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Review on In-pit Treatment of Acidic Pit Lake in Jorong Coal Mine, South Kalimantan, Indonesia

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Abstract Jorong Coal Mine is located in Asam-Asam Coal Basin, South Kalimantan and has been operated since 1999. Pit M4E is one of the mine pits that is already mined out since 2006. This void has been filled with acidic surface run-off water. Poor water quality is a big challenge for the coal mining company since the pit lake contains approximately 8 million m3 of acidic water of pH around 3. Following the success of in-house treatment experiments, an in-pit treatment method was implemented to improve water quality of pit lake. A review on the neutralization performance has been conducted and the result and analysis is discussed in this paper.
Keywords acidic pit lake, lime addition, neutralization performance, treatment

Introduction

Coal contract of work for PT Jorong Barutama Greston (known as PT JBG) was signed in 1997. The first production was in 1999. PT JBG is located in South Kalimantan Province and uses a surface mining method using shovel and trucks to exploit low sulfur coal with calorific value of 5300-5800 kcal/kg.

The coal seams belong to Warukin Formation from late Miocene in Asam-Asam Coal Basin striking approximately SW-NE. There are 10 main coal seams with the thickness ranging from 1 to 34 m and some minor seam of 0.1 to 2 m thick. The coal bearing formation consists of claystone and sandstone intercalated with thin to medium siltstone. In general the coal seams are classified into two zones, namely M-zone and U-zone. There are five coal seams in the M-zone namely M1 (the oldest) to M5 (the youngest). Another five seams belong to the younger U-Zone.

Acidification is the central problem in many mining areas affecting water in pit lakes (Geller et al, 2011). M4E pit in the M-zone is one of the mined out pits in this area which is filled with water, mostly originated from rain water. Rahmawati (2010) identified that the pH value of the M4E pit lake was in the range of 2.8 to 3.2. In pit treatment method has been implemented in this pit lake using a lime mixing facility .This study is conducted to evaluate the performance of this method.

Description of M4E pit lake

The M4E pit lake is located in the eastern block of PT JBG's contract area. This pit was mined out in 2006. The target seams were M410 and M420 as shown in the cross section in fig. 2. The lowest pit bottom is at the elevation of -27 (mean sea level) msl. The volume of water in the lake is approximately 8.2 million m^3 at water level of +23.64 msl. The water is mainly originated from direct rainfall and surface runoff. Groundwater inflow is relatively insignificant as the pit lake catchment area is only approximately 25 ha.

Rahmawati (2010) conducted measurement on water quality of M4E pit lake at four sampling points. Water samples for physical parameters such as pH, electric conductivity and were collected every 5 m depths to identify whether stratification exist. The result showed that the pH values were relatively homogenous in the range of 2.8 to 3.2.

Following the success of field scale experiment using a lime ($Ca(OH)_2$) mixing plant to neutralize approximately 460,000 m^3 of acidic water with average pH of 2.8 in M23E pit lake to achieve pH of 7 in 3 months, this method was introduced in M4E pit lake in January 2013. Liming activity was conducted for approximately 3 months but it was not continuous. After not treating lake water for approximately 3 months, lime was added again for three weeks and then the lake remained untreated again for another three months just before measurement took place again in November 2013.

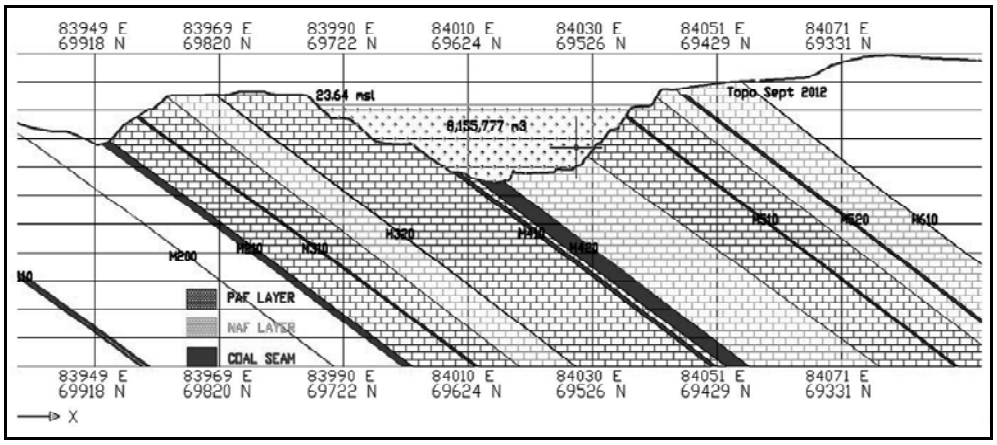

Fig. 2 *Typical cross-section of M4E pit geology*

Sampling and measurement.

To evaluate the performance of liming in M4E pit lake sampling & measurement of water quality in the pit lake was conducted. Lateral as well as vertical variations in water quality were determined from ten sampling points distributed evenly throughout the lake (fig. 3). In each sampling point samples were collected every 5 m depth and analyzed for: pH, electric conductivity, total dissolved solids, temperature as well as anions and cations. Sampling was conducted in 10-11 June and 27 November 2013.

