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SmallModular Reactors –Impact on aerosol fission product deposition under accident scenarios

Small modular reactors (SMRs) with revolutionary features offer advantages in terms of design, operational and safety characteristics. Apart from the thrust on the inherent, active and passive safety enhancement, innovative SMR designs are evolved keeping in view economy, deployment and public acceptance. Increased surface area-to-volume (A/V) ratio is the most notable design characteristic that plays an important role in reducing the severity of the accident by enhancing the removal of radioactive aerosol particles following a nuclear incident (Carless et al., 2019). Larger A/V ratio affects gravitational settling, diffusion, impaction and higher thermo-phoretic and diffusion-phoretic gradients differentiate aerosol deposition patterns in a conventional Light water reactor (LWR) and the futuristic SMR geometries. In this work, aerosol deposition velocities were calculated for a simplistic containment geometry and the effect of increasing A/V ratio was studied. Deposition rate constant was found to increase by more than 5 times for the characteristic A/V dimension of SMR as compared to that of LWR. The CFD simulations were performed for expected geometries (A/V ranging from 1.5 to 2.5 m-1) and thermal- hydraulic conditions in SMR containment. The results show that high A/V contributes to making SMRs safer and a promising option for meeting future energy needs with minimized concerns related to nuclear safety.

Reference:
Travis S. Carless, Sola M. Talabi, Paul S. Fischbeck, (2019) Risk and regulatory considerations for small modular reactor emergency planning zones based on passive decontamination potential, Energy, 167, 740-756

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