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Advanced Methods for Treatment of Organic Compounds Contamined Water

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Abstract

The progress recorded in the field of science and advanced engineering at nanometric scale supplies large opportunities for more efficient (from the point of view of the costs) and more ecological approach of the processes of water purifying. This paper delivers a short description of the possibilities of using advanced materials in purifying the contamined water with toxic metallic ions, organic and anorganic compounds. The opportunities and challenges were also emphasized when nanomaterials were used for the surface, underground and industrial used waters treatment.

Keywords: filtration, gas-chromatography, organic compounds

1.Introduction

The progress at nanometric scale in the field of science and engineering, suggests that lots of the crrent problems,which involve the good quality water could be solved or much improved using nanoabsorbants, natocatalyzers, bioactive nanoparticles, nanostructured catalytic membranes, filtration nanoparticles, besides other products resulted from the processes of nanotechnology development.

Taking into consideration the serious pollution problems we confront and those araized by the industrial waste, the abundance of the natural zeolites, and their deficient valuation, avoiding the environmental pollution and limitation of tits effects is imposed.

The actions of water pollution prevention and fighting against pollution effects must be coordinated in all countries, based on a legislation menat to protect the water resources of the aimed countries.

The surface waters represent the main source of potable water, but in these waters, majority of waste waters are collected. The surface waters may not contain pollutants with harmful effects on human health, and that could not be eliminated in stations for water purifying.

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In order to treat the waste waters, appropriate technological processes are used, taking into account the pollutants nature and waste waters traits. In advanced waste water treatment phase, the ionic change was imposed as specific technological process. Besides the allowance of the advanced treatment of waste waters, the ionic change, during regeneration process, allow the capture of the heavy metals ions as useful products.

The use of the natural zeolites with sensible improved ion exchange capacity by chemical activation, in advanced processes of treatment of the waste water with high content in heavy metalls represents an efficient method with large perspectives. The exhausted zolites may be used in other aims without the risk of the environmental pollution.

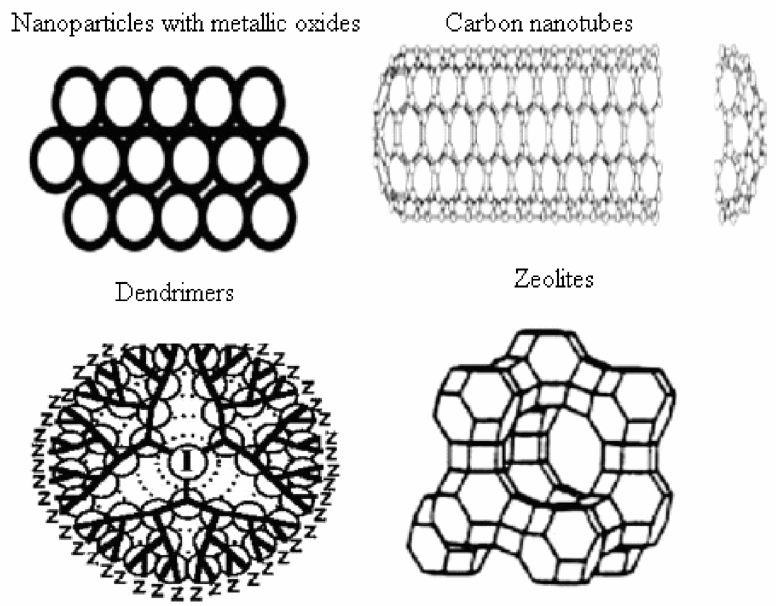

Figure 1. Nanomaterials researched for wather treatment

2. Special techniques for water treatment

Within the separation processes, besides clasical separation processes (distillation, rectification, extraction, ionic chance, filtration, centrifugtion, sedimentation), a series of other processes appeared, known as **membrane processes**.

Beginning with '70, the membrane processes recorded a spectacular development, being used with industrial aim in processes as: waste waters treatment, medical technologies, chemical industry. The rapid and diverse evolution of these technologies was possible due to improvement of the experimental techniques for mambrane preparation and characterization.

