ALPART'S IMPROVEMENTS IN QUALITY
CONVERSION OF BATCH TO CONTINUOUS PRECIPITATION

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ABSTRACT

Alumina Partners of Jamaica (Alpart), the largest alumina refinery in Jamaica, was commissioned in 1969 with three batch precipitation trains and only one continuous train. In the early 1970's another batch train was added, and in the early 1980's two of the batch trains were converted to continuous trains. However, based on available data, it proved best to use the remaining batch trains as the primary agglomeration trains

In order to enhance its global competitiveness, Alpart embarked on a modernization program aimed at making improvements to product quality and cost. Alpart has since reviewed its philosophy on the use of batch technology, which adversely affects product soda, attrition index, yield, classification operation and operating cost. Subsequently, in addition to changes in the classification and seed charge systems, the remaining batch trains were converted to continuous trains.

The estimated impact of the conversion of the batch precipitators, using Kaiser technology, is a 1.5 gpL overall yield improvement, a 5% reduction in the average Attrition Index and a 18% reduction in Product Soda.

This paper describes the operational, maintenance, and construction aspects of the process of converting from batch to continuous precipitation without any impact on plant performance.

KEY WORDS:

attrition index, batch precipitators, continuous precipitators, product soda, coarse seed, fine seed, agglomeration

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1.0 INTRODUCTION

Alumina Partners of Jamaica (Alpart), a partnership of Kaiser Aluminum and Chemical and Hydro Aluminum, began a project in 1997 to improve product quality. The Precipitation area was laid out in five trains, three continuous and two batch. This project converted the two batch trains to continuous trains using Kaiser agitation and cooling technology. This paper will describe what was constructed and the product quality and other benefits.

2.0 BACKGROUND

Alumina Partners of Jamaica (Alpart), the largest alumina refinery in Jamaica, was commissioned in 1969 with three batch precipitation trains and only one continuous train. In the early 1970's another batch train was added, and in the early 1980's two of the batch trains were converted to continuous trains.

The trains are referred to as A, B, C, D and E with each train consisting of 12 tanks each being of 2460 cubic meters. A, D and E are continuous trains while B and C are batch trains. 'A' train utilizes a Flash Cooler while 'D' and 'E' uses two Double Piped Heat exchangers on each train for step wise cooling. The batch trains have no special cooling systems while one tank on each train is used as a seed storage tank. See Figure 1 – Layout of Precipitators.

In this mode of operation 80% of fine seed is charged to batch precipitators, in order to achieve a high agglomeration of fines. This was particularly advantageous to the operation of the facility especially in the event of excessive fine seed inventory, caused for instance by high oxalate concentration.

It is however recognized that the high agglomeration of batch precipitators leads to the problems of high sodium oxide in product and high particle attrition index. Both of these result in inefficiencies for the alumina smelters.

At the smelters, sodium oxide in alumina converts to sodium floride when added to cells, this in turn increases the "Bath Ratio" (Ratio of NaFl to $AlFl_3$) which must be reduced by the addition of purchased aluminium floride. Besides being an additional cost, the use of aluminium floride increases the bath volume and can result in an environmental problem, if the excess volume has to be stored (Howard, 1997).

