Ramu NiCo Long Distance Ore Slurry Pipeline and Deep Sea Tailings Placement (DSTP) Pipeline Operation

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ABSTRACT

The USD1.5 billion Ramu Nickel laterite HPAL project has been commissioned in Madang, Papua New Guinea. The ore from Kurumubukari Mine is transported to Basamuk Refinery through a 135 km pipeline. The tailings from the refinery are neutralized and discharged into deep sea near Basamuk. The world's first Nickel laterite slurry pipeline and Deep Sea Tailings Placement (DSTP) pipeline are the key components of the project. Both pipelines were successfully commissioned with slurry in January 2011. The integrity of the two pipeline systems has been confirmed since then.

The long distance pipeline incorporates many innovations, including Pipeline Expert™ control system with Leak/Plug detection functions, gChoke™ station, high pipeline slope up to 25% and flexible pipeline support. Pipeline operation and maintenance teams have been systematically trained with Pipeline Simulator™ and the operation procedures to secure pipeline safety and integrity. The geo-hazards and risks along the mountain ridges are monitored by periodical surveys to trend and evaluate the movement of pipeline during operation phase.

Since the loading commissioning of Basamuk Refinery in March 2012, the impacts on marine environment by DSTP at Basamuk Bay have been monitored internally by Ramu Nickel Management (MCC) Ltd. (RNML) and externally by independent organizations according to the conditions of approved Operational Environment Management Plan (OEMP). The operation of the DSTP system has been proven sound and up to environmental permit standards.

1 INTRODUCTION

The Ramu Nickel laterite HPAL Project is located in Madang Province, Papua New Guinea. The Project was developed by Ramu Nickel Joint Venture (RNJV). Ramu NiCo Management (MCC), Ltd (RNML) was appointed by RNJV as the manager of construction and operation. The Project is comprised of Kurumbukari Mine, Long distance pipeline, Basamuk Refinery and DSTP pipeline.

The Ramu project faced many challenges. Ore transportation and tailings management are two of them. The ore needs to be transported through 41 km of mountainous area with unstable slopes, frequent earthquakes, annual rainfall of over 5000 mm, and 68 km of coastal area with numerous high turbulent rivers. Transportation by highway or railway in that area cannot be reliable. The cost is also prohibitively high. The slurry pipeline is the only option. The high strength steel pipeline has much higher tolerance to slope sliding than highways or railways. The cost is also much lower.

Tailings management and monitoring is another challenge. The geotechnical and weather conditions in PNG create high risks for developing conventional retaining structures on-land. River disposal is no longer acceptable because of the high environmental impacts. By comparison, Deep Sea Tailings Placement (DSTP) was determined to be the preferred option. The definition of DSTP is the planned deposition of tailing solids in a specific area located deep below the ocean surface. “Deep” is a major provision to minimize the marine environmental impact and to differentiate DSTP from conventional ocean dumping of tailings.

2 RAMU LONG DISTANCE SLURRY PIPELINE

Ramu slurry pipeline system consists of a pump station at Kurumubukari mine connected to the terminal station at Basamuk refinery via a 135-km long pipeline. Between these two stations are five pressure monitoring stations (P) and three cathodic protection stations (C). The choke station is located at the terminal.

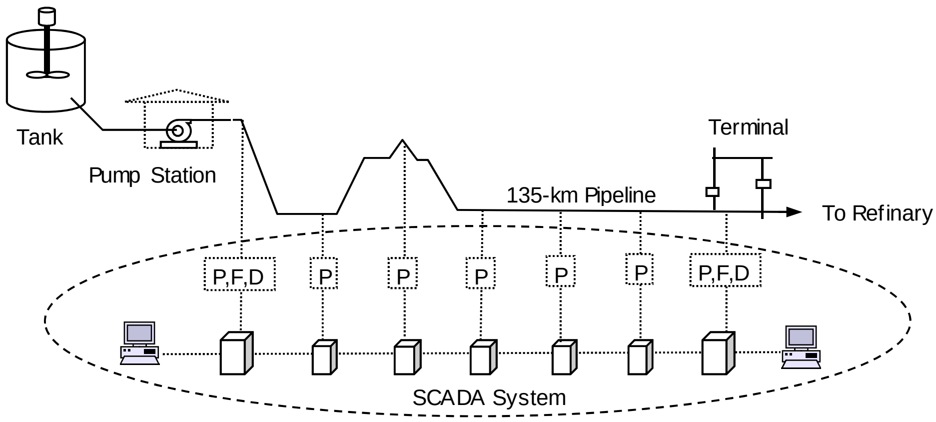

Figure 1 Ramu Slurry Pipeline Configuration

The pipeline design capacity is 2080m³/h at 18% solids concentration. The pipeline ID is 610mm. The wall thickness varies from 10.5mm to 12.7mm with different internal pressure and safety factor requirement.

