Application of Dewatering Screens in Tailings Filtration

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Abstract

This work presents the results from a piloting study on an alternative process to the tailings filtration in horizontal belt filters currently being used at Mantos Blancos Division of Anglo American Chile. This alternative process consists on the recovery of solids > 45 mðm contained in the tailing, through two cycloning stages followed by a drainage stage in dewatering screens to reduce tailing moisture and turn it into a paste easily to be transported to the adjoining dumping facility.

1. Current Tailings Treatment at Mantos Blancos Division

The Sulphide Plant at Mantos Blancos Division of Anglo American Chile Ltda, that started its operations in 1981, has had a tailings treatment plant from the beginning. Basically, it consists of a classification circuit, fines thickening and filtration of the coarse fraction. As this plant is located in one of the most arid lands in the world, coarse tailing are filtered in order to maximise water recovery. Disc filters were used at the beginning. Later 1984, during the expansion of the concentrate plant to 8,000 t/d, horizontal belt filters were incorporated and are still being used today (Figure 1). Tailings are finally disposed in a dam for thickened fines and in a dam for the coarse fraction, in a 40/60 % ratio respectively and a solids concentration of 60% and 80%, respectively.

Figure 1: General view of Vacuum Filters and Filtration Pilot Plant.

1.1. Classification, Coarse Fraction Filtration and Fines Thickening

Tailings from the concentrator plant are classified in a gravity fed Eral 500 mm cyclones cluster, in conical configuration, with four operating and two stand-by 500 mm units. This classification system produces a solids distribution of 50-55 % and a cutting size of *d50* between 50-60 mðm. The cyclones overflow, 24-26% solids, is conducted to three thickening units (Larox of 200 ft., Dorr Oliver of 145 ft. and Eimco of 145 ft.) for sedimentation process, using a flocculant dosage of 5g/t, which is fed with a 55-60% solids to the filtration units and to the fine tailings dam in a proportion subject to the absorption capacity of fines in the filters. Thickeners recover approximately 63-67 % of the water, which is re-circulated to the concentrator plant (Figure 2).

Figure 2: Tailings thickener treating cyclones overflow.

The cyclones underflow, 65-67 % solids, is forwarded to three filtering units (horizontal belt filters of 100 m^2 ea.), previously mixed with some part of the thickened fines (Figure 3). Cakes of 17 % moisture are obtained, which are then transported to the coarse material dumping facility by means of conveyor belts (Figure 4). Filtrates, plus water from the cloths washing, are re-circulated to thickeners to settle solids in suspension.

Figure 3: Current filtering of tailings.

Figure 4: "Cake" in vacuum belt filter.

2. Dewatering Screens in Fines Filtration

Dewatering screens were initially employed in filtering industrial minerals of fine size such as: silica, feldspar, kaolin, fluorite, salts, coal, etc., in order to expedite reduction of their residual water content, thus allowing their storage in a silo as well as reducing stock pile areas. In this manner, an optimum handling of products in hoppers and conveyor belts is obtained. Later, its use was extended to sands drainage for the construction, glass and ceramic industry, where other uses for the filtering of ultra-fine sizes were developed. In Chile, dewatering screens have been mainly applied to the treatment of coal, silica sand for smelting and glass, salts washing in the chemical industry as well as aggregates and fine minerals processing.

The operational principle in this equipment is the presence of an extra cover formed by the material itself. In this way, the filtering process is performed mainly though the stratified material bed, which is in contact with the filtering screen.

Therefore, although the screen aperture may be higher than the smallest particles being processed, if a good filtering bed is accomplished an efficient reduction of moisture can be obtained with no significant loss in fines. The development of this bed is due to cyclones that recover the filtered material from the screen. These are the actual pillars of dewatering screens filtration.

3. Tailings Filtering with Dewatering Screens

3.1. Background

In order to reduce the filtering operation costs, Mantos Blancos agreed with Eral-Chile to run some pilot tests. The process consists of a first classification stage by cyclones (existing and to be modified) and a second stage by a compact cyclone -plant with dewatering screen (new).

