

Section 4.8 Operational Report

1. The Bayer Process

Aluminium manufacture is accomplished in two phases: the Bayer process of refining bauxite ore to obtain aluminium oxide (which is carried out at AAL), and the Hall-Heroult process of smelting the aluminium oxide to release pure aluminium (the smelting process is not carried out at AAL). The first step is the separation of aluminium oxide from iron oxide and other impurities in bauxite. This is accomplished using a technique developed by Karl Joseph Bayer, an Austrian chemist, in 1888. In the Bayer process, bauxite is mixed with caustic soda, or sodium hydroxide, and heated under pressure. The sodium hydroxide dissolves the aluminium oxide, forming sodium aluminate in solution. The iron oxide and other caustic insoluble impurities remain in suspension and are separated by decantation and filtration. The filtrate is cooled and aluminium hydroxide seed introduced to the liquid sodium aluminate causes precipitation of solid phase aluminium hydroxide or alumina tri-hydrate. The alumina tri-hydrate crystals formed are washed and calcined to get rid of water and the result is pure aluminium oxide, a fine white sandy material known as alumina.

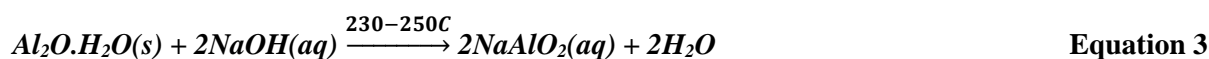
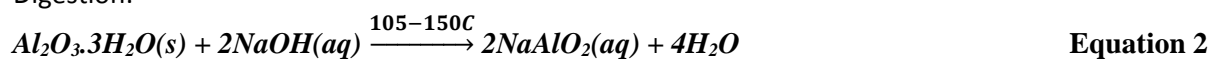
The Bayer process is a continuous process which may be separated into four simple steps: hydrothermal digestion, where the bauxite is heated in hot caustic soda solutions to dissolve the aluminium bearing minerals; clarification, where separation of the aluminium-rich solutions and undissolved components of bauxite (bauxite residue) occurs; crystallisation, where recovery of aluminium occurs as alumina tri-hydrate; and calcination, where alumina tri-hydrate is heated to form alumina. Several other side processes exist within the Bayer process, such as desilication, where dissolution and crystallisation of silicates occur prior to the digestion process, lime addition to control digestion reactions, flocculant addition to control residue settling, and oxalate removal, where the major impurity of the process is removed. Figure 1 shows a simple block diagram of the classic Bayer process.

The Bayer process is based on the dissolution of aluminium bearing material in highly caustic conditions and its precipitation as gibbsite can be described by a simple equilibrium reaction shown in Equation 1.



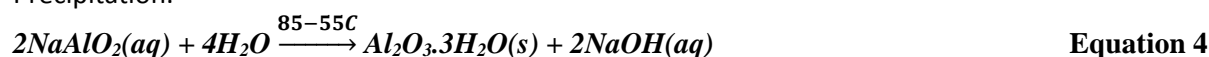
The basic reactions are shown in Equation 2 (low temperature digestion), Equation 3 (high temperature digestion), Equation 4 (precipitation), and Equation 5 (calcination).

Digestion:



Heat or increased caustic concentration drives the reaction to the right.

Precipitation:



Cooling or seeding drives the precipitation reaction to the right.

Calcination:



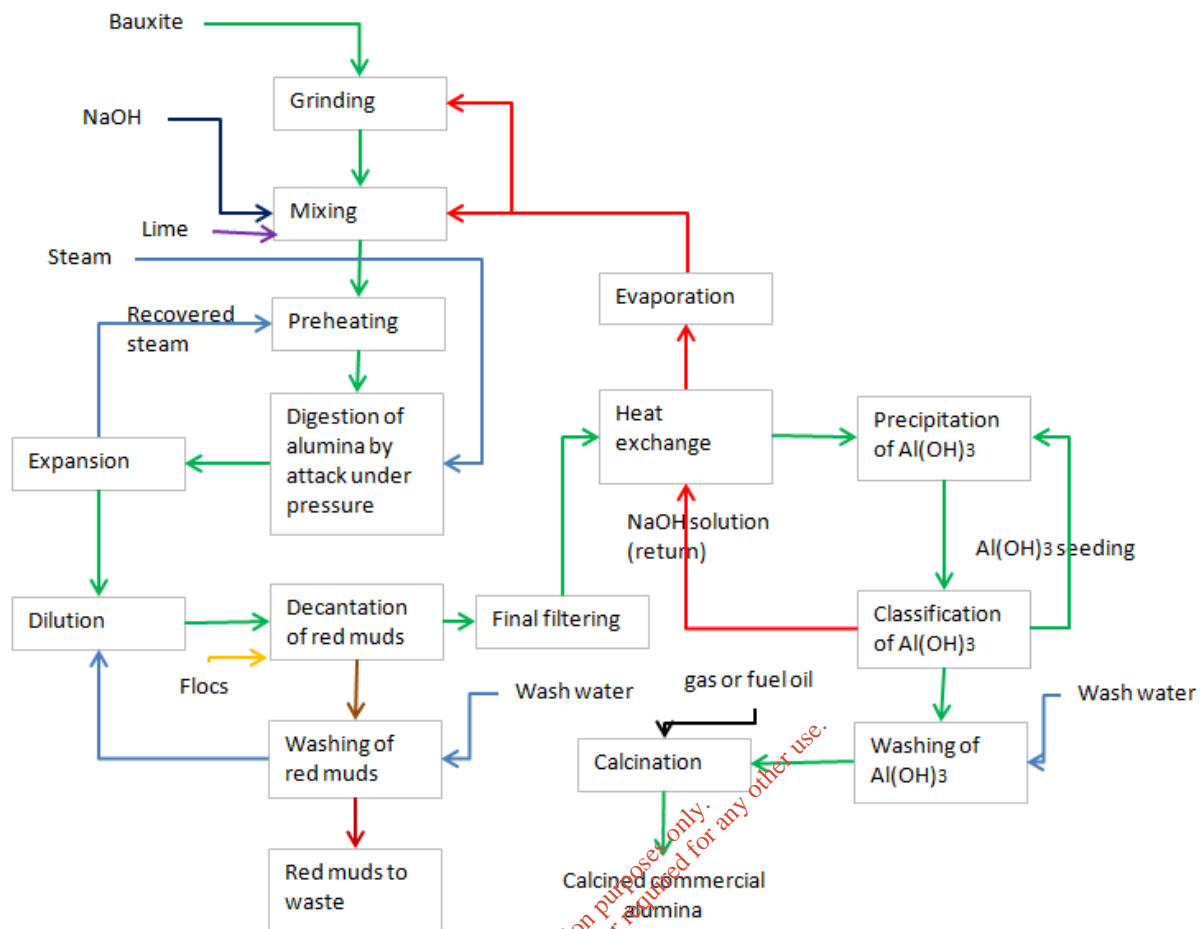


Figure 1: Block Diagram of Unit Operations

The key steps in the process as outlined in Figure 1 are detailed in the following sections. Schematics are provided where relevant.

1.1 Bauxite – Raw Material Delivery and Storage

The marine terminal at AAL is an L-shaped marine structure. One leg of the structure is the 1,100 m long approach arm from the shore which connects to the other leg, the 330 m long jetty for ship berthing. The outer, northern face of the jetty provides a single ship berth which is used for the unloading of bauxite. The inner, southern face of the jetty provides a berth for loading alumina and for unloading liquid caustic and acid tankers. The approach arm from the shore supports a conveyor gallery for bauxite and alumina, caustic, acid, fresh water and effluent pipelines plus a single lane roadway.

The bauxite ship unloaders are grab type unloaders and travel on the same set of rails on the outer berth. It is noted that a new unloader was installed on the outer berth in August 2017 bringing to two, the number of bauxite unloaders at the AAL site. Both the old and new unloaders operate in the same general manner.

The grab discharges into a hopper mounted on the unloader, from where the bauxite is conveyed by belt conveyors (inhaul conveyors) to the bauxite sheds. Each of both bauxite sheds has a shuttle conveyor in the top for building a stockpile along the length of the shed.

There are two enclosed bauxite storage buildings with a total capacity of 420,000 tonnes located at the North end of the plant. The reclaiming is done by a rail mounted portal scraper, travelling the length of the building. There is one reclaimer per building discharging onto a conveyor belt for transportation to the crusher building.

