EXPORTS OF CHEMICALS AND ALLIED PRODUCTS (Continued)				EXPORTS OF CHEMICALS AND ALLIED PRODUCTS (Concluded)			
OTHER PRODUCTS (Continued):	1913 Pounds	1916 Pounds	1919 Pounds	OTHER PRODUCTS (Concluded):	1913 Pounds	1916 Pounds	1919 Pounds
Blackening and polishes:				Paper and Pulp (Concluded):			
In containers weighing 5 kilos or more.....	67,460	429,020	89,730	Germany.....	123,460	50,040	17,640
In containers weighing less than 5 kilos.....	166,010	100,310	116,850	Italy.....	130,730	218,920	731,490
Candles:				United States.....	31,750	174,380	.....
Ball tapers, Christmas tree candles, colored or ornamental candles.....	660	20,500	1,320	Packing.....	495,600	2,875,930	2,278,700
All other.....	58,860	209,220	33,950	France.....	199,740	2,720,060	1,427,270
Dextrin.....	352,080	1,100	11,680	Italy.....	95,680	20,720	665,580
Glue:				Paper pulp:	Metric Tons	Metric Tons	Metric Tons
For joiners, house painters, plasterers.....	2,914,950	2,631,000	3,953,770	Chemical.....	4,831	4,890	7,092
France.....	263,450	891,770	1,084,670	France.....	3,193	3,715	2,946
Germany.....	1,658,540	580,920	2,442,280	Italy.....	1,532	1,175	4,075
Italy.....	921,310	144,620	178,130	Mechanical.....	1,818	1,765	2,238
United Kingdom.....	19,620	697,320	38,360	France.....	1,702	1,700	2,192
United States.....	16,310	139,770	33,070	Pitch, unmanufactured.....	26	534	14
Gelatin, fish glue.....	432,330	413,140	300,270	Resins, manufactured (brewers' and shoemakers' pitch, etc.)	Pounds	Pounds	Pounds
France.....	18,300	88,180	57,980	and shoemakers' pitch, etc.)	23,590	436,730	16,630
United Kingdom.....	93,480	108,910	91,270	Soap:			
United States.....	160,720	39,020	29,320	Common, in bulk; in lumps, cakes, etc.; soft soap.....	253,310	1,298,300	1,601,650
Liquid or in powder.....	12,350	105,600	23,590	Germany.....	34,610	1,235,690	1,045,210
Liquid, for office use.....	10,140	1,760	9,480	Russia.....	440	.....	300,490
Ink:				France.....	112,440	48,720	10,360
Printing.....	7,060	126,100	15,650	Other (toilet, medicinal, special soaps).....	60,410	49,160	242,730
Writing and other.....	31,970	100,090	86,200	Soap powder and preparations for laundries.....	265,220	125,220	447,540
Paper and pulp:				Soap waste.....	2,186,540	315,480	488,550
Paper:				Starch gum, preparations for sizing and finishing.....	97,000	117,730	109,130
Newsprint.....	23,810	2,474,250	3,771,890	Metric Tons	Metric Tons	Metric Tons	Metric Tons
Belgium.....	.....	.....	446,000	.....	.....	101	.....
France.....	23,590	2,474,030	2,817,510	Pounds	Pounds	Pounds	Pounds
Italy.....	.....	220	472,450	.....	36,150,740	1,039,480	256,620
Other printing, writing, and drawing paper.....	514,780	1,973,140	2,735,050	France.....	8,007,630	51,370	31,970
France.....	64,600	1,347,900	1,599,680	Germany.....	27,925,730	982,600	220
				Turpentine, spirits of.....	69,450	.....	220

ORIGINAL PAPERS

NOTICE TO AUTHORS: All drawings should be made with India ink, preferably on tracing cloth. If coordinate paper is used, blue must be chosen, as all other colors blur on reduction. The larger squares, curves, etc., which will show in the finished cut, are to be inked in.

