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Industrial pollution

ENVIRONMENTAL MEASURES AT OVACIK GOLD MINE, TURKEY

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Abstract. The Ovacik Gold Mine is designed to treat 300 000 t of ore annually producing 100 000 ounces of gold and same amount of silver. The mine consists of open pit and underground mining and carbon-in-pulp (CIP) process plant using sodium cyanide as a principal reagent. CIP tailings will be treated in a three-stage chemical destruction circuit. The first stage uses INCO SO_2/air process to destruct cyanide while second stage uses ferric sulphate to precipitate arsenic and antimony. Limits for cyanide and heavy metals in the tailings are required by the Ministry of Environment . Limit for cyanide is 1 mg/l as total. Treated tailings will be deposited in a rock fill tailings pond and covered with a composit liner system of 50 cm of clay, 1.5 mm HDPE geomembrane and 20 cm of clay layers. The Ovacik mine is one of the few mines in the world to have both tailings treatment for cyanide and heavy metals and a geomembrane and clay lined rock-fill tailings pond with no process water discharge to the environment.

Kewyords: gold mine, cyanide, chemical destruction, tailings pond.

AIMS AND BACKGROUND

The Ovacik Gold Mine is owned by Eurogold Madencilik A.S., a subsidary of Normandy Mining of Australia. The mine is located about 100 km north of Izmir on the west coast of Turkey, some 15 km inland from the Aegean sea.

Eurogold was established in 1988 to explore for gold and to undertake mine development and operation in Turkey. After extensive regional exploration in Western Turkey, a series of epithermal veins was discovered in the area where the mine is located today. There are two major economic epithermal quartz veins and the current resource estimates for the Ovacik deposit are 24 t of gold and 24 t of silver. A production level of 3 t of gold and 3 t of silver per year over 8 years of operation is planned.

Sodyum cyanide is used to extract gold. This is the most common process used for gold extraction worldwide. After recovery of the gold, the residual tailings are treated in a three-stage INCO chemical destruction plant. In the first stage

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cyanide is destructed to less than 1 mg/l total cyanide while in the second stage heavy metals such as arsenic and antimony are precipitated. Treated tailings, in compliance with the Ministry of Environment limits, are discharged to a tailings pond sealed with 50 cm clay, 1.5 mm high density polyethylene (HDPE) geomembrane and another 20 cm clay layers. Process plant and chemical destruction circuit are operated and controlled through automatic control loops using PLC and operator interface program in the control room computers. The system provides sequence control circuits, graphic displays of all plant areas showing status of equipment, actual and set values and trends for critical process variables and alarm displays.

Construction of the plant and the infrastructures were completed in December 1997 in compliance with the conditions of the permits and licenses according to the relevant regulations and the protocol with the Ministry of Environment. However, Turkish Supreme Court decided in favour of the petition of the local environmental groups in May 1998 and cancelled the "environmental permit" issued by the Ministry of Environment due to potential risks. Eurogold has assessed each potential risks mentioned in the court decision and taken additional precautions to comply with the court decision.

The results of the environmental audit and risk assessment by an international consulting firm[1,2] and the most recent (October 1999) overall environmental risk and technology assessment report by TUBITAK (Turkish Scientific and Technical Research Organization)[3] confirmed that the project design met all national requirements and on the whole, the internationally relevant standards for comparable projects, and indeed, exceeded these applicable and appropriate requirements in certain areas. Currently, the mine is awaiting an operating license from the Turkish government.

ENVIRONMENTAL MEASURES

Legal requirements and group policies. To commence plant construction and operate a gold mine, permits and licenses are required from various Turkish state departments under relevant health and environmental regulations. These are:

- EIS approval from the Ministry of Environment according to the EIS Regulation;
- Site selection permit, plant permit and operating license from the Ministry of Health according to Unhealthy Plants Regulation;
- Waste disposal licence from the Ministry of Environment according to Dangerous Waste Control Regulation;
- Tailings storage facility project approval and construction quality control by the State Hydraulic Works;
- Emission licence from the Ministry of Health according to Air Quality Control Regulation;

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• Plant construction licence from the Public Works;

• Import Control Certificate for sodium cyanide from the Ministry of Environment according to Regulation on Materials and Wastes to be Controlled for enviromental protection.

Along with the above regulations, other regulations such as noise control, water pollution control and dangerous materials and products control set the standards on health and environment with which gold mines are required to comply.

In addition to full compliance with all applicable Turkish regulations and licence conditions, Ovacik gold mine, as an operation site of Normandy Mining Group, considers Normandy Group environmental policies in the setting of environmental objectives and targets and the development of relevant environmental management plans. Details of the Ovacik site specific objectives, targets and plans are documented in an "Ovacik Gold Mine Environmental Management System" report prepared in accordance with ISO 14001. An internal environmental audit program using 5 Star Assessment process will be conducted on an annual basis to assess the environmental management systems and level of environmental performance at the operation.

Similarly, management plans on other issues such as health and safety, tailings storage, mine closure and rehabilitation, emergency action and community relations have been prepared.

Dust control. Dust control and monitoring systems have been set up at Ovacik. Both suspended particulate matters less than 10 μm (PM10) and settled dust are continously measured in and around the mine site to comply with the limits in the Air Quality Control Regulation. Real time beta-gauge and gravimetric dust gauges for PM 10 and five gauges for settled dust have been installed. The precautions for dust control include wet dust scrubbers for crushing and screening; enclosing the dust generating equipments and conveyors; wetting dust generating surfaces such as open pit, stockpiles, roads; dust sprays over the run-of-mine ore bin and apron feeder and dust filters on the fine-ore-bin and lime silo.

