Digital Technologies in the Educational Process of the Thermal Power Plant Department, Kazan State Power Engineering University

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***Abstract*— The necessity of digital technologies using in the educational process with the growing demands on the quality of higher technical education is shown. The possibility of software using in the educational process at the Thermal Power Plants Department, of Kazan State Power Engineering University in considered.**

***Keywords*— digital technology, educational process, educational software, computer simulators of the Thermal Power Plants**

I. Introduction

Thermal and electric energy production at thermal power plants involves the use of high fluids pressures and temperatures of the working. Thermal power plants are the hazardous production facilities with expensive equipment. Therefore, it is advisable to train training and improve the training of highly qualified specialists on models of heat and power equipment implemented in computer programs.

II. Description of the Software of the Thermal Power Plants Department, Kazan State Power Engineering University

At the Department of Thermal Power Plants, a scientific and educational platform, Computer Simulators in the Power and Electric Power Industry, is being implemented [1] (Fig.1). It included all-mode computer simulators: a 300 MW power unit simulator (Ivanovo State Power Engineering University), PGU-410 power unit (TEST JSC), PGU-450 power unit (TEST JSC – Fig. 2), cross-link stations (TPP with TP-80 type boiler units, PT-60-130 / 13 and T-100/120-130 type turbo-units - TEST JSC, – Fig. 3).

The following practical, laboratory works have been developed to acquire knowledge, abilities and skills in laboratory and practical exercises using computer training and analytical complexes at the TPP department:

- study of mimic diagrams of computer simulators, determination of operation energy indicators turbine units K-300-240, PT-135-130, T-50-130, R-50-130, boiler units TGM-84A, TPE-430 [2];

- planned and emergency turbo pump shutdown with switching to the power electric pump; comparison of power unit energy indicators when working with a feed pump on a turbo drive with the operation electric drive with a feed pump;

- prevention of automatic power unit shutdown during an emergency shutdown of one of two circulation pumps of a 300 MW power unit technical water supply system;

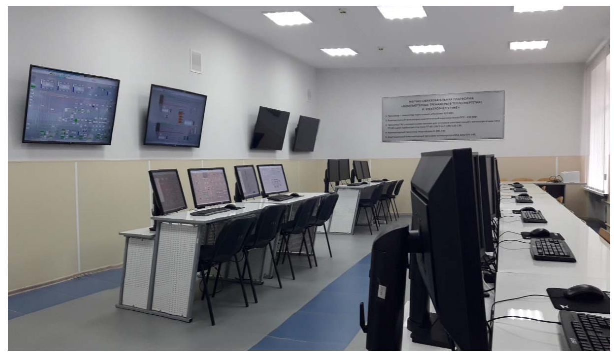

Fig. 1. Scientific and educational platform "Computer simulators in the thermal and electric power industry"

- prevention of automatic power unit shutdown during an emergency shutdown of one of two circulation pumps of a 300 MW power unit technical water supply system;

- transfer of the deaerator of high pressure to atmospheric mode, allowing the deaerator inspection and perform the necessary work without the power unit stopping;

- familiarization with the operation of the turbine K-300-240 oil supply system [3];

- familiarization with the feed plant operation, with the methodology for switching to a backup electric pump during an emergency feed turbine pump shutdown [4];

- familiarization with the gas-air path operation of the condensing power unit (the methods for the scheduled shutdown of one blower fan and emergency shutdown of one smoke exhauster are given), with the gas-air path operation modes in these situations (transient processes of the main unit values, changes in the boiler combustion mode, changes in the water and steam temperature in boiler, boiler injection operation) [5];

- familiarization with the low and high pressure heaters operation, study of ways to turn off regenerative heaters on operating equipment when leaks occur in one of them (transients are given: the operation mode of the deaeration-feed plant changing, the operation mode of the high pressure washer, high pressure water supply, and the power unit main parameters changing) [6-7];

