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ORIENTAL JOURNAL OF CHEMISTRY
An International Open Free Access, Peer Reviewed Research Journal

www.orientjchem.org

ISSN: 0970-020 X
CODEN: OJCHEG
2017, Vol. 33, No. (3):
Pg.1347-1353

Development of the Composition and Method of Producing A Liquid Complex Fertilizers With A Stabilizing Additive

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http://dx.doi.org/10.13005/ojc/330335

(Received: April 14, 2017; Accepted: May 10, 2017)

ABSTRACT

The article is devoted to the study of technological bases of processing of phosphate waste – cottrell dust and vermiculite as a stabilizing additive in a liquid complex fertilizer. Target of the research work were implemented as a result of engaging in technological conversion of solid industrial waste – cottrell dust. While cottrell dust was used as a phosphorus raw material, and vermiculite as the substrate, for mulching and aeration of the soil, nourishes the plants with minerals. Results of studies allowed to establish as a optimal regime parameters of the process of obtaining liquid complex fertilizers.

Keywords: chemical industry, cottrell dust, recycling, industrial waste, liquid complex fertilizer.

INTRODUCTION

Liquid fertilizers are water solutions or slurries of mineral and some organic nutrients. The most common mineral nitrogen - and phosphorus-containing liquid complex fertilizers. This product group includes solutions of salts containing two or three major nutrients (N, P, K) and macronutrients (Ca, Mg, S) and micronutrients (Fe, Mn, B, Cu, Zn, Mo, Co). Nitrogen-phosphorus liquid complex fertilizer are solutions of phosphates of ammonium, obtained by high temperature treatment with ammonia, H_3PO_4 or polyphosphoric acids[1].

MATERIAL AND METHODS

Unlike the traditional methods, for the production of housing services uses a mixture of

cottrell dust, vermiculite and humic acid at[2] various ratios. Vermiculite of Kulantau field[3] having the following composition: SiO_2- 37,44, CaO-2,10, MgO-23,88, K_2O+Na_2O-1,18, Fe_2O_3 - 6,01, Al_2O_3 - 11,23, H_2O - 17,18, used as stabilizing additive[4]. Pre-synthesized humic acid with pH = 0,760, as in previous works, is used as a substitute for sulphuric, nitric or phosphoric acids.

It was established that the composition cottrell dust[5] meets the following content, %: P_2O_5 total - 25, K_2O - 5, Na_2O- 1, SiO_2 - 25, CaO - 10, MgO - 1, Al_2O_3 - 3, Fe_2O_3 - 1, C - 24.

A mixture of finely cottrell dust, activated water, vermiculite, of a dilution solution consisting of potassium sulphate and 30% ammonium sulphate is decomposed by humic acid at a temperature of 60^{0}C and 90 minutes. The addition of solutions of potassium sulphate and ammonium sulphate increases[6] potassium and nitrogen and consequently in the composition of the liquid complex fertilizer[7].

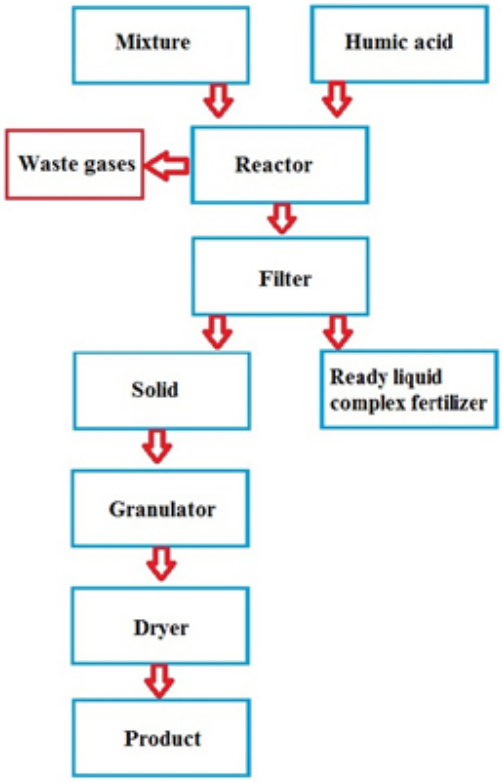

Fig. 1: Process flow diagram of receiving liquid complex fertilizer with a stabilizing additive

The process chemistry is possible will present as follows[8,9]

$Ca_5(PO_4)_3F$ + 6Humic Acid + $2(NH_4)_2SO_4$ + K_2SO_4 + H_2O = $2CaSO_4$ + NH_4(Hum) + H_3PO_4 + $2Ca(Hum)_2$+ $Ca(H_2PO_4)_2$ + HF + 2KHum

Process flow diagram for synthesizing the liquid complex fertilizer is shown in Fig. 1.

