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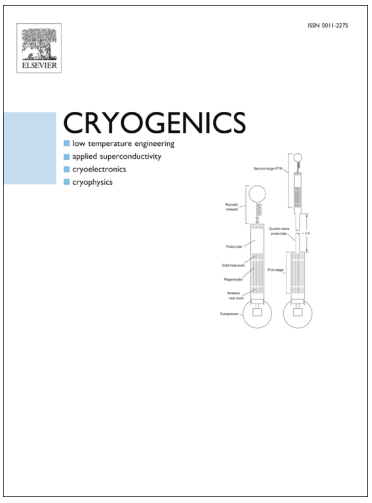

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Numerical Investigation of Potential Stratification Caused by a Cryogenic Helium Spill Inside a Tunnel

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Abstract

The sudden release of cryogenic fluid into an accelerator tunnel can pose a significant health and safety risk. For this reason, it is important to evaluate the consequences of such a spill. Previous publications concentrated on either Oxygen Deficiency Hazard or the evaluation of mathematical models using experimental data. No studies to date have focussed on the influence of cryogen inlet conditions on flow development. In this paper, the stratification behaviour of low-temperature helium released into an air-filled accelerator tunnel is investigated for varying helium inlet diameters. A numerical model was constructed using the OpenFOAM Toolbox of a generalised 3D geometry, with similar hydraulic characteristics to the CERN and SLAC tunnels. This model has been validated against published experimental and numerical data. A dimensionless parameter, based on Bakke number, was then determined for the onset of stratification, taking into account the helium inlet diameter; a dimensionless parameter for the degree of stratification was also employed. The simulated flow behaviour is described in terms of these dimensionless parameters, as well as the temperature and oxygen concentration at various heights throughout the tunnel.

Keywords: cryogenics, stratification, accelerator tunnel, unexpected helium release, ODH hazard

1. Introduction

The sudden release of cryogenic fluid in the case of a failure can pose a significant health and safety risk. In the case of a spill, atmospheric oxygen can be displaced by the evaporated cryogen, creating an Oxygen Deficiency Hazard (ODH), of which asphyxiation is a possible consequence.

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