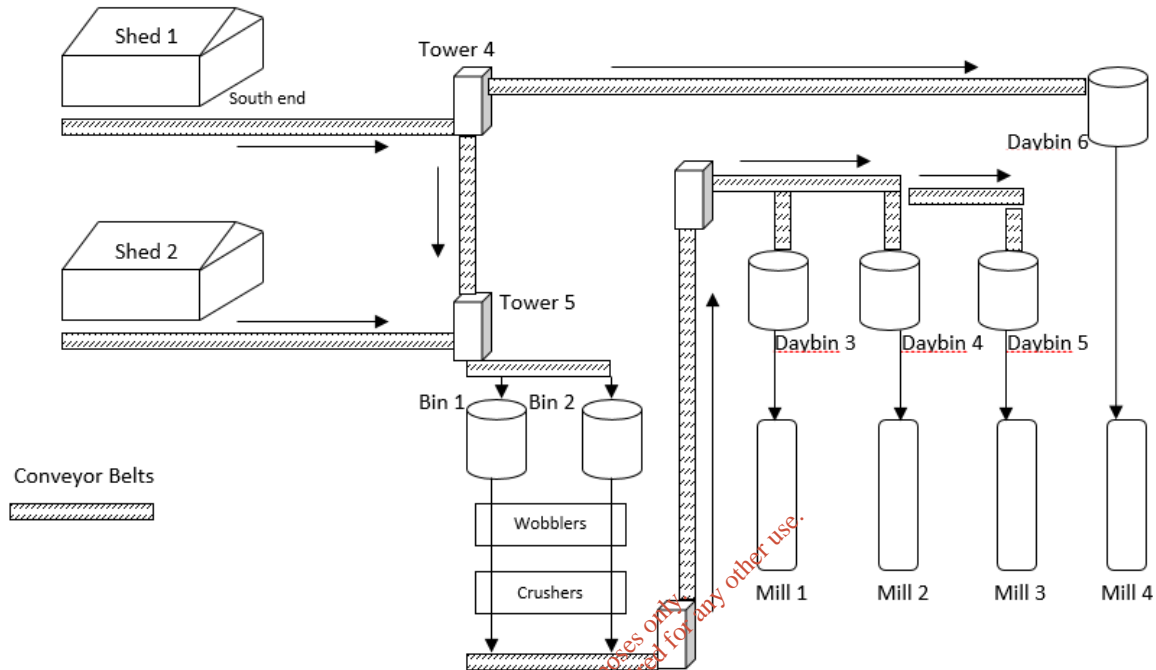


Figure 2: A01/02 Schematic

1.2 Grinding

The coarse bauxite surge bins operate in parallel on the streams of bauxite reclaimed from the storage sheds. The bins are emptied by rotating bar grizzly feeders mounted directly under the bin discharge opening. The bins are supplied with bauxite using a conveyor system. Fixed speed reversible hammer mill crushers are installed, each being located at the discharge point of the rotating bar grizzly feeders. The crushed bauxite is carried by conveyor to bins, each bin being assigned a conveyor, a rod and ball mill and a slurry transfer pump. The bauxite, along with spent liquor which is recycled from the process, is fed into the mill. The percent solids of bauxite in the liquor is controlled before the slurry is pumped to the predesilication tanks in Area 03 (refer to section 1.3).

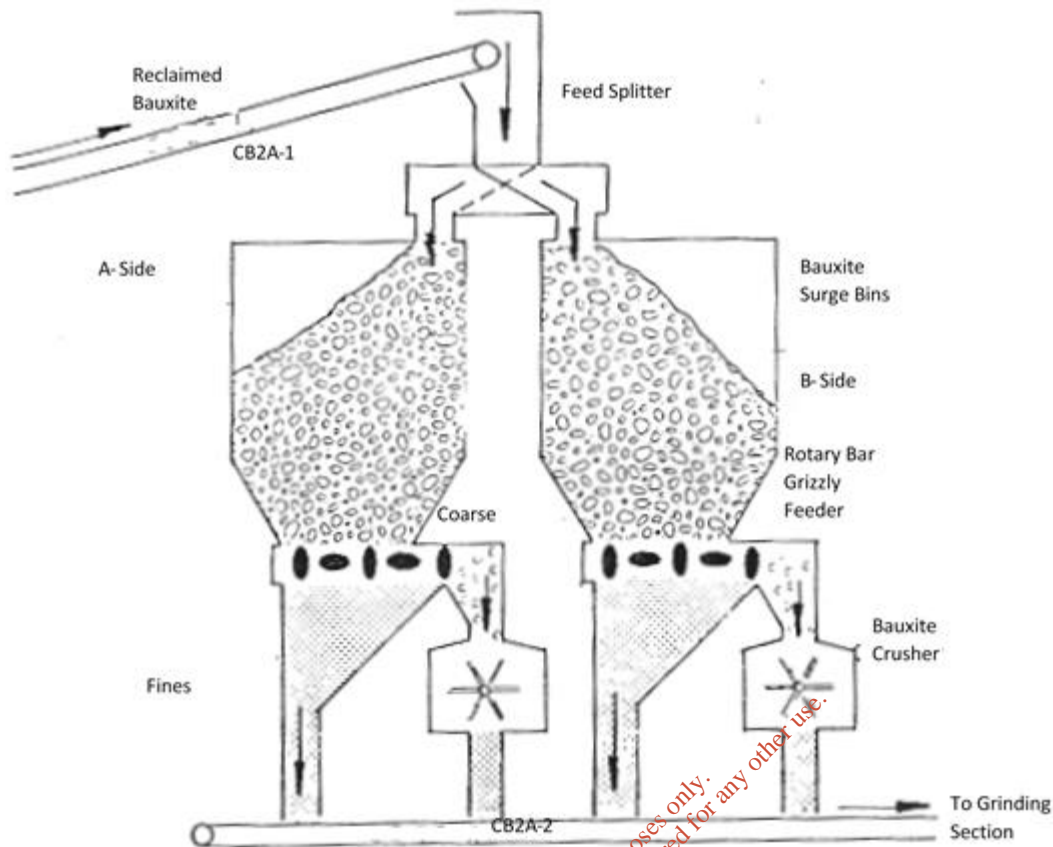


Figure 3: Bauxite Crusher Schematic

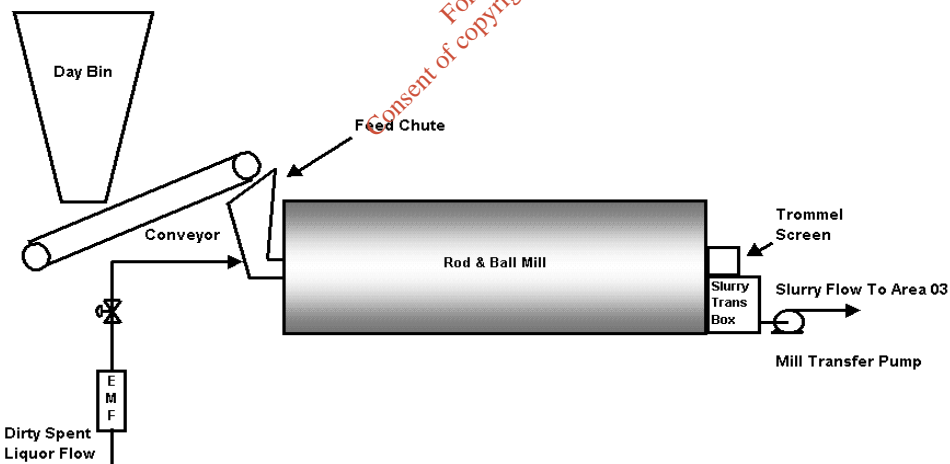


Figure 4: Rod and Ball Mill Schematic

1.3 Mixing

This part of the process allows the desilication of bauxite before digestion, a process known as pre-desilication. The area has four bauxite slurry storage tanks, each equipped with an agitator. Each tank has two pumps (one operating, one standby), which transfer the slurry to the next tank and in case of the last tank (tank 4) feeds the sweetening system. Low pressure steam from the digester flash tanks is used to raise the temperature of the slurry to aid desilication and reduce the requirement for live steam in the digesters. The slurry storage tanks provide surge capacity between the slurring

in Area 02 and the continuous digestion operations. They also allow the blending of the bauxite slurry to provide a more uniform quality of bauxite slurry. Silica which is present in bauxite dissolves in the caustic liquor and then precipitates as Bayer sodalite (sodium aluminium silicate). This reduces silica in the liquor to a sufficiently low level to produce an acceptable product alumina for the smelters, but also removes both alumina and soda from the process.

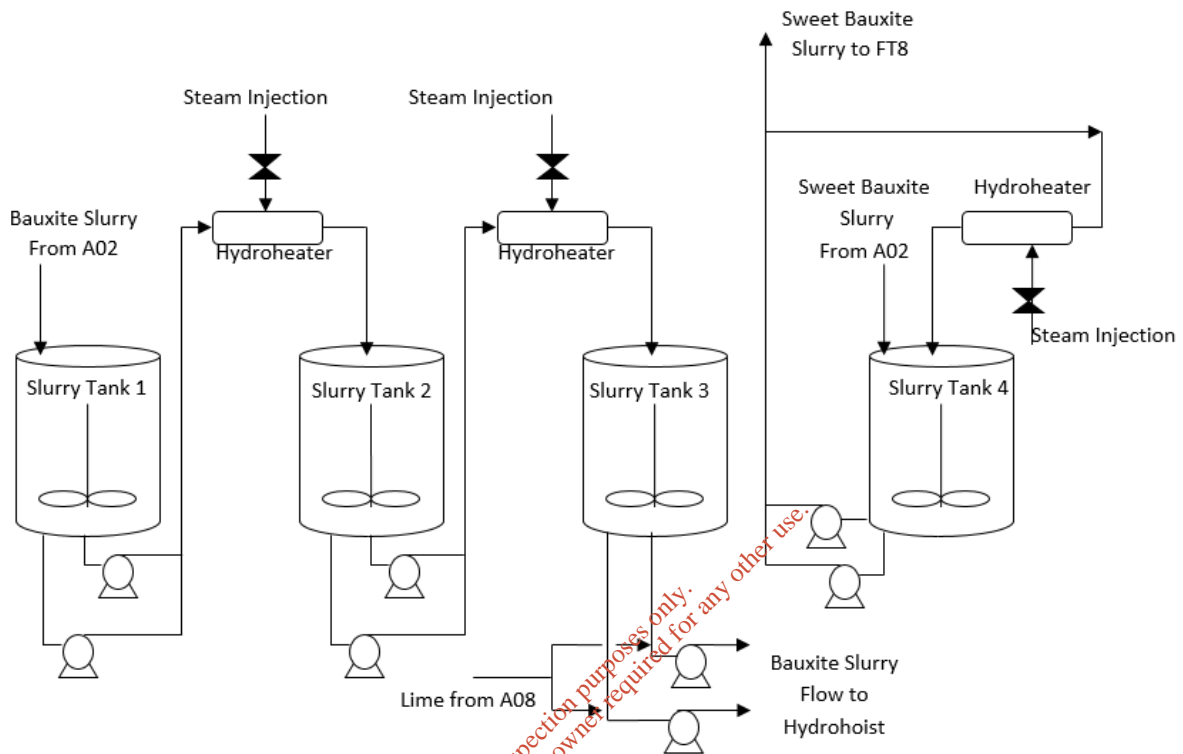


Figure 5: A03 Schematic

1.4 Digestion

In the digestion process, caustic soda (NaOH) is used to dissolve the alumina (Al_2O_3) in the bauxite for later precipitation (recrystallisation) and then calcination. There are two types of bauxite, trihydrate (Gibbsite $Al_2O_3 \cdot 3H_2O$) and mono-hydrate (Boehmite $Al_2O_3 \cdot H_2O$). The gibbsitic bauxite can be extracted at relatively low temperatures (138-143 °C), whereas the boehmitic bauxites must be extracted at higher temperatures, typically 245-255 °C. Aughinish uses Boké bauxite (a boehmitic bauxite) from Guinea, West Africa and therefore operates a high temperature digestion process. In addition AAL use a sweetening bauxite supplied from Trombetas in Brazil which requires a lower temperature to extract the gibbsite. This gibbsitic sweetening bauxite is added downstream of the existing boehmite digester at the pressure reduction and flashing stage.

