Spray Characterization in a DISI Engine During Cold Start: (1) Imaging Investigation

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Abstract:
Spray angle and penetration length data were taken under cold start conditions for a Direct Injection Spark Ignition engine to investigate the effect of transient conditions on spray development. The results show that during cold start, spray development depends primarily on fuel pressure, followed by Manifold Absolute Pressure (MAP). Injection frequency had little effect on spray development. The spray for this single hole, pressure-swirl fuel injector was characterized using high speed imaging. The fuel spray was characterized by three different regimes. Regime 1 comprised fuel pressures from 6 ¿ 13 bar, MAPs from 0.7 ¿ 1 bar, and was characterized by a large pre-spray along with large drop sizes. The spray angle and penetration lengths were comparatively small. Regime 2 comprised fuel pressures from 30 ¿ 39 bar and MAPs from 0.51 ¿ 0.54 bar. A large pre-spray and large drop sizes were still present but reduced compared to Regime 1. The spray angle and penetration lengths were typically larger then in Regime 1. Regime 3 comprised fuel pressures from 65 ¿ 102 bar and MAPs from 0.36 ¿ 0.46 bar. The fuel spray had a fully developed hollow cone structure with recirculation vortices at the edges of the spray, which constricted the spray angle. The spray angle was similar to Regime 2, while the penetration length increased. The pre-spray and drop size were reduced compared to Regime 2. In all regimes, decreasing MAP enlarged the spray angle, while injection frequency was not a significant factor.