The mixture after decomposition is filtered. It is established that the obtained liquid phase has a density of 1.2 and pH = 2,7.

The resulting solution is analyzed for the content of assimilable and water-soluble P_2O_5, ammonia and nitrogen.

RESULTS AND DISCUSSION

Laboratory work has been tested in the laboratory of the Department Chemical technology of inorganic substances, M. Auezov SKSU, and physicochemical analyses[10] were performed in the Regional Laboratory Test Engineering Profile (RLTEP) on the basis of the M. Auezov SKSU.

The resulting product has the following material composition:

Physicochemical features derived from cottrell dust liquid complex fertilizer. Using a scanning electron microscope is performed element-by-element and mineralogical analysis of its composition. The results of the microscopic studies allowed to image the surface of samples and the spectra of individual points, with the idea element by element, and percentage composition, as well as diffraction peaks of individual elements with high

Table 1. Physico chemical parameters obtained in the laboratory liquid complex fertilizer

N_0	Name of indicators	Indicators
1	Mass fraction of total phosphates, %	11,3
2	Mass fraction of assimilable phosphates, %	11,0
3	Mass fraction of total nitrogen (N), %	0,75

Table 2: Element wise composition of liquid complex fertilizer, calcined at 500^{0}C

Element	Weight composition, %	Weight composition, in terms of oxide, %
O	54,07	-
Na	1,38	1,86
Mg	1,30	2,15
Al	0,31	0,58
P	27,52	63,04
S	0,48	1,20
Cl	0,98	-
K	9,16	11,95
Ca	3,99	5,58
Mn	0,22	0,28
Zn	0,49	0,60
Fe	0,10	0,12

Table 3: Element wise composition of solids

Element	Weight composition, %	Weight composition, in terms of oxide, %
O	43,95	-
Na	1,48	1,99
Mg	1,98	3,28
À²	2,77	5,23
Si	19,49	41,68
P	10,96	25,19
S	2,28	5,70
Cl	0,52	-
K	4,85	6,32
Ca	9,11	12,74
Mn	0,24	0,30
Zn	0,86	1,06
Fe	0,53	0,67