The difference in the maximum and minimum amounts of alumina which the caustic liquor can maintain dissolved in solution is known as the liquor productivity. The maximum concentration of alumina dissolved in the caustic, known as the ratio (as Al_2O_3/Na_2CO_3), occurs in digestion, while the minimum should be found immediately after the precipitation section. The digestion arrangement maximises both alumina recovery from bauxite and liquor productivity.

Spent liquor is pumped from Area 18 into the digester through parallel trains of shell and tube heat exchangers plus a direct live steam injection heater. High pressure steam from the boiler house is added by direct injection to bring the digester temperature up to a temperature of 245-255 °C. At this

temperature the alumina in the bauxite slurry dissolves and the spent liquor becomes saturated with sodium aluminate (NaAlO_2) in the digesters. The digested slurry containing dissolved alumina and undissolved impurities is cooled down in a series of flash tanks. The liquor boils (flashes) in each flash tank stage as the pressure is reduced to atmospheric pressure. As the liquor boils, it releases flash steam (known as regenerative steam) which is then used in the shell and tube heat exchangers to heat the spent liquor which is also fed into the digesters. The flow of digester slurry then discharges into the blow-off tank before being pumped to Area 27. Excess regenerative steam from the blow-off tank goes to the low pressure boiler feed water heaters and to atmosphere through the pressure relief tank.

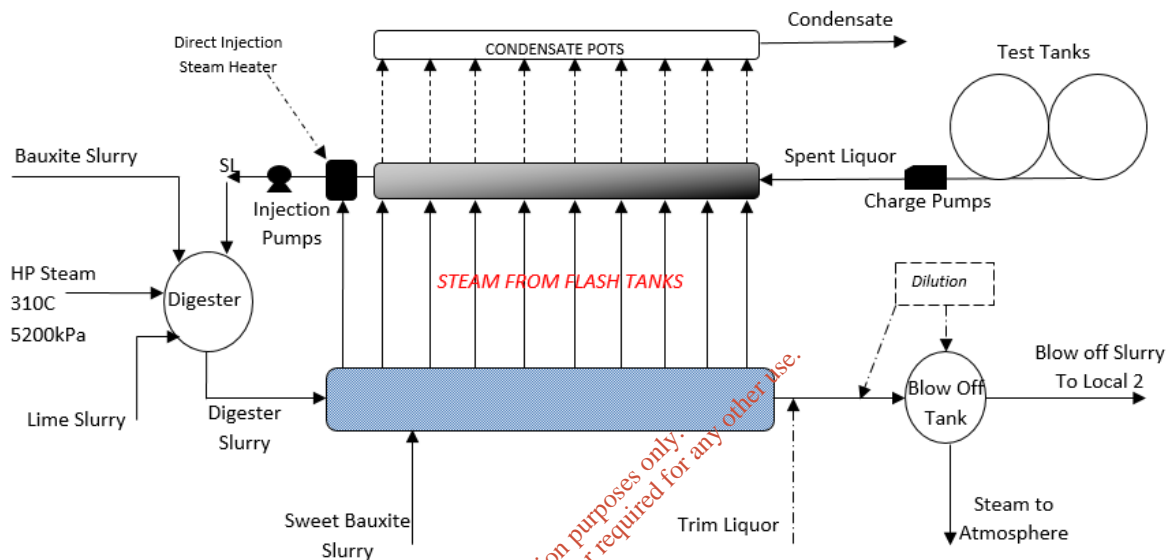


Figure 6: Area 04 Schematic

Lime Slaking

The lime slaker is used to prepare lime slurry which is pumped to the digestion unit Area 04 to improve boehmite extraction. Burnt (calcined) lime, which is produced externally, is stored on site in a large lime storage shed. The lime is transferred for intermediate storage as required to two lime storage bins before transfer to a rotary drum slaker, where it is slaked. The slaker discharge is equipped with a screen drum to reject unburnt lime rocks (CaCO_3). The slaked lime slurry passes through a slow speed rake classifier where the coarse grits are separated and further slaking can take place. The first stage degritter discharges into a slurry holding tank consisting of several agitated compartments in series. Removal of the fine grits is accomplished by circulating slurry from the last compartment, via a pump, through a second rake classifier, referred to as second stage degritter, back to the last compartment. The lime grits are disposed of in the BRDA.

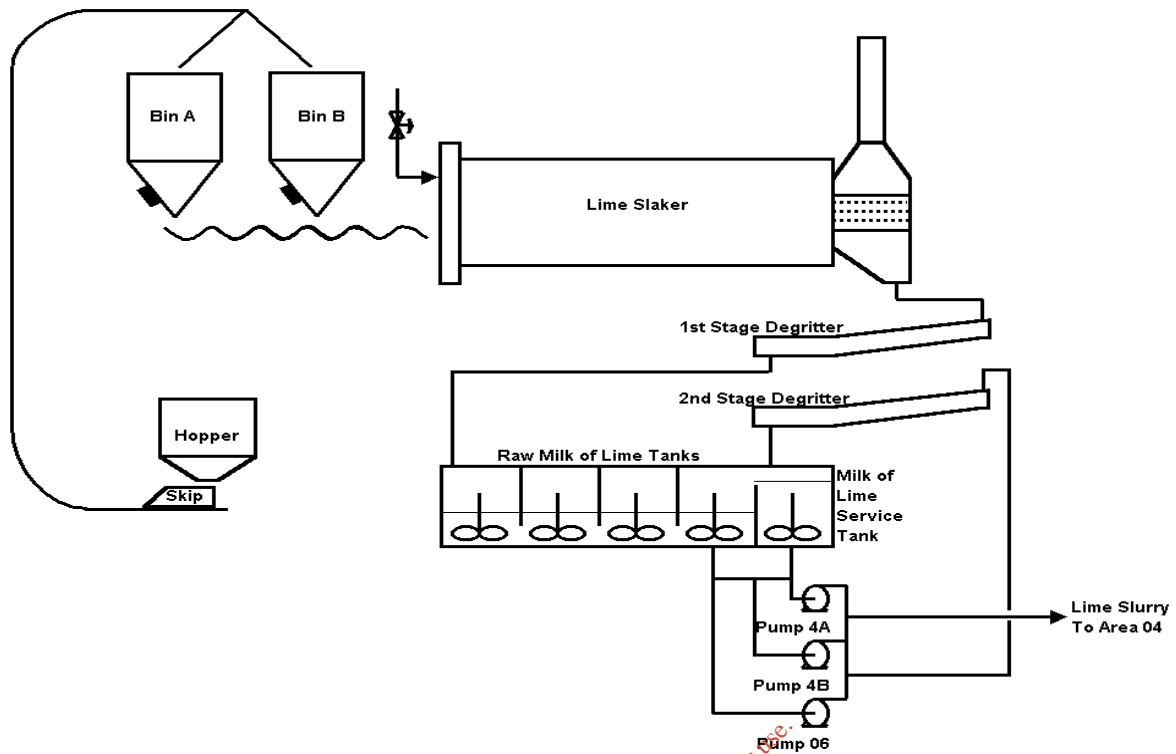


Figure 7: A08 schematic

1.5 Decanting & Bauxite Residue Washing

The digester blow-off slurry is pumped from the blow-off tank (Area 04), through Area 27 sand traps to feed the liquor decanters in Area 28. Area 28 performs two functions, 1) the separation of the suspended solid particles of residue from the blow-off slurry, thus providing a clear liquor as feed to Area 05 (Polishing Filtration) and 2) the wash circuit recovers the soluble soda from the residue slurry before disposal. Recovery is effected by counter current washing and settling against a flow of water. The area comprises six identical sedimentation tanks, with an additional deep cone thickener which was commissioned in April 2018. The deep cone thickener (DCT) is an extra washing step added in series to aid in improving the solids content of the underflow to Area 34 and improving caustic recovery. Two tanks serve as decanters, four tanks, including the new DCT serve as residue washers and one serves as a spare decanter/washer. The decanters have a centre feed well, a rake, a peripheral overflow launder and two underflow points on the sloping cone bottom. Counter current washing is initiated from a further tank, the wash water tank, which receives the filtrate from the residue filters as well as other dilute streams. For residue settling, residue compaction and liquor clarity a synthetic flocculant is used. The flocculants are prepared in Area 33.

