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A Procedure for Improving Pressure-Monitoring System in KOC

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Abstract

Monitoring system for reservoir pressures in Kuwait Oil Company (KOC) consists of several components in the workflow. These include such processes as well bore surveillance plan, data acquisition from well bore surveys, data conversion into well-designed formats, data validation checks, flow of the formatted data into database, processing and analysis of total data for appropriate reporting. The reports on reservoir behavior may then be used for making informed decisions.

A review of the existing pressure monitoring system in the organization revealed some opportunities for improving the information system. This was found to be especially the case, since it was recognized that the corporate database that serves as a common platform for storing many different classes of data, could now be utilized efficiently to support an improved information system. Potential areas of improvement were found to lie in areas such as, increasing the speed of process flows, improving the value of the information itself and improving the user-friendliness of the overall system. These factors were taken into account while formulating an approach for system improvement.

Accordingly a series of software applications were developed in-house to improve the pressure monitoring system. The overall design was tightly integrated with data support from the corporate database. In terms of technology, the new system offered solutions through an integrated interface and provided flexibility in information generation on the basis of a variety of criteria that can be selected on-line. Such features offered versatility in the diagnostic capability of the system.

Deployment of this new monitoring system will be complemented by a training program where potential users will be shown how to access the system with ease and comfort and on how to derive the value-enhanced information through a faster work flow.

Introduction

Pressure monitoring workflow in Kuwait Oil Company (K.O.C) to monitor static bottom hole pressure behaviour at different reservoirs has different components, much of which can be endowed with enhanced IT support for improved performance. This is much so desirable now in light of exploiting the full potential of the corporate database towards an improved information system for pressure monitoring.

The current article is about a procedure that encapsulates a series of software applications to offer an IT enabled improved pressure monitoring system in K.O.C.

Details of the procedure, the software applications used for improvements in the system are discussed below. First the existing workflow for the pressure monitoring system and scope of improvements in it are discissed. This is followed by a discussion of the new model developed in the study.

Highlights of the improvement scope in static bottom hole pressure monitoring system in the organization:

The scope of having an improved pressure monitoring system in K.O.C is reviewed with respect to the following:

- Study of the workflow for the pressure monitoring system
- Scope of improved job performance through the opportunity of an appropriate information system
- Perceived opportunities of improvement at different components of the pressure monitoring system

Study of the workflow for the pressure monitoring system:

The focus in the current article is on the monitoring system for static bottom hole pressure (SBHP). A representation of the salient components of the SBHP-monitoring workflow in K.O.C for focused attention is as illustrated in Figure-1. Improvement is sought in the relevant components of the illustrated workflow. The workflow consists of the well bore surveillance plan to start with, for bottom hole pressure monitoring that has intimate link with the reservoir management business context. The acquired data from well bore surveys passes through format conversion, depth correction and data validation check before being loaded into the master database. The usual life cycle then ends at making informed decision with the help of the acquired data and information generated from the data.

