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HEAT SUPPLIES PREDICTION BASED ON SIMILAR DAYS

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Abstract: *This paper describes an experiment focused on heat supplies proposal which is based on seeking days with similar outdoor temperature behaviour. There is model of distribution system for heat consumption prepared but the main questions still remain. When, how much and in what heat condition to deliver into the urban agglomeration? The first and simplest answer was similar as we did yesterday or better, day alike the one we want to control now. And of course, all needs must be always guaranteed. From the information we got from previous (similar) day, the new control starts. The idea is to make the model more precise and offer possibility to learn and improve control which worked, but perhaps can work better.*
Key words: *heat, consumption, model, temperature*

1. INTRODUCTION

This paper describes practical experiment which utilizes Municipal heating network simulation model (Vasek, 2010) which offers possibility to describe distribution and consumption of heat energy in the urban agglomeration. There are many different approaches to simulation models and operational optimisation of district heating networks (Helge et al., 2006; Balate et al., 2008) and Heat-load modelling (Heller, 2002). Our approach is to use data mining combined with simple model of heating network (Kral, 2010).

For our model, the chosen city was simplified and model was trained on real measured data. The main aim of this experiment, facing the question: When, how much and what temperature to set-up for hot water supply, is to find day whose outside temperature is close to one we are just going to control. Such, for “tomorrow” we need to know weather forecast and based on it to seek database to pick up day with likely the same values. The found day is base for “tomorrow” heat supply proposal. The expectations are that the data from that day are telling us consumption needs and also provide information about trace in time.

Simulation and control can be described in these steps:

- obtain weather forecast for day to propose
- seek and choose best matching day from the past
- train the model
- predict behaviour for proposing day

2. MODEL TRAINING

The experiment described below is based on real data measured by the heat producer and distributor company. The city about eighty seven square kilometres with about sixty seven thousand citizens has been chosen for setting up model (Vasek, 2010) and identification of its parameters (Kral 2010; Varacha, 2009). Location has been split into four parts to embrace the whole area, shown on Fig. 1.

The simulation model used basically contains two types of parameters:

- static, e.g. length and diameter of the pipes,
- variable.

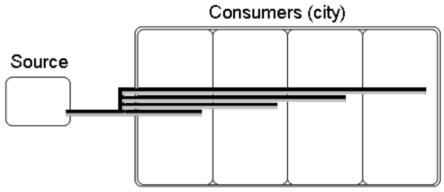

Fig. 1. Location split (4 parts with in- and out-coming pipes)

The variable parameters are covering variables which are adapted by the evolution algorithms during model training. Those variables held information about amount of heat mass needed for particular time. The evolution algorithm used in this model is described in detail in (Kral, 2010).

2.1 Particular experiments

The above mentioned design came from series of experiments. There were tested variant samples.

- Month and more
  The main idea of those tests was to cover variety of weather during a winter season and model identified on such long period will enclose the most situations. As shown on Fig.2., the prediction coming from such trained model has many inaccuracies. Even the identification was not able to adapt to all abnormalities.
- 14 days
  Subsequent alteration comes up with the same ideas as Month experiment – to adapt model parameters for long period but train model for short prediction, just after trained samples. The results are quite better compared to month samples but disadvantage of this approach is high sensitivity to outside temperature changes.
  For example, if temperature changed into values which were not included in training samples, the subsequent prediction for these cases is inaccurate.
- Week
  Another cut in training samples length brought another improvement. The model is adapted more accurate but problem with incoming days which are markedly different still remains. See Fig. 3.
- Day
  As can be seen from previous experiment the best result could be obtained if the model is adapted for small time period but subsequent conditions must be met.

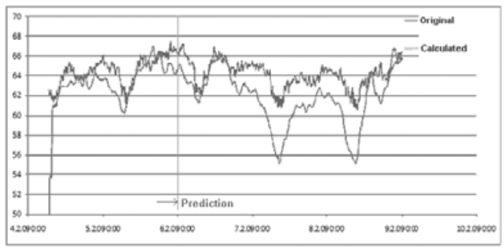

Fig. 2. Month adapted and subsequent prediction

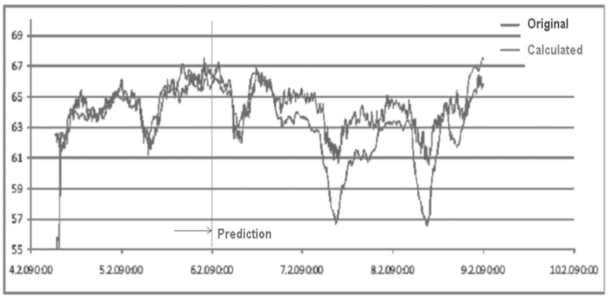

Fig. 3. Week adapted and subsequent prediction

Difference between Original (measured) and Calculated (predicted) course, which can be seen in Fig.2 and 3 is reduced when shorter time period is used for training. Output values, shown in those figures are back-water temperatures.

