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An Aluminum Hydrate Plant

By PHILLIP J. BORNHORST, '28

Part II

Log of Run of 100 lb. Experiment:

Time P.M.	Operation Performed
1:35-1:36	Water run into tank B 1194 lbs., tank A 465 lbs.
1:37-1:45	Temperature of water in tanks raised to 35° C. with steam.
1:46	Agitators started and run continuously.
1:46-2:06	Soda ash added to tank B and Alum to A.
2:06-2:17	Temperatures regulated with steam.
2:17-2:40	Alum added to Soda Ash solution in tank B.
2:40	Acidity of Solution taken and more soda ash solution added.
2:43	1500 cc. of solution taken for sample.
2:50	Temperature checked 32° C.
2:51	Test for end point and excess aluminum sulfate.
2:52-3:09	More aluminum sulfate added (21) lbs.
3:15	Temperature taken—30° C.
3:38	Test showed excess alum added.
3:40	1500 cc. sample of solution taken.
3:41	Depth of solution 22.5 inches in tank B.
3:45-3:54	Filtration of precipitate until press was filled. Group No. 1 in charge of Mr. Chadwick.
3:55	Depth of solution in tank B 17 inches.
3:55-9:00 A.M.	Washing of cake with tap water—35 lb. press.
9:00-1:00 P.M.	Drying cakes with air.
1:05-1:50	Cakes removed with 4 men.
2:00	Filtered cake weighed—134 lbs. wet. Sample taken.
1:50-2:15	Press reassembled after washing (3 men).
2:15	Group No. 2 began their filter press run, etc., until the four press runs were made.
	Final clean-up of lab. and equipment by entire class of 23 students.

NOTE: After end point of reactions and acidity tests were satisfactory the amount of materials added compared very favorably with the sample of the calculation given previously.

Actual time required to run filter press with the operations of filtering, washing, drying, disassembling and reassembling was approximately a 3 hour cycle. In log above there was no time to finish the job on press No. 1 in the afternoon so it had to be run over to the next afternoon.

Bill of Material for Plant

1. 372 pounds of Aluminum Sulfate.
2. 179 pounds of Soda Ash.
3. Piping and fittings:
 - a. 35 feet of 1" Water Pipe CI.
 - b. 10 feet of 1½" Water Pipe CI.
 - c. 30 feet of 1½" Steam Pipe CI.
 - d. Nipples, Tees, Plugs, Valves, Unions, Bushings, Valves, 1. Dorr Co., New York City.
4. One Hauser Stauder Wooden Tank, Size 32"x46" (250 gal.)
 - a. Hauser Stauder Co., Cincinnati, Ohio.
5. One Hauser Stauder Wooden Tank, Size 56"x70" (750 gal.)
 - a. Hauser Stauder Co., Cincinnati, Ohio.
6. One agitator for each tank with motors.
 - a. Mixing Equip. Co., New York City.
7. One drying oven. "Freas" 40"x40"x36", 3 shelves.
 - a. 220 volts, 30 amps, 60 cycles.
8. 4 presses, Shrivens No. 18—150 lbs. pressure.
 - a. 16 Chambers. Capacity 1.7 cubic feet.
 1. Shrivens & Co., Harrison, N. J.
9. One Toledo Scale, 300 lbs. capacity.
 - a. Toledo Scale Co., Toledo, Ohio.
10. One Weiman Pump No. 3182, Size 1½"-2", capacity 120 gallons per minute.
 - a. Weiman Pump Mfg. Co., Columbus, O.
11. 3 Standard 100 degree Thermometers.
 - a. Taylor Instrument Co., Rochester, N.Y.

Working Schedule for plant to make 100 lb. batch of light Aluminum Hydrate (Refer to Sketch).

