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WellTaPPS, A Web-Based Oracle Database Wellbore Temperature and Pressure Plotting Software

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ABSTRACT

The Reservoir and Resource Management Department (RRMD) developed a Web-based Oracle Database system known as Reservoir Information System, to store and process reservoir engineering and well logging data. The system has a Windows-based texture of data entry and output. Being web-based, any authorized user connected to the Local Area Network (LAN) can enter and retrieve data using the internet browser.

To fully serve the requirements for a fast and accurate retrieval of information from the Oracle database, web-based graphical interfacing software packages were programmed for development. Among these software packages are plotting of wellbore temperatures and pressures, bore output measurements graphing module, and contouring of reservoir temperatures and pressures.

Wellbore Temperature and Pressure Plotting Software or WellTaPPS was the first developed by RRMD. This web-based graphical application is event-driven and user-friendly interface software designed to download multiple sets of temperature, pressure, casing and other reservoir data from different Oracle database tables. It is capable of generating multiple temperature and pressure plots with casing profile, blockages and permeable zones. Additional features included in the software are interpretation modules for prediction of stable temperature, Boiling Point with Depth calculations and potential for the well to self discharge.

1. INTRODUCTION

The need for accurate, complete, and well-organized data is critical to the success in the management of geothermal resources. Data management affects all phase of geothermal energy utilization; from exploration, development, exploitation to the abandonment of the project. The need by geothermal operators to have an integrated and sophisticated data management led to the development of database softwares that can handle scientific and engineering data. Foremost of this is the GDManager software, developed by PB Power, GENZL Division. GDManager stores field data and can be accessed readily, with functions that includes maintenance of data integrity, data correlation between disciplines, integration of data from multidisciplinary studies, manipulation of data and its validations (Anderson, 2000). The Philippine Geothermal, Inc. adopted the Oil Field Manager (OFM), a program developed by Geoquest Schlumberger, in storing reservoir engineering data and is used in managing their operating fields (Aquino, 2001).

In the Philippine National Oil Company-Energy Development Corporation (PNOC-EDC), the Reservoir and Resource Management Department (RRMD) developed the Reservoir Information System (RIS) in 1997. The RIS is a web-based geothermal database management system using thin-client architecture as its repository of large volumes of data coming from the company's different productions fields and exploration areas (Zapanta, 1997). At present, the RIS database contains information of around 350 wells from the geothermal production fields of Bacon-Manito (BGPF), Tongonan (LGPF), Mindanao (MGPF), and Palinpinon (SNGPF), developing area of Northern Negros (NNGP), and from exploration areas of Mt. Labo, Central and Southern Leyte.

Geothermal data gathered from these sites are collected into the central database located in our Ft. Bonifacio head office. The database contains well test data interpretations such as permeable feed zones, injectivity indices, permeability thickness and skin value; downhole data like well blockages, pressure and temperature data; and drilling data such as casing configuration and drilling directional surveys.

The present RIS, however, still requires a lot of improvement before it can fully serve the requirement of RRMD of a fast and accurate retrieval of information. In particular, the system does not have a graphical interfacing software that can download multiple sets of temperature, pressure, casing and other well and reservoir data from the different database tables. Moreover, the system cannot generate multiple temperature and pressure plots with casing profile, blockages and permeable zones.

To address this concern, RRMD developed the Wellbore Temperature and Pressure Plotting Software (WellTaPPS) which can retrieve data from various database tables and generate multiple set of temperature and pressure graphs. These plots will give complete and accurate information quickly that will aid the decision-making process of end-users managing geothermal fields.

2. EVOLUTION OF THE TEMPERATURE AND PRESSURE PLOTTING SOFTWARE

PNOC-EDC has been operating geothermal production fields in the Philippines for over twenty years. Through this long period of managing geothermal fields, it has accrued voluminous well and reservoir data that are important in the management of the geothermal reservoir. Before the era of computers, the data were tabulated and plotted manually, and were kept in filing cabinets.

With the advent of computers in the mid 80's, plans were made to automate or semi-automate the plotting of temperature and pressure profiles. This was first realized in the early 90's when the then Reservoir Engineering Section of the Geoscientific Department first acquired a commercial plotting software GRAPHER™ for DOS, developed by Golden Software. Using the BASIC programming language a routine was developed to interface with GRAPHER™ for DOS (Figure 1). The "KTKP Plot" (Kuster Temperature and

Kuster Pressure) was the first version of computer application software in plotting temperature and pressure surveys. The required input data were basic well data, vertical and measured depths, and temperature and pressure survey data. The program automatically saves the inputted data as an ASCII file. GRAPHER™ is launched to plot the temperature and pressure profiles.

With the start of the Windows operating system era in the mid-90, Golden Software delivered its first Windows version of GRAPHER™ to the department. The more user-friendly Windows version of GRAPHER™ was installed in all project sites and used extensively not only in plotting temperature and pressure profiles but also in other reservoir engineering and well logging plotting applications. The problem in the use of GRAPHER™ was the different sites developed their own databases using different applications such as Paradox and Excel. Furthermore, different project sites developed different formats in plotting temperature and pressure profiles.

To address this problem, SNGPF Reservoir Engineering staff developed the Windows version of KTKP Plot, named as "KTKP3" (Tilos, 1998). Like the KTKP Plot DOS version, a routine was created using DELPHI to interface with GRAPHER™ for Windows (Figure 2). Similar to the DOS version, the temperature and pressure profiles were generated by launching GRAPHER™ for Windows.

This application was, however, not adopted in other project sites (BGPF, LGPF and MGPF), since they already adopted their own plotting routine.

