LIQUID HELIUM SUPPLY AT PSI

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One item of the services PSI provides to its users is the supply of liquid Helium to experimental facilities, as well as the running and maintenance of the large cryogenic facilities. An efficient and reliable service is essential for a smooth operation of the experiments.

INTRODUCTION

The demand for liquid Helium is widespread at PSI. Four refrigerators and one liquefier are available to accomplish the various tasks and demands. In addition to the refrigerators, PSI operates a Helium recovery system to regain the evaporated Helium gas.

FACILITIES

The cooling power of the refrigerators, their main purpose and attached facilities are listed below:

KA I	3600 W at 20 K D2-source SINQ
KA II	2500 W at 80 K, 550 W at 4.5 K UCN-facility (2007) He-liquefaction, Storage Dewars of 1000 & 2000 litres
KA III	6000 W at 60 K, 1200 W at 4.5 K SULTAN (**Su**pra**l**eiter **T**est**an**lage) He-liquefaction, Storage Dewar of 2000 litres
KA IV	4000 W at 60 K, 900 W at 4.5 K Myonchannel 1 He-liquefaction, Storage Dewar of 2000 litres
Helial	Cooling the superconducting cavity at SLS
HRS	(**H**elium **R**ecovery **S**ystem) with compressors, dryers and storage tanks

To meet all demands, PSI provides 30 vessels of 100 litres, 12 vessels of 250 litres and 4 vessels of 450 litres volume to all Helium users.

HELIUM RECOVERY SYSTEM (HRS)

PSI runs a Helium recovery system consisting of a storage capacity of 10’000 m³, recovery lines of some 4 km length, balloons, recovery compressors with a suction power of totally 140 m³/h, and gas dryers. Fig. 1 shows the layout of the HRS. One system consists of an operating balloon, an overflow balloon, a compressor and a gas drying unit. The collecting pipes can be found in almost every building at PSI. These pipes can be individually connected to one of the two balloon systems. This allows a better distribution of the accumulated gas and, if there are problems with the collecting pipes, it does help as a diagnostic instrument. In normal operation, only the small balloon will be filled. Level sensors on the balloon pilot the compressor. The gas will be compressed up to 200 bars. After the compression, the gas will be dried, i.e. moisture and oil vapour will be removed.

When the capacity of the recovery compressor is not sufficient or the compressor does not run, the valve to the large balloon opens. When the large balloon is half filled, the second compressor will be connected and started so that we can double the suction power or, in case of a failure of the first compressor, the second one operates as a backup. If the large balloon is full, the other recovery system will be connected automatically. This cascade of adding compressors and the second recovery system turned out to be very reliable. After the installation of the described logic, helium losses due to excess returning gas or technical defects of the HRS did not occur.

The main problem with the recovery system is the proper handling by the users. When operating at temperatures below 4.2 K the Helium bath will be pumped. This pumping is usually performed using vacuum pumps. The resulting exhaust gas contains oil vapour which is deposited in the HRS. This causes problems with our instrumentation and facilities. Vapour filters on the vacuum pumps would help very much. However, they are rarely installed. There are also times when the experimentalists keep the recovery lines open to atmosphere or fill the recovery lines with gasses other than Helium. In these cases, Helium gets lost or the HRS gets polluted with the other gas. The loss of Helium is expensive and too much air and other gases in the Helium cause big problems during the purification process. However, the discipline of the users is generally satisfactory and the recuperation rate is, on average, approximately 95 %.