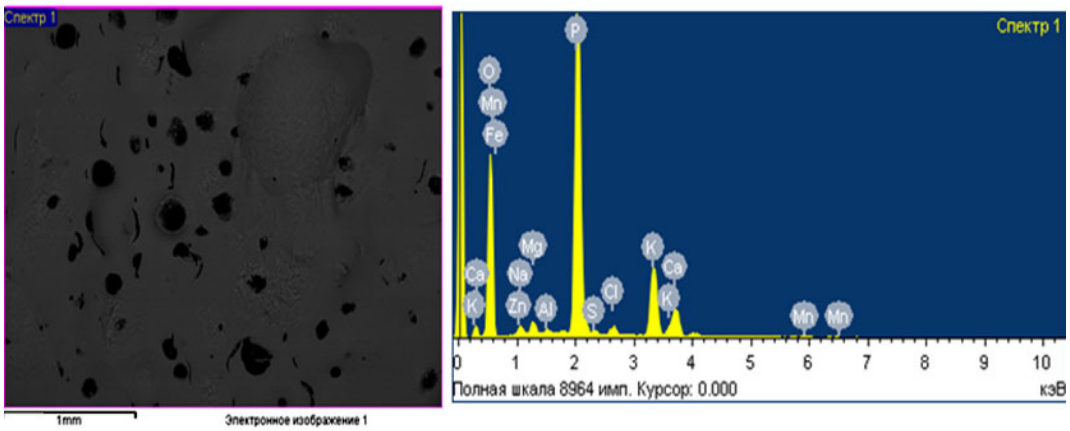

Fig. 2: Microscopic picture of liquid complex fertilizers

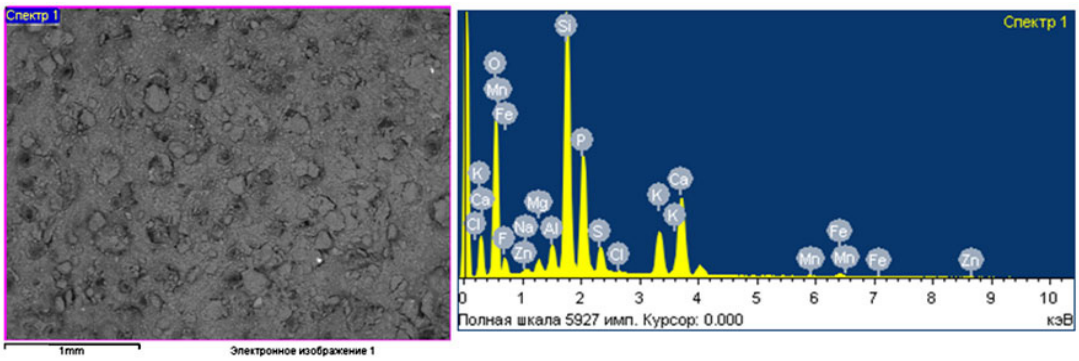

Fig. 3: Microscopic picture of solids after filtration

spatial resolution and the desired depth of field of view.

Microscopic picture and the results of elemental analysis of the liquid complex fertilizer is presented in fig. 2 and table 2.

The dry residue remaining after filtration is also is a useful product which corresponds to a double super phosphate low grade (Fig.3, table 3). The residue is granulated and dried at a temperature of 100-110 ^{0}C in 3-5 hours. The obtained dry residue has the following physical characteristics, %: P_2O_5 total – 20; P_2O_5 assimilable-15; P_2O_5 water-soluble-8,75.

IR spectral analysis of liquid complex fertilizers was conducted on the instrument IR spectrometer Shimadzu IR Prestige-21. In table 4 and fig.4 shows the main peaks according to the results of IR spectral analysis of liquid complex fertilizers.

IR spectra of the studied[10] samples of the liquid complex fertilizers are characterized by intense peaks of the broad bands of absorption with satellites

