Abstract

In the diesel engine, a topic that has arisen great interest in the last decades is the injection system, due to its influence on the processes of atomization and formation of the air-fuel mixture, which directly affect the performance and emissions of the engine. With the aim of reducing the scientific breakthrough on knowledge of the internal flow behavior and the spray behavior at the outlet of the hole have been numerous studies, both theoretical and experimental, and fluid dynamic modeling. However, the study of the flow inside the injection nozzles and their effect on the atomization of fuel spray development in its earliest stages, which still shows significant uncertainties, remain a major challenge for research in this field.

In this Thesis a system for visualization of internal flow and the spray using transparent nozzles is designed and developed. With this design, and implementing a visualization technique with high spatial resolution, it is possible to establish a more direct relationship between the flow characteristics inside the holes and the formation of the spray in their first millimeters. Furthermore, the visualization system can work with different geometries and hole sections (2D or cylindrical), which allows to characterize the influence of geometry both in the internal flow as the spray.

Thus, in the first place has been analyzed the influence of geometry on the formation and development of cavitation inside the orifice and its relationship with the mass flow collapse. For this purpose, different geometries of 2D transparent nozzles approaching actual dimensions have been used. As a result of this study it has been observed that nozzles with a larger outlet section are more likely to cavitate. It has also been observed that nozzles with orifice longer require more critical conditions to form cavitation and the mass flow collapse occurs in supercavitating conditions.

Once it has been studied the influence of geometry on the performance of the internal flow has been studied, the influence of the appearance and development of cavitation inside the holes on the atomization and spray characteristics is studied. As a result of this study different atomization regimes are appreciated and it can be seen that cavitation leads to a significant improvement of micro-spray cone angle, together with an increment of spray contour irregularities, which enhances the atomization process.