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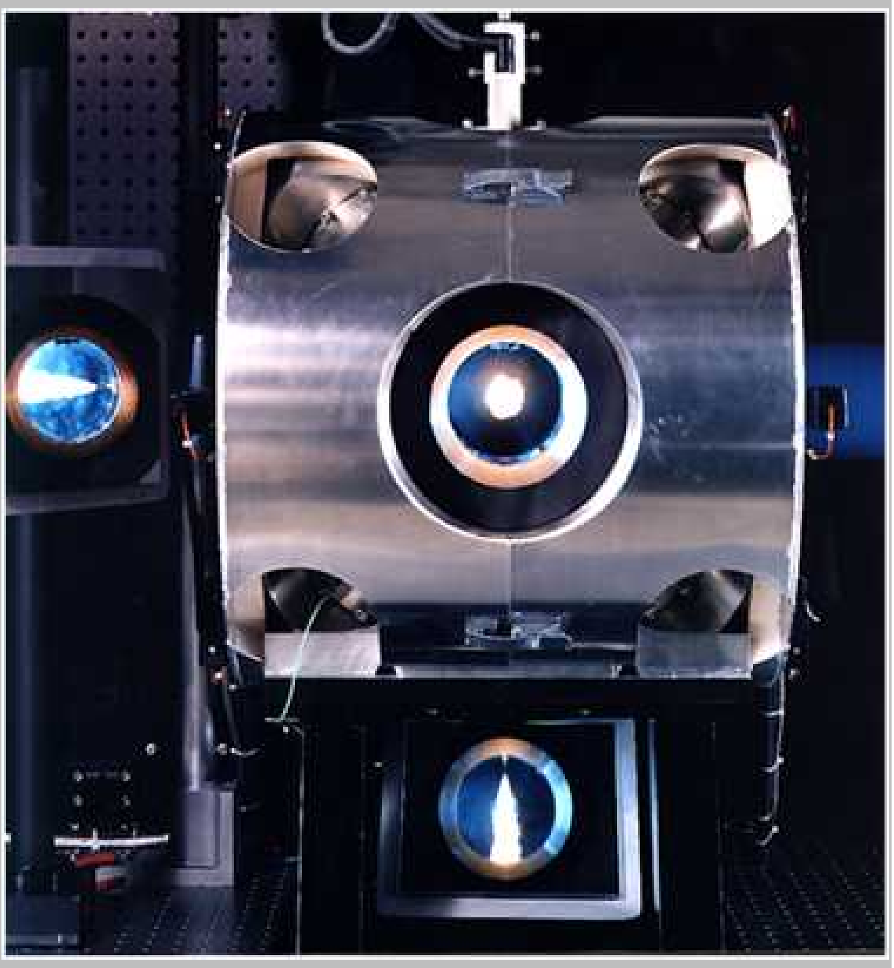

Ducted fuel injection for diesel combustion

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Sandia National Laboratories

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called Leaner Lifted-Flame Combustion (LLFC). LLFC is a type of mixing-controlled (diffusion) combustion that does not produce soot. Typically, diesel combustion occurs through diffusion, where the fuel inside of a diesel engine is not mixed evenly with the air. Fuel rich regions of diffusion flames produce soot which is a pollutant. This project will investigate whether injecting fuel into a duct in the combustion chamber will allow the fuel to mix more evenly with the surrounding air and produce LLFC in a compression ignition engine. The process of injecting fuel into the duct should entrain (draw some of the surrounding) air into the duct as well. When the air and fuel are in the duct together they will mix together resulting in a more even fuel air mixture and which will create the conditions for LLFC.