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An Application of the Vapor Pressures of Potassium Compounds to the Study of the Recovery of Potash by Volatilization^{1,2}

By Daniel D. Jackson and Jerome J. Morgan

COLUMBIA UNIVERSITY, NEW YORK, N. Y.

The immense amount of work which has been done upon the extraction of potash from complex mineral silicates is clearly shown by a bibliography on the subject published at the beginning of 1918 by E. C. Buck.³ This bibliography refers to no less than one hundred and thirty patents and fifty general articles published in the six years, 1912 to 1917. Of the proposed processes for the recovery of potassium in the form of soluble salts from the natural potassium-bearing silicates fully one-third are based upon the separation of the potassium compounds by volatilization. In spite of this great amount of work and with the stimulus of the inflated prices of potassium compounds, only a very few of the numerous processes proposed have been put into actual operation on a commercial scale. It was decided, therefore, to apply the knowledge obtained from the vapor pressure experiments recorded in a previous paper⁴ to an investigation of the volatilization of potassium compounds

from mixtures of silicates with releasing and volatilizing agents. It was thought that this investigation would show the reason for the apparent failure of so many of the proposed methods and might suggest the conditions for a method which would be commercially successful. In the light of the vapor pressure determinations the methods involving the use of a chloride seemed to be most practicable, and glauconite, or greensand, was thought to be the most promising of the natural silicates containing potassium. Hence the first experiments were made with mixtures of greensand and calcium chloride.

VOLATILIZATION OF POTASH FROM MIXTURES OF GREENSAND AND CALCIUM CHLORIDE

In these experiments a carefully weighed amount of greensand, powdered to pass a 200-mesh sieve, was well mixed in a small platinum boat with approximately 10 per cent of its weight of powdered, anhydrous, C. P. calcium chloride. The boat and contents were heated in the vapor pressure apparatus in a current of nitrogen dried with calcium chloride, as has been described under the determination of the vapor pressure of potassium chloride.

Irregular results obtained at 1200° C. were thought

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² Part of a thesis submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in the Faculty of Pure Science, Columbia University, New York, N. Y.

³ *Met. Chem. Eng.*, **18** (1918), 33, 90.

⁴ Jackson and Morgan, *THIS JOURNAL*, **13** (1921), 110.

to be due to the temperature being too low for complete fusion and rapid intermingling of the reacting substances. At 1300° the results of duplicate determinations agreed better, and the amount of potassium chloride volatilized varied with changes in the speed of the gas stream in such manner that it was possible to plot the partial pressures and obtain the vapor pressure of potassium chloride in the mixture. The value of 1.6 mm. of mercury thus obtained at 1300° bore, however, no apparent relation to the known vapor pressure of potassium chloride or to the amount of potassium in the mixture. The percentage of K₂O volatilized at 1300° was found to be only slightly greater than at 1200°. On account of the claim of Spackman and Cornwell¹ that the presence of water vapor in a cement kiln aids in the formation of soluble potassium compounds from potassium-bearing silicates and acid-forming gases, *e. g.*, chlorine from the decomposition of chlorides added with the charge, experiments were made in which water vapor was mixed with the nitrogen used in the vapor pressure tube. The results of these experiments show plainly that no advantage in the formation and volatilization of potassium chloride is gained by the use of water vapor with a mixture of calcium chloride and greensand.

The figures obtained with mixtures of greensand and calcium chloride are given in Table I.