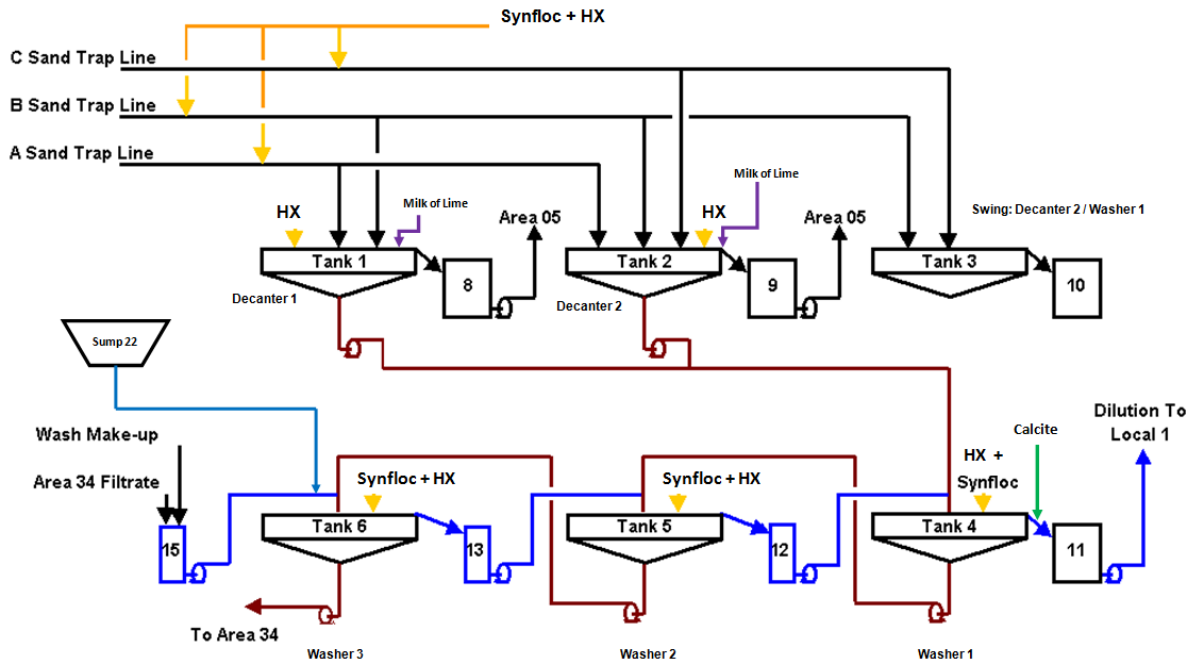


Figure 8: A28 Schematic

Figure 9 shows a schematic of the new deep cone thickener, which takes the underflow from Tank 6 as shown in Figure 8 above. The underflow of the deep cone thickener goes to A34 for final filtration before the residue is pumped to the BRDA.

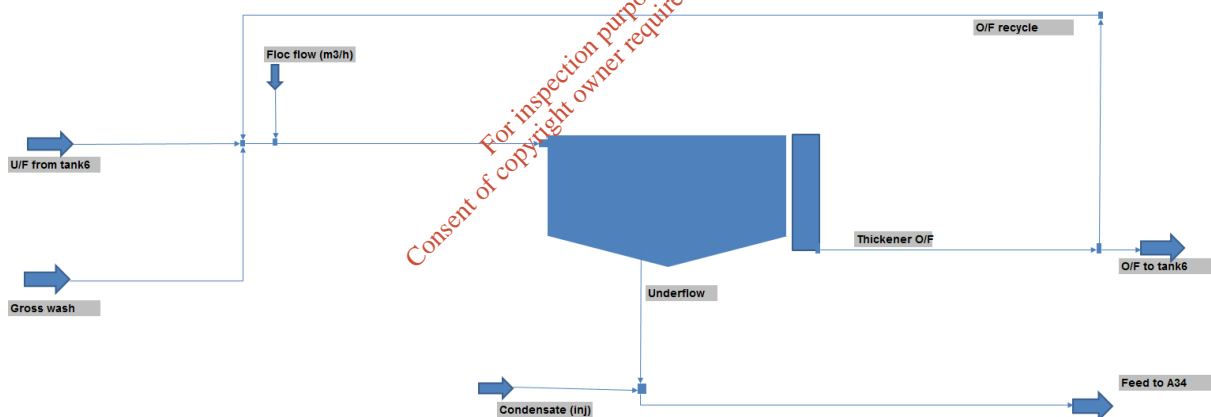


Figure 9: Deep Cone Thickener Schematic

1.6 Bauxite Residue Transfer and Storage

Eight rotary vacuum drum filters are installed for final residue washing and dewatering. The objective is to recover as much as possible of the remaining caustic and alumina from the final residue washer underflow. It is also necessary to obtain a filter cake high solids for the purpose of residue stacking in the Bauxite Residue Disposal Area (BRDA). The filters are arranged in pairs. Each filter has a dedicated filtrate receiver, entrainment separator and filter cake screw conveyor. The filtrate is discharged via a common header to the Wash Water Tank in Area 28. The residue filter cake is conditioned with an agitator which simultaneously provides a shearing as well as a mixing action to assist in pumping of the thixotropic residue to the BRDA. Five residue pumps discharge into a common high pressure residue disposal pipeline routed to the BRDA.

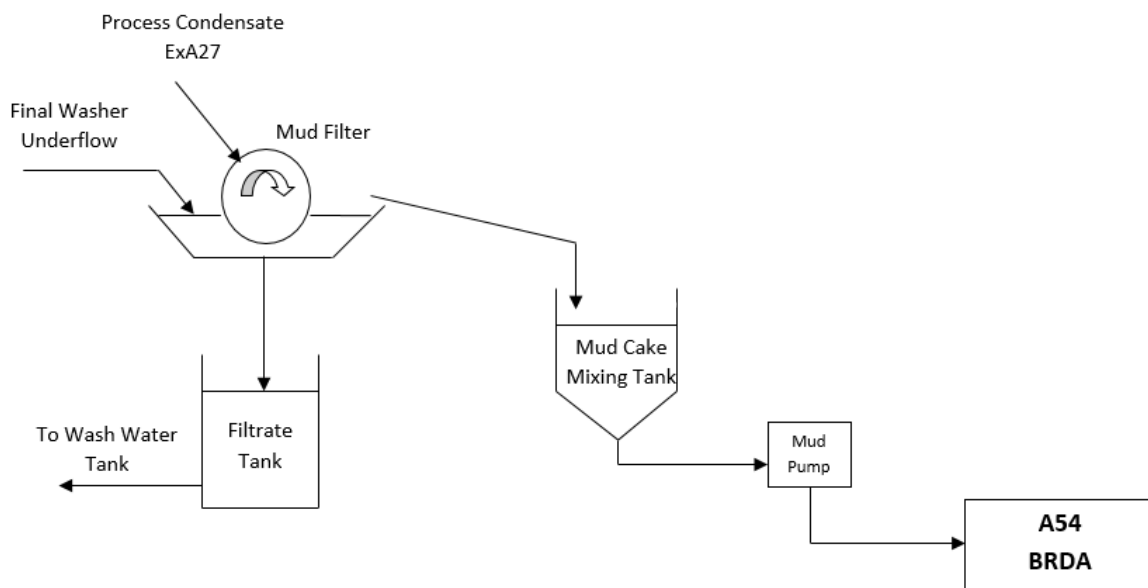


Figure 10: Bauxite Residue Filtration and Disposal Schematic

Bauxite Residue Disposal Area (BRDA)

Area 54 consists of a BRDA, a storm water pond and a liquid waste pond. The primary functions of this area are to provide a disposal site for the washed bauxite residue and to provide a surge for the treated waste effluent water. The BRDA which covers approx. 180 hectares is designed and operated in accordance with the Extractive Waste Directive since it is designated as a Category A facility. The residue feed to the stack is approximately 50-60 % solids. When the residue has been adequately dewatered, it is atmospherically carbonated using amphirols. Bauxite residue farming, carried out by the amphirols allows for atmospheric carbonation of the residue to become known as farmed bauxite residue, with a pH of less than 11.5. The rainwater falling on the BRDA runs off the surface of the stack and percolates through the inner retaining limestone rock dyke into the BRDA perimeter channels from where it is pumped to the Storm Water Pond (SWP). The Storm Water Pond is pumped to the Waste Water Treatment Plant for neutralisation. The clarified overflow of the A34 effluent clarifier is fed to the Liquid Waste Pond before being discharged through a diffuser into the Shannon estuary. The discharge line to the diffuser has a pH meter, flow meter, thermowell, a suspended solids analyser and a continuous Isolock sampler fitted. These parameters are continuously monitored and recorded via the plant's Distributed Control System.

1.7 Final Filtering of Decanter Overflow

The function of the polishing filters is to remove particulates from the liquor to control iron in product. The liquor to be filtered passes downward through a bed of proprietary fine grained inert filter media. The bed is fluidized by a slowly rotating sparge arm which injects more liquor into the bed, so redistributing the filtered particulates through the bed preventing the formation of an impervious skin of particles. After the filtration step in the overall cycle, the filter bed is backwashed with hot spent liquor to displace the particulates from the filter and dissolve the slight amounts of hydrate which may have precipitated in the bed.