3.2. Pilot Plant

3.2.1. First classification stage [SI]

Tailings from flotation were classified in two fractions by means of a cyclones cluster (existing), SI, generating a fine fraction, which was sent to the thickeners as usual; and a coarse fraction, which was sent to a new filtering pilot plant, through a dewatering screen and cyclones, instead of being sent to the vacuum belt filters.

To recover a maximum of coarse particles, the existing 500 mm cyclones were kept in operation but their configuration and geometry were modified, in order to increase the percentage of solids reporting to underflow. To effect this, it is necessary to decrease its separation or cutting size, $d50_c$.

To achieve this goal, classification of the future 500 mm cyclones was simulated through a 250 mm cyclone, to obtain an appropriate amount of solids to meet the treatment capacity of the filtering pilot plant installed as a second stage in the process. At the same time, classification of the existing 500 mm cyclones was controlled in order to achieve the necessary comparison with the classification achieved by the 250 mm cyclone (Figure 5).

Figure 5: First classification stage: 500 mm cyclone cluster and 250 mm cyclone.

3.2.2. Second separation stage [SII]

This second stage, consisting of a compact cyclone pilot plant, which includes a dewatering screen that directly receives the coarse fraction obtained during the first classification stage, produces a final "cake" with the enough concentration to allow its transportation through conveyor belts to the tailings deposit area (Figure 6).

Pulp being filtered by the screen is pumped towards a cyclones battery cluster, which performs a solids/liquids separation (Figures 7 - 8).

As the purpose of this classification stage, SII, is to recover almost the total amount of solids contained in the filtering operation, 100 mm cyclones with a high cutting capacity are employed. These cyclones are capable of producing an overflow with minimum solids concentration, which is forwarded to the thickeners along with the fines obtained during the first classification stage.

Figure 6: Compact Plant with cyclones (2 units), dewatering screen and pumping group.

Figure 7: Filtration Pilot Plant, frontal view.

Figure 8: Filtration Pilot Plant, rear view.

The coarse fraction recovered by these cyclones is discharged over the “cake” formed in the screen by the feeding (coarse fraction resulting from the first classification stage). In this manner, the filtering of the fines is actually done by this “cake”, retaining the fines in the screen and preventing their filtration through the screen panels.

This is the reason why this type of plant can filter solids of a size significantly finer than the aperture of the installed screen.

3.2.3. Testing period

The proposed equipment represents significant advantages regarding reduction in structures, facilities, less energy used, decrease in fungible elements (filtration and wear out elements) and a simpler operating system.

During this period various adjustments in equipment were tested. The corresponding metallurgical controls were performed.

3.2.4. Equipment description

First stage of classification [SI]:

- A 250 mm Cyclone, conical configuration, model PP025102 IV for Arrangement 1 and PP025102 V for Arrangement 2, gravitationally working in both cases at 60 kPa.

Filtration and Second classification stage [SII]:

- Dewatering Screen, model EV 22, 300 mm wide and 1.600 mm long. Working power 1.8 kW (Figure 9).
- Centrifugal pump, model WP 50, equipped with an electric motor of 7.5 kW.
- Two 100 mm Cyclones, conical configuration, model PP010041 IV for Arrangement 1 and PP010041 V for Arrangement 2, working at 138 kPa.

This last equipment constitutes a Compact Cyclone Plant model MUE 10/2-50.8-22, with total installed power of 9.3 kW.

Figure 9: Filtration Pilot Plant, detailing dewatering screen and “cake”.

3.2.5. Tests development

From many different preliminary tests, intended to achieve the necessary circuit stability to accomplish the maximum efficiency of the pilot plant, test groups identified as Arrangement 1 and Arrangement 2 were established as valid tests for the present evaluation.

See Annex 2 and 3 (enclosed): Evaluation of Classification First Stage (SI) and Second Stage (SII).

Adjustment efforts were made at the plant in order to obtain a not too dry "cake" with the maximum moisture allowed by conveyor belts transportation (Figures 10 – 11).

