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Cleaner Environment by Emission Reduction with Intelligent Fuel Injection System

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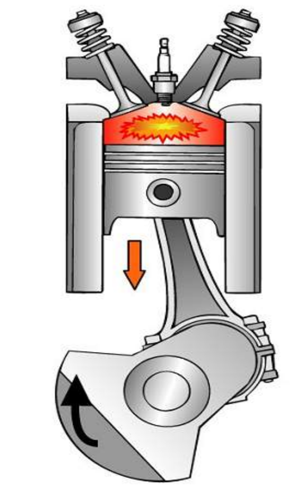


INTRODUCTION

•The focus of this project is on the reduction of pollution emissions of exhaust gas in a direct injection diesel engine to help preserve the environment and better public health

•Diesel is the primary fuel for commercial transportation and also for non-road engines used for construction, agriculture, and locomotives.

•The exhaust of an internal combustion diesel engine emits relatively high levels of Nitric Oxides (NOx), Particulate Matter (PM), soot, and smoke.

•The most advanced method to reduce in cylinder formation of emissions in an internal combustion engine is through advanced injection strategies.

•Implementation of a Common Rail Injection System will allow electronic control through an electronic control unit (ECU) with advanced control modules providing complete flexibility of injection amount and timing for super low emission strategies with decreased fuel consumption.

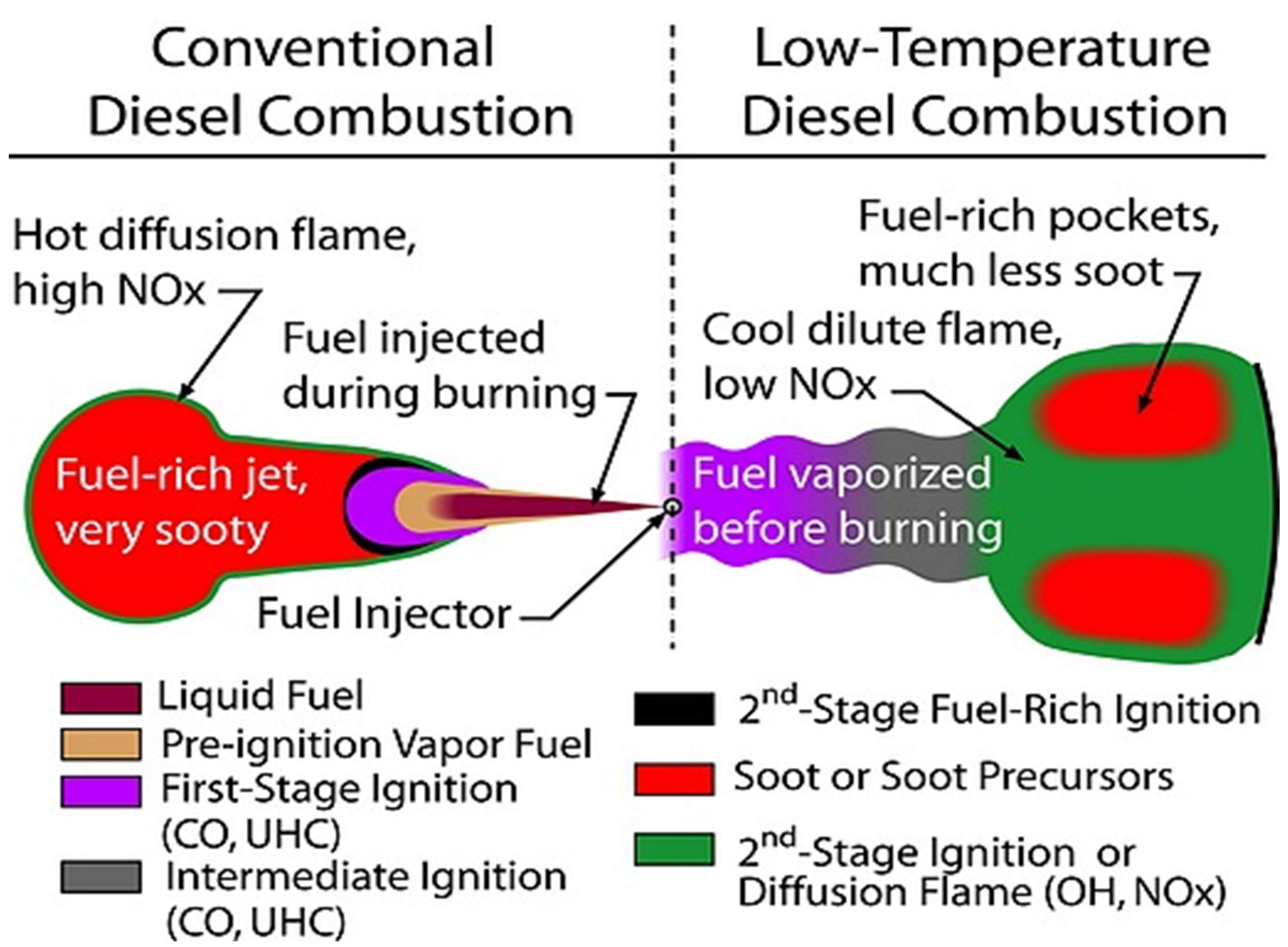
•Traditional fuel injection systems only employ a single injection event per engine cycle, but the common rail allows multiple injections through advanced electronic control units providing pilot, main, and post injections reducing noise pollution, reducing NOx and soot, and providing power.

