Research on Abnormal Detection Method of Data Flow Trend in Oil Drilling Engineering Early Warning

Liwei Yu1,*, Yutian Feng2, Xintong Wang1, Yuanyue Wu1, Yutao Liu3

1Engineering Technology Research Institute of Xinjiang Oilfield Company, China, 834000
2Chengdu Kingray Information Technology Co., Ltd., China, 6100413
3Xinjiang Central Asia Petroleum and Gas Co., Ltd., China, 834000

*Corresponding author e-mail: yulw@petrochina.com.cn

Abstract. In this paper, by collecting and analysing the domestic and foreign oil drilling accident data and early warning technology, combined with the oil drilling process prediction and forecasting process deficiencies. Based on theoretical analysis and analysis of five typical accident modes in actual drilling rig engineering, the early warning method and train of thought of oil drilling engineering are established, and the index of early warning of accident is given. The sensitivity of various accident prediction indexes to the corresponding accidents is studied. On the basis of analysing the forecast signal and processing, the comprehensive model of accident early warning under multi-objective condition is established.

Keywords: Oil Drilling, Data Integration, Comprehensive Database

1. Introduction

Early warning should take the causes, characteristics and development of accidents as the research object, and use modern system theory and early warning theory to construct a "self-organizing" system that can "immune" to disasters of the same nature, and can prevent and "correct" various accident phenomena. The early warning system is also a kind of warning oriented, correction means, immunization for the purpose of error prevention and correction system. In this system, the elements and components of early warning should be made clear, and then the corresponding early warning mechanism can be established.

2. The overall framework design of petroleum comprehensive database
2.1. The framework design structure of traditional petroleum comprehensive database

The goal of early warning is to warn the hazard level in the process of safe production by monitoring and evaluating drilling activities and management. The tasks that need to be completed are to complete the monitoring, identification, diagnosis and evaluation of various accident signs, to give an alarm in time, and to correct and control the adverse trend of accident signs according to the results of early warning analysis.

![Diagram of framework design structure of petroleum integrated database](image1)

**Figure 1.** The framework design structure of the petroleum integrated database

As shown in Figure 1, Early warning must determine what kind of state to alarm, so the object of early warning should be a phenomenon and situation. This is called a warning situation. In drilling engineering, a single or series of undesirable events that result in loss of life, injury or occupational disease, loss of equipment or environmental damage.

2.2. Connotation of integrated petroleum information database management

In order to carry out alarm warning, it is necessary to carry out careful analysis to the cause of the accident, in order to determine the corresponding warning parameters and indicators, and put forward the technical way and route of early warning, so the root of alarm is the alarm source. Figure 2 is a prototype of the oil drilling technology we used:

![Data summary of oil drilling technology applications](image2)

**Figure 2.** Data summary of oil drilling technology applications
Any alarm source has different abnormal changes in the development process, which is the omen that leads to the outbreak of the accident. Although there is contingency and uncertainty in the occurrence of accidents, there are precursors in the occurrence process of various accidents. The foreboding of the accident is the appearance of the alarm source, that is, the alarm. The warning sign of drilling engineering refers to the appearance of possible safety problems and the abnormal changes of various technical parameters in the drilling process.

![Figure 3. Integrated oil data exploration based on oil drilling technology](image)

As shown in Figure 3, the international petroleum hydrological information is the main data source of the petroleum hydrological database. The calculation methods and formulas of the derived parameters are different. The method of interpolating the standard layer from the measured layer data also has its own advantages and disadvantages. Even the data processing standards and codes adopted, as well as the format of recorded data, are still in the process of being unified. Therefore, standardized construction methods and standardized construction process, as well as advanced discharge technology and rigorous quality control methods are the premise to ensure the construction of a reasonable and applicable petroleum information management system.

3. Design of main functions of database management based on improved oil drilling technology

Minor wall collapse is common during drilling, and 20% to 40% of the cuttings returned to the wellhead are not drill cuttings but collapse debris. From the data of electric log diameter, it can be seen that the phenomenon of diameter enlargement is common, and the expansion is mainly in the mud shale interval. Such a slight collapse would not make drilling difficult. However, if the shale with strong water absorption and developed cracks is encountered, large-scale collapse will be formed in a short period of time, exposing a layer, denudation a layer, continuous, so that drilling operations cannot be carried out, or even buried drilling tools, causing serious accidents of collapse and stuck drill. In order to prevent the collapse of the shaft wall and to take timely measures to prevent the expansion of the accident, it is necessary to take appropriate technical measures at the drilling site.

