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HEAT SUPPLY ELECTRONIC MODEL DEVELOPMENT FOR TOWN OF DOBRYANKA, PERMSKIY KRAI, RUSSIA

Abstract

Computerized simulation of the processes in the heat supply system of a city allows to estimate parameters of the current operation at the maximum possible accuracy, to calculate reliability, to investigate various options for future potential development of the system and within shortest timeframe to determine efficiently optimum solutions of heat supply to consumers in emergency situations which is extremely vital question in cases of low negative temperatures of the ambient air in the Ural region of Russia and in other parts of the world.

Keywords: heat energetics, heat supply system of a city, heat network, hydraulic simulation, on-line operation, accuracy, reliability, safety, accidents precaution.

Facility General Description under Investigation

Population of the town is approximately 30 thousand people.

Heat energy is supplied by Production Process-and-Heating Boiler Plant of Inter-RAO - Power Generation JSC (Joint Stock Company) (affiliated with Permskaya GRES power plant), installed heat capacity is 298 Gcal/hr.

The temperature chart for direct supply and return water is 150/70 ^{0}C, trimmed to 130/70 ^{0}C.

The heat energy consumption of the town (maximum) is 85 Gcal/hr (based on data provided by heat supply enterprise).

The quantity of Central Heat Supply Station - 1, Individual Heat Supply Stations ~ 500. Length of the heat supply lines is 101 km (double tube representation).

Project Objectives and Tasks

- Development of the first on-line chart of heat energy the towm supply.
- Comprehensive analysis of the heat supply system on the basis of the chart.
- Computer-aided calculation of thermal losses.
- Investigation of potentialities for occurrences of various emergency conditions and non-standard situations.
- Search the ways for emergency isolation methods with minimum damage [1-10].

Integrated Information System Development for Heat Supply of a Town

The description of source information materials as of the project commencement date:

- The list of consumers with the preset agreed loads.
- The obsolete but in majority cases still valid technical data sheets for main networks and quarter-based networks illustrated as diagrams.
- The thermal chamber diagrams indicating existing shut-off and control valves.
- The obsolete utilities database of Dobryanka town (as of 1987) which is the key source of geodetic marks of the heat supply networks (as per Baltic elevation system).

Generation of graphic representation of the town layout and of the heat supply system

The sample of the quarter layout derived from processing of the hard copy field survey maps is shown Fig.1