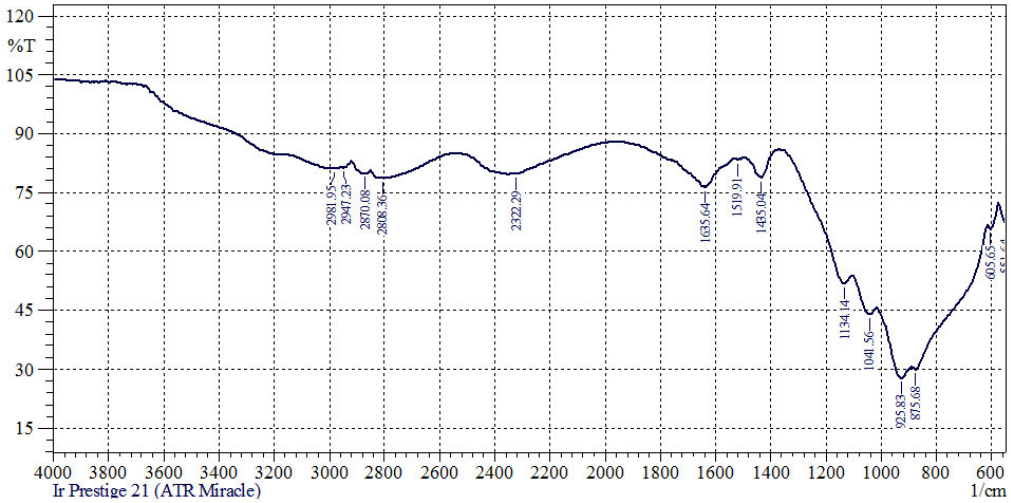

Fig. 4: IR spectral analysis of liquid complex fertilizers

Table 4: The peaks in the IR-spectral analysis of liquid complex fertilizers

No.	Peak	Intensity	Corr.intensity	Base	Base	Area (H)	Corr.area (L)
1	551,64	67,192	0,980	574,79	547,78	4,367	0,098
2	605,65	65,697	2,139	613,36	578,64	5,902	0,385
3	875,68	29,990	2,608	891,11	617,22	98,804	4,773
4	925,83	27,691	6,704	1014,56	894,97	56,342	4,823
5	1041,56	43,898	3,995	1103,28	1018,41	27,792	1,816
6	1134,14	51,955	5,310	1365,60	1107,14	43,230	2,061
7	1435,04	78,933	6,091	1496,76	1381,03	9,916	1,740
8	1519,91	83,358	0,458	1557,62	1500,62	2,100	0,040
9	1635,64	76,504	8,317	1932,67	1531,48	33,421	6,617
10	2322,29	79,715	0,201	2330,01	1978,97	26,267	0,041
11	2808,36	78,723	2,333	2846,93	2549,89	26,765	2,349
12	2870,08	79,866	1,492	2916,37	2850,79	6,201	0,459
13	2947,23	81,359	0,461	2954,95	2920,23	2,994	0,063
14	2981,95	80,959	0,879	3151,69	2958,80	16,234	0,590

Table 5. The peaks in the IR-spectral analysis of dry residue after filtration

No.	Peak	Intensity	Corr.intensity	Base (H)	Base (L)	Area	Corr.area
1	563,21	69,162	3,293	578,64	547,78	4,671	0,336
2	601,79	70,888	5,015	621,08	582,50	5,134	0,450
3	655,80	77,998	0,153	659,66	640,37	2,057	0,013
4	675,09	77,475	0,115	678,94	659,66	2,104	0,004
5	802,39	68,978	4,538	840,96	686,66	20,773	1,387
6	910,40	66,648	3,849	956,69	844,82	18,315	1,522
7	1033,85	42,840	31,505	1330,88	960,55	59,024	25,826

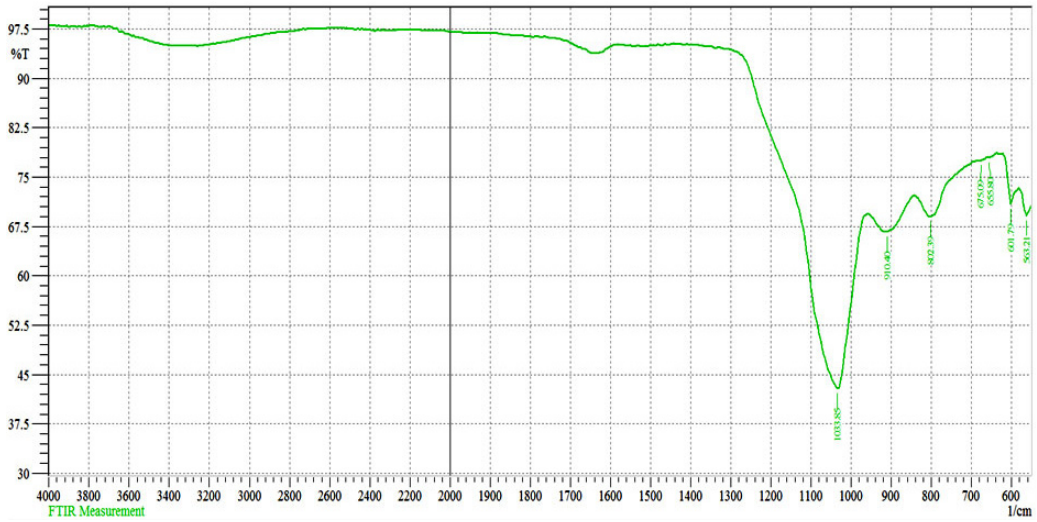

Fig. 5: IR spectral analysis of dry residue after filtration

in the areas of 500-900 cm^{-1} and 2600-3700 cm^{-1}. It should be noted that the wavelengths in the absorption region of 550-700 cm^{-1} is characteristic for alkanes and alkene with communication RC≡CH, and 850-900 cm^{-1} for compounds alkane and alkene of a number of types of the C=C=C. The peaks of intensive absorption in the region of 2600-3700 cm^{-1} characterizes carbonyl group aromatic a number of types CH_2-COOH, C=C-COOH.

