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PHOSPATE REMOVAL BY CRYSTALLIZATION IN A PELLET REACTOR

USUWANIE FOSFORANÓW METODĄ KRYSTALIZACJI W PELLET REAKTORZE

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ABSTRACT. Phosphorus was removed from synthetic solutions based on the crystallization of calcium phosphate in a granular form in a fluidized bed. The major advantage in this new pellet reactor process is the fact that no sludge is produced, but a small quantity of water free pellets. Phosphorus removal effciencies using stable concentrations of phosphate and with pH = 8.0 were evaluated in the laboratory scale studies.

KEY WORDS: phosphate removal, fluidized bed, calcium phosphate crystalization, pellet reactor.

Phosphorus, one of the main nutrients that cause eutrophication in enclosed water bodies, is a major constituent of wastewater. Technology for phosphorus removal from wastewater has been developed rapidly in the last few years. The need for practical phosphorus removal process has arisen as a result of the overfertilization and eutrophication of the water courses and impoundments.

An activated sludge wastewater treatment plant removes only 20 to 30 % of this phosphorus.

A more effective phosphorus removal method is chemical precipitation. The technique of chemical precipitation with metal salts has been almost universally applied for nutrient control. Conventional methods for the removal of phosphates from wastewater in sewage treatment plants are based on the precipitation of metal phosphates. Iron salts ($FeCl_3$ or $FeSO_4$), aluminum salts ($Al_2(SO_4)_3$) or lime compounds (CaO or $Ca(OH_2)$ are dosed to the wastewater, where after a precipitate is formed which can be removed by sedimentation. The main disadvantage of the conventional methods is the production a sludge disposal problem that may be extremely troublesome for plant operators. Handling, transport and disposal of this sludge leads to increased cost and a solid waste problem, which cannot easily be solved in densely populated areas.

This paper deals with a new process for the removal of phosphate from wastewater, based on the crystallization of calcium phosphate in a granular form in a fluidized bed with pellet reactor. The major advantage of this process that it is free from sludge handling

problems, uses comparatively small amounts of chemicals and produces only a relatively small quantity of waterfree pellets that can be re–used in the phosphate processing industry.

The crystallization method proved to be practicable as advanced technology for phosphorus removal from wastewater and creating a simple and effective method of recycling phosphate.

MATERIALS AND METHOD

The process is based on the appliance of a pellet reactor in which calcium phosphate crystallizes on seeding grains. The crystallization takes place in a fluidized bed.

Column experiments were carried out with fixed bed reactors of diameter 3 cm with the granular seed crystals of diameter 1 mm for bed high 90 cm and bed expansion 60.8 % in the laboratory conditions at room temperature with tap water.

The synthetic feed solution was passed upward through the seed bed with NaOH 10 % to adjust pH and Na_2HPO_4.

The experiment was done with almost stable concentration of ortophosphate on level from 4.3 to 5.06 ng PO_4/dm^3 at pH 8 in a long period.

Influent and effluent samples were collected from the column and analyzed for phosphate, calcium, and pH. Phosphorus concentrations were determined spectrophotometrically by the phosphomolybdate method. Calcium was measured by titration with 0.01 M ethylenediamine tetraacetic acid.

RESULTS AND DISCUSION

Phosphorus removal test in a laboratory conditions in a pellet reactor using the calcium phosphate precipitation method were carried out. The flow diagram of the column experiments is shown in Figure 1.

Results from the experiment are summarized in Table 1. Phosphorus concentration reduced average 4.47 % and calcium decresed only 6.4 %.

Phosphorus removal from wastewater and water solution by the crystallization method has been investigated. In these experiments the effects of phosphorus removal was strongly affected by the operating conditions such as pH and calcium concentration (Joko, 1984; Dijk, Eggers, 1988).

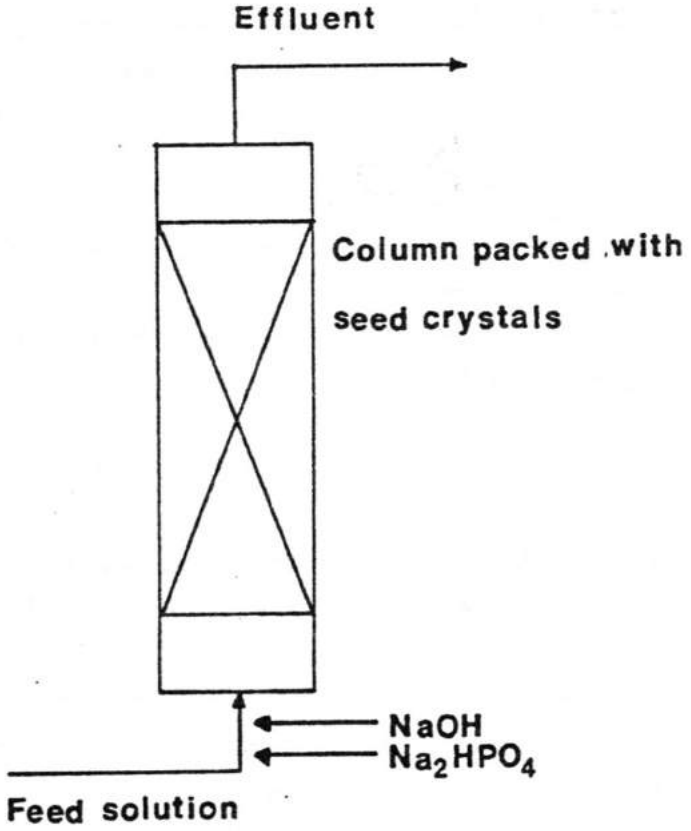

Fig.1. Flow diagram of column experiment

Table 1. Phosphate and calcium removal with pellet reactor at pH 8

Influent		Effluent		Recovery	
Ca mg $CaCO_3/dm^3$	PO_4 mg/dm^3	Ca mg $CaCO_3/dm^3$	PO_4 mg/dm^3	% Ca	% PO_4
320	5.06	320	3.80	–	24.9
324	5.06	312	4.20	3.7	16.9
324	4.84	318	7.30	1,9	–
326	4.75	326	5.35	–	–
324	5.06	324	5.00	–	1.2
330	4.30	314	5.15	4.9	–
326	4.80	306	4.80	6.1	–
320	4.80	244	4.10	23.8	14.6
330	4.80	330	5.15	–	–

CONCLUSION

Phosphate removal by crystallization in a pellet reactor with pH = 8.0 and concentration from 4.3 to 5.06 mg PO_4/dm^3 in the influent isn't efficient.

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STRESZCZENIE

W pracy przedstawiono badania nad usuwaniem ortofosforanów z roztworu, oparte na zasadzie krystalizacji fosforanu wapnia w formie granulatu w pellet reaktorze wypełnionym złożem fluidalnym.

Metoda usuwania fosforanów w pellet reaktorze jest bezodpadowa, co należy uznać za jej ogromną zaletę w porównaniu z innymi procesami. Podczas wytrącania fosforanów wapnia zużywa się stosunkowo małą ilość związków chemicznych, a uzyskany produkt końcowy w postaci granulatu może być wykorzystany w rolnictwie bądź w procesach przemysłowych.

Przedstawione wyniki dotyczą efektywności procesu przy stałej koncentracji ortofosforanów i odczynie na poziomie pH = 8,0.