

Study on the Optimization of the Smart Oilfield Construction

Jianxi Huang^{1, a}, Bin Zhang^{2, b}

¹CNPC Bohai Equipment Manufacturing Co., Ltd, Petroleum machinery factory, Renqiu, Hebei, China, 062552.

²Petroleum Production Engineering Research Institute of Huabei Oilfield Company, Renqiu, Hebei, China, 062552.

^abingzhi201@sina.com, ^bcyy_zhangb@petrochina.com.cn

Keywords: Smart oilfield; Big data; Integrated module

Abstract: Although the current intelligent oilfield construction is based on the network and other technology such as the internet of things, it is embodied mainly by individual system, based on fixed localized platform, or established solutions for a particular user. Operating system, remote decision-making system and risk early warning system are just an independent system. Using the simple cloud computing, there is no conformity in a same platform. By integrating the existing historical drilling data together, effectively using the visual and data-mining technology to realize the compositive mode of management, construction and maintain of the operations, and the controlling of the longitudinal and transverse data. To form the experience-sharing mode of dynamic information, make a comprehensive perception and automatic control of the oilfield, and strengthen the guide of the application. Enriching the ways that solving the problems originally only depend on the experience of the experts, and making the locality, individuality, discrete, relatively isolated data effectively be organized and managed, then integrating the professional data which has the valuable information. Furthermore, predict the trend of the oilfield's development, explore a sustainable way of smart oilfield's developing featuring, and promote the production to a new stage and better the decision-making optimization of the oilfield.

Introduction

Nowadays, current oil price is slumping, the situation of the economy and management is grim in the oilfield, at the same time, the liability and penalty of the security environmental protecting work in the enterprises is becoming increasingly strict. Each company in the oilfield considers reducing the cost efficiently as an important work to deploy. The construction of the oilfield need to integrate the considerations of reservoir, drilling, oil production, oil and gas's gathering and transferring, etc. The smart oilfield technology playing a role as the impetus, through the construction of the intensive smart oilfield's framework, producing resources in an efficient and safe way, comprehending the dynamic of the oilfield and forecasting the oilfield's trend, operating the oil field's main-body activities in an automatic and efficient way, optimizing the oil field's management and decision-making way, implementing the new mode of the green field's construction and promoting the enterprise to increase the production.

According to the oil field's development, the informational construction of the oil and gas's production in the enterprise need to build the online-data resources, just as the big data, based on network and cloud computing service platform. Through effective systematic planning, management, operation, providing the users the superior services.

With the aid of a cloud platform, the oilfield can make mass data and a wide range of engineering technology be shared and applied. The function that contains the storage and computing ability can be realized by means of the cloud platform, it can also provide users enjoy all of the resources and applications. Making full use of cloud computing, internet of things and so on, to build a new network of large-scale oilfield's oriented operating mode, to realize the intelligent resource be shared and allocated, eventually forming a new pattern of the intelligent oilfield construction, promoting the fused construction of the oilfield to be industrialized and informationized effectively.

The overall frame of the smart oilfield construction

Making the existing operating systems, remote real-time systems, cloud computing, cloud security, high performance computing, internet of things, and other technologies fuse together, realizing the unity of the reservoir, drilling, oil extraction, the ground engineering, the intensive and intelligent management, to provide a smarter, safer, more efficient operating services of the whole cycle.

To explore possible value of the target during the process of the large-scale multi-type data mining is the technical difficulty in practical application. Combined with bringing in the experiences and products abroad, each oilfield can choose the forms of independent construction, outsourcing or cooperative development based on their own characteristics. According to their own need to customize or modify some big-data constructing system, perfect the construction of the platform. To implement the oilfield construction from low-level integrated system to digital system, then convert to the smart system, gradually formed the models of the real-time data acquisition, the process monitoring and the data application.