Figure 10: Detail of the "cake" delivered by the dewatering screen.

Figure 11: Detail of the "cake" falling from the discharge chute.

See Annex 1 (enclosed): Flow sheet and Metallurgical balance.

3.3. Results

According to resulting values collected from the circuit, the total recovery of solids was **56 %**, with a **82 %** of solids concentration for Arrangement 1, and **68 %** with a **78 %** of solids concentration for Arrangement 2.

4. Operating Costs

COMPARATIVE TABLE COMPACT PLANT vs. BELT FILTER	**Energy Cost kUS$ / yr**	**Cost of Spares & Operat /Mainten., Labour kUS$ / yr**
3 Horizontal 100 m^2 Belt Filters	200	315
3 Cyclone Compact Plants, MUE 10/38-150.90-86	122	117

5. Conclusions

According to the results obtained from the pilot tests with dewatering screens plus a suitable selection of cyclones configuration, it is possible in this case to replace the existing belt filters by a compact plant with dewatering screen and cyclones, with a lower operating cost.

Mantos Blancos is planning to run an industrial test in order to ratified these results.

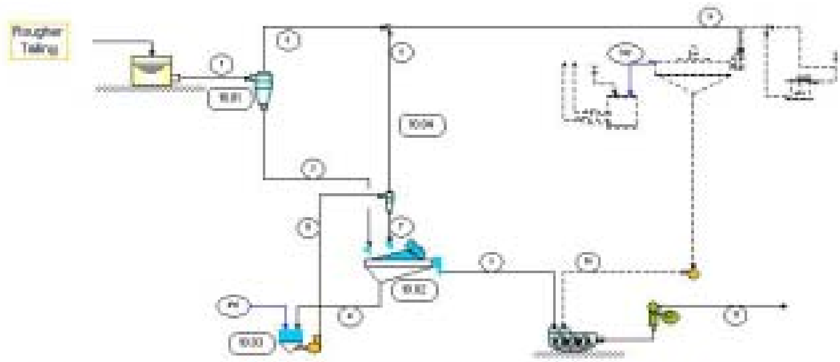
Acknowledgements

We would like to extend our appreciation to all members of the technical staff in the projects, metallurgic laboratory and plant units of Mantos Blancos Division, for the valuable cooperation and support rendered during the execution of these pilot tests.

ANNEX 1

FLOW SHEET: INDUSTRIAL PLANT

CLIENT: MANTOS BLANCOS DIVISION (ANGLO AMERICAN CHILE)
PROJECT: TAILINGS FILTRATION WITH DEWATERING SCREENS
DATE: January 1st, 2005
REV.: INDUSTRIAL PLANT



