Essential Readings in Light Metals: Alumina and Bauxite.
Edited by Don Donaldson and Benny E. Raahauge.

THE GRAFTING OF INDUSTRIAL CHEMICALS OPERATIONS ONTO THE BAYER PROCESS

Lester A.D. Chin

Chin's Consultant International, Inc.

430 Tenth Street, Suite S-206

Atlanta, GA 30318

U.S.A.

ABSTRACT

Concepts are presented for the grafting of industrial chemicals manufacturing processes onto a Bayer Process, and the implications of these chemical processes on the host process are identified. The application of these concepts as guidelines for the downstream manufacture of chemicals at alumina chemicals complexes located away from Bayer refineries, is also considered. A full line of industrial alumina chemicals is covered.

BACKGROUND

Since 1983, the large surplus of Bayer alumina capacity has focussed attention on how the capabilities of individual alumina plants might be diversified to produce various industrial chemical products, using feedstocks available from the Bayer Process. This paper presents concepts of how a full line of industrial chemical products can be produced by grafting a number of chemicals manufacturing processes onto the Bayer Process. These concepts can also be used as guidelines for planning a complex of manufacturing processes for the downstream processing of feedstocks imported from remote Bayer refineries.

The opportunities to manufacture additional products, are accompanied by technical and operating implications of the chemical manufacturing processes on the Bayer Process.

The product lines considered include Bayer hydrates, tabular aluminas, calcium aluminate cements, white hydrates, special calcined aluminas, reactive aluminas, and activated aluminas.

OVERVIEW

Figure-1 presents a block-and-line diagram of a Bayer Process with the possible grafts of chemical manufacturing processes.

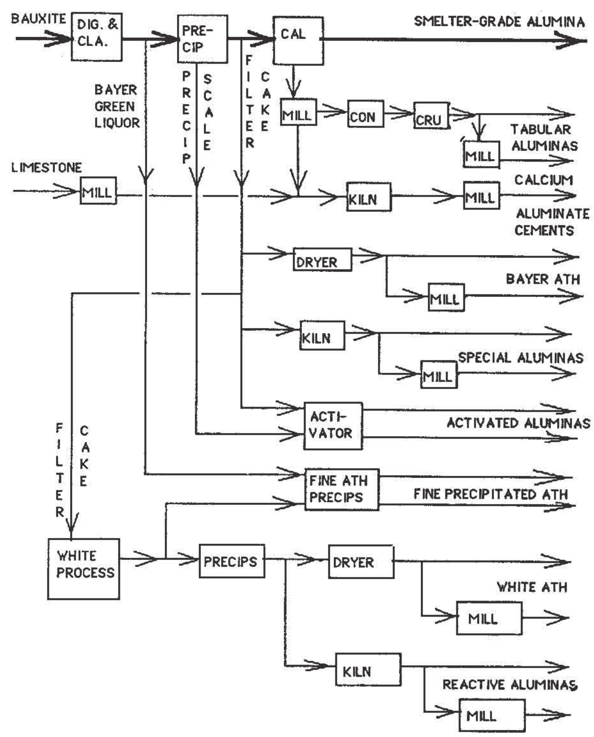

Figure-1: Block-and-line diagram of Bayer Process with possible grafts of chemicals manufacturing processes.

The Bayer process flowheet is a very simplified version showing the bauxite preparation, digestion and red mud clarification areas, i.e. the red part of the process in one block. The major input into this red-areas block is bauxite, and the major outputs are red mud which is disposed of and Filtrate Liquor which is sent to the white areas. The white areas are shown as a precipitation-hydrate classification-hydrate washing block, with moist hydrate filter cake passing to the calcination block. In general, Bayer alumina plants can be described as inflexible large-scale manufacturing systems designed to produce a single product, namely, reduction (smelter)-grade alumina, and the first major challenge is how to synchronise the capabilities of this inflexibe Bayer system with the demands of the relatively small-scale markets for a variety of specialty alumina chemical products, without sacrificing the Bayer Process efficiencies.

The grafting of flexible chemicals manufacturing processes onto an existing Bayer process provides obvious feedstocking advantages, while the disadvantages are less obvious. The two types of operations must be separated by large feedstocks surge-storage capacities, and the transfers of feedstocks and liquors between the plants must be accurately metered and recorded, in order to retain the capability of making materials balances around each process. The materials and energy balances for the Bayer plant are made more complicated.

It should be mentioned that the differences in the nature and scale of the Bayer and chemicals operations, demand significant differences in the appropriate organization and staffing for the two types of operations. The differences in the markets for reduction-grade alumina and alumina chemicals are another major challenge. The advantages of uncoupling the downstream manufacture of alumina chemicals from the economics and operations of a single Bayer refinery are also obvious. However, these factors are outside the scope of this paper.

The incompatibilities between the Bayer Process and the Chemicals processes can be avoided by the concept of a complex of alumina chemicals operations for the downstream processing of feedstocks imported from remote Bayer refineries. The alumina chemicals plants can be strategically located in the markets for chemical products.

