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Aerosol evolution in a typical SMR containment under hypothetical accidental conditions

Enhancing safety measures for Small Modular Reactors (SMRs) necessitates a comprehensive understanding of aerosol behavior within containment structures during accidental conditions. This study employs the NAUA aerosol dynamics code (Bunz et al., 1987) to investigate the dynamic evolution of aerosols in a typical SMR containment (surface area to volume ratio = 0.022 cm^{-1}). Assuming a large-scale release of 2.2 g/s for 1-h in a containment volume of 3.5E+09 cm^3, simulations are conducted for 10^4 minutes. Results, depicted in Fig. 1, reveal gravitational settling as the predominant deposition process, followed by diffusional deposition, while the contribution of diffusio-phoretic deposition is negligible. However, NAUA does not account for thermophoretic deposition, highlighting a need for future consideration. The study focuses on elucidating the effects of various accident scenarios, such as loss-of-coolant incidents, on aerosol distribution and concentration profiles over time. Ongoing research aims to incorporate more realistic input conditions and additional physical processes into the numerical code to improve the prediction of aerosol evolution and radioactive source term during postulated accidental conditions. Insights gained from this investigation can inform the design of emergency response strategies and optimize containment systems for SMRs, thereby advancing nuclear safety engineering.

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Reference

Bunz, H., Kyoro, M. and Schoeck, W. (1987) NAUA Mod 5 and Mod 5-M, Zwei Computerprogramme zur Berechung des Aerosolverhaltens im Containmentsystem eines LWR nach einem Kernschmelzunfall. KfK-4278, Kernforschungszentrum, Karlsruhe.

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