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Dust Processing of Cement Plants for Nitrogen-Calcium Fertilizers

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ABSTRACT: Physicochemical substantiation and effective technology development for processing dust from clinker kilns to obtain liquid and granular nitrogen-calcium fertilizers with the establishment of optimal production parameters**.**

KEYWORDS. clinker kilns, soil ameliorant, electrostatic precipitator, dusting preservatives, aluminum, iron, calcium, cobalt, cadmium, lead, arsenic, strontium, chromium, barium, molybdenum, titanium and zinc.

I.INTRODUCTION

When receiving cement, dust is formed as a waste from clinker kilns, which is captured by electrostatic precipitators. The chemical composition peculiarities of the dust from clinker kilns previously did not allow to completely return it back to the production cycle. The main amount of dust from clinker kilns was sent to dumps and over the years several million tons were accumulated in special designated places - storage facilities.

The dust composition of electrostatic precipitators' clinker kilns to a large extent depends on the processed raw materials type and technological parameters of the cement clinker firing process. The average chemical dust composition from clinker kilns on average in the Republic of Uzbekistan (Kuvasay, Akhangaran and Bekabad cement plants) (wt.in %): IPC is 22,0 - 27,6; SiO_2 is 12,0 - 115,6; Al_2O_3 is 4,3 - 8,7; Fe_2O_3 is1,6 - 4,7; CaO is 40,0 - 55,0; MgO is 0,6 - 3,5; SO_3 is 0,3 - 1,5; Na_2O is 1,5 -3,9; K_2O is 1,0 - 7,4. However, when the technological parameters of the process change, the chemical composition can change quite dramatically. The dust from clinker kilns contains compounds that are readily soluble in water, which can be leached out by water, contaminating ground and ground waters. In addition, the dumps occupy a large number of fertile areas.

At the moment, the generated dust bulk from clinker kilns in the Republic of Uzbekistan is used in the cement industry itself, i.e. cement plants operate on waste-free technology. However, the previously accumulated huge amount of dust from clinker kilns is not used due to the lack of acceptable technology. Meanwhile, environmental protection is one of the key aspects of the country's economic development. Indeed, in addition to a developed economy, it is necessary to leave the descendants also clean air, water and land [1].

The dust from clinker kilns contains on average 2 -4% potassium (in terms of K2O) and up to 55% calcium (in terms of CaO). Potassium and calcium are in the 3rd and 5th in importance for plants. However, in the dust of clinker kilns, they are in an insoluble and, accordingly, indigestible form for plants. The best way to process the dust from clinker kilns is its nitric acid decomposition to obtain compound and complex fertilizers. Moreover, these fertilizers are the best for use on saline soils [2].

The declared demand of the Republic in calcium nitrate is 250-300 thousand tons per year. And there is no need to talk about the need of the Republic for potassium fertilizers [3]. Although there are potassic salt reserves in the Republic (Tyubegatan field) and there is an operating plant for the potassium chloride production - Dekhkanabad potassium plant, dust from clinker kilns can also become a source of potassium salts and trace elements. The latter production is absent in the Republic, which are so necessary for agriculture, and which are currently purchased from abroad.

In the cement clinker production, dust from clinker kilns is generated as a waste, which is very toxic and poisons everything around.

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In the works [4] using the atomic emission spectrometry method, a quantitative chemical analysis of all water supply sources in areas with a developed cement industry and in two conditionally clean areas was carried out. In Volsk city of Saratov region, in drinking water, in comparison with the MAC according to SanRaR and WHO, was revealed the bpollution with chemical elements of the 1st and 2nd hazard classes - lead and chromium. In comparison with the chemical composition of drinking water from water supply sources in conventionally clean regions, in the residential zones, in the cities of the cement industry, a significant excess of chemical elements of the 1st, 2nd, 3rd and 4th hazard classes was revealed. It is concluded that industrial plants for the cement production are a source of water pollution.

