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CONTRIBUTIONS TO THE IMPLEMENTATION OF THE TELEMETRIC PROGRAMMABLE AUTOMATS BY RTU TYPE FOR AUTOMATION, MONITORING AND CONTROL INSTALLATIONS

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Abstract:
The equipment RTU (Remote Terminal Unit) monopolize much more the sphere of industrial applications who necessities the control and monitoring from distance of the processes, stored under histories form of land events, take some measures in case of damage or to alert the personal. So, with help of SCADA interface (Supervisory Control And Data Acquisition) all the process can be monitoring and controlling with the computer help. In the paper an application created with the help of the RTU Tbox equipment is presented, application used for the monitoring of a solar installation for the processing of hot water. The application is located in a mountain area, the solar system being made up of collectors with a surface of 2x16 mp, two 500 liter reservoirs and two heat switches.. It also presents an application for monitoring and control of a production line, made from 16 hydraulic presses, with the help of software SCADA Ethernet Tview. Because the major products realized by beneficiary (hub from auto) get to the export where the customs want a strict monitoring the times of vulcanization, of the temperatures and pressures uses, it is necessary to search the best solutions who permit a production control from computer and who can accomplish some conditions impose.
Obs.: The final results will be presented through online link, with authors' access only.
Key words: technological lines automation, Remote Terminal Unit, control and monitoring

1. INTRODUCTION

RTU equipment is a device installed at distance from the centre of control, who acquires the data from the process. They are coded in an easy format to be transmitted to the control centre. Also, the RTU equipment can take the commands from the control centre, dispose of modules of inputs and outputs for the interaction with the process and of course by multiple module communications. A typical RTU dispose of communication interfaces (serials, interfaces Ethernet (LAN), GSM or GPRS, Radio, PSTN etc), by a processor, interfaces with digital or analogue inputs/outputs.

The systems of monitoring and control from the distance dispose of SCADA (*Supervisory Control and Data Acquisition*) type interfaces for visualizing in real time the applications from the field. The SCADA type software is already very well known due to the success obtained in applications such as those of power, water, oil products distribution, leading completely automatic lines in real time etc...

A SCADA system will control and monitor a local process or one from far away through communication channels and RTU-s from the field.

2. THE RTU CONCEPT – PRESENT AND FUTURE

With the help of inputs/outputs, a RTU will read/command the equipments from the field; it will connect to the devices with serial communications through the communication ports, all the processed information and events being stocked as historical (datalogging) in the memory assigned for this purpose. Once stocked, the information can be accessed through different ways: through SCADA type software, through emails, through *SMS* messages, through a structure of files transferred by *FTP* (File Transfer Protocol) or through *Internet Explorer browsers* (Fig.1).

The data transfer from RTU to SCADA equipments is done through standard communication protocols; among the most popular transfer protocols for industrial applications, I mention the

Modbus protocol (*Modbus ASCII, Modbus RTU, Modbus TCP/IP*). The SCADA software can be connected locally to the RTU through the *Modbus RTU* protocol or through the *Modbus TCP/IP* if the software is of *Internet* SCADA type. RTU equipment will generally communicate with a serial device (gas, water, power meter, frequency variation device etc.), with the help of *Modbus ASCII* protocol.

