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Development of Electromagnetic Devices for Sodium Cooled Fast Reactor Application

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Liquid sodium is used as coolant due to its suitable neutronic and thermal properties in fast reactors. Good electrical conductivity of sodium is used for development of electromagnetic devices such as electromagnetic pumps & flowmeters and level probes for use in sodium cooled fast reactors, where conventional devices used in chemical plant cannot be used due to high chemical activity of sodium and high temperature. Design, development and testing of a Sodium Submersible Annular Linear Induction Pump (ALIP) was carried out recently. The developed pump can be used for sodium draining from main vessel of pool type of Sodium Cooled Fast Reactor (SFR) and any other application where pump has to be submerged in sodium. The developed pump does not require any external cooling when submerged in radioactive sodium of 200oC. The winding of submersible ALIP can withstand 550oC. The submersible ALIP was tested in sodium loop for obtaining pump characteristics. AC Conduction pump for low flow application in sodium loop has been developed. Design, analysis and manufacturing aspects are brought out in the paper. Development of three different types of compact electromagnetic flowmeters based on Samarium Cobalt permanent magnet, electromagnet formed from soft iron in combination with mineral insulated cable and small probe type permanent magnet flowmeters were successfully demonstrated. Samarium Cobalt magnet helps in reducing the size and weight of flowmeter due to its high energy product. Flowmeter having electromagnet coil made from mineral insulated cable has high temperature withstand capability of around 500oC. The electromagnet coil in combination with soft iron replaces permanent magnet, hence it provides diversity in flow measurement in critical applications. The probe type flowmeter uses small permanent magnet encapsulated in a slender probe which can be inserted inside the pipe where sodium flow measurement is required. Eddy current based ex-vessel level probe was developed for measurement of sodium level in the vessel without insertion of probe inside the vessel. It works on the principle of eddy current and using this probe, sodium level inside the stainless steel vessel can be obtained by keeping the probe outside the vessel. This technique of discrete sodium level measurement is first of its kind. This paper enumerates development of sodium submersible ALIP, newly developed flowmeters and development of ex-vessel sodium level probe. Test results obtained from sodium testing are also brought out in the paper and FEM analysis carried out for different devices are also depicted.

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