This state of affairs naturally affects the population health. For example, the articles [4] analyze the microelement composition of hair and nails, as well as urine in 37 children from 1 to 18 ages living in a region with a cement industry, and in 20 children from relatively clean regions. In the quantitative chemical analysis of hair and nails in children of the main group, compared with the control group, there is a disbalance of trace elements, an excess of aluminum, iron, calcium, cobalt, cadmium, lead, arsenic, strontium, chromium, barium, molybdenum, titanium and zinc in the nails. The hair accumulates cadmium, zinc, arsenic, antimony, chromium, cobalt, molybdenum, copper, vanadium, magnesium, barium, boron and bismuth. And this, in turn, leads to multiple diseases [5].

Dust from clinker kilns is also a source of radioactive elements. The works investigated the dispersed and chemical composition of the dust from clinker kilns. The heavy metals distribution by dust particles fractions has been analyzed, and the main sources of dust enrichment with heavy metals have been established. The presence of radionuclides in the dust from clinker kilns is shown.

In this regard, the use of dust from clinker kilns as fertilizer or soil ameliorant [6] is somewhat ill-considered.

Also, it is doubtful the use of dust from clinker kilns in agriculture to protect plants from pests. In the patent, dust from a cement plant or lime fluff is used as a means of protecting spring rapeseed from pests at a consumption rate of 1 ton per 1 ha of crops.

The work shows that gas cleaning dust from the cyclones in the Zykovsky (ZPP) and Achinsky (APP) expanded clay plants of Krasnoyarsk territory, as well as gas cleaning dust from the electrostatic precipitators of Krasnoyarsk cement plant (KCP) are good adsorbents and can be used as preservatives-powdering agents for preserving potatoes in winter, which is also protected by patents of the Russian Federation.

The use of dust from clinker kilns for environmental purposes should be considered more promising. The invention relates to ecology, more specifically, to the soil processing contaminated with oil substances. The method includes applying to the contaminated surface dust from clinker kilns, captured by electrostatic precipitators from the exhaust gases of rotary kilns from cement plants, with moisture content no more than 2%, with a layer 1 - 5 cm and mixing with a soil layer 5 - 10 cm.

The invention is intended for the destruction of pathogens in waste. The waste is mixed with dust from clinker kilns, defended, maintained at 12 pH for at least 2 hours while the temperature of the mixture rises to a predetermined level, in a closed chamber, for a predetermined period of time. The device includes a mixing chamber for sludge and a mixing device. Heating elements provide additional heat to the sludge. The set pH level of the sludge is regulated by pH measuring devices.

The method provides a decrease in the pathogens in the waste, in accordance with existing standards, while increasing the process efficiency [6].

There are various liquid fertilizers, both single and complex. In the production of liquid complex fertilizers (containing nitrogen, phosphorus and potassium), numerous studies have been carried out, including those from extraction phosphoric acid based on phosphorites of the Central Kyzylkum. From liquid nitrogen fertilizers, only CAN solutions - carbamide and ammonium nitrate - have been well studied.

There are also a number of studies in obtaining liquid one-sided nitrogen fertilizers: ammonia, ammonia water, ammoniac and others. With the joint or separate dissolution of certain amounts of ammonium or calcium nitrate, carbamide and other nitrogen-containing substances in ammonia water, solutions called ammoniac are obtained.

Solid ammoniac are formed by the some solid salts interaction with gaseous or liquid ammonia and are complex compounds of a crystalline structure.

Ammoniaates, obtained in the solutions form, are light liquids (yellowish color is also allowed), the density which depends on their composition and ranges from 0.9 to 1.25 g/cm^3. The vapor pressure over ammoniaates is significantly lower than the vapor pressure over liquid ammonia. The composition of ammoniaates based on ammonium nitrate corresponds to $NH_4NO_3 – nNH_3 \cdot mH_2O$ formula. Ammoniates based on calcium and ammonium nitrate correspond to $Ca(NO_3)_2 \cdot NH_4NO_3 – nNH_3 \cdot mH_2O$ formula. Also used are ammoniates carbonates - mixtures of aqueous solutions of ammonium carbonate, ammonia, carbamide or ammonium nitrate.

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The carried out tests and obtained data indicate that nitrogen-calcium fertilizers from the dust of clinker kilns (JAKU-2 и GAKU-2) have a positive effect on the full-fledged bolls accumulation, which leads to an increase in the raw cotton yield by 6.60 and 8.53 % compared to the control option (ammonium nitrate). An additional increase in yield is due to the presence of trace elements of zinc and molybdenum.

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