Cool-down of LTS magnets by a closed loop helium gas flow

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1. Introduction

LTS magnets are typically used and kept at 4K, but when being build or retrofitted they will be at ambient temperature. Cool-down at the factory or installation site can be done using LN_2 and LHe, but this is an inefficient process involving a number of operational steps.

This poster describes how cool-down can be achieved simpler and more efficiently using a closed loop helium gas flow. In this concept no nitrogen gas is introduced in the LHe cryostat, while a temperature of less than 20K will be reached, limiting the amount of LHe required. Very importantly, the cool down time can be reduced by 50%.

2. Cool down phase 1, 300 to 80 K

Often magnets are cooled by slowly filling them with LN_2. Alternatively, the LN_2 is used as coolant for a flow of helium, which in turn cools the magnet. This is a more friendly method and avoids the need to remove the LN_2 again. Refer to Figure 1 for the system set-up.

The cooling down process of phase 1 is stopped once the magnet is near LN_2 temperature and no more heat will be transferred.

Since the helium density is quite low due to the temperature and low allowed pressure, a large volume flow is required. For this purpose we have developped a large CryoFan making it possible to displace a lot of heat in an efficient way, decreasing cool-down time.

Temperature of the helium at the CryoFan is kept at 80K from start of cool down so that the massflow is contstant throughout the temperature range, refer to Figure 2, blue line.