3. DEVELOPMENT OF ORACLE DATABASE GRAPHICAL USER INTERFACE PLOTTING SOFTWARE

The development of Web-based Oracle database system was conceptualized primarily for RRMD to have a single centralized database system located in the head office, and thus avoid multiple databases residing in several field locations. The database can be updated live in all project sites of PNOC-EDC and in the head office using a web browser such as Microsoft Internet Explorer. Processed data can also be retrieved using a web browser. Though the system has been in placed since 1997, this was not used extensively particularly in the project sites primarily because of very slow network connection between the Head office and the project sites, and the lack of application plotting software to retrieve the data from the Oracle database

It is a common misconception, especially among non-technical users and managers, to put corporate data in a single centralized database from which all users in all disciplines to manage their data (Hoffman, 2003). For the case of Reservoir Engineering Department of PNOC-EDC, this is not always practical because there are wide differences between non-technical, like financial, accounting, etc., and technical database requirements. Centralized database, from our experience, compounded by data access problems brought about by network instability and bandwidth limitations.

Reservoir Engineering, in designing its database system, merged the advantages of centralized and distributed databases. Data inputted from the different field locations goes to the central database located in Fort Bonifacio. The central database allows easier administration, support, maintenance, scalability, and adaptability to company standards. This central database, however, is replicated in the field to allow access to data from other locations and flexibility in developing customized programs or application integration solutions.

To optimize the utilization of the RIS database, RRMD envisions the development of application softwares that will retrieve and plot data from the Oracle database. The application softwares include plotting wellbore temperature and pressure, bore output trends and bore output curves, among others. The first to be developed was the temperature and pressure plotting software.

3.1 "WellTaPPS": Wellbore Temperature and Pressure Plotting Software

The development of application software to retrieve and plot temperature and pressure data from the database was conceived in early 2003. The ideal software has to be Web-based, event-driven and user-friendly (click-and-draw, drag-and-drop type). It must have the basic controls of a Windows environment, such as "SAVE", "EDIT", "VIEW", and "PRINT". Moreover, the software must be compatible with Windows 98, 2000 and XP operating system.

WellTaPPS was developed using Java™ 2, an object-oriented programming language. Java is the only programming language capable of creating applets designed to be transmitted over the Internet and executed by a Java-compatible Web browser. Furthermore, applications created in Java can be executed in any operating system platform.

Aside from the Web-based version of WellTaPPS, a stand-alone version was also developed. Due to slow network connection between FB and project sites the Oracle database was replicated in Microsoft Access database. This version of WellTaPPS will be used in all project sites until the connection problem is addressed. Both versions have the same graphical user interface (GUI).

WellTaPPS is capable of extracting temperature and pressure data from the database and plotting these data against depth. The program basically displays dynamic two-dimensional plots of temperature and pressure data for any given well. Several temperature and pressure data measured during several survey runs are shown in different symbols and colors for distinction. The survey run condition, for example shut survey or flowing survey, and the date of survey run are also indicated as guide for analysis.

3.1.1 Basic Features of WellTaPPS

When the program is invoked, the GUI will initially display a window showing the different projects sites of PNOC-EDC. By selecting a particular project site, a list of wells drilled in the said project will be displayed. When a particular well is clicked, the program by default settings will generate a two-dimensional plot showing the casing configuration, depths of permeable zones, and blockage survey depths for the selected well. Also tabulated in the interface are the temperature and pressure surveys conducted on the selected well. The temperature and pressure data will be plotted by checking the check box of the survey runs (Figure 3).

WellTaPPS program is also capable of displaying tabulated well basic data such as casing information, permeable zones, and blockages (Figure 4) as well as temperature and pressure data (Figure 5). A maximum of five wells can be analyzed in a single session. Another feature of WellTaPPS is "KTKP Comparison" wherein the user can compare different survey runs of different wells and from different projects at the same time in a single plot (Figure 6).

3.2 WellTaPPS Utility Modules

WellTaPPS is also designed as a tool for wellbore interpretation and analysis software. Utility modules are incorporated in the program that will help reservoir and well test engineers obtain a quick and accurate analysis by simply clicking and dragging at the user interface.

3.2.1 Stable Temperature and Pressure

From the plotted temperature and pressure in the interface, the user can generate stable temperature and pressure for the well by just clicking at plotting area the data points which the user interprets as the stable values. The values generated are saved into the Oracle database (Figure 7).

3.2.2 Boiling Point Depth (BPD)

By invoking the BPD in the options menu bar, the BPD curve will be displayed with the top-most Y-axis value as its default value. By dragging the BPD curve, the user can freely set the depth where the boiling point starts.

3.2.2 A_f/A_c Module

Production of steam, particularly for new wells, does not result in successful discharge. Several factors influence the outcome of a discharge attempt, the major one being thermal losses to and through the casing.

An empirical method was developed to predict the success of well discharge after being stimulated by air compression. It is postulated that the amount of steam flashed from the water will be proportional to the excess energy contained above the energy of saturated water. This is also proportional to the area of flashing, Af, enclosed by the boiling point curve and formation temperature profile. It is also postulated that the energy taken from the steam flow up the well used to heat the casing is proportional to the area of condensation, Ac, between the formation temperature and fluid flowing temperature profile which is approximated to be 100ºC. For most PNOC-EDC wells that were compressed, correlations were established to serve as guidelines for a successful discharge of a well (PNOC-EDC, 1990). These are, if Af/Ac < 0.70 – little chance of successful discharge; if Af/Ac > 0.85 – excellent chance of successful discharge, and; if Af/Ac = 0.70 – 0.85 – uncertain discharge.