Gathering information, integrating the big data and comprehending the perception of oilfield. Developing the data system based on EPDM (Exploration and Production Data Model), the electronic way directly face to a new database model, to form an unified logical model library. For new wells, through the integration of the data-acquisition platforms, to implement data collection at the scene of all-in-one control, to realize the automatic data-collection and data-reporting pattern with the advanced instruments, and provide various access of the terminals and acquisition.

For old wells, it is necessary to build the transferring process and specification of the electronic history data, and establish the transferring standards and related rules between the old and new data, then according to the new models and standards of the database to check the consistency and integrity. Then forming the database of a single well in it's all lifecycle.

Integration of the synergic managing department. Information construction, which mainly depends on a single original manual management mode should be changed. The related departments need to strengthen the management to be interconnected, then improving multidisciplinary collaborative degree between different departments, further more strengthening the degree of the informational management, implementing the integrated management. To implement the information transmitting between departments in two ways: the "synchronous sharing" way of persistent connections between the department, and the "rally" way, which have been supervised by the effective transmission of intermittent connection pattern.

Integration of operating process. On the current, the level of the automation and informationization is not high during the operating process. The process needs to be closely integrated with the standards and the implementation, to establish standards of professional data dictionary, then opening the interface to be accessible for data integration, forming a compositive mode of operation during the whole process such as "before the implementation", "in the implementation", "the assessment after the implementation", through the course of positive cycle, reverse cycle, self-checking optimized cycle, to achieve the integration of operational processes, to provide the overall information for the full life-cycle of the operations in the oilfield. As is shown in Fig.1, as the "integration" idea, the integrated planning, reservoir, drilling, ground engineering are all under the intelligent control.

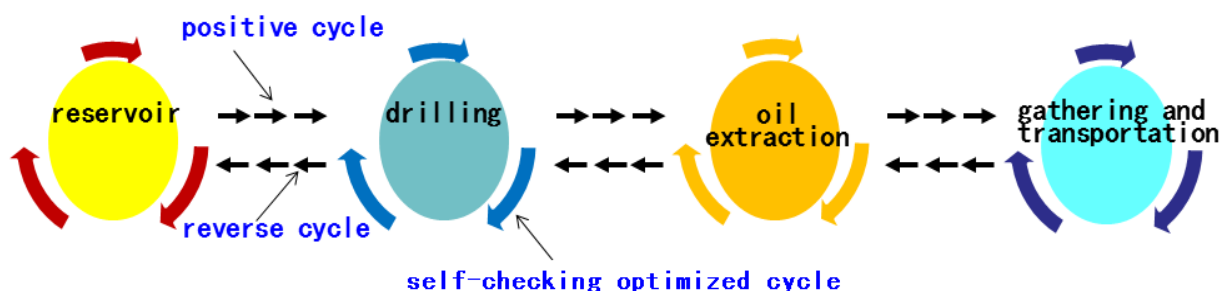


Fig.1. Data mining integration of all the process operations

Scale application of the internet of things technology, based on the sensing-control technology,

network communication technology, oilfield engineering technology, according to the study process of the body, comprehensively analyzing the impacting factors of the reservoir, drilling, oil extraction, ground engineering, which need to integrate the decentralized systems, establishing the platform of the operational system with the process integrated, researching the technology, to realize the real time data collecting pattern, and the process can be monitored and controlled, a real time controlling pattern of the dynamic production is given, and decisions from the process of the production are making in a timely manner.

The integration of data control in both the vertical and horizontal domain. The data that the smart oilfield gathered and analyzed is no longer just a small part of the data, but the big data, of which the type is various, and volume value's density is low, the commercial value is high, the processing speed is fast, and even need to accept in the traditional sense of the data that are not accurate even considered useless. Then combing the key data from the big data source, analyzing the algorithm of the data model, the standardized data interface and the collaborative platform in which the software is embedded based on the demands in the oilfield, to strengthen the interconnection of the data and increase the efficiency of the data mining, and achieve the compositive data control in both the vertical and horizontal domain.

