Design and Simulation of a 1D Mechanical Injector Model for Marine Applications Using AMESIM

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The rapid advancement of technology in the maritime transportation sector has significantly increased the demand for fuel-efficient and low-emission systems. In this context, fuel injectors play a pivotal role in enhancing combustion efficiency and reducing environmental impact. For marine applications, such as ships, mechanical injectors remain a viable solution. These systems utilize mechanical pumps to deliver fuel directly into the combustion chamber, where it mixes with air and undergoes combustion. Mechanical diesel engines rely on this direct injection process via individual injector nozzles, driven by a mechanically operated pump. The development of mechanical injectors typically involves multiple complex stages, often requiring substantial time and financial resources. To address these challenges, this study proposes a one-dimensional (1D) simulation model of a mechanical injector developed using AMESIM software. The model enables comprehensive performance analysis of the injector and supports the evaluation of optimal injection strategies. It comprises three main components: the mechanical injector, the delivery valve, and the inline injection pump. Through the adjustment of component parameters and boundary conditions within the simulation environment, the injection process can be effectively replicated. This study simulates the injector's performance using two types of fuel—diesel and Castrol oil—under two pressure conditions: 0.25 MPa and 190 MPa. The simulation outputs include critical performance parameters such as needle lift, injection flow rate, and injection volume. The model demonstrates high effectiveness in facilitating design modifications and optimizing injection strategies to achieve improved mechanical injector performance.