TABLE I—VOLATILIZATION OF POTASH FROM MIXTURES OF GREENSAND AND CALCIUM CHLORIDE

Expt. No.	Minutes	Temperature ° C.	Weight of Greensand	Charge CaCl ₂	Charge	K ₂ O in Charge	K ₂ O in Residue	Per cent K ₂ O Volatilized
82	12	1204	0.5993	0.060	0.0363	0.0320	12	12
83	12	1203	0.6744	0.075	0.0408	0.0354	13	13
84	14	1208	0.6153	0.061	0.0373	0.0332	11	11
85	14	1205	0.5710	0.064	0.0346	0.0301	13	13
86	16	1201	0.7117	0.072	0.0431	0.0385	11	11
87	15.5	1202	0.6660	0.066	0.0403	0.0350	13	13
88	18	1303	0.6364	0.065	0.0386	0.0319	17	17
89	11	1301	0.6008	0.061	0.0364	0.0310	15	15
90	11	1300	0.6086	0.061	0.0369	0.0313	15	15
91	18	1301	0.6314	0.065	0.0383	0.0317	17	17
92	26	1302	0.5819	0.058	0.0353	0.0286	19	19
93	26	1302	0.5879	0.059	0.0356	0.0284	20	20
94 ¹	26	1297	0.5541	0.055	0.0336	0.0281	16	16
95 ¹	26	1303	0.5728	0.057	0.0347	0.0277	20	20
96 ¹	16	1298	0.6059	0.061	0.0367	0.0311	15	15
97 ¹	17	1302	0.5900	0.059	0.0358	0.0306	14	14
98 ¹	12	1299	0.6235	0.062	0.0377	0.0310	18	18
99 ¹	12	1301	0.6338	0.063	0.0384	0.0333	13	13

¹ The gas used was a mixture of nitrogen and dry steam.

VOLATILIZATION OF POTASH FROM MIXTURES OF SILICATES WITH LIME

The next experiments were with calcium oxide as a releasing agent. On account of the number of experiments necessary to obtain results which can be plotted and extrapolated to vapor pressures, and on account of the difficulty in finding any definite relation between the vapor pressures of potassium compounds in the mixtures and the vapor pressures of the pure compounds involved, it was decided to run the experiments in duplicate. The speed of the gas stream was varied, but the time of the experiment was kept constant. The results were expressed in terms of the percentage of potassium oxide volatilized. The knowledge of the vapor pressure of the pure potassium compounds involved was then used in interpreting the results. In the experiments with lime as a releasing agent the mixtures given in Table II were

used. The results of heating these mixtures for 11 min. at 1300° C. are shown in Table III.

TABLE II—MIXTURES OF SILICATES AND LIME USED IN VOLATILIZATION EXPERIMENTS

Mixture No.	Materials Used	Proportions Grams	Per cent of CaO after Heating Calculated	K ₂ O in Raw Mixture
I	Greensand	10		
	CaCO ₃ pptd.	22	64	1.90
3	Greensand	30		
	Limestone	70	50	2.38
VI	Greensand	10		
	Calcium hydroxide	15	62	2.46
VIII	Greensand	6		
	CaCO ₃ pptd.	9	48	2.42
VII	Greensand	6		
	CaCO ₃ pptd.	6	38	3.03
III	Feldspar	3		
	CaCO ₃ pptd.	9	65	3.50
V	Feldspar	3		
	Ca(OH) ₂	6	64	4.70

TABLE III—VOLATILIZATION OF POTASH FROM SILICATE AND LIME MIXTURES (Heated 11 min. at 1300° C.)

Expt. No.	Mixture No.	Cc. N ₂ per Min.	Water Vapor Mg.	Charge Grams	Loss in Weight Per cent	Mg. K ₂ O in Charge	K ₂ O in Residue	Per cent K ₂ O Volatilized
100	I	150	....	0.5754	34.9	10.9	2.7	75
101	I	117	....	0.5727	34.9	10.9	2.7	75
102	I	79	....	0.5529	35.0	10.5	2.4	77
106	I	150	10.9	0.5502	35.2	10.5	1.0	91
107	I	117	7.8	0.5695	35.2	10.8	1.1	90
108	I	80	6.0	0.5839	35.2	11.1	1.2	89
150	3	162	....	0.5588	32.9	13.3	9.3	30
151	3	134	....	0.5390	33.0	12.8	9.8	23
152	3	163	8.2	0.5242	33.5	12.5	6.1	51
153	3	132	7.2	0.5062	33.6	12.1	5.5	55
116	VI	161	....	0.5032	19.9	12.4	7.4	40
117	VI	135	....	0.4971	20.0	12.2	6.6	46
122	VI	161	13.7	0.5362	20.3	13.2	5.8	55
148	VIII	160	....	0.4763	30.6	11.6	10.4	10
146	VIII	160	19.9	0.4732	30.7	11.4	10.0	12
142	VII	160	....	0.4140	27.3	12.5	11.5	8
144	VII	160	5.8	0.4290	27.1	13.0	12.1	7
112	III	162	....	0.3100	34.0	10.9	9.9	9
113	III	134	....	0.3077	34.0	10.8	9.7	10
118	III	158	7.6	0.3030	34.3	10.6	8.5	20
119	III	133	6.6	0.3050	34.3	10.7	8.4	22
114	V	164	....	0.3030	17.7	14.5	13.5	7
115	V	133	....	0.2992	17.8	14.3	13.1	8
120	V	160	12.3	0.3262	18.1	15.7	13.5	14
121	V	146	11.1	0.3116	18.3	15.0	12.8	15

