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Research of Drilling Slurry Flux and Correlation Parameter Modeling

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Abstract: This cycle of the monitoring system of drilling mud, drilling mud is the main monitoring parameter object reference for the current international advanced technology, drilling mud measurements and mathematical modeling, and intelligent judgments conditions conducted in depth study and on this basis, the use of new technology, new technology and new technology research and development of a set of high precision, functional and user-friendly real time drilling mud parameter monitoring system, proved that the system can better meet the needs of production, achieved good economic results.

Keywords: colliery artesian well; real time data; slurry; monitor; modeling

1. Introduction

Resources and environment, population is the three problems that human society faces. In the world, the 21st human society has been faced with serious issues of resources. According to the statistics, the world's known oil and gas reserves in 2020 will be exhausted, coal as the basic exploitation of resources in traditional social development still plays an important role. Current coal mine is above using vertical way, vertical due to exploit the complex technology, narrow space, environment, equipment, although only vertical quantities all mine construction project of the bill, but the drilling of mine construction total duration of vertical, so the construction of the new mines are the main engineering.[1]~[3] In a certain sense, the mine construction speed slow and early will directly influence the quality of the operation efficiency and to coal comprehensive economic benefit. How to develop scientific and engineering optimization cutting, and finally realize the mathematical drilling, it is necessary to mine construction and an important issue. [4]

2. Drilling method and slurry recycling systems

Drilling method is based on the requirements and design of mine in drilling equipment in a proper position, drill hole diameter and depth and permanent support, comply with the design requirements of mine shaft. All assignments are drilling in the ground, is a highly mechanized construction method. It is less, the construction safety and high quality, suitable for sparseness, large diameter drilling, deep in the surface layer of drilling technology impact economic advantages. At present, our coal mine construction method used in drilling of drilling equipment for turning disc drilling. The process steps general: borehole drilling, Wash well applied, The ground, prefabricated sidewall Shaft sinking floating, After filling wall cementing, etc.[5]

Drilling mud is used by water, clay and mud treatment (including organic and inorganic chemical agents and natural or synthetic polymers), according to a certain proportion of configuration, stir and decentralized system. Used in coal mine slurry performance parameters including the relative density and viscosity commonly, sand and water quantity of mud and stone, ph, colloid, stability, etc. They experience in scope listed below:.

Table 1 the performance parameters of drilling mud.

Mud parameter	Bound	Mud parameter	Bound
The relative density.	*1.04～1.15*	*Viscosity /s*	*15～30*
Loss of water. /ml • (30min)-1	*10～15*	*Thickness of mud /mm*	*0.5～1.5*
Cutting force /Pa	*0 or as small.*	*Ph.*	*Neutron or ⩽8*
The sand content /%	*<2*	*Colloid rate./%*	*>97*
Stability.	*<0.003*		

This paper mainly studies the mud recycling system is mainly composed of pressure ratio of water, wind, drilling mud, wash well, slag cement early, etc.

3. The filed experiment data collection and analysis

Usually in drilling process, the site of the data collected. The present study mainly for mud flow data object, mud density, the wind, the cumulative depth, the sand content and viscosity. In the initial stage of study due to the system, thus only with the five research mud flow between single change trend. Site for a group of mud collecting the data flow and mud density as follows:

Table 2 Mud flow and mud density data table.

Numbers	Density	Mud flow (m3/h)
1	*1.190*	*1402*
2	*1.200*	*1392*
3	*1.205*	*1377*
4	*1.210*	*1360*
5	*1.218*	*1346*
6	*1.230*	*1339*
7	*1.238*	*1327*
8	*1.242*	*1322*
9	*1.245*	*1318*
10	*1.250*	*1302*

It can be seen, mud density values are higher than the design scope, because of the use of drilling cycle continuously joined the clay mud and debris, its density is often around. A moment can be found: the density of the slurry, mud flow, whereas the mud flow is smaller.

4. Mathematical model

We assume that the mud flow as random variables Y, and mud density or drilling depth or wind as the independent variable x and drilling for each value x, Y has its own distribution, if $E(Y)$ present, it must be written to the function, and called $\mu(x)$. By the analysis of data that should be a linear function, namely. $\mu(x) = a + bx$.

Assume for a certain range of values x,

$$Y \sim N(a + bx, \sigma^2).$$

Among them, a, b, σ^2 are unknown parameter. To make the normal hypothesis, this is to discuss the following linear model

$$y = a + bx + \varepsilon, \varepsilon \sim N(0, \sigma^2) \quad (1)$$

Type (1) is our discussion is unitary linear regression model.

By the sample can be obtained $\hat{a}$, $\hat{b}$ through certain method (4.1),estimates that for a given, we take $\hat{y} = \hat{a} + \hat{b}x$ as estimates for the equation about the linear regression equation. For sample, and (x_1, y_1), (x_2, y_2), …, (x_n, y_n), And, by the type (1).

$$\left.\begin{aligned} y_i &= a + bx_i + \varepsilon_i \qquad i = 1, 2, \cdots, n \\ \varepsilon_i &\sim N(0, \sigma^2), \qquad independence \end{aligned}\right\} \quad (2)$$

Considering the function of a、b

$$Q(a,b) = \sum_{i=1}^{n} (y_i - a - bx_i)^2 \quad (3)$$

Using least square estimation a, b.

