Survey about the data acquisition system used for cryogenic process with configuration of the simulation system in LabVIEW software

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Abstract: - Based on experience achieved in isotopes separation for heavy water, since 1992 was started a tritium program at National Institute of Research and Development for Cryogenic and Isotope Separation Technologies with the objective of Romanian technology for Tritium Removal Facility (TRF). During the normal operation of a CANDU reactor, the tritium is formed in the moderator heavy water and cooling agent. Thus, the concentration may increase up to a steady regime in each system, where the tritium development is balanced by its radioactive disintegration. Designing and implementing the concept of cryogenic distillation column require experiments to be conducted as well as computer simulations. Particularly, computer simulations are of great importance when designing and evaluating the performances of a column or a series of columns. Experimental data collected from laboratory work will be used as input for computer simulations run at larger scale (for The Pilot Plant for tritium and Deuterium Separation) in order to increase the confidence in the simulated results. Therefore for simulating system required the paper present the importance of developing a performed data acquisition system.

Key-Words: - data acquisition, process analyses, simulation system

1 Introduction

The implementation of the new software and hardware technologies for the tritium processing nuclear plants and, in particular, in experimental and technology-driven installations, shows a high complexity degree due to the problems imposed by the implementation of efficient equipments and installations in a unitary system for identifying important parameters for the nuclear technological process of tritium separation. To preserve the system flexibility stands for a requirement in experimental nuclear plants where it is common to change the configuration, the process and the monitored parameters. The high amount of data to be processed, stored and accessed in view of monitoring power within the technological flow requires the setup of integrated systems for monitoring consumptions and power distribution on primary sources. Thus, built-in monitoring systems will be developed, with parameter identification function, needed for the supervision of the technological process, the next step being the development of the control system by choosing new and advanced methods appropriate to the technological processes within the tritium processing nuclear plants.

The software development applications is created by way of the highly efficient equipments and software packages dedicated to industrial processes and incorporates dedicated sub-modules for the acquisition of parameters together with the sub-module for process data storage, all being used subsequently for the software application of monitoring power consumption within the tritium separation technological process.

2 Short History about Data Acquisition Systems used in Cryogenic Pilot Plant

The first monitoring system used in cryogenic pilot plant for experimental tritium installation was realized with the interface AT-MIO-16-XE-10, SCXI multiplexer and LabView 5.

With this system was monitored a number of 50 critical parameters from three important modules: isotopic exchange column, purification installation and cryogenic distillation installation.

Because was necessary to increase the number of parameters we developed a system with Field Point modules: FP-AI-111, FP-AT-110, FP-AI-TC and FP-1001 for communications, between data acquisition room and control room from installation (Figure 1).

Figure 1

The new system has Field Point modules connected to the serial board, configured for RS-485 from computer. The real advantage is that we can connect all necessary Field Point modules to make the monitoring of entire installation. In this way we will reduce the costs and are easy to use.

The system realized has the main characteristics:

-System is flexible, easy to use and make improvements

-Low cost for equipment

-Can replace dedicated hardware and software

-The information, which is provided, is essential in the dynamic prioritization and conditioning alarm message

-Application design assure a good interface between hardware and software with high speed

-A friendly human - machine interface

In figure 2, is presented the monitoring system with LabView 7 - Professional, which is connected to the data acquisition system.

The sensors used for monitoring the process are type J thermocouples, RTD and with platinum. The control system uses different sensors of the same type but better quality. The temperature control is achieved by controlling the electrical power fed to the heaters. Besides sensing the fluid temperatures at various points, we also monitor the vapor

pressure and the heavy water level in the isotopic exchange column, an important module for tritium removal.
Security and monitoring system is connected to the controlling system from control room in tritium removal pilot plant. The main function of this system is to monitor all parameters in installation.
At this moment we changed the monitoring system with Field Point module because we used the new and performed Compact Field Point Module.