EXHAUST EMISSIONS

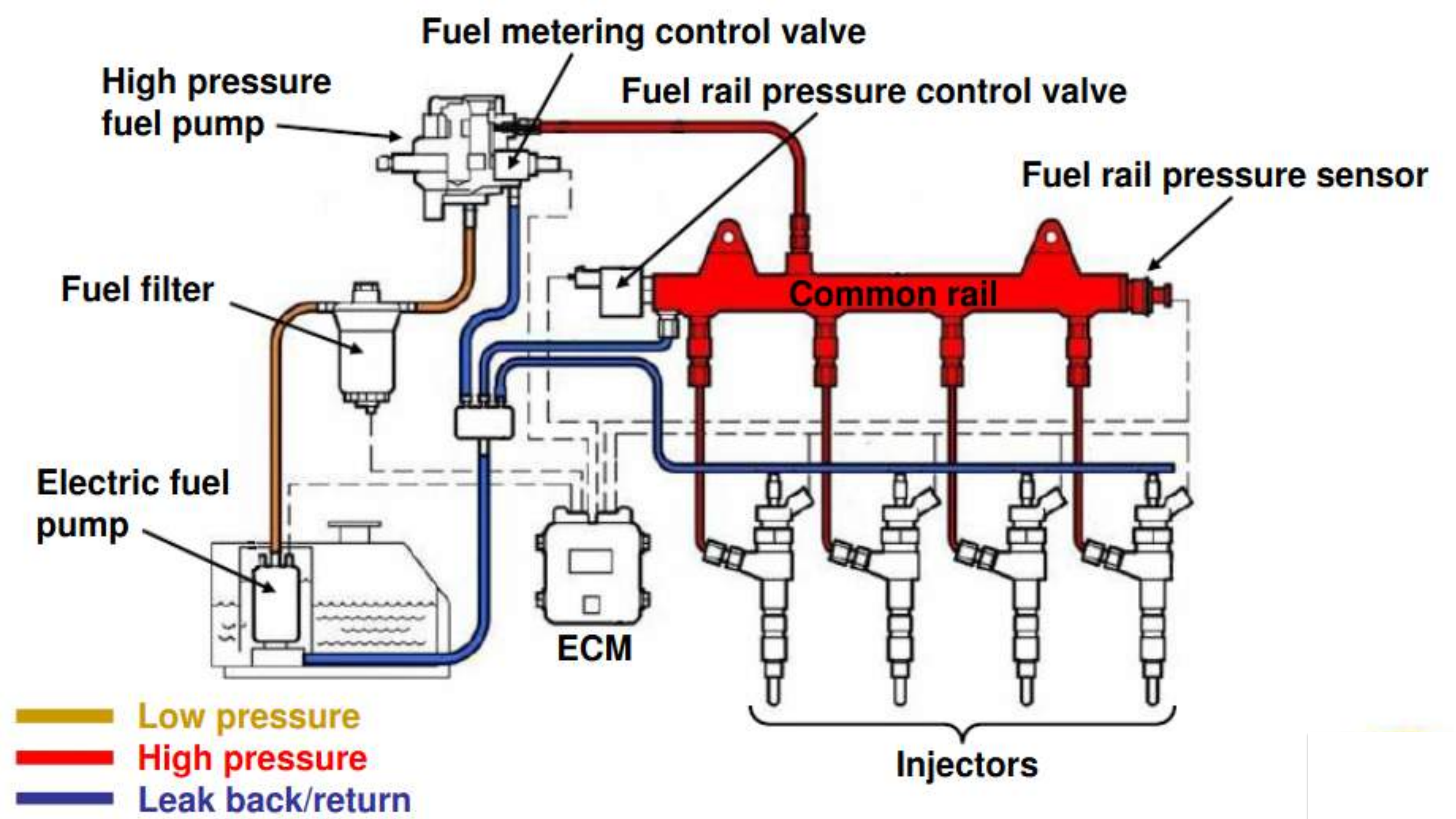
•NOx creates ozone at the atmospheric level that weakens peoples' immune systems causing many health issues and is harmful to vegetation and wildlife.