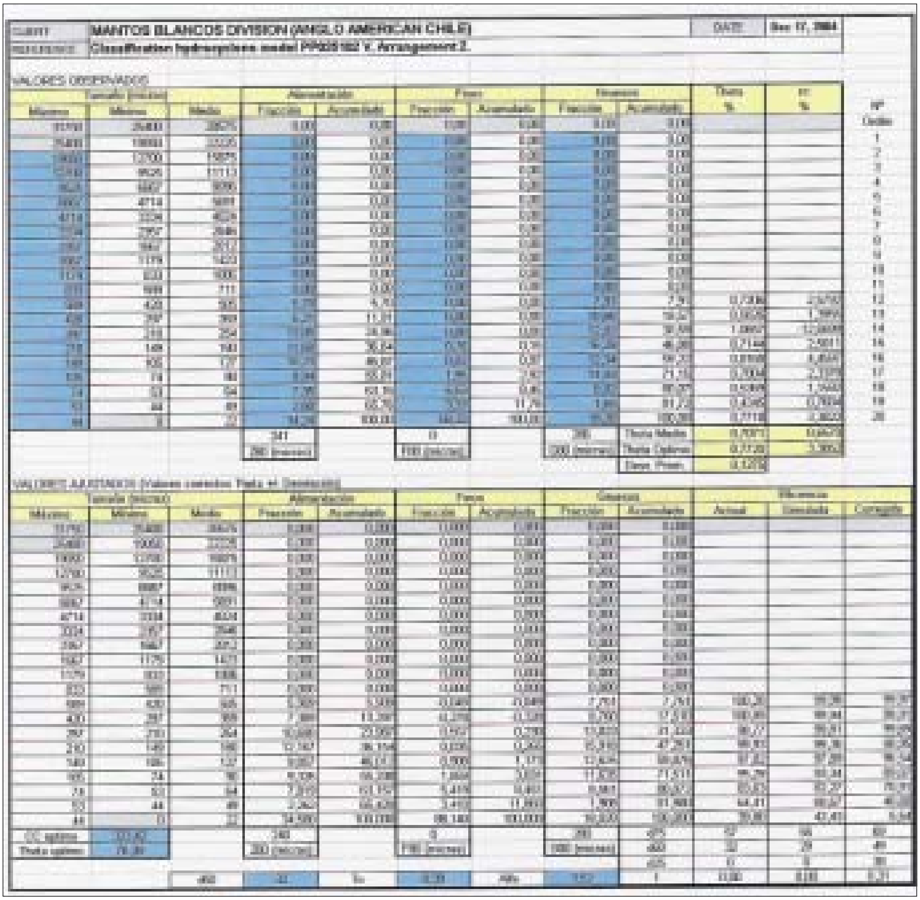
γs (t.g/m³)	2,80											
FLOW	1	2	3	4	4W	5	6	7	8	9	9W	10	11
T	526,00	124,24	401,76	517,37		517,37	44,32	473,05	357,44	168,58		168,58	526,00
M	873,00	500,64	372,36	730,42	757,78	1479,20	891,50	586,70	236,64	1382,14	1231,49	150,65	428,29
J	603	248	1079	718		350	50	806	1499	121		1119	1227
Cw	44,0%	23,5%	65,0%	45,5%		28,8%	4,8%	56,8%	79,1%	11,2%		87,4%	70,2%

T: t/h dry solids
M: m³/h pulp
J: g/l solids concentration
Cw: % concentration by weight