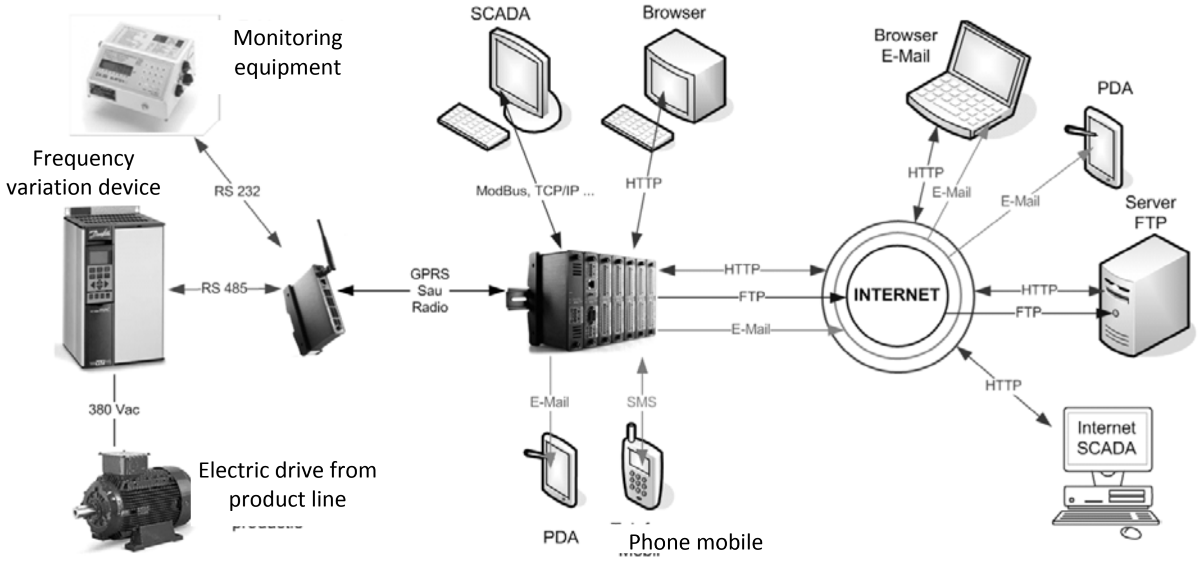

Fig. 1. *The principle scheme*

Presently, there is a tendency of the great producers of PLC (*Programmable Logic Controller*) equipments to develop and attach to PLCs the characteristics of actual RTU equipments: memory for *datalogging* (events journal) or multiplication of communication ports, but as long as there will be processes situated on field and far away from the control centre, RTU equipment is the answer.

RTU-s of the future will be equipped with faster and faster processors and multi-processors, with communication modules allowing higher and higher speeds for data transfer and a higher and higher capacity of stocking the historical from the process. The wired communication lines between different RTU equipments will remain of actuality, but the transfer protocols and the speeds will increase considerably. Wireless communications between RTU equipments will be used when the distances between them increase, or when the communication is done through SCADA type interfaces.

3. THE HARDWARE AND SOFTWARE ARCHITECTURE OF RTU [3]

The hardware architecture of RTU equipments has the following variants:

- Modular – each module having previously established and dedicated functions (ex.: the power source module, the processor module, input/output communication modules). The modular series has the advantage of being able to develop the application in time by simply adding new input/output modules, it disposes of processors faster than 32 bits and it is set up in the DIN automatic case on runner.
- The *"All in One"* concept, meaning everything in one carcase, contains the processor, the communication modules and a fix number of digital and analogue inputs/outputs in the same carcase.

The systems type SCADA permit the monitoring and control of the equipments from the field with help of computer; to a simple command from *mouse* or *keyboard* its possible to give commands to process, all these can be monitored online on the screen of the operator.

The softwares type SCADA dedicated to the monitoring and control of the RTU equipment has in general the next facilities:

- they are *Data Collecting Centres:* they gather all the information and history from the RTU storing them in databases;
- they are *Supervisors:* by connecting to the RTU (local or wireless) and listing the parameters in real time;
- they are *WebServers*: allowing users to access the list of history, alarms etc., by means of the classical network (LAN) and of a *Internet Explorer browser*.

The field data can be collected:

- *locally*, through a *Ethernet* connection or a serial connection using the RS232, RS485 communication ports. The data transfer is done in this case by means of standardized communication protocols (TCP/IP, Modbus TCP/IP, Modbus ASCII, Modbus RTU, etc.);
- *wireless* by means of GSM/GPRS modems, Radio, PSTN etc. for real time monitoring or through FTP, E-mail services for acquiring history.