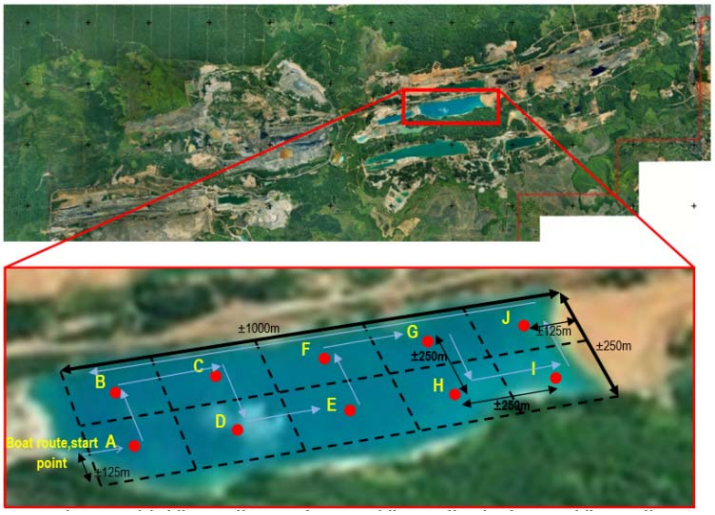

Fig. 3 *M4E pit lake& sampling points (Novianti, 2014)*

Results and discussion

Lime discharge into the M4E pit lake in early 2013 was at the point close to sampling point G. The results of measurement conducted in June 2013 after three months of untreated pit lake indicated decrease of pH value from 4.8 to around 3.5. Total amount of lime was added during January to March was 157.12 (metric) tons. fig. 4 shows the vertical distribution of pH at point A and E. pH valuesfor depth of 5 m and 10 m for the whole lake are shown in fig. 5.

Liming was continued in July 2013. As much as 15.87 tons of lime has been added into the lake. The pH value increased up to 5.8. The second complete sampling was then conducted in November 2013 following the same methods with the first complete sampling in June 2013. However, lime addition wasat a different discharge point in the western part of the lake took place during the sampling. The results are shown in fig. 6.

The in pit treatment activity in M4E pit lake is resumed in Figure 6. A total of 180.99 tons of lime has been added into the lake from January to November 2013. Back analysis simulated by Rahmawati & Gautama (2010) concluded that the potentially acid forming (PAF) materials (i.e. pit wall rock) in the surrounding catchment area are the main sources of acid mine drainage. It seems that the rainfall influenced the water quality in the lake as shown in fig. 7. Although reclamation and re-vegetation in the surrounding area is quite successful, there is still a bare land area which is believed to consist of PAF material. The bare land is identified as cleared area surrounding the mine pit used for supporting facilities or overburden dump.

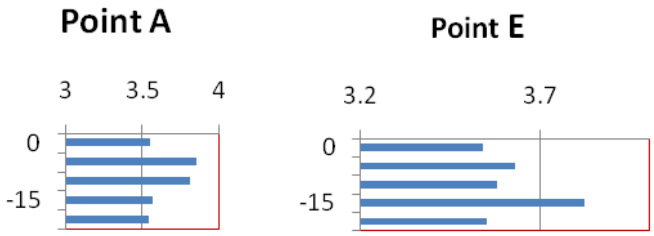

Fig. 4 *Vertical distribution of pH values*

This study indicates the potential of in pit treatment method applied in M4E pit lake. The still remaining questions are the most effective liming quantity and frequency to stabilize the neutralization of pit lake water. Novianti (2014) calculated the amount of lime need to neutralize the acidic water in M4E pit lake which is 1050 tons/year. Another measure should also be implemented namely managing the surrounding area to avoid the exposure of potentially acid forming materials. As studied by Saputri & Gautama (2010) the surrounding area has the potential to generate acid mine drainage.

Conclusions

The occurrence of acidic pit lake at M4E is one of the biggest challenges because it is not comply with Government Regulation Nr. 82 of 2001 on water resource quality and decree of Minister of Environment Nr. 113 of 2003 on water effluent standard for coal mining.

In pit treatment through lime mixing plant conducted in M4E pit lake has added a total of 181 tons of lime into the lake. This amount seems insufficient to neutralize the water in the lake because according to Novianti (2014) as much as 1050 tons of lime is needed.

