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Application of Artificial Intelligence in Evaluation and Management of SEC Oil and Gas Reserves

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In order to study the application of artificial intelligence in the evaluation and management of SEC oil and gas reserves, this paper analyzes the distribution of SEC oil and gas reserves and the attributes of management objects, combines the basic information of assets and the management of evaluation results to attempt a refined management model, and makes use of SOA framework and artificial intelligence technology to design the system. It is found that the system can present the relevant data well and make statistics and management of the data. It can be seen that the system can actively adapt to the need of supporting basic data resources under the new criteria on SEC oil and gas reserves.

1. Introduction

Oil and gas storage is of great importance to large petroleum enterprises in the world, and it is an important reference data for evaluating the development ability of enterprises. In the developed countries such as Europe and America, after evaluating and auditing the assets of oil and gas reserves, it needs to be disclosed to the society by the SEC of the United States, which puts forward higher requirements for the evaluation and management of the SEC oil and gas reserves. There is still some gap in the evaluation and management of SEC oil and gas reserves between China and abroad, which is mainly reflected in the low level of evaluation and management information and the low efficiency of management. With the development of artificial intelligence technology, some scholars try to apply it to the evaluation and management of SEC oil and gas reserves. Based on the analysis of the distribution of the SEC oil and gas reserves and the attributes of the management objects, this paper thus combines the asset base information and the management of the evaluation results to try a refined management mode with SOA framework and artificial intelligence technology.

2. Literature review

At the end of 1930s, the research on monitoring system of oil and gas reserves began to rise again. In the 1950s, oil and gas reserves monitoring system has been gradually developed and improved, and its practicability has been greatly improved. American reserve statistician Moore revised the monitoring index system in the 1930s. Reserve indexes were divided into three types: advance, synchronized and lag. The diffusion index method, a method to construct the macro-reserve oil and gas reserve system in the United States, was put forward, so that the prosperity detection method entered the normal stage. In 1960s, Shiskin of the United States proposed the study of using CI synthetic index method to build oil and gas reserve system. In the late 1970s, the International Reserve Indicator System (IEI) was established in cooperation with NBER and the International Reserve Cycle Research Center of the United States to monitor the changes in the prosperity of major western industrial countries. In the early 1980s, the reserve oil and gas reserve system has been initially improved and has been recognized by many countries. In the middle and late 1980s, in Asia alone, Malaysia, Singapore, Thailand, Indonesia, India, Korea and other countries have built oil and gas reserves monitoring systems. Since 1990s, with the rapid development of information technology and communication technology, oil and gas reserve research has received strong technical support, and oil and gas reserve theory and methods have also been developed rapidly and widely applied in various fields. The

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research results also showed a rapid growth trend (Shukla and Karki, 2016). In 2015, Muralidharan and Vasudevan successfully applied the artificial neural network model to the analysis and prediction of world green energy consumption (Muralidharan and Vasudevan, 2015). In terms of oil and gas reserves, oil and gas reserve research mainly focuses on oil security, the most typical of which is the international energy agency's oil and gas reserves and emergency countermeasures. Kardooni, et al., used artificial neural network to predict reservoir properties, and input prediction parameters into the prediction model to improve the accuracy of historical fitting (Kardooni et al., 2016). In 2015, Sueyoshi and Goto applied artificial neural network method to predict production performance of discontinuous tight reservoirs (Sueyoshi and Goto, 2015). In recent years, there have been many studies on oil and gas reserves prediction, mainly using formula fitting method and artificial neural network (Animah and Shafiee, 2018). China's research on oil and gas reserves began in the middle of 1980s, and started relatively late. The process of oil and gas reserve research is from qualitative to qualitative and quantitative, and from macro oil and gas reserve to enterprise oil and gas reserve (Pascoe and Innes, 2018). The initial stage of the study is mainly to draw lessons from the western theory of reserves development and the theory of reserves fluctuation cycle, and then to analyze the long-term fluctuation and motivation of China's reserves form. After introducing the Western boom cycle index method, the short-term change of reserve morphology has been realized and achieved rapid development (Moussaoui et al., 2018). In 2017, Lorigooini et al. carried out in-depth research on China's macro-reserves of oil and gas, published the book Prepare for a Rainy Day: Reserve Research on Macro-Reserves of Oil and Gas, established a macro-reserve of oil and gas reserve system in line with China's national conditions, and filled the gaps in the study of China's macro-reserves of oil and gas. They also used the analytic hierarchy process method to find out the dominant factors affecting oil security, established the crisis oil and gas reserve model of oil security, and constructed the oil and gas reserve monitoring index system of production and operation system of petroleum enterprises. In addition, they set up the comprehensive evaluation oil and gas reserve model of production and operation of petroleum enterprises by using the weighted average method, and established the oil field production monitoring and prediction. Oil and gas reserve system made real-time monitoring and prediction of production become a reality. A dynamic oil and gas reserve model based on support vector machine (SVM) was established to carry out oil and gas reserve for production performance of oil wells. In the same year, Ren Baosheng, Liu Zhibin and others published the book Oil and Gas Reserve Prediction and Development Planning of Oilfield Development Dynamics in the Middle and Late Stage, and systematically expounded the theory and method of oilfield development dynamics prediction (Lorigooini et al., 2017). Since 2000, the application of oil and gas reserves has been further expanded, not only in the field of reserves, but also in other fields (Rassenfoss et al., 2018). Farid et al. established the index system and standard of petroleum resources safety evaluation, evaluated the safety of petroleum resources, and studied the oil and gas reserves in China. By using factor analysis and correlation analysis, a risk dynamic oil and gas reserves index system of industrial enterprises with high efficiency and reliability was constructed. It provided ideas and directions to build the enterprise risk dynamic oil and gas reserve index, dynamic oil and gas reserve model, and dynamic oil and gas reserve index, and the research and formulation of comprehensive risk management path strategy and specific measures (Farid et al., 2016).

