FEEDSTOCK CONVERSION FROM BAUXITE TO SGH

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Abstract

Sumitomo Chemical Co., Ltd. (SC) and other Japanese alumina makers committed to quit the ocean-dumping of bauxite residue by 2015 at the 2005 Scientific Group Meeting of the London Convention. In 2006, SC planned to change the feedstock from bauxite to imported Smelter Grade Hydrate (SGH), because we considered that this method (re-precipitating aluminium tri-hydrate (ATH) from the digested SGH) was the most suitable for the stabilization of the quality of the downstream products. The plan brought concern about the change of the impurities included in ATH and Bayer liquor by feedstock conversion. To confirm it, we built a 1/10,000 scale Bayer pilot plant, operated it for about 2 years and collected many quality data of the products sample before changing the feedstock.

These data showed that re-precipitated ATH from the liquor of digested SGH had the same quality as ATH from bauxite. We obtained customer's approval to change feedstock based on that data.

In May 2010, we executed feedstock conversion, and confirmed the quality of re-precipitated ATH is the same quality as the one from bauxite. We also confirmed the plant data is the same as the pilot plant. Customers are satisfied with the quality of our products.

1. Introduction

Bauxite mainly consists of aluminium hydrate but contains many kinds of impurities, e.g. Kaolinite (Al_2O_3-$2SiO_2$-$2H_2O$), SiO_2, Fe_2O_3, TiO_2, and organic compounds such as humic acid.[1)] The impurities are excluded as bauxite residue (BR) by Bayer process. Japanese alumina makers have bought bauxite from overseas and BR has been disposed of with ocean-dumping. However SC and other Japanese alumina makers committed to quit the ocean-dumping of bauxite residue by 2015 at the 2005 Scientific Group Meeting of the London Convention.

In order to solve this issue, SC planned to change the feedstock from bauxite to imported Smelter Grade Hydrate (SGH) in 2006, because we considered that this method, re-precipitated ATH from the digested SGH, was the most suitable for the stabilization of the quality of the downstream products.

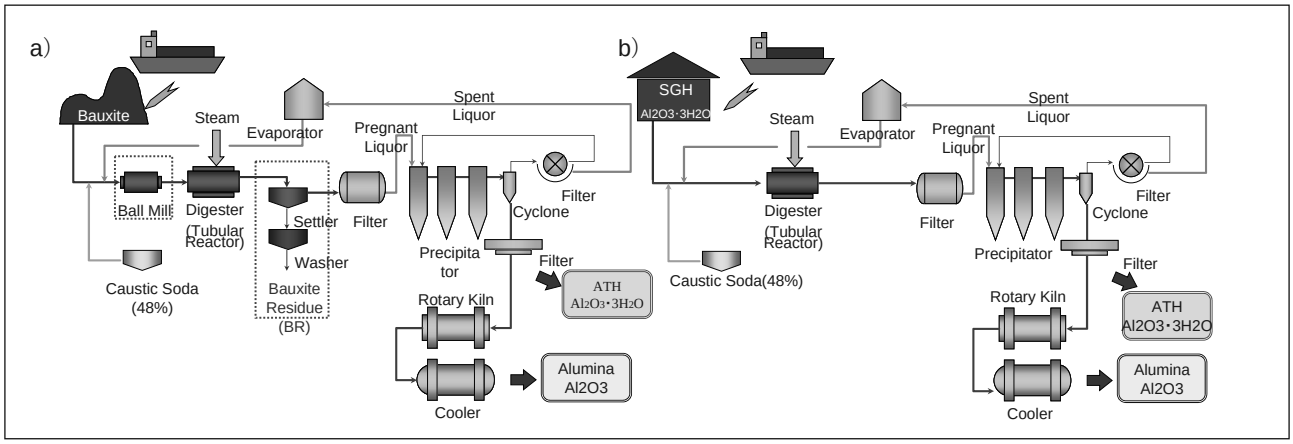

Figure1 shows Bayer process in Ehime plant before/after feedstock conversion.