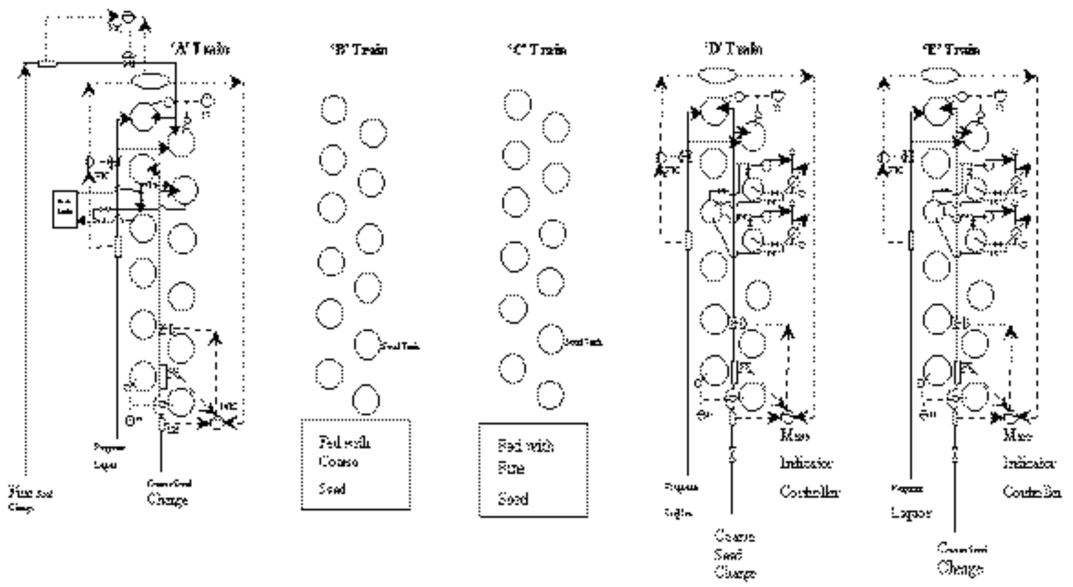

Fig 1. Layout of Precipitators.

The Attrition Index indicates the likelihood of particle breakage during alumina handling, and when viewed in conjunction with Particle Distribution gives an indication of the dusting properties of the alumina. Alumina dustiness not only affects Smelters that operate the older type Soderberg cells, which have less adequate facilities for containing dust emissions, but also seems to affect the more modern Prebake cells through blockages at the point feeder (Howard, 1997).

Typical results obtained at the Alpart facility while operating in this mode versus what is popularly accepted as "World-Standard" are shown below.

Alpart's World-Standard

- Fines (minus –44 micron) 6.85% 4.0%
- Attrition Index 18% 7%
- Sodium (Na_20) 0.45 0.30
- Calcium (CaO) 0.048 0.040
- Iron (Fe_2O_3) 0.009 0.008
- Silica (SiO_2) 0.014 0.010

A survey of Alpart's customers alumina quality needs revealed, that the top three areas of concern are Fines/Dustiness, Sodium in Product and Calcium in Product in that order. Based upon current technology, the first two of these concerns can be addressed by operating a totally continuous precipitation circuit, which would imply that there are no batch fine seed charges.

Other plants had looked at converting batch trains to continuous trains and could not justify the cost. However with the need to improve alumina quality and with the realization that liquor yield could be improved by more effective use of the Batch Precipitators, Alpart explored the feasibility of converting Batch to Continuous trains and found that this could be done at a justifiable cost.

The justification arising since, the batch tanks were positioned similarly to the continuous tanks in their respective trains, with equal potential for cascading flow between tanks because of the successive lowering of each tank's foundation. Two major structural differences between both types of trains were the non-existence of inter-connecting flumes between tanks and the inclusion of Seed Storage Tanks on the batch trains.

3. SEED CHARGE SYSTEMS

3.1 Previous Seed Charge System

The seed charge system that existed consisted of six seed charge tanks. Two of these 10B and 10C were positioned one each inside the two batch precipitation trains. These two tanks provided coarse seed to B, C, D and E trains.

Four primary seed tanks are located south west of the precipitation trains. Three of these were operational, one provided coarse seed to A train, another provided fine seed to both A Train and to the batch agglomerators in C train, while the other was a spare for either tank.

The 10B and 10C seed tanks were each fitted with two 300 kW pumps and the three other operational seed tanks were fitted with a total of four pumps each 225 kW with flexibility on both suction and discharge.

The Aluminium Hydrate from the precipitation circuit is classified, in terms of particle size, by using gravity classifiers. These classifiers consist of six Primary Thickeners (from which product grade hydrate is usually obtained), six Secondary Thickeners (from which coarse seed is obtained) and ten Tertiary Thickeners (from which fine seed is obtained).