Using WellTaPPS, the user can determine if the well will discharge successfully or not by air compression. This is done by setting the BPD curve to a depth where the air compressor can compressed the well's water level to its maximum depth, normally at the production casing shoe, and then invoking the Af/Ac in the options menu bar, the program then calculates for the Af/Ac value (Figure 8).

3.2.2 Pressure and Temperature Difference

The program also features a module that will calculate for the pressure and temperature difference on a particular depth of the well in study. By clicking the survey runs, the drawdown between the succeeding runs against the baseline (the first selected survey) is calculated (Fig 9). The generated drawdown table can then be saved as a comma delimited (*.csv) format. This file is retrievable using Excel.

4. SUMMARY AND RECOMMENDATIONS

RRMD's Web-based Oracle database and application softwares are still in the process of development. To fully serve the requirements for a fast and accurate retrieval of information from the RIS, graphical interfacing softwares `such as plotting of wellbore temperatures and pressures, bore output measurements graphing module and contouring of reservoir temperatures and pressures are programmed for development. WellTaPPS was the first developed by RRMD. WellTaPPS, in the near future, will be linked to other softwares used by reservoir engineers such as wellbore simulators (WELLSIM and GWELL) and reservoir simulators (TETRAD, TOUGH2). Simulated temperature and pressure, which will be saved into the database, will be extracted and plotted by WellTaPPS. Another plot to be developed is a time-series graphing module that will plot the pressure and temperature drawdown of wells in study. This graphing module will be an integral part of WellTaPPS.

RRMD envisions sharing all information in the RIS to all departments of PNOC-EDC involved in management of geothermal resources. WellTaPPS will eventually be made accessible to Drilling, Production and Geoscintific Departments as well as to the decision-making body of the company.

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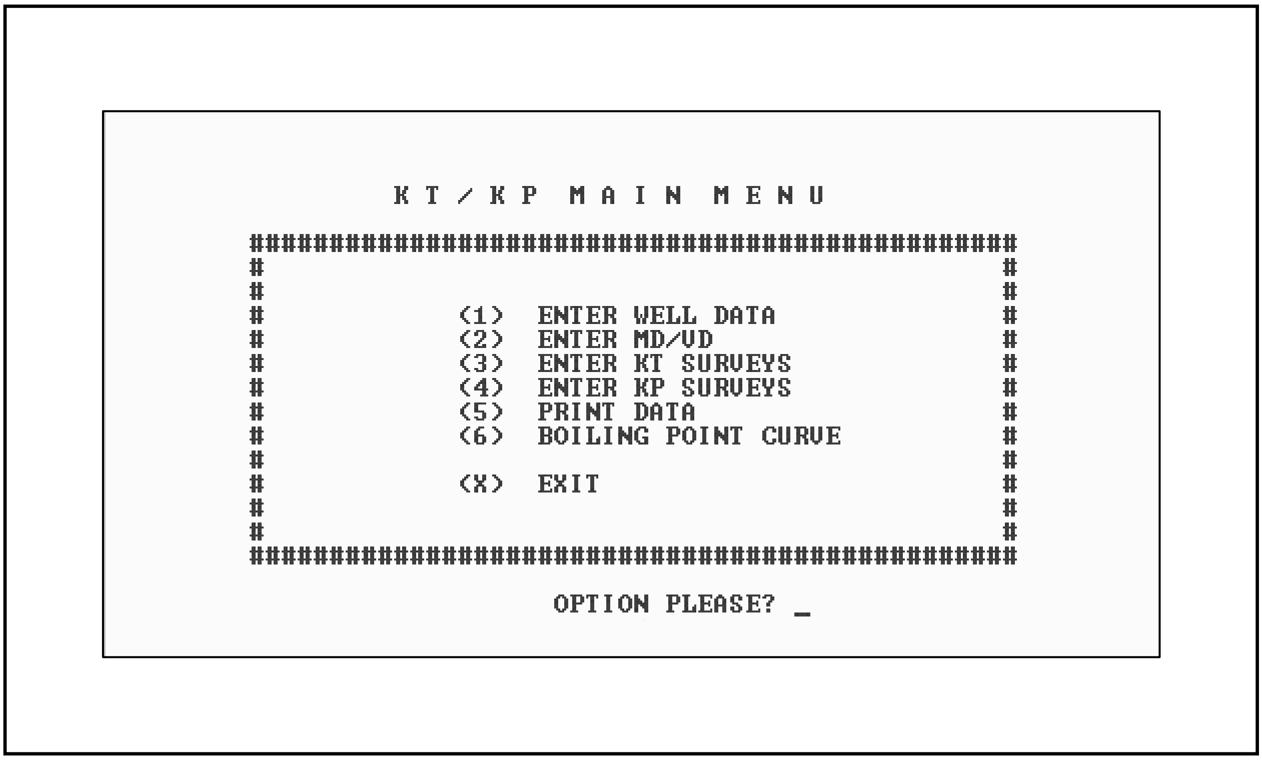

Figure 1: The user interface of KTKP Plot, DOS version, in plotting temperature and pressure surveys.