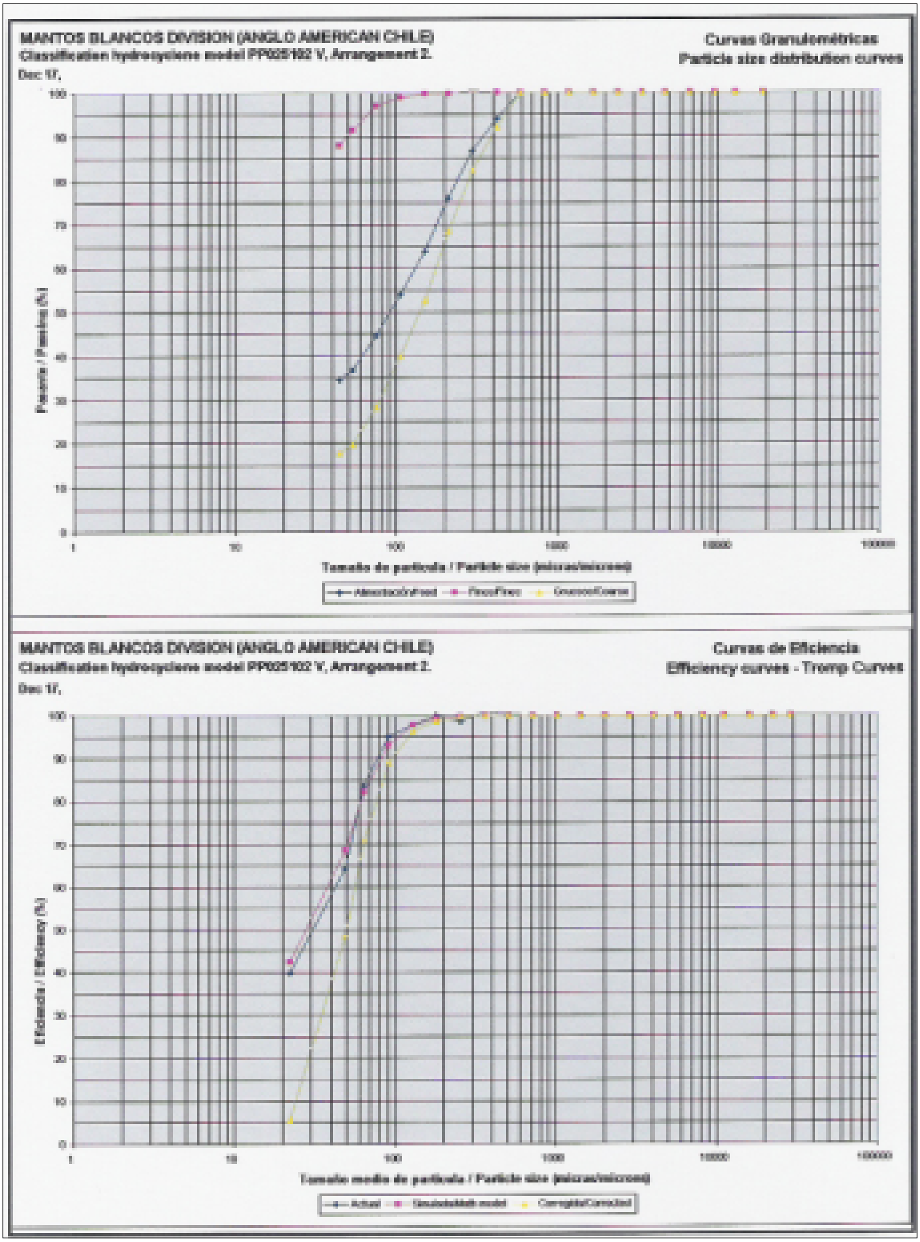
Annex 2

Evaluation of Classification – First Stage (SI)

