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PGDP

PADUCAH GASEOUS DIFFUSION PLANT

MARTIN MARIETTA

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PILOT PLANT PROCESSING
OF SODIUM BIFLUORIDE TO
SODIUM FLUORIDE PELLETS

S. M. Leone

January 1985

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***Pilot plant processing of sodium
bifluoride to sodium fluoride
pellets***

25 Jan 1985

Paducah Gaseous Diffusion Plant, KY (USA)

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PILOT PLANT PROCESSING OF SODIUM BIFLUORIDE
TO SODIUM FLUORIDE PELLETS

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ABSTRACT

Sodium fluoride (NaF) traps in the PGDP purge cascade presently use NaF pellets to remove residual UF_6 from the gas stream. These pellets are procured from ORGDP which converts sodium bifluoride pellets to NaF by thermal decomposition. Discussions of the possibility of no longer producing pellets at ORGDP, due to oven corrosion problems, led to a pilot plant test at PGDP. This test was designed to examine the feasibility of producing the NaF pellets at PGDP in the event that an alternative source of supply became necessary.

Satisfactory pellets were produced without difficulty; however, it was determined that the conversion process could not be readily carried out in the existing NaF traps. Construction of a separate facility with provisions to handle the large quantities of hydrogen fluoride (HF) released during the process would be required to produce pellets at the rate needed.

EXPERIMENTAL

This test was conducted in the C-410 pilot plant area. A line drawing of the system used in this experiment is shown in Figure 1. The 8-inch diameter, 23-inch long reactor was filled with 41.8 pounds of sodium bifluoride pellets to a depth of 19 inches. An absolute pressure transducer and differential pressure transducer were used to monitor the reactor pressure and pressure drop across the reactor, respectively. A constant temperature oven was used to heat the packed reactor. Temperatures were monitored as shown in Figure 1 using thermocouples located at the cross-sectional center, 2 inches into the packed reactor and at the wall of the reactor.

The procedure used for this test, is similar to the procedure used at ORGDP as described below.

1. Bring the temperature of the pellets from ambient to 350°F in 4 hours
2. Hold this temperature (350°F) for 4 hours
3. Raise pellet temperature from 350°F to 600°F in 1 hour
4. Hold this temperature (600°F) for 8 hours.

A nitrogen purge flow of 1 scfm was used during the entire heat-up and cool-down cycles.

An 8-inch diameter, 36-inch long reactor was filled with ~81 pounds of calcium carbonate (CaCO_3) rock for HF removal prior to venting to atmosphere. An infrared spectrophotometer was used to monitor the HF being removed during the conversion process.

RESULTS

Data from the test are shown in Table 1. The run lasted approximately 33 hours compared to a nominal 17 hours described in the ORGDP procedure. Hydrogen fluoride concentration in the trap effluent was being monitored by IR; therefore, the test was continued until the reaction was essentially

Table 1

EXPERIMENTAL DATA FROM PILOT PLANT TEST

Time (Hr)	Average Bed Temp, °F	Absolute Reactor Press, psi	Differential Reactor Press, psi	HF Conc., Mole %
1.2	146	15.3	0.00193	0.6
2.4	212	15.4	0.00425	1.3
3.4	289	15.3	0.00754	4.1
4.4	353	15.4	0.00213	8.8
5.4	379	15.5	0.00406	11.2
6.5	372	15.4	0.00425	7.9
7.5	348	15.4	0.00348	5.1
8.5	345	15.4	0.00213	4.9
9.0	367	15.5	0.00367	7.8
9.5	391	15.6	0.00116	14.0
10.5	439	15.7	0.00561	16.3
11.5	469	15.7	0.00483	14.2
12.5	476	15.7	0.00232	12.7
13.5	481	15.7	0.00445	11.5
14.1	485	15.6	0.00425	11.5
26.1	598	15.5	0.00696	4.7
28.7	594	15.5	0.00387	3.5
29.8	606	15.5	0.00445	3.0
30.8	606	15.5	0.00406	2.1
32.6	609	15.5	0.00425	<0.4

complete as indicated by no further HF being evolved. The NaF pellets produced during the test contained approximately 0.4% residual HF which indicates about 98.8% conversion from NaHF_2 to NaF. This value compares favorably with an average of about 2% residual HF in pellets received from ORGDP. Pressure drop across the bed and bed volume change due to removal of HF were negligible. Crush strength tests were performed on the pellets and the results are given in Table 2. Strength was comparable to pellets produced at ORGDP. No operating problems were experienced during the 33-hour experiment.

Table 2

COMPARISON OF SODIUM FLUORIDE CRUSH STRENGTH

Source of Pellets	Crush Strength ^a Lbf/in. Displacement
Paducah ^b	7,600
Oak Ridge ^c	7,400
Japan ^d	7,600

a. Crush strengths were determined by crushing 200 gram samples in a 3-inch diameter cylinder. The crush strength was calculated by taking the average force needed to displace the bed of pellets 1 inch.

b. Sodium fluoride pellets processed at Paducah during this test.

c. Sodium fluoride pellets processed at ORGDP.

d. Sodium fluoride pellets manufactured by Morita Chemical Industry Co., LTD of Japan. Estimated cost per pound for a 10,000 pound batch, FOB New York is \$7.05 (\$70,500/10,000 pound batch).

Reactions occurring during the conversion process and HF trapping process are shown in equations 1 and 2, respectively.

Large quantities of HF are generated by this process (~ 0.5 lb HF/lb NaF produced). The HF can be effectively eliminated by reaction with CaCO_3 ; however, this reaction generates significant amounts of water (~ 0.22 lb H_2O /lb NaF produced). For these reasons, it is not considered feasible to perform the conversion of NaHF_2 to NaF in place using the C-310 NaF traps as reactor vessels. If preparation of NaF pellets is to be performed at the PGDP, it is recommended that a dedicated facility be constructed.

CONCLUSIONS

The following conclusions were drawn from this pilot plant test:

1. Sodium fluoride pellets can be readily produced on a pilot plant scale from a packed bed of sodium bifluoride pellets.
2. The pellets produced in this study were as good as the pellets received from ORGDP.
3. The production of NaF pellets in the C-310 NaF traps or in other existing facilities at PGDP is not considered feasible at the desired generation rates.
4. The present cost of NaF pellets manufactured in Japan is higher than the cost of K-25 processed NaF pellets, \$7.00/pound vs. \$4.00/pound respectively.
5. Sodium bifluoride pellets should continue to be procured from ORGDP as long as possible.

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