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KY - 197

Technology

Feed Materials

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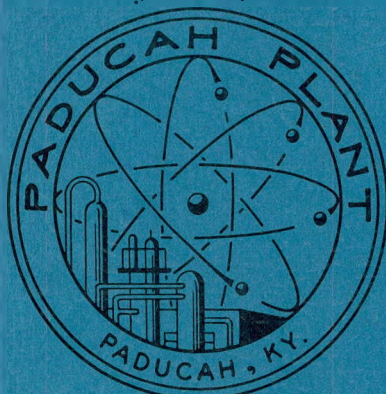
RECOVERY OF URANIUM HEXAFLUORIDE FROM VENT GASES

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FEED MATERIALS
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RECOVERY OF URANIUM HEXAFLUORIDE
FROM VENT GASES

T. J. Mayo, W. R. Golliher, W. R. Rossmassler

Special Analysis Section

Laboratory Division
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A B S T R A C T

Three materials, UO_3 , U_3O_8 and UF_4 , have been tested for their ability to absorb or react with low concentrations of UF_6 in the presence of large amounts of fluorine and air. It was found that at 400°F a fluidized bed of UF_4 will react with the UF_6 and that UF_6 in the amount of 10% of the weight of the UF_4 can be reacted before detectable UF_6 is found in the gas leaving the reactor.

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RECOVERY OF URANIUM HEXAFLUORIDE FROM VENT GASES

The vent gases from the UF_6 cold traps in the Paducah Feed Processing Plant necessarily contain a small percentage of UF_6 due to the vapor pressure of this material at the temperatures involved. The average composition of these vent gases is in the range of 0.1 mole % UF_6 , 3 mole % F_2 and 15 mole % HF with the remainder nitrogen and oxygen. Reducing the quantity of UF_6 lost can be accomplished in several ways mechanically and by chemical absorption by various compounds. However, it appeared that recovery of UF_6 in a fluidized bed of powder such as UO_3 , U_3O_8 or UF_4 would possess several inherent advantages. Among these are simplicity of design and production of a material suitable for fluorination reactor feed. The intent of this investigation was to determine the feasibility of recovering this UF_6 by absorbing or reacting it with a uranium compound in a fluidized bed.

CONCLUSIONS

The amount of UF_6 that reacted with U_3O_8 was too small to be of significant value. UO_3 reacted with 6% of its weight of UF_6 from a mixture of air and UF_6 at 600°F . UF_4 reacted with 15% of its weight of UF_6 from a mixture of air and UF_6 . This value was reduced to 10% in the presence of 3 mole % fluorine. Two different types of UF_4 were tested, Mallinckrodt and Paducah, and no significant difference was found.

EXPERIMENTAL

Apparatus

The powder under consideration was heated and fluidized in a 2 inch monel tube reactor (Figure I). A porous nickel plate supported by a drilled plate was used to distribute the fluidizing air. Metered UF_6 and fluorine were admitted to the system by mixing the gases with the fluidizing air stream. The off gases from the reactor were filtered through a porous nickel filter. Sample points were located on the inlet and outlet gas lines.

Materials

The UO_3 used was unground Hanford continuous calcined powder designated SHS-10. The U_3O_8 was made from this UO_3 by heating the UO_3 at 850°C for 16 hours. Two types of UF_4 were used. Type I was metal grade D-38 UF_4 from Mallinckrodt. Type II UF_4 was material produced on "B" tray in the Paducah Feed Plant. This UF_4 was made from a shipment of sulfated Hanford pot calcined UO_3 received August 25, 1956. Chemical and physical data for these powders are shown in Table No. 1.

Procedure

The system used was a batch process. The powder was charged to the bed, fluidized, and heated to the desired temperature. In all cases a static

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powder bed height of approximately 14 inches was used. UF_6 and/or fluorine were then admitted to the fluidizing air at the proper concentrations. Inlet and outlet gas samples were analyzed at regular intervals to determine the inlet and outlet concentrations of UF_6 and F_2 . The amount of UF_6 absorbed by the bed was determined by the weight loss of the UF_6 feed cylinder.

DISCUSSION

The per cent UF_6 and per cent F_2 recovered at various temperatures by the different compounds are given in Tables No. 2 and No. 3, respectively. The capacities of the compounds for the absorption of UF_6 are shown in Table No. 4. The temperatures for determining the capacities of the various compounds were chosen to optimize the recovery of UF_6 and minimize the recovery of F_2 .