A consideration of the results of the experiments given in Table III leads to the following conclusions:

(1) The low volatilization in the feldspar mixture (III) is due to the fact that the vapor pressure of potassium oxide alone is too low at 1300° C. to cause rapid and complete volatilization of the potassium in the mixture. The vapor pressure of potassium oxide from potassium carbonate has been found to be 1.68 mm. at 970° C. and 5.0 mm. at 1130°, while the vapor pressure of potassium chloride at these temperatures is 10.1 mm. and 52.7 mm., respectively. If the vapor pressure curve for potassium oxide in potassium carbonate has the same general form as that for the chloride, the vapor pressure of the oxide at 1300° C. would be about 13 mm. It would seem that the vapor pressure of potassium oxide in the highly limed mixture of silicate and lime is not greater than that of potassium oxide in the carbonate, and has probably about the same value as the vapor pressure of water at 15° C.

(2) The explanation of the higher results in the greensand mixture (I) lies in the fact that greensand is a hydrated silicate. Accordingly, any K₂O formed by the action of CaO upon the greensand is formed in the presence of water vapor which is being evolved from the silicate. This affords an excellent opportunity for the formation of potassium hydroxide, provided the reaction

is not completely reversed at 1300° C. The statements of Deville,¹ quoted by Roscoe and Schorlemmer,² and of Watts³

¹ *Compt. rend.*, **45** (1857), 857.

² Roscoe and Schorlemmer, "Treatise on Chemistry," Vol. II, "The Metals," 1907, 321.

³ Watts, "Dictionary of Chemistry," Vol. IV, 1868, 702.

¹ U. S. Patent 1,202,327 (1916); C. A., **11** (1917), 89.

are contradictory on this point, but it is believed that at a temperature of 1300°, or lower, the reaction of K_2O and H_2O to form potassium hydroxide must certainly take place at a speed which is not inappreciable. Now the vapor pressure of potassium hydroxide at 800° C. has been determined and found to be about as great as that of the chloride at 950° and considerably greater than that of the oxide from the carbonate at 1130°. At 1300° the vapor pressure of potassium chloride is 202 mm., and at this temperature the hydroxide must be near its boiling point. Hence it is believed that when the greensand molecule reacts with calcium oxide at the high temperature of these experiments, a considerable portion of the potassium in the greensand forms potassium hydroxide with the oxygen and hydrogen which are combined in the silicate, and is thus volatilized from the mixture. In an attempt to aid the volatilization of potassium from the greensand and feldspar before the theory of the volatilization as given above had been fully developed, some experiments were made in which calcium hydroxide was substituted for calcium carbonate in the mixtures (V and VI). The use of calcium hydroxide did not aid the volatilization and it is not to be expected that it would, for this compound is dissociated into calcium oxide and water vapor so rapidly at the high temperature of the experiments and the water vapor is so quickly carried away from the mixture by the rapid stream of dry nitrogen used that there is little chance for the formation of potassium hydroxide. On the other hand, the water vapor from greensand is given off rather slowly, and since the hydrogen and oxygen exist closely associated with the potassium in the greensand molecule there is every chance for the formation and volatilization of potassium hydroxide.

