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APPLICATION OF NEW-SYNTHESIZED POLYMERS TO PURIFICATION OF COAL MINE PIT WATERS USING COAGULATION PROCESS

ZASTOSOWANIE NOWO SYNTEZOWANYCH POLIMERÓW W PROCESIE KOAGULACJI WÓD DOŁOWYCH KOPALNI WĘGLA KAMIENNEGO

Abstract: Chemical modification of polystyrene waste materials allowed to receive effective polyelectrolytes. Received polyelectrolytes (flocculents) were used in aiding bituminous coalmine pit waters coagulation process, which characterised among others high concentration of chlorides and sulphates. As a result of aiding coagulation process with new-synthesized polymers, very well soluble in water, sodium salts sulphone derivatives of polystyrene, occurred significant reduction of sulphates and chlorides and also other impurities in researched waters.

Keywords: polystyrene wastes, synthesis polymers, water-soluble polymers, coagulation

The polymer waste materials modification allows to receive polyelectrolytes comparable in properties to the traditional, commonly applied flocculants.

New polyelectrolytes can be used with good results in processes of wastewater and industrial water treatment [1-12]. Applying new-synthesized polymers enables lowering of coagulants consumption, makes the flocculation time shorter and improves suspension sedimentation conditions. Great role in industrial wastewater treatment play chemically modified wastes of foamed polystyrene. Chemical modification of polystyrene wastes allows to get potential flocculants and in addition reduction of polystyrene wastes. Obtaining sodium salts of sulphone derivatives of foamed polystyrene as potential flocculants gives broad possibilities for their application as agents that support coagulation process of industrial and municipal wastewaters. Characteristics of eleven sulphone derivatives of foamed polystyrene wastes were presented in previous publications that concern synthesis and possible applications of new type polyelectrolyte [1, 3, 10, 11]. From among of the polyelectrolyte one was chosen for the future research. This product was the most efficient in flocculation process of waste and industrial water chosen for previous examination.

Present paper shows results of coalmine waters indicators analyses. Examination was perform for water from two coalmines with application of sulphone derivatives of foamed polystyrene wastes chosen before. Analyzed parameters of two examined types of water, that were coming from two coalmines, differed widely. Both coalmines belong to Katowice Holding Mine Company.

Experimental

The sulphone derivatives with the highest percentage sulphur contents were chosen to test. There were received through sulfonation of polystyrene wastes with concentrated

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sulphuric acid H_2SO_4 according to commonly applied sulfonation methodology of aromatic compounds. There was carried out liming process with $CaCO_3$ in order to remove acid excess. The product was precipitated as sodium salts in reaction with Na_2CO_3. Process of 1.0% coagulant solution and 0.1% solution of received polyelectrolyte was performed in order to determine flocculation properties of sulphone derivative of foamed polystyrene wastes.

Turbidity was determined with use of Turb 550 IR instrument that gives possibility of fast and reliable measurements. Measurement method applied in instrument meets requirements of ISO 7027/DIN 27027 norms and is in accordance with US EPA recommendations.

Determination of physical-chemical factors of coalmine waters was carried out in laboratories in accordance to norms:

- PN-72 C-04559/02 - General and mineral suspensions and volatile suspended solids with weight method determination
- PN-74 C-04566/09 - Chloride with titration method determination
- PN-ISO- 659:1999 - Calcium and magnesium total contents with titration method with EDTA determination
- PN-74 C-04578/03 - Chemical oxygen demand with dichromate method determination
- PN-85 C-04578/02 - Chemical oxygen demand with permanganate method determination
- PN-84 C-04578/04 - Biochemical oxygen demand (2001-2002) determination
- PN-EN 1899-1:2002 - Biochemical oxygen demand in 5 days (BOD_5) determination.
- Part I. Diluting and grafting method with addition of thiosynamine (from 2003)
- PN-EN 1899-2:2002 - Biochemical oxygen demand in 5 days (BOD_5) determination. Part II Method for not diluted samples (from 2003)
- PN-EN 25813:1997 - Diluted oxygen determination. Titration with iodic method
- PN-86C-04573/01 - Total inclusion of contents of organic substances extracted with petroleum benzine with weight method determination
- PN-C-04576-5:1994 - Nitrogen compounds with direct Nessler examination method
- PN-78C-04541 - Dry residue, residue after roasting, losses during roasting and also dissolved substances, dissolved substances after mineralization and dissolved volatile substances determination
- PN-74 C-04566/09 - Sulphates with weight method determination
- PN-ISO 9280:2002 - Sulphates(VI) with gravimetric method with barium chloride (from 2003) determination
- PN-ISO-64-39-1994 - Phenols determination
- PN-80/C-04603/01 - Cyanides determination