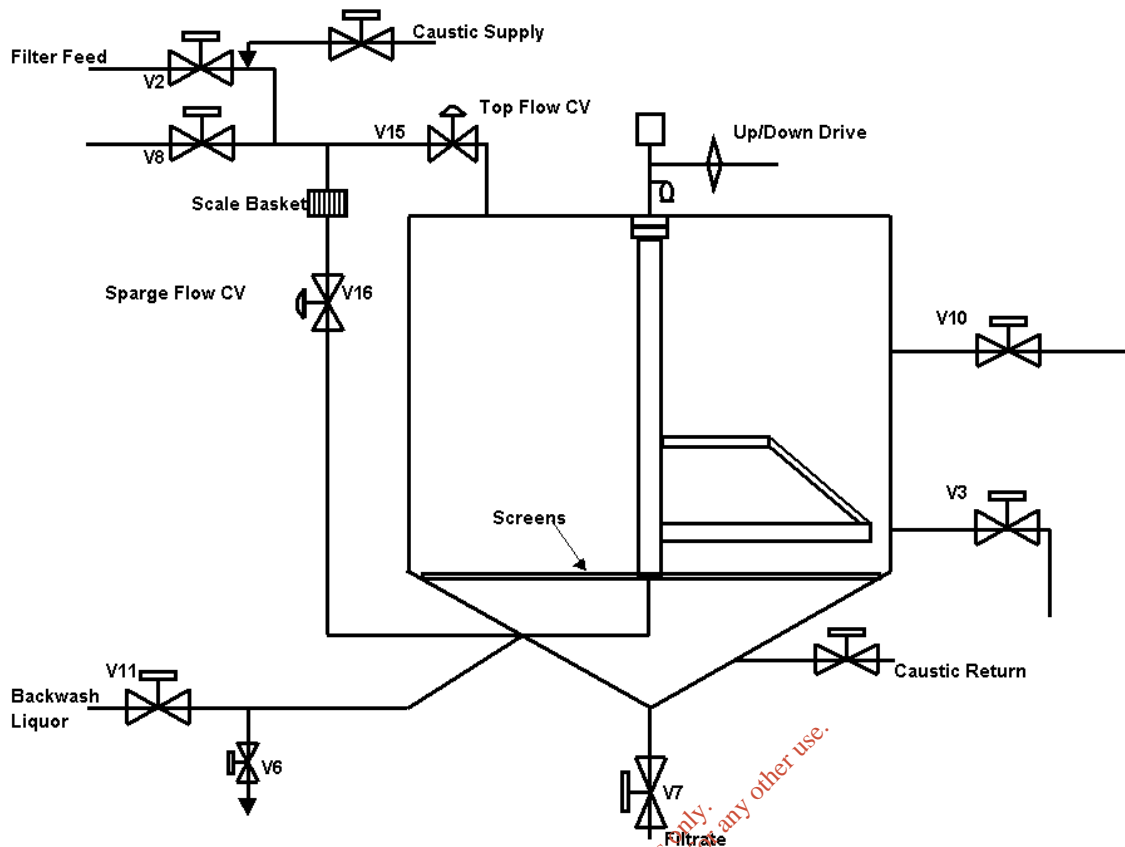


Figure 11: Polishing Filter Schematic

1.8 Heat Exchange

The purpose of this area is to cool the filtrate liquor from Area 05 as it passes to the precipitation circuit in Area 07. Simultaneously, as much heat as possible is recovered by the spent liquor as it passes to the Test Tanks in Area 18. The two flows are counter current. Area 41 contains two lines of flash tanks with a shell and tube heat exchanger dedicated to each flash tank.

1.9 Precipitation and Classification

The purpose of the precipitation circuit is to precipitate (crystallise) as much alumina trihydrate ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$) as possible from the supersaturated caustic liquor while maintaining the crystals within a specified size range. This is done by adding previously precipitated hydrate, as seed, to continuously agitated precipitation tanks. There are two parallel chains of 15 tanks, the 'A' chain and the 'B' chain and the precipitator slurry flows by gravity from tank to tank down each chain. The function of the classification circuit is to separate product hydrate and the coarsest fraction of the seed in the precipitation slurry. This is achieved by gravity settling in conical bottom tanks.

The slurry flows by gravity from the last precipitator to the primary classifier tank where the coarsest fraction of hydrate settles and is removed as product. The coarse and fine seed passes with the liquor into the secondary classifier tank following which coarse seed is filtered and pumped back to the growth stage while fine seed is filtered and returned to agglomeration. The liquor overflowing the final stage of classification is referred to as spent liquor and is recycled back to the start of the process (bauxite slurring).

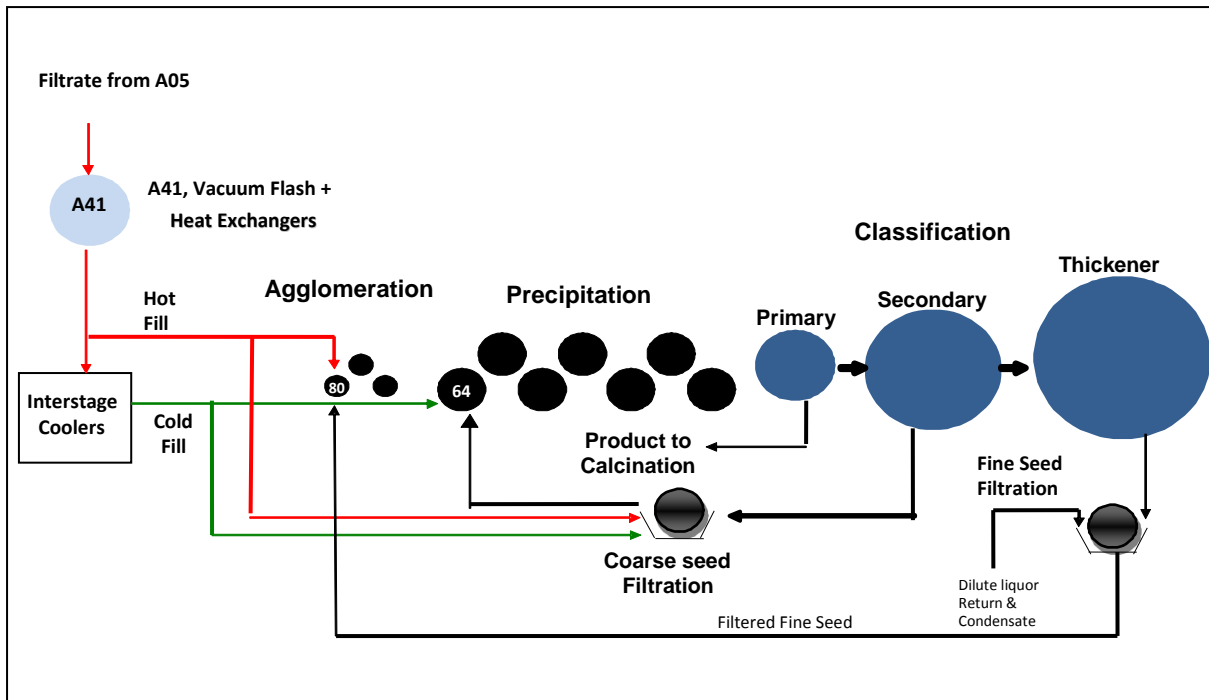


Figure 12: Precipitation process flow schematic

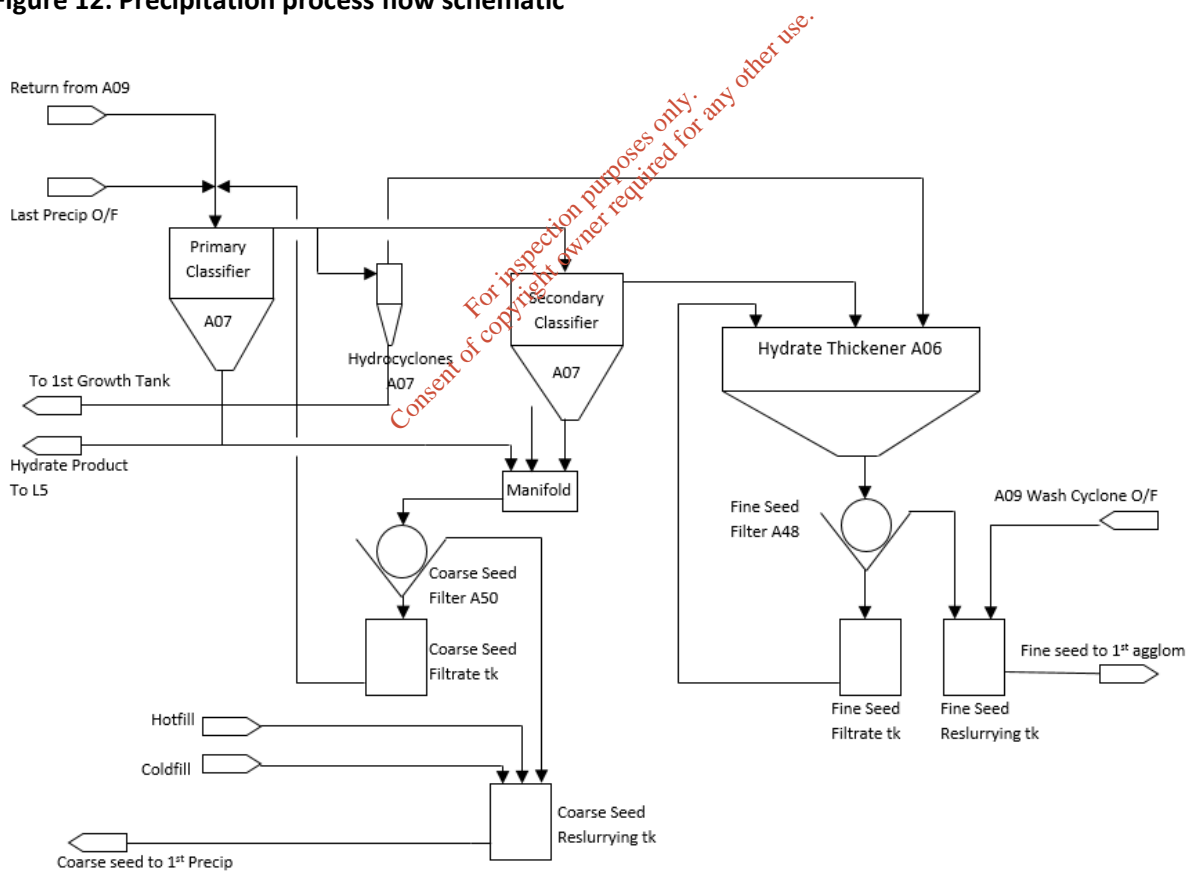


Figure 13: Classification (A06/A48/A50) schematic

The function of the hydrate thickeners is to separate the fine seed from the spent liquor in order to minimise recirculation of alumina and loss of productivity in digestion. This is achieved in four large thickener tanks, A1, A2, B1 and B2. The underflows of these tanks can be pumped to either the fine seed storage tank or the fine seed filtration section in Area 48, while the clear liquor overflows into the spent liquor tanks. From here, the spent liquor returns to the test tanks in Area 18.

