3He/4He Dilution Refrigerator with Pulse-Tube Refrigerator Precooling

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We present the construction concept of a cryogen-free 3He/4He dilution refrigerator (DR) which is precooled by a commercial pulse tube refrigerator(PTR). 3He/4He mixture gas entering the refrigerator is precooled to 40K at the first stage of the PTR. Mixture gas is further cooled to 2.5K in the heat exchanger mounted on the second stage and a Joule-Thomson stage is used to condense the mixture gas before it enters the dilution unit. Once the liquid 3He/4He mixture is obtained, a conventional DR design including a still, counterflow heat exchangers, and a mixing chamber is adopted for the continuous operation. The pre-cooling procedure from room temperature to 2.5K that takes about few hours is fully automatic. The dilution refrigerator is expected to have an ultimate base temperature of about 15mK without using liquid cryogens.

Keywords : pulse-tube, refrigerator, dilution