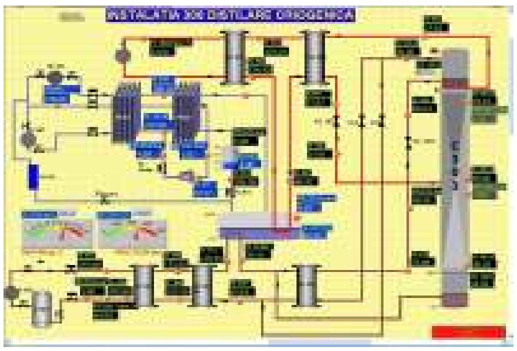

Figure 2

3 Cryogenic Process Analyses in Labview 8

The modules Compact Field Point will scan the measurement points on the plant and the process simulation system in case of failures will be developed by the monitoring program. This system plays also an important role in preventing natural disasters and industrial hazards during normal duty operation and running.
The system also contains the graphical management and security section which includes all the components monitored and tracked throughout the process, on-line in real time.
The entire process is managed from a central point in the control room isolated from the environment in the production plant. The increase in the intelligence level of the automation system consists in achieving efficient software of tracking the process as well as in performing the computational modeling for the main elements in the technological plant and in developing the algorithm for the information structure of the process simulation.
The system allows for the integration of functions for the control data collection, communication and display in an interactive process both locally (acquisition, control loops) as well as at the level of the whole system (diagrams on the computer, data folders etc.).
The system will also include the software developed for mathematical modeling with the monitoring of all parameters and process analysis software for the main modules in the tritium processing plant.
In Figure 3 is presented the starting of mathematical model for tritium removal process, which means the graphical representation of Entropy function by temperature for cryogenic distillation module from tritium removal installation.
The new software in LabView 8 with Real Time module and Compact Field Point modules will be effectively verified on an existing plant, by simultaneously checking the parameter values (classic system – optimizing software system of the process and of the relevant monitoring system).

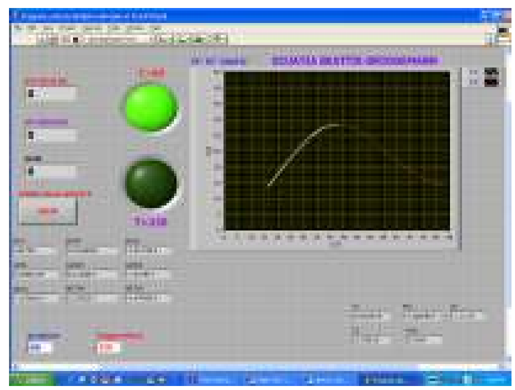

Figure 3

4 Considerations on Measuring Low Temperatures with PT 100 type Transducers in Cryogenic Plant for Tritium Separation

In electrical devices for temperature measurement the temperature-to-electrical conversion is done with temperature transducers, the most commonly used for measuring cryogenic temperatures are thermo-sensors and thermocouples.
The characteristic of the Pt 100 - R = f (T) transducer, is slightly non-linear up to 31 K, which allows the development of calibration methods which, depending on the number of calibration points used, can lead to very good accuracy.
Under the temperature of 31 K its feature shows a sudden fall. To measure the temperature variation of the transducer with the temperature, obtained for a

Pt100 sensor is used the mounting variants b), c), d) of Figure 4 and a carbon thermoresistant mounted in variant a) (TRC). The graph presented in Figure 5 shows the theoretical temperature curve (T) also is demonstrated that the best performing type is the variant b of Pt100 mounting.

