



P-20

Urea/Ammonia Distribution Optimization in an SCR Emission Control System Through the Use of CFD Analysis



Gi-Heon Kim, Matthew Thornton National Renewable Energy Laboratory

Light Duty Biodiesel Project Overview

- Evaluating the impact of biodiesel on future engine and emission control system performance
- ECS configurations and set-up in test cell and on vehicle



Mercedes C200 CDI



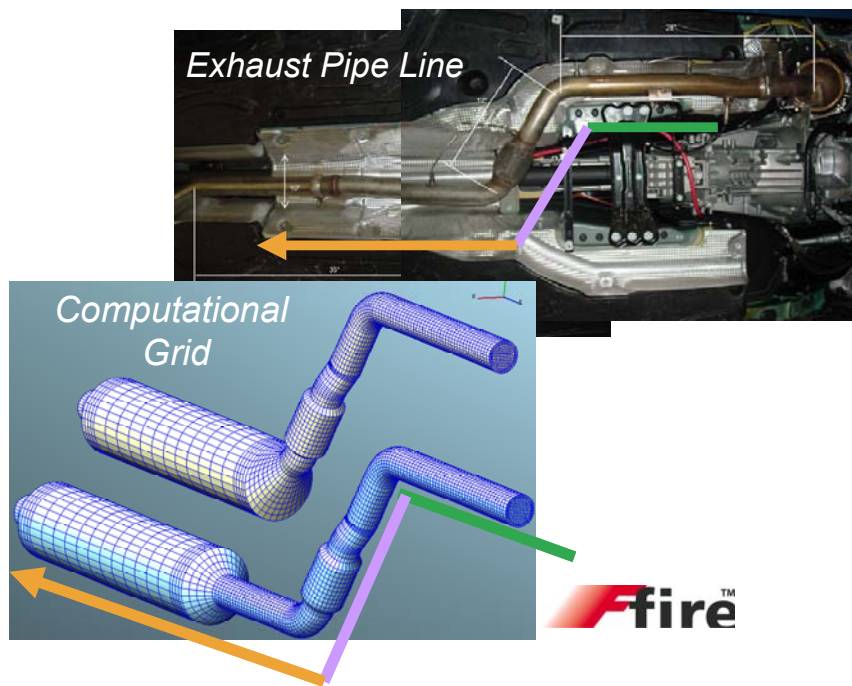
Test Bed



Objectives

- Develop a 3 dimensional CFD model which can properly address urea/ammonia distribution for SCR system performance prediction
- Optimize system design & parameters for test cell set-up

Analysis & Results



Impact of Injection Direction

Analysis & Results

- Catalyst located downstream from the second elbow
- Urea Water Solution injection at the second elbow

0.2 sec after Start Of Injection

centrifugal for elbow curvature

centripetal for elbow curvature

- Slow liquid particle evaporation and following thermal
- More liquid particles and more ammonia at lower section
- More uniform distribution in centripetal direction injection
- particle convergence to the lower section of the pipe

NOTE: Contour scales are not matched between the figures.

Impact of Pipe Diameter

Analysis & Results

Direct impact on the exhaust gas flow speed and the spray droplet residence time in mixing zone

Exhaust Velocity Field

Ammonia

- Similar ammonia distributions in front of catalyst in spite of significant difference in pipe diameter and exhaust flow speed
- More residence time for droplet evaporation in the larger diameter pipe
- High shear for better droplet breakup in the smaller diameter pipe
- Too large droplet size and too short mixing length

Impact of Catalyst Location

Analysis & Results

Tail View

0.2 sec after SOI

Catalyst located immediately after the second elbow

Catalyst located downstream from the second elbow

When the catalyst is located immediately after the second elbow:

- Many of the particles hitting the concentrated region at the bottom section of catalyst
- Highly concentrated uneven distribution at the catalyst face due to slow evaporation and the inertia of droplets