The pump station includes four 20 m (D) x 22 m (H) agitated holding tanks, two feed pumps (one operation, one standby) for viscosity monitoring loop operation, and two 2-pump trains (one operation, one standby). The pumps are Warman 14/12 AH with the maximum discharge pressure of 2.5 MPa. In most cases, pumping is not required. Flow is driven by gravity.

The choke station at the terminal is a major facility to control pipeline operation. To minimize the capital investment while keeping the operating range wide, gChoke™ design technology is used. Compared to the conventional choke station design methodology, the number of choke loops is reduced from five to three. The traditional vertical loops are also changed to horizontal. Station maintenance work is simplified.

Figure 2 Terminal with gChoke™ Station

The slurry settling and restart-abilities in the pipeline were carefully investigated in the laboratory and simulated with the hydraulics model. The maximum allowable pipeline slope was increased to 25% from 15%, which was the traditional limit. Consequently, construction cost in cut-and-fill was reduced significantly. Figure 3 shows a typical steep valley along the pipeline.

Figure 3 Ramu Pipeline Crosses A Steep Valley

The pipeline has to cross many unstable slopes. Deep piles were installed, which have effectively stopped slope sliding in the identified land sliding areas. Frequent earthquakes and heavy rains continuously generate new sliding areas. Therefore, the pipeline was designed to lay above-ground with flexible support system, which prevents adding earth load on the pipeline when the land moves down. The pipeline movement and strain are closely monitored by a survey team, as shown in Figure 4. A dedicated maintenance crew has been established to respond any emergences along the pipeline.

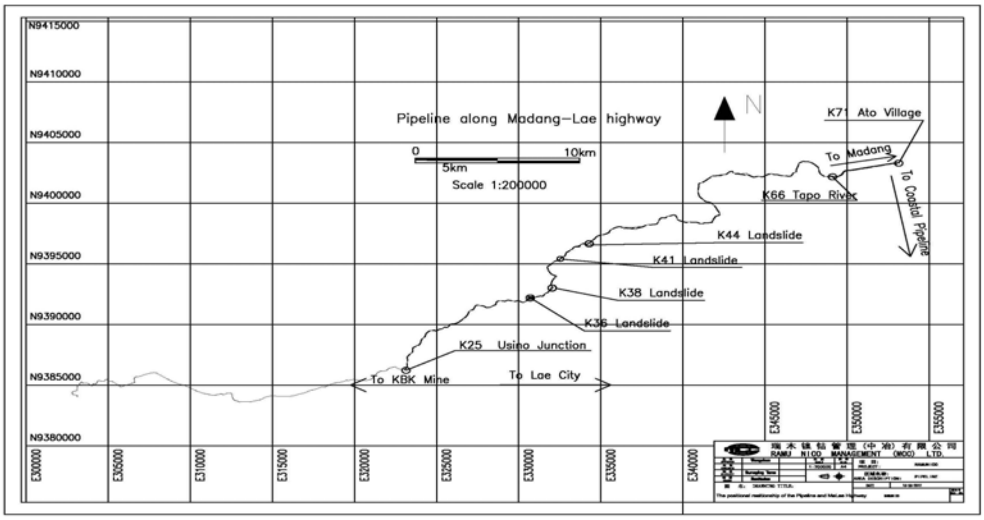

Figure 4 Landslide Monitoring Locations along Pipeline Corridor

As a responsible company, Ramu NiCo puts environmental monitoring and management as one of its top priorities. Preventing and minimizing slurry spill caused by pipeline leakage or plug is a great challenge for a slurry pipeline. Pipeline Expert™ control software, as shown in Figure 5, is required to be installed to assist the operation. In addition to the function of leak and plug detection, the software can also monitor the pressure along the whole pipeline to

Figure 5   Pipeline Expert™ Control System

prevent over-pressure and slack-flow, optimize the pump speed to save power. The software tracks the slurry batch movement and provides the estimated time of arrival to the terminal operator.

Two years have passed since the pipeline was commissioned. The pipeline system performance is satisfactory.

3 DSTP SYSTEM

The DSTP system has been proven to be the most environmentally sound tailings disposal method in Papua New Guinea. The tailings are neutralized with lime milk to pH of 8.0 through five stages of neutralization tanks to minimize the metal content in tailings liquor before discharge through DSTP system. The system, as shown in Figure 6, includes a head tank and 550 m overland pipeline, a mixing tank on shore, a 108 meter seawater intake pipeline feeding the tank and a 428 meter outfall pipeline transporting the diluted tailings to deep sea.

