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INVESTIGATION OF REACTIONS FOR PROCESSING OF SUGAR-JUICE DEFECATION SLUDGE FOR OXIDE MATERIALS AND FERTILIZERS

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At first, reactions of defecate of sugar production with acid oxides MoO_3, WO_3 (I) and phosphate acid H_3PO_4 (II) were investigated with methods of chemical analysis, pH-measuring, thermogravimeasuring and X-rays. In the system (I) separate phases with tetragonal syngony are forming, while in the system (II) the mixture of $Ca_3(PO_4)_2$, CaHPO4and $Ca(H_2PO_4)_2$ are precipitating.

These products can be used as inorganic oxide materials and fertilizers or forages addings for agriculture.

Introduction. The defecate of sugar production (carbonate precipitate or sugar-juice defecation sludge) is a chemical setting of sugar-refinery, it is used as fertilizer for acid grounds [1, 2], its application in other industries is not known. The data published about investigations of this precipitation as adsorption for purification of waste water from textile dyestuff [3] and as component of mixtures with NPK-fertilizers [4, 5]. Studying of defecate of sugar production is not realized in other fields. That's why the purpose of this research is to study reactions of defecate of sugar production, chemical composition of which is determined for tests of two plants [6, 7].

The experimental part and discussion of results. For the experiment acid oxides MoO_3, WO_3, phosphate acid H_3PO_4 with qualification "A. R. purity", defecate of sugar production taken from Kapitanivskyy sugar plant of the Kirovograd region were used. Chemical composition of this sugar-juice defecation sludge (IPC-MS analysator Element 2) is represented in table 1.

Methods of chemical analysis (trilonometry [8] — for determination of quantity of Ca^{2+} and precipitation of NH_4MgPO_4 — for determination of quantity PO_4^{3-} ions [9]), pH-measuring (pH-meter Y-160 MY), termogravimeasuring (derivatograph Q-1500-D of system of P. Paulik – L. Paulik – L. Erdey, with the speed of heating 0,1667 grad/s, DTA — 250, DTG — 500, TG — $0{,}2 \cdot 10^{-3}$kg) and X-ray (DRON 3M with Cu_kα-ray) are used.

Mixtures of defecate sugar production and MoO_3 or WO_3were taken at ratio $[CaCO_3]:[EO_3] = 1{,}0:1{,}0$, E – Mo, W, ([$CaCO_3$] – quantity of the matterin the defecate)

1.Resultsof chemicalanalysisofcarbonate precipitate of Kapitanivskyy sugar plant

Formula of oxide	Contents ofoxide, mass.%	Element	Contents ofelement, mass.%
SiO_2	5,49	Mn	0,02
TiO_2	0,09	Ni	0,0002
Al_2O_3	3,13	Cd	not find
Fe_2O_3	0,77	Ti	0,01
FeO	1,43	V	0,0003
MnO	0,01	Cr	0,0001
MgO	1,20	Cu	0,0005
CaO	36,56	Be	not find
Na_2O	0,14	As	not find
K_2O	0,20	Pb	0,0002
P_2O_5	0,07	Mo	0,001
H_2O (OH–group)	3,68	Zn	0,004
ignitionloss	46,61		
sum	99,69		