Static Bottom Hole Pressure monitoring workflow for focused attention

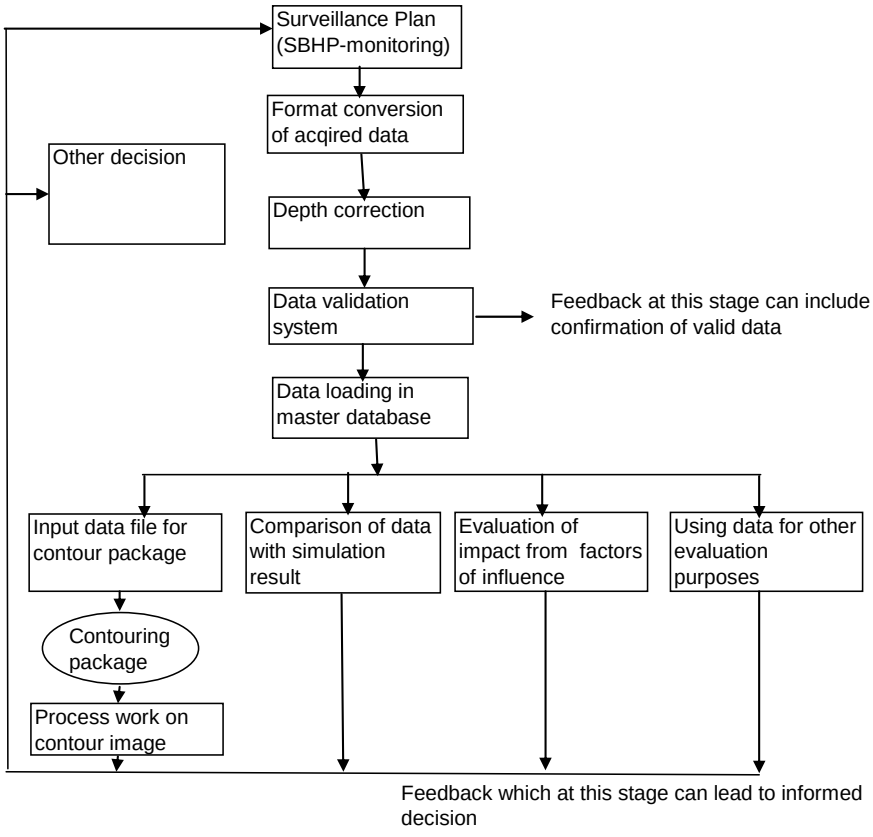

Figure-1

Investigation into the existing workflow has revealed that while there is a workflow for the pressure monitoring system and there is the corporate database that accumulates all relevant data and is capable of providing comprehensive information support to the pressure monitoring system, the workflow components are still not equipped to take full benefit from the

corporate database through some desirable arrangement of integration. Components which can particularly benefit from an integrated support are surveillance planning, depth correction in data, data validations, data deployment for the planned business objectives and the overall workflow monitoring and control. At the same time, at different components of the workflow there are manual tasks which can be replaced by automation for improved worklow. These are indications for a good prospect for some improvement measures. In light of such indications, scope and prospects of some appropriate information systems for improved service to workflow are further investigated from relevant literature surveys as outlined below, before embarking on some specific treatments towards an improved pressure monitoring system in K.O.C.

Scope of improved job performance through the opportunity of an appropriate information system

Role of appropriate information structure in improving job performance is well recognized. That covers also E&P business, as is seen from relevant literature surveys for E&P related business. Schmitzer et al (1997) have identified the important role of a suitable information structure to improve job performance through automation of workflow. Importance of a suitable information system as an enabler has also been indicated in the works of Yonke (1995), Opsahl et al (1994) and Denney (1998).

Additionally, importance of data integration, for an improved representation of information for the surveillance of petroleum reservoirs, has been highlighted in the work of Yonke (1995). Importance of an integrated surveillance database system that allows multi-user access has been highlighted by Yonke, who also emphasized that accurate and comprehensive data must be collected routinely and updated electronically.

Another driving point may be cited from the work of Hunter L. R (1994) who presented that in respect of the merit of an information system, IT can be considered to be contributing through efficiency (doing something easier and faster), through effectiveness (doing something better) and through technical advantage.

He observed “if an application shows a technical advantage, there may be an opportunity, even a necessity to maintain or improve on that competitive advantage. An application that provides this special business leverage will be aligned to and be an enabler of important business process.”

In terms of facilities in K.O.C, a good prospect of having improved job performance in the pressure monitoring system can be a reality looking at the prospect of using the corporate database effectively and developing necessary applications around it, providing the appropriate information structure where multiple users can have common access to an integrated arrangement. The overall system can be an effective enabler to the pressure monitoring system.

In terms of making improvement in the overall workflow from the view point of improved process, the prospects are visualized from three way perpespectives namely;

- Scope of improvements in the workflow
- Scope of improvements in the information content
- Scope of improvements in the user-friendliness of the improved system.