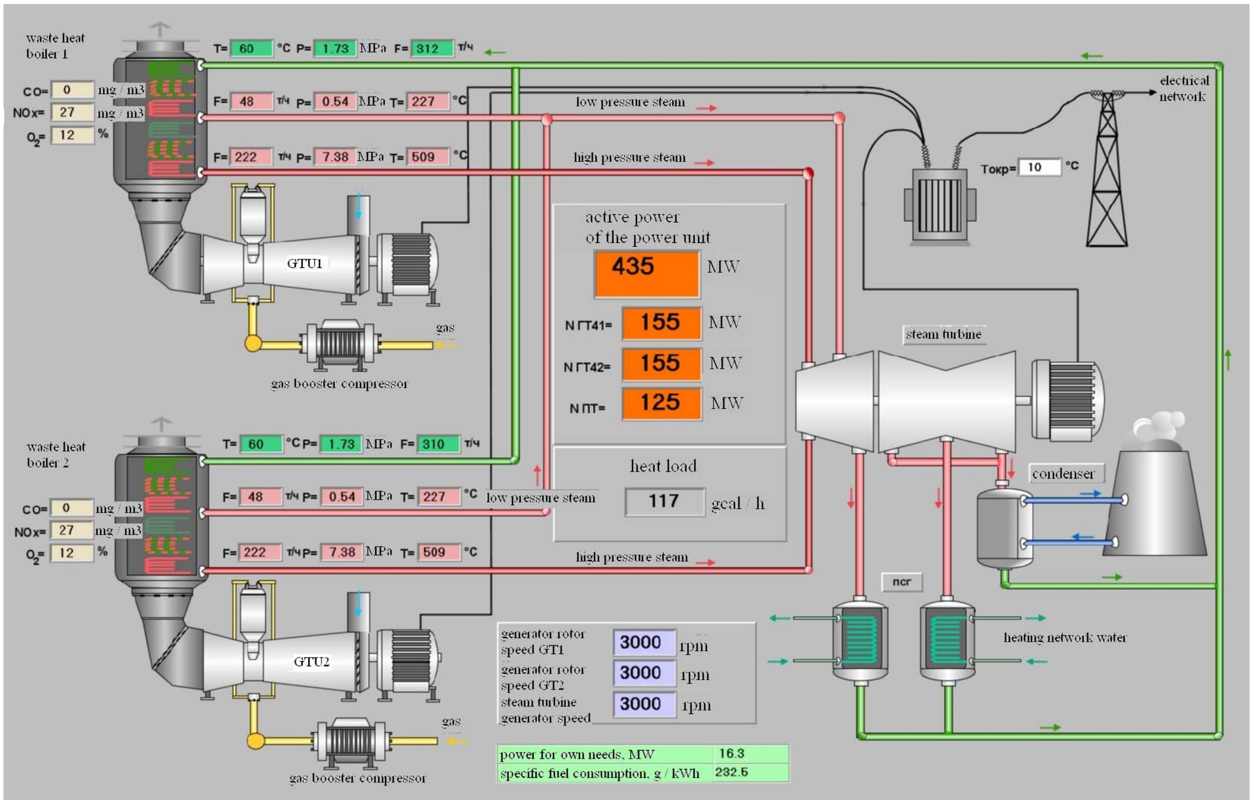

Fig. 2. One of the mimic diagrams of the power unit simulator PGU-450

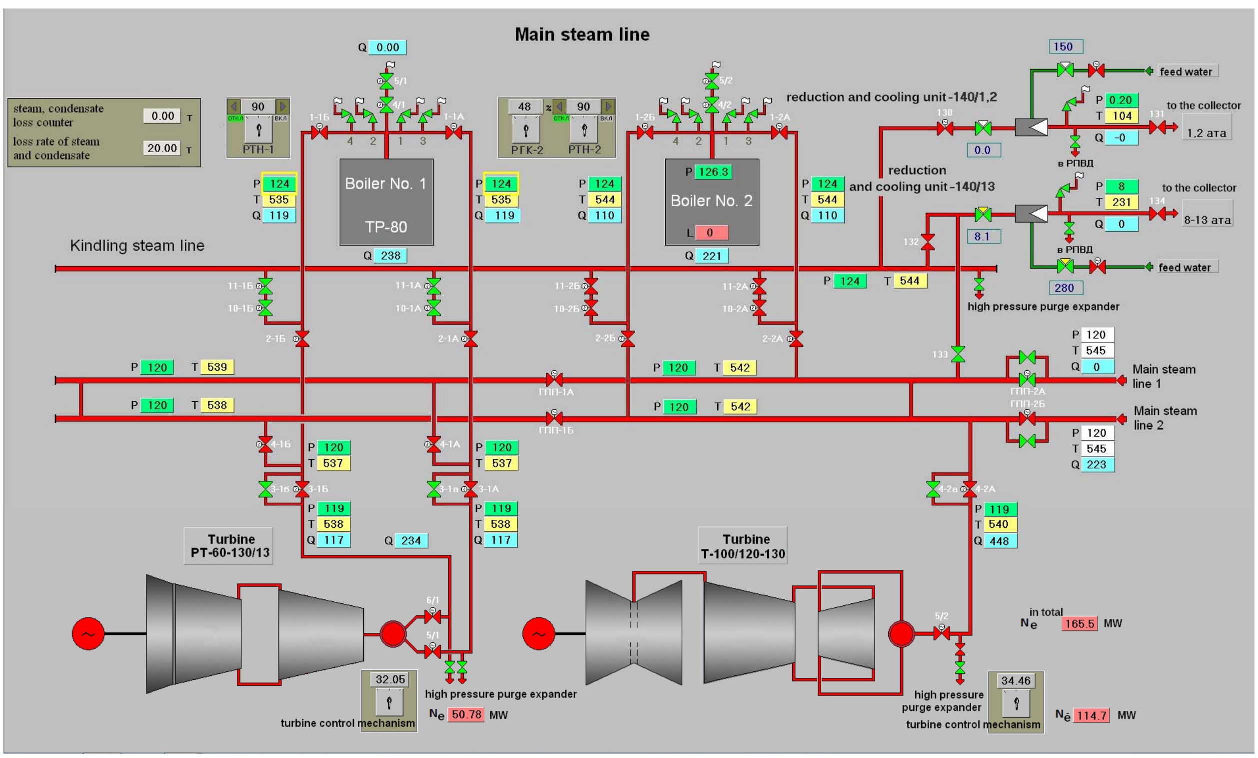

Fig. 3. One of the mimic diagrams of a simulator of a thermal power plant with cross-connections

- study of the power unit operation at a moving initial vapor pressure;

- study of TGMP-314 boiler transient conditions (study of the direct-flow boiler operation reliability with rapid changes in load, steam and water parameters);

- familiarization of students with the power unit operation of the (the power unit driver actions) with a deterioration in the fuel oil calorific value [8];

- study of start-up technologies, start-up of the TGM-84 boiler and 300 MW power unit [9];

- study of the start-up stages, start-up of the CCGT-410 power unit (start-up of the unit cooling system; start-up of the unit oil system; start-up of the generator shaft sealing system, start-up of a water treatment plant; preparation and start-up of the vacuum-condensation unit; start-up of the deaerator unit; preparation and filling of the recovery boiler; starting of the gas facility of the power unit; starting of the integrated air preparation device; preparing for gas turbine starting; preparing for steam turbine starting; starting of the gas turbine; the gas turbine loading; the steam turbine unit starting) [10];

- study of the start-up stages, start-up of the CCGT-450 power unit (the recovery boiler for start-up preparing; the gas pipelines purging, the GDK system putting into operation; the GT-41 gas turbine unit for start-up preparing; start-up of the steam turbine on sliding parameters from a cold state; the PSG-1 and PSG-2 network heaters switching on; shutdown of heat selection; the block stopping; the block from a hot state starting; turning on electrical circuits) [11]:

- study of the start-up stages, start-up of thermal power plants equipment with boiler units TP-80, turbine units PT-60-130/13 and T-100/120-130 (station-wide equipment switching on; the circulation and technical water supply turning on; of the turbine PT-60-130; oil systems for lubrication turning on, generator shaft seals and PT-60-130 turbine shaft rotator; start-up of PT-60-130 condensation, regenerative unit; a TP-80 boiler preparation for cold start; kindling and loading of a gas-fired boiler; heating of steam lines, start-up and loading of the PT-60-130 turbine from cold state; start-up of the lubrication system and UVG T-100-130 system; start-up of the condensing, regenerative devices of the T-100-130 turbine unit; start-up of the T-100-130 turbine from the cold state in condensation mode; set of the electric load; shutdown of the high-pressure steam boiler TP-80; the boiler transfer from gas to fuel oil burning; the boiler transfer from fuel oil to gas burning) [12].

It should be noted that such computer simulators variety at the TPP department for the training of highly qualified power engineers was achieved in a short time thanks to the support of the our university leadership. The employees of the TPP department, in turn, developed the necessary educational and methodological support. At the same time, employees of energy companies were involved in the development of these training manuals.