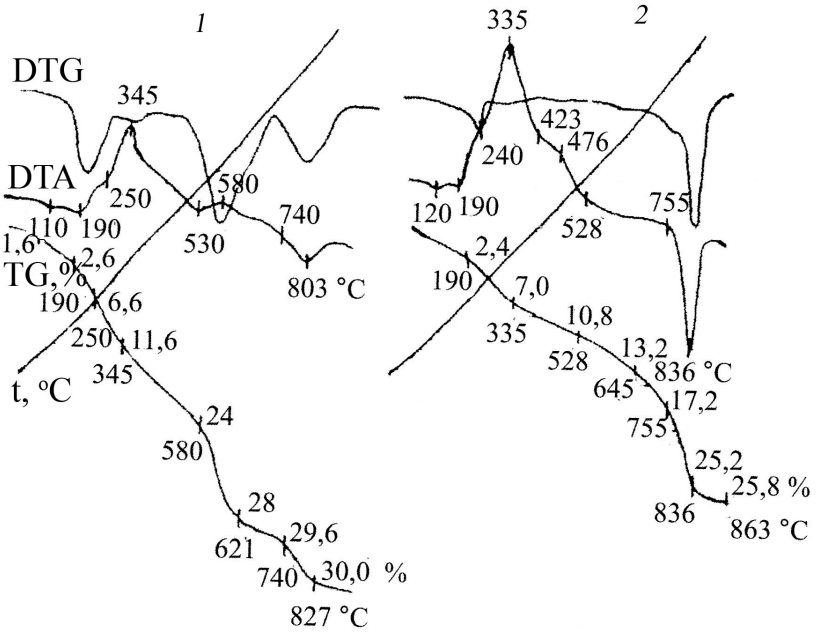

Fig. 1. Derivatogram of carbonate precipitate and oxides: precipitate and threeoxide of molybdenum,[$CaCO_3$]:[MoO_3] = 1,0:1,0 (1), precipitate and threeoxide of tungsten, [$CaCO_3$]:[WO_3] = 1,0:1,0 (2)

Results of thermogravimetric analysis of mixtures are represented on fig. 1 and in the table 2.

Share of interaction (α) of carbonate precipitate with acid oxides is calculated on base of loss mass (curve of TG) in dependence from temperature (fig. 2)

2. Results of termogravimetric analysis of mixtures of calcium carbonate of defecate of sugar production and MoO_3 or WO_3

Composition of mixtures	Temperature of anhydration, °C	Temperature of thermolysis and reduction of EO_3, °C	Temperature of interaction, °C	Final substance
$[CaCO_3]:[MoO_3]$ = 1,0:1,0	110–190	250–530	580–827	$CaMoO_4$
$[CaCO_3]:[WO_3]$ = 1,0:1,0	120–190	240–528	645–863	$CaWO_4$

Nature of finished products of these reactions was studied by X-ray and defined that its belong to tetragonal symmetry with parameters for $CaMoO_4$ a = 0,5237 ±0,0002 nm; c = 1,147 ±0,0005 nm; for $CaWO_4$ a = 0,5225 ±0,0002 nm; c = 1,144 ±0,0005 nm. The difference of these values of parameters of elementary cells from literature facts [10] is caused by admixtures of MnO, Fe_2O_3, SiO_2, $TiO_2$and ZrO_2 in prepared products, thus they are modified oxide materials for metallurgy [11].

$CaCO_3$ of defecate belong to hexagonal symmetry with parameter a = 0,498 ±0,002 nm, c = 0,853 ±0,005 nm.

The results of application of those methods confirm the following process or reactions:

$EO_3 + C_xH_yO_z$ (organic phase) $\rightarrow EO_{3-x} + CO_2\uparrow + y/2H_2O\uparrow$;

$2EO_3 + xO_2 \rightarrow 2EO_3$;

$CaCO_3 + EO_3 \rightarrow CaEO_4 + CO_2\uparrow$, E—Mo, W.

Chemical interaction H_3PO_4 with sugar-juice defecation sludge was studied too. For this purpose variable quantities of volumes $2{,}11\cdot10^3 mol/m^3$ H_3PO_4 were added to constant mass of carbonate precipitation ($1\cdot10^{-3}$kg) and water to $5\cdot10^{-5}м^3$. The specified ratios $[PO_4^{3-}]:[Ca^{2+}]$ in the heterogeneous system were changed from 1,00:0,17 to1,0:3,0. Mixtures after one month of retention and mixing were filtrated. Then pH and concentrations of $Ca^{2+}$and PO_4^{3-} were determined. The precipitations underwent the X-ray and the thermo-gravimetric analysis. The fig. 3 below shows thepH dependence of filtrate from the specified ratios $[PO_4^{3-}]:[Ca^{2+}]$. Reaction of sugar-juice defecation sludge and H_3PO_4 is accompanied with the change of pH quantities from 8,1 to