The coarse seed from numbers one through four Secondary Thickeners can be routed to the primary seed tanks as well as 10B and 10C. The numbers 5 and 6 Secondary Thickener tanks can only be routed to 10B and 10C.

The system was so designed in order to provide the necessary flexibility whenever:

a. classification units are switched
b. to correct potential seed inventory imbalances
c. to adhere to the principle of not calcining the Primary Hydrate obtained from the highly agglomerated batch fine seed charged precipitators. This being necessary since the hydrate, albeit coarse, would tend to be more fragile than that which was obtained from the trains with more growth and less agglomeration. See Figure 2 – Previous Seed Charge System.

Also note that in this system of Batch and Continuous trains, three types of coarse seed tanks are needed to facilitate this seed charge system (Types A, B and C in Figure2).

The fine seed was agglomerated in one continuous train and one batch train with a high agglomeration index. The coarse seed was grown in two continuous trains and agglomerated and grown in one batch train.

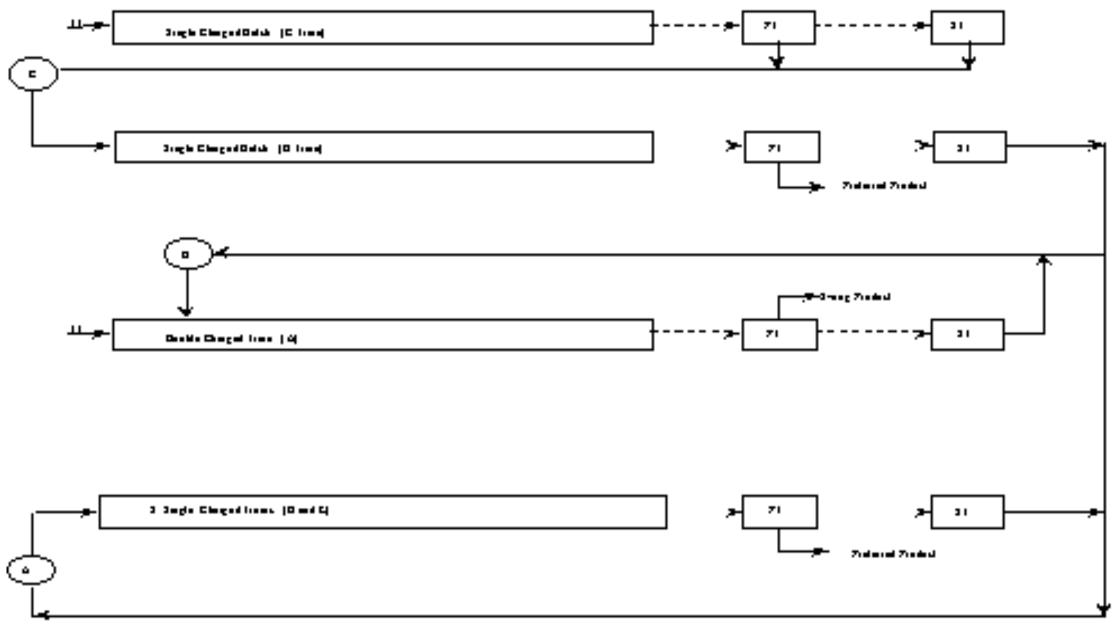

Figure 2
Previous Seed Charge System

3.2 New Seed Charge System

The new seed charge system utilizes only the four primary seed tanks; two for coarse seed, one for fine seed and one as spare for either coarse seed or fine seed. This could be achieved since only two types of coarse seed stocks were needed in the all-continuous operation, as opposed to the mixture of batch and continuous precipitators (see following diagram). Improvements in liquor yield would therefore result not only from the more effective use of batch tanks as continuous Precipitators but also because 10B and 10C could now be used as regular precipitators

The coarse seed system is fitted with seven pumps, such that five would be operating, one to each train, while two would be spares. The numbers 5 and 6 Secondary Thickeners were modified so as to be able to provide coarse seed to the primary seed tanks.