Scope of improvements in the workflow:

Scope of improvements in the workflow for the pressure monitoring system can cover various aspects such as acceleration of the flow of information along different parts of the workflow, more comprehensive and timely information supply at different points of workflow, faster processing of information at different parts of the work flow, quicker generation of classified information, improved provision for detailed tracking of information as and when needed and as a whole improved visibility of the workflow status

Scope of improvements in the information content:

The opportunities for improvements in the contents of information itself, include elements such as arrangement to generate a good many varieties of information using on-line processing flexibilities, provision for improved data integrity by dint of elaborate data validation check, generation of enriched information by dint of analytical process such as reliable projection of values for different contexts and better representation of information by generating and

presenting context sensitive reports.

Scope for improvements in the user-friendliness of the improved system:

Opportunities for an improved user-friendly system are visualized through elements such as extending the information generation ability to the end users to generate a good many varieties of desired information without the trouble of software programming. User-friendliness may be offered also through providing improved visibility for the information along with improved framework for sharing of information by multiple parties.

Perceived opportunities of improvement at different components of the pressure monitoring system:

An approach has been made to scrutinize salient components of the workflow for the pressure monitoring system in K.O.C and subject them to process improvement, having noted various prospects of improvements in the workflow, information contents and user-friendliness of the system. The driving objective has been to carry out process improvement having taken due advantages of IT enablers, including the centrally available corporate database. The opportunities for improvement through software have been visualized through an integrated arrangement covering three main areas which are

- Diagnostic evaluations
- Support to data processing after data acquisition
- Support to workflow tracking

Diagnostic evaluations :

Diagonstic evaluations will be applicable during bottom hole pressure monitoring plan. It will also be needed further after data acquisition during data validations and verification of the data in relation to the relevant business context for which the data acquisition was planned.

One important consideration in pressure monitoring plan is to align such plan to reservoir management perspective. Thus salient factors of influence in respect of reservoir management do come into picture, acknowledging that these factors would have influence on pressure monitoring plan.

The improved pressure monitoring system ought to consider the importance of providing adequate processing support relating to monitoring plan.

Investigation has recognized that the overall static bottom hole pressure monitoring plan may be derived from multiple objectives of reservoir management plan and the pressure monitoring plan needs to be aligned accordingly to the reservoir management objectives.

The context of pressure monitoring plan will also be useful further down the workflow, during data validation check and data verifications to the survey planning context, and the context will provide reminder about what is to be expected from the acquired data.

The proposed pressure monitoring system is to be geared towards generating a good many varieties of information in support of different evaluations during pressure monitoring plan and afterwards as needed.

Support to basic data processing features after data acquisition.

The data processing activities beyond the phase of pressure monitoring plan, do offer opportunities for improvement of process speed and improvement of data while also offering user-friendliness in the overall process.

Dominant components of software support that can be used for value addition at post-planning phase are as recognized below:

- Quick view of raw data quality

- Raw data processing - format conversion
- Static pressure computed to a reference depth
- Support to data Validation
- Input file generation for contouring
- Importing contour images for further work
- Importing data extracted from reservoir simulation results, for comparison

Support to workflow tracking

The tracking of workflow has the impact of detecting bottle-necks and then removing the factors that have the influence of delaying the workflow.

Workflow tracking would also facilitate improved visibility of the total workflow and would bind the acquired sets of data to the planned objectives of survey, by attaching relevant information with flow of data.

Model specifications for the improved system:

Based upon the perceived opportunities**, t**he model identified to address implementation of an improved procedure of pressure monitoring in K.O.C is as illustrated below in Figure-2, indicating the proposed software layer between the workflow and the data layer to support improvement at different components of the workflow.

Oracle developer forms tool has been chosen to develop the software layer.

