Integrated system for modelling thermoenergetic 50 MW groups destined to energetically personnel training

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1. General considerations

Integrated modeling system simulates the operation of a thermal power station with collector bars composed of 2 boilers of 420 t/h, two of 50 MW turbines and a generation and delivery energy system.

This system offers a solution to increase security in the supply of electricity and thermal energy based on intelligent decision support system and based on professional cognitive training of specialized personnel.

System consists of a software structure implemented on a hardware structure that simulates real-time operation of the production installations of electricity and thermal energy.

The paper is based on exploiting the experience of partners (Politehnica University of Bucharest – UPB, Institute for Studies and Power Engineering – ISPE, SC SIMOD SRL and SC Mikon Systems SRL) for elaboration of a high complexity system.

The system integrates complementary knowledge for mathematical formalization of specific technological processes and accomplishment of a system adequate to immediate use by cogeneration power plants. Also, the system allows performing analysis on the evolution of thermal power plant parameters behind technological maneuvers simulated in order to increase economic efficiency, availability and security of energy supply in the preparation and training of specialized staff and management decisions assist. The system can be used in specialized training of students, master and doctoral candidates.

Implemented application is made on a configuration consisting of 3 computers: 2 workstations for operators from the boiler and turbo-generator group, and a workstation for instructor, which allows him to track and coordinate activity in the application.

Important steps taken so far in the pursuit system can mention: developing mathematical models analog and binary, the software simulation corresponding mathematical models, the graphical interfaces of the design and implementation of active elements (ActiveX).

2. Mathematical models

The project shapes the following circuits and technological installations:

- for the turbine:
  - the scheme of the SRR IP circuit
  - the scheme of the SRR JP circuit
  - the scheme of the low pressure water circuit
  - 1,2 at deaerator
  - scheme of the condenser and water cooling
  - scheme of the main condensate circuit
  - scheme of the PJP circuit
  - scheme of the base and peak water heater circuit
  - 6 at deaerator
  - scheme of the water supply circuit
  - scheme of the PIP circuit
  - scheme of the oil turbine circuit
  - scheme of the bleeder turbine

- for the generator unit:
  - electrical scheme of the main circuit and excitation circuit of the generator unit
  - the scheme of the confining oil circuit of the generator

- for the boiler:
  - scheme of the air circuit
  - scheme of the exhaust gases circuit
  - scheme of the coal supply circuit (1-6 mills)
  - scheme of the water-steam circuit of the boiler 1
  - scheme of the water-steam circuit of the boiler 2
  - scheme of the skimming and de-ashing circuit

Representation of these circuits on thermodynamic schemes shown on display and both contain information about the state of equipment (motor on / off, valves open / closed, etc..), and values of technological parameters calculated.

In Figures 1 and 2 are presented two examples of technological schemes which are part of the graphical interface of the application.

