World Academy of Science, Engineering and Technology
International Journal of Chemical and Molecular Engineering
Vol:13, No:09, 2019

Considering Aerosol Processes in Nuclear Transport Package Containment Safety Cases

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Abstract : Packages designed for transport of radioactive material must satisfy rigorous safety regulations specified by the International Atomic Energy Agency (IAEA). Higher Activity Waste (HAW) transport packages have to maintain containment of their contents during normal and accident conditions of transport (NCT and ACT). To ensure containment criteria is satisfied these packages are required to be leak-tight in all transport conditions to meet allowable activity release rates. Package design safety reports are the safety cases that provide the claims, evidence and arguments to demonstrate that packages meet the regulations and once approved by the competent authority (in the UK this is the Office for Nuclear Regulation) a licence to transport radioactive material is issued for the package(s). The standard approach to demonstrating containment in the RWM transport safety case is set out in BS EN ISO 12807. In this document a method for measuring a leak rate from the package is explained by way of a small interspace test volume situated between two O-ring seals on the underside of the package lid. The interspace volume is pressurised and a pressure drop measured. A small interspace test volume makes the method more sensitive enabling the measurement of smaller leak rates. By ascertaining the activity of the contents, identifying a releasable fraction of material and by treating that fraction of material as a gas, allowable leak rates for NCT and ACT are calculated. The adherence to basic safety principles in ISO12807 is very pessimistic and current practice in the demonstration of transport safety, which is accepted by the UK regulator. It is UK government policy that management of HAW will be through geological disposal. It is proposed that the intermediate level waste be transported to the geological disposal facility (GDF) in large cuboid packages. This poses a challenge for containment demonstration because such packages will have long seals and therefore large interspace test volumes. There is also uncertainty on the releasable fraction of material within the package ullage space. This is because the waste may be in many different forms which makes it difficult to define the fraction of material released by the waste package. Additionally because of the large interspace test volume, measuring the calculated leak rates may not be achievable. For this reason a justification for a lower releasable fraction of material is sought. This paper considers the use of aerosol processes to reduce the releasable fraction for both NCT and ACT. It reviews the basic coagulation and removal processes and applies the dynamic aerosol balance equation. The proposed solution includes only the most well understood physical processes namely; Brownian coagulation and gravitational settling. Other processes have been eliminated either on the basis that they would serve to reduce the release to the environment further (pessimistically in keeping with the essence of nuclear transport safety cases) or that they are not credible in the conditions of transport considered.

Keywords : aerosol processes, Brownian coagulation, gravitational settling, transport regulations
Conference Title : ICAST 2019 : International Conference on Aerosol Science and Technology
Conference Location : Prague, Czechia
Conference Dates : September 05-06, 2019