

# Managing a hydraulic system in district heating (1996 N7)

## Introduction

The International Energy Agency, IEA, District Heating and Cooling Implementing Agreement, in its efforts to point to ways to reduce the use of energy, has produced a number of publications dealing with various aspects of implementing and improving district heating and cooling systems. This brochure highlights the management of using low temperatures in a direct district heating system in the Netherlands.

More and more low-temperature systems are in operation in district heating. The advantages are obvious, especially when operating a direct system and a STAG (STeam And Gasturbine combined cycle), combined heat- and powerplant. Low temperatures allow for the cooling of condensers at temperature levels comparable with cooling towers at attractive electricity generating efficiency.

Return temperatures from consumers may be as low as 25-30 °C and may even be cooled down further by partially wasting heat.

If at the same time sufficient storage capacity of heat is included, a STAG powerplant may be operated almost at will, regardless of the discrepancy in demand for electricity and heating.

A STAG plant of limited capacity may be incorporated in a regional or national electricity grid, located near consumers and operated to follow heat demand if and when it occurs at optimum conditions for generating electricity. Such a plant, or several strategically located plants, could be regarded as stand-by capacity replacing older, less efficient powerplants.

When heat storage tanks are located near clusters of consumers, a reduction in piping and pumps will result. Allowing for a lower capital layout and reduced pumping costs.

This report looks at a system where all the above advantages were eventually taken into consideration.

Although some of the advantages were lost in the late implementation of the proper heat source, the overall picture will be of interest to all concerned with planning, operating and implementing district heating systems.

Apart from the obvious advantages in reducing the effect of heating upon the environment, the overall cost of heating could be reduced dramatically by generating electricity at the best possible efficiency, paying for the plant and the necessary adaptations to produce heat. Even more advantageous when governments find ways and means to allow consumption of energy used for heating only at consumer prices in order to force the optimal use of combined heat and power generation.

## Summary

Purmerend is a town with presently 60,000 inhabitants growing to 100,000. The town is located 20 km north of Amsterdam, the Netherlands.

In 1980 the town council of the municipality of Purmerend decided to implement a district heating system.

A municipal department was created to build, run and manage the system. At the same time the provincial electricity board decided to build a combined heat and power station (CHPS) from which heat would be sold to the municipal heating scheme at cost.

The present municipal heating system serves 20,400 housing equivalents through a 32 km transport pipeline and 165 km distribution pipelines. The system is equipped with 47 substations. Heat is supplied by a combined heat and power station, capacity 68 MWe and 65 MWth, an auxiliary boiler house (ABH) containing 4 boilers of 16 MW each, four mobile boilers of 3.5 MW for temporary or emergency duties and three decentralized storage tanks of a combined capacity of

550 MWh. The transport pipelines have a storage capacity of 70 MWh.

The system may be expanded to serve 30.000 housing-equivalents. Re-organisation of the power industry brought the CHPS in hands of the regional power company UNA (NV Energieproductiebedrijf UNA, the energy production company of the provinces of Utrecht and North Holland and the city of Amsterdam).

By means of well protected modem, public telephone and portable computer, the functioning of the entire system may be called up at any time, any place. Flow-charts and diagrams may be consulted and, whenever required, autonomous controls adjusted.

Overall control depends on the type of users served: one family housing, flats, major users. The controls are adjusted to demand for heating and individual supply of hot water. Heat consumption is measured individually by energy meters.

The entire transport, distribution and storage system is protected against six potential calamities: high pressure in pumping stations, high pressure in substations and distribution grids, high pressure in return pipelines, overflow of storage tanks, draining of storage tanks and uncontrolled flow into one another. Moreover, the entire system is monitored, data are collected and stored at 10-minute intervals. Faultfindings are sorted according to importance, registered and, where necessary action taken by calling up service personnel till satisfied.

### **Conclusion**

As was the case for many a heating system, the project Purmerend was originally designed and partly laid-out in far too grand a fashion allowing for far greater demand, as well per connection (housing-equivalent) as for the entire system (simultaneity), then would be

ultimately required.

This made it possible to change the planned indirect system to a direct system. The indirect system started from a 90/70 regime, i.e. 90 °C input into house connections and 70 °C return. This to be realized through transport pipelines wherein water at a temperature of 125 °C would be delivered.

At the time the first part of the system was completed, it became evident that a direct low-temperature heating system was possible, e.g. at a 90/50 regime. This would allow an equal transport capacity in the same pipelines and at the same pump pressures. Costs in layout, maintenance and heat losses would be considerably lower. Also, this regime corresponds well with the implementation within the system of a CHPS at the highest possible electricity generating efficiency. In addition, direct operation will reduce power required by pumps through upgrading of pump efficiency and consequent reduction of pressure.

The general conclusion drawn means that application of a direct system requires 15 % less capital investment than an indirect system. Additionally, heat losses and maintenance costs will be lower, upkeep and operation will be simplified.

Further reduction of pumping power may be obtained by installing booster pumps. Hereby all required pressure does not need to be supplied at source, giving the opportunity to either reduce pressure or reduce pipe sizes. Optimising of heat supply may be gained by optimal application of auxiliary heat sources and heat storage tanks.

Heat storage tanks have two functions. The first function is that they allow the CHPS to run at full capacity (or not at all) allowing for optimal efficiency. Additionally, this will reduce the number of starts, especially in

summertime whereby the plant may only be required to run once every two or three days. The second function is that storage tanks may deliver heat at times of peak demand, thus reducing the maximum size of heat source required. The obtainable savings in relation to the cost of installing heat storage tanks is so dramatic that consideration will be limited to optimisation.

To increase the effect to its maximum, tanks should be situated where their capacity meets demand.

An autonomous control system was designed, incorporating the entire system. When the CHPS produces heat, transport pumps will take hot water out of the storage tank into which the CHPS delivers, and deliver hot water to the transport grid at a pressure of maximum 6 bar. The water level of the storage tank nearest to the CHPS is controlled by a control valve, all other storage tanks by flow balancing. Control

of storage tanks and auxiliary boilers is autonomous. All sorts of situations may occur, depending on conditions in the grid.

The controls automatically take care of heat storage. Pumps are directed by a compilation of signals found in the grid, pumps located at the CHPS and at the ABH have key-functions.

By use of telecommunication and a central computer, control may be gained by means of altering parameters of the autonomous controls and reactivating local control systems.

Through conditioned parameters, storage tanks may be switched on or off by means of altering values intended for automatic functioning.

Pressure rising, and thus the outgoing flow to the grid, may be changed by altering the relating factor.

By this a state of the art district heating system was designed, implemented and managed for the municipality of Pumerend, the Netherlands.