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Abstract to the Project

ADSORPTION ACTIVE FILTERS FOR CLEANING OF THE INDUSTRIAL GASEOUS WASTE STREAMS FROM ACID GASES

Traditional adsorption apparatus using granulated sorbents are not efficient enough for the treatment of gases in order to separate the toxic components from the gaseous waste. Therefore chemical active filters have been used to this propose using mineral tissue (web) in the planar form. The advantages planar sorbent in comparison with the traditional (granular) sorbents:
- higher efficiency sorption;
- possibility of differential design of the sorption ensuring high technological flexibility;
- optimisation of the mass transfer and heat transfer in the sorption units (the chemisorption is connected with the release of heat which should be transferred out of the system).

Aims of our research are:
1. Investigation of potential use of the new planar sorbents and the regular structure apparatus (adsorption active filters) for cleaning industrial gases (e.g., flue gas of the incineration process) from hazardous pollutants
2. Used of adsorption active tissue (interior sorbents) for removal of acid gases (H2S, SO2 or CO2) from workplace air

Materials: Acids treatment basaltic fibres, tissue and felt.

Working program:
1. Design and preparation of the tailored sorbents, intermediate products and planar sorbents (tissue, fibbers, felt).
2. Design of adsorption apparatus of regular structure and active filters.
3. Testing of functional materials for sorption of hazardous acid gases by means of gas chromatography (adsorption capacity/breakthrough).
4. Investigation of gas evolution from sorbents with using mass spectrometry detectors.
5. Study of effectiveness of new methods for treatment of gaseous waste in the various incineration processes.

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ACTIVE FILTERS WITH PLANAR ADSORBENT OR CATALYSATORS

Regular structures apparatus

Emission of pollutants (e.g. volatile halogenated organic compounds) to the atmospheric are a serious problem, particularly due to large volume flows and low concentration levels.

Aim of research is investigation of potential use of the new sorbents (adsorption or catalytic active filters) for cleaning industrial gases from hazardous pollutants (gases, organic contamination's and heavy metals.)

Materials:
- Acids treatment basaltic fibres, tissue and felt;
- Active coal fibres, tissue and felt;
- catalytic active basaltic filters.

We have made studies into regular structures apparatus with planar adsorbents uses for next aims:

- Treatment of gaseous multicomponent waste streams;
- Removal H_2O, CO_2, SO_2, H_2S from air;
- Volatile organic compounds (chlorinated micropollutants like dioxins and furanes, volatile ketone (MEK, MIBK), dioxins (PCDD sterioisomers) etc. recovery from gaseous waste;
- Monitoring of pollutants (benzene, xylol, dichlormethan, toluene, butanol, methanol) in workplace air;
- Cleaning air from volatile hazardous elements (I, Ag, Sb, As, Cr etc.) and their separation form polluted air resulting during incineration of municipal waste and in fire accidents;
- Removal and storage of heavy metals.

We have considered the potentiality of regular structures apparatus with planar catalysators uses for the performance of the next processes:
- conversion of dioxins stereoisomer sobtained in various incineration process to simple gases;
- transformation of organic compounds to gases may be important for energetic.
- thermo- and photodegradation of halogenated hydrocarbons
- production of methane and ethylene from agricultural and industrial wastes

Pollutants removal from fluegas with active filters compared with conventional techniques the granular adsorbents has a main advantaged: high removal efficiency, small volume, simple operation, excellent scale-up ability, no entertainment, flooding or channelling. Filtration through the sorption or catalytic active filters is a new, very selective separation process which combines adsorption, catalysis and filtration technology to produce an optimized hybrid process.

The prior analysis demonstrated that regular structures apparatus with planar adsorbents and/or catalysators hold the greatest promise for next application:
- environmental protection;
- energetic;
- chemical and petrochemical industry.

Project GSF-MSU

Short Title: Optimisations of organic/inorganic polymers incineration
Full Title: Optimisation of the incineration process of organic polymers containing inorganic substances

1. Objectives of the Project

Determination of the conditions for pyrolysis and thermodestruction of organic polymers containing inorganic substances (Si, Ge, Sn). Analysis of the evolved gases.
Use of adsorption active filters with planar sorbents and membrane absorption of hazardous components in order to achieve a more efficient separation of hazardous volatile from the effluent gases resulting after incineration. Testing of active filters using German and European Standards.
Recommendation for the optimization of the incineration process of silicon and other elements containing polymers, used as, varnish, lacquer, glue, binders, hermetic, heat insulator of spacecraft, refrigerator buildings materials, coatings of gas and oil lines, wire and cable, membrane materials and another organic/inorganic polymers used recently in the Russian Federation and other countries.