A complex system made up of solvent where ionic chemical species, molecules, macromolecules, molecular dispersates and particles are solved, may be separated in components using membrane processes. Due to the large using oportunities, five important membranar processes are emphasized. (microfiltration, ultrafiltration, reverse osmosis, dialysis and electro - dialysis), which cover the entire particle size domain to be separated, in the mean time exhibiting the versatility of the sedimentation in centrifugal field. The membrane processes also allow the separation of some solved chemical species, fractioning of some homogenous systems, from this point of view being similar with extraction, distillation or ionic exchage.

According to the data presented in table 1, microfiltration, ultrafiltrtion, nanofiltration and reverse osmosis have the pressure difference as moving force and for this reason they are call the **baromembrane processes**. The baromembrane processes occupie within the industrial specific processes. These proceses are usualy framed within the category of advanced filtration. Thus, the inverse osmosis is similar to a dehydrationg process through hiperfiltration; the ultrafiltration is similar with the techniques ofconcentration, purification and fractioning of the macroomolecules of colloidal dispersions, and microfiltration is wel known in processes of suspension separation. Practically, each mambrane process may repreent a viable alternative for other separation processes.

Table 1.The traits of the processes of separaton using porous membranes

The process	The nature of phases to be separated	Porosity	The origin of the selectivity	The pressure gradient	Unitary operations
Microfiltration	Liquid/liquid	0.1 – 10 µm	The inequal size of the particles or molecules to be separated	1-3 bar	Clarification, bacteria removing, depollution, separation
Ultrafiltration		1 nm – 1 µm		3-10 bar	Clarification, depollution, purification, concentration
Nanofiltration		< 2 nm	The diffusion difference of the molecules to be separated	10-40 bar	Purification separation, depollution, concentration, demineralizing
Gase filtration	gas / gas	0.01 – 100 µm	The inequal size of the particles to be separated	0.1-5 bar	Separation, dusting
Gase separation		50 nm – < 2 nm	The diffusion difference of the molecules to be separated	0.1-50 bar	Separation, extraction, depollution

3. Nanofiltration (NF)

The nanofiltration is functioning at low pressures 3.5 - 15 bar with highest values of permeate recovery (80 - 90%). The nanofiltration membranes usually made up synthetic polymers, remove all insoluble particles from the supplying water in the mean time with a series of inorganic solved salts and organic molecules. The application of the membranes (NF) in potable water treatment is especially destined to underground waters with relatively small solved salts content, but with big durity and high ontent of coloured substances and conţinut ridicat de substanţe colorate şi de precursori THM precursors. The specific flow of memnrane passage depends on temperature, pH, concentration. The part of the water that does not pass the membrane and contains rejected solutions, named concentrate, is evacuated from the installation with a reduced pressure. The realively big hydraulic pressures may modify the structure of the membrane polymer, and this may affect the specific passage flow. The efficiency of a NF installation imposes the improvement of the permeate recovery and solute rejection. The exploitation of a NF installation also imposes the improvement of the chemical penetration and cleaning frequencies with the aim of minimizing the filling-in, in the mean time, without affecting the production needs. The long time performances of the NF systems depend on a correspondent pre-treatment and maintainance, but the most important factor is the pre-treatment.

4. Ultrafiltration (UF)

The ultrafiltration differs of the nanofiltration because in UF, the size of the membrane pores is about one size order bigger compared to the NF. In the past, UF was used for water treatment in manufacture industries and in treatment of the waste waters. Its use for obtaing the potable water is a recent concept. In order to maintain the long term performances of the installation at project level, the cyclic cleaning of the filling-in membranes or membranes with crust is necessary together with a correspondent pre-treatment, which also represents one of the most important factors. This can reestablish the device performances at project scale.

5. The chromatographic method

In order to identify the trace organic compounds from potable waters, the gas-chormatographic (GC) method is used. The main component of the gas/chromatographer is representd by the detector, which confer sensitivity to the detection method, and in this way thhe analyze of lots trace elements become possible, for non pollar organic substances, especially, as chloroform, TCE (trichloretylene), PCE (perchloreylene), but also aromatic compound, as chlorbenzene. In majority of cases, the most used detector is the detector with flame ionization (FID) whch has satisfactory sensitivity for trace elements.