To sum up, the above studies mainly focus on the evaluation and management of sec oil and gas reserves, but few studies pay attention to the application of artificial intelligence in the evaluation and management of sec oil and gas reserves. Therefore, based on the above researches, the technology of artificial intelligence is mainly introduced. And combined with artificial intelligence, the evaluation and management of oil and gas reserves is studied.

3. Principles and Methods

The application of artificial intelligence in exploration and development is not only dominated by foreign companies. CNOOC has also successfully used neural network technology and probabilistic inference algorithm for dense gas exploration. CNOOC has two dense gas exploration blocks, Linxing and Shenfu, in the eastern margin of Ordos Basin. In the face of the different exploration situation from conventional oil and gas, researchers have made remarkable achievements in reducing the exploration risk and improving the success rate of exploration by using artificial intelligence and statistical learning for innovative reference. In the field of drilling and completion, artificial intelligence has also been applied. The Southwestern Energy Co. and Anadarko Petroleum have applied machine learning to drilling location decision-making to increase the return on investment in drilling. BP and Abu Dhabi National Oil Company apply machine learning to real-time prediction of drilling tubing, and prejudge the signs of friction events through system learning, making the driller to correct the method of string entry before the tubing occurs. An electric intelligent continuous pipe drilling system is developed abroad, supplies power to the downhole through an intelligent continuous pipe, and drives the downhole electric intelligent drilling system, with the functions of continuous tripping and

continuous circulation, and high-speed, large-capacity and bidirectional transmission of data at the same time. Electric intelligent continuous pipe drilling system will become another important way to realize intelligent drilling in the future. BP used neural network technology to establish identification analysis model in Cherry Point in America, which can identify the influencing factors in the production process and improve the monitoring ability of SPC (Statistical Process Control) system effectively. Sinopec applies machine learning methods such as clustering, classification analysis, neural network and gray scale model to predict the deterioration trend of the equipment operation state in the whole life cycle management of petrochemical plant, and reduces the "overrepair" and “disrepair” by reducing the unplanned parking of the production plant.

In order to manage, the management object must be determined first, and the structure, attributes and characteristics of the object must be clarified. The SEC oil and gas reserves management objects are divided into three major types: proven reserves (P1), probable reserves (P2) and possible reserves (P3), wherein each object is divided into developed reserves and undeveloped reserves from the development state as shown in Figure 1. The SEC requires that proven reserves (P1) must be updated and disclosed annually, and there is no mandatory disclosure of probable reserves (P2) and possible reserves (P3), but oil and gas companies may disclose the estimated reserves according to their specific conditions.

