In this study, syngas combustion was investigated behind reflected shock waves in order to gain insight into the behavior of ignition delay times and effects of the CO2 dilution. Pressure and light emissions time-histories measurements were taken at a 2 cm axial location away from the end wall. High-speed visualization of the experiments from the end wall was also conducted. Oxy-syngas mixtures that were tested in the shock tube were diluted with CO2 fractions ranging from 60% - 85% by volume. A 10% fuel concentration was consistently used throughout the experiments. This study looked at the effects of changing the equivalence ratios (phi), between 0.33, 0.5, and 1.0 as well as changing the fuel ratio (theta), hydrogen to carbon monoxide, from 0.25, 1.0 and 4.0. The study was performed at 1.61-1.77 atm and a temperature range of 1006-1162K. The high-speed imaging was performed through a quartz end wall with a Phantom V710 camera operated at 67,065 frames per second. From the experiments, when increasing the equivalence ratio, it resulted in a longer ignition delay time. In addition, when increasing the fuel ratio, a lower ignition delay time was observed. These trends are generally expected with this combustion reaction system. The high-speed imaging showed non-homogeneous combustion in the system, however, most of the light emissions were outside the visible light range where the camera is designed for. The results were compared to predictions of two combustion chemical kinetic mechanisms: GRI v3.0 and AramcoMech v2.0 mechanisms. In general, both mechanisms did not accurately predict the experimental data. The results showed that current models are inaccurate in predicting CO2 diluted environments for syngas combustion.