3. SIMILAR DAY

Unlike previous experiments, the examination of the period just prior to the desired section of prediction is not required, but it is the principle of finding similar days (periods), and application of its relevant model parameters on the stretch of the same nature. The advantage of this approach should also be that, having regard to the accuracy of weather forecasts for the period length of 24 hours so there should be no unexpected fluctuations and thus should be removed error caused by previous procedures inappropriateness of the samples used to identify the model.

To determine whether the day (period) is "similar" to another, the minimum variations of outdoor temperature were used. The day called “similar day” to day we just want to predict is considered such a day when outdoor temperatures forecast deviation from the measured temperature will be minimal.

Needs to verify the approach, prediction was carried out for the day already gone, and therefore was not required for outdoor temperatures forecast. Forecast has been replaced by the real temperature record. Two pictures below show the example of selected similar days, Fig. 4 illustrates the outside temperature and Fig.5 shows the values of mass flow supplying the particular location.

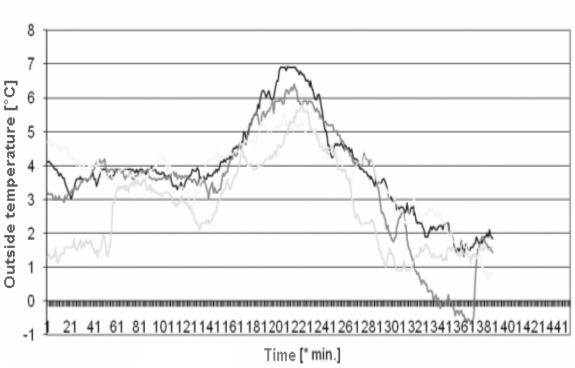

Fig. 4. Course of the outside temperature in similar days

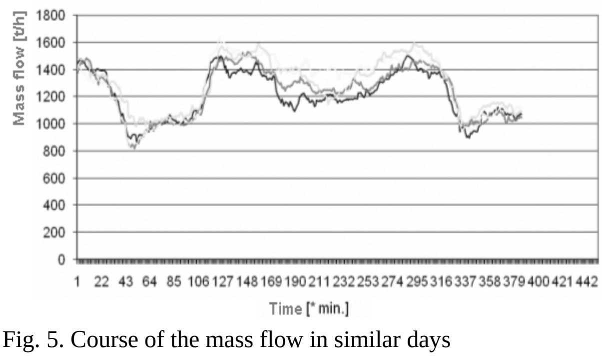

Fig. 5. Course of the mass flow in similar days

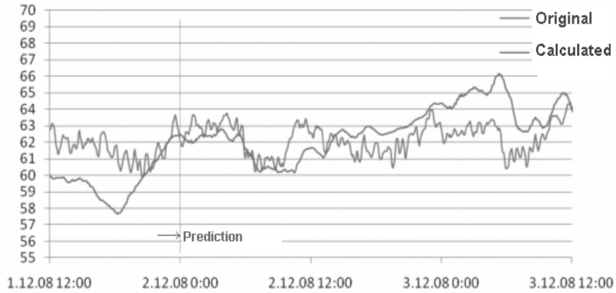

Fig. 6. Similar day adapted and subsequent prediction

The main idea was to identify the model for one of those days, and then verify that provided parameters give as accurate results in the field of prediction for the similar days. Fig. 6 shows the good agreement of expected and actual returned water temperature. With regard to the results of all previous test method appears to identify a model based on such day seems to be the most effective.

4. CONCLUSION

The experiments focused on adaptation for longer periods (week, month, etc.) suggest the increased need for finding the parameters reflecting the diversity of the system behaviour on a different course with the outside temperature. Tests show that the most appropriate method of identification and prediction of back-water temperatures into the model can be considered an application of similar days method. In subsequent experiments, it would be useful to examine the possibility of establishing different ranges of similarity search (now "day" = from midnight to midnight of the following day). However, the model which takes into account most important parameters affecting the amount of the heat and the experiments carried out so far showed good performance.

5. ACKNOWLEDGEMENTS

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