The plan brought concern about the change of the impurities included in ATH and Bayer liquor by feedstock conversion. As mentioned above, bauxite contains various kinds of impurities, for example silica, hematite, titanium oxide, organic compounds such as fumic acid and so on. On the other hand SGH has a very small amount of impurities compared with bauxite. Consequently the removing process of BR becomes unnecessary after feedstock conversion but the concentration of impurities in ATH might change. It is well known that impurities in Bayer liquor have possibility to affect precipitation.[2, 3, 4)]

It is not easy to estimate the change of impurities in ATH produced in the Bayer plant because of various effective factor. In order to comfirm the effects by feedstock conversion we constructed a small scale Bayer pilot plant and precipitated commodity ATH using Bayer liquor from both Bauxite and imported SGH.

2. Experimental

We investigated the effects of feedstock conversion in our pilot plant. Precipitators in pilot plant were 1/10,000 scale of Ehime Bayer plant's. Figure2 shows experimental procedure in the pilot plant. The experiments were conducted with two steps. Step1 was the experiment for finding out the conditions in pilot plant to precipitate ATH which had the same chemical and physical properties as Ehime plant ATH, using the Ehime plant pregnant liquor. We precipitated chemical grade ATH (C-12: D50= ca. 50um), because the objective of experiments was to confirm quantities of impurities in ATH.

