Study on desulfurized gypsum used as cement retarder

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Abstract. The effects of desulfurized gypsum, heat-treated desulfurized gypsum and hydrogen peroxide modified desulfurized gypsum on the setting time of Portland cement were studied. The results showed that when the content of desulfurized gypsum after 80 ℃ heat treatment was 4% of Portland cement, the initial setting time was 136min, and the final setting time was 196min, which met the requirements of cement. Compared with natural gypsum, the retarding effect of desulfurized gypsum on Portland cement is more significant at the same dosage. The desulfurized gypsum treated with hydrogen peroxide can improve the stability of cement. When the proportion of desulfurized gypsum and natural gypsum is 1:1 and the content is 3%, it has a better retarding effect on Portland cement.

1. Introduction
At present, the retarder used in cement production is mainly natural gypsum [1]. if things continue this way, it will not only increase the consumption rate of natural gypsum, but also cause the damage of ecological environment. If desulfurized gypsum, the industrial byproduct of power plant, cannot be effectively treated and utilized [2-3], it will also cause serious environmental pollution. If desulfurized gypsum can be used to replace natural gypsum as retarder of Portland cement [4-6], it not only protects the ecological environment, but also effectively realizes the rational utilization of power plant resources. This paper studies the effect of desulfurized gypsum and 1% hydrogen peroxide modified desulfurized gypsum on the setting time of Portland cement, and analyzes the retarding effect of desulfurized gypsum in Portland cement.

2. Experiment
2.1. Material
The desulfurized gypsum produced by Baotou Huaneng Power Plant is selected. The cement clinker produced by Inner Mongolia Jidong Cement Plant is selected. The hydrogen peroxide produced by three factories of Tianjin Huadong reagent was selected for analysis. See Table 1 for composition of main elements of desulfurized gypsum and cement clinker.
2.2. Method
Dry the desulfurized gypsum under normal temperature, and use it for standby after grinding. The desulfurized gypsum is heat treated at 50℃, 80℃ and 110℃ respectively. After grinding, it is mixed with 3%, 4%, 5%, 6% and 7% clinker of cement clinker quality for standby. The desulfurized gypsum is modified by adding 1% of the mass of desulfurized gypsum with hydrogen peroxide, dried and ground for standby. According to GB / T 1346-2001, determine the standard brick consistency and setting time of cement clinker after adding different desulfurization gypsum.

3. Results and discussion

3.1. Effect of desulfurized gypsum on setting time of Portland cement
It can be seen from Fig. 1 and Fig. 2 that the general trend of change is that the setting time of Portland cement increases with the increase of the amount of desulfurized gypsum, the initial setting time and final setting time can meet the use requirements of Portland cement, so it is feasible to use desulfurized gypsum as cement retarder. At the same time, it can also be seen that the setting time of Portland cement is also affected by desulfurized gypsum treated at different temperatures. The general trend is that with the increase of treatment temperature, the setting time increases first and then decreases. Considering the stability of cement and the convenience of operation, it is more suitable to use desulfurized gypsum which has been heat treated at 80 ℃ and added 4% as the retarder of Portland cement.

| Sample     | SiO₂  | Al₂O₃ | Fe₂O₃ | CaO    | SO₃  | K₂O  | MgO  | Na₂O  | Cl   |
|------------|-------|-------|-------|--------|------|------|------|-------|------|
| desulfurized gypsum | 0.456 | 0.210 | 0.159 | 45.102 | 40.213 | 0.120 | 0.365 | -     | 1.010 |
| Clinker    | 21.890 | 4.469 | 2.541 | 67.879 | 0.678 | 0.900 | 1.553 | 0.068 | 0.014 |

**Fig 1.** Effect of different temperature treatment and different amount of desulfurized gypsum on initial setting time of Portland cement
Fig 2. Effect of different temperature treatment and different amount of desulfurized gypsum on final setting time of Portland cement

3.2. Comparative analysis of the effect of desulfurized gypsum and natural gypsum on setting time of Portland cement

It can be seen from Figure 3 that the desulfurized gypsum after heat treatment at 80 ℃ has the same retarding effect on Portland cement as the natural gypsum, and the retarding effect of desulfurized gypsum is more obvious under the same dosage. This further shows that it is feasible to replace natural gypsum with desulfurized gypsum as Portland cement retarder.

Fig 3. Effect of desulfurized gypsum and natural gypsum on setting time of Portland cement

3.3. Effect of hydrogen peroxide on setting time of cement

It can be seen from Figure 4 that the desulfurized gypsum treated with hydrogen peroxide has more significant retarding effect on Portland cement than the untreated desulfurized gypsum, mainly because hydrogen peroxide oxidizes the calcium sulfite in the desulfurized gypsum to calcium sulfate, which is
more conducive to the retarding of Portland cement. This is also conducive to reduce the amount of desulfurized gypsum in Portland cement and improve the stability of cement.

![Fig 4. Effect of desulfurized gypsum treated with hydrogen peroxide on setting time of Portland cement](image)

**3.4. The influence of the mixture of desulfurized gypsum and natural gypsum on the setting time of cement**

It can be seen from Figure 5 that the setting time tends to decrease with the increase of the ratio of desulfurized gypsum and natural gypsum, the more appropriate ratio is 1.0, and the setting time meets the setting time of cement when the mixing amount is 3%. Therefore, it is feasible to mix desulfurized gypsum and natural gypsum as retarder of Portland cement.

![Fig 5. Effect of ratio of desulfurized gypsum to natural gypsum on setting time of cement](image)
4. Conclusion

It is feasible to use desulfurized gypsum as retarder of Portland cement. When the content of desulfurized gypsum after 80℃ heat treatment is 4% of Portland cement, the setting time can meet the use requirements of cement. Compared with natural gypsum, the retarding effect of desulfurized gypsum on Portland cement is more significant at the same dosage. The desulfurized gypsum treated with hydrogen peroxide can improve the stability of cement. When the proportion of desulfurized gypsum and natural gypsum is 1:1 and the content is 3%, it has a better retarding effect on Portland cement.

Acknowledgements

Author wish to thank Inner Mongolia Natural Science Foundation for funding through the project 2017MS(LH)0514.

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