Progress Towards the Development and Qualification of an All Optical Temperature and Pressure Compensated Fiber Optic Oxygen Sensor for Monitoring Oxygen Environment in Aircraft Fuel Tanks

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An all optical pressure and temperature compensated oxygen sensor is under development for use in the in-situ closed-loop-control of the inert atmosphere environment inside fuel tanks of military and commercial aircraft. The all-optical oxygen environment control sensor is a passive, intrinsically safe, fiber-optic sensor device with no electrical connections leading to the sensors installed within the fuel tanks of an aircraft. To monitor and control the fuel tank environment, an array of multiple sensors is deployed throughout the fuel tanks of an aircraft, and a remote multi-channel optoelectronic system is used to monitor the status of all the sensors in real time, and to provide feedback oxygen environment information to the OBIGGS system. The deployed sensors installed in the aircraft tanks are connected to the optoelectronic system via a fiber-optic cable. The all optical sensor consists of an integrated multi-parameter fiber-optic sensor probe that integrates a fluorescence-based optical oxygen optrode with built-in temperature and pressure optical sensors within the same probe for compensation of temperature and pressure variants induced in the fluorescence response of the oxygen optrode. A multichannel frequency-domain fiber-optic sensor read-out (FOxSense™) system is used to interrogate the optical signals of all three sensors in real-time and to display the fuel tank oxygen environment in a "safe (green light)", "warning (yellow light)", and "alarm (red light)" visual display suitable for aircraft fuel tank ullage status and alarm applications. Preliminary testing of the all optical sensor have demonstrated the ability to monitor the oxygen environment inside a simulated fuel tank environment in the oxygen range from 0% to 21% oxygen concentrations, temperatures from (-) 40°C to (+) 60°C, and altitudes from sea level to 40,000 feet. Oxygen sensors with built-in temperature compensation as well as the conduit fiber optic cables have passed DO-160E including acoustic noise and burn test.