4. Principle and application of key technologies

4.1. Technical principle of oil drilling
First of all, a reasonably well structure should be designed according to the specific situation of the location. Surface casing should be used to seal off soft formations above, as these formations are most likely to collapse and are most responsive to the pressure of the drilling fluid column. For obvious leakage layers such as weathering crust of ancient buried hill, limestone cracks and karst caves, the upper part should be sealed off by casing. Because drilling into these formations often results in large leaks, geological logging must be done carefully, typically no more than 3m into the weathering crust. In the same open hole interval, no flow and loss zone can coexist. To minimize the large hole reservation length below the casing shoe, it is generally required to be 1-2m. Because the stability of a large hole is much worse than that of a small hole.

Secondly, it is necessary to adjust the performance of drilling fluid to the drilling formation. For the uncemented sand layer and gravel layer, the drilling fluid should have appropriate density and high viscosity and shear force; for the mud shale, coal seam and peat mixed layer with stress unstable fracture development, the drilling fluid should have higher density and appropriate viscosity and shear force to reduce the amount of filtration loss.

![Figure 4. Basic site for petrochemical data observation](image)

Finally, a cave-resistant drilling fluid is used to prevent wall collapse. With the in-depth study of drilling fluid, the collapse prevention performance of drilling fluid is diverse, including oil-base drilling fluid and potassium drilling fluid, and water-in-oil emulsion drilling fluid, low fluid loss and high salinity drilling fluid, silicate drilling fluid, drilling fluid with various plugging agent, partly hydrolysis, cationic and phthalein amine drilling fluid, etc.

4.2. Petroleum sensor space-time cooperative observation technology

Appropriately improve the salinity of drilling fluid and make it equal to or slightly higher than the salinity of mud shale, reduce the osmotic pressure, reduce the water content and pore pressure of mud shale around the borehole wall, and increase the strength of mud shale; To promote is conducive to the stability of ion exchange of the shale, Na + is the main source of clay hydration, if the introduction of K + in the drilling fluid, can effectively reduce the inflation pressure of mud shale, and can react with the component of the shale, to enhance cementing force of the mud shale.

5. Conclusion
Through the establishment of a set of complete and multi-source heterogeneous oil comprehensive database management platform, integrated oil real-time observation data, history data, basic geographic information data, social and economic data, remote sensing image data and historical data, such as oil disasters to provide user management interface based on oil drilling frame, make the non-professional ordinary users can conveniently to design the database structure and management, disaster warning analysis for oil, big wisdom oil providing the data such as data mining, has been greatly increased wisdom for oil in the department in charge of management ability, It provides reliable data support and technical means for rational utilization of petroleum and scientific protection of petroleum.

References

[1] Amp M S, Najibisupb/Sup H. Application of the -Exponent Method for Abnormal Pressure Detection in Ahwaz Oil Field: A Comparative Study [J]. Petroleum Science and Technology, 2012, 30(4):p.339-349.

[2] Chang Y, Wang X, Han Y, et al. The Removal of Crude Oil in Waste Drilling Muds by a Constructed Microbial Consortium [J]. Lecture Notes in Electrical Engineering, 2014, 250:1245-1257.

[3] Fan J M, Guo R S, Chang S C, et al. Abnormal trend detection of sequence-disordered data using EWMA method [wafer fabrication] [J]. IEEE, 1996.

[4] Geng Z, N Chen, Han Y, et al. An improved intelligent early warning method based on MWSPCA and its application in complex chemical processes [J]. The Canadian Journal of Chemical Engineering, 2020.

[5] Luan Y. Early Warning Technology in Drilling Muds Lost Circulation Anomaly Based on Data Analysis [J]. IOP Conference Series Earth and Environmental Science, 2018, 170:022047.

[6] Najibi M. Application of the dc-Exponent Method for Abnormal Pressure Detection in Ahwaz Oil Field: A Comparative Study [J]. Petroleum Science and Technology, 2012.

[7] Rezki D, Mouss L, Baazziz A. Using a data mining CRISP-DM methodology for rate of penetration (ROP) prediction in oil well drilling [J]. Post-Print, 2018.

[8] Sun B, Sun X, Dai J. Research on Error Correction Method of Filter Assembly Based on Abnormal Trend Recognition of Sequence Data [J]. Measurement, 2020, 163:107932.

[9] Xin L, Sun X, Qi X, et al. Research on analysis method of multi-fractal de-trended fluctuation of electroencephalogram focus on mental stress evaluation [J]. Journal of Biomedical Engineering, 2017, 34(2):180-187.

[10] Zeng L, Zhang H P, Liu E C, et al. Research on Rapid Detection and Accounting of Small Particles in Marine Hydraulic Oil [J]. Key Engineering Materials, 2015, 645-646:687-692.