Generally speaking in order to insure continuity in acquiring data from the field, one uses a redundant configuration of communication, namely if the local communication fails the SCADA software will switch the application to another local or wireless communication line so that no data within the process is lost.

At the same time with the data acquisition these will be stored in a database which will allow the future visualization of the entire history of the process in graphics, alarm lists or chronologies, being able to be exported in different formats (SQL, MySQL, Oracle, Access etc.).

The SCADA software administrator has access to a control panel which will allow the configuration of all communication, acquisition, authentication parameters. (Fig. 2).

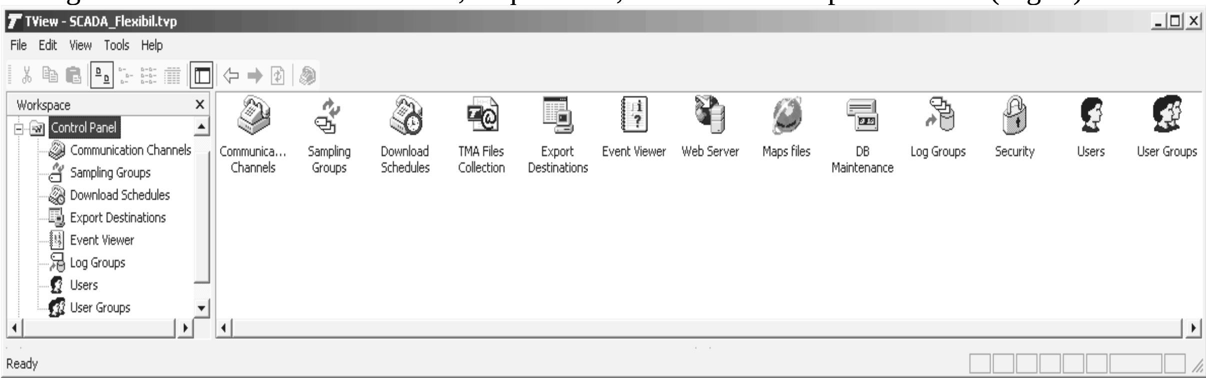

Fig. 2. The control panel

In general, the control panel has a series of interfaces like this:

- *the configuration of communication*: through LAN (Local Area Network), or through a modem (serial, GSM/GPRS etc.); one can configure redundancy groups for those cases when one of the communication lines fails, the next available line taking over the process data (Fig. 3);

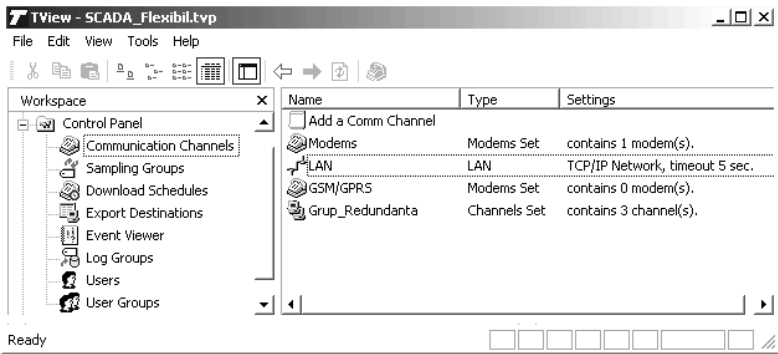

Fig. 3. Communication configuration interface

- *access level and user configuration,* having the possibility to add/delete with every user which has access to the SCADA interface (Fig. 4). The authentication is done with username and password, the level of access being: without access rights, reading rights, reading and editing rights, these being established by the SCADA administrator

