Design & Development of Well Site Drilling Information System used in South Azadagan

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Abstract. Based on our experience and success in the development of drilling information management software as well as our understanding of the South Azadagan well site situation in Iran, the South Azadagan Well Site Drilling Information Management System has been designed. Through the establishment of database of DIMS, the integrated well site drilling information management and application system is developed. In the process of collaborative information management under network environment, a convenient and unified data management and analysis platform for well site drillers in different Rigs has been provided. This paper describes the design and development of South Azadagan Well Site Drilling Information Management System in detail.

1. Introduction

To improve drilling information application level, it must fully consider the data sharing among drilling engineers, mud logging engineers and rig supervisor, realizing collaborative drilling information management and application\(^{[2-5]}\). So it puts forward a higher demand to convenience and flexibility of data organization. In traditional database management system, data has a low correlation between each other, lacks of effective centralized storage and management mechanisms of information, and can’t provide the required comprehensive and statistical data for collaborative drilling information management and application\(^{[6-8]}\). Therefore, how to make full use of various kinds of data resources and to get accurate and scientific data timely is very important for engineers and supervisor at South Azadagan well site. For this reason, It should use data warehouse technology to build integrated drilling information system, providing a convenient and unified data analysis and processing platform for collaborative drilling information application among specialists and engineers from well site and drilling company office.

2. Well site Drilling Data Management function design

Well site Drilling Data Management Module mainly provides an information management platform for the drilling supervisors in such operations as drilling, mudding, logging and cementing. At the same time, to satisfy the drilling supervisors’ need in the management of the materials and costs in the well site, the module is designed to includes such 6 main functions (as show in fig.1) as data input,
daily reports, end well report, other regular reports, operation analysis and data query, according to the drilling operation process and the responsibility of the inspector in the well site.

Fig. 1 The function list of Well Site Drilling Data Management System

2.1. Data Input
Data input module can enter in various on-site drilling data in such simple and convenient ways as code input, record copy and paste, online calculation, automatic unit switch, auto-draft (wellbore structure, wellhead equipment diagram etc.) so as to provide data support for the daily report, final report, statistical analysis, cost control and project management.

The data inputted in are divided into 4 main categories:

(1) Static data: the records of the basic condition of the well in operation such as the fundamental data, casing program, geological introduction etc.

(2) Daily operation data: the records of the drilling operation, property of drilling fluid, consumption of materials, the utilization of diesel and water, costs etc.

(3) Operation data: the records of various procedures filled in operation rather than in each day, for example, pre-drilling acceptance, drilling machine examination, bit records, BHA log, borehole deviation log, casing log, cement log etc.

(4) Well completion data: including the filling of the handover book and completion operation information, drawing of the completion pipe string, and writing of the completion summary.

The logic organization of drilling data to organize numerous static data, daily operation data, operation data and completion data into reasonable structures, so as to optimize the data storage and avoid data redundancy (as show in fig. 2). The logic relationship of data includes:

(1) All the data tablets are associated through the number of the wells and operations like addition and revision of the data of a specific well are only allowed when there is the record of the well in the general data. In the same way, if the records of the data of a specific well are to be deleted from the general data, all the corresponding data of the well in all the data tablets will be deleted.

(2) A large number of the drilling data are generated automatically and progressively. That is, monthly data generate automatically based on the everyday data, yearly data on monthly data, and in turn, the complete data of the specific well generate at last, so as to guarantee the uniqueness, consistence and enclosure of the data.

(3) The output data of various reports are the result of the conjunctive query in the tablets of the static data, operation data, completion data etc. according to specific condition.
2.2. Daily Reports

Daily Reports can be generated automatically according to the required format and distributed to the related departments. The data (parameters and diagrams etc.) in the report will be derived from the data input module. Daily reports primarily include Daily Drilling Report, Daily Mud Report, Daily Completion Report, Daily Geological Report, Daily Directional Drilling Report, Daily Mud Logging Report and Daily Drilling Brief etc.

2.3. End well report

This module can provide auto-generated end well reports by the drilling crew immediately after the completion of the well drilling. End well report is summative technical document provided after the well completion. According to the requirement of South Azadagan drilling department, it includes 6 sections (show in table 1): general information, performance review, drilling data, completion data, HSE summary report, highlights and lessons learnt, as is shown in the following diagram.

