

## Technology Information

# Immobilization of heavy metals by oversaturated $\text{Ca(OH)}_2$ -grouts

### Fundamentals

Lime addition is one of the most used method to treat acidic waste waters. The pH increase results in the precipitation of metal hydroxides. Due to the low solubility of  $\text{Ca(OH)}_2$  (at 25 °C approx. 1.8 g/L) solid lime or lime suspensions are used.

Especially for the in-situ treatment of acidic rock drainage a grouting agent was developed on the basis of dissolved  $\text{Ca(OH)}_2$ . It was found that the solubility of  $\text{Ca(OH)}_2$  can be increased significantly by the use of special chemicals. These offer the possibility to prepare clear  $\text{Ca(OH)}_2$  solutions with high concentrations. There are two ways to obtain such solutions:

- Dissolution of  $\text{Ca(OH)}_2$  in a solution containing a dissolver (Fig. 1),
- Addition of NaOH or KOH solutions to  $\text{CaCl}_2$  solutions in the presence of the dissolver (Fig. 2).

The first method requires higher amounts of dissolver and leads to solutions containing up to 30 g/L dissolved  $\text{Ca(OH)}_2$ . The second way results in solutions with  $\text{Ca(OH)}_2$  concentrations up to 25 g/L.

The chemical behavior of the solutions is similar to pure  $\text{Ca(OH)}_2$  suspensions. Mixing with acidic solutions results in a pH jump leading to the precipitation of metal hydroxides. The amounts of precipitated metals depend on their solubility product and the mixing ratio with the grout. Immobilization is achieved both by precipitation of diluted metal ions and by the formation of hydroxide layers on reactive mineral surfaces.

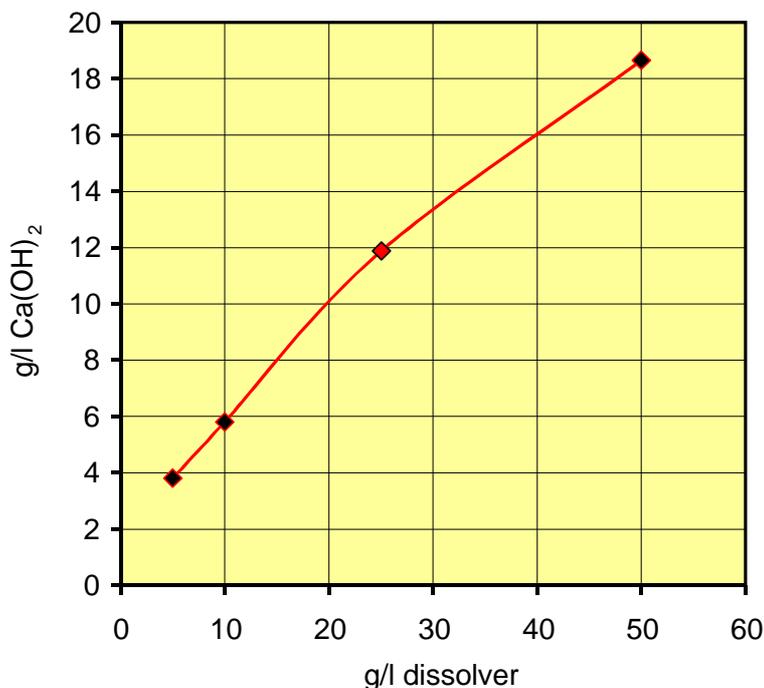


Fig. 1:  
 $\text{Ca(OH)}_2$  solubility depending  
on the dissolver concentra-  
tion

### Applications

$\text{Ca(OH)}_2$  oversaturated solutions have a stability between 24 and 72 hours, depending on the absolute concentration and the amount of dissolver. After that time,  $\text{Ca(OH)}_2$  precipitation

