HYDROGEN PEROXIDE BIPROPELLENT SYSTEMS

Although some studies have indicated that 90 w/o and 98 w/o hydrogen peroxide solutions are hypergolic (i.e., ignites without producing damaging overpressures to the system) with the hydrazine and 50 w/o N_2H_4-50 w/o $(CH_3)_2N_2H_2$ fuels (Ref. 1), other studies (Ref. 4) have indicated that the hypergolicity of 90 w/o hydrogen peroxide with both hydrazine and $(CH_3)_2N_2H_2$ is questionable. Ignition delays (e.g., the time period from injection of the second propellant into the combustion chamber to 90 percent of the designed chamber pressure) of ~5 to 25 ms were reported for H_2O_2/N_2H_4 systems in Ref. 1; however, large overpressures (e.g., the peak pressure to chamber pressure ratio) and erratic chamber pressure fluctuations were demonstrated in these systems. In the studies reported in Ref. 4, which demonstrated ignition delays for this system of 10 to 109 ms (with average delays of 35 to 52 ms recorded for various mixture ratios), it was concluded that hypergolicity was marginal and unreliable.

As a result of these and similar studies of other hydrogen peroxide bipropellant systems, including the $H_2O_2/CH_3N_2H_3$ (Ref. 1) and H_2O_2/B_5H_9 (Ref. 2) systems, it is concluded that the hypergolicity of hydrogen peroxide with various fuels is, at best, marginal. For this reason many hydrogen peroxide bipropellant systems utilize hydrogen peroxide decomposition gases (resulting from injection of the hydrogen peroxide in a catalyst chamber upstream of the main combustion chamber) as the ignition source. Through the use of this concept, successful system ignition has been demonstrated with various liquid (including those noted above, as well as with JP-5 in the AR-2 system), solid (Ref. 2) and heterogeneous (Ref. 3) fuels. Ignition delays between the hot decomposition gases and the fuels are minimal (5 to 10 ms), although the system design controls the overall start transient period (ie., from injection of the hydrogen peroxide into the catalyst chamber to the achievement of main chamber combustion). Many system designs employ only a small “pilot light” catalyst chamber with subsequent mainstream liquid injection (which bypasses the catalyst chamber), while other systems utilize prior decomposition of all of the hydrogen peroxide throughout the operation of the bipropellant system.

The use of hypergolics in the ignition of hydrogen peroxide oxidized bipropellant systems has been studied (Ref. 4) with the hydrazine, (CH3)2N2H2 (UDMH), and JP-5 fuels. In these studies, which were designed to demonstrate the feasibility of direct liquid injection of 90-percent hydrogen peroxide into bipropellant chambers, relatively smooth and rapid ignition was achieved with all three fuels using nitrogen tetroxide as the hypergolic for the first two fuels and aluminum triethyl with the later fuel. In addition, the use of mixed cyanide salts as an ignition aid to the H2O2/N2H4 system is noted in Ref. 4.

Source : http://www.diyspaceexploration.com/hydrogen-peroxide-bipropellent-systems/