



Soot and NOx Emissions Reduction in Diesel Engines via Spin-spray Combustion



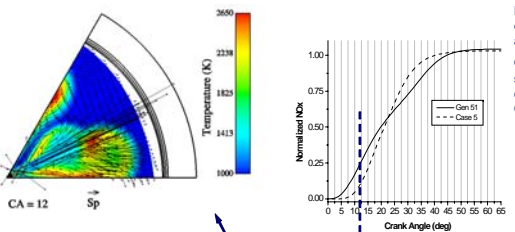
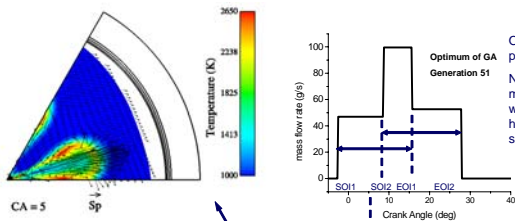
Mike Bergin, Rolf D. Reitz, Randy P. Hessel

Acknowledgement: Anonymous industry sponsor and DOE/Sandia

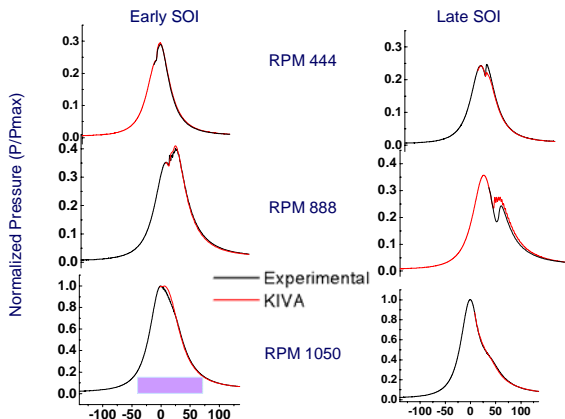
Non Road Engine Geometry and Operating Conditions

Bore	Approx. 225 (mm)
Bore/Stroke	0.78
Cylinder Head	4-valve low swirl
Combustion Chamber	Quiescent (bowl dia = 0.83*bore)
Displacement	Approx. 15.0 (L)/cyl
Injection system	Unit injector (8 holes)
Engine Speed and SOI	Case 1 444 RPM Early SOI Case 2 444 RPM Late SOI Case 3 888 RPM Early SOI Case 4 888 RPM Late SOI Case 5 1050 RPM Early SOI (baseline) Case 6 1050 RPM Late SOI

Non Road engines used in construction mining and marine applications



Model Validation



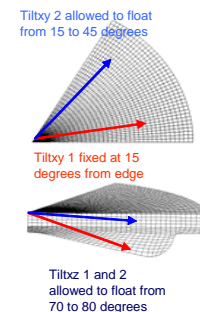
Genetic Algorithm Optimization

- The current (2006) non-road EPA emissions targets do not appear to require the use of aftertreatment or EGR
- Fuel economy increases without exceeding emissions or changing engine geometry were sought

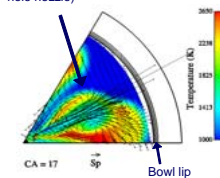
Optimization Parameters

The engine operated with two independent rows of injector holes

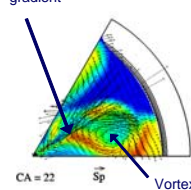
parameter	min	max
fraction of sector fuel mass to hole 1	20%	50%
injection velocity	300 (m/s) (700 Bar)	550 (m/s) (1700 Bar)
SOI hole 1	-10 ATDC	+10 ATDC
SOI hole 2	-10 ATDC	+10 ATDC
tiltaz hole 1	70 deg	80 deg
tiltaz hole 2	70 deg	80 deg
tiltxy hole 2	15 deg	45 deg



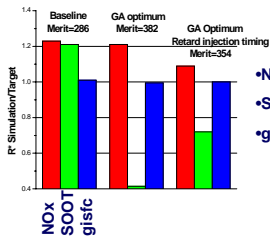
Combined sprays have greater penetration (group hole nozzle)



Steep temperature gradient



Vortex formation is characteristic of "Spin Spray Combustion"



- NOx reduced 14%
- Soot reduced 51%
- gisfc improved 1%

Conclusions

- Spin-Spray Combustion demonstrated to reduce engine-out soot by enhanced mixing (improved soot oxidation)
- NOx reduction occurs through rapid convection of burned gas into evaporation region

Future Work

- Increase load.
- Combine independent sprays with bowl geometry optimization.
- Allow for more than 1 injection from one or both rows of holes.