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## C1Po1A-02: Active Magnetic Regenerative Refrigerator (AMR) with rotating permanent magnet for liquid hydrogen

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Liquid hydrogen is attracting attention as an energy carrier derived from decarbonized power generation. Magnetic refrigeration is an application of the magnetocaloric effect, which is the reversible heating and cooling of magnetic materials by applying the external magnetic field. Active Magnetic Regenerative Refrigeration (AMR), which is one of the magnetic refrigeration methods, has been studied for hydrogen liquefaction to improve the cooling efficiency. In our device, eight magnetic material containers installed in a horizontal plane were in a radially with 45 degrees each other. Rotating permanent magnets for applying the magnetic field are similarly arranged four at 90 degrees each and can repeatedly magnetize and demagnetize the magnetic materials at each 45-degree rotation. Atomized particle of magnetic materials for AMR are used not only for their magnetocaloric effect, but also for their regenerative effect by enclosing them in containers that allows heat exchange gases to flow through the spaces between the particles. A temperature gradient can be created in the magnetic material container by flowing the heat exchange gas in opposite directions after the magnetic material is magnetized and demagnetized, respectively. The AMR was designed to recondense the boil-off hydrogen gas from the liquid storage tank, and the operating temperature was set close to 20 K. A 20 K-class single-stage GM refrigerator was used to absorb exhausted heat from the AMR at about 30 K. The magnetic field applied to magnetic materials is up to 1 T. Refrigeration operation has been performed using HoAl<sub>2</sub> or HoB<sub>2</sub> as magnetic materials and reached to 20 K and create the temperature gradient along to the magnetic material container about 10 K. To improve the cooling capacity, we are developing the new permanent magnet using novel materials invented by X. Tang et al. In the presentation, experiments result of the new magnet will be also reported.

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