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Simulator for SUPO, a Benchmark Aqueous Homogeneous Reactor (AHR)

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A simulator has been developed for SUPO (Super Power) an aqueous homogeneous reactor (AHR) that operated at Los Alamos National Laboratory (LANL) from 1951 to 1974. During that period SUPO accumulated approximately 600,000 kWh of operation. It is considered the benchmark for steady-state operation of an AHR. The SUPO simulator was developed using the process that resulted in a simulator for an accelerator-driven subcritical system, which has been previously reported[1].

As with the simulator described in reference 1, the SUPO simulator utilizes National Instrument's LabVIEW as the platform for the simulation. Functionality is comparable to actual physical controls that were used to operate SUPO. These include fuel height, cooling water flow, and control rod position. The underlying physics model for the reactor was validated against experimental data from SUPO operations[2]. This dynamic system simulation, originally developed in a specialty scripting language, DESIRE, was then converted to C++ operating in Visual Studio. It is this C++ implementation that operates in LabVIEW.

Description

Figure 1 provides a view of the basic LabVIEW operator's console.

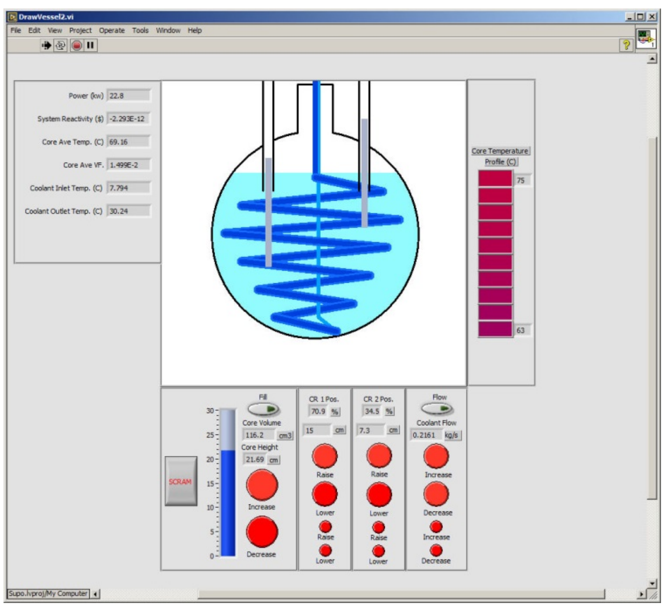

Figure 1: Operator's Console for SUPO

The major controls and displays necessary to operate SUPO are shown in the figure. Volume of the uranyl nitrate fuel is controlled by pumping the solution fuel into the spherical reaction vessel. SUPO

[1] "'Simulator for an Accelerator-Driven Subcritical Fissile Solution System", LA-UR-15-27110, Steven K. Klein, Christy M. Day, and John C. Determan; September 2015

[2] "A Generic System Model for a Fissile Solution Fueled Assembly", LA-UR-13-22033; Robert H. Kimpland and Steven K. Klein; March, 2013.

generally operated at a specific volume of fuel so a “Fill” control is provided to that level; however, if desired actual fuel level can be adjusted by the controls provided. SUPO utilized two control rods to establish desired reactivity in the system. Rod position could be independently controlled by the operator. The simulator provides this capability. The reactivity established by rod position in the simulator is derived from the rod calibration curves reported for SUPO. In a similar manner the flow rate of cooling water can be adjusted by the operator through the appropriate control on the simulator.

Core parameters during operation are shown by a set of digital displays typical of direct instrumentation, or computed values. These include the fission power of the system, reactivity, core and coolant temperatures and estimated void due to radiolytic gas. Core temperature profile is also shown as a color bar.

Operations can be performed typical of that for the physical SUPO reactor. Initial conditions may be established with ensuing critical operation based on those conditions. During operation at any point modifications in reactivity can be accomplished through the controls and resulting reactor response demonstrated.

As with the simulator for an accelerator-driven subcritical system, the SUPO simulator may be used as a training tool to introduce typical operational characteristics of an AHR.