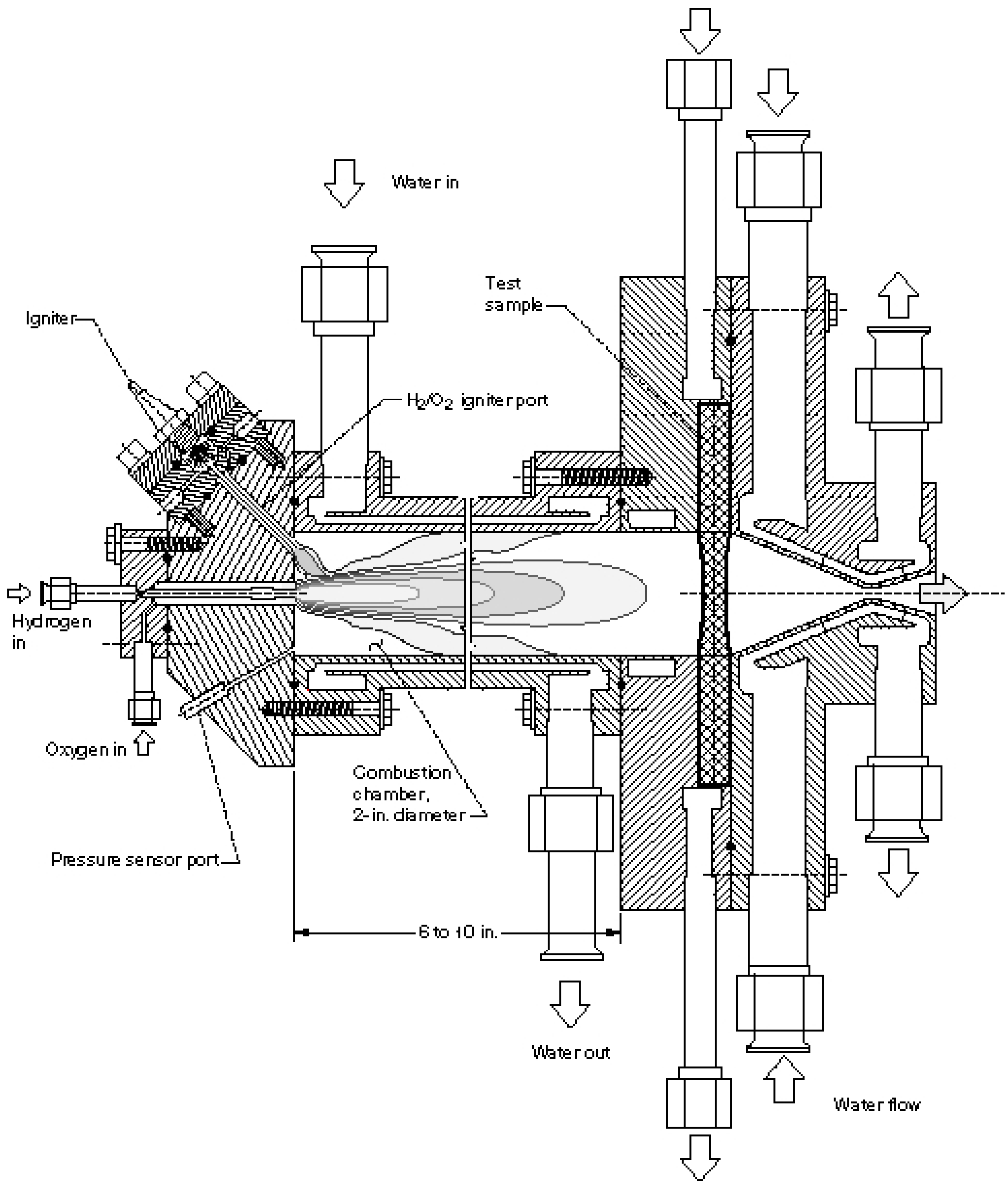
Oxygen Compatibility Screening Tests in Oxygen-Rich Combustion Environment

The identification and characterization of oxygen-rich compatible materials enables full-flow, staged combustion designs. Although these oxygen-rich designs offer significant cost, performance, and reliability benefits over existing systems, they have never been used operationally by the United States. If these systems are to be realized, it is critical to understand the long-term oxidative stability in high-temperature, high-pressure, oxygen-rich combustion environments. A unique facility has been constructed at the NASA Lewis Research Center to conduct tests of small-scale rocket engine materials and subcomponents in an oxygen-rich combustion environment that closely approximates a full-scale rocket engine. Thus, a broad range of advanced materials and concepts can be screened in a timely manner and at a relatively low cost.

The test stand and corresponding tests are part of a national program to evaluate materials for use in oxygen-rich combustion environments. At the onset of the program, a facility suitable for long-term oxygenrich exposure testing did not exist. Cell 22 of Lewis' combustion research laboratory (CRL) could operate in oxygen-rich environments, but not at the desired oxygen-to-hydrogen ratio of >150:1. Modifications to the test stand allow operation of multiple full-design cycles (10 min each) at oxygen-to-hydrogen ratios of up to 175:1. In addition to revamping the oxygen-to-hydrogen ratio capability, the facility was modified to accommodate testing specimens inside the combustion chamber (see the figure). Internal placement of the test specimens provides an environment with higher pressure and reduced flow in comparison to placement in the exhaust plume.



Hydrogen/Oxygen combustor test stand for advanced materials evaluation (internal test sample configuration).

In summary, a new national facility was constructed for long exposures of advanced materials in high-temperature, high-pressure, oxygen-rich combustion environments. The facility demonstrated excellent temperature distribution and control across the test sample gage. Five materials, downselected from data obtained by other tests, were exposed to more than 2130 min total in the new facility. All five materials survived multiple full-design cycle exposures, with only minimal surface oxidation visible afterwards.

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