(3) The results of the experiments in which nitrogen carrying a considerable amount of water vapor was used instead of dry nitrogen confirm in a very striking manner this new theory of the volatilization of potassium from mixtures of silicates with lime in about the proportions used in the manufacture of portland cement. According to the theory, the low volatilization of potassium from the feldspar and lime mixtures is due to the low vapor pressure of potassium oxide formed by interaction of the potassium aluminium silicate and calcium oxide, and the higher volatilization of the potassium from the greensand and lime mixtures is on account of the high vapor pressure of potassium hydroxide, which is formed along with potassium oxide by the action of calcium oxide on the *hydrated* potassium iron silicate. The potassium hydroxide thus formed may be dissociated at this high temperature, possibly according to the reaction:

Hence it would be expected that a continuous and fairly large supply of water vapor in the atmosphere of the reaction chamber would prevent to some extent the dissociation of the potassium hydroxide and aid in the volatilization of potassium from the mixture. It would also be expected that the water vapor thus supplied would react to form hydroxide with the potassium oxide in the feldspar mixtures and increase the volatilization of potassium from these mixtures as well. The results of the experiments in which water vapor was used completely fulfilled these expectations, and thus confirmed the theory of the volatilization of potassium as developed above.

(4) The percentage of potassium volatilized from the mixture (3) of greensand with limestone is lower than that obtained when either precipitated calcium carbonate or calcium hydroxide was used. This is probably due partly to the lower lime content of the mixture and partly to impurities present in the limestone. Even in this mixture, however, the volatilization was doubled by the use of water vapor.

(5) The very low volatilization of potassium in the greensand mixtures (VII and VIII) is due partially to the small percentage of lime in the mixtures, but mainly to the fact that these low lime mixtures at this temperature fuse completely,

forming a glass in which the potassium is probably combined with the silica and thus dissolved in the other liquid silicates so that it is prevented from volatilizing both by being chemically combined in a rather nonvolatile compound and by being dissolved in a viscous liquid. Undoubtedly the small amount which was volatilized came off during the melting of the mixture. Naturally when potassium is held in a glassy silicate, water vapor cannot aid in its volatilization.

VOLATILIZATION OF POTASH FROM MIXTURES OF SILICATES WITH LIME AND CALCIUM CHLORIDE

From our knowledge of the vapor pressures of the compounds involved it might be predicted that better results would be obtained in the volatilization of potassium from silicate mixtures containing both lime and calcium chloride, than from mixtures of silicates with either of these compounds alone.

In the experiments to test the efficiency of calcium chloride as a volatilizing agent when used in conjunction with lime as a releasing agent, the mixtures given in Table IV were used. Both were made in proportions which would give, after heating, a residue that approached portland cement in composition.

TABLE IV—MIXTURES OF SILICATES WITH CALCIUM CARBONATE AND CALCIUM CHLORIDE

Mixture No.	Materials Used	Proportions Grams	Per cent of—	
			CaO after Heating Calculated	K ₂ O in Raw Mixture
II	Greensand	10		
	CaCO ₃ pptd.	21		
	CaCl ₂ anhyd.	1	65	1.90
IV	Feldspar	10		
	CaCO ₃ pptd.	26		
	CaCl ₂ anhyd.	2	65	3.70

The results of heating these mixtures for 11 min. at 1215° and at 1300° C. are given in Table V. The experiments with the greensand mixture at 1300° were made first. Since the volatilization was practically complete at this temperature, the experiments at 1215° were performed so as to find whether the use of water vapor had any influence on the volatilization of potash from cement mixtures when used in connection with a chloride.

TABLE V—VOLATILIZATION OF POTASH FROM MIXTURES OF SILICATES WITH LIME AND CALCIUM CHLORIDE (Heated 11 Min. with 125 to 170 Cc. of Nitrogen Passing per Min.)