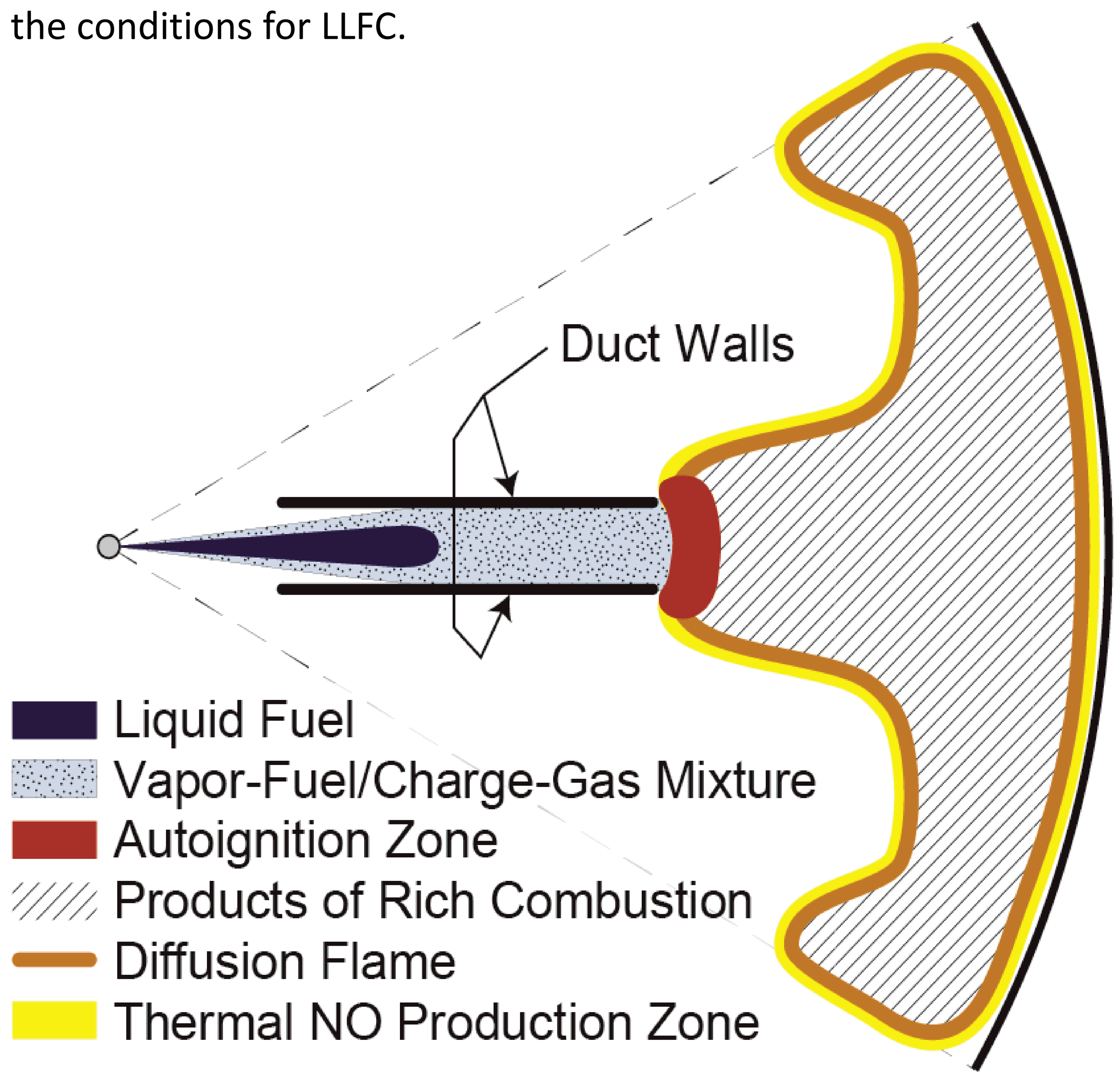


Diagram of ducted fuel injection for diesel engines concept

Introduction

Soot is made up of small carbon particles created by the rich regions of diffusion flames inside of a diesel engine. Soot is an environmental hazard and is an emission regulated by the Environmental Protection Agency (EPA) in the United States. Currently, soot is removed from the exhaust of diesel engines by heavy and expensive filters in the exhaust system. These filters have to be maintained by the vehicle owner to continue to effectively reduce the soot emissions.

Prior research indicates that LLFC can greatly reduce the production of soot inside the engine. The challenge is to enable LLFC, while maintaining adequate fuel flow to the engine at operating temperatures typical of diesel engines. An attempt will be made at achieving LLFC by injecting the fuel into a duct inside the combustion chamber. This duct will enhance the mixing of the fuel and air before the fuel autoignites. When the fuel is injected into the duct it will create a low pressure zone inside the duct. This low pressure zone will draw air into the duct with the fuel. The air and fuel inside the duct will mix together before the mixture exits the duct and autoignites. The resulting LLFC flame will produce less soot than the typical-diesel diffusion flame that would have been created without the duct.

greater freedom for testing ducts of different sizes and materials. The combustion chamber also provides unobstructed optical access to record the data from the experiments.

