Pressure influence in burning velocity and quenching processes in acetone/air mixtures using Laser Induced Fluorescence

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ABSTRACT

The burning velocity is a fundamental parameter of fresh gas burning mixtures and is important both practically in the stabilization of flames, and theoretically to analyze flame propagation. This study presents an analysis of the burning velocity of the acetone vapor as a function of pressure from the atmospheric pressure to fifteen bars. The behavior of the phosphorescence quenching with the air under high pressure is also structured. Thanks to the acetone large absorption spectrum in the UV and its emission in the visible and near-UV range, this ketone is a very good candidate for laser induced fluorescence (LIF). Fluorescence is the spontaneous emission of radiation from an upper energy level which has been excited. For the quenching with the air, we are going to consider a mixture of acetone-N_2 as reference, because with this element the phosphorescence is not quenched.

The experimental setup is a burner with conic flame and its stabilization is secured by sixteen pilot flames around the main one. This allows the anchorage by the propagation of the front flame to the gas. All the flames are seeded with the same fuel. A cylindrical inox tank is used to analyze the pressure influence. The internal walls are protected by a radiated screen which is cooled by water and the pressure is setting up by a valve whose opening is variable and it is found in the exhaust and guided for regulating the pressure. This cell is supplied by scuttles to

visualize the inside. For the LIF diagnostic, a Nd:Yag laser at 266nm of wavelength is used. Signals are acquired using photodiodes, a non-intensified camera to determine the burning velocity and an intensified CCD camera for the quenching study. The filters used are prepared for capturing the emission of the acetone, which is found between 350 and 550 nm.

At atmospheric pressure the images between the mixtures acetone-air and acetone-N_2 are not very different as the quenching does not affect a lot the acetone's signal. But as the pressure increases, the signal is getting worst because the acetone's phosphorescence is quenched by the air, so only the fluorescence having a lifetime of about two nanoseconds at this wavelength remains. This too short signal is difficult to observe. So we are going to try to quantify this quenching with this experimental setup. We have observed that the acetone burning velocity is faster than the methane and the propane for all the equivalence ratio studied at atmospheric pressure. Also for the equivalence ratio lower than 0.6 and superior to 2 the flame gets very non-stable and the quantitative analyse gets harder. This present study allows us to know more about the behavior of the acetone and also is useful to perform other analysis using the acetone as a tracer in mixtures at high pressures.