Oct. 23, 1962 G. MARULLO ETAL 3,059,773

PROCESS FOR CONCENTRATING KAINITE BY MEANS OF FLOTATION

Filed July 6, 1960

3 Sheets-Sheet 1

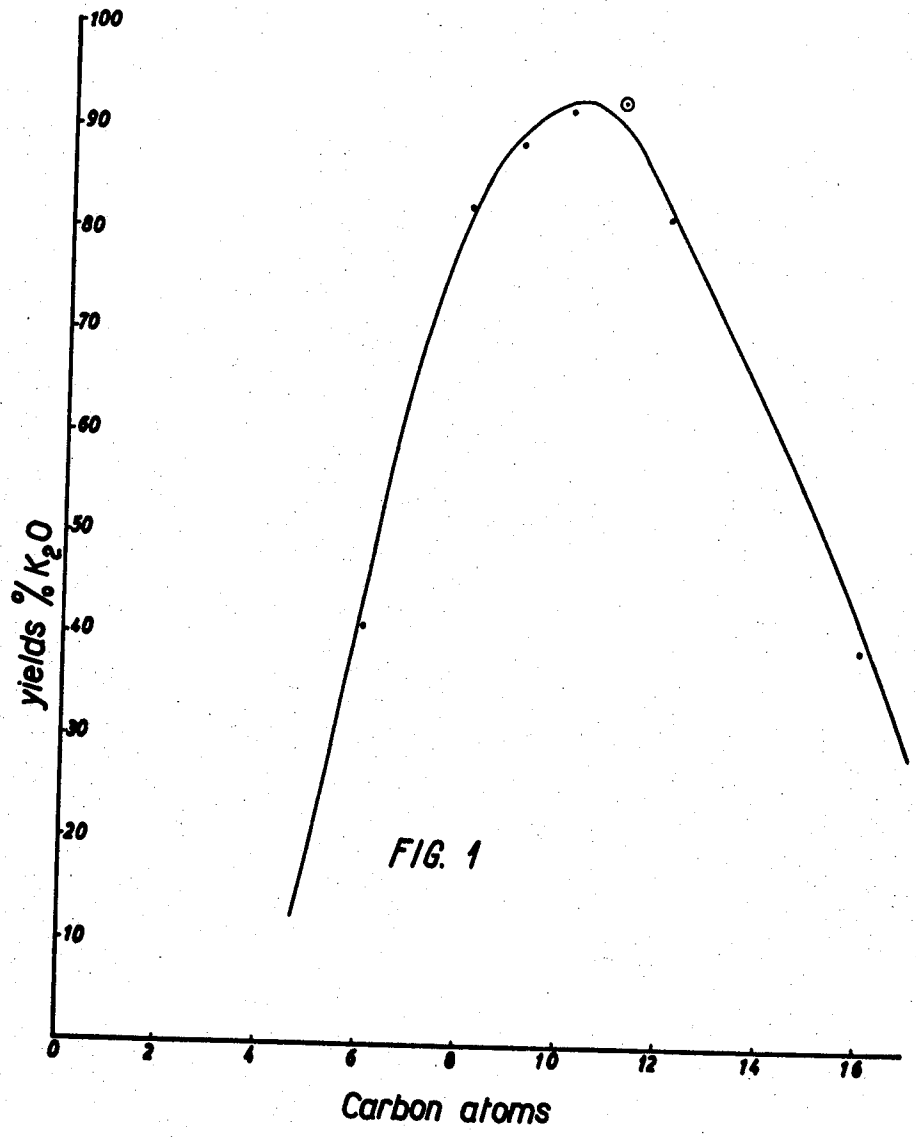

