

A.4: Design and development of torque measurement rig for stepper motor at cryogenic temperature

Stepper motors used for ultrahigh vacuum (UHV) and cryo-temperature applications are generally very expensive and a very limited number of its manufacturers are found worldwide. Moreover, they do not provide the mechanical and electrical parameters of motor like torque at cryo-temperatures. Since cryo-temperature and UHV compatible motors are required for superconducting accelerator development programme of our country, RRCAT is in the process of development of stepper motor for cryo-temperature application. A very important aspect of this development is the measurement of torque of the motor at low temperature. Therefore, a torque measurement rig has been designed, developed and tested at Advanced Accelerator Modules Development Division of RRCAT.



Fig. A.4.1a: Chain sprocket based torque measurement rig.



Fig. A.4.1b: The rig with LN₂ box.

The first device (shown in Fig. A.4.1a and Fig. A.4.1b) is based on the principle of torque balance on pulley by dead weight. Here, chain sprocket based mechanism is used to facilitate transfer of torque from the motor in the liquid nitrogen (LN₂) immersed chamber to the pulley supported on ball bearings at room temperature. Few

experiments of torque measurement were done successfully. However, it was found that for prolonged experiments, the chain gets jammed because of increased friction due to condensation and ice deposition. Therefore, a new device was designed and fabricated.

An electronic force measuring method (load cell) was used. For the same, a commercial electronic weighing scale was modified. The load cell was mounted vertically on a frame and the weighing-pan was replaced by a light weight aluminium plate. The motor fixed in a stainless steel box can be immersed in LN₂. A resilient (relatively flexible) lever is mounted on the shaft and when the motor is made to rotate, it exerts a force on the load cell and hence torque of the motor can be computed (holding torque can be measured at various frequencies of pulses of the stepper motor driver). This rig gives more accurate torque measurement compared to the previous one because there is no friction of the bearings supporting the pulley and also that in the chain sprocket. The rig is regularly being used for the torque measurement both at room and LN₂ temp.

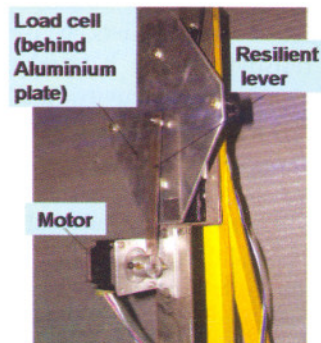


Fig. A.4.2a: Load cell based torque measurement rig

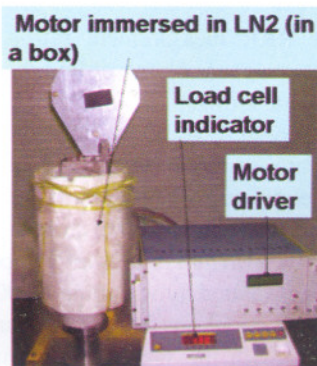


Fig. A.4.2b: Load cell based rig with LN₂ Box (immersed in LN₂ for testing)

Reported by:
G. Mundra (mundra@rrcat.gov.in), P. Saxena