

CAST SOOT GENERATOR FOR LIQUID FUEL

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INTRODUCTION

A soot generating CAST-burner has been developed for liquid fuel (diesel, gasoline, kerosene etc.) to form submicron soot particle with adjustable characteristics. The new CAST-burner is designed for applications such as the investigation of soot emissions with regard to the fuel type and for the improvement of soot reduction techniques with e.g. additives, and for calibration purposes.

METHODS

As shown in Figure 1, a fuel mixture of liquid fuel droplet and fuel gas is continually formed using an atomizer built in the CAST burner. The fuel gas flow is coated by an parallel air flow in order to form a co-flow diffusion flame within the combustion chamber. Due to the oxygen deficiency within the flame, fuel droplets are pyrolysed as a consequence of high temperature and form soot particles.

The CAST burner enables the soot particles to escape from the flame without contact with oxygen. Subsequently the particle stream is mixed with a quenching gas in order to prevent further combustion processes in the particle stream and to stabilize the soot particles. The quenching inhibits condensation in the particle stream at ambient air condition. To dilute the particle stream, compressed air is supplied to the quenched particle stream.

Figure 2 demonstrates the installation of the CAST burner which is dimensioned in order to work with the CAST unit manufactured by Matter Engineering AG (5610 Wohlen, Switzerland). The same burner is suitable for both operation mode: with gas only or with gas and atomized liquid fuel.

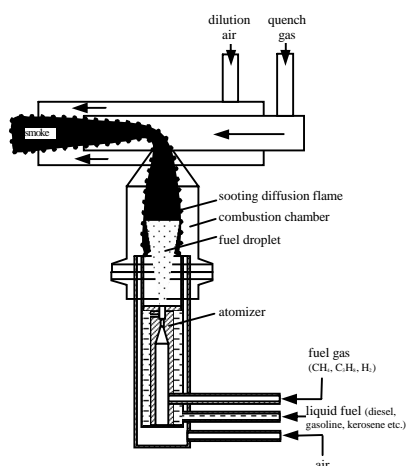


Figure 1 CAST burner for liquid fuel

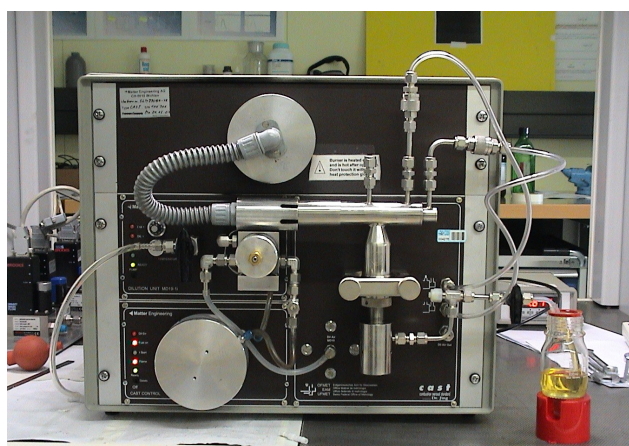


Figure 2 CAST unit equipped with a burner for liquid fuel (diesel)

RESULTS

The experiments have been performed with diesel and propane as fuel gas. The evaluation of the performance of the CAST burner has been focused on the targets: characterization of the particle size and number concentration using SMPS, coulometric analysis of the chemical composition of soot to learn the content of elementary and organic carbon, and overall stability and reproducibility of operation.

The CAST burner for liquid fuel works with a stable flame. The operation point can be varied by changing the operation parameter in order to generate soot particles of different size. The operation points have been optimized by inhibiting the soot particles generated by propane. The amount of propane soot has been determined without diesel supply for the same operation. Figure 3 shows 4 examples within the size range between 10 – 1000 nm and their unimodal number size distribution. The majority of the soot analysed has originated from the combustion of diesel droplets. The background soot from fuel gas might be further reduced by improving the operation or using fuel gas such as CH₄ and H₂. The coulometric analysis of the soot let know that the diesel soot from CAST consists of both EC and OC. The content of OC is higher than propane soot.

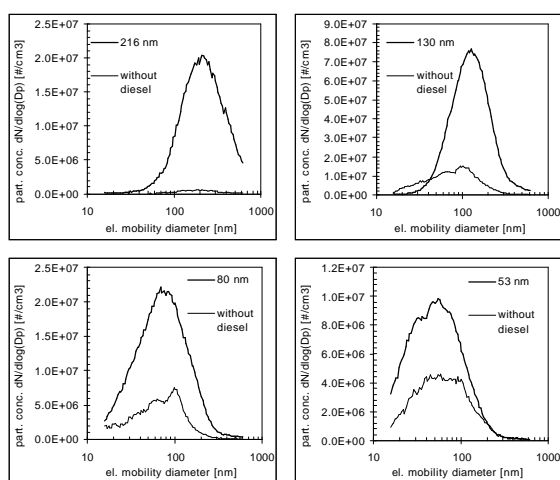


Figure 3 Number size distributions of soot particles generated by CAST using diesel that was atomized by propane

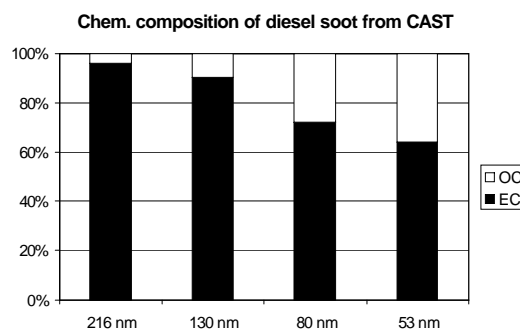


Figure 4 Results of coulometric analysis of the diesel soot from CAST burner

CONCLUSIONS

The CAST burner for liquid fuel (diesel, gasoline, kerosene etc.) is designed to generate submicron soot particle with reproducible characteristics. The same burner is suitable for both gas and gas-liquid mode. The characteristics are set by operation parameter and the particle size can be varied in submicron range. The CAST burner for liquid fuel gives the possibility to investigate soot emissions and soot reduction (e.g. using additive) directly with the fuel concerned and with small operation expenditure. The calibration of particle measuring instrument can be performed with diesel soot particle as well or soot particle from fuel concerned respectively.

ACKNOWLEDGMENTS

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