2. Working program and time schedule

1. Life cycle analysis and environmental risk production assessment of silicon polymers for membranes and related materials Collection of polymer waste sample in various places in Russia and Germany. Chemical analysis of the collected samples.
Characterisation of thermal stability of silicon polymer waste.

June 1999-May 2000

2. Investigation of oxygenate pyrolysis and thermodestruction of organic polymers containing inorganic substances. Following materials will be investigated: polysiloxane, halogen and silicon-containing carbochain polymers, random and block copolymers, fluoroilicone polymers.
Determination of optimal conditions for burning of the silicon containing polymers.
Use of the new planar sorbents and the regular structure apparatus (adsorption active filters) for separation effluent gases of the incineration process from hazardous pollutants.

June 2000-February 2001

3. Development of recycling methods of complete utilisation of Si-containing polymer waste, in particular, transformation of organic parts of polymers into petrochemical-like substances and transformation of the silicon residuals into high-porous adsorbents.

Practical recommendation for the complete utilisation of organic polymers containing inorganic substances in industrial waste processing.

Organization of joint workshop.

Results will be transferred to the incineration plants and potential users petrochemical substances and sorbents in both countries.

March 2001-October 2001

4. Preparation of final reports and manuscripts of publications to journals

November 2001-December 2001

5. Exchange of Scientists

Travel of German Partner to Russia

1999	2000	2001
3 weeks/person	4 weeks/person	3 weeks/person

Travel of Russian partner to GSF

4 weeks/person	6 weeks/person	4 weeks/person

6. Material

1999 Chemicals, materials, Updating experimental equipment for adsorption and membrane absorption 8000 DM

2000 Updating experimental equipment for solids, liquids and gases testing, chemicals, consumption materials, software 6500 DM

2001 Consumption materials, chemicals, external services 3500 DM

3. Task sharing

3.1 German Partner

Develop optimal methods for incineration polymeric waste containing inorganic substances. In particular, it concerns silicon-organic polymers for industrial application and selective Si-organic-based membranes. Thermal Analysis characterisation of the Si-containing polymers will be carried out by means of DTA, TG, EGA/MS. The GSF laboratory is well equipped for this task.

The German partner will also participate in the dissemination of the results and practical use of the incineration process of Si-containing polymer waste to potential German users (e.g.).

3.2 Russian partner

Development of phenomenological theory of kinetics of thermodestruction of Si-organical polymers. Mathematical simulation of gas evolution from polymers during heating.

Development of methods of transformation of the silicon-organic polymers of various composition, structure, and industrial application into high-porous adsorbents. Testing sorption properties of porous products of thermodestruction Si-containing polymers and surface area determination.

Separation of gaseous products of polymers decomposition using advanced membrane absorbers.

Use of the basaltic fibrous sorbents and the regular structure apparatus (adsorption active filters) for cleaning flue gas of the incineration process from hazardous pollutants

4. Rationale

Moscow State University study of thermostability of selectively membranes (silicone polymers, organo-mineral membranes, organic/inorganic hybrid membranes) used in Russian industry for separation of gas-gas, gas-liquid or liquid mixtures. Following materials used for polymer membrane production in Russian Federation will be considered in the project: polydimetylsiloxane, polytrimethylsilylpropine, polyviniltrimetilsilane, block-copolymers (polyarylate-polydimethylsiloxane, polyviniltrimethylsilane-polydimethylsiloxane), plasticized polymers (polyviniltrimethylsilane (PVTMS) oligovinyltrimetrimethylsilane, PVTMS-oligovinyloctyldimethylsilane, PVTMS-dioctylsebacinate); organo-mineral membranes (polymers and ceramics material), e.g. polysulfone+ZrO_2, organic/inorganic hybrid membranes (porous inorganic membranes with grafted or trapped organic species, nanoscale

ceramic/polymer composites, organic/inorganic hybrid polymers). Materials used in coatings (fluoroalcylsilane based systems, silicone grease, silicon rubber, etc.) will be investigation.
The project will be used for the introduction of life cycle management of silicon polymer waste from automobile and building industry in the Russian Federation and Bavaria.
Investigation of processes pyrolysis and testing pyrolyses products from the view-point of their toxicity as well as and solid residues will be carried out by means of methods available at MSU and GSF, respectively.
Information about methods of complete utilisation of Si-containing polymers will be used in the production and subsequent treatments polymer materials. The results will be dissemination to potential users both in the Russian Federation and Germany.
A joint workshop will be organises in the third year of the project.