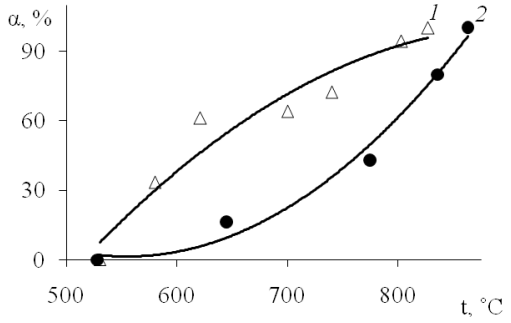

Fig. 2. Dependence of share interaction (α) of carbonate precipitate with acid oxides from temperature (t): $[CaCO_3]:[MoO_3]$ = 1,0:1,0 (1); $[CaCO_3]:[WO_3]$ = 1,0:1,0 (2)

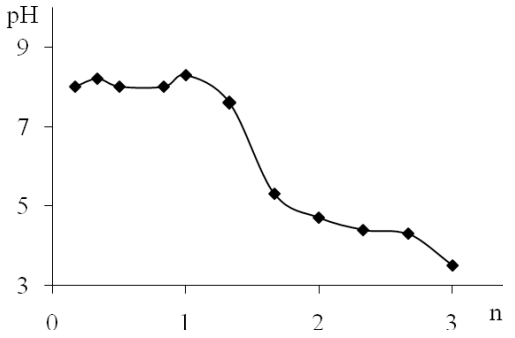

Fig. 3. pH dependence in the system filtrate: carbonate precipitate –H_3PO_4 – H_2O from the specified ratios $[PO_4^{3-}]:[Ca^{2+}]$, (n).

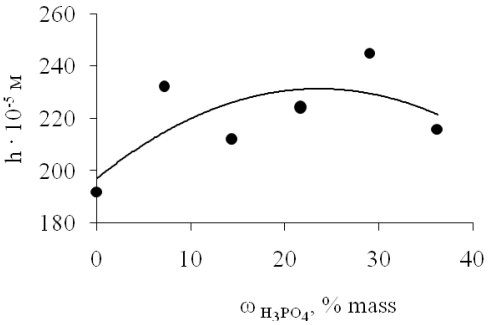

Fig. 4.Dependence of height (±0,002 m) of vegetables rye from contain H_3PO_4 into mixture with carbonate precipitate (19 days of growth, subsandy ground)

4,4 and corresponds to the specified ratios $[PO_4^{3-}]:[Ca^{2+}]$ from 1,0:1,0 to 1,00:2,33.

X-ray of precipitations is determinate the forming mixtures of$Ca_3(PO_4)_2$, $CaHPO_4$and $Ca(H_2PO_4)_2$at the specified ratios $[PO_4^{3-}]:[Ca^{2+}]$ = 1,5:1,0; 1,0:1,0 and 1,0:2,0. It is possible in case if the next reactions or processes take place:

$3CaCO_3 + 2H_3PO_4 = Ca_3(PO_4)_2 + 3CO_2\uparrow + 3H_2O\uparrow$;

$CaCO_3 + H_3PO_4 = CaHPO_4 + 3CO_2\uparrow + 3H_2O\uparrow$;

$CaCO_3 + 2H_3PO_4 = Ca(H_2PO_4)_2 + CO_2\uparrow + H_2O\uparrow$;

$Ca(polygalactur.)_x + 2H_3PO_4 \rightarrow 2xH(polygalactur.) + Ca(H_2PO_4)_2$.

Polygalactur is aremainofpolygalaturonacid.

Phosphate fertilizers were prepared on base of those investigations and tested on growth of wheaten or rye seeds, positive biological effect was obtained (fig. 4)[12].

Fulfiled experimental work is having letiny possibility to form scheme of researches and processing of sugar-juice defecation sludge (fig. 5), it is having practical meaning for industry as of Ukraine as of foreing countries.