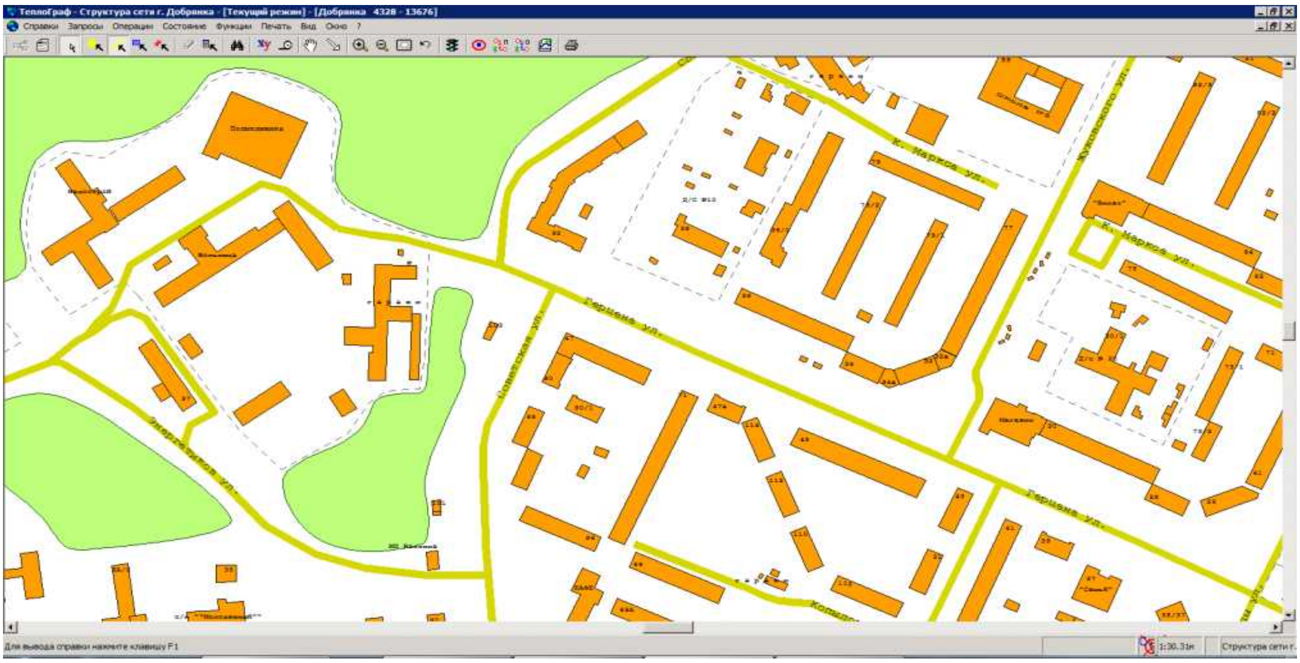

Fig.1

The same quarter referenced to space view map is present on Fig.2

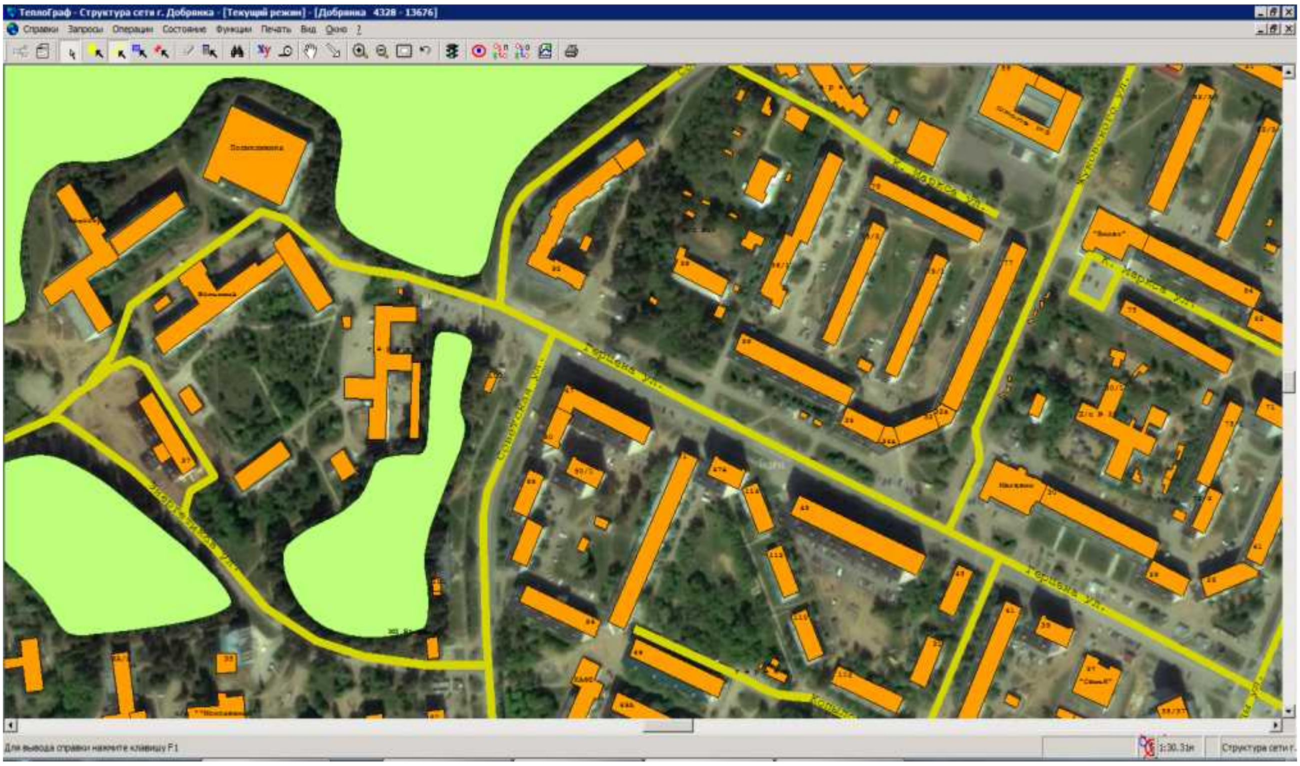

Fig.2

The same quarter. Finalized on-line chart of heat energy supply (Fig.3)