FIG. 1

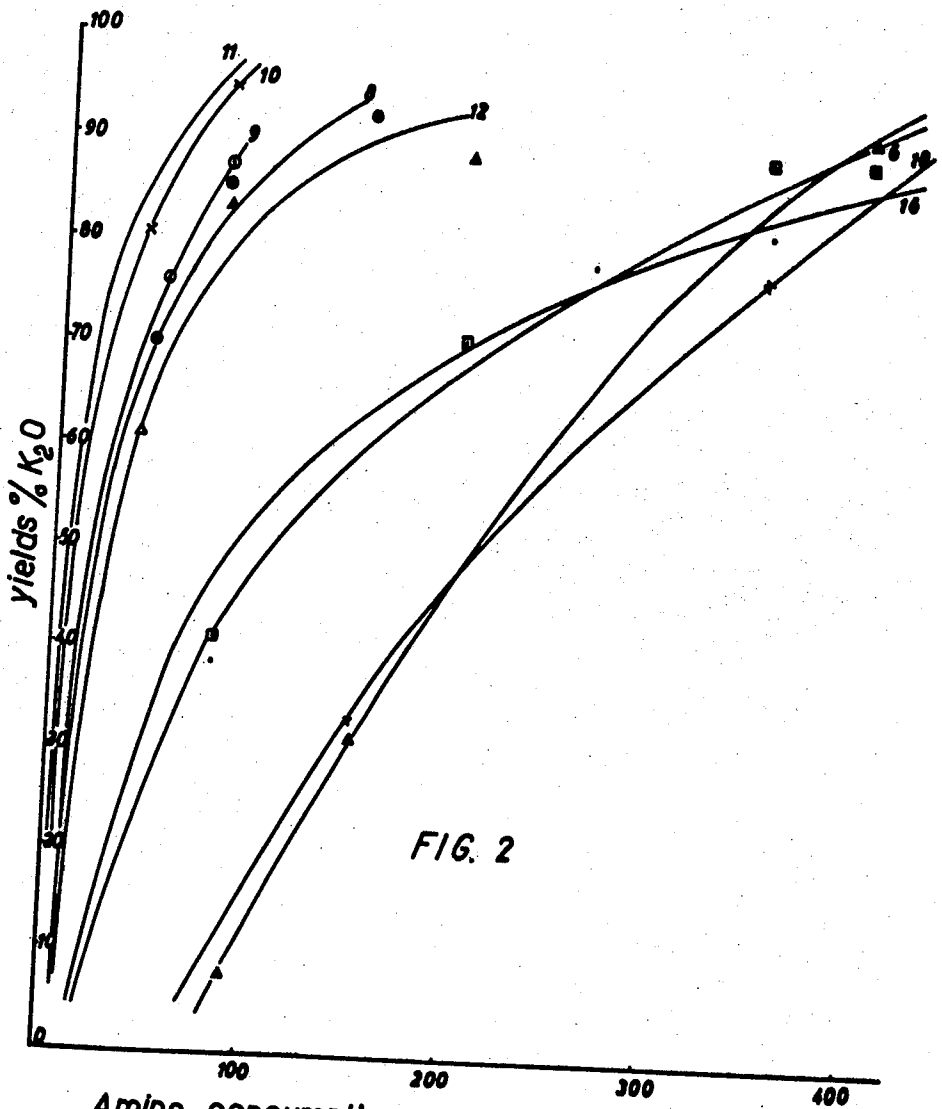
yields % K_2O
100
90
80
70
60
50
40
30
20
10
0
100
200
300
400
Amine consumption as hydrochloride in grams per ton