Results and discussion

Chemical modification of foamed polystyrene wastes carried out in excess of concentrated sulphuric acid allowed to receive sulphone derivative, among others with sulphur contents 7.71%, which corresponds to contents of one sulphone group for two constitutional units.

Characteristic of examined product, description of synthesis and substrates included basic material (wastes of foamed polystyrene) were presented in previous publications [1, 3, 10, 11].

There were carried out researches on flocculation process for chosen polymer (SPP - sulphoneted derivative of expanded polystyrene). Examination was performed for two different types of coalmine water from two different coalmines (KWK 1 and KWK 2). Examinations were performed in accredited laboratory "Ekolab" in Katowice. This laboratory makes tests for many industrial plants among others for coal mines.

There was carried out analysis of impurities, in accordance with the norms, before their purification and after purification.

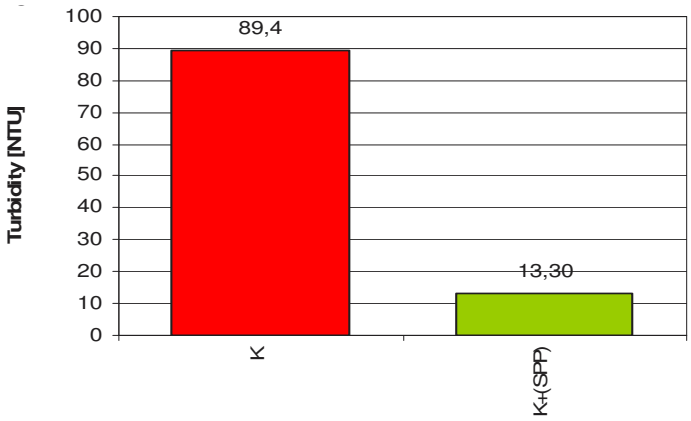

Fig. 1. Turbidity of coal mine water KWK 1 before and after flocculation process (K - coagulant - aluminium sulphate, SPP - new polyelectrolyte)

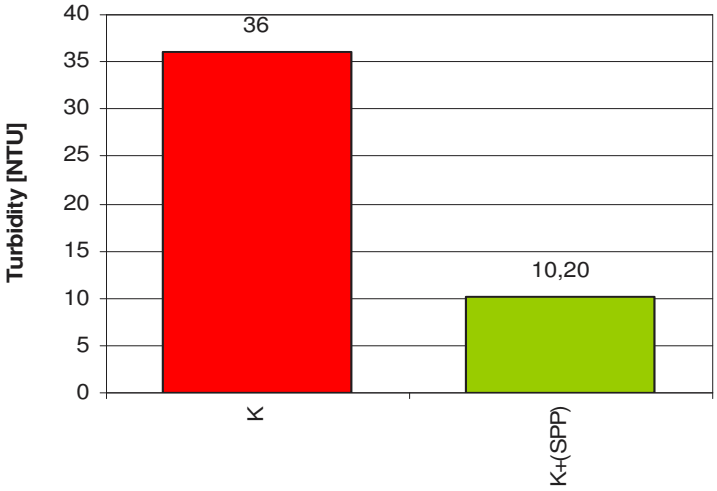

Fig. 2. Turbidity of coal mine water KWK 2 before and after flocculation process (K - coagulant - aluminium sulphate, SPP - new polyelectrolyte)

