Ultrasonic Testing on Pipelines of Oil Fired Heater of Steam Generator Test Facility

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Abstract

Liquid sodium is used as a coolant in fast reactors and steam generator is one of the most critical components. Investigation of thermal hydraulic performance of various steam generator components in liquid sodium is carried out in a steam generator test facility (SGTF). For these investigations, liquid sodium is required and as sodium is solid at room temperature, oil-fired heater is used to keep the sodium in liquid state at around 765K. The oil-fired heater consists of multiple S type pipelines (running East-West on either side (North and South) of the burners. The diameter and wall thickness of pipeline are 100 mm and 8 mm, respectively. During the annual shut-down maintenance of the oil-fired heater, it was desired to identify non-destructively if there was any solidified sodium in the bottom rows of pipelines due to improper draining and also to determine the extent of sodium presence in the pipelines.

Ultrasonic pulse echo method (normal beam, 10 MHz) was employed for this application. Adherence of sodium to inner diameter (ID) surface of pipe is expected to lower the back wall echo amplitude (damping) due to partial transmission (approximately 24%) of ultrasound into sodium. Hence, attenuation of back wall echo from the ID/sodium interface was analyzed to find out the presence of sodium. A detailed ultrasonic testing procedure was made and testing was carried out on eastern and western locations on each of the 4 bottom pipes, on North as well as South side pipes of the heater. At each location, ultrasonic measurements were carried out on three clock positions i.e. 12’o Clock (Top of pipe), 9’o Clock (inspector side) and 6’o Clock (Bottom of pipe) to know the extent of sodium presence. The maximum back wall signal from the interface between steel and air i.e. in a sodium-free location in a mock-up pipe was taken as reference. The ultrasonic observations were grouped into, based on the obtained on the reflected amplitude of the back wall echo amplitude, three categories viz. No reduction in back wall echo amplitude i.e. No sodium; Slight reduction in back wall echo amplitude i.e. discontinuous presence of sodium on ID surface; and Significant reduction in back wall echo amplitude i.e. Presence of continuous sodium.

The ultrasonic procedure detected presence of sodium in a few pipelines and the extents of sodium presence were found to be non-uniform in different places. Ultrasonic
measurements were also carried out after complete draining of sodium by localized heating to verify the ultrasonic measurements and 100% back wall echoes, close to the reference echo, were observed confirming the complete draining of sodium in the pipelines. This paper discusses the details of the oil-fired heater, ultrasonic procedure developed and the results of inspection concerning identifying pipelines with sodium presence on the ID side.