FIG. 2

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3 Sheets-Sheet 3

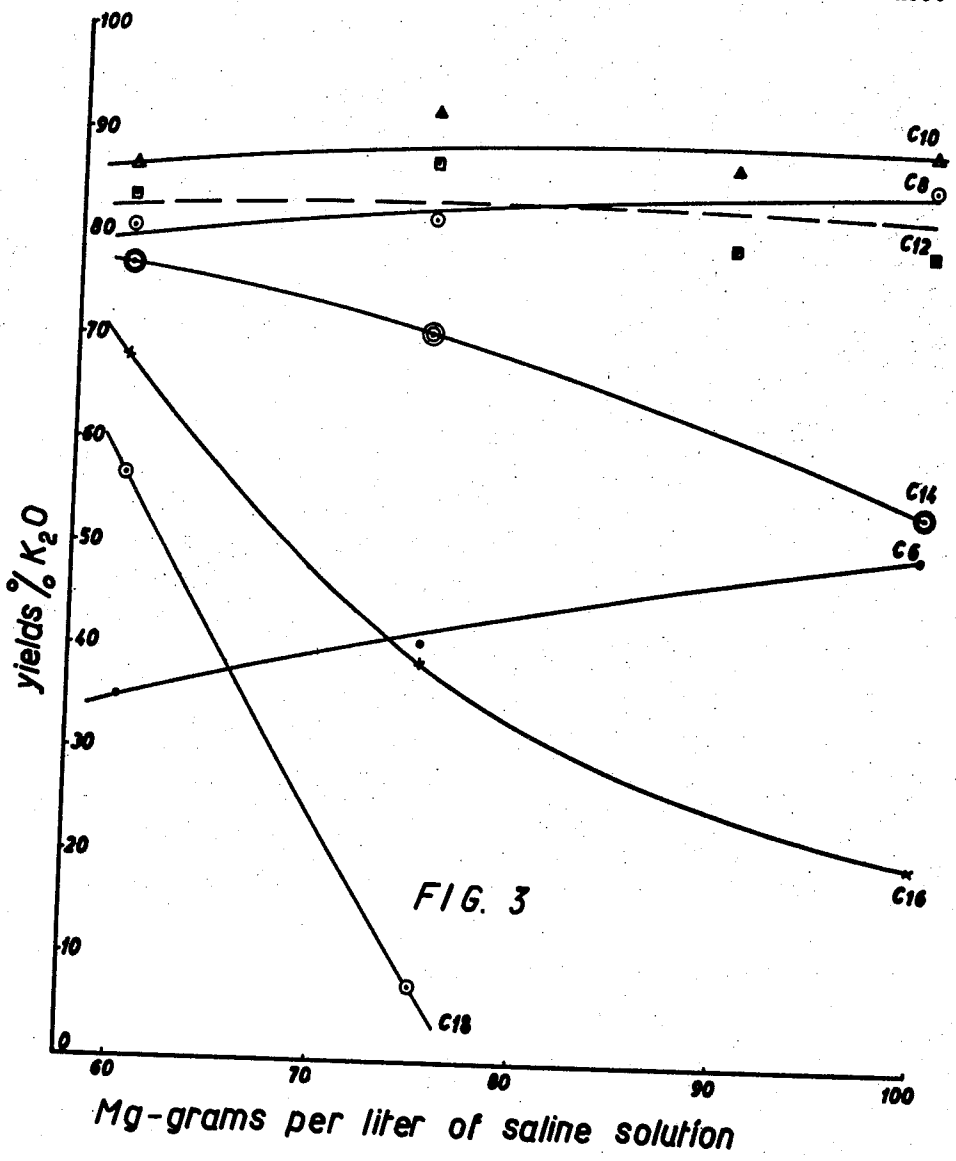

FIG. 3

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3,059,773

PROCESS FOR CONCENTRATING KAINITE BY MEANS OF FLOTATION

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8 Claims. (Cl. 209—166)

This invention relates to an improvement in a process of concentrating kainite by froth flotation, particularly for separation of sodium chloride therefrom.

Such processes are described in the U.S. Patents No. 2,766,884 and No. 2,766,885, of October 16, 1956, issued to Gerlando Marullo and Giovanni Perri. The first patent process employs an acid salt of a branched-chain amine, such as trimethylhexylamine hydrochloride, as flotation agent, to bring kainite into the froth. The second patent process uses a long-chain alkylamine acetate. The consumption of these amines in part depends upon the argillaceous nature of the ore, and its granulometry. It is always greater than the average consumption required in the flotation of other potassic ores, for example sylvite, employing the same amines.