Handling of hazardous chemicals. Relevant regulations as well as international standards are considered in the import, transport, storage and handling of the hazardous chemicals such as sodium cyanide. Sodium cyanide will be purchased in solid form and transported to the site in sea containers. It will be stored in a fenced separate enclosed store. The store and the fence will be kept locked all the times. Cyanide leaching will be carried out in steel tanks which are located on bunded concrete plant units.

Chemical destruction circuit. Residual tailings after gold recovery are treated in the chemical destruction circuit designed by INCO Technical Services Ltd. of Canada to achieve limits for total cyanide and heavy metals set by the Ministry of

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Environment. The limits are given in Table 1. Due to the low heavy metal content of the ore, concentrations of the heavy metals in the tailings are expected to be below the Ministry limits even before the chemical treatment as shown by the testworks carried out on the representative ore samples (Table 1)[4].

Table 1. Limits in the tailing pond for cyanide and heavy metals and their expected levels in tailings before and after chemical destruction

Element	Unit	Limits in pond	Before destruction	After destruction
Total cyanide*	mg/l	1	144	0.5
Cadmium	mg/l	1	<0.01	<0.01
Zinc	mg/l	5	1	<0.1
Copper	mg/l	5	6	0.78
Lead	mg/l	2	<0.05	<0.05
Arsenic	mg/l	5	2	0.05
Antimony	mg/l	5	10	4
Iron	mg/l	10	3	0.05
Total Chromium	mg/l	2	<0.01	<0.01
Mercury	mg/l	0.1	<0.01	<0.01

* Limit for total cyanide is in the chemical destruction effluent.

The tailings are treated in three stages. In the first stage sulphur dioxide as sodium metabisulphite solution is added to oxidize free and weak acid dissociable (WAD) cyanide. Copper sulphate is added to catalyze the oxidation and precipitate more stable iron cyanides as insoluble complexes. In the second stage ferric sulphate is added to precipitate arsenic and antimony.

Destructed tailings are pumped to the tailings pond. Decant water from the pond is pumped back to the process plant for reuse in the process. If necessary, recycle stream of decant water can be treated in the third stage to further reduce arsenic and antimony by adding ferric sulphate to this stage. Third stage can also be used for the hypochlorite treatment of cyanide spillages collected in the process plant.

The pilot-test run of the process plant and the chemical destruction circuit in 1998 revealed that the total cyanide level in the treated tailings discharged into the tailings pond was average 0.2 mg/l which is much below the 1 mg/l required by the Ministry of Environment[5].

Tailings storage facilities. The tailings pond is constructed in a valley next to the process plant by cross-cutting the valley with two rockfill embankments (main and upstream embankments) which provide storage of 1.6 million m^3 of tailings. The storage area with the embankments covers 15 ha.

The mine is located in an area of seismicity where peak ground accelaration is 0.4 *g*. The tailings embankments were designed in accordance with the Turkish

earthquake code and was approved by Turkish State Hydraulic Works. It is designed to withstand eathquake of 0.6 *g* accelaration[1].

The tailings pond is covered with a composit liner system of 50 cm compacted clay, a 1.5 mm thick high-density-polyethylene-geomembrane, 20 cm of another compacted clay and 20 cm filter layer. Drainage pipes are placed in the filter layer to collect the tailings water into the decant tower from where it is pumped to the process plant for reuse.

A monthly ground water samples will be taken from six monitoring wells located at the downstream of the main embankment for water analysis. An assessment will be made of changes in the water quality and water levels.

Water management. The design criteria and management system for Ovacik tailings pond is set for zero release of water to the environment. This is possible as the operation is net consumer of water. Mean annual rainfall and evaporation of the area is 728 and 2313 mm, respectively.

Catchment area at the point of diversion is 0.62 km^2. Maximum possible flood discharge is calculated as 24.6 m^3/s. This value is used in engineering design. The flood coming from the catchment area will be stored in the runoff water pond behind the upstream embankment. The accumulated water will be pumped to the tailings pond or diversion channel which is arranged along the north side of the pond to prevent the entrance of the rain water coming from the catchment area.

The water management plan includes control of potential excess water that could be generated from the underground mine. Any water from the mine will be recycled to the process plant as the plant-tailings pond system is a net water consumer and requires additional water for process water make-up. Any excess water will be discharged to the environment after appropriate treatment to comply with the conditions of the Turkish "Water Pollution Control Regulation". According to the acid rock drainage tests carried out on Ovacik ore and waste rock samples, acid production resulting in elevated concentrations of metals and sulphates in the mine water is not expected[6].

Rehabilitation. To the extent practicable, rehabilitation will be concurrent with the operation. Topsoil removed during construction is retained in the project site for subsequent rehabilitaiton. Conceptual mine closure and rehabilitation plan has been prepared and will be reviewed annually during operation.

Mine site will be rehabilitated according to the protocol with the State Hydraulic Works and Forestry Department. The tailings pond area first will be covered by rock, gravel, clay and topsoil then replanted with trees. Prior to the operation, rehabilitation bond will be provided in favour of State Hydraulic Works to secure the completion of rehabilitation and closure in accordance with the protocol. The key objectives to be considered in the rehabilitation program are the stabilisation of the area, hydrology, contamination, visual impacts, after use consideration and safety.

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CONCLUSIONS

The environmental precautions taken at Ovacik gold mine mine all the requirements of Turkish health and environmental regulations and international standards. The combination of chemical destruction of the cyanide and heavy metals in tailings to very low levels and deposition of the treated tailings in a sealed rockfill tailings pond with zero discharge to the environment makes Ovacik gold mine over the world standards. This is confirmed both by the external audit by an independent international consulting company and environmental risk and technology assessment by Turkish Scientific and Technical Research Organization.

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