In table 5 and fig.5 shows the main peaks according to the results of infrared spectral analysis of dry residue after filtration.

From fig.5 and table 5 data follows

- 1049-1060 absorption spectra with wavelengths characteristic of phosphorus compounds, P=O (with hydrogen bonds)
- 952-906 typical P-F and phosphates
- absorption spectra with wavelengths of 1020-1090 characterize the presence of cottrell dust in compounds of silicates with valence relations Si-O-Si
- absorption spectra in the region 800-802 characteristic of silicate compounds charge materials in the valence state of Si-O-Ca and Si-O-Al[10]

Studied optimal regime parameters to the production of liquid complex fertilizers. The results are shown in table 6 and fig.6.

From table 3.2 it is seen that the optimal regime indicators developed technology for production of liquid complex fertilizers are

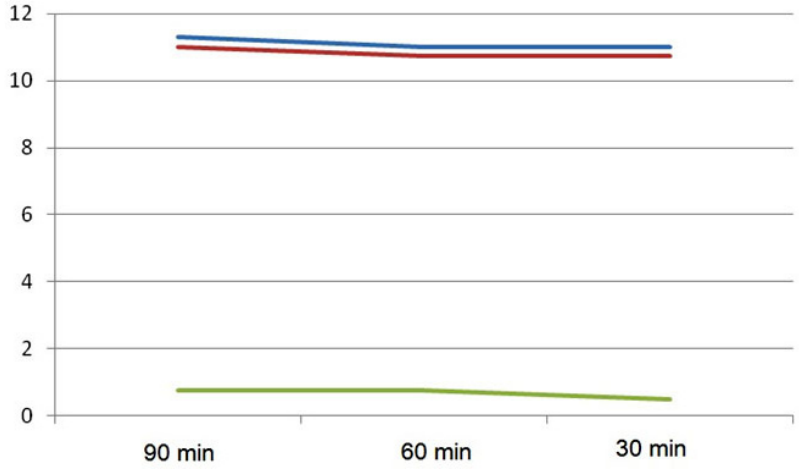

Fig. 6: The dependence of the process at 60^{0}C

Table 6: The results of the research of optimal regime parameters

Time, min	$P_2O_{5\ total}$, %	P_2O_5 assimilable, %	N, %
1	2	3	4
	30 ^{0}C		
90	9,5	9,0	0,5
60	9,4	8,36	0,5
30	9,0	7,76	0,12
	40 ^{0}C		
90	9,75	9,0	1,0
60	9,6	8,75	0,75
30	9,5	8,5	0,75
	60 ^{0}C		
90	11,3	11,0	0,75
60	11,0	10,75	0,75
30	11,0	10,75	0,5
	75 ^{0}C		
90	10,3	10,0	0,5
60	10,3	9,8	0,5
30	10,0	9,75	0,3

- temperature – 60 ^{0}C
- for the duration of the process – 90 min.

CONCLUSION

Thus, on the basis of a mixture of phosphorus sludge and vermiculite in conditions of temperature 60 degrees and at optimum process duration of 90 minutes it is possible to obtain liquid complex fertilizer with the content of assimilable phosphoric anhydride - 11%, nitrogen is 0.75%, zinc is 0.60%; the dry residue obtained after the stage filtration, is composed of : phosphor – of 10.96% (calculated as P_2O_5 – 25%, including P_2O_5 assimilable – 15%, P_2O_5 water-soluble – 8,75%), in line with double superphosphate; the source of the vermiculite used in the process of decomposition of the phosphate of secondary raw materials, is a highly effective stabilizing additive, which are used to improve soil structure, referred to as the “agronomic” rock. The residual part of the utility and double superphosphate humic acid will fulfill the role of organic-mineral additives, which improve the soil structure, and show the quality of the protective compositions of plants from pests and diseases.

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