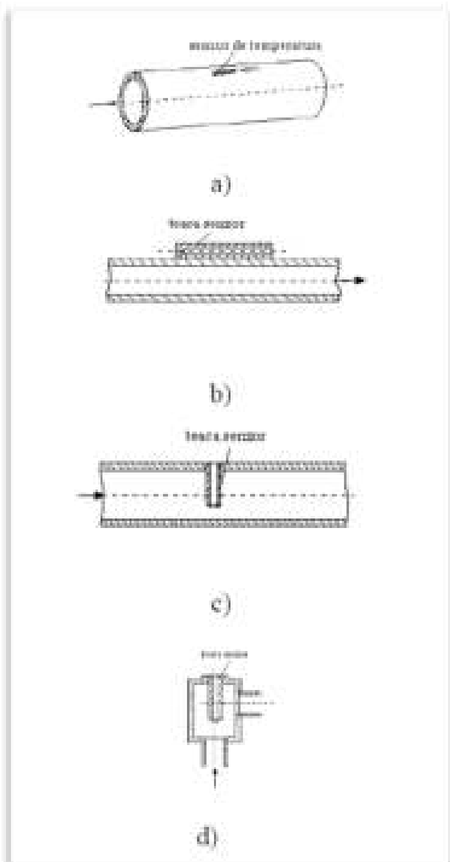

Figure 4

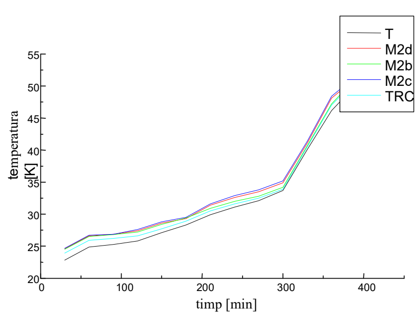

Figure 5

As a conclusion, for cryogenic temperatures, it is preferable to use Pt100 or carbon-thermo-resistive sensors. Thus, for carbon thermoresistant, having small gauge dimensions (10x2x1.5 mm), the fitting of variant a) of Figure 4 was chosen.

5 Conclusions

This system presented in paper is particularly useful for those nuclear technological processes requiring tracking of radioactive and toxic fluids where the human operator's involvement is minimum, contributing to the reduction of the impact the nuclear plants' operation on the environment.

The system novelty is highly rated, being very useful for the monitoring of the complex systems, in the nuclear technological plants, of safety systems preventing the leakage of radioactive or toxic agents and of those preventing some risks of explosion, which require taking a set of prevention actions.

The simulation and modeling software application will also contain the security architecture of a plant processing toxic fluids, this application being mainly composed of the following systems:

a. Interlocking and inter-conditioning system – ensures the control of the plant for the smooth operation with minimum leaks of toxic fluids; it also controls and commands the recovery fluids from the plant and/or building after the occurrence of accidents.

b. System for dosimetric and emissions quality monitoring – ensures the personnel's dosimetric monitoring, checks the level of toxicity inside the premises as well as the release of gases into the atmosphere; it also supplies signaling values for the concentration levels of radioactive/toxic substances.

c. System for recovery and treatment of toxic gases – allows for the recovery of toxic gases in case of hazards resulting in the release of toxic gases in higher concentration levels than the maximum admissible concentration.

The system works in case of hazards caused by the release of toxic substances exceeding the maximum admissible concentration levels. In such cases, the precinct is isolated and all the air from the ventilation system passed through this system. The system allows the recovery of toxic leaks without discharge into the atmosphere.

d. System for plant draining in case of emergency – ensures the drainage of the plant in case of accidents; the system is activated for particular values of the technological parameters coinciding with the signal emitted from a radioactive fluids detector.

It is necessary to drain the plant in case of failure with release of toxic substances for safety reasons (to avoid contamination and pollution) and economic purposes (recovery of the process fluid). The discharge takes place after the gas has been passed through the recovery and treatment plant.

The system security function is to reduce toxic leakage within the premises in case of failure and to preserve the process fluid stock.

e. Ventilation system – ensure the ventilation of the facilities processing toxic fluids as well as the control room with the view to diluting their concentration in the air; it also starts up the gases recovery system in case of failure.

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Contribution of individual authors to the creation of a scientific article (ghostwriting policy)

Carmen Maria Moraru, Iuliana Stefan carried out the simulation and the data acquisition system.
Ciprian Bucur, Ovidiu Balteanu has implemented the electrical part of the monitoring system and the mounting systems presented in the paper.