Proposed model for improved system

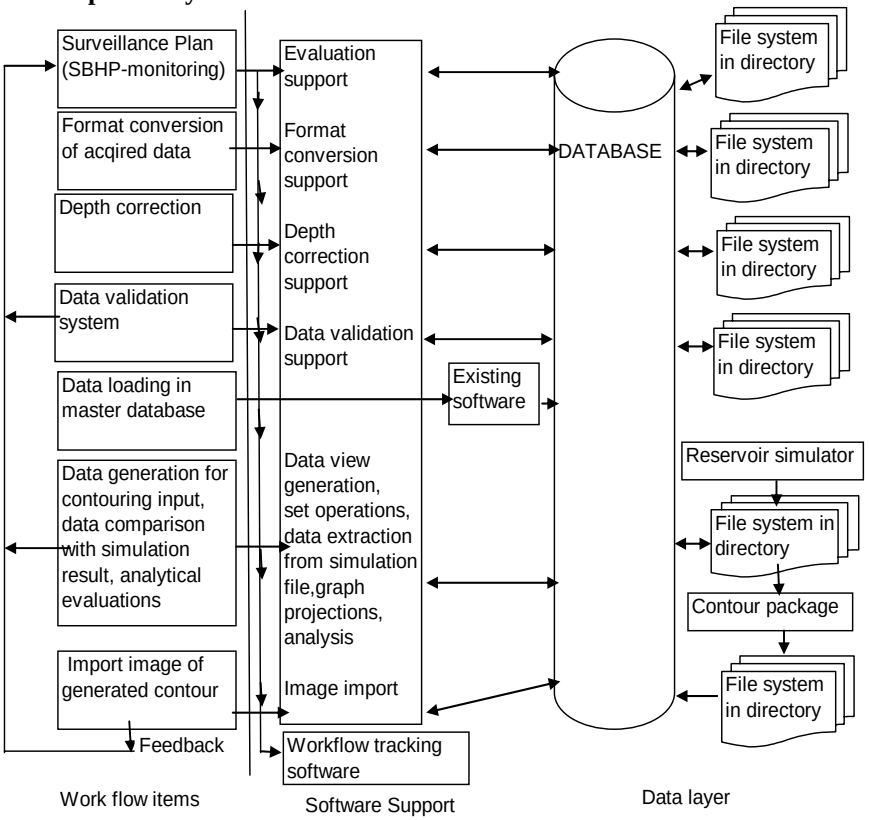

Figure-2

Figure-2 indicates software support at different components of workflow. It also indicates the database, data files and external packages in use, with arrows indicating their association to different components of workflow. The software for workflow tracking has link to all components of workflow.

Elaboration of the software arrangements in the improved system

The improved system aspires to render its service through the software configuration that is grouped into three application wings to be applied from an integrated arrangement. These are;

- Software in support of diagnostic evaluations
- Software for treatment of data after data acquisition from survey
- Software for workflow status monitoring

Software arrangements in the improved system are further elaborated as follows to highlight relevant features.

Software in support of diagnostic evaluations

Software in support of diagnostic evaluations will have principal use in aid of well review for pressure monitoring plan and also after data acquisition at the stage of verifying data to meet business objectives. The value addition is dominantly in the form of enriched information content provided through a system with improved user-friendliness. Also the improved system will help to accelerate the evaluation process for pressure monitoring plan.

In light of the business objectives for static bottom hole pressure monitoring plan, a list of perspectives to be served in the improved system by diagnostic evaluation support during pressure monitoring plan and afterwards are envisaged as follows:

- Diagnostic evaluation from the view point of adequate representation of data points for preparation of iso-pressure maps of the concerned reservoirs at regular time intervals, based on new surveys and predictability from past surveys at the wells
- Diagnostic evaluation from the view point of consolidating and fine tuning representative reservoir models for simulation studies.
- Diagnostic evaluation from the view point of filling data gaps in different parts of the reservoir
- Diagnostic evaluation from the view point of re-verifying the authenticity of some survey result
- Diagnostic evaluation from the view point of investigating the impact of some factors of influence having impact on pressure performance
- Diagnostic evaluation from the view point of allowing some possible cost optimizations, by deferring surveys in wells where feasible
- Diagnostic evaluation with care to avoid those wells suspected to have well-bore communication problem that may cause erroneous pressure measurements
- Diagnostic evaluation to consolidate a perceived co-relation or trend
- Diagnostic evaluation for specialized pressure survey plan , in the context of investigating for specific structural features or reservoir condition.

