Usage of Web Applications for Monitoring of Geothermal Systems

Radovan Hajovsky*. Petr Vojcinak**
Jiri Koziorek***

**Department of Measurement and Control, VSB – Technical University of Ostrava, Ostrava, Czech Republic (e-mail: radovan.hajovsky@vsb.cz).*
***Department of Measurement and Control, VSB – Technical University of Ostrava, Ostrava, Czech Republic (e-mail: petr.vojcinak@vsb.cz)*
****Department of Measurement and Control, VSB – Technical University of Ostrava, Ostrava, Czech Republic (e-mail: jiri.koziorek@vsb.cz)*

Abstract: This paper deals with a description of a unique system for borehole temperature measurement, and its consequent Web application for data visualization based on OPC communication and FTP access. There are some short descriptions of the Big Research Polygon (BRP), and the Small Research Polygon (SRP) – main parts of the largest heating system with heat pumps in the Czech Republic. They serve not only for scientific and education purposes, but also for problem of renewable energy resources. Each of these boreholes contains some temperature sensors (analogue, digital) connected to some PLC/PAC systems for data acquisition, data processing, and their saving to a measurement file. A Web application uses possibility of dynamic HTML pages created in PHP programming language. Current version of this application reshapes measurement data (from boreholes and heat pumps) into some general tables in dependence on borehole competency, and heat pump parameters, such as mass-flow, density, or volume-flow. In the future it is planned to use MS SQL database system.

Keywords: Database systems, FTP access, geothermal systems, heat pumps, HMI/SCADA system of Promotic, OPC communication, PAC/PLC systems, research polygons, temperature profiles, Web application.

1. INTRODUCTION

First installations of heat pumps have practically expanded since 1970s in the USA in connection with the 1973 oil crisis. In the Czech Republic this phenomenon has started since 1990, when the first high-quality heat pumps were especially imported from Germany, Austria, and Sweden. Although a gradual progress of their installations took place during the whole time of 1990s, massive expansion has just started since 2000 due to advantageous governmental support programs (Koziorek et al., 2009).

Hence in 2006 a multifunctional building of Nova aula VSB – TUO became one of the most extensive sui generis projects realized in the Czech Republic, where heat pumps are installed. Nowadays it is used not only for tutorial and trainee, but also for ceremonies (e. g. graduation ceremonies, the Academic Senate councils etc.), congresses, international conferences, and cultural activities (Fig. 1) (Bujok et al., 2005).

At the district of VSB-TUO there are two experimental polygons used for applied research of any temperature changes of the rock massif:

- the Big Research Polygon (BRP),
- the Small Research Polygon (SRP).

Installation of measuring systems for the BRP and the SRP was realized to acquire some data about heterogeneous system behaviour of a ground exchanger for heat pumps installed at the district of the Nova aula VSB – TUO building (for the BRP), and the building of the Energy Research Centre (for the SRP). Ground exchanger temperature measurement during heat pumps operation is used for mathematical modeling and simulation of space thermal exchange, and system behaviour prediction in the future (Koziorek et al., 2009).

Fig. 1. A multifunctional building of the Nova aula VSB – TUO located in Ostrava – Poruba.

All the experimental and research activities are coordinated by research team, which consists of the members from (Bujok et al., 2005):

- Faculty of Mining and Geology,
- Faculty of Mechanical Engineering,
- Faculty of Electrical Engineering and Computer Science,
- VSB – Technical University of Ostrava,
- Energy Research Centre.

1.1 The Big Research Polygon (BRP)

The BRP is mainly determined for rock heat take-off influence monitoring. There are 10 Swedish heat pumps (type of IVT Greenline D70) with total power of 700 kW at the Nova aula VSB – TUO building. This research polygon has 110 operating boreholes with 140 m depth represented so-called low-energy heat source. These boreholes are also line-sorted with the distance of 10 m between lines, equipped with some double U-tube polyethylene (PE) collectors, and fixed by compaction grouting compound (Koziorek et al., 2009). BRP monitoring configuration is as follows:

- **10 energy-exploited boreholes** (V071, V073, V075, V079, V081, V082, V084, V086, V087, V088) – they are connected to heat pumps, whereas input line includes 2 temperature sensors in depths of 20 m and 100 m, output line includes 4 temperature sensors in depths of 20 m, 50 m, 100 m, and 140 m,
- **5 measuring boreholes** (MV01, MV02, MV03, MV04 a MV05) – they are not connected to heat pumps, whereas 4 temperature sensors are situated in depths of 20 m, 50 m, 100 m, and 140 m,
- **1 groundwater borehole** (HKV01).

This system for borehole temperature measurement, monitoring and systematic archivation, used for BRP heat pumps, was started on 1th September 2007 (Bujok et al., 2005).

1.2 The Small Research Polygon

The small research polygon is mainly determined for regenerative and accumulative behaviour of the rocks near energy-exploited boreholes used for small-business applications, especially family houses. This polygon is located near the Energy Research Centre building, which is also situated at the district of VSB – TUO, and composed of 9 boreholes and 3 groundwater boreholes as follows:

- **1 core borehole** (A) – depth of 160 m, 17 temperature sensors and distance between them is 10 m; constructed in 2008,
- **1 testing borehole** (C1) – depth of 140 m, 15 temperature sensors and distance between them is 10 m; constructed in 2008,
- **4 monitoring boreholes** (C2, E1, E2, E3) – depth of 140 m, 8 temperature sensors and distance between them is 20 m,
- **2 technological boreholes** (TC1, TC2) – depth of 140 m, input line includes 2 temperature sensors (20 m, 100 m), output line includes 4 temperature sensors (20 m, 50 m, 100 m, and 140 m); these boreholes are connected to 2 Swedish heat pumps (type of IVT Greenline E11 Plus) located in the Energy Research Centre,
- **1 experimental borehole** (PV) – depth of 20 m, 29 digital temperature sensors (type of DS18B20, TO92 case) and sensor distance is from 0.25 m till 1.00 m depending on their depth,
- **3 groundwater boreholes** (B1, B2, D) – underground water level and temperature measurement.

All the boreholes, except the experimental borehole and groundwater ones, contain an analogue type of temperature sensors – PT1000 type with 4-wire connection (Koziorek et al., 2009).

2. DATA ACQUSITION, PROCESSING, AND PRESENTATION

In the case of these polygons there are two ways how to realize remote access to measured data, thus:

- **using remote desktop mechanism in Windows** – this way is used especially for service access to the monitoring application and also for standard work with monitoring system,
- **Web access to monitoring application** – Promotic system provides Web functionality – local application can act as Web server and visualization screens can be displayed via Web browsers.

2.1 Development of Web application in Promotic

Web Server is a part of Promotic application, which can provide local visualization screens as Web pages to Internet/intranet (HTML, XML, and BMP formats). These pages can be displayed in standard Web browsers (Internet Explorer, Firefox, Netscape, Opera etc.), but due to dynamic HTML pages it is required to use IE version 6 and higher for correct data visualization (Fig. 4) (Hajovsky et al., 2009).

Development of a Promotic application has some advantages, for example:

- **clients –** it is not required Promotic system installation on a client PC, because measured data can be viewed in some Web browser,
- **data transmission –** it is based on HTTP protocol, port 80 can be used for local network,
- **data access –** WWW pages can be available only for given group of users according the authentication.

Download English Version:

https://daneshyari.com/en/article/719552

Download Persian Version:

https://daneshyari.com/article/719552

Daneshyari.com