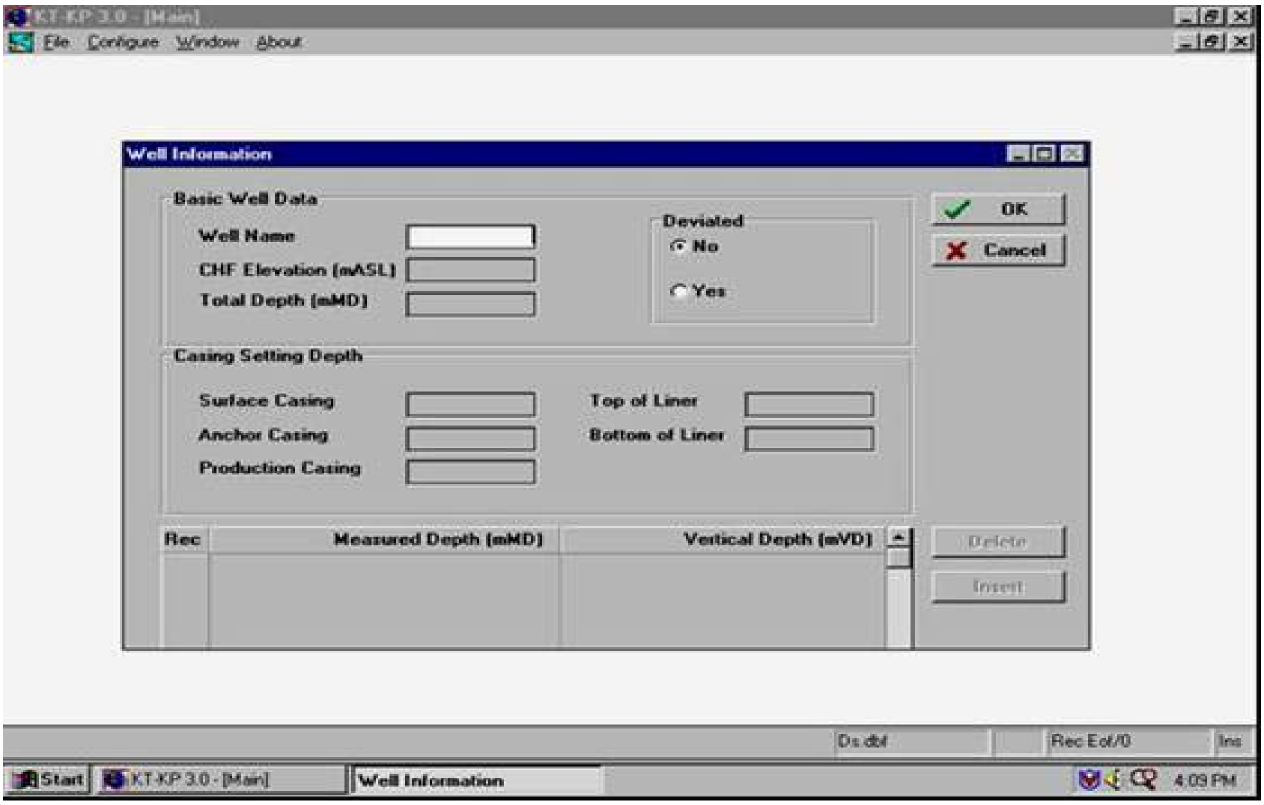

Figure 2: The user interface of KTKP Plot, DOS version, in plotting temperature and pressure surveys.

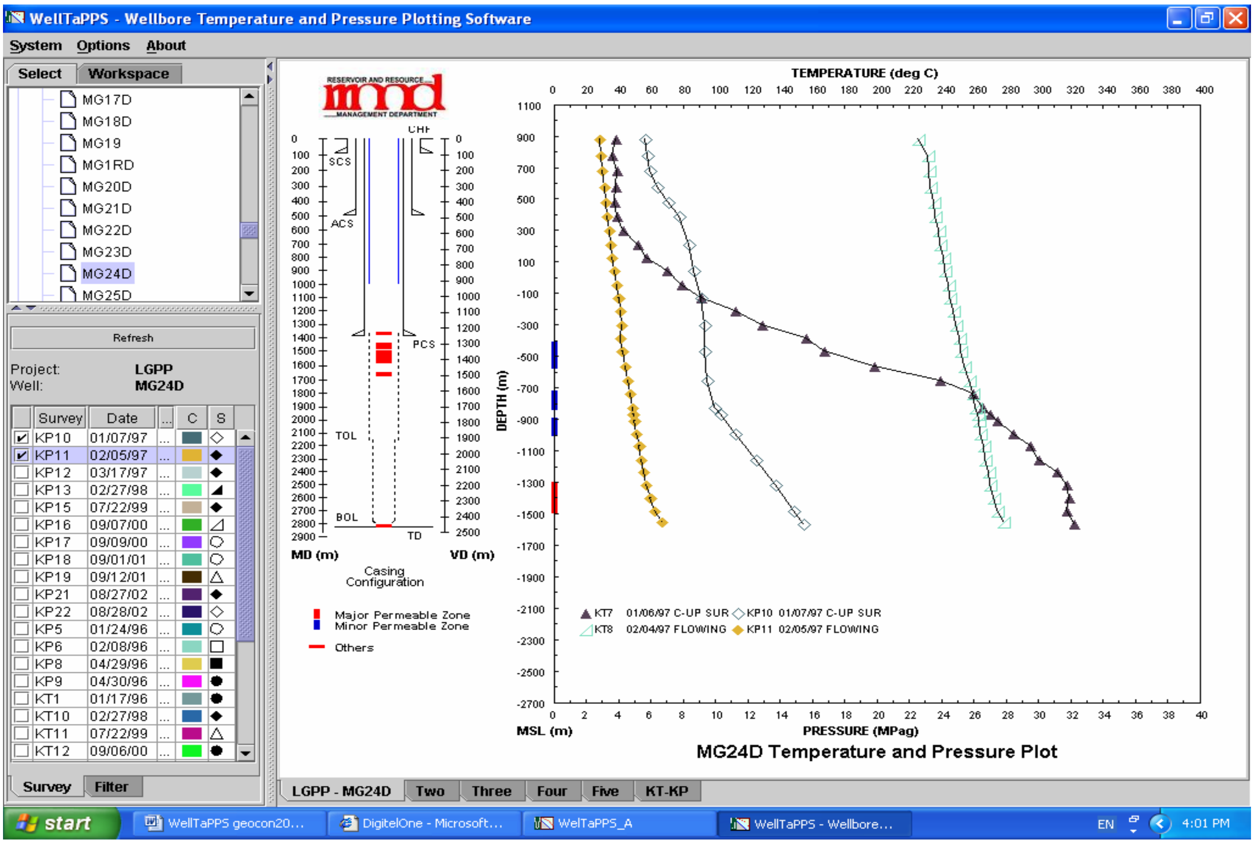

Figure 3. The graphical user interface of WellTaPPS showing the different wells found on a project site and the corresponding surveys conducted on the well.