The evaluation service will be rendered through the essential software provisions in the system architecture that will generate reports for different data types (such as static bottom hole pressure, pressure build-up surveys, water cut history, production rate, well head pressure history), will conduct on-line criteria based result filtering as needed, will provide support to on-line object capture from maps, carry out on-line set operations on different sets of wells and then allow on-line viewing of well sets in location map along with well sketch and will also support on line generation of graphs along with the facility to draw projections from the graphs.

The features also include connectivity with result files of external packages such as. Eclipse simulation result file, contour images of contouring package in order to extract relevant data and information.

Software for treatment of data after data acquisition from survey

Software components for data processing following acquisition of data from survey jobs consist of data sampling and quick view of data quality through graphical presentation, raw data processing to generate data in tabular format, depth correction in data, data validation check, review of fluid pressure gradient for reservoirs. The value addition here is dominantly in the form of improved process speed at individual components of workflow and overall improvement in the speed of workflow. The overall integration also improves user friendliness

The software applications are as highlighted below for some salient components:

i. Quick quality checking of raw pressure survey data

Data sampling and generation of graphical result with such sampled data can provide a quick look into data quality acquired from survey.

ii. Raw data processing software

Raw data collected from bottom hole pressure surveys may not be in standard tabular format. In order to conveniently carry out onward processing along the workflow, it is necessary to process the raw data and convert it into a tabular format. A typical case of raw data as for instance can have header description consisting of well name, date and start time of survey along with other information. The header information is followed by data measurement records along with intermittent statements for tool lowered depth. The processing here involves capturing the key header information and the tool depth information and then attaching such information with every record of data measurement at different time instants. This will thus generate a tabular data sheet, for convenience of onward processing.

iii. Software module for Pressure data conversion to a common datum depth

Different reservoirs have different reference datum depths. Depending upon the well and the reservoir concerned in the pressure survey, the reference depth and the fluid pressure gradient in the depth range between zone depth at the middle of perforation intervals in the well and the datum depth for the zone is extracted from the database. Based on the extracted information, pressure at middle of perforation depth is first computed by spot pressure extrapolation and then pressure at the datum depth is computed. The associated data stored in database helps to carry out the conversion process.

iv. Data validation

The historical performance of pressure behaviour in relation to production withdrawal history would be useful guide for data validation check on a new data. Information tips about the expected pressure behaviour owing to some factors of influence, noted during the pressure monitoring plan would be another useful aid.

Connectivity to simulation result also allows extraction of simulation result for comparison. In the event of satisfactory history match in the simulation study, the predicted well behaviour for the well can provide necessary guidance to data validation, if updated simulation result is available taking into account of the events in the wells.

v. Input file generation for contouring

The data points for use in contour generation are derived from set operations on various sets of data. After viewing distribution of all such data in the location map, the satisfactory set of data can then be exported into a file in a format compatible to an identified contour generation package. The current model supports formatted file generation for contouring by OFM package.

vi. Importing contour images for further work

The model supports importing of map image from a directory, into its display system. Data can be superimposed over it. Well objects of interest can be retrieved from it by selecting any patch of interest and the retrieved well list then can be stored as a set for further use.

vii. Import of data extracted from simulation result

The model supports import of well pressure data extracted from simulation study result file and then compare such data with actual measured values.

Software for workflow status monitoring

Software for monitoring of workflow status consists of tracking various components of the workflow. Different set operations can be conducted to derive different classified pieces of information, some examples are as given below:

- List of wells commonly representing multiple categories of survey plan
- List of wells having gone through different components of workflow such as survey event, data quick check, format conversion, depth correction, data validation check, data loading in the database
- Workflow status of a given well survey plan
- List of wells for which data of survey is yet to be received in the system
- List of wells for which survey is done but data is yet to be validated

Conclusions:

- The pressure monitoring system for static bottom hole pressure is developed in due consideration of the business context for such monitoring and the system aspires to supply the varied information need as well as the quality assurance for data, through an improved system.
- The integrated software infrastructure takes care of improved process for data processing and evaluation for survey plan in terms of faster process flow and improvement of the information contents, in a user friendly set up, that extends the power to the end users to generate a good many varieties of information without the trouble of software programming.
- Any additional information need over and above what can be generated can be met in future by further update of the system after identifying the enhancement needs.

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