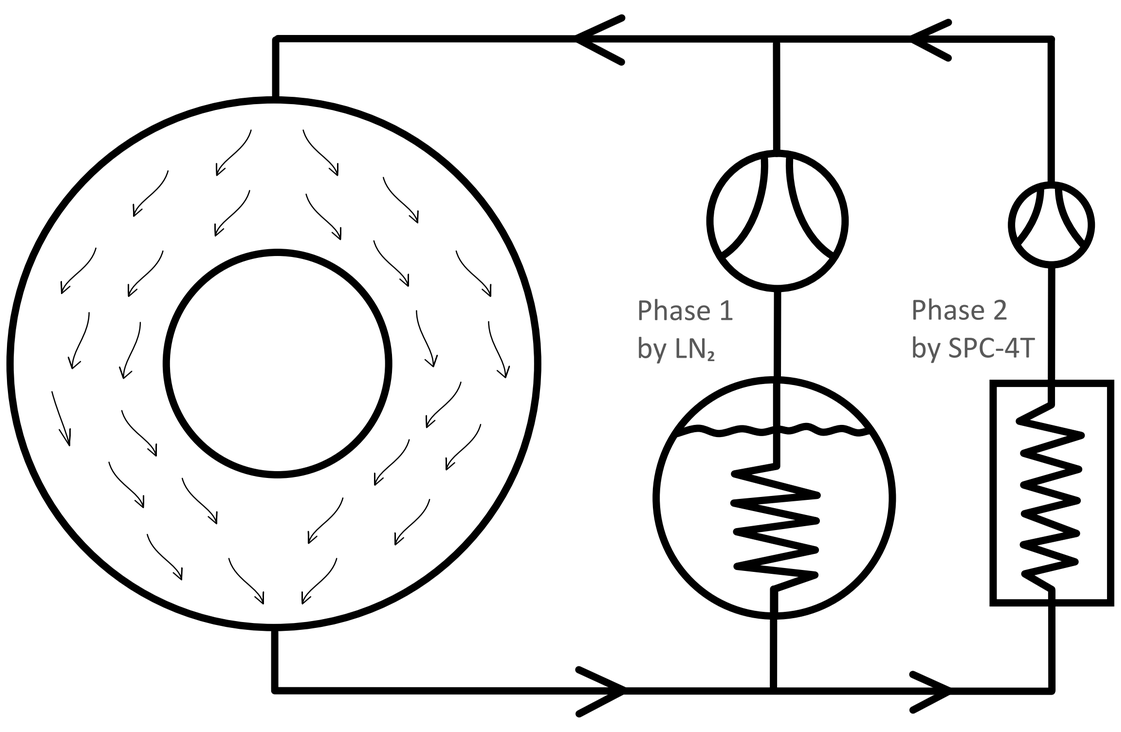

Figure 1. System set-up to cool a magnet with helium in two phases

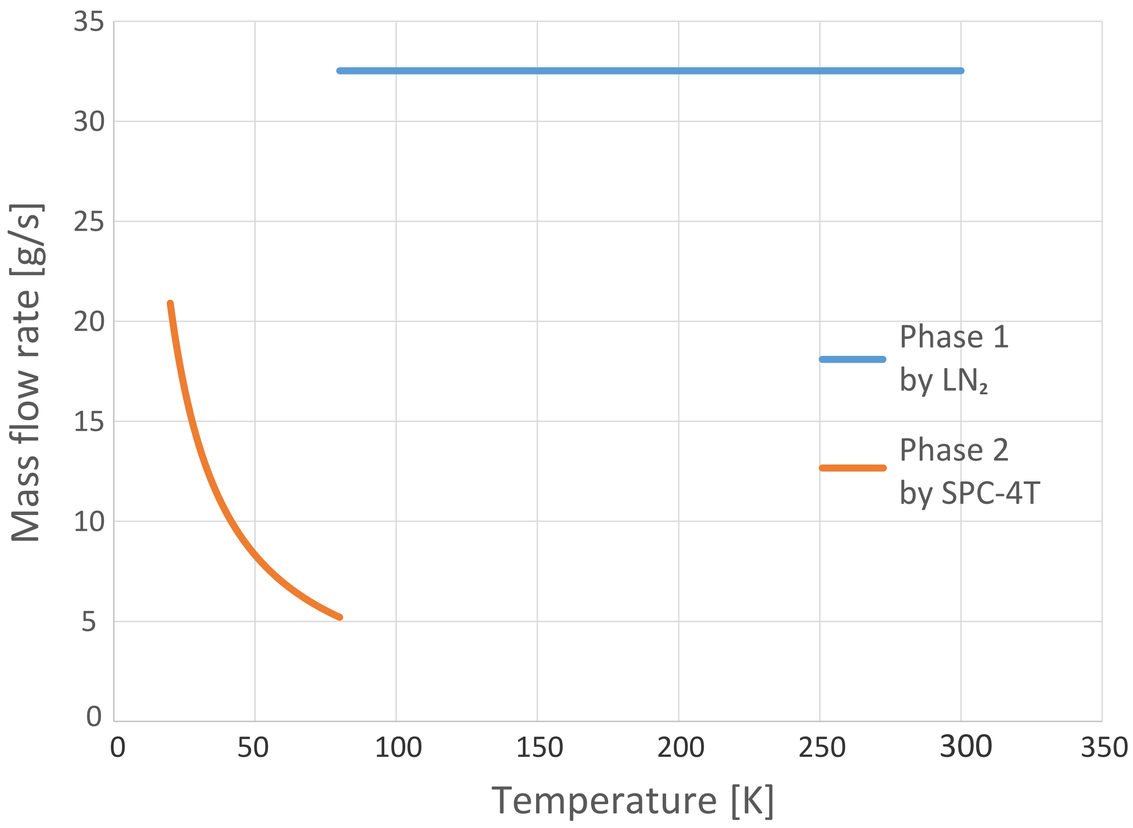

Figure 2. Helium mass flow rate during cool-down as function of magnet temperature in phases 1 and 2

3. Cool down phase 2, 80 to 20 K

Once about 80 K is reached the same helium gas flow is switched from being cooled by LN_2 to cooling by the two stage Stirling Cryogenerator. The helium is directly cooled in its internal heat exchanger, which in turn is cooled by the Stirling Cycle.

Swith over between the phases is immediate by closing and opening valves and switching on the Cryogenerator. Refer to Figure 1. Not draw but possible by introducing more valves, is to cool two magnets simultaneously in two different phases.

Since the cooling power is smaller and helium density will increase, a smaller CryoFan is used to minimise pump losses.

In this phase the helium gas, the magnet and the Cryogenerator will decrease in temperature together. The helium density will thus increase, and therefor will the massflow, refer to Figure 2 red line.