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Sorption-based helium-3 pump for a closed-cycle dilution refrigerator

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At the University of Twente a sorption-based helium-3 pump is under development. It will be incorporated in a closed-cycle dilution refrigerator (CCDR) that is developed by the Néel institute in Grenoble. This CCDR is to be used for future long-lifetime missions requiring a cooling power of the order of 1 microWatt at typically 50 mK for at least 5 years. Crucial component in this zero-gravity dilution refrigerator is a pump to circulate helium-3 between 5 mbar and 200 mbar. For this purpose, a sorption-based pump is developed that consists of a single sorption-compressor cell of which the sorber container measures 1 cm in diameter and 10 cm in length. It uses passive inlet and outlet valves and is thermally linked to a 15-K platform. Small gas buffers are applied for stabilizing the low pressure and for storing the gas at 300 K thus reducing the filling pressure to below 20 bar. The required input is 90 mW of which 50% is to drive the compressor cell and 50% is for controlling the temperature of the low-pressure buffer. We expect to establish a flow of 20 micromol/s. Compared to mechanical pumps the main advantage is lower mass and less complex interfacing. Both advantages result from the fact that the pump is fully integrated with the cold part of the CCDR, whereas the mechanical alternative pumps need to be operated at the 300 K level. The design of the sorption-based pump will be presented as well as introductory experiments.

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