A mass spectrometer (MS) is also used, with large applications, being preferred for standardized methods. For detection of the nitroaromatic compounds, but for organo - chlorinated compounds, especially, the detector with electron capture (ECD) is used. With such a detector the TCE and PCE concentrations may be determined. The measurements were performed with a HRGC 4000B Konik gas / chromatographer.

For the TCE and PCE extraction n-hexane was used, and sample volumes ranged between 1 and 3 mL, after three extractions with 3 up to 8 mL de n-hexane, being then dryied with sodium sulfate.

As supplementary gas N_2 was used, and H_2carrier gas ca gaz with 13 and 1,3 mL/min, flow. The sample injection was prformed with 10 mL Hamilton seringe, 4 mL in volume within a kieselgel capillary column DB5 type. The temperature programme was adjusted at T_1 = 37 °C, t_1 = 3 min, R_1 = 7 °C / min, T_2 = 70 ° C, t_2 = 3 min, R_2 = 20 °C / min, T_3 = 200 °C, t_3 = 3 min, R_3 = 20 °C / min, T_4 = 240 °C, t_4 = 15 min. In these conditions, the retention time was of 1.8 min for TCE and 2.6 min for PCE. In figure 2 the calibration curves of the GC/ ECD method for TCE and PC are presented.

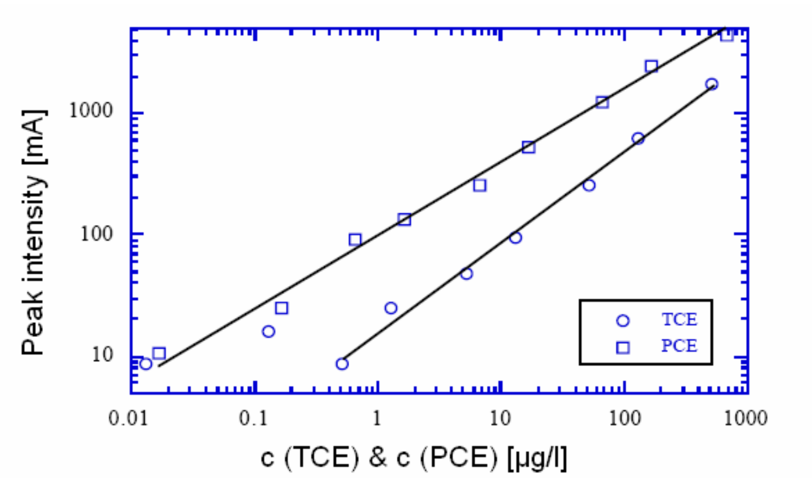

Figure 2.The calibration curves for TCE and PCE in n-hexan with V = 4 mL

The logarythmic graphical representation was selected due to the concentration domain in the 5 points, betwwen 10 ng/l and 1mg/l. For TCE the detection limit is about 1mg/l, while for PCE a concentration about 10 time smaller was recorded The determination could also be performed directly from liquid phase, e.g. using the ion – chromatography, which is more sensitive as method. Another possibility of determining the polar substances with big sensitivity is represented by the gas – chromatographic method using a water resistant column.

6. Conclusions

The ionic change method is one of the most advanced methods of water treatment. Within the separation process, besides the calssic separation processes (distillation, extraction, ion exchange, filtration, centrifugation, sedimentation) a series of other processes, called membrane processes, were developed.

The use of the membranes for the water treatment is specific for the treatment of the surface water containing solved salts, with big durity and organic sunbstances content. The gas - chromatography (GC) is used as detection method for traces non polar organic substances, as chloroform, TCE (threechloretilene), PCE (perchloretilene) but also for aromatic substances as chlorbenzene. The best detector is the detector with electron capture (ECD). For TCE and PCE the method is very sensitive, and the controlof small quantities, even in traces, become possible..

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