At the Department of Thermal Power Engineering, KSEU, students acquire knowledge, abilities and skills in laboratory and practical classes using programs created in the Mathcad software (Fig. 4);

- study of the low pressure heater operation at partial loads (study of the heat transfer coefficient influence, heating surface area, heating steam pressure and water temperature at the heater inlet on the under heating amount, heat load and temperature head) [13];

- study of the jet deaerator operating mode (studies of heating steam pressure influence, water temperature at the inlet of the deaerator and water flow rate on the value of its under heating to the saturation temperature using the its upper stage example) [14];

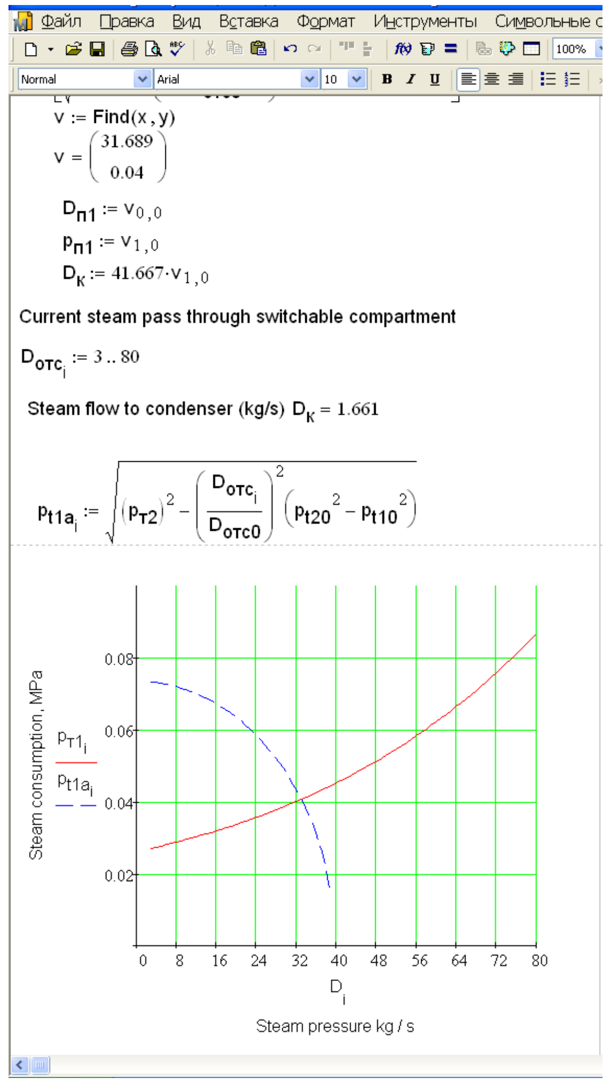

Fig. 4. A fragment of the laboratory work performed in the Mathcad software

- study of the jet deaerator operating mode (studies of heating steam pressure influence, water temperature at the inlet of the deaerator and water flow rate on the value of its under heating to the saturation temperature using the its upper stage example);

- study of pipeline thermal insulation (study of the heat-insulating material thermal conductivity influence, heat transfer from heat insulation to air, steam temperature and air temperature on the temperature value on the of thermal insulation surface and specific heat loss);

- study of the chimney operation modes (study of the influence of changes in the chimney height, the exhaust gases temperature, the outside air temperature and the flue gases exit velocity on the static pressure profile inside the exhaust pipe);

- study of the electrostatic precipitator operation modes (investigation of the ash drift velocity influence, gas velocity in the electrostatic precipitator, the distance between the precipitation electrodes and the degree of the flow unevenness at the inlet of the electrostatic precipitator on the operational efficiency value) [13];

- the fuel and energy losses determination during 300 MW units startups [14];

- the steam parameters determination in the elements of the turbine thermal circuit on a computer; calculation of the heating turbine T-110-130 network heating installation of the (heating network water study); determination of the turbine thermal efficiency indicators (students familiarizing with the methodology for turbine thermal efficiency determining indicators using the forward and reverse balance method based on a computer model of a 300 MW power unit); calculation of the turbine operating modes according to the turbine compartments characteristics [15].

In addition to the above, in the process of training at the TPP department, electronic educational resources developed at Moscow Power Engineering Institute [16] are used: the Water Steam Pro program for water and steam properties calculation, computer simulators that simulate water-chemical regimes at TPPs, as well as photo materials for studying of steam turbine repair technologies.

The TPP computer simulators acquisition allowed to build the educational process in a new way. The experiment [17] showed that the assimilation of material during training using computer simulators simulating the operation of real heat power equipment is higher than when studied in the traditional way.

Conclusion

The use of digital technologies in the educational process has improved the quality of training, reduced the costs of organizing and conducting training events, redistributed the load of teachers from routine to creative activities, increased the efficiency of the educational process providing [18].

The training costs reduction was achieved due to: transfer of routine functions from teachers to computer-training tools; reducing the need for teaching aids on paper; the load reduction on the material and technical support of the educational process; travel costs reduction to training venues.

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