The real-time database is stored in an unified format such as in binary, data are dealt with according to the requirements of the comprehensive analysis, acting in accordance with a standard format for relational database archived, the function involves data collected, screened, relational data mapped, which also contains the parts of the interface and the error tolerance, etc. Ensure the secure storage of the data volume which shared in certain ranges. Completing the deployment and configuration of data transmission, via some way such as satellite, optical fiber to ensure the network working smoothly between the well site and the headquarters. On the well site, drilling and oilfield company set up the integrated data acquiring software to make sure the database communications.

To realize the entirety that is integrated by different platforms, systems and domains, the formation of an unified, centralized, integrated personal platform is suitable for oilfield. Construction and maintenance are both important.

The research on the collaborative data mining, the automatic control of the oilfield and forecasting the trend in development. Through a distributed information system and integration of multiple departments, the architecture of the big-data control model is set up, forming the environment which supports collaborative data mining, implementing the construction of the environment for the data mining in the whole life cycle.

The mainly process of the data mining. The data mining process contains six parts, which is an ongoing gradual process.

Selecting a target. Such as choosing the bit type, optimizing the cementing quality and well track, in addition, to form a clear solution. According to the main analysis body, sorting the elements of the main cause and the second cause, making the global optimization and the correlation analysis of each influencing factor.

Preparing the data: According to the plan of the data mining, to collect data in purpose, and filtering the data, screening the data that can solve the task.

Selecting the data mining method: Contraposing the existence of the difference targets and correlations between many complicated influential factors, to form the corresponding algorithms and the optimized data mining model for mining data effectively. Then implementing the optimization of reentrant functions during the cyclical process, constantly forming a concise and efficient optimal algorithm. To provide possible for hierarchical data analysis.

Making the junior mining-visual features. Through the data mining, the most intuitionistic analysis of the target, the influential factors, and the connections between them can be visually showed. All that providing the most intuitive basis to solve problems.

Making the advanced mining-deep analysis. On the basis of primary data mining, carrying on the deep analysis, mining the essence through the phenomena. Then forming the specific optimization way that can control the oilfield, further more grasp the developing trend of the oilfield.

Carrying out the plan. The deep data mining results which highlight the pertinence and effect are compiled into the implementation of the plan, through the validation to optimize the strategy. The feedback of the optimal results is return to the database, to provide more information for the subsequent optimization. Task oriented, associated with the optimization of the data algorithm, the integration and data mining , to guide the engineering optimized.

Using the application guide drive, optimizing the oilfield decisions. It is necessary to set up the RTOC (Real Time Operation Center) to get a more useful application and optimized decision, as is shown in Fig.2.

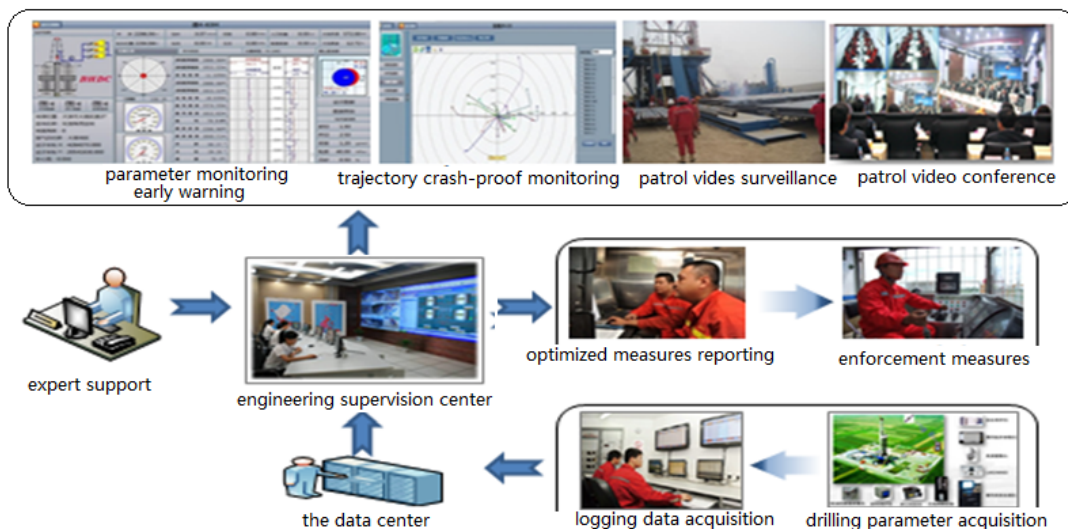


Fig.2. Remote data transmission in combination with multiple well monitoring and technical supports