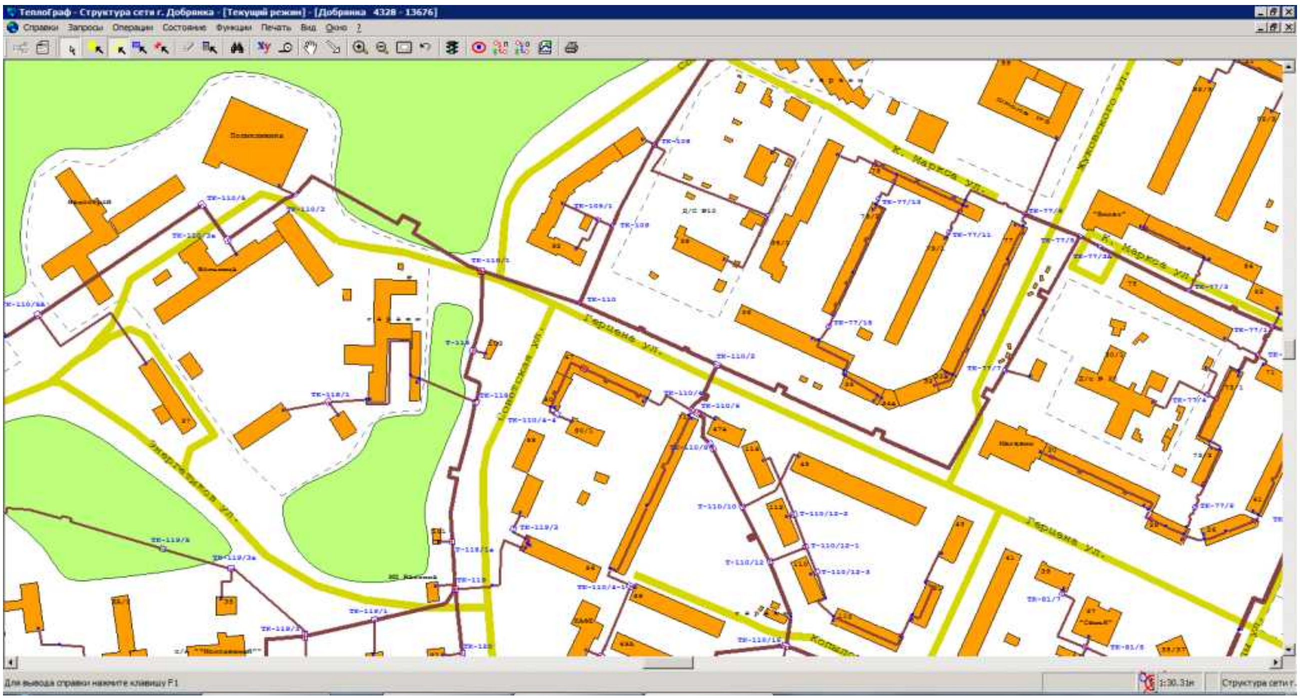

Fig.3

Analysis of heat supply

- Actually delivered heat for the heating period is calculated as per design ambient air temperature, we defined maximum heat load at the heat supply source output:

  Qmax=83.7 Gcal/hr.

- Actually delivered heat energy for the summer period defines the heat load at the heat supply source output for preparation of the hot water supply:

  Qhot wat.sup. av.=11 Gcal/hr.

- Conclusion: heat energy load at the heat source output when calculated for the ambient air temperature Tamb.air=-35^{0}C (for Ural, region of Russia) can be compared to contractual consumed loads.