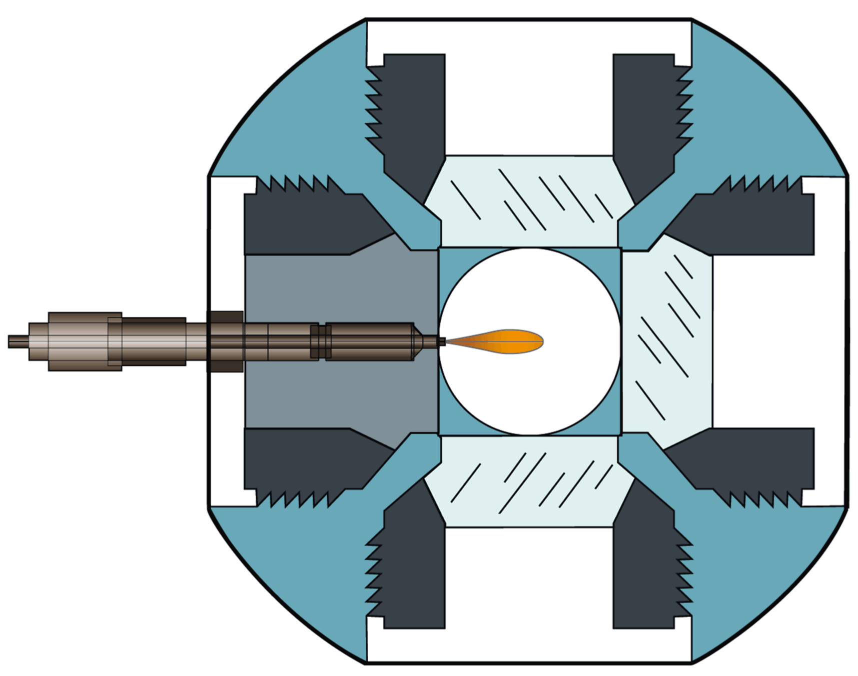


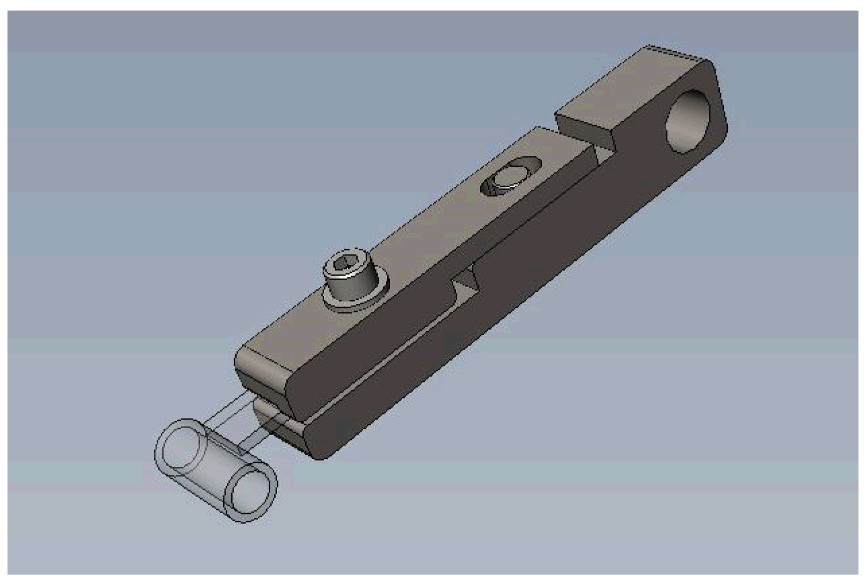
Diagram of constant-volume combustion-chamber

The experiment will be conducted using a set of operating parameters known as Spray A. Spray A is known to create soot which will allow us to analyze and quantify the improvement made by the duct.

Table of spray A data

Spray A	Temperature	Pressure	Gas Density	Ambient Gas	Nozzle Diameter	Fuel
	900 K	6.0 MPa	22.8 kg/m^3	15% O_2	0.090mm	N-dodecane

Duct diameters of 3, 5, and 7 mm and duct lengths of 7, 14, and 21 mm will be tested in this experiment. The ducts will be tested at varying distances from the injector to determine what conditions give the best results.



Quartz duct and duct holder

The duct will initially be made of quartz to allow optical access to the inside to the duct to record possible combustion.

Results

Soot incandescence will be used to determine if soot is present, which will indicate if LLFC is achieved. OH* chemiluminescence will be used to measure the lift-off length of the flame (axial distance between the fuel-injector and autoignition zone). The hardware for this experiment is still in the production process. As a result, data is not yet available.

Acknowledgments

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