Study on stability of coal water slurry under different coal water slurry dispersants by using stability analyzer

Lei Ge¹,²,³,⁴, Junguo Li⁵

¹Shaanxi Provincial Land Engineering Construction Group Co., Ltd. Xi’an, China
²Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd. Xi’an, China
³Key Laboratory of Degraded and Unused Land Consolidation Engineering, the Ministry of Land and Resources. Xi’an, China
⁴Shaanxi Provincial Land Consolidation Engineering Technology Research Center, Shaanxi Xi’an, China
⁵Shaanxi University of Science and Technology, Xi’an, China

*Corresponding author e-mail: gelei917@foxmail.com

Abstract. The stability analysis of CWS by Turbiscan Lab stability analyzer not only can clearly observe the change of the supernatant layer in the slurry, but also can observe the change of the turbid area. It can objectively reflect the agglomeration and flocculation in the slurry. Settlement and a series of changes. The results show that the sedimentation mainly occurs in the coal-water slurry system made by HSC and HS, and the coal-water slurry system produced by NSF mainly reunion and sedimentation. The three dispersants on coal-water slurry stability enhancement ability were: HSC> HS> NSF.

1. Introduction
As the largest producer and consumer of coal in the world, China’s coal resources account for a far larger share of fossil energy resources than oil and natural gas, accounting for about 81.6% of the total. The excessive dependence on coal in China's energy production and consumption structure has made it more difficult to control such issues as environmental pollution. Coal production and utilization are the major causes of environmental problems such as air pollution, acid rain and climate change. Coal-water slurry as a new generation of coal-based clean fuels, is through the 60 ~ 70% coal, 30 ~ 40% of water and then supplemented with about 1% of special additives, the special process of processing from the suspension State-based coal-based fuel, with good economic, environmental protection, energy-saving benefits. Because coal-water slurry is a kind of coarse-grained dispersed suspension, it is unevenly stable on its own. As the standing time increases, the coal particles in the slurry will inevitably settle under the action of gravity, resulting in uneven or granular precipitation in the space. The stability of CWS is a key performance index of CWS. In large-scale industrial applications, the stability of CWS is often more important than its concentration and rheology. It not only determines whether the normal storage of coal slurry, transportation, more directly related to the coal slurry production plants and users of the normal production. Studying the stability of CWS has important guiding significance for its industrial application.
At present, the methods of evaluating the static stability of coal-water slurry are mainly water-splitting method and observation method. The stability analysis of CWS by Turbiscan Lab stability analyzer can not only observe the change of the supernatant layer, but also changes in the cloudy area can be observed, and a series of changes of agglomeration, flocculation and sedimentation in the slurry can be objectively reflected. The stability analysis of coal-water slurry with stability analyzer has the advantages of faster and more accurate than the traditional method, but also can be applied to study the stability mechanism. In this paper, Turbiscan Lab stability analyzer analysis of two kinds of humic acid dispersant HSC, HS and Naphthalene dispersant NFA on the stability of coal-water slurry.

2. Materials and methods

2.1. Preparation of coal water slurry
Coal-water slurry is produced by dry-process pulverizing method. Pulverized coal is pulverized by a FW-200 type pulverizer, sieved by a sample sieve of 20, 40, 120, 200 and 300 meshes, Particle size distribution of the ratio of mixing, into the grinding tank. At the same time add a certain amount of dispersant and water, and then add the appropriate amount of grinding ball, placed on a planetary ball mill XM-4 grinding, rotation 600 r/min, time 10 min.

This experiment uses Binchang coal as experimental coal, coal analysis in Table 1

| Coal species | Industrial Analysis /wt% | Elemental analysis /wt% |
|-------------|--------------------------|------------------------|
|             | M<sub>ad</sub> | A<sub>d</sub> | V<sub>daf</sub> | C<sub>daf</sub> | H<sub>daf</sub> | O<sub>daf</sub> | N<sub>daf</sub> | S<sub>t,d</sub> |
| Binchang coal | 5.71 | 10.58 | 23.59 | 67.84 | 3.97 | 10.86 | 1.04 | 0.36 |

2.2. Test Methods
The stability analyzer test was performed using a Turbiscan Lab dispersion stabilizer (FORMULACTION, France). Test Method: A small amount of fresh coal water slurry sample into the stability analyzer sample tube, loading height of about 40mm, to ensure a complete half moon. The sample tube placed in the stability analyzer, the entire process to avoid damage to the sample of the meniscus, the sample tube set aside after standing 5min to start the measurement procedure set. Experimental set test program: experimental temperature 25 ℃, the number of scans for a total of 60 times, scanning interval 5min. Use Turbi Soft software to analyze the results.