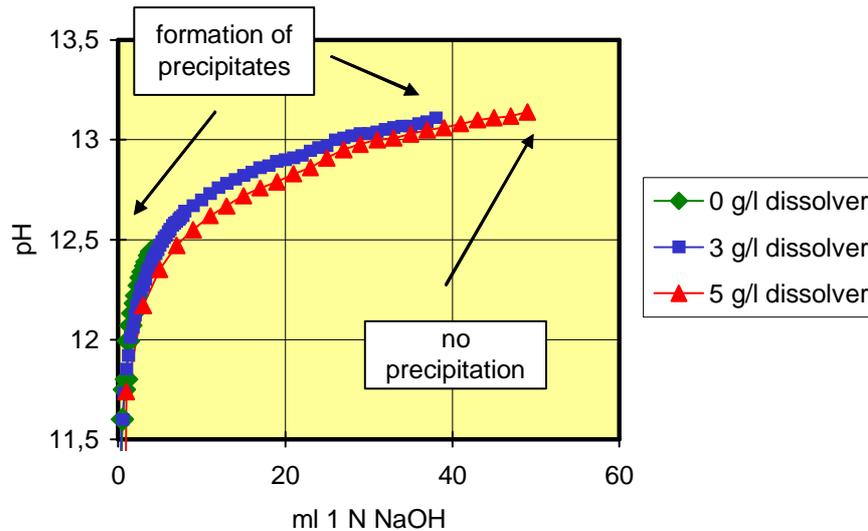


Fig. 2: Mixing of 100 ml  $\text{CaCl}_2$  solution (11 g/l) and 1 M NaOH in the presence of different dissolver concentrations

starts. If a soil formation is penetrated with  $\text{Ca}(\text{OH})_2$  solutions in-situ precipitation of calcium hydroxide takes place.  $\text{Ca}(\text{OH})_2$  covers the mineral surfaces and can act as a reactive barrier. In contact with air,  $\text{CaCO}_3$  is formed. The treatment of soils with  $\text{Ca}(\text{OH})_2$ -solutions results in a strong increase of the acid neutralization capacity of these zones. For practical applications, solutions containing between 3 and 10 g/l dissolved  $\text{Ca}(\text{OH})_2$  are suitable in the most cases. To increase the ability to immobilize heavy metals it is possible to add sodium sulfide to  $\text{Ca}(\text{OH})_2$  solutions.

The immobilization capacity of soils treated with  $\text{Ca}(\text{OH})_2$  solutions demonstrates Fig. 3. The pore water of a column filled with sand was replaced by a solution containing 12 g/l dissolved  $\text{Ca}(\text{OH})_2$ . After 72 hours a solution containing 1 g/l  $\text{FeCl}_3$  and 1.33 g/l  $\text{Na}_2\text{SO}_4$  was pumped continuously through the column. Approximately after 25 hours the  $\text{Cl}^-$ -concentrations of the output and input solutions were equal. The pH value, however, remained at 12 and no iron ions could be detected in the output solution. Only after 80 hours the pH of the output solution decreased to 7. Within this time the pore volume of the column was replaced more than six times by the  $\text{FeCl}_3 / \text{Na}_2\text{SO}_4$  solution.

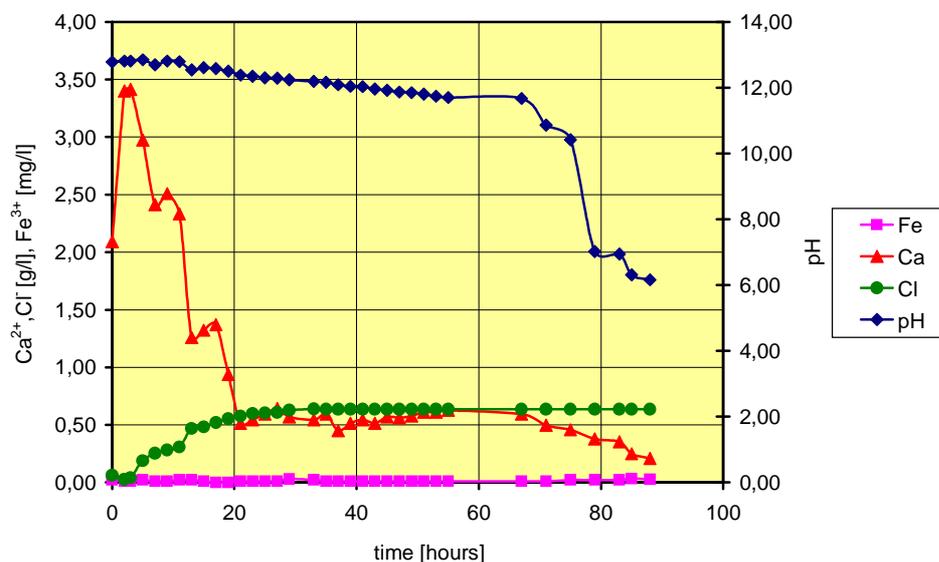


Fig. 3: Results of column tests