Seed Filtration

The function of fine seed filtration area is to remove sodium oxalate that has precipitated onto the surface of the fine seed. The oxalate is removed by a washing and filtration step. Seed is pumped from the Fine Seed Storage Tank directly to the re-slurry tank where a flow of condensate mixes with the fine seed.

The coarse seed filtration area comprises a filtration system which improves the process efficiency by removing the spent liquor in the coarse seed slurry from the solids. The seed is then re-slurried directly with supersaturated liquor entering the precipitation area.

1.10 Hydrate Washing and Calcination

Areas 09 and 10 are fed with the underflow of the primary classifiers in Area 07 (precipitation). This slurry is discharged to three hydrate storage tanks in Area 09. The underflow from each on-line hydrate storage tank is fed to a horizontal pan filter, where it is de-liquored, washed and dried. A scroll discharger delivers moist hydrate cake from the filter table, via a chute to a screw conveyor ready to feed to its dedicated calciner. The overflow liquor from the hydrate storage tanks, containing some fine hydrate, is pumped back to the secondary classifier in the precipitation circuit. AAL uses a "Fluid Flash Calcination" process, where, in essence, pre-heated hydrate is calcined in a furnace with pre-heated air using natural gas. The system at AAL uses the hot combustion gases from the main furnace to heat up cold hydrate. In so doing, the flue gases are cooled for emission and much of their heat is recovered. Likewise, the solids leaving the calciner are used to heat-up cold combustion air entering the system. This air is further heated in an air pre-heat furnace. The solids must be cooled sufficiently before discharge to avoid damaging the calciner discharge conveyor belts.

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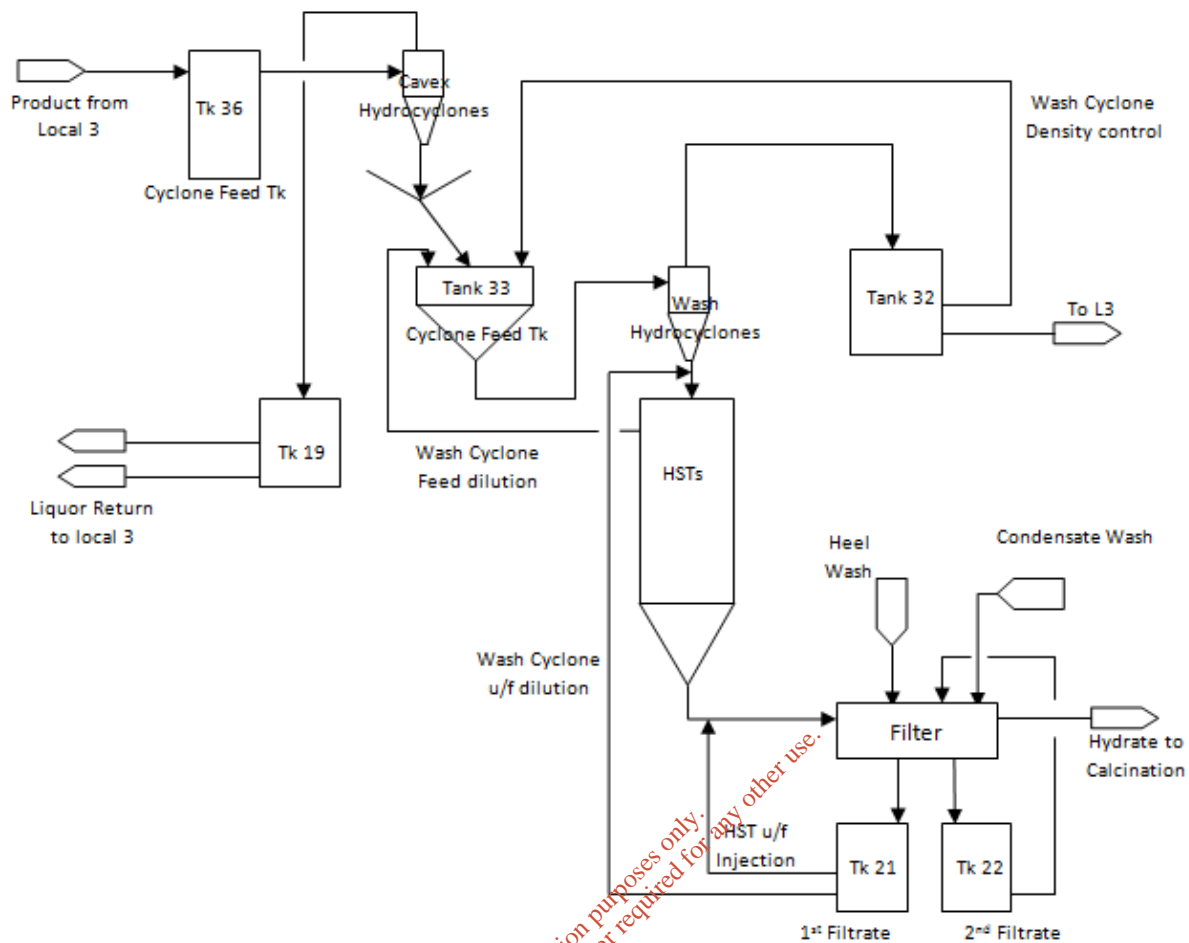


Figure 14: Hydrate wash circuit schematic

In more detail, hydrate entering the calciner, is dried of surface moisture using a flash dryer. This uses hot calciner flue gases to dry and at the same time, heat up the hydrate. The gases are cleaned prior to discharge by passing through electrostatic precipitators, (ESPs) where fine solids are removed. The gases are discharged to atmosphere via the calciner stack. From the dryer, hydrate, now partially converted to boehmite ($\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$), is conveyed to the calciner furnace via the top of the holding vessel. In the main furnace they are calcined at approximately 1000 °C. Natural gas and air, which has been preheated are used in the main furnace for combustion. Combustion gases from the main furnace carry the partially calcined solids to a holding vessel. The solids fall to the bottom of the holding vessel and are conveyed counter currently via a series of cyclones to the fluidised alumina cooler. This uses water cooling to reduce the temperature of the product alumina before it is discharged to conveyor belts which feed the alumina silos in Area 12. Alumina residence time at high temperature in the calciner furnace (1,050 °C) is approximately one minute, while residence time in the calciner holding vessel (980-1,020 °C) is three to four minutes, depending on the level in the holding vessel.

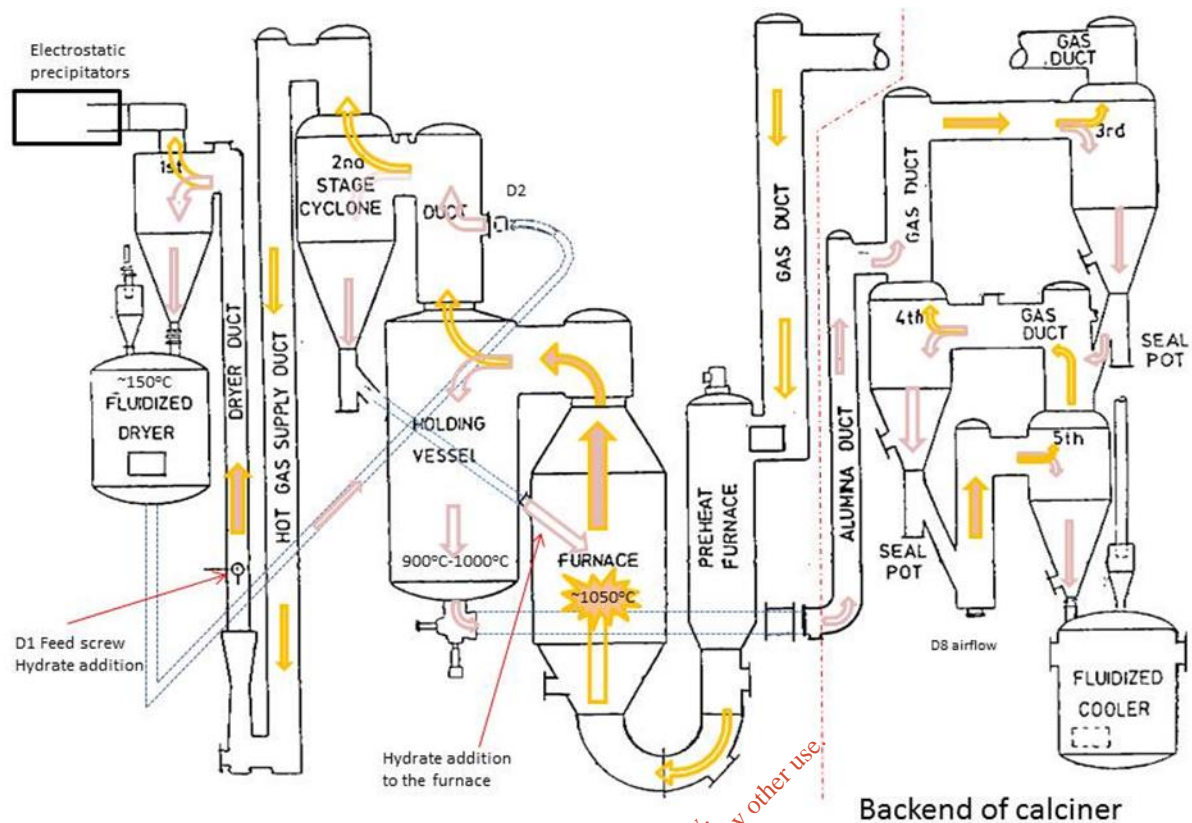


Figure 15: Calciner Schematic

Because of the continuous nature of the hydrate operation and the dis-continuous nature of the calciner operation, occasions arise when the production rates do not match over a period of time. The resultant inventory changes are controlled in Area 09. A system of out-haul and in-haul, to and from the hydrate storage pad, is used. Pan filters are used to wash and de-liquor excess hydrate production for out-haul to the pad. When calciner capacity exceeds the hydrate production rate, moist hydrate from the pad is reclaimed by re-slurrying it and discharging the slurry to the hydrate storage tanks.

