Study of optical fibers luminescence for nuclear reactors power measurement

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Abstract

Optical fibers are studied in order to be used as power meters in experimental research reactors. Compton scattering of γ-rays inside an optical fiber leads to electrons being emitted at a speed higher than the speed of light in silica. This effect creates Cerenkov radiation which is propagated by the fiber. Such sensors are of great interest for experimental reactors since they provide a passive measurement, are low intrusive, and are immune to electromagnetic perturbations. Wang et al. demonstrated that there is a linear dependence between the Cerenkov radiated power and the reactor γ flux. Later, Brichard et al. measured that the radiated power at 860 nm and 1060 nm is proportional to the reactor power. For nuclear reactor operating in pulse mode, Peric et al. obtains interesting correlations between the maximum radiated power and the maximum reactor power, as well as between the radiated energy and the energy released by the core. One of the remaining issues for this sensor is the delay between the Cerenkov light signal and the real power trace. This has been studied by Gay et al. on the CABRI reactor for high power transients (more than 10 GW). They highlighted that the time at maximum light intensity depends on the fiber OH concentration as well as the considered wavelength. To improve Cerenkov-based power meters, a new experimental campaign has been performed in the TRIGA-Mark II of the Jozef Stefan Institute (JSI) in order to highlight fiber-related issues of such sensors.

Keywords: Cerenkov Radiation, Optical Fiber Sensors, Nuclear Reactor Monitoring, Point Defects

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