*GEHO® Info for sales representatives*
*Volume 18, No.2, March 2008*

# Brazilian Paragominas bauxite pipeline: proven economical!

The Brazilian Mineracao Bauxita Paragominas pipeline has now been in operation since early 2007, proving the myth that bauxite cannot be pumped (economically) over long distance has been wrong! The 245 kms, 13.5 MTPA capacity pipeline feeds the expansion of the Alunorte refinery from the abundant resources at Paragominas´ Miltonia mine. The line was designed and commissioned by PSI for Companhia Vale do Rio Doce (now called Vale). From the start of operation the pipeline operated well and achieved target production requirements with a high availability and at low operating costs. For that reason Vale decided to increase the capacity and procured the additional GEHO® pumps required once more from Weir Minerals Netherlands.

Initial pipeline loop test had indicated particle break down and increasing yield stress of the bauxite slurry over time. PSI developed a laboratory test procedure to simulate this particle break down with time of travel through the pipeline. This test involved shearing over time simulating power input resulting from pumping through the pipeline. The impact thereof was considered in the design of the pipeline. However, after pipeline startup the bauxite mined showed to be very stable and no significant particle breakdown was apparent.

The 24 inch outside diameter pipeline was selected to handle the max flow of 13.5 MTPA required in subsequent years in 3 steps. In order to prevent sedimentation the initial capacity of 4.5 MTPA and 9 MTPA requires the batching of water and slurry alternately:

1. Initial capacity of 4.5 MTPA for the first year allowed the use of a single pump station since discharge pressure would still be low. Vale installed 6 GEHO® TZPM 2000 piston diaphragm pumps (5 operating and 1 stand by with a capacity each of 356 m3/h at 137 bar)
2. Capacity increase to 9 MTPA. The same pumps allow to generate the higher pressure required for a capacity of 9 MTPA resulting from the increased length of slurry batches.
3. The success of the first year of operation has now prompted Vale to make optimum use of this technology and capitalize on savings in operating costs to the maximum. It has been decided to increase the capacity to 14.85 MTPA in year. This leads to an increase of the pump capacity and slurry batch length and required discharge pressure of the pumps, for which an additional intermediate pump station with 6 pumps GEHO® TZPM 2000, however equipped with larger size water ends, will be added. In addition, the existing pumps in PS1 will be re-fitted with larger piston diameter to handle the increased flow and an identical new (7th) pump is added.

Since corrosion limits the pipe pressure rating after 5 years, an intermediate pump station will reduce the discharge pressures in the first section of the pipeline. By applying the largest pump available in the market combined with the high pump availability proven in this project, the margin for unavailability was further reduced which made it possible to use a smaller number of only 6 GEHO® pumps per pump station for PS 2. This way reducing overall investment costs for pumps, piping and valves, civils and buildings. Each pump will however now be required to produce 461 m³/h at 130 bar, turning this to the highest loaded

piston diaphragm pumps in the world. For that reason, the pump power end rating is most critical. The GEHO® pump power
end is unique in that it is equipped with a direct-driven crankshaft that is made of forged steel and is supported in a cast frame which can absorb much higher rod loads, since welds (previously the pump's weakest point) are now fully eliminated and abrupt material transitions (stress risers) are avoided. It has an unprecedented reliability at the rod load for the design duty. The margin available in the load rating of this power end, the so-called continuous piston rod rating, ensures an AFBMA L-10 bearing life of more than 100,000h as was demonstrated by detailed calculations. The water end will be supplied with large size 70 l diaphragm housings to handle the high flow.

Pipeline transportation requires a suitable grind. This was optimized in a way to also allow dewatering at the refinery at reasonable costs to obtain a
concentration of ±12% water, comparable to bauxite as it comes available from the mine. Slurry quality is monitored continuously on aspects like, rheology, density and particle size distribution before each batch is admitted to the pipeline. The pipeline operator stationed at the mine stays in touch with the terminal station so that the departure and arrival time and location of each batch is known. The terminal station determines the flow of the slurry being admitted to the pipeline to ensure that sufficient holding capacity is available.

The pipeline operates continuously at a constant flow rate and is not shut down other than for emergency reasons. In such case the pipeline filled with slurry can be restarted with water through a carefully controlled sequence of operations. It is for that reason that the pipeline slope is limited to 15%.
Hyperbaric filters dewater the slurry at the terminal to produce bauxite with about 12% moisture. The filtered bauxite is then used by Alunorte to produce alumina.

At the 2008 TMS light metals conference, Mr. Geraldo Brittes, Director Operations at Mineracao Bauxita Paragominas and co-writer of a paper about this novel application commented: "Since the start of commercial operation in May 2007 the pipeline has operated well and has achieved target production requirements with a high availability. The pipeline has proven a higher availability than the beneficiation plant or the filter plant and never posed to be a bottle neck in achieving production targets".

## Conclusions

The use of pipeline for transport of bauxite now turns the exploration of more remotely located bauxite deposits economical, since the alternative means
of transport, like railway and trucking presented itself as too costly. Considering that bauxites vary significantly in a number of properties like e.g. particle size degradation and dewatering properties, it is advised to study the feasibility and economics for each project based on the specific bauxite considered for long distance transportation by pipeline. The use of caustics as transport medium for short lines with a recirculation pipe for the return caustic may even be an option for short distance pipelines, eliminating the dewatering issue altogether.

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