

§18. Power Saving Trial of Helium Compressors for the LHD Cryogenic System

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Figure 1 gives an arrangement of compressors for the LHD cryogenic system. Eight single-stage compressors of oil injection type were applied. They have a discharge capacity of 1100 g/s for the electric power of 3.45 MW. Massflow rate of the main circulation is controlled to 700 g/s, and the other of 400 g/s was bypassed for the typical operation w/o pulse operation mode, because the heat load and heat input into the cryogenic parts is not so large than that of the designed values.

In long-term operation, reduction of power consumption will be one of the most important issues. To minimize the bypass flow and to reduce the electric power consumption, unload operating characteristics of the compressor system were investigated. In this test, the compressors of AL1 and AL4 of low pressure stage were used. Following method was applied for the unload test: (1) set the stroke of the valve of AL1 gradually from 100% to 5%, and come back to 100% again, then (2) set the stroke of the valve of AL4 gradually from 100% to 0%, and come back to 100% again. To avoid the perturbation for cooling the SC coil system of the LHD, we watched carefully whether the cooling conditions of the turbines in a cold box would change. The stroke of the valve and the massflow rate change are shown in Fig. 2, and the relation of the electric power consumption and massflow rate change are shown in Fig. 3.

It was clearly seen that the massflow rate of a compressor responded with sufficient accuracy to a gradual change of a stroke. The maximum flow rate of the compressors, AL1, AL2, and AL3 were 240 g/s. The maximum flow rate of AL4 was 120 g/s. All compressor units have the capacity margin of more than 10 %.

Figure 4 shows the relation between the electric power consumption and massflow rate. The experimental result of the power consumption to a massflow rate was

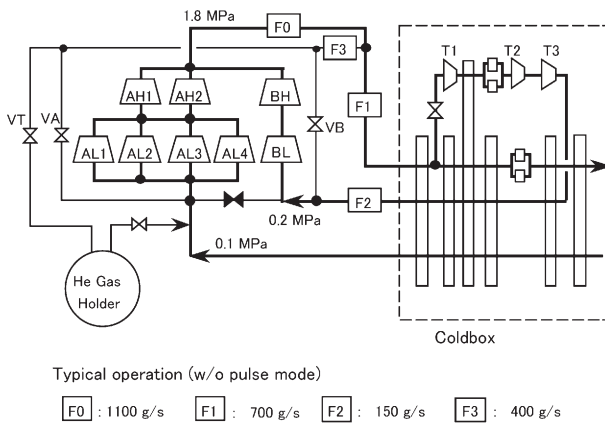


Fig. 1. Arrangement of compressors and measuring points of mass flow rates.

almost the same for the compressors AL1 and AL4. The slight difference of inclination in a Figure may originate in the difference of the load efficiency of the induction motors. It was confirmed that power consumption of 500 kW can be decreased by reducing the massflow rate of 200 g/s in the bypass circuit.

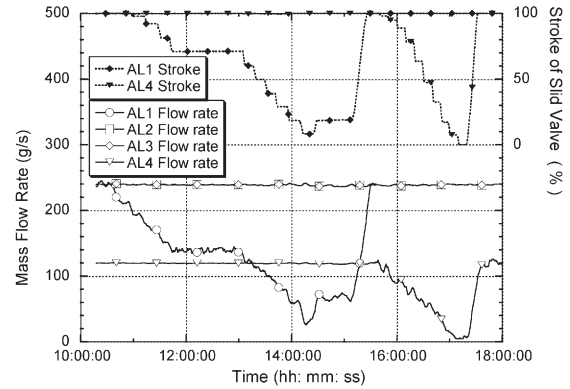


Fig. 2. Typical waveforms of slide valve stroke and massflow rate change.

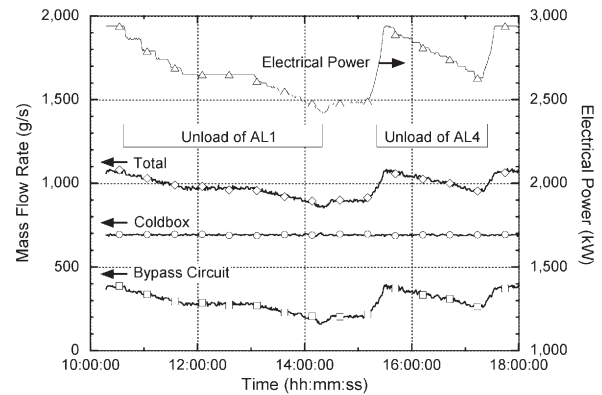


Fig. 3. Typical waveforms of slide valve stroke and massflow rate change.

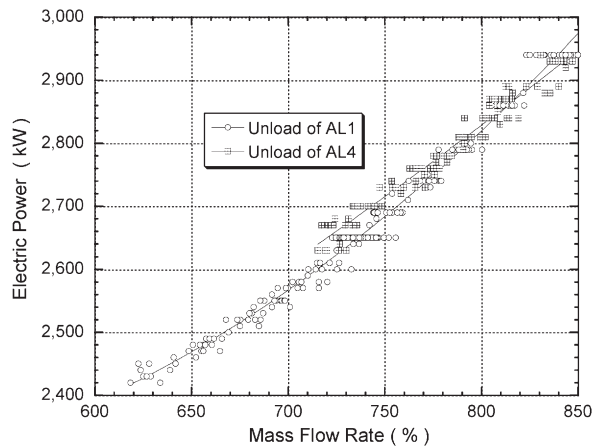


Fig. 4. Typical waveforms of slide valve stroke and massflow rate change.