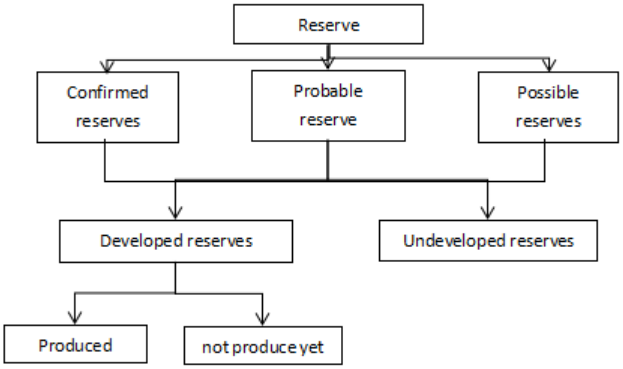

Figure 1: SEC oil and gas reserves classification system

The annual reserves evaluation work mainly involves three aspects of work content and process: the evaluation of expanded reserves and newly discovered reserves, the renewal evaluation of proven developed reserves (PD), and the renewal evaluation of proven undeveloped reserves (PUD). Expanded and newly discovered reserves will also be rated as PD reserves or PUD reserves, that’s, three aspects of work, and two types of reserves. Evaluation of SEC reserves is mainly to calculate reserves value and reserves value. Static method (such as volumetric method and probability method) and dynamic method (commonly used production decline method and material balance method) are mainly applied, and cash flow method is applied to calculate reserves value, as shown in Figure 2.

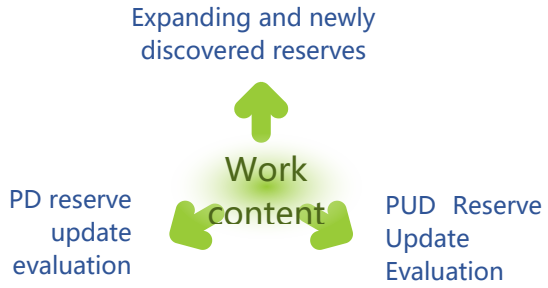

Figure 2: Schematic diagram of EC reserves evaluation work and reserves status

After defining the classification structure and workflow of management objects, it is necessary to study the logical relationship of each management object. It can be seen that the SEC reserves information management system mainly relates to reserves assets evaluation and classified management after evaluation, in which the data objects are divided into oil and natural gas, and the data state is divided into developed and undeveloped reserves, and the evaluation is divided into two grades: oil and gas field and evaluation unit.

Therefore, the data management base unit takes the oil and gas reserve assets as the unit, and is designed as the developed unit and the undeveloped unit according to the status. Each base unit contains evaluation result data, evaluation base data, and evaluation base drawings.

The SEC oil and gas reserve assets evaluation and information management system strictly follow the concept of software engineering in the construction process, and establishes a standardized, safe and open information system based on the basic criteria of being "practical, efficient, advanced and reliable."

Taking oil and gas reserve assets as management object and information management system platform as a carrier, functional modules or database such as oil and gas well production data management system (A2), evaluation software, reserve data and graphic database, analogy reservoir graphic parameter library (expert assistant analysis system) are collected to form a circular whole of asset evaluation and management as shown in Figures 3 and 4

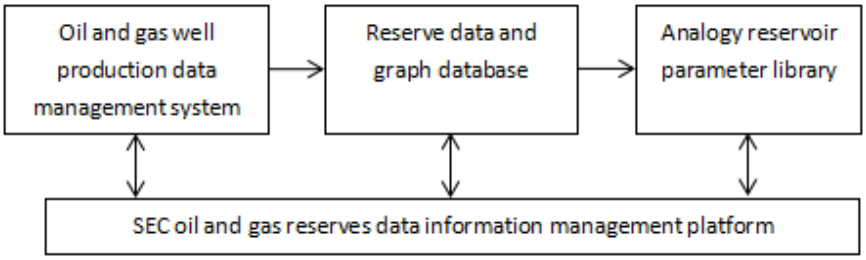

Figure 3: SEC oil and gas reserves asset evaluation and information management system framework and functional module design

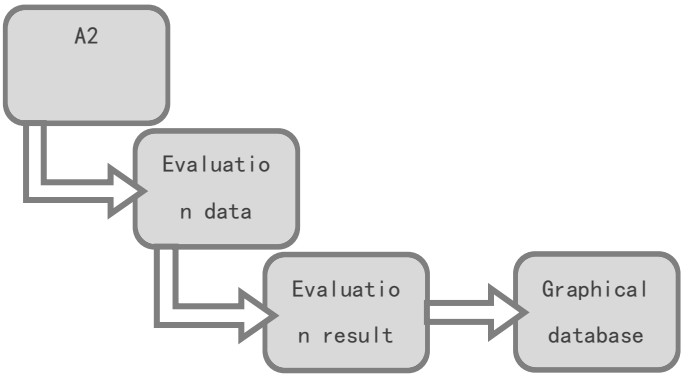

Figure 4: SEC reserves management system function module process design

The oil and gas well production data management system (A2) mainly provides the reserve assets with the single well related data contained in each oil and gas reserve asset, and through the related functions of the information management system platform, the standard gas production curve is drawn with the graphic function template to observe the asset production, and provides the dynamic data on standard evaluation production for the evaluation with the data processing module. The evaluation software can be independently developed, or by purchasing mature and reliable evaluation software at home and abroad. The key is to set open data interface in the management system and interface with the evaluation software, so as to evaluate the entry and other functional extensions of results data and graphics.

