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Helium Recovery from Guard Vessel Atmosphere of the ALLEGRO Reactor

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ALLEGRO is a helium-cooled experimental fast reactor, which is under development by the consortium „V4G4 Centre of Excellence” (Czech Republic, Hungary, Poland and Slovakia) associated with France. The current pre-conceptual stage of development by the V4G4 CoE is based on the 75 MWt concept presented by CEA in 2009. The main purpose of ALLEGRO is 1) Demonstration of viability of the gas-cooled fast reactor (GFR) technology in pilot scale, 2) Testing of innovative carbide-based refractory GFR fuels in the start-up oxide core driver, 3) Qualification of other GFR-specific technologies such as components of the primary circuit, helium-related systems, fuel handling etc.

One of the GFR-related helium technologies is the recovery system for the helium leaked from the pressurized boundaries such as primary circuit into the gas-tight guard vessel (GV - a metallic pressure boundary around the primary circuit filled with 0.1 MPa nitrogen, whose main function is to provide backpressure of at least cca 0.4 MPa to make the emergency cooling system functioning properly in loss-of-coolant accident conditions). The helium recovery system will be able to separate the leaked helium from the nitrogen-helium GV atmosphere and return it into the helium storage system. This feature will make the future GFRs (including ALLEGRO) much less dependent on the helium market.

The paper describes a helium recovery system with emphasis on both the separation method and the proposed (pre-conceptual) technical solution. The system is based on multi-cycle semipermeable membrane separation and is expected to be operated not continuously, only when the helium concentration in the GV exceeds a certain limit. Up to 99% helium purity can be reached by this process, while the final purification is planned to be performed by other methods, e.g. by using a pressure swing adsorption (PSA) technology, which can achieve high purity helium. For good yield of helium a membrane with high selectivity of nitrogen/helium should be used. A membrane-based recovery system was developed, tested on laboratory scale and a first concept of the recovery system was proposed for the conditions of ALLEGRO. The work has been so far supported mainly by the Technology Agency of Czech Republic.

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