Actual readings of metering devices if compared to preset temperature chart (Fig.4)

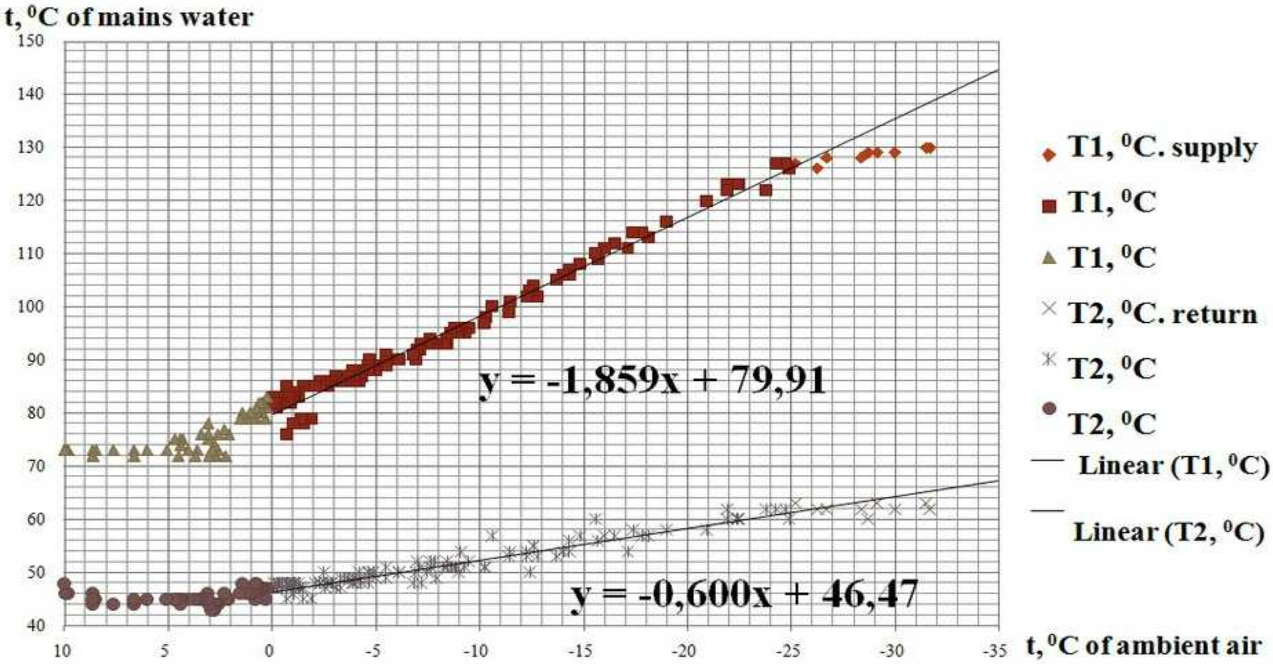

Fig.4

Some of the conclusions of computer-aided analysis of the heat supply system

- Actually released heat energy determined in the project illustrated by the graphics shows that no temperature is exceeded in the return pipeline

  (if compared to the approved temperature chart and consumption of the mains water).

- Obtained and proven by the analysis conclusion: necessary measures intended to adjust the heat supply system of the town at present are maintained in proper condition.

Hydraulic calculation of main network pipelines

- The calculation shows <u>unsatisfactory</u> hydraulic operation mode for certain localities:
- Available head of the consumers of the upper zone of pump station is 8-9 m of water column which is unstable for normal work of tempering valve units of the consumers.
- Minimum pressure in the supply pipeline of the private residential area units from PA-11 plant amount 26 m water column which is less than boiling pressure of the heat transfer medium under the rated temperature. Maximum allowed temperature of the heat transfer medium under the rated pressure in the plant is 135 ^{0}C, which is in compliance with the preset temperature trim.