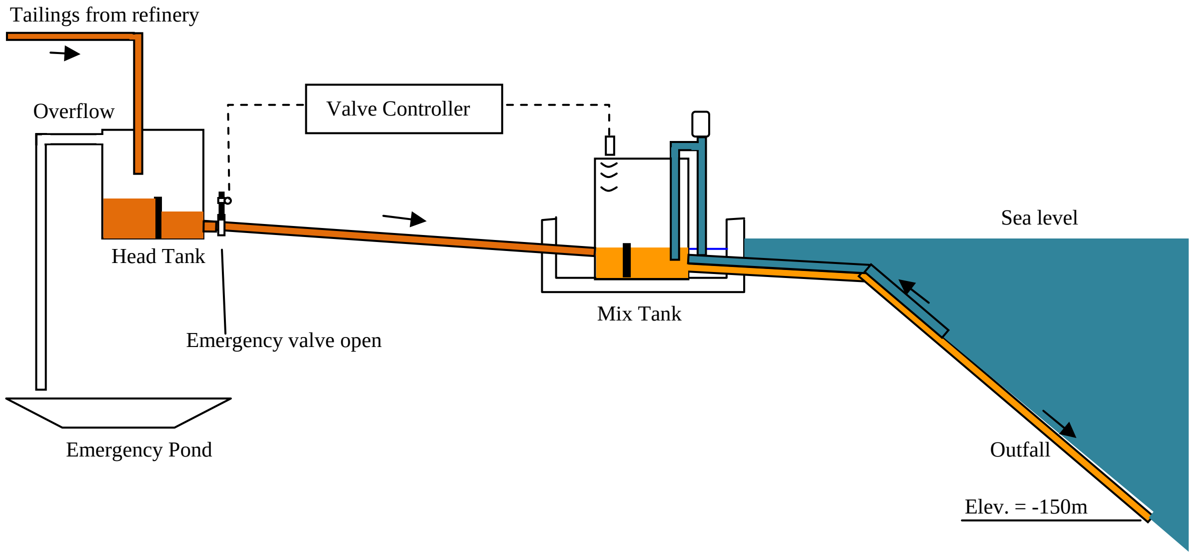

Figure 6 DSTP System Configurations

All pipelines are 32-inch HDPE pipe. The tailings are discharged to the mixing tank and mixed with the seawater in a ratio of 1 to 1. The diluted slurry is discharged to the depth of 150 m undersea on a steep slope along which the dense tailings current continuously flows down to the 1500 m deep valley with sufficient retaining capacity. A small portion of fine tailings escape from the dense current and form plums, which are diluted and carried away by ocean current, eventually settling down on the bottom of the sea bed and covered by the alluvium from nearby rivers.

To ensure the safety and integrity of the DSTP system, high safety factor has been applied in the design. High quality HDPE pipes from KWH Toronto were used for the system. The pipe can withstand 1.1 MPa differential pressure, while the maximum differential pressure on the pipe is only 0.06MPa. The safety factor is 18, much higher than 1.1, which is required in the slurry pipeline design code.

The pipeline can withstand tensile force of 188 tons, while the maximum force caused by slope sliding undersea is only 14 tons. The safety factor is 13, much higher than 2, which is required by the design code.

Therefore, the pipeline leak caused by over-pressure or mechanical failure is unlikely. If a leak does occur, the emergency valve will close and the plant will shut down. The tailings in the plant can be diverted to the two emergency ponds on shore. The impact to the environment can be controlled.

Figure 7 Tank Mixing Tailings with Seawater

RNML has conducted the tailing quality monitoring program since starting the discharge according to Environmental Permit (EP) and Operational Environmental Management Plan (OEMP). The monitoring has been conducted internally by RNML and verified by an accredited laboratory. The quality of discharged tailings has met the environment permit conditions since commissioning.

4 Conclusions

Mining project in Papua New Guinea can be environmentally friendly. The operation of the Ramu slurry pipeline and DSTP pipeline has proven the following:

1. Long distance pipeline with innovative design features has performed well in Ramu NiCo.

2. Deep Sea Tailings Placement is the most suitable solution for Ramu NiCo’s tailings management. The undersea pipeline was engineered with provisions to ensure environmental safety and pipeline integrity. The quality of discharged tailings has met the environment permit conditions since commissioning.

5 Acknowledgement

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