3. Test results and analysis
The dispersant HSC was used for the preparation of Binchang coal-water slurry with a fixed concentration of coal-water slurry of 60 wt% and a dispersant dosage of 0.75 wt% (compared with anionic dispersant HS and NSF plus 0.75 wt%). Effect of Three Dispersants on Coal Water Slurry System.

Figure 1 Scanning of Binchang CWSs prepared from HSC
Figure 2 Scanning of CWSs prepared from HS

From Figure 1, 2, and 3, it can be seen that the reflected light intensities of the CWSs prepared by the three dispersants change in a gradient manner over time, which is a "differential settlement." The instability phenomenon in the sample can be generally judged by the change of the curve topography of the reflection spectrum, for example: (1) Floating phenomenon, as the particle concentration decreases in the lower layer and the upper layer increases, the intensity of the lower BS decreases, (2) The sedimentation phenomenon, the particle concentration in the sinking increases, the upper decreases, the performance of the lower BS strength increases, the strength of the upper BS decreased; (3) reunion, flocculation, agglomeration and flocculation will lead to sample size increases, the performance of The overall BS intensity decreased for the sample. In most cases, the instability of a sample is a collection of phenomena that can be studied by reflection spectroscopy. The sedimentation phenomenon mainly occurs in the coal-water slurry system made by HSC and HS, while the coal-water slurry system made by NSF mainly has many instabilities such as agglomeration and sedimentation.
3.1. Effect of dispersant on CWS area
According to the projection spectrum, the appearance time and the relative width Dr (Dr, Dr) of the supernatant zone (precipitation water) of CWS can be determined by the following formula.

\[ \text{Dr} = \frac{\text{height of clear liquid area}}{\text{total height of sample}} \times 100\% \]  

(1)

In general, the later the liquid zone appears, the smaller the relative width, the more stable the CWS system. Experimental analysis of the clear liquid zone of CWS samples made from three dispersants showed the results are shown in Figure 4.

![Figure 4: Effect of dispersants on the clarifying zone of CWSs](image)

As can be seen from Figure 5, the clear liquid area of CWS made by HSC appears the latest, about 100 min, and the settling time is 240 min, the relative width Dr of clear liquid area is 2.89%; HS when the CWS appeared in the clear water zone for 40 min and the standing time was 240 min, the relative width Dr of the clear zone was 3.20%. The NSF CWS appeared the earliest, and the settling time was 240 min, the relative width Dr of the clear liquid zone is 3.55%. The stability of the three dispersants were as follows: HSC > HS > NSF

3.2. Effect of Dispersants on the Instability Coefficient of Coal Water Slurry
The coefficient of instability (TSI) represents the result obtained by integrating the change of the intensity of the reflected light and the intensity of the reflected light measured by the previous scan with respect to the total sample height at a given height, as follows:

\[ TSI = \sum_n \frac{\sum_h |X_n(h) - X_{n-1}(h)|}{H} \]  

(2)

TSI——Instability coefficient;

n——Number of scans;

h——Scan the height;

H——Sampling height;

\(X_n(h)\) ——Projected light scanned n times at height h reflects the intensity of the light.

For CWS samples, the instability coefficient can not only indicate the change of turbidity of the supernatant zone and the middle layer, but also can be used to consider the change of the overall stability of the slurry. The larger the instability coefficient is, the more unstable the slurry is. The effect of standing time on the overall instability coefficient of CWS was investigated experimentally and the results are shown in Fig. 5.
As can be seen from Figure 5, with the extension of standing time, the instability coefficients of CWS prepared from the three dispersants have been increasing and gradually flattening, indicating that the CWS stability over time The growth continued to decrease. When the stability dropped to a certain level, the internal changes of the slurry tended to be stable. When the instability coefficient of CWS prepared by HSC is about 40min, the trend tends to be gentle and increases to 0.2 at 150min. The instability coefficient of CWS made by HS tends to be stable at 120min , To 0.5; the instability coefficient of CWS made by NSF increased rapidly within 0 ~ 60min, then stabilized, and the instability coefficient increased to 1.1. Comparing the instability coefficient of coal water slurry prepared by the three dispersants, the relationship between them is: HSC <HS <NSF, which indicates that HSC has good dispersion stability for Binchang coal-water slurry.

4. Conclusion
The settling phenomenon mainly occurred in the CWS system made by HSC and HS. With the increase of standing time, the relative width of clear liquid layer increased, the particle size in turbid area decreased, the instability coefficient increased, and the stability decreased. Coal slurry produced by NSF mainly reunion and sedimentation, with the increase of standing time, the relative width of clear liquid layer increases, the particle size of turbid area increases, the instability coefficient increases, and the stability decreases. The three dispersants on coal-water slurry stability enhancement ability were: HSC> HS> NSF.

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