Despite having many advantages, compression ignition engines emit harmful gases and particulates. Increasing concerns of environmental pollution and their harmful effects on human health led to evolution of stringent emission legislations. To meet these emission legislations, different technologies and exhaust gas after-treatment methods have been developed. Future stringent regulations have forced the vehicle manufacturers to develop technologies to prevent pollutant formation during combustion. Fuel- air mixing is the most important process, which affects diesel combustion and pollutant formation. Fuel-air mixing is mainly affected by in-cylinder air flow characteristics. Therefore, in-cylinder flow characterization using optical diagnostic techniques in an engine becomes essential. In this study, in-cylinder flows in a single cylinder optical research engine (SCORE) was investigated using 2 camera tomographic particle image velocimetry (PIV) technique. Air flow-field of SCORE was visualized to study the in-cylinder flow evolution during intake and compression strokes. To investigate the effect of different operating parameters, experiments were performed at different engine speeds (1200, 1500, 1800 and 2100 rpm), intake air temperatures (35, 50 and 80ºC) and intake port configurations (swirl, tangential and combined port). Intake air temperature was controlled using a closed loop temperature controller and intake ports were deactivated by using an aluminum gasket. In-cylinder flow visualization indicated that energy dissipation was maximum near the end of the intake stroke. The non-homogeneous and highly fluctuating flows in intake stroke became uniform during the compression stroke. In-cylinder air flow characteristics were significantly affected by the engine speed. Air velocity and turbulence were significantly higher at higher engine speeds. Comparative investigations for increased intake air temperature and deactivated port configuration showed lower energy dissipation rates at particular conditions.