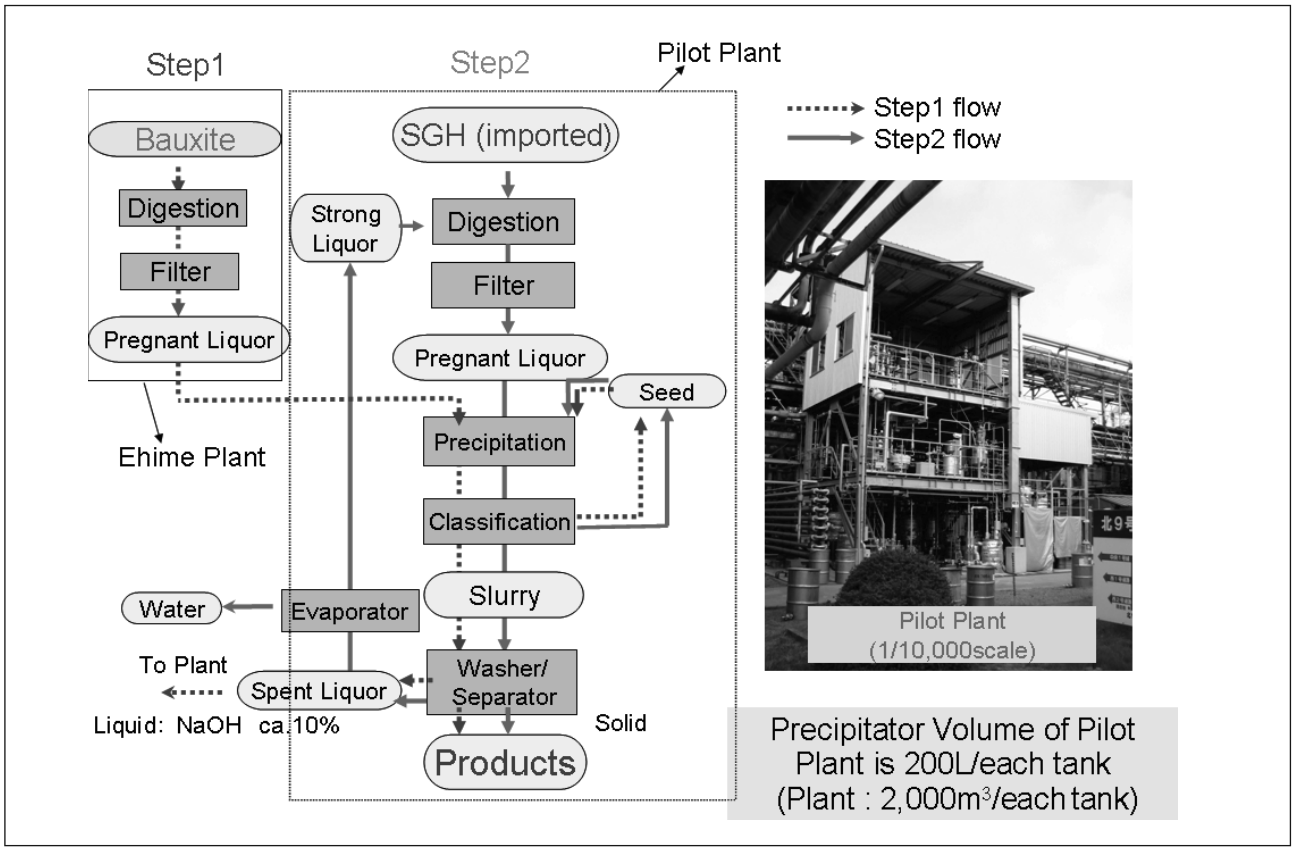

Figure2. Experimental procedure in pilot plant

After fixing the precipitation condition for chemical grade ATH, we proceeded to the next Step2 experiment. In Step2, the pregnant liquor was made from imported SGH with digester in pilot plant, and the precipitating condition was the same as in Step1. Spent liquor was evaporated in pilot plant and reuse to digest SGH. Because of recycling the spent liquor in pilot plant, it took a quite long time for impurities in Bayer liquor to stabilize. According to our calculation, the Step2 experiment had to be continued for 8 months to make pilot plant's impurities stable. After finishing the Step2, we analysed and compared the chemical compositions and the physical properties among Ehime plant ATH, the Step1 ATH and the Step2 ATH.

3. Result and discussion

3.1 Pilot plant test results

Table1 shows the results of analyzing the Step1 and the Step2 ATH (C-12: from Bauxite and SGH) in pilot plant. Chemical compositions of the Step1 50um ATH could be controlled within the past fluctuation range of Ehime plant ATH (C-12). And D50, bulk density and angle of repose were also controlled within the past fluctuation range of Ehime pant ATH.

Table 1 Analytical data of ATH (C-12) from pilot plant

Plant		Ehime plant	Pilot plant	
Feedstock		Bauxite	Bauxite (Step1)	SGH (Step2)
Moisture	wt%	9-10	9-10	9-10
Loss on ignition	wt%	34.5	34.5	34.5
Fe_2O_3	wt%	0.003-0.010	0.005-0.007	0.007-0.009
SiO_2	wt%	0.003-0.009	0.004-0.006	0.003-0.004
TiO_2	wt%	0.001-0.003	0.001-0.003	0.001-0.002
Na_2O	wt%	0.13-0.22	0.17-0.18	0.17-0.18
MgO	wt%	0.001	0.001	0.001
CaO	wt%	0.002-0.018	0.004-0.010	0.010-0.012
Organic carbon	wt%	0.02-0.03	0.02	0.02
Total carbon	wt%	0.03-0.05	0.02-0.04	0.03-0.04
D50*	μm	43~62	55-58	55-57
Packed bulk density	g/cm^3	1.2-1.4	1.3-1.4	1.3-1.4
Loosed bulk density	g/cm^3	0.9-1.1	1.0-1.1	1.0-1.1
Angle of repose	°	35-40	35-40	35-40

*Measured by laser diffraction method

Figure3 shows the SEM images, and Figure4 shows the PSD. SEM images of the Step1 ATH and Ehime plant one had almost the same shape and particle size. Both ATH also shows the same PSD curve. We confirmed that we were able to produce the same ATH with the Ehime plant ATH in the pilot plant.