Expt. No.	Mixture No.	Temperature ° C.	Water Vapor Mg.	Charge Grams	Loss in Weight	—Mg. K ₂ O—		Per cent K ₂ O Volatilized
					Per cent	in Charge	in Residue	
103	II	1300	....	0.5603	36.0	10.7	0.3	97
104	II	1300	....	0.5618	35.9	10.7	0.3	97
105	II	1300	....	0.5629	36.1	10.7	0.2	98
109	II	1300	10.9	0.5132	36.2	9.8	0.3	97
110	II	1300	12.0	0.5551	36.2	10.5	0.3	97
111	II	1300	8.1	0.5350	36.2	10.2	0.2	98
132	II	1215	....	0.5223	36.2	9.9	0.7	92
133	II	1215	....	0.5301	36.2	10.1	Trace	..
134	II	1215	7.4	0.5301	36.2	10.1	0.8	92
135	II	1215	15.6	0.5257	36.2	10.0	0.4	96
136	IV	1215	....	0.3249	36.8	12.0	3.5	71
137	IV	1215	....	0.3056	36.9	11.3	3.1	73
138	IV	1215	13.7	0.3021	36.9	11.2	2.9	74
139	IV	1215	7.3	0.3149	36.9	11.6	3.0	74

The results of the experiments on mixtures of greensand and of feldspar with both calcium oxide and calcium chloride in proportions to give a residue which has about the composition of portland cement show that:

(1) The removal of potassium by volatilization from the greensand mixture is practically complete in 11 min. at a temperature as low as 1215° C., but the volatilization of potassium from the feldspar mixture is not as complete.

(2) As might be expected, no advantage is gained by the use of water vapor when there is present in the mixture sufficient chlorine as chloride to form with the potassium of the silicate the stable compound potassium chloride, whose vapor pressure, 101 mm. at 1215° C. and 202 mm. at 1300° C., is high enough to allow of rapid evaporation.

(3) The claims made by Spackman and Cornwell¹ that the presence of water vapor aids in the formation of potassium chloride from chlorides and potassium-bearing silicates appear to be unfounded.

VOLATILIZATION OF POTASH FROM LOW LIME SILICATE-CHLORIDE MIXTURES

In the previous experiments we had learned: first, that potash is volatilized at a lower temperature and more rapidly from greensand mixtures than from feldspar mixtures; and, second, that the volatilization of potash from low lime mixtures which fuse is slight. It was surmised, however, that in the latter case the low volatilization was due rather to the fusion of the mixture than to the lack of lime to set free the potash from the silicate.

A series of experiments was therefore run using mixtures of greensand with a chloride and with limestone in much smaller proportions than the proportion of limestone used in portland cement mixtures. In these experiments the mixtures given in Table VI were used.

TABLE VI—LOW LIME GREENSAND-CHLORIDE MIXTURES

Mixture No.	Materials Used	Proportions Grams	Ratio of Greensand to Limestone	(Percentage of—) Chloride Added	K ₂ O in Mixture
5	Greensand	50	1:1	None	3.85
	Limestone	50			
7	Greensand	10	1:1	5.0	3.67
	Limestone	10			
	Sodium chloride	1			
8	Greensand	10	1:1	4.5	3.69
	Limestone	10			
	Calcium chloride	0.9			
9	Greensand	20	2:1	7.0	4.75
	Limestone	10			
	Sodium chloride	2.1			
10	Greensand	20	2:1	3.0	4.95
	Limestone	10			
	Sodium chloride	0.9			

The results of heating these mixtures at temperatures just below those at which they start to fuse are given in Table VII.

TABLE VII—VOLATILIZATION OF POTASH FROM LOW LIME GREENSAND-CHLORIDE-LIMESTONE MIXTURES
(Air Passing at Rate of 100 to 150 Cc. per Min.)