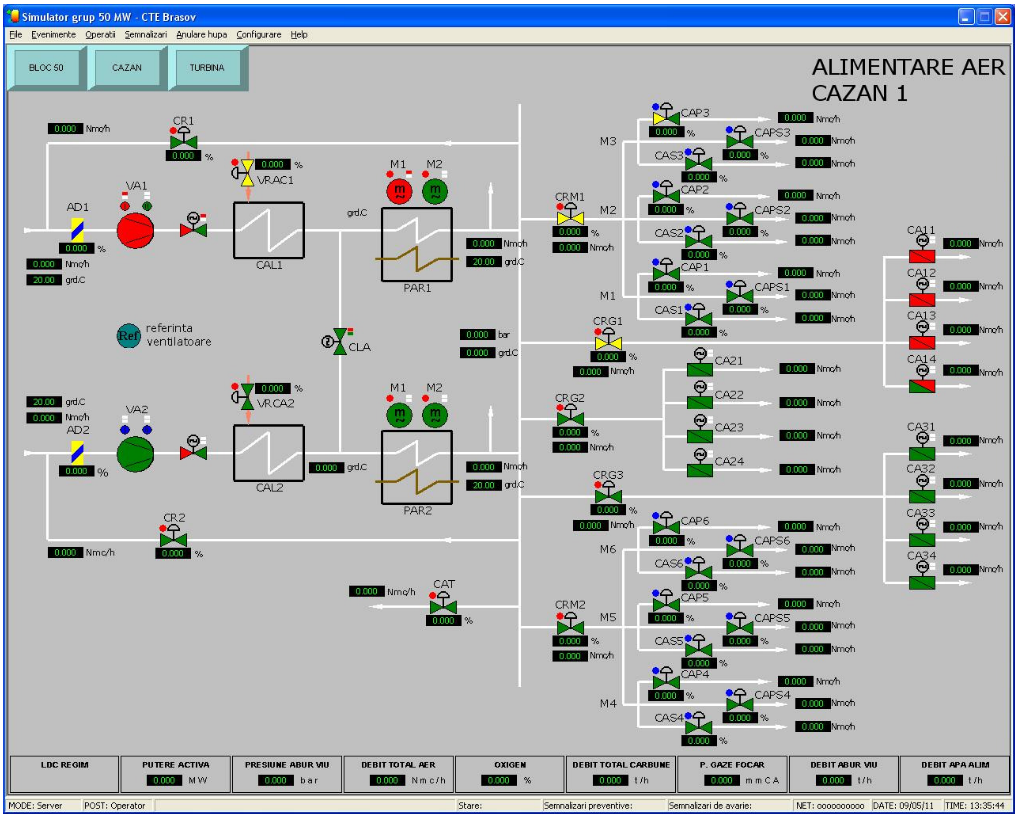

Figure 1. - Graphical interface – air supply scheme.

In the application are simulated operation regimes between 0 and 100%, aiming both reproducing the parameters specific to stationary states, and the parameters specific to dynamic regimes.

Operation in the incident or damage regimes is simulated by introducing in the calculation formula of the mathematical model of some variables that represents breaking of pipes, the soiling pipes, wear engines, unexpected stops of the engine, blocking valves, etc..

For entire system to simulate real-time operation of installations, calculation of mathematical models is made in the execution time of less than 0.25 seconds.

Input data of each analog mathematical model are data proper to the model (state on / off, connected / disconnected, closed / open and positions of regulating components) and data calculated by adjacent models (flows, pressures, temperatures). The output data of analog mathematical models are represented by flows, pressures, temperatures, enthalpies, threshold overrange of signalling and damage displayed on the technological schemes.

Simulation process includes also binary mathematical models that implements automation , protection and signaling schemes used in real installations. The input data for these models are the actuating commands, threshold overrange for calculated parameters and equipment states. The output data of binary mathematical models are represented by signalings, protections, states of equipment and installations.