We have investigated the floating power of normal, saturated and unsaturated, aliphatic amines having from four to eighteen carbon atoms in the chain, while using saline solutions of the following types:

Types	Grams per liter				
	K	Na	Mg	Cl	SO_4
A	7.32	5.6	100	280	34.8
B	14.7	8.04	91	250.7	60.0
C	26.3	20.0	75.5	210.2	92.0
D	32.8	21.5	61.35	213.4	66.85

We found, to our surprise, that amines comprised between C_8 and C_{12} have a floating power remarkably higher than others. In particular, for the n-amines C_9, C_{10}, C_{11} the amount required for good flotation is about 5 times lower than that of longer chain-amines, such as C_{14}, C_{16}, C_{18}. It was also found that the floating power of the following amines: C_8, C_9, C_{10}, C_{11}, C_{12}, remains almost constant despite any variance of the composition of the saline solution constituting the turbid liquid, whereas, in contrast it varies markedly for other longer chain-amines. The diagram in FIG. 1 illustrates the variation of the flotation yield as a function of the number of carbon atoms in the amines. On the abscissa are plotted the numbers of carbon atoms of the amines, and on the ordinate are the yields in percent K_2O. This diagram indicates that a maximum floating power corresponds to the following normal amines: C_9, C_{10}, C_{11}.

The tests referred to on this diagram were carried out by maintaining constant the consumption of the amine collector and the composition of saline solution.

The curves in FIG. 2 show the variation of flotation yield as a function of the consumption of the collector, for various amines. On the abscissa is plotted the amine consumption, as hydrochloride, in grams per ton of kainite ore, and on the ordinate is plotted the yield in percent K_2O. From this diagram it is evident that the amines C_9, C_{10}, C_{11} have the highest floating power, and their consumption, other conditions being equal, is about 5 times lower than longer chain-amines (C_{14}, C_{16}, C_{18}).

The diagram in FIG. 3 shows, as an alternative, the influence of the composition of saline solution upon the floating power of the amines. On the abscissa are plotted the Mg contents in grams per liter of the solutions indicated in the table in column 1, and on the ordinate the yields in percent K_2O.

From this diagram it is evident that floating powers of these shorter chain amines, and among them C_9, C_{10}, C_{11}, remain almost unvaried upon varying the composition of saline solution.

FIGS. 1, 2, 3 and the following examples, which are of an illustrative character presented without intent to limit the present invention, show synthetically the results obtained by the tests.

From these results, it now becomes evident that, by employing in the kainite flotation, aliphatic amines having nine and ten carbon atoms, the process is very much more economical, and more suited to the ore pulp liquid.

The amine consumption of 80 gr./ton, as indicated in the examples, relates to the use of freshly prepared saline solutions. In industrial practice, such consumption is greatly reduced by recycling the solutions which contain amine dissolved therein.

In the following examples kainite mineral having the following composition was employed:

K_2O=12.5%; Na=12.6%; Mg=6.45%; Cl=28.85%
Insoluble in water =0.5%; SO_4+H_2O=at 100

The mineral was ground to 1 mm. The granulometry is tabulated as follows, the figures signifying weight percent departure from 1 mm. size:

mm.	mm.	Percent
>0.6	<1	0.3
>0.5	<0.6	6.5
>0.4	<0.5	20.1
>0.3	<0.4	20.2
>0.2	<0.3	21.6
>0.1	<0.2	17.1
>0.06	<0.1	6.2
	<0.06	8.0

This mineral was suspended in one of the solutions referred to in the table found in column 1, so as to make an ore pulp comprising 35% by weight of solid. After the amine collector was added in the form of hydrochloride, the solution was conditioned for three minutes. Then 80 grams per ton of cyclohexanol were added as foaming substance, and flotation was carried out according to the known technique in a small laboratory cell having a 2-liter useful capacity.

Examples 2, 3, 4 and 5 employ the longer chain amines, being presented for comparison with Examples 1, 6, 7, 8. In the latter, the yield of K_2O in the floated mineral is markedly superior.

EXAMPLE 1

Kainite mineral ---------- 1000 gr.
Type C solution ---------- 1500 cc.
n-Primary decylamine (in form of hydrochloride) ---------- 80 gr./ton.
Cyclohexanol ---------- 80 gr./ton.

