SEALING WATER IN SHAFT WALL WITH C-S GROUT AND CHEMICAL GROUT

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ABSTRACT

This paper presents the method, grouted materials, principles and results of sealing water in shaft wall with C-S grout and chemical grout on three shafts.

INTRODUCTION

Main shaft of Chengxi Coal Mine, Hunchun, sand and pipe shaft of Fujia Mine, Panshi Nickel Company, Jilin Province, have sealed leakage water with C-S grout and chemical grout, the results have proven to be satisfaction. The following is an example from Main shaft of Chengxi Coal Mine, completed in 1991.

Geological condition of Main Shaft of Chengxi Coal from the upper to the lower is the soil formation (1m to 2m), the quaternary deposit (sand and gravel, 5m to 10m), the weathered cracked coal-measure seam. After the completion of the project the hydrogeological condition and the quality of the concrete have resulted in leakage water in shaft wall. The quantity of leakage was 8.72m^3/h. the leakage water was 5m to 60m in depth. The underground water flowed down along the shaft wall and part of it flowed into the coal bunker. When coal was hoisted, water was poured into the hoisting skip, which increased the water capacity in coal and influenced the heating value of power plant greatly. So we decided to seal water in shaft water with C-S grout and chemical grout. After sealing water for two months the 90%-sealing water rate has been attained.

GROUT MATERIALS ANG THE PRINCIPLES OF GELLING AND CONSOLIDATION

According to the experience of choosing grout give by Prof. Terzaghi. K, the soil included slightly thin fissure or very thin fissure(d_{10}<0.02mm) is suitable for pure solution (propionyl gelatinoid etc.), and the soil included thin fissure or middle grain size(0.02mm<d_{10}<0.5mm) is suitable for the gelatinoid solution or the prepalymer (silicon gelatinoid, cyanide gelatinoid, cement-water glass etc.), and the soil included thick fissure or thick grain size(d_{10}<0.5mm) is suitable for the grained Bingham fluid solution(clay, cement grout etc.). Main shaft of Chengxi Coal Mine has chosen propionyl gelatinoid and cement-water glass grout to seal water.

Chemical grout

Propionyl gelatinoid grout is chosen to be chemical solution, whose main solution is amide propene , and its viscousness is low(about 1.2cp), and its grouting capacity is good to be similar to water. The grout goes where the water comes from under the pressure of grouting. The gelling time may be accurately controlled from a few seconds to a few minutes . The permeability resistance and durability of grouting solid are good.

The chemical grout consists of solution A and B(see table 1).

Table 1: Compound grout of 100 ml

Grout density	Solution A				Solution B	
	Amide propene(g)	Di-propenyl(g)	Terethano -lamine(g)	Water to (ml)	Transammo - nium(g)	Water to (ml)
10%	0,5	0,5	0,40 - 5	50	0,5	50
15%	14,25	0,75	0,60 - 75	50	0,5	50

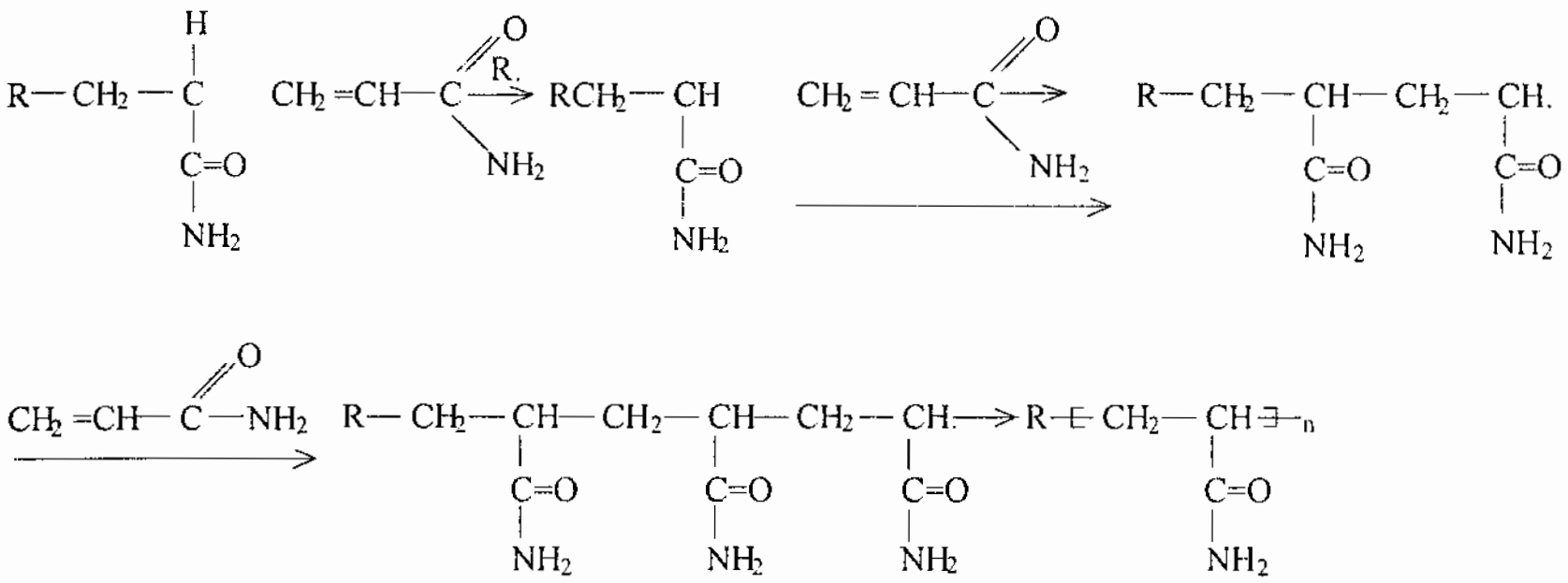
While grouting at the work site, the grout are diluted by underground water. We may use the density of 15%. After mixing up solution A and B the gelling time is from 1min to 3 min, in the general temperature.