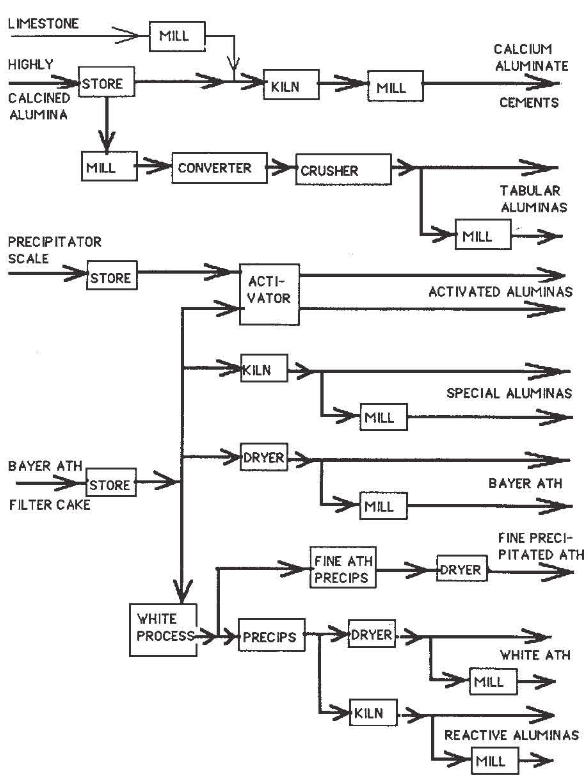

Figure-2: Block-and-line flowsheet of possible alumina chemicals complex.

A block-and-line flowsheet for such a complex is preseented in Figure-2. The feedstocks are those intermediate products which can be efficiently produced at high rates in the Bayer plants using facilities normally used for reduction-grade alumina, for supply in bulk to a number of chemical plants strategically located in the world-wide markets for alumina chemicals.

BAYER ATH

As shown in Figure-1, moist hydrate filter cake can be dried, and some ground and packaged to manufacture a line of unmilled and milled Bayer (or Tan) ATH products. Equipment used for the calcination of alumina can be modified to produce dry Bayer ATH.

This process is easy to graft onto a Bayer plant, except for the dry grinding and the packaging operations which are foreign to Bayer plants.

Some aluminum chemicals manufacturers dissolve Bayer ATH feedstock, and these manufacturers can use Bayer ATH in the moist filter cake form.

TABULAR ALUMINAS

As shown in Figure-1, tabular aluminas can be made by operating the alumina calciner to produce a calcined alumina feedstock, which is much more highly calcined than sandy reduction-grade alumina. The tabular alumina produced from this feedstock is crushed, screened, and some ground and packaged to manufacture a line of tabular alumina products.

The need to control the soda contents of tabular aluminas significantly below that which can be tolerated in reduction-grade aluminas, demands that the Bayer plant produces a special lower-soda hydrate and that the washing of the hydrate feedstock be very thorough. Where soda reduction is carried out during the tabular alumina production process, the disposal of the soda-bleed stream presents special problems.

CALCIUM ALUMINATE CEMENTS

Figure-1 also shows that highly-calcined alumina and milled limestone can be mixed, and the mixture calcined in a rotary kiln to produce the clinkers of various calcium aluminate cements. The clinkers are then milled to produce the cements, which are bagged.

SPECIAL ALUMINAS

Bayer ATH and White ATH can be calcined in rotary kilns with special additives and under special conditions, to produce a line of special aluminas. A part of this production is ground and bagged.

The disposal of products made while changing from the conditions required to produce one product to the conditions required to make another product, is a major concern. Furthermore, soda-bleed streams must be disposed of, and the handling of highly-recrystalised platelets of alumina is unfamiliar to Bayer plants which produce sandy alumina.

ACTIVATED ALUMINAS

Bayer hydrate and ground precipitator scale can be activated to produce a line of formed and granular activated aluminas, as is shown in Figure-1.

The trend in modern Bayer plants to avoid the formation of precipitator scale and the increasing use of in-situ caustic descaling, is reducing the availability of precipitator scale for the production of granular activated alumina.

FINE PRECIPITATED HYDRATES

Pregnant Bayer or White liquors can be sent to special precipitators for the precipitation of 0.5 to 2 micron size gibbsite crystals. This product is usually wash and dried, but can be supplied in high solids-concentration slurry form.

The very large specific wash water required to adequately wash the very fine hydrate crystals is a major concern in this process. Impurity inputs into the Bayer process liquors, and dust control in the handling of the fine hydrates after drying, are also major concerns.

WHITE HYDRATES

White hydrates can also be made from Bayer hydrate. The cross contaminations of Bayer and White liquors and their products are major concerns.

SUMMARY

Industrial chemical products from Bayer alumina feedstocks, can be manufactured by either grafting chemicals manufacturing processes onto the Bayer plant, or by dwonstream processing of imported Bayer feedstocks at complexes located away from the Bayer refineries. The refinery-location of chemicals operations has obvious advantages and not-so-obvious disadvantages. Increased materials, energy, and water consumptions, cross contaminations of product and process streams, and packaging are some of the technical disadvantages of grafting. Staffing, organizational, and marketing/sales incompatibilities are evident.

The large inflexible Bayer manufacturing process is incompatible in many ways with the much smaller and flexible manufacturing processes which are appropriate for alumina chemicals products. The location of alumina chemicals complexes at strategic locations in the world-wide markets for alumina chemicals, uncouples the chemicals operations from the economics and incompatibilities of individual refineries.