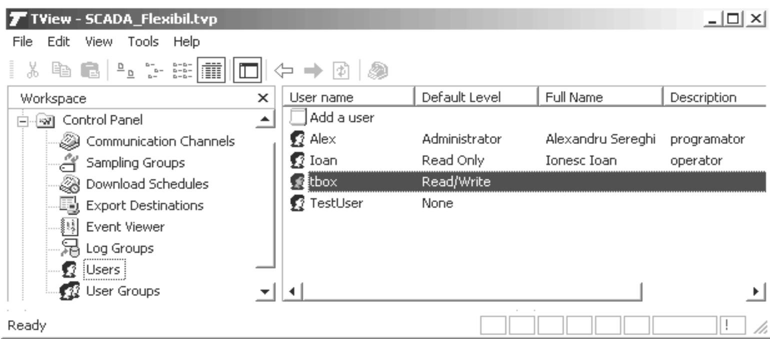

Fig. 4. Access level and user configuration interface

- *visualization of events which happen during SCADA usage.* One can thus monitor the location from where users will access the monitoring and control interfaces, the warnings or error which can occur during the usage of the program, thus filling in the list of the SCADA interfaces advantages.

The software architecture of RTU equipments

The software met in the development of RTU applications is grouped in that of:

- *Programming* of the automation (programming the internal PLC);
- *Monitoring and control* of the conducted process (SCADA type software).

Programming Software of RTU equipments

New interfaces for programming RTU equipments dispose of more and more advanced programming tools and more intuitive windows for creating and administrating a programme.

The following steps intervene in the programming of RTU equipments:

- *The configuration of the RTU's properties:* it allows the selection, the adding and the modification of the application's main parameters, starting from communication parameters (the Modbus address, TCP/IP, communication drivers with equipments on field or other SCADA type software) up to things related to the security of communication ports or of the application itself;
- *The adding of input/output modules*: RTU equipments disposing of a high diversity of modules, from the classic ones with digital inputs/outputs, analogues on 14 bits or modules with temperature inputs (for PT100, PT1000 drills, etc), up to GSM/GPRS, PSTN, optical communication modules etc. Other RTU equipments or, through standard protocols, other equipments such as temperature controllers, measuring equipments (debits, levels, movements...), frequency variation devices etc, generally any equipment disposing of a communication port, can be added to the existing configuration of RTU equipments, due to the many ways of communication;
- *The realisation of Tags*: a *Tag* is the location of the RTU equipments' registers memory in which the value of a parameter (digital – a single memory bit, or analogue – 8, 16 or 32 memory bits) will be found. Each Tag will represent a direct or indirect link with the inputs or outputs from the process, in the programme which will be developed in the future (in *Ladder, Basic, Statement List, Function Block* etc.);
- *The realisation of the programme: Ladder* language, the most often used language in programming RTU equipments, represents the structure of the programme under the form of a ladder; *Basic* language presents the advantage of developing complex programme lines, but the most important fact is that the code lines are executed by the processor more rapidly compared to other programming languages, thus resulting a shorter scanning cycle;
- *The realisation of alarms:* is one of the elements which makes the difference between a RTU and classic PLCs. The interfaces with alarm lists allow the choosing of any event from the process we desire to start an alarm. The alarms will automatically be saved in a historic, enabling us to use them in the programme or send them towards the service personnel by SMS, Email, FTP etc.
- *The realisation of Datalogging*: is another distinct element specific to RTU equipments, being responsible for stocking the main parameters to be monitored, forming the historic of the process. The digital measures' passing from an estate to another can be stocked, but also the variations in time of the analogue measures.

The monitoring and control Software of RTU equipments

SCADA type interfaces allow the visualizing and control of field processes with the help of the computer; commands can be given towards the process by a simple mouse or key touch, all these being visualized in real time on the screen in front of the operator.

SCADA type software dedicated to monitoring and controlling from the distance of RTU equipments generally dispose of the following main facilities:

- They are *Data Collecting Centres:* they get all the information and historical from RTU equipments and stock them into data bases;

- They are *Supervisors:* through the connection to RTU (local or wireless) and display of parameters in real time;
- They are *WebServer:* allowing the access of users to the lists of historic, of alarms etc, through the classic network (LAN) and an *Internet Explorer* type *browser*.

