ABSTRACT

TITLE:	Design of a Fluid Level Indicator for Hazardous and High Temperature Liquids
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ABSTRACT: Generator IV and other nuclear fast reactors have historically used liquid sodium as a coolant. The choice of coolant determines the main design approaches and the technical and economic characteristics of a nuclear power plant. Coolant fluids, such as liquid sodium, are often hazardous and exothermically reactive with oxygen and water which require them to be sealed in an oxygen free environment because liquid sodium burns when exposed to air releasing toxic aerosols and liquid sodium exposed to water undergoes an exothermic reaction generating sodium hydride and sodium hydroxide. It is desired to be able to measure the fluid level of liquid sodium without opening the vessel containing pyrophoric or anaerobic compounds. Argonne National Laboratory in Lemont, Illinois, is building a Mechanisms Engineering Test Loop (METL) with liquid sodium coolant (shown in appendix: Figure 1) which is the largest single sodium testing facility in the world. The METL system contains a sodium volume of 800 gallons and the design constraints for the system include a maximum operating pressure of 100 psig and a temperature of 600 C. At the desired temperature, sodium vapor becomes a major issue for measuring devices. Sodium has a minor, but non-negligible, vapor pressure that increases as temperatures increases and can re-condense to form pockets of solid or liquid sodium. A practical method used for measuring high temperature fluid levels can be accomplished by using a pressure transducer which will allow for the device to reach the desired temperature and pressure constraints. Conducted research and relevant evaluations found that the limiting constraint for measuring the fluid level using a pressure transducer are the possibilities of plugging and corrosion. In order to combat these issues, the design utilizes enlarged tubing and 316 stainless steel material which is sodium compatible. The experimental outcomes resulted in an accuracy within 0.60% for continuous level measurement. Due to the danger and inability to acquire liquid sodium, testing was conducted with water because of the viscosity and density similarities to sodium. These accurate level measurements will aid in the advancements for the nuclear and solar industries in developing efficient heat transfer mediums used to produce energy for various applications.