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I.N.Bekman Main Publications

1. Use of diffusions membranes for cleaning gas rejects of atomic plants (with E.I.Bozhenko, F.A.Mahmutov, V.K.Belijakov, V.N.Nikonov) - *J.Plactic. Mass., N2 (1982) 51-52 (Russia)*
2. Radioactive diffusion gas probe method in study of nonhomogeneous of structure adsorbent (with A.V.Zusin, V.I.Korobkov) - *Radiokhimia, v.32, N1 (1990) 52-54 (Russia)*
3. Inert gas diffusion probe in study of polymer materials-*Thermochim Acta, v.190, N4 (1991) 66-72*
4. Separation of gas mixtures under unsteady-state conditions (with A.B.Shelekhin, V.V.Teplyakov) - *J.Membrane Sci., v.55 (1991) 283-297*
5. Gas separation processes in membrane absorber (A.B.Shelekhin)-*J.Membr.Sci*., v.73 (1992) 73
6. Plane adsorbents. 1. Adsorption sulfur maintaining gases on the treatment acids basaltic fibbers (with A.V.Zheleznov, E.A.Kalinin, M.S.Safonov) - *J.Phys.Chemistry, v.66 (1992) 1277 (Russia)*
7. Plane adsorbents. 2. Study of diffusion permeability of adsorbing gas through similar to felt fibrous basaltic adsorbent (with A.U.Zuzin, V.K.Belnov, E.A.Kalinin, M.S.Safonov) - *J.Phys.Chemistry, v.66, N5, 1992, 1281-1285 (Russia)*
8. Plane adsorbents. 3. Dynamic of impurities adsorption under filtration through layer of seemlier to felt fibrous basaltic adsorbent (with V.K.Belnov, M.S.Safonov, A.U.Zuzin, E.A.Kalinin) - *J.Phys.Chemistry, v.67, N3, 1993, 582-584 (Russia)*
9. Evaluation of thermal analysis of experimental data. 1. Computer modeling and interpretation of thermal decomposition of solids studied by evolved gas analysis and thermogravimetry (with A.V.Zheleznov, V.Balek) - *J. Thermal Analysis, v.37 (1991) 1479-1485*
10. Evaluation of thermal analysis experimental data. 2. Optimal conditions for evolved gas analysis of thermal decomposition of solids (with A.V.Zheleznov, V.Balek) - *J. Thermal Analysis, v.39 (1993) 1019-1029*
11. The selective membrane valve for ternary gas mixtures separation: Model of mass transfer and experimental test (with D.G.Bessarabov. V.V.Teplyakov) - *Industrial and engineering chemistry research, v.32, N9 (1993) 2017-2022*

12. Sorption dynamic of water vapour on thin layer basaltic fibbers (with A.U.Zuzin, V.K.Belnov, H.M.Voskresenskii, M.S.Safonov) - *J.Phys.Chem., v.68, N6 (1994) 1122-1125 (Russia)*
13. Unusual membrane prosesses: non-steady state regims, nonhomogeneous and moving membranes. Polymeric gas separation membranes (Eds .D.R.Paul, Y.P.Yampolskii),chap.5, CRC Press, Boca Raton, Florida, USA, 1994, p.301-352
14. Regimes of gas diffusion kinetic in mickroheterogeneous materials (with B.K.Belnov, M.S.Safonov) - *J.Phys.Chem., v.69, N.9 (1995) 1546-1569 (Russia)*
15. High-efficiency separation of ethylene/ethane mixture by a large-scale liquid-membrane contactor flat-sheet non-porous polymeric gas-separation membranes and selective flowing-liquid absorbent (with D.G.Bessarabov, R.D.Sanderson, E.P.Jacobs) - *Ing. Eng. Chem. Res., v.34 (1995) 1769-1778*
16. Use of nonporous polymeric flat-sheet gas-separation membranes in a membrane-liquid contactor: experimental studies (with D.G.Bessarabov, E.P.Jacobs, R.D.Sanderson) - *J. Membr. Sci., v.113 (1996) 275-284.*
17. Integrated membrane systems for gas separation in biotechnology: potential and prospects (with V.Teplyakov, E.Sostina, A.Netrusov) - *Word Journal of Microbiology and Biotechology, vol.12 (1996) 477-485*
18. Thermostimulated inert gas release analysis in the diagnostics of materials (with V.Balek) - *Themochim. Acta. v.295 (1997) 147-165*
19. Perspectives, development and application of membrane-liquid contacting systems for gas and vapour separations (with D.Bessarabov, R.Sanderson) - *Book of Abstracts Euromembrane'97 "Progress in membrane science and technology" 3th Intern. symposium, University of Twente, The Netherlands, 1997, p.23-25*
20. V.V.Teplyakov, I.N.Beckman
Polymeric membrane materials for gas separation: opportunities of phase design (with V.Teplyakov) Ibid, p.72