After the evaluation, all the evaluation result data, the evaluation basic data and the evaluation basic drawings are stored in the reserves database and the graphic database, and are managed through the system inquiry, statistics and analysis functions. The analogy reservoir graphic parameter library belongs to the expert assistant system in the system, because in the SEC reserves evaluation, the analysis of analogy reservoir plays an important role in the evaluation, especially in the determination of recovery ratio. After the analogy reservoir sequence is established, the expert knowledge base is formed according to the analogy conditions and standards, the target reservoir is automatically analyzed and matched with the analogy reservoir, and is evaluated and scored according to the expert knowledge base in the human-computer interaction cluster analysis model. After cluster analysis of the analogy reservoir sequence, the most suitable part is selected to assist the evaluation.

Based on the function analysis of the above modules, the function of the system is mainly designed from three aspects: data collection, data management and system function. Data collection includes data import, entry, maintenance and other functional modules; data management includes function modules such as data hierarchical browsing, data tracking, data query, statistics and report output; system functions includes auxiliary basic functions, history library management, interface functions with each database system, as shown in Figure 5.

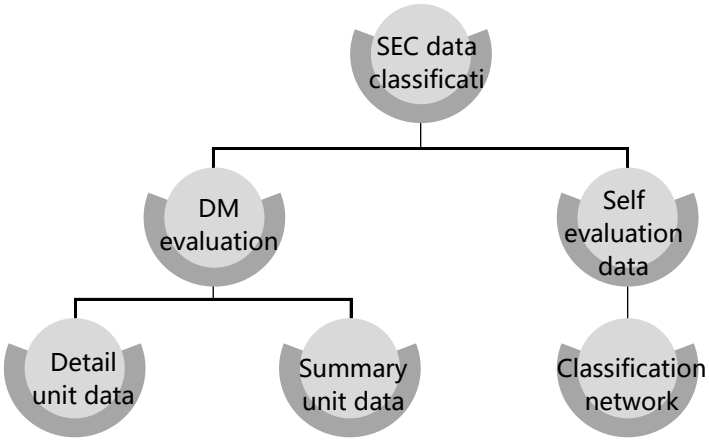

Figure 5: Information Management System Management Function Design

4. Results and Analysis

The research and development tool environment of assets evaluation and management system of listed oil and gas reserves mainly adopts Microsoft Visual Studio software research and development platform, and is programmed in C # programming language. The data uses the Microsoft SQL Server database, and the database operation language is the SQL language. The second development control of MAPGIS is used in the research and development of graphic tools. The interface design uses Devcomponent's DotNetBar interface design control. After entering the system, you can enter the "production data management" function module, connect with the production data management system (A2) of oil and gas wells, update the single well information of each oil and gas reserve asset, make statistics, check the production status, and generate the dynamic data format required by the evaluation software (mainly for checking asset status and PD reserves evaluation), as shown in Figure 6.

Figure 6: Production Data Management Function Module

Another important function module of the system is to manage the basic data, basic drawings and evaluation results of the SEC reserves in the past years, and to make historical inquiry, statistics and correlation analysis. The assets management area manages the SEC oil and gas reserve assets in the form of an asset tree. The asset tree can be made in various forms by starting the selection of key parameters according to the user's needs.

5. Conclusions

Improving the information level of reserves evaluation management and adapting to the requirements of the current "big data age" are the important contents of reserves management of petroleum energy companies at present. On the basis of the SEC reserves classification system, the attributes of management objects, and the appraisal work flow, the listed oil and gas reserve evaluation and management reserve system is designed and developed, which will combine the basic single well information, asset basic information and evaluation software, evaluation result management and statistics and expert-assisted analysis system to actively meet the needs of supporting basic data resources under the SEC new criteria for oil and gas reserves. It is convenient for unified and efficient management and lays a solid foundation for PetroChina to embark on the strategic layout of independent evaluation in the future, and to support and assist management decision-making effectively.

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