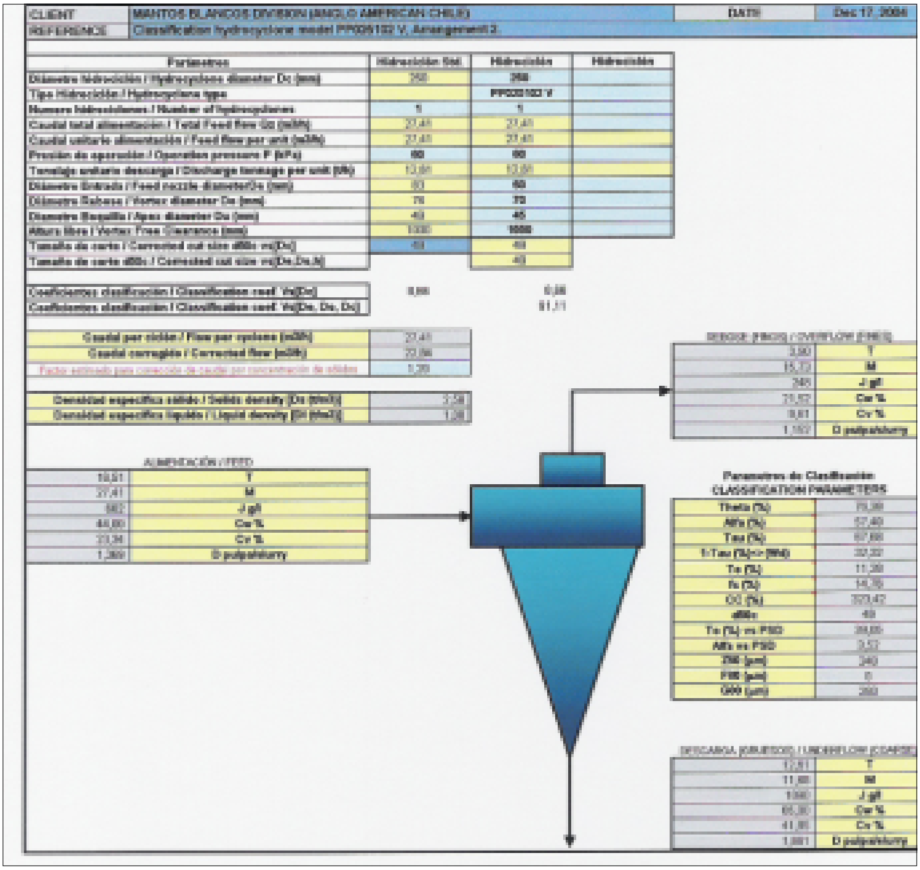
VALUES



PARTICLE SIZE DISTRIBUTION CURVES



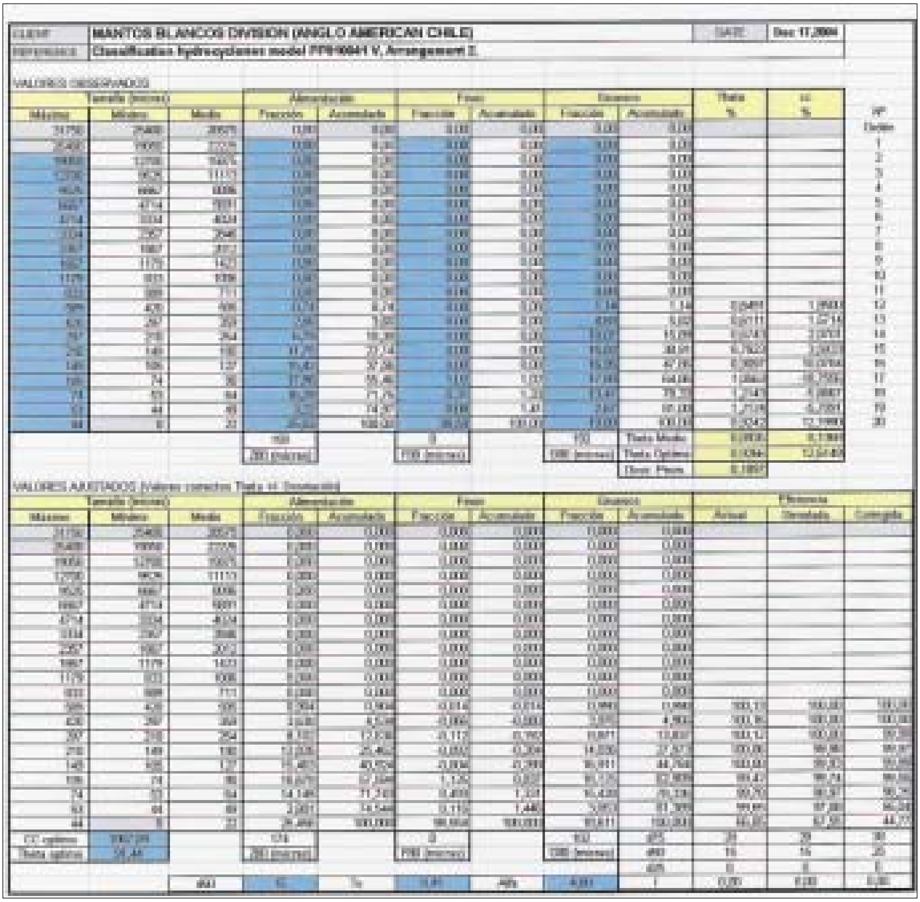
BALANCE


CLIENT
MANTOS BLANCOS DIVISION (ANGLO AMERICAN CHILE)
REFERENCE
DATE
Dec 17, 2004
ALIMENTACIÓN / FEED
T
M
J g/l
Cw %
Cv %
D pulpa/slurry
Parametros de Clasificación
CLASSIFICATION PARAMETERS

ANNEX 3

EVALUATION OF CLASSIFICATION – SECOND STAGE (SII)

