Speed control of the HP "Zemliane" main networks pump

SOFENA, Sofia Municipality, Bulgaria

Summary

The ongoing implementation of new automatic heating substations in the apartments houses and installation of regulating valves on the individual room radiators cause substantial variations of the domestic heat consumption.

The aim of the case study is to increase efficiency of the HP "Zemliane", through saving electrical energy, consumed by the main heating network pumps, regulating their flows, respectively heating energy, by variable speed converters (VSC). The case study was financed by the Sofia Municipality as part of the Municipality share for founding SOFENA under the SAVE II project in 2001. In the development of the project experts from HP "Zemliane" and two professors form Technical University of Sofia took part.

End-user area		Target Audience		Technical	
	New buildings		Citizens	■	Energy efficiency
	Refurbishment of buildings	■	Households		Heating
	Transport and mobility		Property owners		Cooling
	Financial instruments		Schools and universities		Appliances
■	Industry		Decision makers		Lighting
	Legal initiatives (municipal regulations, directives, etc)		Local and regional authorities		CHP
	Planning issues		Transport companies	■	District Heating
	Sustainable communities		Utilities		Solar energy
	User behaviour		ESCOs		Biomass
	Education		Architects and engineers		Wind
	Other		Financial institutions		Geothermal
			Other		Hydro power
					Other

Context

The City of Sofia has 4 District Heating Regions with own District Heating Plants. One of the biggest is the "Zemliane" Heating Plant (HP). The Plant is 51% Municipality owned and 49% State owned. Because of the continually growing prices of natural gas, it is crucial for the HP to increase its efficiency, by decreasing of the losses in the plant and hence maintain the prices of the heating energy for the households in reasonable limits. Otherwise, some of the consumers should be forced to decline using the district heating. On the other hand, the ongoing implementation of new automatic heating substations in the apartments houses (in Bulgaria, over 95% of the flats are private properties) and installation of regulating valves on the individual room radiators, substantial variations of the heat consumption occur. This forced in the start of a project in 2002, assigned to SOFENA, for control the delivery of the heating energy by controlling the flow of the heating water.

Objectives

The aim of the project is to increase efficiency of the HP "Zemliane", through saving electrical energy, consumed by the main heating network pumps, regulating their flows, respectively heating energy, by variable speed converters (VSC). Up to now, the flow rates were regulated by means of throttling valves at the output of the pumps. This results in great losses of electrical energy, consumed by the pumps. The ultimate result of the project was development of Technical Specification for VSC purchase bid invitation.

Process

The project has two phases:

- Investigation of the hydraulic and temperature processes;
- Choice of means to effectively regulate the speed of the main network pumps.

In the **first phase**, the investigations were held using software modeling of the heat distribution network and the HP itself. A number of typical scenarios were simulated using real data for the outdoor temperature and the variability of the hourly heat consumption due to concrete needs of the inhabitants. Thus, the expected variations of the heat loads were determined and the necessary variations of the heating water flows (and temperatures) are examined. The investigations took into consideration the comfort of the consumers too. Based on the software simulations, the number of pumps and the structural scheme for installation of the VSCs was developed. The VSCs were chosen because they represent the most efficient method for speed regulation of the AC motors of the pumps. Again a simulation of the heating region with the VSCs was performed to verify the concept adopted. The expected savings of electrical energy and the investments Rate of Return were calculated.

In the **second phase**, a comprehensive specification of the requirements for the envisaged VSCs, appropriate for the existing pump motors, was presented. The necessary measuring devices and controllers for development of an overall control system were specified too.

There were no considerable problems.

Financial resources and partners

The project was financed with 10 kEURO by the Sofia Municipality (through it's firm "Toploficatzia-Sofia"Plc.) as part of the Municipality share for founding SOFENA under the SAVE II project in 2001.

In the development of the project experts from "Toploficatzia-Sofia"Plc., HP "Zemliane" and two professors form Technical University of Sofia took part.

Results

For the purpose of the model evaluation, the following table presents a comparison of the total heating water flow and the heat energy consumption values from real measurements, without pumps speed regulation, and those calculated by the model, with pumps speed regulation.

№	TYPICAL DAY	Average hot water flow, t/h			Average hourly heat energy consumption, MWh		
		Measured	Model	Relative difference, %	Measured	Model	Relative difference, %
1	Cold winter	9925,8	9344,0	5,9	337,6	319,3	5,4
2	Hot winter	9987,8	9024,2	9,6	170,9	225,2	-24,1
3	Summer	3637,6	3095,0	14,9	40,8	52,8	-22,8

During the real measurements, throttling valves regulated the hot water flow. as could be seen, the coincidence of the flow values from the real measurements and the model is very close, but the modeled values of the heating energy is overestimated by the model for hot winter and summer days. The model values for the heating energy are greater because during the simulation experiments we tried to meet as close as possible the requirements for the consumers' comfort.
Note: The heating energy during summer is for domestic hot water only.

The next table presents a comparison between pumps' electricity consumption without speed regulation (100%) and with speed regulation. Further, the expected savings are calculated. As could be seen, considerable savings are expected, especially during summer days.

№	TYPICAL DAY	Pumps daily electricity consumption, MWh			
		Pumps speed 100%	Pumps speed regulated.	Savings	
				MWh	%
1	Cold winter	138,776	120,869	17,907	12,90
2	Hot winter	143,288	111,239	32,049	22,37
3	Summer	71,440	37,133	34,307	48,02

From statistics we have the following figures for the number of the three types of days:

- Cold winter days 41,
- Hot winter days 124,
- Summer days 200.

The **expected savings** due to the pumps' regulation are:

For the cold winter days: 41 days x 17,907 MWh = 734,187 MWh,
For the hot winter day: 124 days x 32,049 MWh = 3 974,076 MWh,
For the summer days: 200 days x 34,307 MWh = 6 861,400 MWh,

Total: 11 569,663 MWh

Lessons learned and repeatability

It is beyond any doubt that all heat plants need regulation of the heating water flow to decrease their own energy losses. The most efficient method, known so far, for regulation the flow of pump with an AC motor is by means of Variable Speed Converter. Irrespectively from the exact value of the investment rate of return, our opinion is that all heating plants in Bulgaria and those using CHP technology should be equipped with VSCs. Therefore, we consider the project as having a high potential for replicability.

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