Case Study
Kaltim Prima Coal Mine, Kalimantan, Indonesia

Introduction

Kaltim Prima Coal (KPC), an Indonesian incorporated company owned by British Petroleum Co Plc of the UK and RTZ-CRA of Australia and the UK, has mined coal at Sangatta since 1992. The mine is approximately 200 km north of Balikpapan on the east coast of Kalimantan in Indonesia. The company currently mines 11.5 million tonnes annually using trucks and shovels in a conventional open cut operation. The climate at KPC is equatorial with high seasonal rainfall and low wind velocities. Rainfall averages 2 500 millimetres annually and falls mainly as tropical thunderstorms.

Acid mine drainage was detected at the mine in its second year of operation. Since then, significant resources have been invested by the company to understand the nature of the problem and to integrate acid control in the mining process.

Strategies for Acid Control

KPC's strategy for controlling acid drainage focuses on selective emplacement of acid-forming material and the exclusion of oxygen from overburden sulphide, thereby retarding pyrite oxidation. Several conditions exist where potential acid generation has to be controlled. These include:

- Dumps constructed prior to the understanding of the acid generation problem;
- New dumps being built as a part of the current operations; and
- Coal rich in pyritic material exposed during the mining operation.

Each requires a different approach.

Controlling Acid Production from Surfaces of Old Dumps

Prior to identifying the acid production potential at the mine, some early dump surfaces were covered with acid producing overburden. All early dump surfaces have been sampled to ascertain the chemical nature of their external layers and, where acid-producing material has been identified, the surface has been encased with non reactive material.

Research on cover designs has shown that the oxygen barrier has to achieve permeability of less than 10-8 ms^{-1} with less than 10% air voids. Under the conditions prevalent at KPC, this is achieved by either:

- Placing 2.0 metres of non acid-forming overburden and 0.5 metres of topsoil over pyritic material; or
- Compacting half a metre of clay to the engineering criteria stated above, followed by covering with 0.5-1.0 metre of topsoil to foster rehabilitation.

Strict engineering and geotechnical procedures must be followed to achieve adequate clay compaction for oxygen exclusion.

New Dumps and Selective Placement of Overburden

Present day dumps are constructed with the aim of preventing acid drainage. This is achieved by ensuring that all highly reactive overburden is buried in the core of dumps, away from a fluctuating water table and oxygen.

With knowledge gained from the overburden geochemistry study and local geotechnical constraints, KPC has produced guidelines for constructing waste dumps at its minesite.

The objectives of the guidelines are to:

- Achieve long-term geotechnical stability of dumps;
- Build dumps that resist erosion scour during construction and rehabilitation; and
- Exclude potentially acid-forming rocks from dump surfaces.

To achieve these objectives it is imperative to emplace acid-forming material selectively under non acid-forming material. In order to achieve medium to long term, stability all materials in the outer 10 metres of the dumps must be non-acid forming. A typical cross section of dumps at KPC is shown in Fig 17.0 in the Managing Sulphidic Mine Wastes and Acid Drainage booklet.

An important practice is that final drainage design works stabilise the surfaces and minimise any future exposure of acid producing materials.

Interim Dumps

An intermediate dump face is an exposed face that will be over-dumped at a later stage. It includes any dump face that is exposed for two months or less.

Interim overburden management specifications are as follows:

- Any material that is highly acid-forming should be buried deep within the dump;
- Such material should be placed in cells within the dump, below the projected long-term water table where it will not be subjected to fluctuating water levels;
- Non acid-forming overburden should form the outer five metres of intermediate dump faces; and
- Top surfaces of intermediate benches should be covered with at least one metre of non acid-forming material.

Coal Floors

Pyritic materials at KPC are mainly associated with coal roofs and floors. While roof materials are removed as part of the mining process and placed within the core of the dumps, floor material could be left exposed for lengthy periods. To prevent the production of acid, floors are either dug out and placed in cores of dumps along with coal roofs, or covered according to the engineering specifications listed above.

In a limited number of cases, acid is produced from exposed coal floors prior to remedial action being implemented. Currently, such acid water from coal floors is collected and treated with lime to achieve acceptable water chemistry prior to final discharge. Two portable acid neutralisation plants are intermittently used for this purpose. The plants have been very useful because of their cost effectiveness and their mobility, as they can be moved to particular locations to provide short to medium term treatment of acid water. A passive wetland biological filter to polish (or remove final traces of contaminants) in discharge water is planned to be constructed in 1997.

Rehabilitation

Fundamental to any post-mining land use is re-establishment of vegetation. The effective control of acid formation is critical to any rehabilitation program. Some post-mining land uses being considered by KPC are production forestry, agriculture and recreation.

More than 450 000 trees have been planted on 450 hectares on KPC's leases since mining commenced. In 1996, the target was 206 hectares, an area exceeding that cleared for mining during the same year. This trend will continue and areas of 200-400 hectares are planned to be rehabilitated each year.

Conclusions

Acid drainage is unavoidable associated with ground disturbance in East Kalimantan, associated not only with mining, but also with any earthworks exposing pyritic materials. It is important to manage acid drainage because of its deleterious effects on water chemistry, animals and vegetation. In the mining context, perhaps the most significant impact is that acid-producing surfaces will not revegetate.

A number of lessons have been learnt from KPC's experiences with acid drainage.

- Acid prevention has to be integrated into the mining process; (Ideally, the control program begins at the mine exploration stage when valuable baseline information about potential acid formation can be obtained at relatively low cost. Waste rock analysis is essential.)

- The stratigraphically controlled occurrence of acid-forming materials in steeply dipping rocks, coupled with a mining method based on horizontal benches, has complicated the accurate modelling of net acid generation at the mine; (The approach taken by KPC has, however, provided adequate information to manually schedule materials for selective placement within dumps. The strategies described in this case study have shown to be cost-effective.)

- Acid production must be prevented rather than treated; (If the acid-producing potential of overburden is understood before the mining commences, the problem can be arrested before it becomes costly. Selective placement of spoils has proven an effective way to control acid production from open cut mining operations.) and

- Acid control strategies must be implemented completely and in a timely manner to be effective. (A partially implemented acid control program is non effectual—water quality continues to deteriorate and rehabilitation will not succeed.)

In summary, experience at KPC suggests that it will be significantly more cost effective to prevent the problem than trying to remedy it. KPC is continually striving to improve its environmental performance by applying best practice approaches to the prevention of acid drainage.

Questions

1. The acid mine drainage problem was identified in the second year of operation of the mine. What could have been done at the mine planning stage to predict the problem?
2. What are the key strategies used to prevent sulphide oxidation? Why are three different strategies required?
3. What steps would you take to develop a monitoring plan for KPC?
4. What lessons have been learned from the acid mine drainage at KPC? How would you adopt these lessons for a risk management approach to developing another mine on East Kalimantan?
5. If you were developing an environmental management system for KPC what key aspects and impacts would you find? What objectives and targets would you set?