The field data can be collected:

- *Locally*, through an *Ethernet* or serial connection using RS232, RS485 communication ports. The data transfer is done in this case through standard communication protocols (TCP/IP, Modbus TCP/IP, Modbus ASCII, Modbus RTU, etc.);
- *Wirelessly*, through GSM/GPRS, Radio, PSTN etc. modems for monitoring in real time or through FTP, Email services for historic acquisitions.
- Together with the data acquisition, it will be socked in a data base which will later allow the visualizing of the entire historic of the process in graphics, alarm lists or chronologies, being ready for export in different formats (SQL, MySQL, Oracle, Access etc.).

4. CONCLUSIONS

In conclusion we will present an application created by means of the RTU *TBox* equipment and namely monitoring a solar hot water production installation. The application is located in a mountain area, the solar system being made up of collectors with a total surface of 2x16 mp, two 500 liter reservoirs and two heat switches. The monitoring panel is equipped with a RTU TBox device specially designed for such applications, having 6 temperature inputs of the PT1000 type, 8 digital inputs, 2 analogue 4-20mA inputs, and 4 relay digital inputs. One of the main advantages of this type of equipment is the low energy consumption. Thus the monitoring panel was equipped with a 12Vdc battery, which in case of a power failure will continue to supply energy to the TBox equipment, thus the data acquisition being protected from any loss. The solar system supplier wanted a thermal energy threshold ensured with the implemented solution described above, so that it would be able to estimate the energy economy for the client achieved by introducing the solar panels. For this the following were required:

- heat and solar radiation monitoring by means of graphics according to time, with 10 minute acquisition rates and 10 day memory storage;
- water flow measuring;
- monitoring the recirculation pumps situation;
- sending through e-mail the database, process graphics, alarm lists every 24 hours;

The position of every sensor of the application is indicated in figure 5. The analogical radiation sensor with a 4-20mA output indicates the solar radiation in W/mp. The temperature sensors of the PT1000 type are linked to the system's inputs and outputs on the closed system of the solar panels and to the reservoirs' outputs. By means of relays one can monitor the situation of the recirculation pumps in the solar systems' panels. The recirculation pumps are powered according to the temperature difference between the input and output of the solar panel. The measurement of the flow was done with the help of a debitmetru which sends impulses at every liter of water being used.

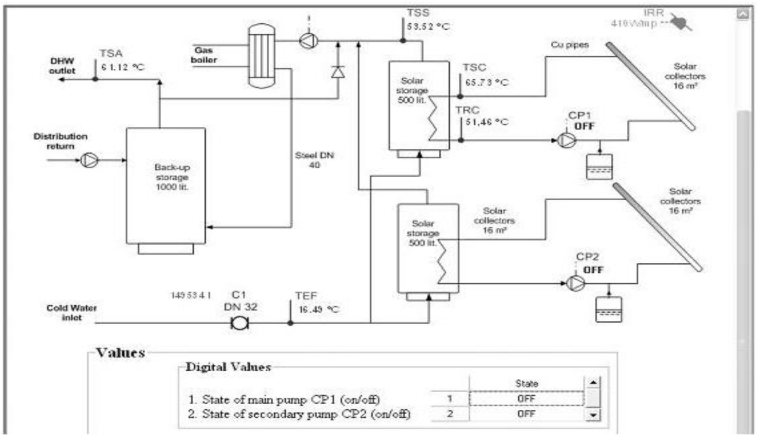

Fig. 5. Visualization interface

The program which will be executed in RTU TBox according to the requirements was developed during the first stage of the project. The program was edited with the TWinSof programming software. TWinSof allows the manipulation of the project on the interface of Windows and Linux operation systems.

During the second stage of the project, once the RTU TBox was configured, the required graphics were configured, and a SCADA monitoring interface was created for field interventions and local visualization; this interface can be accessed by means of an Internet Explorer browser type. This interface was created in the WebFormEditor program, which is identical to TView in terms of the programming mode. The program graphics allows the creation of windows that are intuitive and in accordance with the field application, thus making it easy for the user to use the application. There are some *ActiveX*s, tables, and graphics available, with which one can develop user-friendly interfaces where the position of the sensors on the solar system plan is indicated. The temperatures, the flow, the situation of the pumps will dynamically indicate the values, according to the field values.

