Numerical and experimental investigation of surface vortex formation in coolant reservoirs of reactor safety systems

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Abstract:

The reliable operation of the emergency coolant pumps and passive gravitational injection systems is an important safety issue during accident scenarios with coolant loss in nuclear power plants. Because of the pressure drop and flow disturbances surface vortices develop at the pump intakes if the water level decreases below a critical value. The induced swirling flow and gas entrainment lead to flow limitation and pump failures and damages. Moreover, this affects the amount of available cooling water in the reservoirs and pump sump. The prediction of the critical submergence to avoid surface vortex formation is difficult because it depends on many geometrical and fluid dynamical parameters. An alternative and new method compared to the commonly but used but only on a limited parameter range applicable simple ANSI correlation has been developed for the investigation of surface vortices. The method based on the combination of CFD results with the analytical vortex model of Burgers & Rott. For validation and further investigation, the small scale experiments from the Institute of Nuclear Techniques of the Budapest University of Technology and Economics are used which were inspired by flow limitation problems during the drainage of bubble condenser trays at a VVER type nuclear power plants.