Rated piezometer chart from Permskaya GRES power plant to thermal chamber No.110/5A sheet 1(Fig.5)

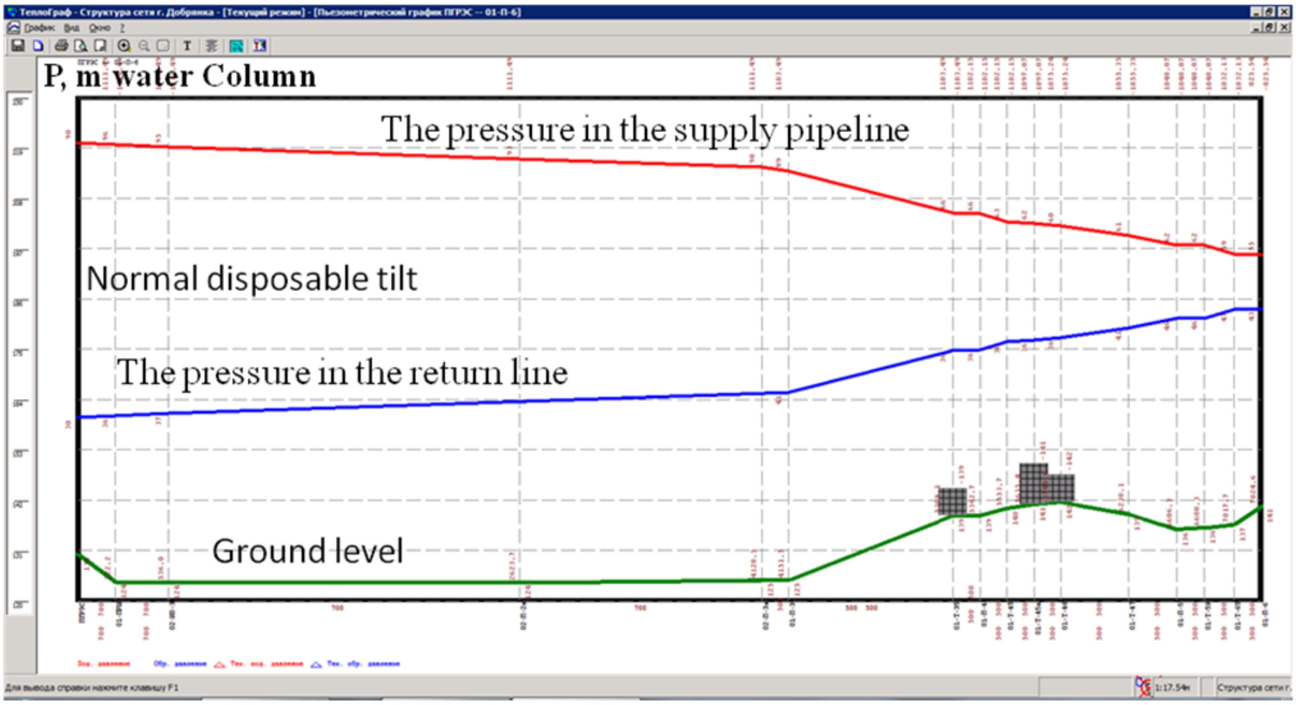

Fig.5

Rated piezometer chart from Permskaya GRES power plant to thermal chamber No.110/5A sheet 2(Fig.6)

Demonstrates the instability of operation of the heat network in the upper area of the pumping station

