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# Experimental and Simulation Study of Piston Ring Pack Influence on Heat Transfer and Friction

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**Abstract**: *This paper provides an integrated experimental and simulation analysis to examine the effects of piston ring pack geometry on heat transfer behavior and friction losses in a single-cylinder internal combustion engine. The piston ring pack, which includes the compression rings and the oil control rings, is responsible for sealing, lubrication, and thermal control between the piston and the cylinder wall. Different ring geometries, such as ring material changes, ring widths, and tension force, were examined under controlled engine operating conditions. During experiments, friction force data were collected with a motored engine test setup and in-cylinder pressure transducers, and a floating-liner friction measurement device. Temperature fluctuations along the piston skirt and ring area were measured through embedded thermocouples. Simultaneously, a thermal-structural finite element analysis (FEA) and computational fluid dynamics (CFD) simulation were conducted with ANSYS to simulate the heat path of transfer from combustion chamber to piston and ring pack and then to cylinder wall. Studies show that ring geometry and tension optimization lower friction loss substantially—up to 12% over the standard design—while retaining adequate sealing performance. Additionally, simulations showed better thermal gradients and reduced peak piston temperatures in designs that have augmented heat transfer coefficients. The results collectively imply that piston ring pack design is a key area not just for mechanical performance but also for efficient thermal management of IC engines. These findings may aid in designing more effective, low-friction engine configurations.*

**Keywords**: computational fluid dynamics