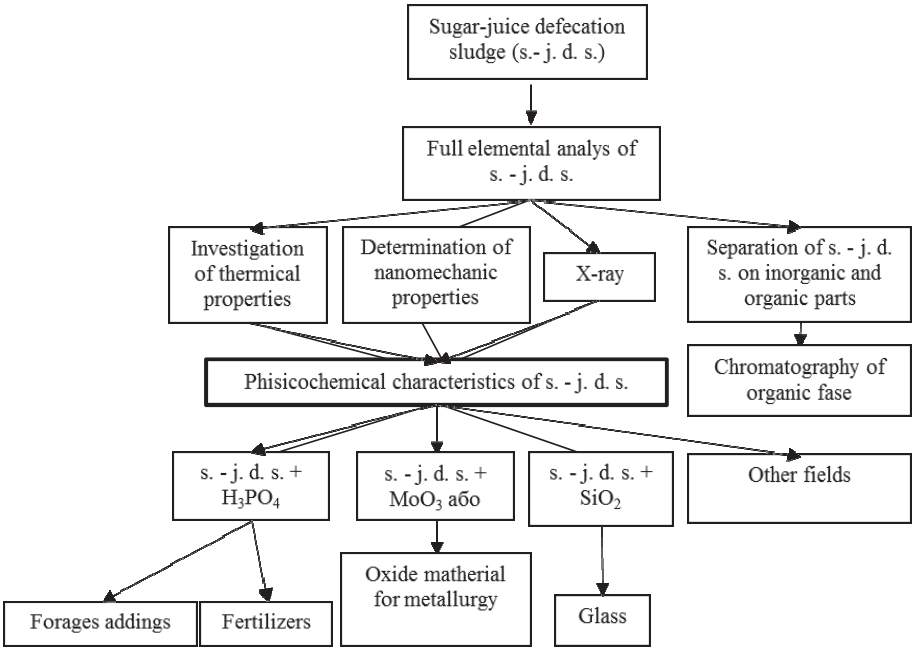

Fig. 5. Scheme of investigation and processing of sugar-juice defecation sludge for different fields

Conclutions

Reactions of sugar-juice defecation sludge with MoO_3, WO_3or H_3PO_4were investigated. The determined products of those reactions are could be useful for technology processing of industrial carbonate precipitation to oxide materials or to phosphate fertilizers and forages addings for agriculture.

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АНОТАЦІЯ

О. П. Перепелиця, Т. В. Петренко, А. І. Самчук. *Дослідження реакцій для переробки дефекату цукрового виробництва на оксидні матеріали і добрива // Біоресурси і природокористування. – 2016. – 8, №5–6. – С.18–23.*

Вперше методами хімічного аналізу, pH-метрії, термогравіметрії і рентгенографічно досліджено реакціїдефекату цукрового виробництва з кислотними оксидами MoO_3, WO_3 (I) та фосфатною кислотоюH_3PO_4 (II). В системі (I) утворюються індивідуальні фази з тетрагональною сингонією, тоді як у системі (II) осаджується суміш $Ca_3(PO_4)_2$, $CaHPO_4$ і $Ca(H_2PO_4)_2$.

Ці продукти можуть бути використані як оксидні неорганічні матеріали і добрива або кормові добавки для сільського господарства.

АННОТАЦИЯ

А. П. Перепелица, Т. В. Петренко, А. И. Самчук. *Исследование реакций для переработки дефеката сахарного производства на оксидные материалы и удобрения //Биоресурсы и природопользование. – 2016. – 8, №5–6. – С.18–23.*

Впервые методами химического анализа, pH-метрии, термогравиметрии и рентгенографически исследованы реакции дефеката сахарного производства с кислотными оксидами MoO_3, WO_3 (I) и фосфатной кислоты H_3PO_4 (II). В системе (I) образуются индивидуальные фазы с тетрагональной сингонией, тогда как в системе (II) осаждается смесь $Ca_3(PO_4)_2$, $CaHPO_4$ и $Ca(H_2PO_4)_2$.

Эти продукты могут бать использованы как оксидне неорганические материалы и удобрения или кормовые добавки для сельского хозяйства.