Making hardware standards of the remote support center; developing the data's publishing system, the information's monitoring of the equipment, the distributing system、the integration system of the video meeting and instant messaging; constructing the supporting center of the remote operation. Through the above work pattern, to perfect the function of the relevant application and make the data and expert resources integrate, further more to realize the remote data monitoring, diagnosing, early warning, analyzing, optimizing and making the experts give more supports in technology and so on.

The benefited field covers oil and gas exploration, reservoir evaluation work, oil and gas development, oil and gas gathering and transferring, working technology, emergency command, producing guarantee and other directing production business, at the same time, which can also meet the internal report of the exploration and development in the oilfield for review of the scheme, consultation of the problem and technical communication, etc.

Conclusions

Smart oilfield construction is the proper fusion of both informatization and industrialization, which promoting the emulational analysis, automatic processing and the ability of the expert's support, using a computer instead of human brain. Integrating exploration, development, production, management, and using a new generation of information technology to form a new smart-mode management. Then strengthening the management and application of the knowledge and expert's experience, comprehensively using the automatic control and processing, reducing the human intervention, making the reasonable prediction and optimization of the production, to strengthen the reacting ability in advance.

Modern enterprise must through the integration of the information resources, to maximize the capacity and availability of the data storage, and realize the goal of the digitized management and better engaged in the management of the smart field, better realize the strategy of the enterprise's development. The smart oilfield which has the integrated module will lead to many improvements:

the exploratory success rate is increasing, the cycle of the oil recovery is shortening; reserves production rate and recovery rate is increasing, meanwhile, the cost of the development is reducing significantly.

Acknowledgements

This work was supported by the oilfield's project "Engineering Construction of the Cloud Platform In the Oilfield".

References

- [1]Xinfa Chen,Ying Zeng,Qinghui Li. Digital Oilfield Construction and Practice: XinJiang Oilfield informationization construction[M]. Petroleum Industry Press,2008.In Chinese.
- [2]Jonas LarsenJohnUrry.Lancaster University, UK.Kay W.Axhausen.2007.Networks and tourism mobile social life.Annals of TourismResearch91:244-262.
- [3]Zhen Yang. IOT Development Research[J].Nanjing University of Posts and Telecommunications:Social Sciences Section,2010,12 (2) :1-10. In Chinese.
- [4]Ulrike Gretzel.2011.Review article intelligent systems in tourism Annals of Tourism Research,3:757-779.
- [5]Tao Liu. IOT technology application[M]. Beijing: Mechanical Industry Press,2011. In Chinese.
- [6]Xijian Liu. PetroChina Information Management[M]. Petroleum Industry Press,2008. In Chinese.
- [7]Shenghou He, ZhongyaWei."Digital Oilfield"Theory and Practice[J],Geography and Territorial Research,2002-02. In Chinese.
- [8]Qiang Chen, Honglin Wang. Digital Oilfield: The Integration of oilfield's data, information, software andknowledge[J],Oil Geophysical Prospecting;2002-01. In Chinese.
- [9]Zhi Li,Qiang Chen. "Digital Oilfield" Design and Application[J], Geo-Information Science,2002-04. In Chinese.
- [10]Weimin Zhang. Cloud computing profoundly change the future[M]. Beijing: Electronic Industry Press, 2009. In Chinese.
- [11]FeiGao. IOT Core Technology[M]. Beijing: People's Posts and Telecommunications Press, 2010. In Chinese.
- [12]Qinghui Li. Digital oilfield information platform architecture[M].Petroleum Industry Press.2008.3. In Chinese.