Balance:

Product	Weight	K_2O, Percent	Yield, Percent K_2O
Raw mineral	1,000	12.5	
floated	700	17	95
residue	340	1.75	

EXAMPLE 2

According to Example 1, but using primary n-hexadecylamine hydrochloride, instead of the decylamine.

Balance:

Product	Weight	K_2O, Percent	Yield, Percent K_2O
Raw mineral	1,000	12.5	
floated	285	17.5	40
residue	765	9.8	

EXAMPLE 3

According to Example 1, but using as flotation agent the substance known as "ARMACT" (trade name of the stearoleopalmitic amine acetate produced by Armour Chemical Co.).

Balance:

Product	Weight	K_2O, Percent	Yield, Percent K_2O
Raw mineral	1,000	12.5	
floated	390	17.5	54.5
residue	665	8.58	

EXAMPLE 4

Type A solution ---------- 1500 cc.
n-Hexadecylamine (as hydrochloride) ----- 80 gr./ton.

The rest according to Example 1.

Balance:

Product	Weight	K_2O, Percent	Yield, Percent K_2O
Raw mineral	1,000	12.5	
floated	262	17.2	36
residue	798	10.0	

EXAMPLE 5

Type D solution ---------- 1500 cc.
n-Hexadecylamine (as hydrochloride) ----- 80 gr./ton.

The rest according to Example 1.

Balance:

Product	Weight	K_2O, Percent	Yield, Percent K_2O
Raw mineral	1,000	12.5	
floated	475	17.4	66
residue	565	7.5	

EXAMPLE 6

Type A solution ---------- 1500 cc.
n-Decylamine (as hydrochloride) ---------- 80 gr./ton.

The rest according to Example 1.

Balance:

Product	Weight	K_2O, Percent	Yield, Percent K_2O
Raw mineral	1,000	12.5	
floated	710	16.8	95.5
residue	330	1.52	

EXAMPLE 7

Type C solution ---------- 1500 cc.
n-Undecylene-amine (as hydrochloride) --- 80 gr./ton.
The rest according to Example 1.

Balance:

Product	Weight	K_2O, Percent	Yield, Percent K_2O
Raw ore	1,000	12.5	
floated	708	17.0	96
residue	334	1.5	

EXAMPLE 8

Type C solution ---------- 1500 cc.
Mixture of amines constituted of 30% n-nonyl, 35% n-decyl, 35% n-undecyl ---------- 80 gr./ton. as hydrochloride.
The rest according to Example 1.

Balance:

Product	Weight	K_2O, Percent	Yield, Percent K_2O
Raw mineral	1,000	12.5	
floated	705	16.9	95.5
residue	342	1.6	

The analyses were carried out using filtered and dried products. The overweight of the products with reference to the weight of the starting mineral is due to the salts from the saline imbibing solution.

We claim:

1. In a process of concentrating kainite by froth flotation, in which a suspension is formed of comminuted kainite containing material in saline water containing a frothing agent, the improvement comprising adding to the water at least one compound of the group consisting of normal primary aliphatic amines of the formula $R—NH_2$ in which R is a hydrocarbon radical having from 8 to 11 carbon atoms and is taken from the group consisting of alkyl and alkenyl radicals, and salts thereof with mineral acids.

2. In a process of concentrating kainite by froth flotation, in which a suspension is formed of comminuted kainite containing material in saline water containing a frothing agent, the improvement comprising adding to the water at least one compound of the group consisting of normal primary aliphatic amines of the formula $R—NH_2$ in which R is a hydrocarbon radical having from 8 to 11 carbon atoms and is taken from the group consisting of alkyl and alkenyl radicals, and salts thereof with mineral acids, the saline solution containing positive and negative ions of the group consisting of K, Na, Mg, Cl, SO_4.

3. The process defined in claim 2, the frothing agent being cyclohexanol.

4. The process defined in claim 2, the amine being normal decylamine.

5. The process defined in claim 2, the amine being normal undecylene amine.

6. The process defined in claim 2, the amine being normal nonyl amine.

7. The process defined in claim 2, the amine being normal undecyl amine.

8. The process defined in claim 1, the compound being an amine hydrochloride.

References Cited in the file of this patent

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