make $Q(\hat{a}, \hat{b}) = \min Q(a,b)$

Then,

$$\left.\begin{aligned} \frac{\partial Q}{\partial a} &= -2\sum_{i=1}^{n} (y_i - a - bx_i) = 0, \\ \frac{\partial Q}{\partial b} &= -2\sum_{i=1}^{n} (y_i - a - bx_i)x_i = 0 \end{aligned}\right\} \quad (4)$$

Obtain equations:

$$\left.\begin{aligned} na + (\sum_{i=1}^{n} x_i)b &= \sum_{i=1}^{n} y_i \\ (\sum_{i=1}^{n} x_i)a + (\sum_{i=1}^{n} x_i^2)b &= \sum_{i=1}^{n} x_i y_i \end{aligned}\right\} \quad (5)$$

Because $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$, $\bar{y} = \frac{1}{n}\sum_{i=1}^{n} y_i$. Type (5) can be rewritten for.

$$\left.\begin{aligned} a + \bar{x}b &= \bar{y}, \\ n\bar{x}a + (\sum_{i=1}^{n} x_i^2)b &= \sum_{i=1}^{n} x_i y_i \end{aligned}\right\} \quad (6)$$

Because not all the same, and the coefficient of equations for 0, so the determinants of equations are only one solution: group.

$$\left.\begin{aligned} \hat{a} &= \bar{y} - \bar{x}b \\ \hat{b} &= \frac{\sum_{i=1}^{n} x_i y_i - n\bar{x}\bar{y}}{\sum_{i=1}^{n} x_i^2 - n\bar{x}^2} \end{aligned}\right\} \quad (7)$$

Because.

$$\left.\begin{aligned} \sum_{i=1}^{n} x_i y_i - n\bar{x}\bar{y} &= \sum_{i=1}^{1} (x_i - \bar{x})(y_i - \bar{y}) \triangleq S_{xy} \\ \sum_{i=1}^{n} x_i^2 - n\bar{x}^2 &= \sum_{i=1}^{n} (x_i - \bar{x})^2 \triangleq Sxx \end{aligned}\right\} \quad (8)$$

Type (7) can be rewritten for:.

$$\left.\begin{aligned} \hat{b} &= \frac{S_{xy}}{S_{xx}} \\ \hat{a} &= \bar{y} - \bar{x}\hat{b} \end{aligned}\right\} \quad (9)$$

Namely, first $\hat{b}$ then $\hat{a}$ for the linear equation for type (10).

$$\hat{y} = \hat{a} + \hat{b}x \quad (10)$$

5. Model solving

According to the above analysis, we know, mud flow problem with mud density should be applied tectonic linear regression model for solving the n = 10, here.

$$\bar{x} = \frac{1}{10} \times 12.22800 = 1.22280 \quad ,$$

$$\bar{y} = \frac{1}{10} \times 13485 = 1348.5 \quad (11)$$

Because (8),

$$S_{xx} = \sum_{i=1}^{n} x_i^2 - n\bar{x}^{-2}$$

$$= 14.95638 - 10 \times (1.22280)^2 \quad (12)$$

$$= 0.003984$$

$$S_{xy} = \sum_{i=1}^{n} x_i y_i - n\bar{x} \cdot \bar{y}$$

$$= 16483.22300 - 10 \times 1.22280 \times 1348.5 \quad (13)$$

$$= -6.24$$

Because (9),

$$\hat{b} = \frac{S_{xy}}{S_{xx}} = \frac{-6.24}{0.003984} = -1565.17 \quad (14)$$

$$\hat{a} = \bar{y} - \bar{x}\hat{b}$$

$$= 1348.5 - 1.22280 \times (-1565.17) \quad (15)$$

$$= 3262.39$$

Mud flow and mud density data sheet.

i	x_i	y_i	$x_i y_i$
1	*1.190*	*1402*	*1668.38000*
2	*1.200*	*1392*	*1670.40000*
3	*1.205*	*1377*	*1659.28500*
4	*1.210*	*1360*	*1645.60000*
5	*1.218*	*1346*	*1639.42800*
6	*1.230*	*1339*	*1646.97000*
7	*1.238*	*1327*	*1642.82600*
8	*1.242*	*1322*	*1641.92400*
9	*1.245*	*1318*	*1640.91000*
10	*1.250*	*1302*	*1627.50000*
Σ	*12.22800*	*13485*	*16483.22300*

Obtain:

$$\hat{y} = 3262.39 - 1565.17x \quad (16)$$

Similarly, we can solve the mud flow and drilling mud flow and air pressure, the relationship between drilling depth.

6. Conclusion and prospect

This article is to drilling mud flow and related parameters of the preliminary research of monitoring and modeling, integrating coal sample collection plate is studied, and the data of flow and the related parameters of the preliminary the correlation between the two are analyzed, the modeling. Through this system of field data acquisition and monitoring, comparison and analysis, the following conclusions:.

- Mud flow problem with mud density, mud flow and drilling mud flow problem, the wind with drilling depth of the mathematical model, after using regression analysis, they conform to solve linear regression model of application.
- Use the model analysis and monitoring system for drilling can provide a relatively scientific construction, digital operation and guiding platform.

This research drilling mud circulation monitoring system, is the main parameters of drilling mud for monitoring objects, reference and the current international advanced technology, to drilling mud parameter measurement method and mathematical modeling and condition of intelligent judgment studied, and on the basis of using the new technology, new technology, new technology developed a set of high precision, complete functions, friendly interface of the real-time monitoring system parameters of drilling mud. Practice has proved that this system can satisfy the needs of production and achieved good economic benefit.

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