Expt. No.	Mixture No.	Temperature °C.	Time, Min.	Ratio Greensand to Limestone	Chloride Kind	Per cent	Charge, G.	Loss in Wt. Per cent	In Charge Mg.	In Residue Mg.	Per cent Volatilized
155	5	1050	60	1:1	None		0.4419	25.12	17.0	17.2	0
161	5	1170	30	1:1	None		0.4810	25.63	18.5	17.3	0
163	5	1170	30	1:1	None		0.4641	25.45	17.9	16.9	6
156	7	1050	60	1:1	NaCl	5.0	0.4434	30.09	16.3	6.0	63
157	7	1190	15	1:1	NaCl	5.0	0.4862	31.96	17.8	0.4	98
158	7	1200	15	1:1	NaCl	5.0	0.4737	31.10	17.4	1.6	91
159	7	1170	15	1:1	NaCl	5.0	0.4627	31.55	17.0	1.6	91
165	8	1170	15	1:1	CaCl ₂	4.5	0.4767	31.63	17.6	3.6	80
167	9	1170	15	2:1	NaCl	7.0	0.4222	28.00	20.0	3.0	85
171	10	1170	15	2:1	NaCl	3.0	0.4260	24.25	21.1	8.1	62

A consideration of the results given in Table VII shows that:

(1) The volatilization of potash from a 1:1 mixture of greensand and limestone without the addition of a chloride is very small at temperatures up to 1170° C. This is true even in the presence of water vapor which was used in Expt. 163.

(2) On addition of a chloride in proportion slightly greater than that calculated for the formation of potassium chloride,

the potash in greensand and limestone mixtures can be readily volatilized at temperatures slightly lower than the temperatures at which the mixtures begin to fuse. This has been shown for mixtures containing as little as one-third limestone.

(3) Sodium chloride appears to be somewhat more efficient than calcium chloride as a volatilizing agent, and when less chloride is used than the amount calculated to give potassium chloride with all of the potassium in the mixture there is a decided decrease in the volatilization.

SUMMARY

1—In the application of a knowledge of the vapor pressures of potassium compounds to a study of the volatilization of potash from silicate mixtures, a new theory involving the high vapor pressure of potassium hydroxide has been advanced to explain the volatilization of potassium from silicate and lime mixtures. This theory is supported by the fact that greensand which contains the elements of water loses its potassium by volatilization very much more readily than feldspar, and by the fact that when water vapor is present to aid in the formation of potassium hydroxide, the volatilization of potassium from high lime mixtures is greatly increased in every case.

2—Experiments on a mixture of feldspar with calcium chloride and lime in the proportions necessary to give a portland cement clinker, and on a mixture of glauconite with lime and calcium chloride, show that the potash is volatilized from both silicates at temperatures as low as 1215° C. The potash is, however, more readily volatilized from the glauconite than from the feldspar.

3—It has been shown that when a chloride is used in the volatilization of potash no advantage is gained by the use of water vapor. This is in accord with what might be expected, since the chloride of potassium is so much more stable at high temperatures than the hydroxide, and is contrary to the patent claims of Spackman and Cornwell.

4—Experiments on mixtures of greensand with a chloride in the proportion calculated to give potassium chloride and limestone in proportions much lower than those used in portland cement mixtures show that the potash can be readily volatilized from mixtures containing as little as one-third of limestone, provided the mixture is heated at a temperature slightly below its fusing point.

Examination for Pyrotechnic Assistant

The United States Civil Service Commission has announced an examination for pyrotechnic assistant at \$1872 a year to fill a vacancy at Picatinny Arsenal, Dover, N. J., and other vacancies requiring similar qualifications. The duties of the appointee will be to assist in the development of design, test, and manufacture of military pyrotechnics and in addition the duties of an observer and firer from aircraft. Competitors will be rated on (1) physical ability, 40; (2) education, experience, and fitness, 60. Applicants must be high school graduates and have had one year's experience along the line of pyrotechnic material. Experience in flying and acquaintance with the present equipment and devices of the Aircraft Divisions of the War Department are desirable. Applications should be filed with the United States Civil Service Commission, Washington, D. C., prior to the hour of closing business on April 5, 1921.

¹ Loc. cit.