Abstract

Two helium liquefiers/liners are operational at VECC while one is dedicated for the Superconducting Cyclotron. The first helium liquefier of 50 LPH capacity from Air Liquide has already completed fifteen years of operation without any major trouble. This liquefier is being controlled by Eurotherm PLC-P300 PLC. This PLC has become obsolete since last seven or so years. Though we can still manage to run the PLC system with existing spares, risk of discontionuation of the operation is always there due to unavailability of spare. In order to eliminate the risk, an equivalent PLC control system based on Siemens S7-300 was thought of. For smooth migration, total programming was done keeping the same field input and output interface, nomenclature and graphset. New program is a mix of S7-300 Graph, STL and LD languages. One to one program verification of the entire process graph was done manually. The total program was run in simulation mode. Matlab mathematical model was also used for plant control simulations. EPICS based SCADA was used for process monitoring. As of now the entire hardware and software is ready for direct replacement with minimum required set up time.

Introduction and selection of new process controller

- One helium liquefier (capacity 250W @ 4.5K or 50 l/h r w/o pre-cooling) is operational in VECC since 2001. Uses Eurotherm PLC-P300 PLC based process controller. PC3000 system has become obsolete [2]. Hence, the system is under risk.
- This paper describes the preparation for migration of control system to Siemens PLC which has long time support and backward compatibility.
- Leading manufactures of helium liquefiers in the world use Siemens PLC for helium liquefier process control. We have another 85 LPH helium liquefier which also uses Siemens PLC. To have common spare and with available knowhow the existing PC3000 process controller with Siemens S-7 300 PLC system.

Description of PLC hardware and program

- Siemens S-7 300 PLC [3] and its input and output cards are selected according to existing field wiring and space. No retooling and changing in the wiring is required.  
- Methodology for PLC programming was finalised. Documentation of the entire logic in printed Sequential Flow Charting (SFC) Format was updated. GRAPH or SFC/ST language was selected for programming the process. Input and output block processing is programmed using ladder logic (LAD), structured DB and Functions. Input, output and variables are named using identical pneumonic. [viz: Figure 2].
- Total sequence was programmed in two GRAPH blocks. Each block has a step and transition limitation of 250. The faults and safety graph block has 67 steps and 75 transitions. The body control program has 216 steps and 215 transitions. A total of 226 steps and 290 transitions were programmed in two GRAPH blocks.
- All program blocks are processed in main sequence (OB1). The PID logics is put in one block called "Control" written in Instruction Listing language (STL) and processed in time scheduled instance (OB35) of 100ms time interval. There are also some ramp and filter functions associated inside the control DB.
- Fault messages generated are stored in Fault Message DB. Command instructions received from software user interface like EPICS (Experimental Physics and Industrial Control System) [5] are put in command DB. A variable DB stores the set points and can accept changes by the software user interface. [viz: Figure 3 & 4].

Conclusion

As long as we are managing the exiting liquefier control with PC3000 PLC and with the available spares we will continue to use it. When there will be crisis, we will have a shut down for replacement of the PLC and the user interface. Complete testing with real field inputs and outputs will be done with proper precaution before putting new ones in service.

References