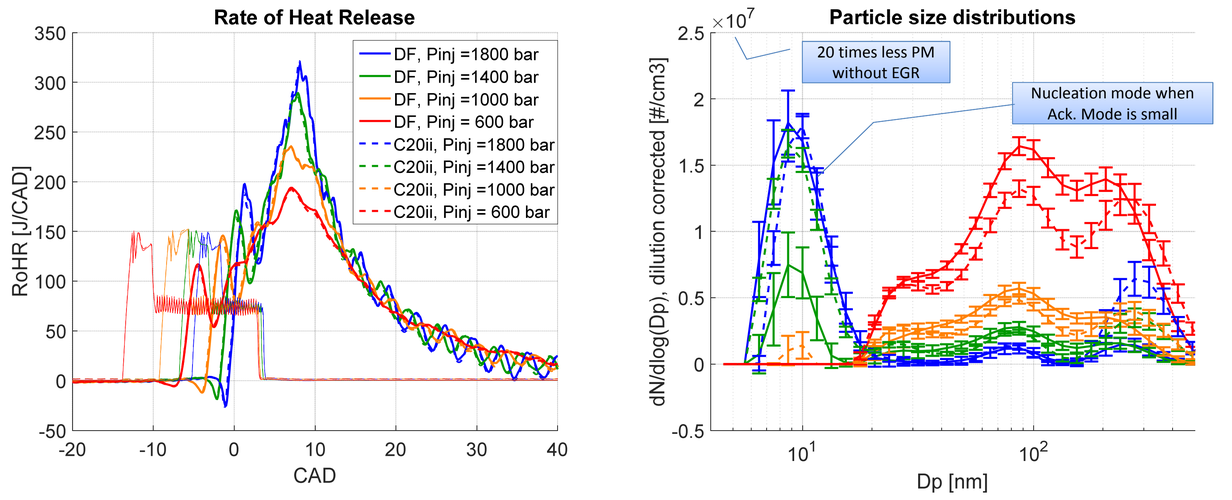
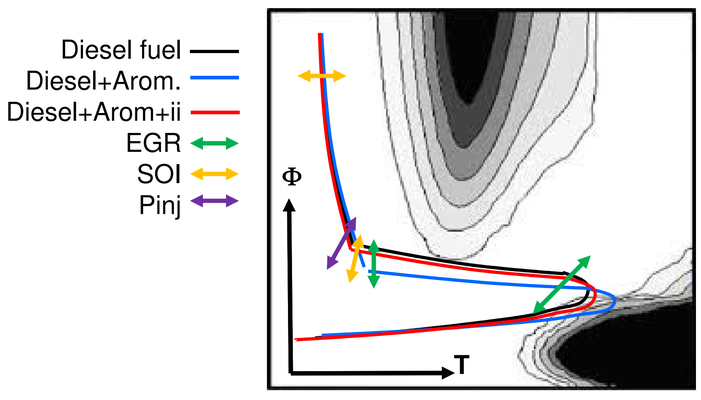



Figure 5. Conceptual model




**Engine: 1 cyl (2 $dm^3$), Operation points: A25 (low load 1200rpm, 78Nm), B50 (medium load, 1500rpm, 146Nm), C75 (high load, 1800rpm, 196Nm). Common rail fuel single injection (600 - 1800 bar)**
**Fuels: Low sulfur diesel fuel (DF), Aromatics (Caromax 28), ignition improver (2EHN)**
**Properties Caromax28 (Diesel fuel): mono-Ar: 24% (5%), di-Ar: 68% (0.1%), poly-Ar <0.02% (0.04%), density: 985 kg/$m^3$ (815 kg/$m^3$) , ibp/fbp 230/290 °C (184/290 °C)**
**Sampling system: Dekati 4000, dilution factor by $NO_x$ analysis**
**Thermodenuder (250 °C), correction factor by diffusion loss measurements (NaCl)**
**PM instrument: DMS 500 (Cambustion), primary dilutor not used, secondary dilutor =1 (not used)**

## Conclusions

- The use of ignition improver reduces PM emissions using aromatic fuel blends.
- The reason is improved pre-mixing, here enabled by high injection pressures
  - Plausible reasons include lower equivalence ratio "per molecule", higher density & lower viscosity. To be explored in future studies.

**References**

[1] IMO, MARPOL Annex VI and NTC 2008 with guidelines for implementation 2013 edition, International Maritime Organization, London, United Kingdom, 2013.

[2] Maria Zetterdahl, et al., Impact of aromatic concentrations in marine fuels on particle emissions., 2016. in manuscript.

[3] Tankai Zhang, et.al., An Experimental Study on the Use of Butanol or Octanol Blends in a Heavy Duty Diesel Engine, SAE International Journal of Fuels and Lubricants, 8 (2015).