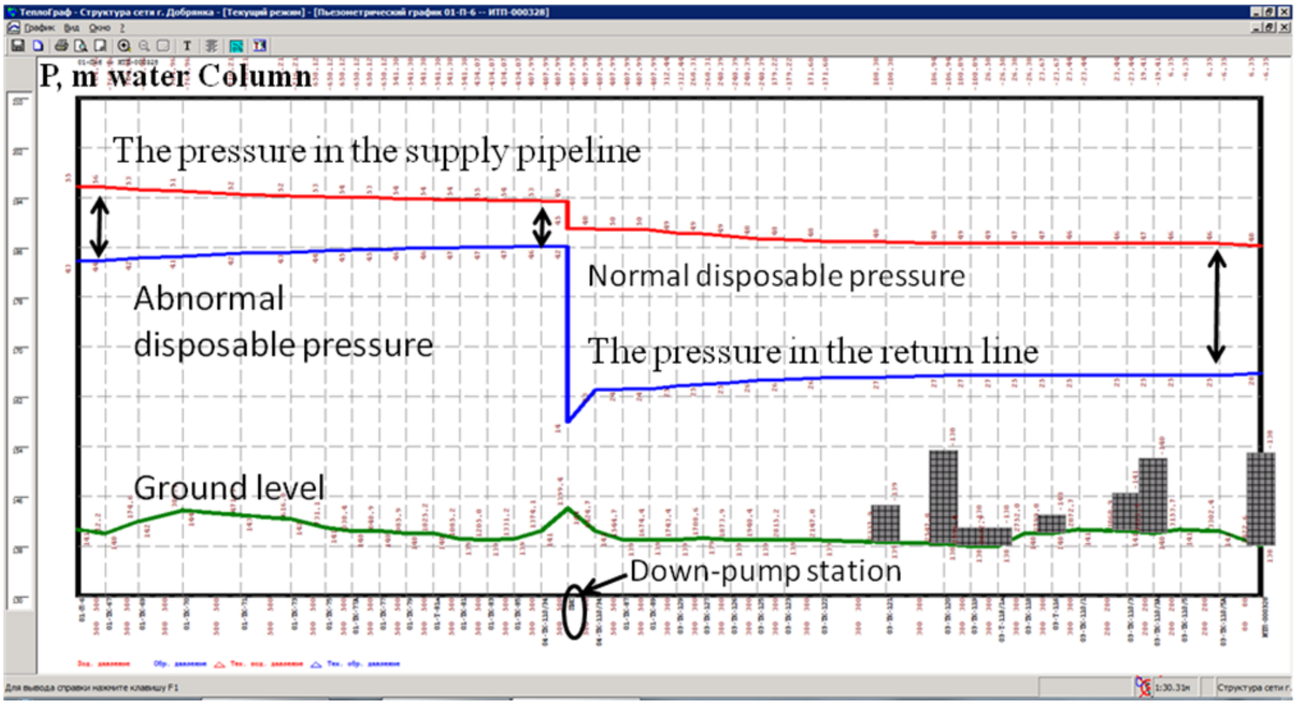

Fig.6

Proposals for enhancement of reliability of the heat supply system of the town

Based on results of the description and hydraulic calculation of the main heat supply networks it is proposed as follows:

- Perform overhaul of the heat supply network and to replace pipes which are in operation for more than 30 years.
- Increase pressure P1 at the output of Permskaya GRES power plant followed by adjustment activities of the consumers of the top zone of the pump house.
- In order to improve the heat supply system reliability and survivability it would be better to construct the 3rd supply pipeline 1Dn 500 at the area from booth No.3 up to arbitrary point No.65.

Isolation of emergency operation models

Recommendations regarding 'Isolation of situations' covered more than 30 various emergency operation modes and three proposals for installation of additional valves, one of the most significant examples is:

Installation of additional cut-off valve in a pipeline Dn 700 close to booth No. 0 aiming to split the heat supply system of the town into two lines of Dn 500 during summer operation.

Energy saving. Recommendations

Reconstruction of the Pavilion №0 to provide various options for working 3-circuit pipe at the site of the Pavilion to №0 Pavilion №3: 1Du700 / 2Dnom500, 1Du700 / 1Du500,

1Du500 / 1Du500. In interheating period, to reduce heat losses in this sector it is advisable to work on the scheme 1Du500 / 1Du500.

To eliminate forced heat to the central heat supply station between the outside air temperature -10 ° C and above, the stabilization of disposable pressure of subscribers, it is recommended not to switch off the pump on blending thermal point before the end of the heating season.

Proved efficiency of the proposed measures

These measures will allow to exclude summer heat losses in one supply pipeline Dn 700 (length exceeding 3 km) amounting to **2332.2 Gcal per year.**

Saving for the heat transfer company (Client in the project) will amount to **$ 30 172.89 per year.**

CONCLUSION

Within the framework of the project heat losses were calculated for each rated mode of heat delivery and heat consumption.

This calculation is one of the most important final results, since the values of heat losses are introduced into cost rate for heat energy transfer from the source to the end users.

Measures aimed at cutting such heat losses will allow to significantly reduce the cost for the transfer of heat energy.

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