NUMERICAL SIMULATION OF INFLUENCE OF ECCENTRIC NEEDLE MOVEMENT ON INTERNAL FLOW CHARACTERISTICS OF GROOVE-TYPE VOC NOZZLE

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Abstract.

The VOC nozzle of the diesel engine is affected by the dynamic characteristics of the needle, and the flow and injection characteristics of each hole are significantly different. In order to improve the spray characteristics of the VOC fuel nozzle, a nozzle structure design is proposed, the main feature is that there is an annular pressure groove on the sealing cone of the needle. In order to study the internal flow characteristics of this structure, a two-fluid model considering the eccentric motion of the needle was established. The results show that the eccentric movement of the needle leads to significant differences in the flow and injection characteristics of each hole. The development of the cavity in hole #1 （on the side of the needle deviation is earlier than that of hole #2 （on the deviation side, and the mass flow rate is also larger. After the needle is raised to 100μm, the mass flow rate and flow field characteristics of the nozzle with an annular groove are better than those of the nozzle without the needle groove. The groove structure of the needle acts as a pressure chamber, which is beneficial to weaken the adverse effect of the eccentric movement of the needle on hole #2.

1 Introduction

In the fuel supply system of diesel engine, the fuel injector is the key component of high-quality spray, and its performance directly affects the fuel injection process and the quality of the mixture, which in turn affects the power and emission performance of the diesel engine [1-3]. Studies have shown that the transient motion of the needle has an important influence on the flow in the nozzle and the near-field spray. Ideally, the axis of needle movement coincides with the axis of the needle body. However, due to the limited guide length of the needle, the processing technology of the needle couplers, and the fuel pressure fluctuation caused by the flow of the cavity inside the nozzle, the radial and axial movements coexist during the reciprocating motion of the needle.

The three-dimensional movement of the needle changes the flow cross-sectional area of each nozzle hole, resulting in extremely unstable gas-liquid two-phase flow in each nozzle hole, which in turn affects the fuel spray characteristics of the nozzle. Although many scholars have carried out a lot of research on the instantaneous dynamic characteristics of the needle on the fuel flow in the nozzle and the spray characteristics of the nozzle, limited by the test conditions, there are few studies involving the eccentric movement of the needle. With the application of X-ray phase contrast imaging technology to photograph the actual needle movement in the nozzle [4], scholars have been able to carry out visual research on the real nozzle needle movement. In view of the extremely expensive test cost, almost all research results are based on Argonne National In the laboratory [5-7], the mechanism and influencing factors of the radial eccentric movement of the needle need to be studied.

The needle tip of the traditional orifice nozzle and the inner side of the needle body head have a cylindrical or conical pressure chamber structure. The pressure chamber is filled with fuel during fuel injection, and the needle is seated and closed at the later stage of combustion. However, there is always a certain amount of fuel residue in the pressure chamber. This part of the fuel is injected into the combustion chamber in the form of oil lines or even dripping and seeping oil under low pressure, which deteriorates the smoke and HC emission indicators of the