The coarse seed system revision was accomplished without any major process disruption, since additional pumps, drives and the entire piping system were installed first, then the existing seed pumps on 10B and 10C were individually re-installed.

The fine seed system is fitted with four pumps and is capable of providing fine seed to the originally continuous trains A, D and E. This system was completed before the conversion of the B & C trains and was accomplished without any process disruption.

All the coarse seed tanks can be fed from any of the secondary thickeners and from the primary thickeners of the two agglomeration trains (A & D). This system allows the flexibility to charge the coarse seed in two modes (see Fig. 3 – Primary Seed Charge System and Fig. 4 – Secondary Seed Charge System). The primary mode allows the weaker hydrate from the agglomeration trains to recycle through a growth train for strengthening. The strong hydrate from the growth trains is added as secondary charge for additional strength.

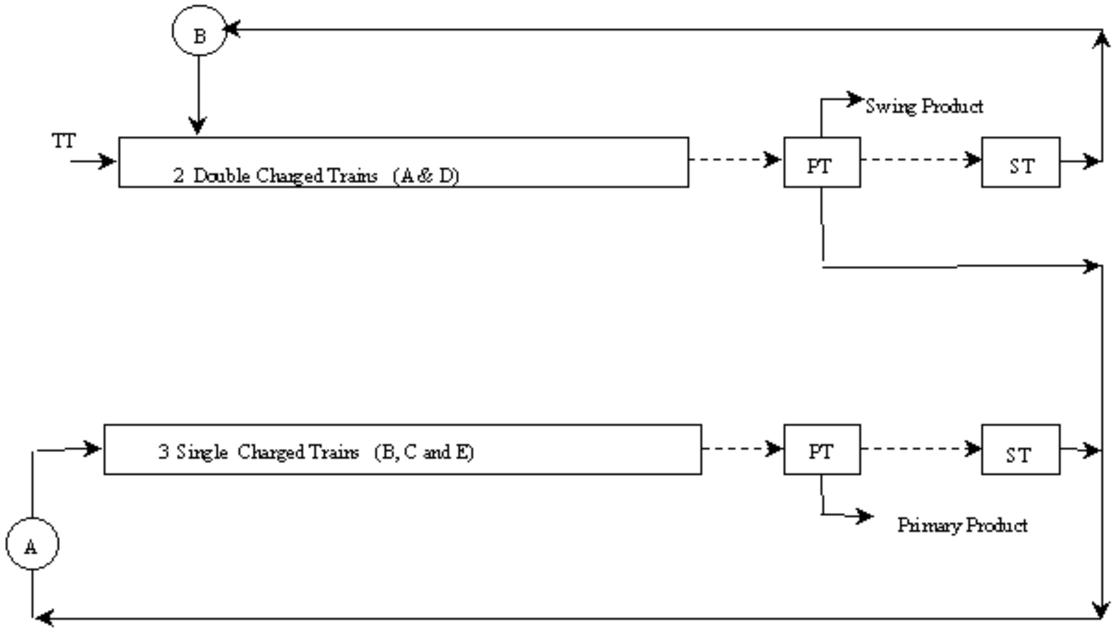

Figure 4
SecondarySeed Charge System

It also allows the hydrate from the growth trains to recycle back to itself for further strengthening. The purpose of the new seed charge system are as follows:

a. To allow mild agglomeration of the fine TT seed (both system diagrams).
b. To correct imbalances in hydrate inventory (both system diagrams).
c. To "cross-charge" the trains as the primary seed charge system, aimed at achieving uniform quality between the different trains (Primary System Diagram).
d. To "high-grade" selected trains (Secondary System Diagram).

4.0 CONVERSION OF B AND C BATCH TRAINS

4.1 Mechanical

The normal and bypass precipitator overflow flumes on A, D and E rows are identical. The problem encountered with this equipment is scaling, which results in flumes becoming restricted and causing spillage. The flume width was increased from 1.8 metres to 2.4 meters to provide additional flow capacity. The original flume blind design was abandoned since it contributed to a hazardous work environment. A new flume blind design was developed and is now being used on the converted B and C rows.

