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Chemistry

MASTER

PREPARATION OF AMMONIUM DIURANATE AND
DETERMINING ITS VISCOSITY-DENSITY
RELATIONSHIP

I. W. Jeter

UNION CARBIDE CORPORATION
NUCLEAR DIVISION
OAK RIDGE Y-12 PLANT

operated for the ATOMIC ENERGY COMMISSION under U. S. GOVERNMENT Contract W-7405 eng 26

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Nuclear Division

OAK RIDGE Y-12 PLANT

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PREPARATION OF AMMONIUM DIURANATE AND DETERMINING
ITS VISCOSITY-DENSITY RELATIONSHIP

I. W. Jeter

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ABSTRACT

Viscosity measurements were made on precipitated uranium diuranate slurries over density ranges from approximately 1.2 to 1.8 gms/ml at a temperature of 25° C. Each density range showed decreasing viscosity with elapsed time, indicating that ammonium diuranate precipitates have thixotropic characteristics.

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SUMMARY

Ammonium diuranate precipitates were prepared at the Oak Ridge Y-12 Plant(a) by dissolving uranium dioxide in hot nitric acid, boiling off the excess acid, diluting with demineralized water as necessary, and precipitating the diuranate by the addition of concentrated ammonium hydroxide to a final pH of 7.0. The precipitate was agitated during the precipitation step. Viscosity measurements were made on the resulting slurries, using selected spindles over a chosen density range. Each density range showed decreasing viscosity with elapsed time, indicating that ammonium diuranate precipitates have thixotropic characteristics.

(a) Operated by the Union Carbide Corporation's Nuclear Division for the US Atomic Energy Commission.

INTRODUCTION

One of the problems associated with the engineering of uranium processing systems is the proper design of pumps for transporting slurries. One slurry commonly used in such processing is ammonium diuranate precipitates which can be easily transported by pumping, but whose density and viscosity characteristics are not well defined. These latter data are not readily available from the usual reference sources; so, at the request of the Y-12 Engineering Division, a series of viscosity-density determinations were made using specially prepared ammonium diuranate precipitates.

SALT PREPARATION AND VISCOSITY-DENSITY DETERMINATION

DIURANATE PREPARATION

Ammonium diuranate precipitates were prepared by dissolving uranium dioxide in hot nitric acid, boiling off the excess acid, diluting the solution with demineralized water as necessary, and precipitating the diuranate by the addition of concentrated ammonium hydroxide to a final pH of 7.0. The precipitates were agitated during the precipitation step.

Solutions were made with varying amounts of uranium dioxide that ranged from 80 to 232 grams (as uranium) per liter of nitric acid. This range of solutions provided slurries of ammonium diuranate precipitates having different specific gravities. (1, 2) Another approach was to dilute the higher-density uranium diuranate precipitate with demineralized water to obtain slurries with lower densities. The latter technique was used for the viscosity determinations made in Runs 2, 3, 4, and 6 (Table 1).

Table 1
DENSITY AND VISCOSITY OF AMMONIUM DIURANATE SLURRIES

Run Number	1A(1)	1B(1)	2	3	4	5A(2)	5B(2)	6	7A	7B
Density (gms/ml)	1.730	1.730	1.605	1.540	1.487	1.431	1.431	1.287	1.177	1.177
Viscometer Model	RVF	LVT	LVT	LVT	LVT	LVT	LVT	LVT	LVT	LVT
Spindle Number	6	4	4	4	4	4	4	4	4	4
Speed (rpm)	10	6	30	30	30	60	60	60	60	60
Elapsed Time (min)	Viscosity(3) (centipoises)									
1	71,000	91,300	11,520	9,080	8,800	3,920	3,730	2,600	1,210	1,160
2	68,700	66,000	10,900	8,400	8,380	3,600	3,530	2,330	1,100	1,180
3	68,500	60,700	10,200	7,760	8,040	3,300	3,350	2,250	1,060	1,190
4	66,700	57,200	9,840	7,560	7,660	3,110	3,180	2,130	1,130	1,260
5	64,900	55,600	9,740	7,460	7,520	2,990	3,050	2,020	1,130	1,200
6	63,400	54,700	9,360	7,320	7,500	2,810	2,910	1,920	1,020	1,220
7	61,800	55,000	9,300	7,220	7,480	2,730	2,870	1,830	1,020	1,140
8	64,800	57,200	9,260	7,100	7,560	2,630	2,750	1,750	870	1,090
9	63,800	56,600	9,220	7,000	7,320	2,550	2,690	1,690	850	1,150
10	63,400	56,500	9,060	7,020	7,320	2,500	2,650	1,660	-	1,040
11	63,500	56,800	9,100	6,900	7,220	-	-	1,650	-	-
12	64,100	56,800	9,100	6,900	7,200	-	-	1,600	-	-
13	64,600	58,400	8,900	6,880	7,160	-	-	1,590	-	-
14	64,500	59,700	8,940	6,860	7,200	-	-	1,500	-	-
15	64,900	61,100	8,940	6,860	7,120	-	-	1,500	-	-
16	60,000	-	-	6,880	7,200	-	-	1,480	-	-
17	59,000	-	-	-	-	-	-	-	-	-

(1) Runs 1A and 1B were made 95 hours apart on the material as received.

(2) Runs 5A and 5B settled.

(3) All measurements were made at a temperature of 25° C.

VISCOSITY DETERMINATIONS

All viscosity determinations were made on viscometers^(b) using either a Size 1, 4, or 6 spindle rotated at speeds best suited to the specific range of viscosities being determined. These data are also presented in Table 1, while the composite density-viscosity relationship for all measurements is graphically presented in the curve of Figure 1.

It was observed that the values determined for each density of precipitate showed decreasing viscosity measurements with time. This fact indicates that ammonium diuranate precipitates possess thixotropic characteristics.^(c)

Figure 1. DENSITY-VISCOSITY RELATIONSHIP FOR VARIOUS AMMONIUM DIURANATE SLURRIES.

(b) Brookfield Models RVF and LVT.

(c) By definition, a thixotropic fluid is one whose apparent viscosity decreases with time to some minimum value at any constant rate of shear, but will return to the original value once the shear force is removed.⁽³⁾

CAUTION

Since the flow of slurries in pumps and piping is an extremely involved problem, the use of these data should not be used to cover all conditions of density, viscosity, homogeneity, acidity, and flow.

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