VALUES

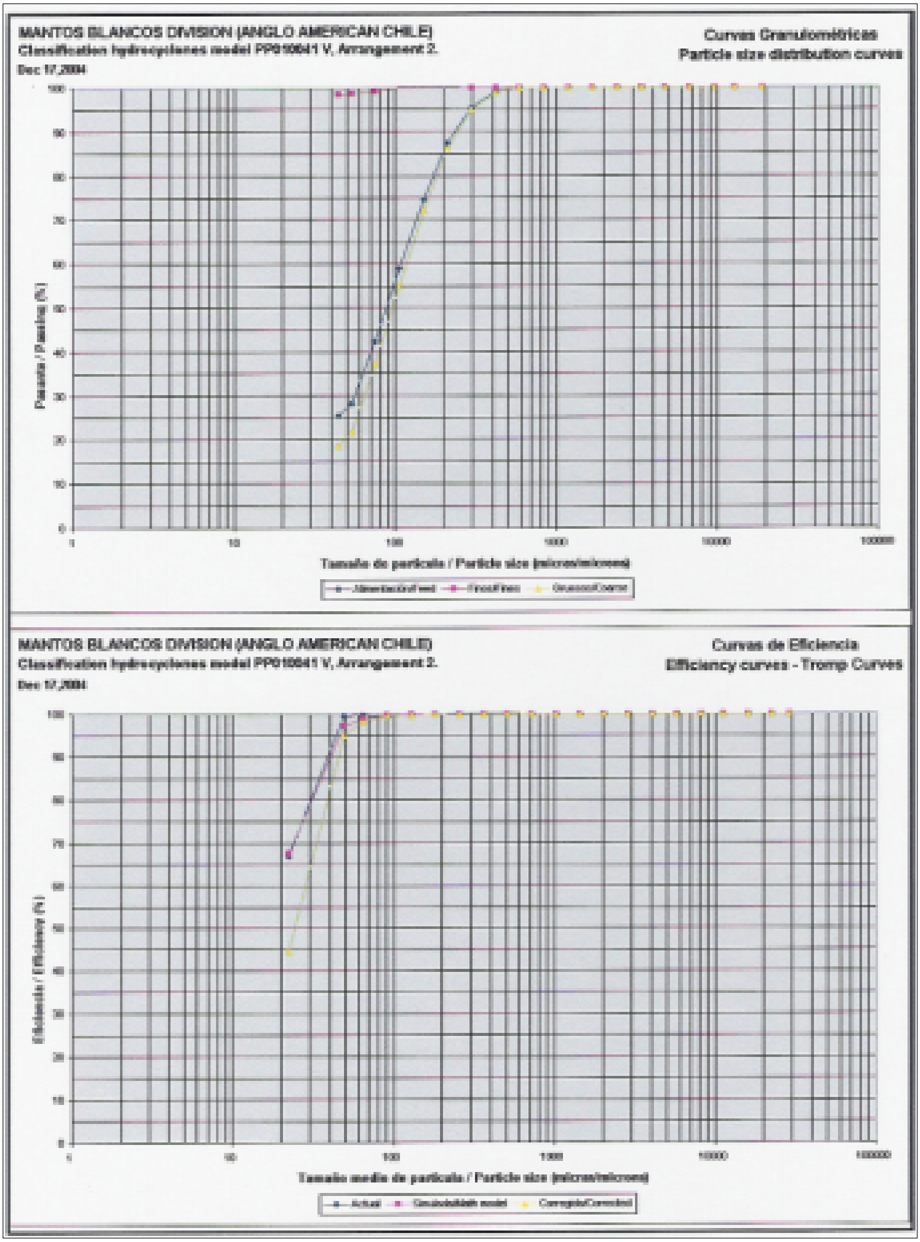


CLIENT: MANTOS BLANCOS DIVISION (ANGLO AMERICAN CHILE)
DATE: Dec 17, 2004
REFERENCE: Classification hydrocyclones model FP8/0841 V, Arrangement 2.

VALORES OBSERVADOS

VALORES AJUSTADOS

PARTICLE SIZE DISTRIBUTION CURVES



BALANCE