Since the B & C trains were batch, installations of the precipitator overflow flumes were done individually with limited process interruption. The 10B and 10C tanks that were previously used as coarse seed tanks, were converted to precipitators to facilitate the continuous process.

4.2 Agitation

The original B & C train tanks were fitted with external airlifts, while the existing continuous trains A, D and E trains are all internal airlifts, with the exception of the final tanks on each train. This facilitated the testing of the hypothesis that external airlifts resulted in more cooling, throughout the cleaning cycle of a precipitator, than internal airlifts; which proved to be true. These tests were done using the cooling data on the continuous #11 (internally agitated) tanks and the continuous #12 (externally agitated) tanks.

The converted B & C train precipitators all remained as externally agitated tanks using individual pumps instead of air to provide the circulating energy. Pumps were used instead of compressed air:

a. In order to minimize the likely carbonation of the liquor caused by air agitation.
b. Because of the energy savings that would be achieved by using pumps instead of compressed air.
c. Allow increased circulation to prevent slurry bypassing the tanks.
d. Allow the use of double pipe coolers for stepwise cooling.

4.3 Cooling

Double Pipe heat exchangers have been successfully installed on D & E continuous precipitation trains. With the conversion of B & C to continuous trains, identical two-stage cooling were installed to allow stepwise cooling. The underflow from the #3 or #4 precipitators is transferred to one bank of coolers by a pump around pump and is returned to the tank from which it was drawn. Underflow from the #4 or #5 precipitators is transferred to the second bank of coolers by another pump around pump and is also returned to the tank from which it was drawn. The coolers are operated counter current with cooling water supplied by a single booster pump. Cooling water flow is indicated and controlled to the coolers, the hydrate slurry flow is controlled by the pump speed, which is established by the belt sheave ratio.

4. Last Tank

The last tank in the B & C precipitation trains is pumped using the existing underflow pumps to the classification circuit. The tank is level controlled and is fitted with an overflow pipe to the associated classifier as an emergency bypass to the underflow system. The last tanks on the other precipitation trains use an overflow system to feed the classifiers.

The changes in the design of the last tanks were aimed at achieving more flexibility in plant volume control and also because it more easily lends itself to high solids precipitation.

5.0 IMPROVEMENTS

5.1 Precipitation Yield

The overall precipitation yield increased by about 1.5 gpL.

This improvement is attributed to the following: -

a. The more efficient use of precipitator tanks (continuous vs. batch)
b. The expansion of the double seed charge system.
c. The increased cooling on the precipitation trains.

5.2 Product Quality

Product quality improvements were seen on attrition index, product soda, particle size and product dustiness.

5.2.1 Attrition index

Attrition index improved from the range of 18 to 21% down to the range of 15 to 17%. Based on known work (Sang, 1989 and Lopez, 1992) this is believed to be as a result of the drop in agglomeration index (from 90% to 65%) followed by growth which was facilitated by employing the double seed charge system on the continuous trains.

5.2.2 Product Soda

Product soda improved from the range of 0.40% - 0.50% as Na_2O, down to the range of 0.30% - 0.40% as Na_2O. This was as a result of the lower occluded soda produced from continuous precipitation and also the lower degree of agglomeration (Anjier, 1993).

5.3 Operation

Operational improvements were seen with respect to flow capacity, seed charge capability, switching of flume blinds and manpower utilization.

6.0 CONCLUSIONS

Alpart has made significant strides in improving its product quality by converting its batch precipitators to continuous operation. This has also resulted in improved liquor yield because batch tanks are now being used more effectively and there are more tanks available to be used as precipitators.

Whereas it has previously been reported that other facilities could not justify the cost of such a conversion, Alpart could do so primarily because of the layout of its batch precipitators.

The conversion of batch precipitators is the first of other planned strategies aimed at improving Alpart's Alumina Quality. The next parameter to be addressed is calcium in product.

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