Analysis enclosed following factors: turbidity, pH reaction, chemical oxygen consumption, solvated oxygen, ammonia nitrogen, sulphates, chlorides, total hardness, solvated parts total amount and suspension - total amount. Turbidity is one of the most important factor in wastewater treatment process. Reduction of this parameter value indicates effectiveness of impurities removing from coalmine waters (Figs. 1 and 2). Researches were carried out for several tests and it was found that analysis results are comparable. For these reasons, there were chosen and shown results of tests performed for one sample (Table 1). Results of examination confirm that addition of polyelectrolyte has relatively no great influence on pH value of waters originating from coal mines. However, in case of other water quality factors there can be observed significant drop of researched parameters values.

Table 1

Analysis of waters from KWK 1 and KWK 2 coalmine after coagulation and flocculation with the use of the synthesized polyelectrolyte (sulphonated derivative of expandes polystyrene waste)

Determined water property*	**Permissible value of indicator for sewage**	**Analysis value of treatment from KWK 1 coal mine****		**Analysis value of treatment from KWK 2 coal mine****	
		Before purification	**After purification**	**Before purification**	**After purification**
Oxygen consumption - dichromate method COD_{Cr} [mg O_2/dm^3]	150.00	45.20	25.20	50.00	23.10
Solvated oxygen [mg O_2/dm^3]	-	8.90	5.30	7.90	4.60
Ammonia nitrogen [mg/dm^3]	6.00	0.91	0.64	1.13	0.82
Sulphates [mg SO_4/dm^3]	500.00	1520.70	171.70	424.10	123.20
Chlorides [mg Cl/dm^3]	1000.00	1876.80	176.70	4996.30	2256.70
Total hardness [mval/dm^3]	70.00	2466.70	294.90	3094.40	1654.10
Solvated parts - total amount [mg/dm^3]	2000.00	5273.50	346.80	7104.50	3813.10
Suspension - total amount [mg/dm^3]	50.00	45.10	12.90	32.30	12.89

*determination before and after water treatment was conducted in industrial plants, from which the water was taken for investigation.

**coalmine pit waters from KWK 1 and KWK 2 differ in parameters before treatment what is shown in Table

Application of chemically modified wastes of foamed polystyrene leads to significant reduction of all analysed factors of researched mine waters. Particularly important and visible is decreasing of sulphates, chlorides and also COD_{Cr} contents.

Conclusions

It was found that salt of sulfonate derivative from polystyrene reduces in significant degree mining pit waters purification factors. From this case it seems to be essentially important to work out recycling technology of foam polystyrene wastes in order to achieve useful product - flocculants - from these materials. Working out of the new flocculants

types is completely new insight into sewages coagulation process. Flocculants, which are now commonly used, are typical, traditional products produced basing on original raw materials.

Current environment state and also resources accessibility demands using of wastes for production of useful products. This approach is profitable for both environment and society. In addition, such approach to waste management is in accordance with political purposes of European Union. Main topics of this politics concern preventing wastes forming, their recycling or recovery, in order to reduce their negative influence on environment.

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ZASTOSOWANIE NOWO SYNTEZOWANYCH POLIMERÓW W PROCESIE KOAGULACJI WÓD DOŁOWYCH KOPALNI WĘGLA KAMIENNEGO

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Abstrakt: Modyfikacja chemiczna odpadów polistyrenu pozwoliła na otrzymanie efektywnych polielektrolitów. Uzyskane polielektrolity (flokulanty) zastosowano we wspomaganiu procesu koagulacji wód dołowych kopalni węgla kamiennego, które charakteryzowały się między innymi dużymi stężeniami chlorków i siarczanów. W wyniku wspomagania procesu koagulacji nowo syntezowanymi polimerami bardzo dobrze rozpuszczalnymi w wodzie, solami sodowymi sulfonowych pochodnych polistyrenu nastąpiła znaczna redukcja siarczanów i chlorków, a także innych zanieczyszczeń w badanych wodach.

Słowa kluczowe: odpady polistyrenu, synteza polimerów, polimery rozpuszczalne w wodzie, koagulacja