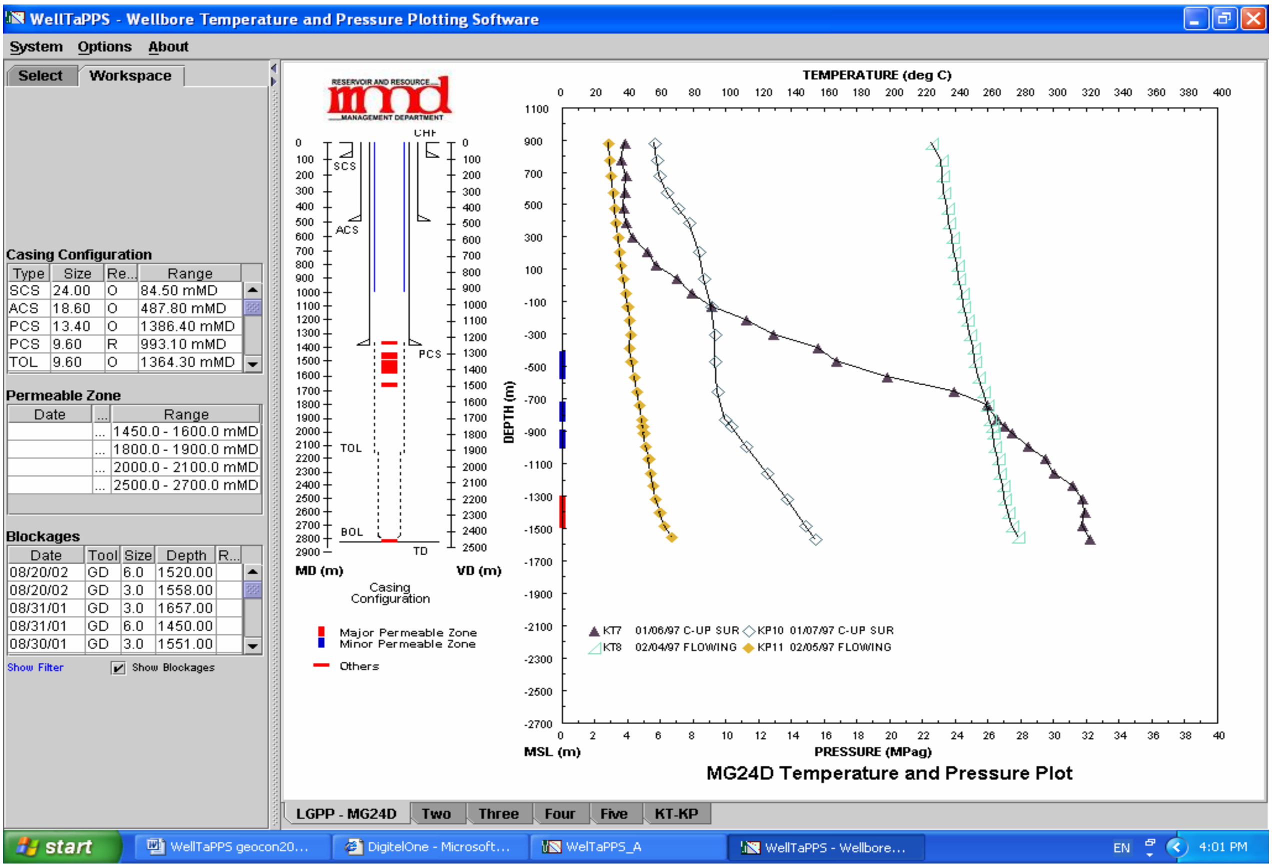

Figure 4: The temperature and pressure profiles of a production well and the wells basic information such as permeable zones, blockage surveys and casing configuration are tabulated by WellTaPPS.

