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Fiber-Optic Liquid-Interface Sensor for Liquid Hydrogen

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We describe a refractometric fiber-optic sensor, which was developed and successfully used for the detection of the liquid interface in liquid-hydrogen storage tanks. The sensor employs a small hemispherical detection element of fused silica, which is integrated with two multimode optical fibers. The sensor parameters are optimized for the reliable discrimination between two media of almost equal refractive indices: liquid hydrogen and gaseous hydrogen. We show theoretically and experimentally that the dimensions of the sensor can be reduced without sacrificing its sensitivity if optical fibers with a small angular aperture are used and the position of the fibers results in a significant loss of non-liquid-dependent light. The advantages of this sensor in comparison with electrical sensors are the smaller heat ingress in the liquid-hydrogen tank, its intrinsic safety, and its potentially low cost. This sensor can be used as a point device, in pairs, or in multipoint arrays, such as those used in discrete liquid-level sensors. Its prospective applications include liquid-hydrogen-level sensing in hydrogen-powered cars, aircraft, space vehicles, and liquid-hydrogen production and storage facilities.

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