ABSTRACT

The aim of this research was to determine the effect of injection pressure, cylinder pressure and cylinder gas density on the spray penetration of diesel with a common rail injection system. A spray chamber capable of holding 20 bar was retrofitted to the Inov8 Test Stand in the Barloworld laboratories at The University of the Witwatersrand, Johannesburg. The data capturing system of the test stand was unmatched in quality and accuracy and the modification allowed the effects of cylinder gas pressure and density to be tested using the MIE-Scattering technique. Tests were conducted with a 1-hole injector with various injection and cylinder gas pressures. To assess the effects of injection pressure, the cylinder pressure was kept constant at 5 bar with injection pressures ranging from 700 bar to 780 bar. To investigate the effect of cylinder pressure, the injection pressure was kept constant at 780 bar and the cylinder pressure was varied between atmospheric pressure and 20 bar. Tests to determine if either the injection pressure or cylinder pressure have a greater effect on the spray were conducted by maintaining a constant 755 bar pressure difference across the nozzle. This was done by varying both the injection pressure (between 755 bar and 775 bar) and the cylinder pressure (between atmospheric pressure and 20 bar). All the experiments were repeated with nitrogen and then carbon dioxide in the spray chamber. The Akribis section of the test stand was used for flow measurements to verify the spray analysis results where necessary. The results were compared to models developed by Hiroyasu and Dent to determine their accuracy. The tests showed that the spray penetration increased with increasing injection pressure and decreased with increasing cylinder pressure. In all cases, changes in pressure had a greater impact on the spray penetration later in the injection, after the spray had broken up. The earlier phase of the injection was mostly dependent on the pressure difference across the nozzle. For the pressure ranges used in this study, changes in the cylinder pressure had a greater effect on the spray penetration than changes in injection pressure. The changes were attributed to the changes in gas density that occurs with pressure changes and had a diminishing effect as the pressure increased. It was found that the injection pressure was more important during the initial phases of the injection (before break up) and the cylinder pressure was more important later on in the injection. Carbon dioxide gave smaller spray penetrations than nitrogen at equivalent pressures due to its larger molecular mass resulting in a greater gas density. Spray penetration decreased at a decreasing rate with increasing cylinder gas density.