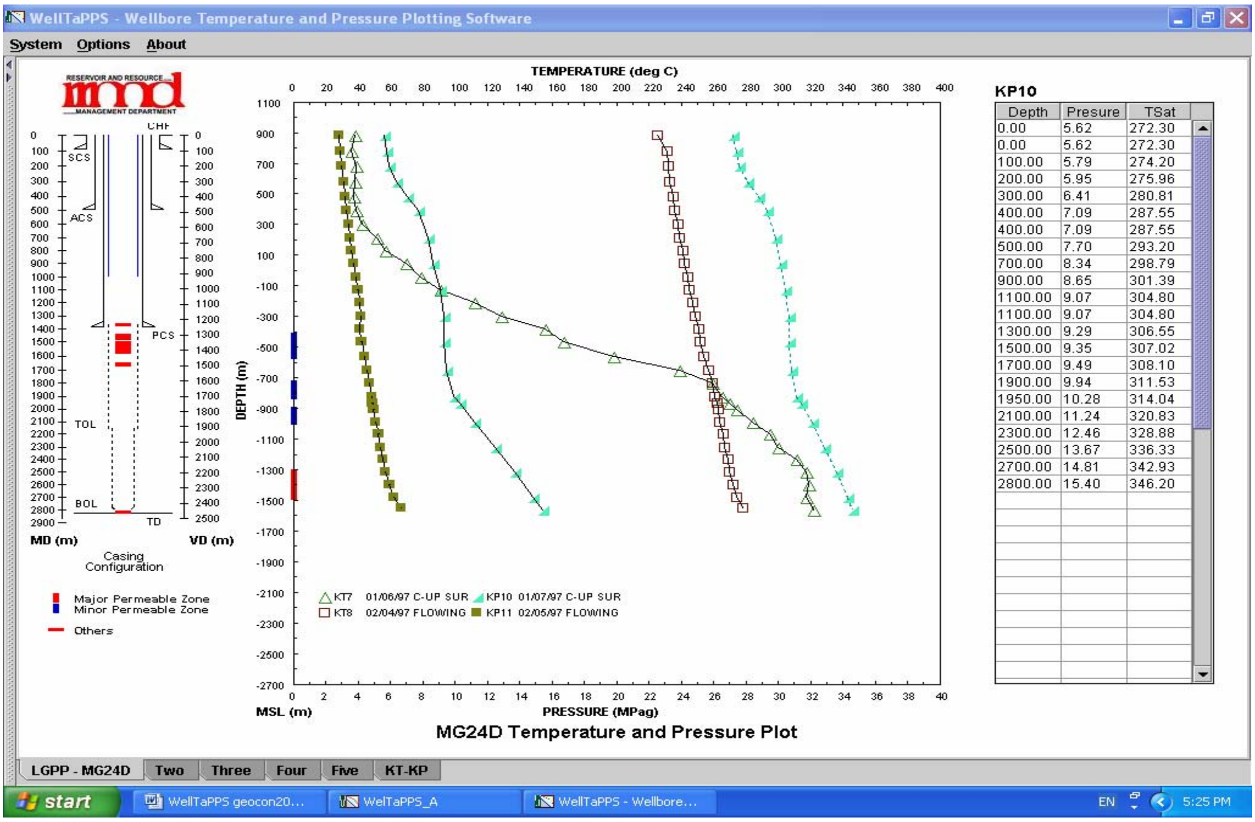

Figure 5: The temperature and pressure profiles of a production well and pressure data with its corresponding saturation temperature also plotted in the GUI.

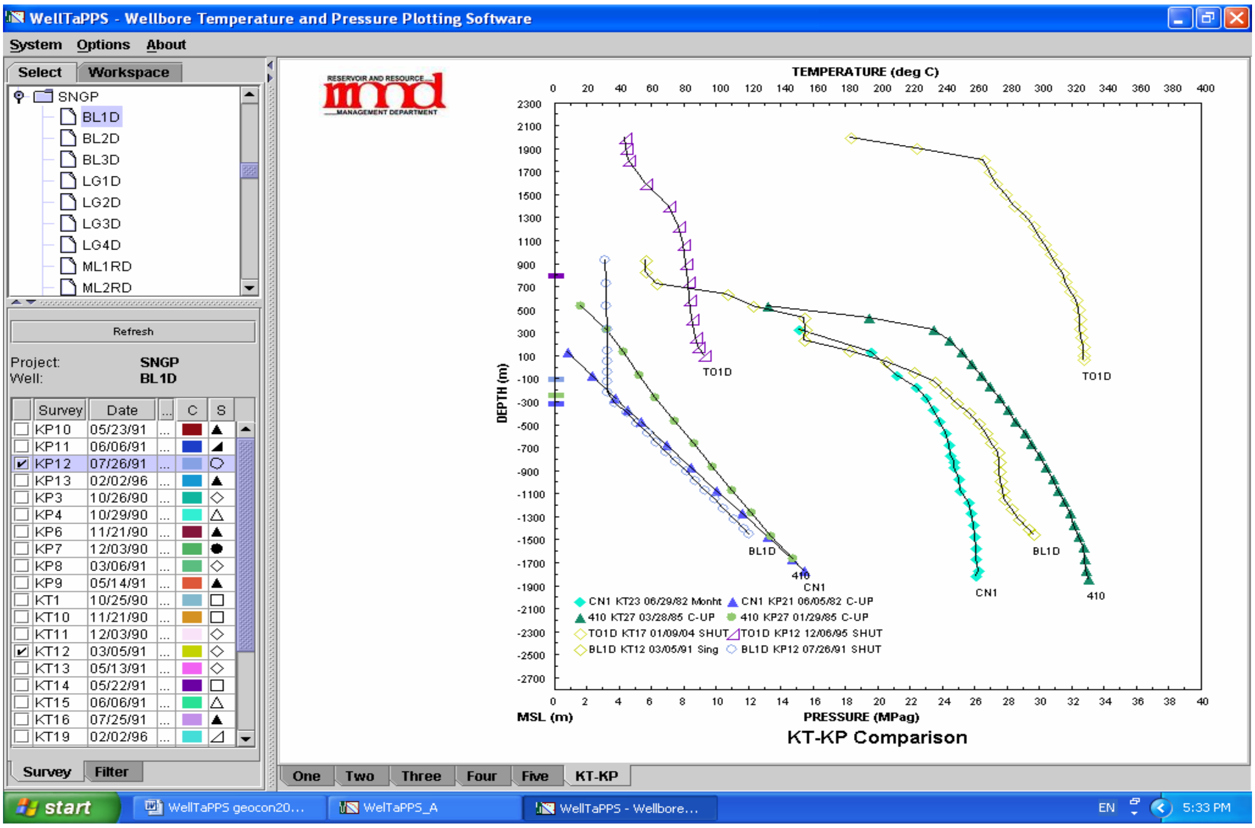

Figure 6: The KTKP Comparison showing the different temperatures and pressures of different PNOC-EDC projects.