Table 1 End Well Report Contents

| Section                        | Contents                                                                 |
|--------------------------------|--------------------------------------------------------------------------|
| 1. General Information         | 3.6 Casing Tally Report                                                  |
| 1.1 Well parameters/overview   | 3.7 Casing make-up torque record                                         |
| 1.2 Well montage               | 3.8 Casing pressure test                                                |
| 1.3 Location map               | 3.9 Formation Fracture Pressure Test Report (FIT)                        |
| 1.4 Brief summary of operation | 3.10 Deviation Survey Data                                              |
| 1.5 Formation tops             | 3.11 Cementing Report                                                   |
| 1.6 Well Schematic             | 3.12 Coring Report                                                      |
| 2. Performance Review          | 3.13 Material consume                                                   |
| 2.1 Section summary            | 4. Completion Data                                                      |
| 2.2 Time Versus Depth Chart    | 4.1 Completion procedure                                                |
| 2.3 Mud weight curve           | 4.2 Completion fluid                                                    |
| 2.4 ROP Chart                  | 4.3 Perforations                                                        |
| 2.5 Drilling time breakdown    | 4.4 Completion String                                                   |
| 2.6 Daily operation summary    | 4.5 Temporary Well Suspension                                           |
| 3. Drilling data               | 4.6 Well head and X-tree                                               |
| 3.1 BOP Stack Arrangement      | 5. HSE Summary report                                                   |
| 3.2 Bit report                 | HSE Summary report                                                      |
| 3.3 BHA Serialized Components  | 6. Highlights and Lessons learnt                                        |
| 3.4 Mud Report                 | Highlights and Lessons learnt                                           |
| 3.5 Downhole Accident/Complication Report | Appendix: Service Company information etc.                               |

2.4. Other Regular Reports

Other Regular Reports module can provide auto-generated any report required by the drilling crew immediately during drilling.

Other Regular Reports include various reports submitted according to the operation and management requirements in the whole duration of the drilling. According to the requirement of South Azadagan drilling department, it includes 14 types of reports (show in table 2) including weekly rig checklist, BOP test report, H2S/fire drill report etc. The specific information is shown in the following table.

Table 2 Other Regular Reports Contents

| Report                        | Contents                                      |
|-------------------------------|----------------------------------------------|
| 1. Weekly Rig Checklist       | 8. Kick and well loss data sheet.            |
| 2. BOP Test Report            | 9. Mud loss Record                           |
| 3. H2S/Fire Drill Report      | 10. Lesson Summary Report                    |
4. Pre-spud Inspection Report  
5. Medical/Incident/Accident Report  
6. Equipment TPI Report  
7. Perforation Report

|   |   |
|---|---|
| 11. Weekly Cost Report | 12. Formation Fracture Pressure Test Report |
| 13. HSE Summary Report | 14. MR/SR |

2.5. **Operational Analysis.**
Operational analysis module can extract the required data according to the searching requirement selected by the users. The data can be proposed automatically and filled into corresponding forms. The statistical searching condition can be combined freely according to the time, regions, units and drilling crews, such as drilling bit analysis shown in fig.3. Both the single and multiple wells can be selected.

![Fig.3 Drilling Bit Analysis](image)

3. **Well site Drilling Data Management System development**
Well Site Drilling Information Management System mainly provides an information management platform for the drilling supervisors in such operations as drilling, mudding, logging and cementing. At the same time, to satisfy the drilling supervisors’ need in the management of the materials and costs in the well site, the module is designed to includes such 8 main functions as data input, daily reports, end well report, other regular reports, material management, operational analysis, supervisor’s instruction and visualization, according to the drilling operation process and the responsibility of the inspector in the well site.

Users can log in the software by starting the IE browser and inputting the url IP address in the address bar. Figure 4 shows the login interface of the software.

![Fig.4 User Login Interface](image)

Users can input the main interface (Fig. 5) of the software when they have inputted the correct username and related password.
Fig. 5 Main Interface of the System

The Main Interface shows the main information of the well including well schematic, drilling progress, 3D borehole trajectory, daily major work description and the basic information of the user.

4. Conclusion
In drilling engineering operation, it is necessary to convert, centralize and manage the various drilling data in South Azadagan through data warehouse technology and generate various type report automatically based on data warehouse according to the requirement of well site. The data warehouse system supports various types of data query, analysis and decision-making, facilitates data query and analysis for engineers of different levels, has overcome the problem of insufficient data use existing in traditional database system, and has provided an effective way to realize integration and collaboration of drilling information management.

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References
[1] Fang Ming, Cuan Ying: Petroleum Science (In Chinese), 2005, Vol.26 (3), p. 90-94.
[2] Liu Zhikun, Li qi: Drilling and Production Technology (In Chinese), 2007, Vol.30 (3), p. 13-15.
[3] Yin Yuanfen, Zhang Zili: Computer Science (In Chinese), 2010, Vol.37(5), p. 162-164.
[4] Wang Tao: Computer Technology and Development (In Chinese), 2010, Vol.20 (5), p. 191-194.
[5] Michele Blaba: M Computer, 2001, Vol.34(12), p. 38-39.
[6] Zhang Weiming. Principle and application of data warehouse[M]. Beijing: Electronic Industry Press (In Chinese), 2002.
[7] Mao Weihua, Gao shujuan. Key Technical platform for business collaboration based on SOA. Computer Engineering[J], 2009, 35(19), p.280-283.
[8] Wang Zhen, Sun Xiaoli. Research of Access Control Model in collaborative design systems. Computer Engineering and design[J], 2009, 30(8), p.1836-1839.