A.4: SCADA system for remote control and monitoring of vacuum furnace

A vacuum brazing facility (vacuum furnace) has been developed at RRCAT for joining aluminium alloys and making bimetallic joints between aluminium and austenitic stainless steel that are compatible with ultra-high vacuum requirements of particle accelerators. The vacuum brazing of aluminium alloys requires precise control of heat cycles, accurate multi-point thermometry, ultra-clean vacuum, and a system for controlling and monitoring the heating process.

A supervisory control and data acquisition (SCADA) system has been developed to remotely program, supervise, control, and regulate heat cycles of the vacuum furnace up to 620 °C. The SCADA system, follows a modular architecture comprising of a data acquisition system and open source python based graphical user interface (GUI) running on the remote computer system. Along with the development of the supervisory and control software, the closed loop proportional integral derivative (PID) control has also been implemented for control of the furnace temperature. To arrive at the proper PID coefficients, a systematic study was carried out on establishing the model of the furnace; wherein the highly temperature dependent parameters like thermal resistance and the system time constants around a few discrete points over the operating temperature range were found out.

System architecture: The design and implementation of the SCADA system is based on distributed control architecture. The scheme is as shown in the Figure A.4.1. All the devices communicate to a master console on RS485 using MODBUS protocol.

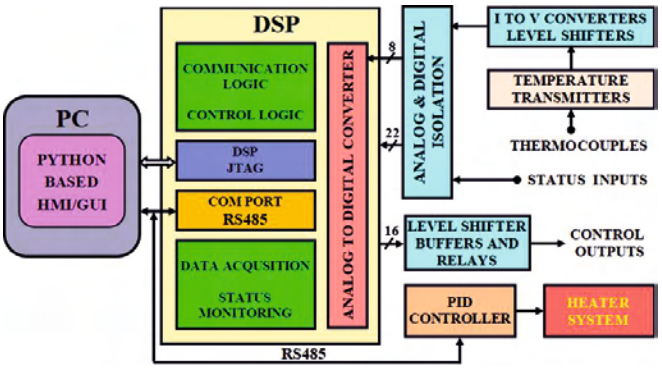

Fig A.4.1: Scheme of SCADA system.

Hardware and software: The data acquisition and control module as shown in Figure A.4.2 has been implemented using digital signal processor (DSP) based central processing unit (CPU), analog and digital I/O boards and front end modules.

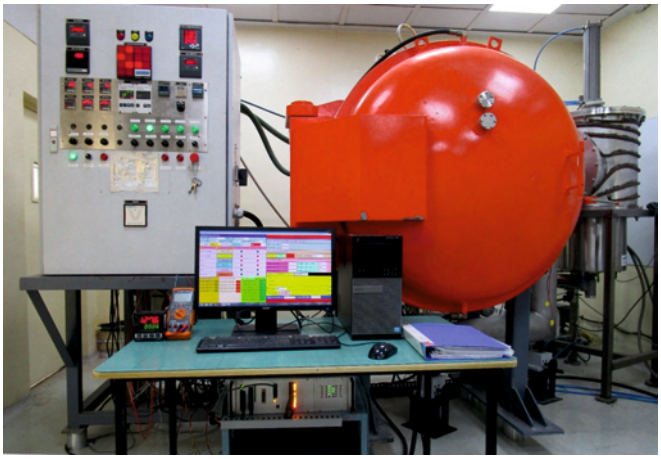

Fig. A.4.2: Vacuum furnace with data acquisition system, control module and GUI.

The SCADA system has dedicated programming interface modules for various functionalities. The GUI of main panel of the system is given in Figure A.4.3.

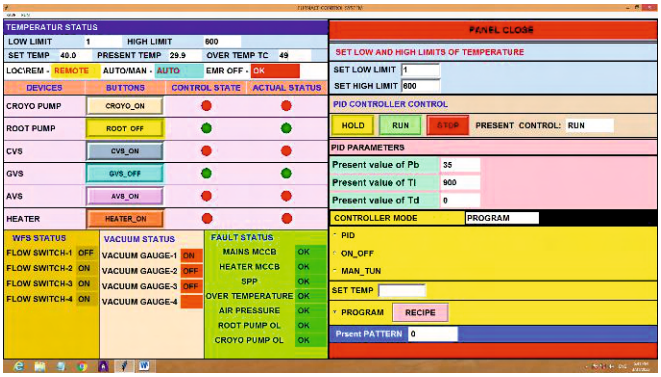

Fig. A.4.3: Main panel of SCADA system.

SCADA system objectives: SCADA system meets the following objectives-
(1) Digital control of pumps, valves and heater; (2) Status monitoring of pumps, flow switches, valves, all switchgear and interlock devices; (3) Setting the furnace temperature and reading the actual temperature at different locations inside the vacuum chamber of furnace; (4) Configuring PID parameters; (5) Setting the mode of operation like PID, ON-OFF, manual tuning and profile PROGRAM; (6) Recipe mechanism that allows the operators to program a temperature profile for the heat cycle; (7) Checking for the abnormality like over temperature or failure of devices and taking appropriate actions.

The SCADA system has been installed and deployed for regular use.

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