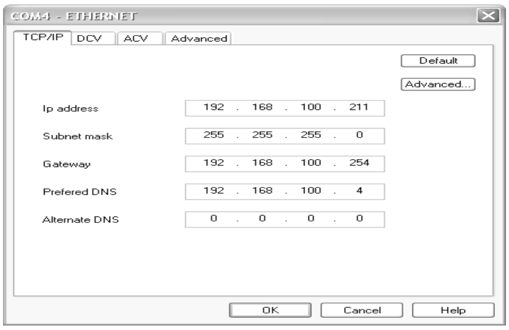

Fig. 6. Ethernet communication configuration

The sending the data through e-mail was achieved by connecting the TBox equipment to the internet. Through the Ethernet communication port programming interfaces from TWinSoft one introduced the communication parameters (see Fig. 6).

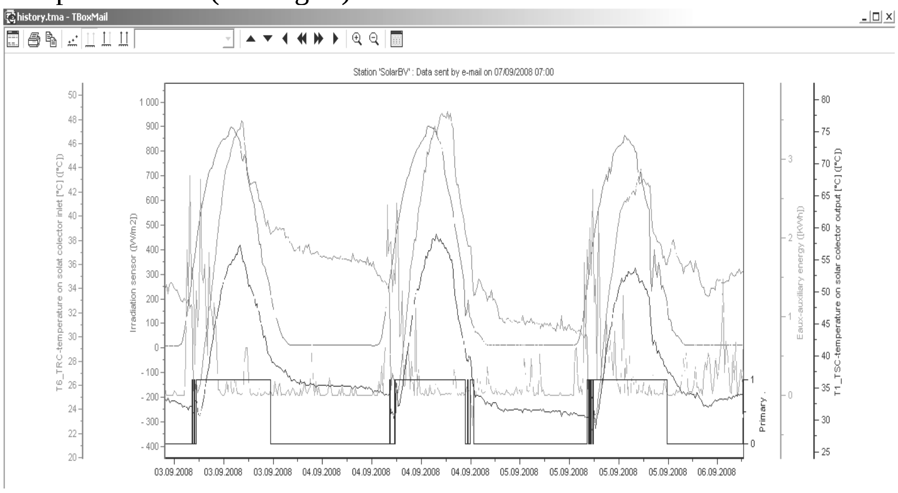

Fig. 7. Process graphic

The process graphics (Fig. 7) sent via e-mail contain all the monitoring data. Upon opening the graphic one can select the desired parameters. The graphic can be exported under .csv format and can be integrated into Microsoft Excel applications. Whenever necessary one can set the parameters, shrink or enlarge the graphics, having the possibility to print or export them under different formats (.jpeg, . bmp, .wmf, .emf, .txt).

As a conclusion, we'll present an application realized with the help of RTU *TBox* equipment in the industry of rubber based products. The monitoring and control of the entire production line is made with the help of *SCADA Ethernet TView* programme.

- The production line which is to be automated is formed of 16 hydraulic presses. Because most of the products need a strict monitoring of the vulcanization time, of temperatures and of the pressures used, the best solution needed to be found for allowing a computer controlled production and for fulfilling the following conditions:
- To allow the adding/modifying/deleting, through a window, of new production receipts for each press and their registration in a data base;
- To allow two working regimes: *Manual* (the initial case without automation) and *Automat* (the case in which the RTU TBox equipment will take over the control of the press);

- To register and display as graphics the main parameters of the process indifferently of the chosen working regime;
- To indicate all the events of interest in the list of alarms;
- To allow the access to the visualizing/controlling of data through a computer linked to internet.