1.11 Alumina Storage and Loading

The alumina storage and loading facilities are located to the north of the alumina refinery. Alumina is stored in three nominal 25,000 mt storage silos. Dead space is approximately 1,000-2,000 mt alumina per silo. The alumina produced by the calciners is transferred from the calciners and their dust collectors to a system of air slides which in turn discharge onto belt conveyors. From these conveyors, the air slides may feed any one of the three silos.

During alumina loading, alumina is withdrawn from one or more of three silos, via air slides, to a series of belt conveyors that forward the alumina to the alumina loader. The alumina conveyors are provided with bag filter dust collectors at the transfer points. The alumina loader incorporates a tripper, two air slides, a boom and a telescopic chute. The tripper discharges the alumina to the first air slide, which feeds the air slide in the boom. The latter air slide discharges the alumina through the telescopic chute (elephant's trunk) at the end of the boom into the ship. The chute may be contracted and the boom can be lifted 15° e.g. when the loader moves to the next hatch. The loader is equipped with a bag filter dust collection system.

1.12 Generation of Power, Steam, Compressed Air and Treated Water for the Plant

The A14 complex includes boiler feed water storage and treatment, feed water heating and pumping and high and low pressure steam generation and distribution. It also includes the production and distribution of compressed air for general and instrument use throughout the plant.

The A15 complex includes the combined heat and power (CHP) plant for the generation of steam for the process as well as the generation of 160MW of electricity. Approximately 40MW of this power generated is used in the plant with the balance, 120MW, exported to the national grid.

Water Supply and Treatment

Potable water is supplied to AAL from the River Deel by pumping via the Limerick County Council municipal water treatment plant. This potable water is routed via a ring main to the Aughinish water treatment plant (WTP) in Area 14 where it is stored as raw water for treatment. It is also available for fire-fighting. Raw water is de-mineralised (i.e. removal of dissolved impurities) in three parallel treatment lines. Two are normally on-line.

Demineralisation is carried out in five stages:

- Weak acid cation
- Degasser
- Organic scavenger
- Strong acid cation
- Anion

Treated water is stored in three storage tanks in the WTP. From there it is pumped to Area 04 and heated using waste atmospheric pressure steam from the digester blow-off and higher pressure regenerative steam from flash tank 3 or 4. At this point a make-up of regenerative condensate can be added to the treated water. This make up is conductivity controlled to ensure its suitability as boiler feed water. The blended low pressure boiler feed water is then passed through a de aerator in Area 14. Here, low pressure boiler steam is sparged through the water to remove dissolved oxygen and raise the temperature. At the exit of the de-aerators, the feed water is dosed with an oxygen scavenger to remove oxygen and increase its pH. From the de aerators, the boiler feed water is pumped by the high pressure boiler feed water pumps through the high pressure boiler feed water (HPBFW) shell and tube heat exchanger. The temperature is raised by condensing steam from digester flash tank number five before being fed to the boilers.

Gas Boilers

A14 houses the two gas boilers, which generate steam only for the process plant. These gas boilers are fuelled by natural gas and do not have the capability to be run on any other fuel.

HFO Boilers

The HFO boilers are only used as back-up to the gas boilers and CHP for steam supply. Of the three boilers that were initially installed, A, B and C boilers, only A and C can operate with B boiler having been decommissioned fully.

CHP

The CHP plant is fuelled with natural gas, with light distillate fuel oil being available for back-up purposes. The plant offers high thermal efficiency, low emissions, low profile, low manning levels and flexible operation.

The CHP plant comprises of two Combined Cycle Gas Turbines each with an input capacity of 250MW and provides both power and steam to the plant. The power not used by the plant is exported to the national grid.

Steam Distribution

Steam from each superheated outlet is fed to a high pressure ring main operating at 5,500 kPag. This supplies the digestion plant in Area 04 with high pressure steam. Steam is also used to drive the high pressure boiler feed water pump and some is reduced in pressure at the two let-down stations to supplement the low pressure steam requirements.

A low pressure steam main operates at 700 kPag. The steam turbine driving the high pressure boiler feed water pump discharges into the low pressure main. So too, does steam exported from flash tank number six in digestion. Further low pressure steam requirements are made up by letting-down high pressure steam through pressure relief valves at the let-down stations A and B.

Compressed Air

Compressed air for the process at AAL is provided by three Centac compressors and one screw compressor in Area 14. The three Centacs run continuously while the screw compressor cuts-in on load to maintain distribution pressure at 800 kPag. The compressors feed a service plant air ring main. Instrument air, de-humidified before entering the instrument air main, is taken off the common plant air main. Two air receivers provide an air reservoir for the instrument air main.

1.13 Process Effluent Treatment and Pond Water Distribution

Process effluent is slightly alkaline containing traces of sodium aluminate and sodium carbonate. It is collected in ponds and from there pumped to the Effluent Neutralisation and Clarification area. Concentrated sulphuric acid is employed to neutralise the dilute sodium aluminate and this generates a fine aluminium hydroxide ($\text{Al}(\text{OH})_3$) precipitate. The resulting water stream containing up to 5,000 mgpl suspended aluminium hydroxide precipitate is flocculated using an anionic flocculant and then clarified in a large diameter raked gravity settler.

The overflow stream reports to the Liquid Waste Pond where it is used as dust control sprinkling water or disposed to the river as neutralised effluent.

The underflow sludge from the effluent clarifier is recycled back into the acid neutralisation tank to seed and densify the fresh precipitate. On a daily basis a portion of this sludge is transferred to the Alumina production process to keep the recycling sludge inventory in the effluent neutralisation unit in balance. At the target recycling rate of ~20:1 the sludge density can be controlled at 15-20% solids but the recycling inventory is normally maintained below this to prevent odour generation problems.

The facility also serves as a collection and distribution centre of various water streams, such as water from the Storm Water Pond (BRDA run-off), East and West Pond (plant rain water collection ponds), cooling tower bleed, excess condensate etc. The purpose is to direct the streams with higher caustic

and alumina concentrations back to process and direct the balance made up of less contaminated streams, to waste effluent treatment.

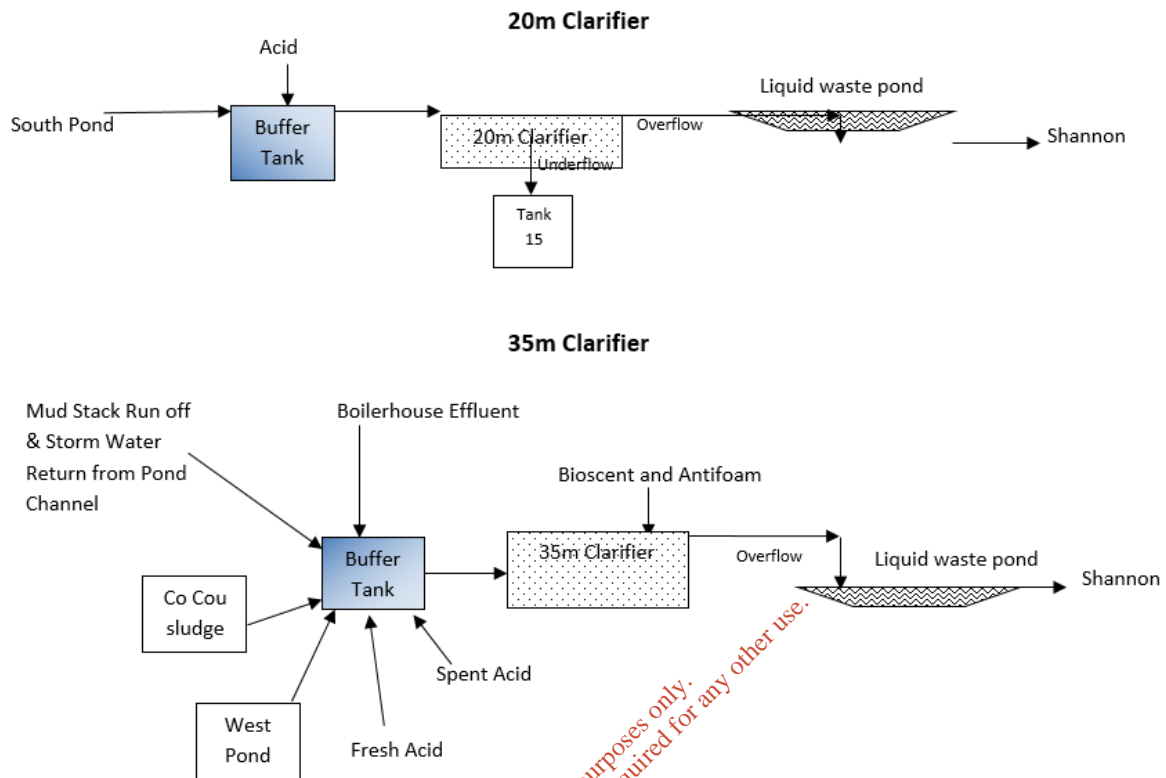


Figure 16: 20m and 35m Clarifier Schematic

1.14 Sanitary Effluent Treatment

Sanitary effluent from all administration buildings is transferred to Area 82 via underground sewers. There are a number of sewage lifting stations which pump the effluent from low areas in the plant. On arrival at the treatment plant, the effluent enters the Influent Tank where the larger particles are broken down in a comminator pump. From there it is pumped into the aerator which mixes the organisms which live in the activated sludge with the raw sewage. Through aerobic digestion, the bacterial organisms convert the organic waste to carbon dioxide, etc. and an aerator is provided to ensure an adequate supply of oxygen is available to the organisms. On leaving the aerator chamber, the activated sludge particles coagulate and settle out from the waste water in the clarifier. The clear supernatant overflows via a serrated edge into the effluent tank from where it is pumped to the Shannon where it is discharged at surface water emission point W1-1. The clarifier underflow (activated sludge) is removed on a weekly basis by an approved contractor.