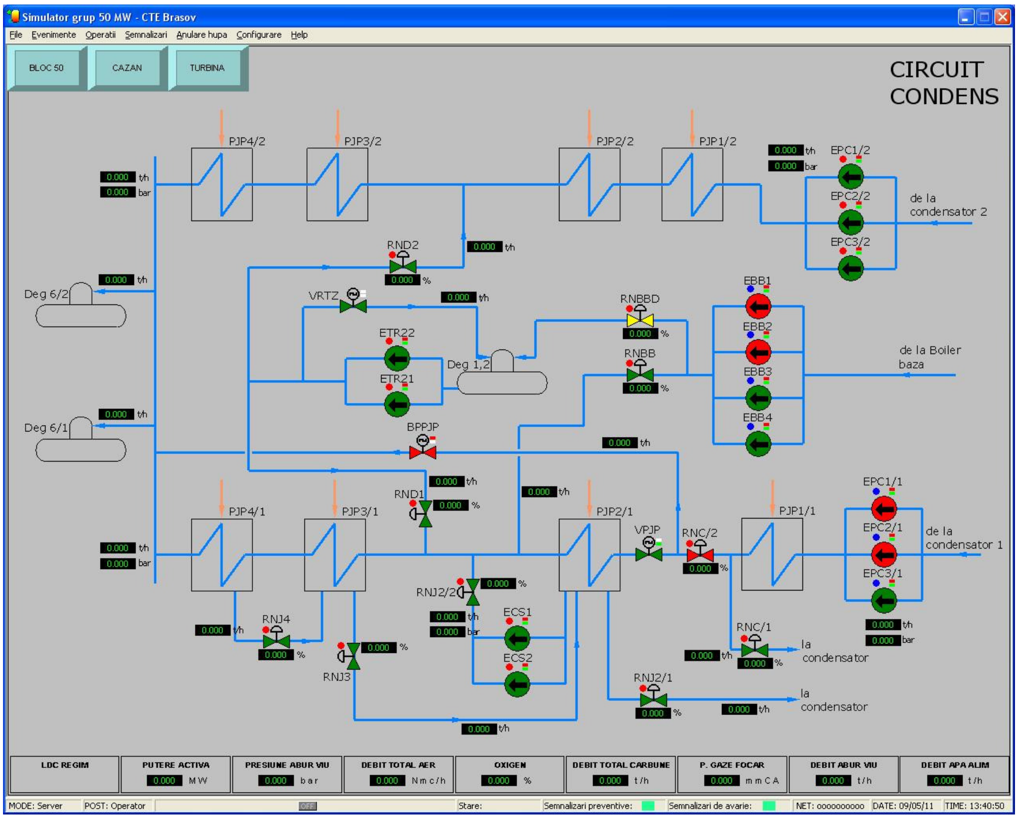

Figure 2. - Graphical interface – condensate circuits scheme.

3. Simulation programs

Package of programs accomplishment running under Windows, is for a graphical visualization of results of mathematical models processing, execution synchronization, changing the input amounts in terms of its adaptation to technological schemes of simulated installations. The programs package is written in Visual C++, language that ensures programs operating under Windows, and uses facilities of object oriented programming and ActiveX use.

Programs packages are such structured:

- category of programs that constitutes the foundation of system operation and implements all the basic functions of such a system namely *software system (basic software);*
- application programs category, containing on the one hand processing actuating algorithms, signaling and protections afferent to automation and protection schemes of simulated installations simulated, and the other processing modules of analogue models afferent to calculation of operating parameters of equipment and installations in their assembly; this programs package represents the *application software*.

The system software and the application software communicate directly both through the tasks, and the database.

The system software implements the functions of an instruction system and allows visualization of the operating technological schemes of the 50 MW group, making and processing of maneuvers, and interfacing with programs afferent to mathematical simulation models.

The graphic component represents the basic module of the visualization and interfacing software. Unlike other components, the graphic component is indispensable to any software interface destined to an integrated system.

4. Application operating modes

The integrated system aims to achieve an application that can run in three working ways, namely:

- training
- evaluation session
- revival

▪ In the *training* mode are running simulation programs for the functioning of boiler, turbine and generator unit. In this working mode the user can give commands and can perform maneuvers, and the system displays the analogue values and equipment states according to mathematical models. This is the simplest way of running the application. In this mode the user (instructor) can appeal also the registration function, necessary for the construction of **standard files**, used later in the evaluation function.

▪ In the *session evaluation* mode, same as in the training mode the simulation programs are running, and the user can give commands to the system. In addition to the training mode, here the system register the student's work in a **student file** so in the end his evaluation could be done. Evaluation is done by comparison with standard file previously saved and executed by an instructor with the student file. Evaluation result is represented by a *general note*, resulting from a complex calculation of comparison of the technological parameters followed in the respective session evaluation and the way how these parameters are included in some preset limits.

▪ In the *revival* mode the application reads one of the recorded files and displays on the graphical interface the read data (analogue and binary amounts). In this working mode are no longer issued in execution the simulation programs and the commands are not removed from the user. The user has the option to follow the registration unfolding and switch from one scheme to another to watch the unfolding process.

5. Conclusions

Great magnitude and complexity of the integrated system, the conditions imposed, requires the collaboration of specialists from Politehnica University of Bucharest – UPB, Institute for Studies and Power Engineering – ISPE, SC SIMOD SRL and SC Mikon Systems SRL and consultation with exploitation staff of the modelled cuts.

The integrated system is designed for formation and training of the personnel from the heat power plants, but can be used also in the process of teaching in higher education institutions in specialties: energy, mechanics and automation.

The system is conceived so the operator can maneuver and follow stationary and dynamic processes in the same conditions as in the real installations.

In achieving the system is taking account of that the instructor can track and intervene in developing processes, creating abnormal operating situations.

In order to use the system and the exploitation personnel the system dispose of an interface similar to those in existing plants.

Achieving integrated system has as general purpose:

◦ capitalization of the experience, of the scientific and technological potential of the partners for achieving an intelligent network based on performant simulators similar to those existing worldwide;

◦ dissemination to the economic and social environment of the research and knowledge gained in order to increase competitiveness of Romanian economic environment.

◦ establishment of some links between research media and economic agents for the development of advanced simulation systems, with ensuring effects of some performant partners in the programs of scientific and technical cooperation;

◦ ensuring the alignment of Romania to the international practice on the analysis and preparation processes with the help of intelligent network-based simulators.

6. Bibliography

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