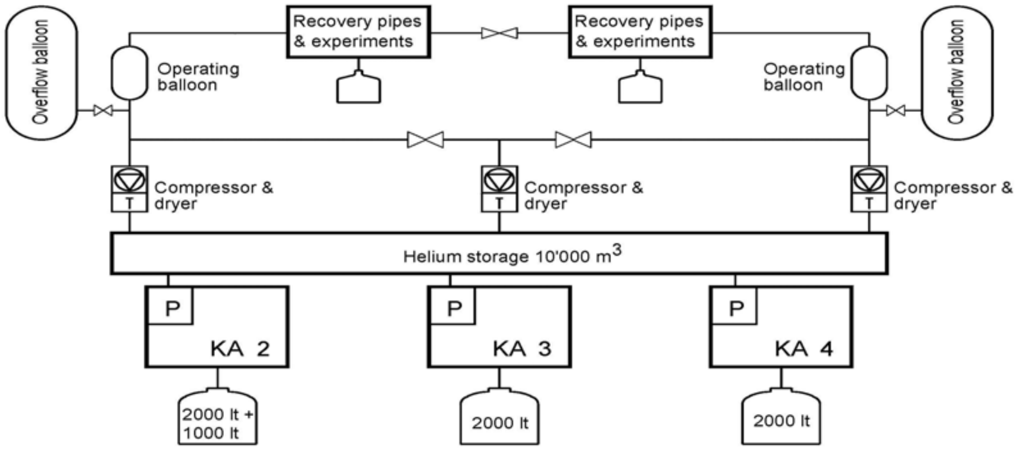

Fig. 1: Logic of the Helium recovery control system.

LIQUEFACTION

The stored Helium is dried of moisture and oil but impure. The impurity is mainly atmospheric air. An impurity ratio up to 3% can be easily handled; a higher degree of impurity reduces the purification efficiency drastically. The impure Helium gas can be purified in the refrigerators KA II, KA III and KA IV. The gas pressure will be set to some 35 bar and then the purification takes place simply by cooling down the gas to 15 K, so that all impurities freeze out. The purified gas will be liquefied and filled into the storage dewars. The purification capacity of each purifier is approximately 30 m³/h. 3 m³ of gas at room temperature forms up to four litres of liquid Helium.

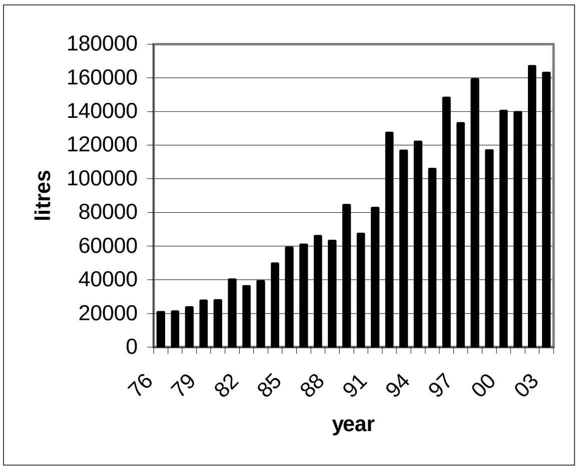

Fig. 2: Delivery of liquid Helium to experiments.

REFRIGERATOR

The main function of refrigerators is the cooling of their attached user facilities such as the Myonchannel, etc. This is done by closed forced cooling circuits using supercritical Helium at 4.5 K and a pressure in the range of 7 to 10 bars. The cooling is continuously controlled and all necessary data is covered by a process logic controller. The cooling temperature of KA I and the cold source is 20 K since we also have to liquefy Deuterium. The systems are laid out to operate for at least 8500 hours per year without the necessity of switching off any machine. The refrigerators and purifiers operate fully automatically. The purifiers switch on as soon as there is spare capacity for liquid Helium in the storage dewars. When the dewars are full, the purifiers turn off automatically.

LIQUID HELIUM DISTRIBUTION

The demand for liquid Helium at PSI continuously increased until five years ago. For the last few years, the consumption has become constant on a high level (Fig. 2). Helium vessels are normally filled only from KA II und KA IV. KA III (SULTAN) does not belong to PSI and cannot be used as a liquid Helium supplier. The supply of liquid Helium in the experimental hall (WEHA) and SINQ is usually done from KA IV. The remainder of PSI (SLS, PSI-East, WLGA, etc.) is usually supplied from KA II. The weekly consumption of liquid Helium fluctuates very much. It varies from 200 litres up to 8'000 litres. We meet this changing demand with a sufficient Helium storage capacity and appropriate vessels and moreover with the discipline of the users. As a consequence, we request orders five days in advance and a prompt return of empty vessels.

PROSPECTS

The demand for liquid Helium will probably remain at this high level. The capacity of liquefaction is not yet fully utilised. However, peak demands above 8'000 litres per week are difficult to handle and if their occurrence increases, some investments will have to be made. Additional purchase of Helium dewars will be unavoidable and a suction power enhancement of the HRS would become imperative.