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ADVANCED AND ENERGY SAVING THERMAL INSULATIONS FOR CRYOGENIC APPLICATIONS

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The power consumption in large scale superconducting devices is due to the refrigeration system and the cryogenic devices used in special applications often require an extremely long cryogen holding time. All cryogenic devices and superconducting instruments, regardless of size, small, large or huge, are all working at cryogenic temperature. To economically maintain the device at its operating temperature and minimize the refrigeration losses, high performance thermal isolation is essential. This includes the thermal insulation system as well as minimizing heat leaks from penetrations and supports. The current advanced developments of various cryogenic thermal insulation technologies are briefly and systematically introduced, discussed and reviewed in the paper as follows:

1. Highly thermal efficient and energy saving cryogenic transfer lines for LH₂ and LHe.
2. Advanced designs to reduce the heat transfer through sophisticated support structures in large accelerator magnets, SRF cavities, detectors and electric power leads.
3. The traditional evacuated powers insulation and newly developed aerogels insulation for large scale cryogenic tanks and special applications.
4. The performance, materials and design combinations of various super-insulations (MLI) for commercial products and research labs.
5. The specific design and implements of MLI with various penetrations, slots and cracks in its MLI for large cryogenic applications.
6. The development of novel thermal isolation devices, such as the energy efficient cryogenic transfer line with magnetic suspension; a smart cryogenic actuator as the warm support structure automatically operated by temperature changes; superconducting thermal switch for interception of heat transfer, etc. are also briefly reviewed.

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