•Mobile vehicles attribute for 50% of the emitted NOx.

•Larger sized PM can be seen as soot or smoke and also affects the ozone, but PM of smaller diameters are of main concern for public health because of their ability to penetrate sensitive areas and be an irritant or cause lung and heart diseases and cancer.

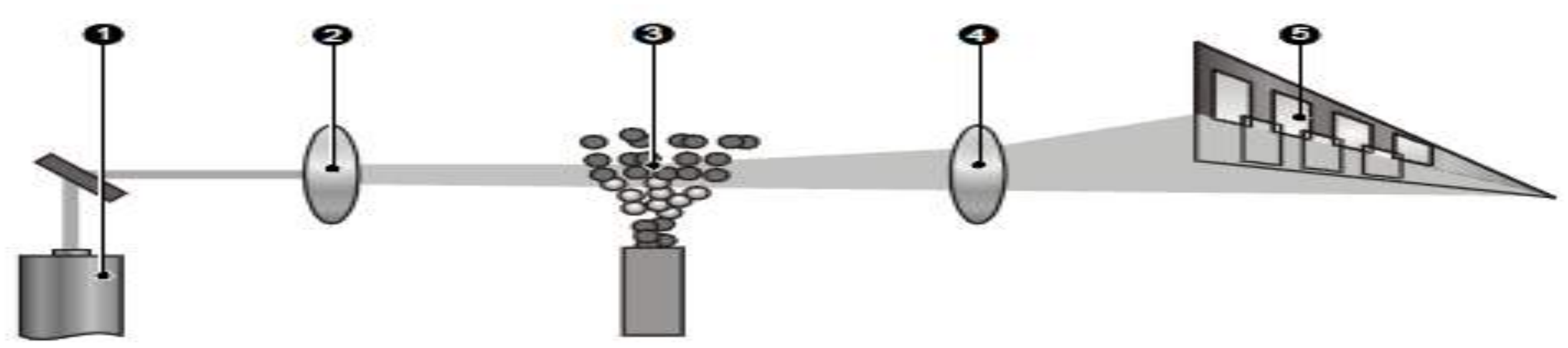


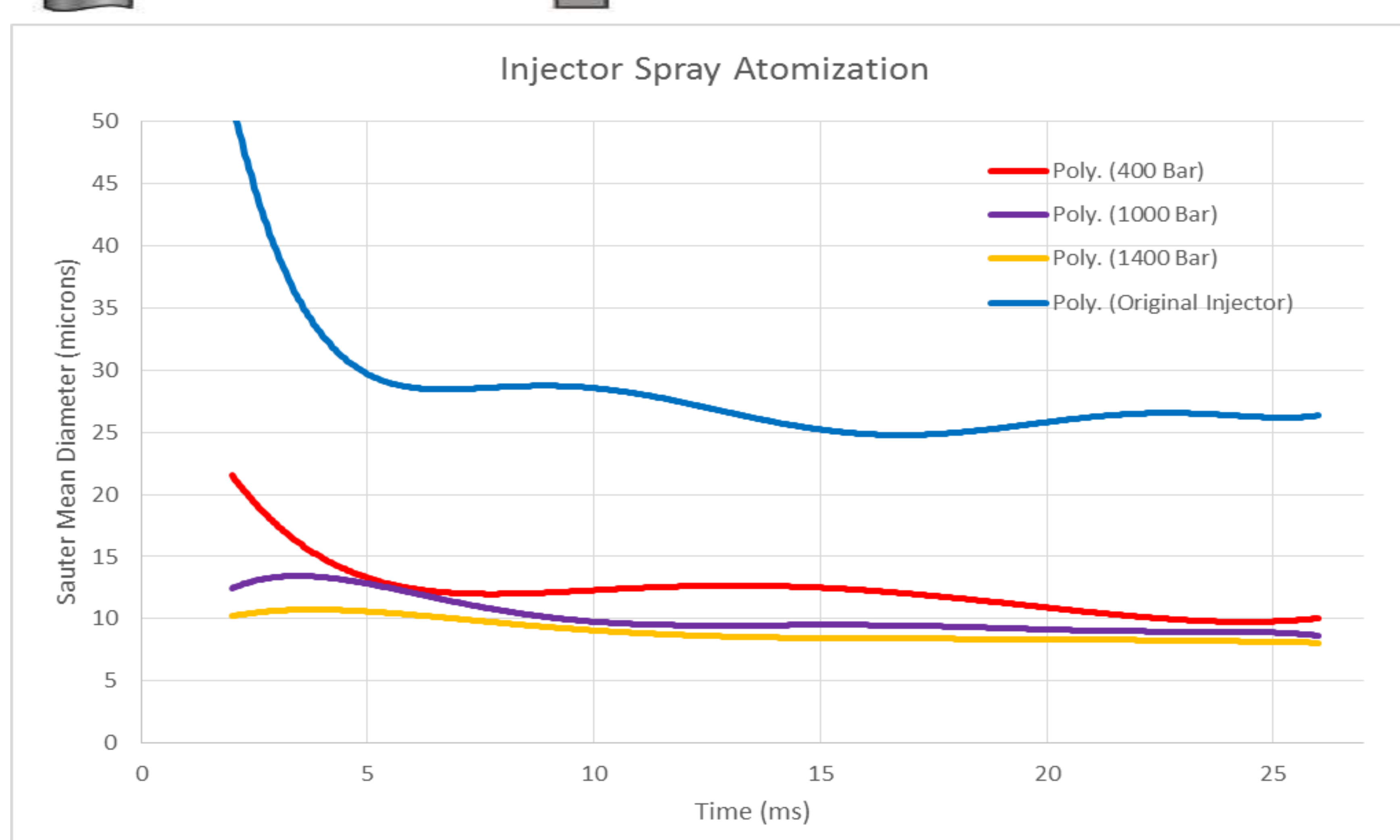
EXPERIMENTAL TEST BENCH SETUP

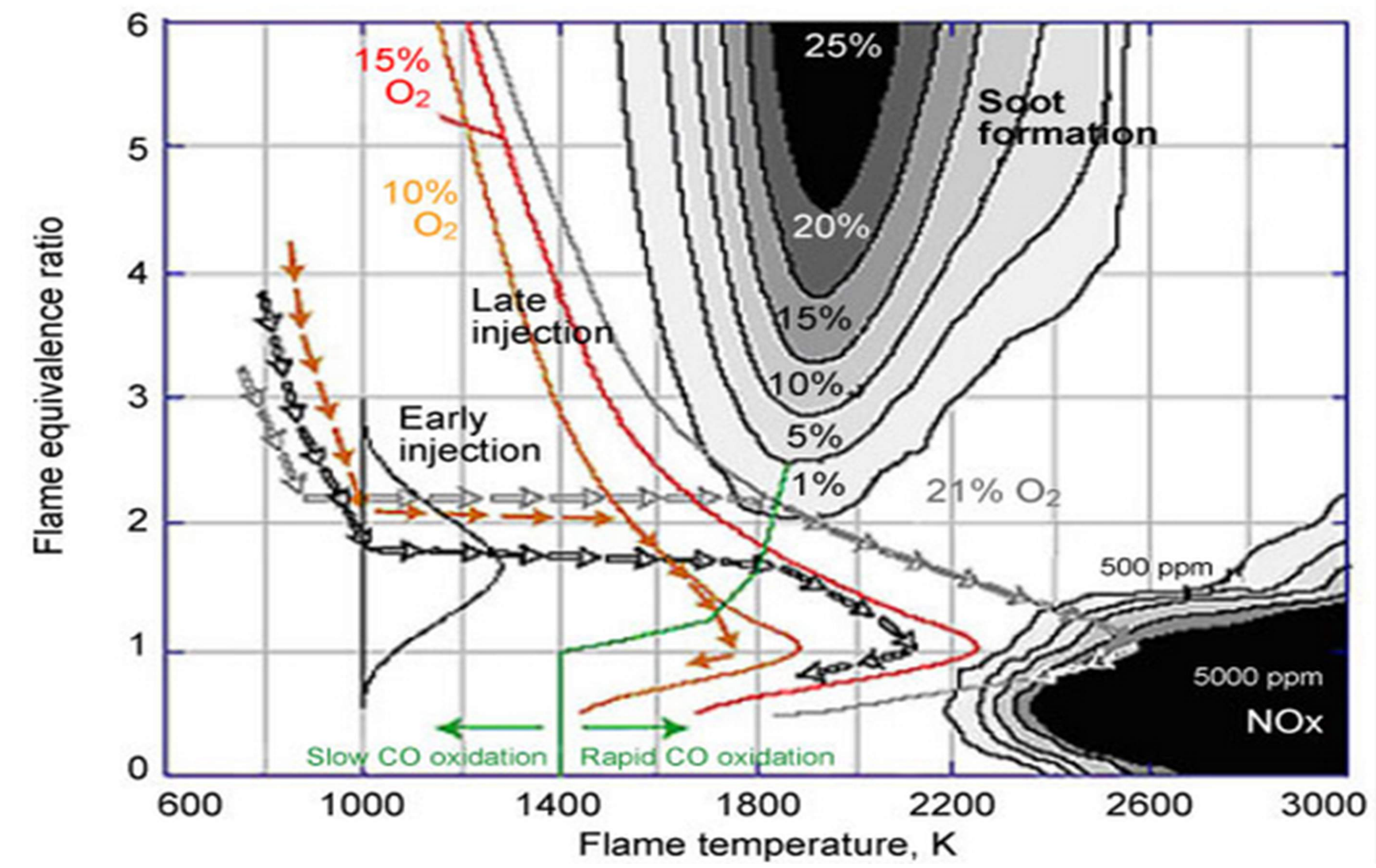


MIE SCATTER SPRAY ANALYSIS

- Predicts the way light is scattered by spherical particles and deals with the way light passes through, or is absorbed by, the particle.
- Requires knowledge of particle including its refractive index and absorption.
- Implements technique of equivalent spheres to measure irregular shapes.







METHODS

•Vary the pilot injection to control the heat release and in turn smoothing the increase in cylinder pressure with a reduction in NOx.

•Adjust dwell between injection events to find optimal soot formation.

•Post injection to promote soot oxidation decreasing the smoke and soot with added mixing and heat release.

•The fuel rail accumulator contains the injected fuel at high pressures up to 1,800 bar, or 26,000 psi, to optimize fuel atomization for a "perfect" combustion for minimal smoke and soot at varied speed and load.

•PID smart control for steady state operation

$$PID\ Output = [Kc \cdot e(t)] + \left[\left(\frac{Kc}{Ti}\right) \cdot \int e(t)\,dt\right] + \left[(Kc \cdot Td) \cdot \frac{dPV}{dt}\right]$$

CONCLUSION

•Reduce emissions with pilot injection to minimize noise pollution, ignition delay, and in turn the premixed combustion phase for low temperature combustion (LTC) with a reduction in NOx emissions as indicated in the image above.

•Post Injection increases mixture formation inducing soot oxidation resulting in decreased smoke emissions.

•Optimized fuel rail pressure and atomization results in "perfect" combustion for decreased fuel consumption and increased power output.

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