Propionyl gelatinoid grout can gel and solidify, because the monomer of amide propene has formed the macro-molecule polymer .

There is a dibond(>C=C<)in a amide propene. This dibond may open by the action of the causing fuse. The transammonism is a oxidizer(causing fuse). The amide propene is a reducing agent. They were put together to make oxidize-reaction take place and to form a free radical(R). The free radical can open the dibond of amide propene to cause polymerization reaction.

By the action of the free radical(R)produced by the causing fuse the dibond of amide propene is opened to form a new free radical.

Which acts together molecules of amide propene. Afterward in this way a big linear molecule may be formed.



The forming process of big molecules is the polymerization reaction. Self polymer of amide propene dissolves in water. The crosslinking agent of di-propenyl includes two dibonds. The so-called cross linkage is that, one of the dibonds is opened and thrusted into a big molecule of amide propene, the other also opened and thrusted into another big molecule of amide propene. In this way two linear big molecules are connected with some intermediate bridges, and the so-called network macro-molecules have been obtained which turns the original liquid into the indissoluble solid and the aim at leakage resistance and sealing water is attained.

C-S mixed grout(cement and water glass grout)

According to the design, we have chosen the common silicate cement by $425^{\#}$ and the water glass by 35 to 40 Baume degrees. Cement and water are mixed into the cement grout in the ratio of 1:1 by weight. The radio of the cement grout and water glass by volume is 1:1 to 1:1.5 and the gelling time is 2 to 5 minutes.

The coagulating and hardening of self the cement are mainly caused by the gel material in process of cement hydration. In hydrated process of calcium silicate, calcium hydroxide is produced:

$$3CaO \cdot SiO_2 + nH_2O = 2CaO \cdot SiO(n-1)H_2O + Ca(OH)_2$$

After adding some water glass ,water glass react immediately with latest produced calcium hydroxide to form gelling solid with certain strength, which is hydrated calcium silicate.

$$Ca(OH)_2 + Na_2O \cdot nSiO_2 + mH_2O \rightarrow CaO \cdot nSiO_2 \cdot mH_2O + 2NaOH$$

The cement hydration and the reaction between cement and water glass are quite complicated physical and chemical changes, so many problems will wait for further investigation.

GROUTING TECHNOLOGY

The main points of the grouting order:

Drilling

Holes of 42mm in diameter are drilled with a pneumatic rock drill on the site of leakage water. The hole is 0.4m deep and it is penetrating the wall. The drilling principles are where is leakage water, there is a drilling hole.

Hiding the grouting pipes

After drilling the hole, a grouting pipe was put into the hole and there kept 0.15m long between the wall and the outside of the pipe. The central part of the grouting pipe was roped with some hemp to prevent the grout from flowing out along the slot between the pipe and the hole wall. The grouting pipe is 0.55m long and is made of a steel tube of ϕ30mm, which can make water in shaft wall to flow out. After two days, we may be grouting.

Testing the pressure

Everytime before grouting the pressure should first be tested on the ground to check the sensitivity of gage and to make it sure that the grouting line has free access and is free of leak. Only when all preparatory work had been finished, might we grout.

Grouting

If the water flow in the grouting pipe is more than 30ml/min, we can directly grout cement and water glass. If the water flow is less than 30ml/min, then chemical grout.

While operating chemical grout solution A and B must be grouted at the same time that they are mixed and must not be grouted after being mixed which is to prevent the solidification of grout in the line. The pressure on operating the chemical grout was generally 0.5MPa to 1.0MPa. After operating chemical grout the manual pump and the line should be washed by clean water at once.

On pumping dual grout we should often check that whether the entrance grout quantity conformed to the regulation proportion. When the grouting pressure reached 1.5Mpa to 2.0MPa, the grouting work might be stopped.

Sealing the hole

When the grouting had been completed, the spherical valve on the grouting pipe was closed. After 3min to 5 min, the spherical valve was removed and the grouting pipe was sealed with wooden corks to prevent the leakage of grout.

After grouting the first order hole, because of the increasing water pressure the original non-water pouring or less-water pouring holes started pouring water or pouring more water out. So the second order holes, third holes, must be drilled, this grouting repeated itself for four times.

The measured results indicated that after grouting the quantity of leakage water in the main shaft had decreased to 0.86m^3/h, the sealing water rate reached 90%.

ECONOMIC BENEFIT AND CONCLUDING REARKS

The grouting have saved the drainage coat of 24,000 yuan per a year. The rusting of hoisting cable have been reduced so that the use life greatly had been prolonged from two years to three years, so a cost of 24,700 yuan had been saved. The moisture content of the coal had been decreased by 1%. The heating value had been increased by 210 to 250J. The value of coal can increase 1.2 yuan a ton. According to the output of 150,000 ton per year, 180,000 yuan can be increased in 1991.

This works of sealing water with grouting went on for two months. We drilled 219 holes, repeated for four times, which proved to be a great success. The design demand of 90% sealing water rate has been attained. The complete moisture in coal had reduced from 20% to 18%19% after construction. The coal quality and selling condition has improved obviously.

Sealing water in shaft wall with cement- water glass grout and chemical grout is simple for the construction technique, for the equipment is less, the cost is lower and the effect is taken sooner. After the solidification the chemical grout does neither poison nor smell and it doesn't pollute the water. The solidification of the cement -water glass grout not only seals the water, but also strengthens the shaft wall. In a word, this new method is feasible in technique and reasonable in economy, so it is an ideal approach of sealing water.

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