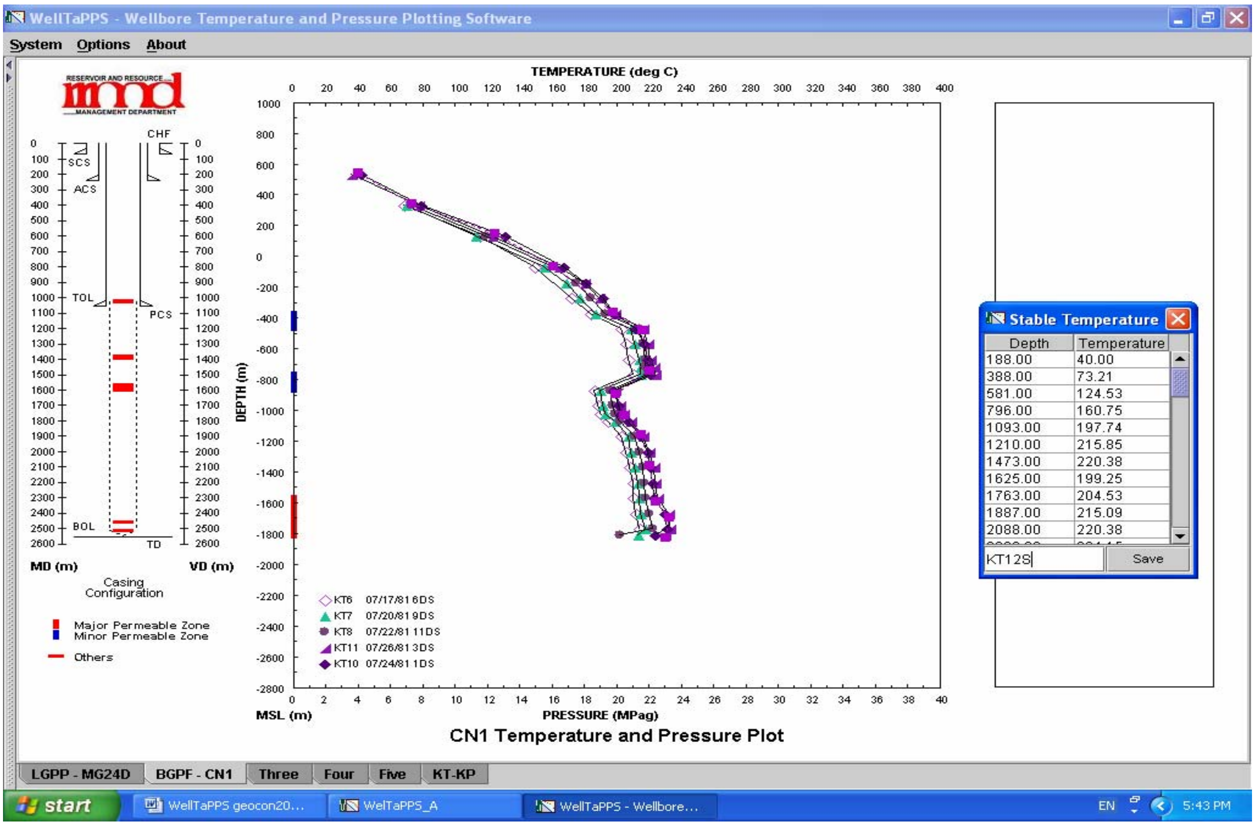

Figure 7: From a series of temperature surveys stable temperatures are generated by just right-clicking inside the plotting area. Stable temperature data points are connected by dashed lines to distinguish them from measured data.