The first powder studied was UO_3 . It was the intent that the mixture of $\text{UO}_3 - \text{UO}_2\text{F}_2$ formed might be fed directly to the fluorine towers by blending this material with green salt. However, the data indicate that a relatively large amount of UO_3 would be needed for the recovery unit. This quantity of $\text{UO}_3 - \text{UO}_2\text{F}_2$ could not be handled in the existing process.

U_3O_8 was investigated next, with the theory that the U_3O_8 could be reclaimed in the reactor by pyrohydrolyzing the $\text{U}_3\text{O}_8 - \text{UO}_2\text{F}_2$ mixture. The ability of U_3O_8 to recover UF_6 under the conditions studied was so small that the process was deemed not to be feasible.

The data with UF_4 indicate that a fluidized bed of UF_4 would be capable of recovering UF_6 in the presence of fluorine and air. No attempt was made to determine the reaction products. However, the black color of the reaction products and the relatively high dissociation pressure of UF_5 at 400°F lead to the theory that the reaction products of UF_4 and UF_6 under these conditions are U_2F_9 and/or U_4F_{17} . Mixtures of these compounds could be fed directly to the fluorine towers.

There was no evidence that these intermediates formed in any part of the system other than in the bed. At all times the powder in the bed remained free flowing, and no evidence of any plugging in the bed, filter or outlet lines was found.

While the preliminary data indicate that a fluidized bed of UF_4 would be capable of recovering the UF_6 in the feed plant cold trap vent gases, additional information should be obtained. Some of the factors requiring further study include the effects of flow rates, HF, variations in gas composition, particularly large concentrations of F_2 and UF_6 , UF_4 purity and composition, and the determination of the reaction products.

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Table No. 1

PHYSICAL & CHEMICAL DATA FOR UF_4

	<u>Paducah (UF_4II)</u>	<u>Mallinckrodt (UF_4I)</u>
% UF_4	78.1	>99
% UO_2	11.5	< 1
% UO_2F_2	10.4	< 0.2
Sieve Analysis, % Passing:		
Sieve No. 40	99.2	99.5
60	95.4	99.0
80	92.5	98.2
100	89.5	92.9
200	81.7	90.7
325	69.1	76.0
Density, g/cc.:		
Free Flow	2.8	3.0
Packed	3.6	4.2

Table No. 2

RECOVERY OF UF_6 BY VARIOUS URANIUM COMPOUNDS

Type Powder	% UF_6 Recovered At					Fluidizing Air Velocity, ft/sec.
	100°F	200°F	400°F	600°F	800°F	
UO_3	-	37	45	99	93	1.0
U_3O_8	-	-	56	88	97	1.0
UF_4 (I)	91	90	98	-	-	0.4 - 0.5

Table No. 3

RECOVERY OF F_2 BY VARIOUS URANIUM COMPOUNDS

Type Powder	% F_2 Recovered At					Fluidizing Air Velocity, ft/sec.
	100°F	200°F	400°F	600°F	800°F	
UO_3	-	6	17	50	36	1.0
U_3O_8	-	-	4	56	96	1.0
UF_4 (I)	30	33	50	-	-	0.4 - 0.5

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Table No. 4

CAPACITY FOR THE RECOVERY OF UF_6
BY VARIOUS URANIUM COMPOUNDS

Type Powder	Lbs. UF_6 Per Lbs. Powder*	Temp. Determined	Fluidizing Air Velocity, ft/sec.	Fluidizing Gas Constituents
UO_3	0.06	600°F	1.0	Mixture of air and ~0.1 mole % UF_6 .
U_3O_8	<0.030	800°F	1.0	Mixture of air and ~0.1 mole % UF_6 .
UF_4 (I)	0.15	400°F	0.2	Mixture of air and 0.1 - 0.7 mole % UF_6 .
UF_4 (I)	0.10	400°F	0.2	Mixture of air, 0.15 mole % UF_6 and 3 mole % F_2 .
UF_4 (II)	0.10	400°F	0.2	Mixture of air, 0.36 mole % UF_6 and 3 mole % F_2 .

*Before the recovery efficiency dropped below 95%.

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Figure I
Fluidized Bed Apparatus