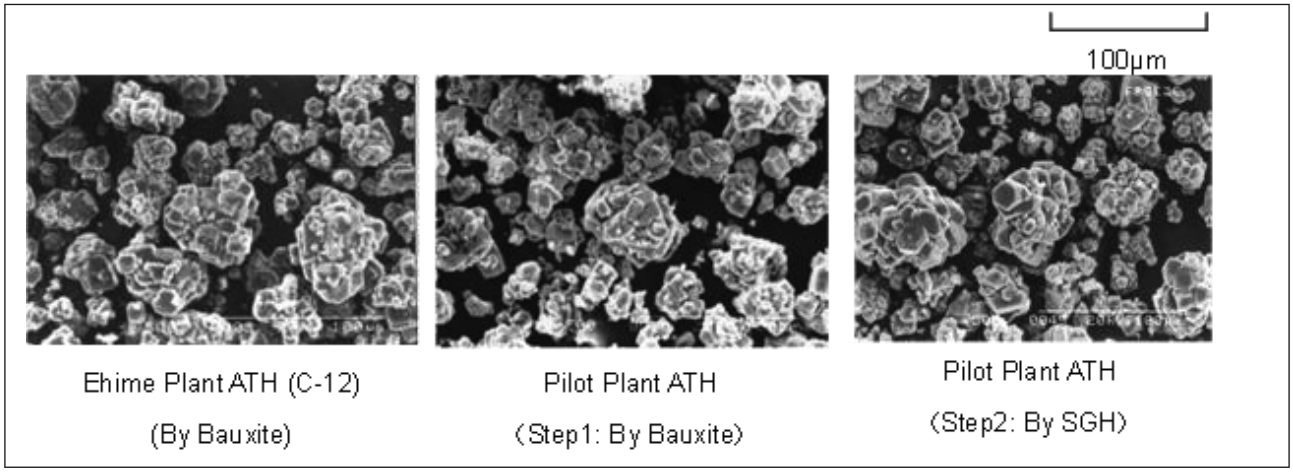

Figure3. SEM images of Ehime plant and pilot plant ATH

Following the Step1 experiment, the Step2 experiment using imported SGH was carried out. The impurities of the Step2 ATH had a little narrower fluctuation range than the Step1 or Ehime plant ATH. The compositions of bauxite and SGH were compared in table2. Bauxite contains impurities by 20-30%. On the other hand, imported SGH has a small amount of impurities of less than 1%. The small fluctuation of impurities in SGH could have caused less variation of impurities in the Step2 ATH than in the Step1. The concentration of impurities in the Step2 ATH was almost same level as in the Step1, and that was in the range of impurities in the Bayer plant ATH. From the results above, the chemical compositions of ATH after FS conversion were expected to be the same as the one before FS conversion.

Table 2 Analytical data of feedstock

Feedstock	Bauxite	SGH(ATH)	Remarks
	Australia/ Indonesia	Overseas	
Loss on ignition	ca. 26-28 %	ca. 35 %	
$Al_2O_3 \cdot 3H_2O$ (Gibbsite)	ca. 70-80	ca. 99	Extractive component
$Al_2O_3 \cdot H_2O$ (Boehmite)	ca. 0-4.0	N.D.	
$Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$ (Kaolinite)	ca. 5.0-12.5	N.D.	
Na_2O	-----	ca. 0.24	
SiO_2 (Quartz)	ca. 0.5-2.1	ca. 0.008	
Fe_2O_3	ca. 8.5-17	ca. 0.006	
TiO_2	ca. 0.7-2.6	ca. 0.003	
Total carbon	ca. 0.1-0.2	ca. 0.06	
Other components ［Ca,Zn,P,F,etc］	ca. 0.1	ca. 0.03	

The physical properties of the Step2 ATH in Table1 are almost the same level as in the step1, too. And both the Step1 and the Step2 data are also in the range of physical properties of the Ehime plant ATH. There is no substantial difference with regard to the particle shape in figure3 and PSD in figure4.

From the pilot plant test results, we concluded that there would be no substantial changes of ATH properties after feedstock conversion. Feedstock conversion was executed in May 2010.

3.2 Results in Ehime plant

Table3 shows the impurities and physical properties data of Ehime plant ATH (C-12) 12 months after Feedstock conversion. Impurities of ATH after FS conversion are the same level as the one before FS conversion. Physical properties are also the same. SEM images in Figure5 and PSD in Figure6 doesn't indicate the difference between ATH data before and after FS conversion.

These quality data of Bayer plant ATH are within the fluctuation range of Pilot plant ATH data (Step2).

Those results show that Pilot plant test was carried out properly. After FS conversion, no serious quality problem has occurred, and Ehime plant ATH has maintained the same quality as ATH before FS conversion.

Table 3 Analytical data of ATH after feedstock conversion

Plant		Ehime plant [before conversion]	Pilot plant [Step2]	Ehime plant [after conversion]
Feedstock		Bauxite	SGH	SGH
Moisture	wt%	9-10	9-10	9-10
Loss on ignition	wt%	34.5	34.5	34.7
Fe_2O_3	wt%	0.003-0.010	0.007-0.009	0.008
SiO_2	wt%	0.003-0.009	0.003-0.004	0.003
TiO_2	wt%	0.001-0.003	0.001-0.002	0.002
Na_2O	wt%	0.13-0.22	0.17-0.18	0.17
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Organic Carbon	wt%	0.02-0.03	0.02	0.02
Total Carbon	wt%	0.03-0.05	0.03-0.04	0.03
D50*	µm	43-62	55-57	55
Packed bulk density	g/cm3	1.2-1.4	1.3-1.4	1.3
Loosed bulk density	g/cm3	0.9-1.1	1.0-1.1	1.0
Angle of repose	°	35-40	35-40	40