Figure 17: A82 Process Flow

1.15 Organics control

The purpose of the area is to remove naturally occurring impurities (which are picked up from the bauxite) from the plant liquor, so as to maintain acceptable liquor concentrations of these impurities. This is accomplished by deep evaporation of a side stream of spent liquor, followed by crystallisation and filtration. Currently the waste product, known as saltcake, is disposed of within a specially engineered cell in the BRDA. The impurities removal area includes an evaporator with associated cooling tower, a crystallisation section integrated with the evaporator, a filtration section and a tankage annex for secondary crystallisation. The evaporator section consists of seven forced type effects where the liquor is concentrated while passing through the successive effects (flash tanks). The crystalliser unit consists of a series of flash tanks where the liquor is flashed down in steps. The product from the last crystalliser is pumped to the Area 65 Annex where it is stored in four tanks before it is pumped to three vacuum belt filters. The saltcake is discharged into a holding bay from where it is trucked to the BRDA. The filtrate from the belt filters is sent to the 'centrate' tank and from there to the Caustic Storage Tank.

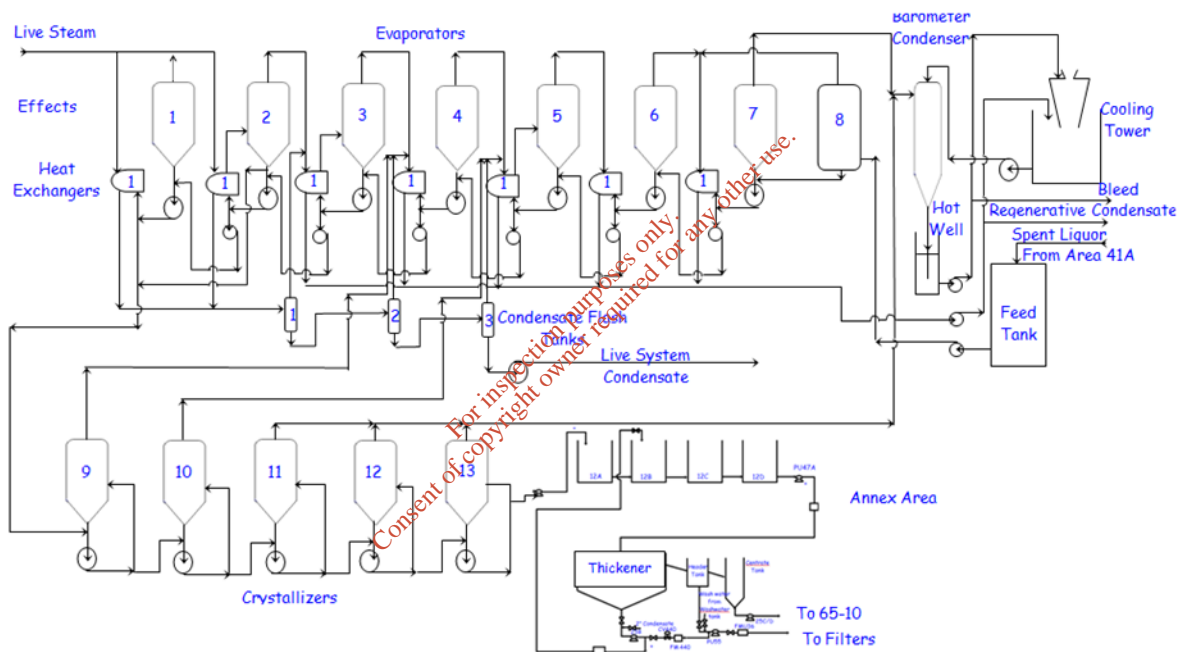


Figure 18: Schematic of existing organics control process

As outlined in sections 1.2 and 4.3 of this application an enhanced caustic recovery process has been developed that will avoid the generation of Saltcake through a process modification of the existing organics control process. This enhanced caustic recovery is achieved via an additional step in the existing organics control process which avoids any filtration step or production of solid waste. Therefore, once implemented (approximately 2021) no saltcake will be produced for disposal. There are no environmental emissions associated with this process modification.

1.16 AAL Laboratory

The AAL laboratory is located in building Area 73 and provides quality control analyses, along with the testing of raw materials, process samples and final products. Research and development also plays an important role, with new processing agents (flocculents, crystal modifiers, etc.) undergoing laboratory trials prior to their introduction to the plant process. The laboratory is located on two

floors comprising six analytical modules on the first floor and sample stores, sample preparation and pre-treatment areas in the basement. The AAL laboratory has all the necessary equipment, procedures and test methods for the correct performance of the tests and measurements. The Laboratory Quality Manual, a working document, identifies the general organisation, staff, responsibility and the range of facilities and equipment used in the operation of the laboratory. It also defines the procedures devised to ensure that all policy objectives are met.

1.17 Proposed Borrow Pit

AAL estimates that there is a requirement for c. 374,000 m³ of rock (post-2017) to provide for on-going works associated with the BRDA over the lifetime of the permitted development at Aughinish. Therefore a borrow pit is proposed on the site, for which An Bord Pleanála has granted permission. The extracted rock will be used within the confines of the site and will not be transported off site.

The proposed Borrow Pit extraction area is c. 4.5 hectares with extraction occurring to an elevation of c. 8.5 metres OD (overall depth of the Borrow Pit is c. 8 metres). Extraction will take place in a northern direction, from the existing former Borrow Pit, which was operational in the early 1980s, toward the plant area. It is proposed that extraction will occur over a 10 year period, with the Borrow Pit operational between April and September, with blasting occurring up to 7 times within this period (per year). The site is accessed via a private road which links to the L1234 Aughinish Road. It is proposed that the Borrow Pit will be extracted over a number of phases during the lifetime of the development. For further detail please see the Environmental Impact Assessment Report attached to this licence review application.

There are three broad stages in the extraction process: blasting of rock faces, crushing of rock and stockpiling of rock.

It is expected that c. 37,400 m³ will be extracted on average per annum. To allow for instances where there is an additional requirement for rock on site in any given year a maximum extraction rate is allowed for at c. 45,000 m³ per annum. This would provide for a resource of c. 8.3 years. However, extraction will not always be at this maximum rate depending upon the requirement for rockfill within the site.

See section 1.1 of the licence application for further detail.

2. Emissions during Normal and Upset Conditions from Process Units

Gaseous, liquid and solid wastes are produced in various areas throughout the process plant. Gaseous emissions occur from the plant due to combustion processes (gas fired CHP, gas fired boilers and gas fired calciners), vapour (steam) generation by process liquor at temperatures exceeding 100 °C and steam-air emissions from cooling towers and vacuum pump exhausts.

Liquid wastes from the process are contained in bunded areas from where they are returned to the process or sumped to the effluent treatment plant (Area 34) via the (east and west) drainage ponds. In the event of a plant upset the North, West and East ponds provide sufficient temporary storage capacity.

Solid wastes from the process are produced in the following process areas:

- Area 27 Sand which is used for internal road building in the BRDA.

- Area 34 produces bauxite residue at 50-60 % solids which is pumped to the BRDA for disposal and farming.
- Liquor impurities (saltcake) removed from the process liquor in Area 65 are currently transported by truck to the BRDA for disposal in the specially engineered cell.

As noted above in section 1.15 it is proposed to modify the organics removal process which will eliminate this waste stream.

Area 08, the Lime Building, produces lime grits which are also used for internal road construction in the BRDA.

Details of all solid, liquid and gaseous emissions into the environment are provided in greater detail in their respective sections of this licence review application.

Atmospheric emissions and emissions to surface water are covered in Section 7, and solid wastes in Section 8 of the review application.

3. Process Control System

The process at AAL is controlled by a Honeywell TDC 3000 Distributed Control System (DCS). This was installed between 1990 and 1993 and replaced the older Taylor MOD 3 system which had been operational since plant start-up in 1983.

Automation is centred on four core components, namely:

- **Hardware Platforms:** Distributed Control System (DCS) (both legacy 1989 installation and the more modern post 2005 server based technology), Gas Turbines controls, ~70 plant wide disparate programmable logic controllers (PLCs) and certain small automation clusters for areas like Residue Farming, Dust Suppression and Environmental Monitoring.
- **People:** A well trained and motivated internal automation team, key alliance automation suppliers supported by contractor specialists.
- **Software:** Operating systems for the installed hardware. Application software for the various control solutions on site. Data mining software to assist in process and alarm data management.
- **Key Utilities:** Fibre Optic networks, Power Systems, HVACs (heating, ventilating, and air conditioning).

The effective, efficient and highly available automation platform allows the refinery to operate safely and efficiently

4. Materials/Chemicals involved in Unit Operations

Details of all materials/chemicals currently utilised, including water and energy usage, during the unit operations be they bulk process raw materials or chemicals, water treatment chemicals, maintenance materials are provided in Section 4.6 of the licence review application. Aughinish as a matter of

continuous development regularly test alternative types of process materials such as flocculants, process and maintenance chemicals, etc. For this reason, therefore, this list is dynamic.

Raw materials, intermediates and products are all stored appropriately and within bunded areas where required. The main large volume storage is related to bauxite (sheds), raw caustic (bunded tanks), in process caustic (bunded vessels and tanks), acid (bunded tanks), alumina (silos), hydrate (shed in bunded process area), lime (bunded tanks/hoppers), diesel (double skinned tanks / bunded tanks), and heavy fuel oil (bunded tank). AAL operate a very extensive structural integrity testing programme, which includes approximately 370 structures such as bunds, tanks, sumps, process drains, pipelines, ponds and sewer lines. These are tested every three years in accordance with the requirements of the site's IE licence.

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