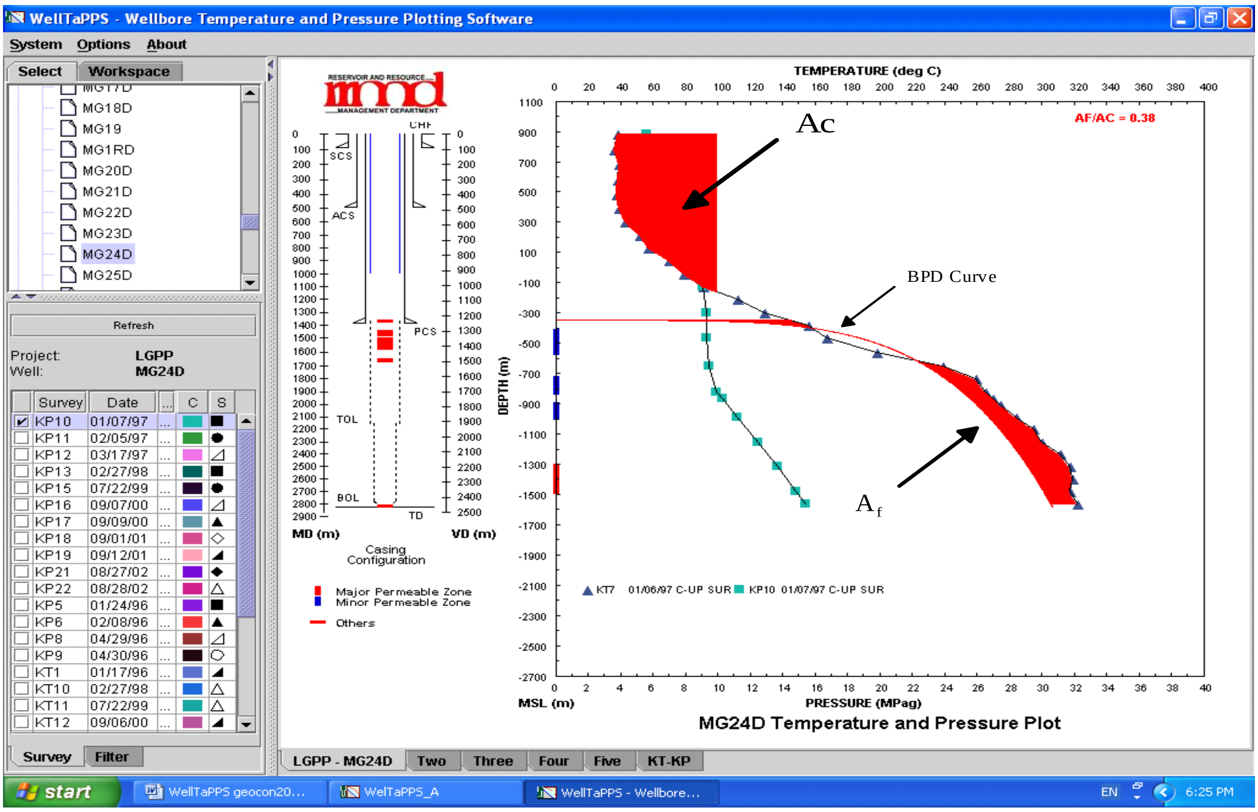

Figure 8: WellTaPPS is capable of calculating the Af/Ac ratio of a production well which determines if the well can be successfully discharged through air compression.

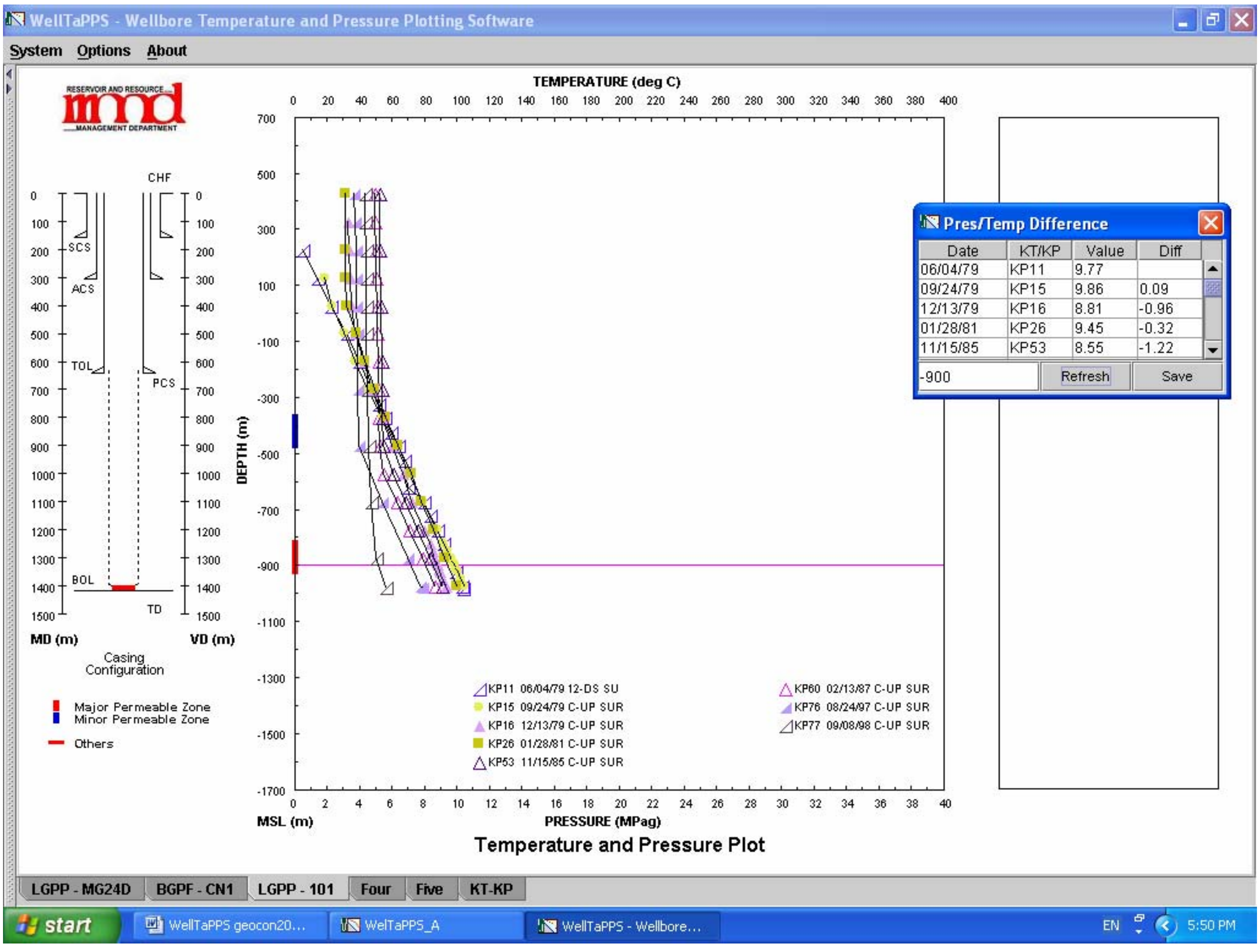

Figure 9: The pressure drawdown at depth calculated by WellTaPPS. The calculated data can be saved and can be retrieved using Excel.