*Measured by laser diffraction method

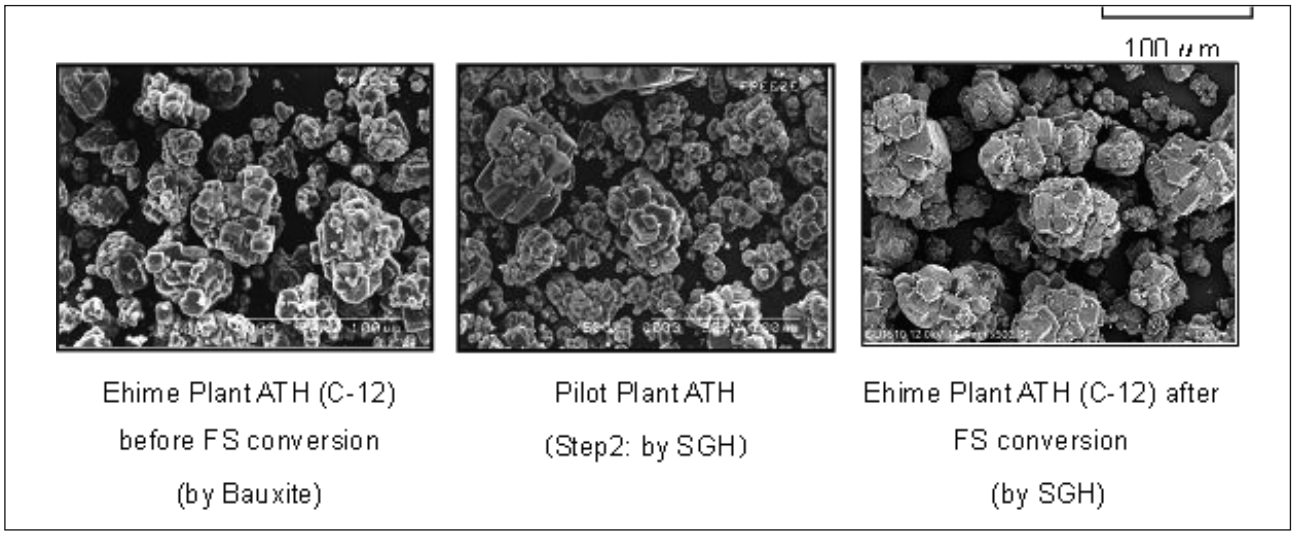

Figure 5. SEM images of Ehime plant ATH (before and after FS conversion) and pilot plant ATH

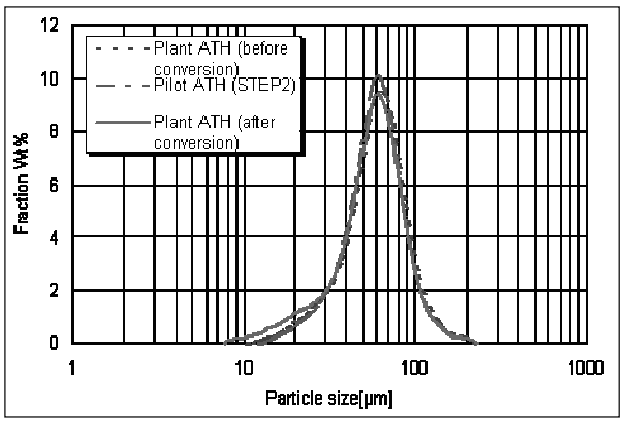

Figure 4. Particle size distributions of ATH

4. Conclusion

We executed feedstock conversion from bauxite to SGH after carrying out the pilot plant test. The precipitation experiment of chemical ATH was carried out in the pilot plant (1/10,000 scale). It showed that there would be little change of the properties of precipitated ATH. We decided feedstock conversion and executed in May 2010 based on the results of pilot plant. There has been no substantial change about quality of the ATH between before and after FS conversion.

5. Acknowledgements

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