# DETECTION OF CAVITATION IN FUEL INJECTOR NOZZLES

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## ABSTRACT

An experimental investigation to detect cavitation in the nozzles of working Diesel injectors was conducted. Cavitation behavior of Diesel injectors was characterized by a non-dimensional cavitation parameter and a coefficient of discharge. Transient behavior in Diesel injectors with different needle opening pressures and different numbersof nozzle holes was observed and measured. The behavior of sharp-edged single and multi-hole injector tips was found to be reasonably consistent with established characteristics of cavitating nozzles, as observed in steady-state experiments and as predicted by a one-dimensional model. The measurement of flow through a rounded multi-hole tip was consistent with the known behavior of non-cavitating nozzles.

## INTRODUCTION

One important method of reducing emissions in Diesel engines is to improve fuel injector spray breakup, producing smaller and more disperse droplets. The flow inside the fuel injector nozzle is known to have a significant effect on the spray, but researchers have not discovered the exact nature of this effect [1]. Recent investigations have suggested that cavitation occurring within the fuel injector nozzle significantly affects spray breakup [2, 3]. However, much of what we know about cavitating nozzles has come from scaled-up models, with precisely determined geometry. Real fuel injector nozzles may have minute imperfections which can cause significant changes in the flow [4].

This investigation uses an experimental technique to indirectly detect the existence of cavitation in a variety of real injectors. The results of this technique should prove especially interesting in more complicated, multi-hole injectors. This experimental method will be applied to a single hole pump line injector and a multi-hole hydraulic electronic unit injector with sharp and rounded nozzle inlets.

### A One-Dimensional Model of Cavitating Nozzles

Cavitation bubbles form because of the very low static pressure that occurs in high speed nozzle flow near a sharp inlet corner. This low static pressure is predicted by incompressible potential flow theory, which indicates that flow around a sharp corner, (e.g. a corner with a zero radius of curvature), will have infinite negative pressure. This physically impossible result is a direct consequence of the constant density restriction. In real injectors the fuel density decreases with decreasing pressure, most likely leading to a change in phase. The sharper the corner and the higher the velocity, the more likely cavitation is to occur.