1. 56 gallons of water are run into tank A or to a depth of 16 inches in tank A. (Make sure that valve in pipe from bottom of tank is closed.)
2. Steam is now run into the water in Tank A.
3. 372 lbs. of Aluminum Sulfate is dissolved in the water in Tank A. The solution can be stirred with a stick if the steam does not furnish enough agitation to dissolve the Aluminum Hydrate.
4. When the temperature of the solution reaches 35°C or 2 or 3 degrees higher the steam is turned off.
5. 143 gallons of water is run into Tank B or to a depth of 13 inches. (See that valve in pipes from bottom of tank are closed first.)
6. Steam is run into the water in Tank B.
7. Start the agitator in Tank B.
8. 179 pounds of Soda Ash is added to the water in Tank B only as fast as it will dissolve, taking care that it does not cake in the bottom from adding too fast.
9. When the temperature of the Soda Ash solution reaches 35°C or 2 or 3 degrees higher, the steam is shut off.

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ALUMINUM HYDRATE

(Continued from Page 10)

10. The Aluminum Sulfate solution is run from Tank A into the Soda Ash solution in Tank B, taking care that the foaming does not reach within 1½ feet of the top of the tank. The agitator is still kept running unless foaming is excessive; then it may be stopped for a few minutes till foam subsides.
11. Test for end point with solutions of Soda Ash and Alum by fitting a small portion in a beaker and then test.
12. 30 minutes after the Aluminum Sulfate solution has been added, the valve in the pipe to the centrifugal pump is opened and the centrifugal pump is started. The pump may have to be primed with a small amount of water from Tank A. (See that valves in pipe to Tank A and in pipe to drain on intake side of the pump are closed when the pump is being run.)
13. All the valves from the pump should be closed except in pipe leading to the upper right hand corner of the filter.
14. Slurry is pumped from Tank B until it has been lowered about 6 inches in the tank, when the valve at the bottom of Tank B is closed.
15. Run 43 gallons of water into Tank A and allow steam to run in until a temperature of 35°C is reached and then turn off steam. This is sufficient water for one cycle of the filter press, so it must be repeated in each cycle of the filter press.
17. Wash water is tested with BaCl₂ solution to see if all sulfates have been washed out. If not more water must be used or pumped through from Tank A. (If sulfates are present a precipitate will be formed; if none are present the solution will remain clear.)
18. After the cake has been washed the valve to the wash water inlet to the press is closed and the compressed air valve is opened, the compressed air going in at the upper left hand corner of the press.
 - a. Shut off centrifugal pump. (It is again started when a new cycle of the press is being run through.) Compressed air is run through the press till water does not drip from the drain.
19. The cake is discharged from the filter press and put in the drying oven to dry, not over a one inch layer and the filter press is set up again and another cycle is run the same as the first.
20. After all solution has been drawn from Tank B the agitator may be stopped.
21. Clean all apparatus when through.

Samples for tests.

A sample was taken immediately after end point was reached and also a sample of each press cake. The following tests to be made on samples:

1. Apparent Gravity.
2. Absorbitive Power with Tint Photometer.
3. Saccharimeter Test with Polarimeter.
4. Moisture in Cake.

Organization of 100 lb. batch manufacturing run.

Dr. James R. Withrow	}	Managing Staff.
Mr. Vilbrandt		
Mr. Brown		
Mr. George		
Mr. Duncombe		
Mr. Way, Code Engineer		in charge of all readings and data.
Mr. Chadwick, foreman of filter press Number 1.		
Mr. Hamilton, foreman of filter press Number 2.		
Mr. E. E. Martin, foreman of filter press Number 3.		
Mr. Walke, foreman of filter press Number 4.		

Now the problem, "Shall we continue to buy on the open market or shall we make ourselves, 20 tons per day of Light Aluminum Hydrate," was ended with Part 6, "Final Preliminary Plans for a 20 ton per day (24 hours) plant for making Light Aluminum Hydrate."

The final report to include the following:

1. Layout and elevation sketch revised.
2. Bill of material.
3. Schedule of operations and time cycles.
4. Engineering flow sheet.
5. Notes, comments and recommendations.

So the problem was now solved, and we may answer the original problem by saying, "We shall make ourselves 20 tons per day of Light Aluminum Hydrate."

Time period for entire problem.

The entire problem with its 6 parts was worked out within a month's time, using the 3 hour laboratory periods five days a week. Of course there were many other problems which came up in between and took away time from this major problem.