Efficiency of in-lake liming of acidic pit mine lakes

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Extended Abstract

In-lake liming is the most effective strategy for the neutralization of acid pit mine lakes. However, each lake has its own characteristics. Important factors are size, depth, exposure to impact of wind on the lake, water chemistry, hydraulic contact to acid groundwater, and last but not least the chemical composition and grain size distribution of the liming product in combination with the application technology used.

The efficiency of the in-lake liming of acidic pit mine lakes strongly depends on the quality of the used neutralization agents as well as on the reaction conditions within the lake body, which may strongly vary with respect to time and space. According to the state of the art, the lime suspension is inputted into the lake as uniformly as possible using pipelines or boats. However, this approach does not consider wind-induced flow in the lake.

Optimal conditions for the reaction in the lake to be as complete as possible can be guaranteed by an online monitoring network, which measures and records pH over time, and the lake's surface area and depth. This data is radio-transmitted and provides the information needed for optimizing the lake liming in particular for repeat liming, which might be needed due to acidic groundwater inflow into the lake. Online data of wind speed and direction is used to simulate in 3d the wind-induced flow in the lake. This makes it possible by means of inverse modeling to optimize the location and amount of the lime input by boat.

Simulating the lake treatment with a calibrated lake circulation model (e.g. ELCOM) is one of the prerequisites. For the calibration of this kind of models data about meteorology, circulation velocity by means of drift bodies, water parameters (e.g. pH and temperature at different depths and locations) and the behavior of the lime products are needed.

Fig. 1 exemplifies the arrangement of a pH monitoring network in the pit mine lake Partwitz in the Lusatia region, Germany. Within the R&D project OILL [1], based on measurements using drift bodies in a pit mine lake, it was shown that the flow regime in such lakes can be predicted using the model ELCOM. **Fig. 2** depicts the flow regime in the pit mine lake Burghammer under westerly wind conditions that are typical for that region.

Figure 1: *proposed pH network for the pit mine lake Partwitz*

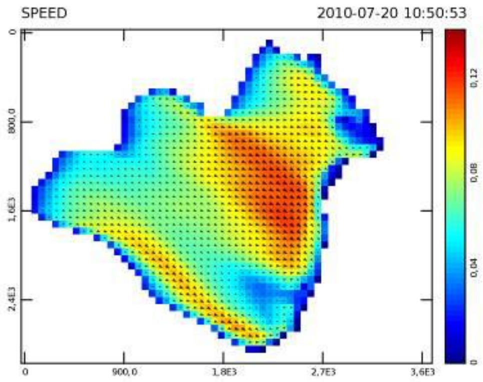

***Figure 2:** Flow regime in the upper layer of the lake body (water depth: 0 – 0.5 m) in the pit mine lake Burghammer under westerly wind conditions (3 m/s)*

For the in-lake liming to be successful, the selection of a suitable lime product is of central rele-vance [2]. Chalk products with a proper grain size have been shown to be a very good choice.

By means of several laboratory experiments different lime products have to be tested with respect to efficiency and reactivity. Such experiments have to be performed with original water from the pit like because even trace elements may have a significant impact on the solubility and reactivity of the different products. Only based on these experiments and including the different application techniques (ship or pipe) a cost-benefit study can be performed providing the best result for a certain pit lake.

Series of batch experiments at TU Bergakademie Freiberg proved that chalk can also create a stronger buffer against the re-acidification of a treated pit mine lake. Within the column experiments (**Fig 3**), chalk from the island of "Rügen" provided the best results. **Tab. 1** shows the corresponding $K_{a\,4.3}$ values for all neutralizing agents used during the experiments.

***Table 1:** pH and net alkalinity K_{al} and net acidity K_{ac} (buffer capacity) in mmol/L for 5 products*

pH of lake water: 2.9	Before liming	Column 1	Column 2	Column 3	Column 4	Column 5
Neutralization agent		Filter cake 63 µm	Semi-calcined dolomite	Calcined dolomite	**Chalk from "Rügen"**	Fine lime RK
pH after liming		6.8	6.1	4.1	7.0	9.4
Kac 4.3 [mmol/L]	3.35			0.09		
Kac 8.2 [mmol/L]	4.41	0.40	0.42	0.66	0.43	
Kal 4.3 [mmol/L]		1.16	0.24		1.66	0.66
Kal 8.2 [mmol/L]						0.28
Efficiency	%	ca. 80 %	ca. 55 %	< 50 %	ca. 90 %	ca. 80 %

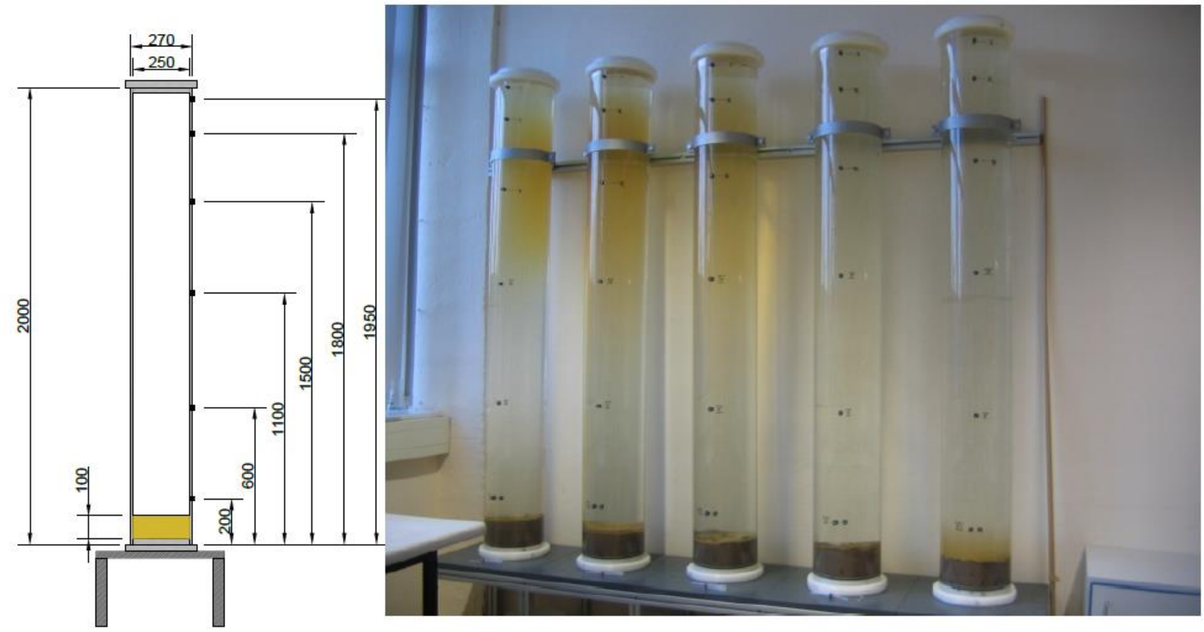

***Figure 3**: Lab tests (column experiments)*

Key words: Optimizing, lime application, lake circulation model, ELCOM, lime products

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