The hydraulic presses are controlled by a manipulator through a control panel. The superior and inferior moulds are warmed with the help of some resistances and of some controllers with a PID curl for adjusting temperature, which dispose of a RS485 communication port.

In the first stage of the project, the programme to be executed in RTU TBox was developed. The programme was edited with the help of TWinSof programming software. TWinSof allows the manipulation of the project under Windows and Linux operating systems. First, the development of a communication driver was needed for the controllers from the production hall with the purpose of reading temperatures and setting temperature thresholds according to each production receipt.

In the second part of the project, once the programming of RTU TBox was done, the SCADA interface of monitoring and control from the distance was realized with the help of *SCADA Ethernet TView* software. The graphics of the programme allows us to create more and more intuitive windows in concordance with the application from the field, so that it is much easier to use the application. We have at our disposal many ActiveXs, tables, graphics to develop friendlier interfaces, where the hydraulic presses are indicated to be placed in the production hall. The estate of the presses (*supplied/unsupplied* with tension, working regime selected *automatically/manually,* production cycle *finished/stopped/in work*) s indicated in real time through messages and bright indicators alongside each press.

Each press will receive a receipt guiding the production in the automated regime. These receipts are created and edited where the most important parameters are the vulcanization time, pressures and prescribed reference temperatures. All receipts are saved in the table with *EntranceData* of the data base. In time, the receipts table will contain more and more registering, and in order to ease the finding of receipts and their reediting we developed a small filter with different searching criteria.

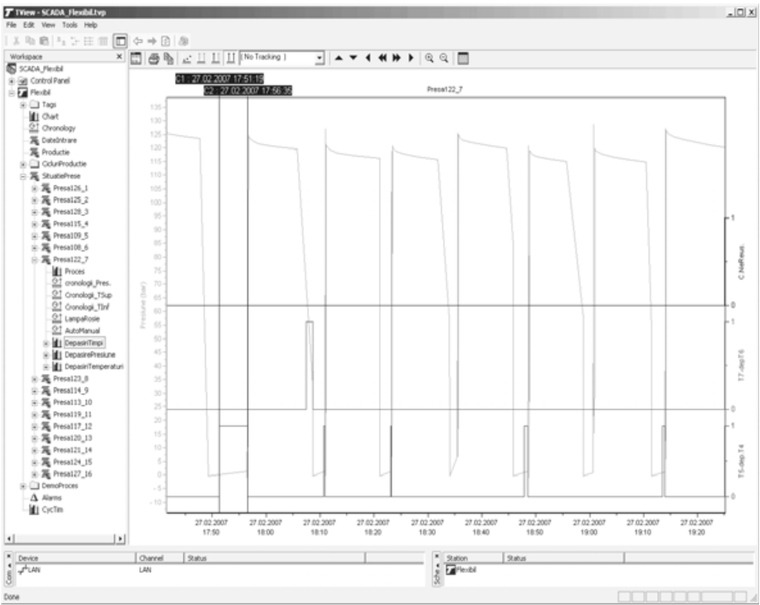

Fig. 8. Trial pressure

Returning to the process and to its monitoring in real time, windows can be created for each press, in which each parameter from the process can be visualized, indifferently of the working regime (automatic or manual).

The pressure and temperatures will indicate values in a dynamic way, corresponding to the values from the field. When the press works in automatic regime, the green arrow from the group of times will indicate the phase of the process in which the manipulator is found; in the table with production cycles, the stage of production can be followed with the exact number of successful/unsuccessful charges.

One of the greatest advantages of SCADA interfaces is the possibility of superposing the monitored parameters on graphics. In Figure 8 we can visualize pressure, superior temperatures, estate of the process (automatic/manual) and the situation of the bright indicator (Red Lamp) which indicates the end of vulcanization time and requires the intervention of the manipulator. Whenever we need, the parameter scales can be set, graphics can be increased or decreased, also having the possibility of printing and exporting them under different formats (.jpeg, .bmp, .wmf, .emf, .txt, .csv).

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