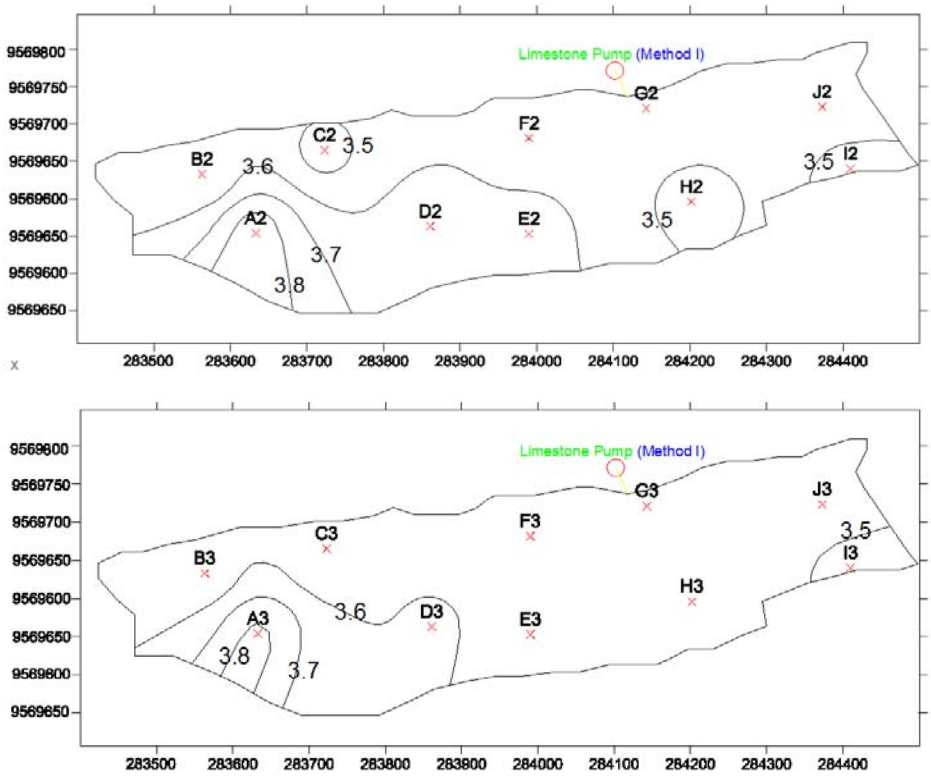

Fig. 5 *pH value distribution at 5 m (above) and 10 m (below) depth below water level*

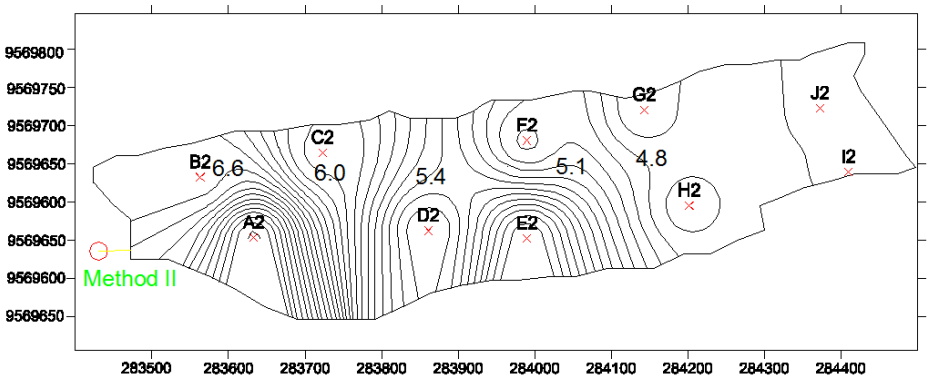

Fig. 6 *pH distribution measured in November 2013 at 5 m depth below water level*

Continuous lime addition should be implemented taking into consideration the water balance into the pit lake since the area has relatively high rainfall. Re-working of bare land surrounding the lake is also important to ensure that potentially acid forming materials are not exposed.

Acknowledgements

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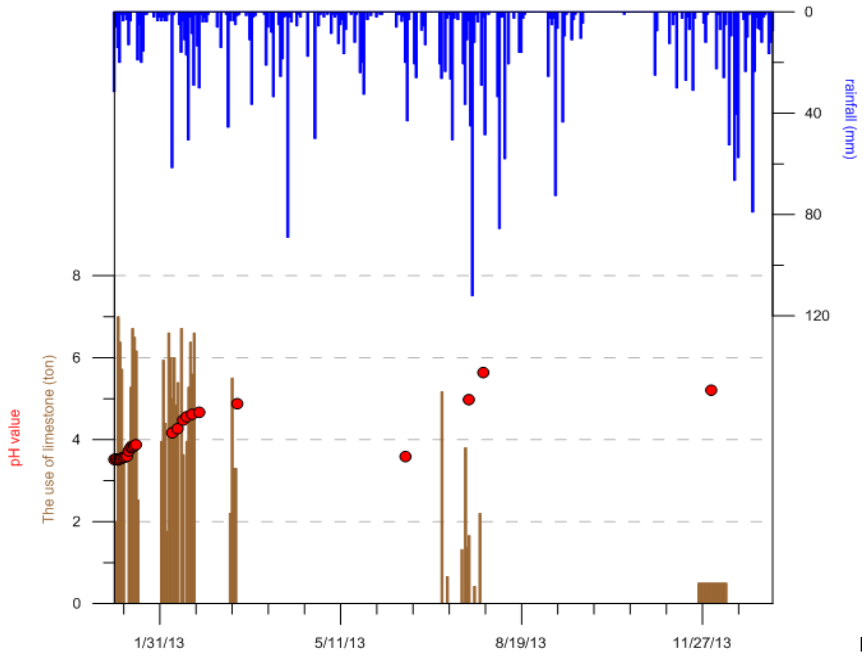

Fig. 7 *Resume of in pit treatment in M4E*

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