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Synthesis of Polymers Based on 1-Vinylimidazole Acetate and its Use for Purification of Carbon Dioxide Contained in Natural Gas

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Abstract:

This article discusses the synthesis of water-soluble ionic polymers based on 1-vinylimidazole acetate and their use for purification of carbon dioxide contained in natural gas, the effect of polymerization on CO2 absorption.

Keywords: Congas, natural gas, polymer, monomer, desorption, solubility, synthesis.

Congas is supplied from conversion units to the lower part of parallel stage I absorbers at a pressure and temperature no higher than 0.024 kPa (2500 mmHg$_2$O) and 45 ^{0}C, where it is purified from carbon monoxide (IV) with an IEA solution with a mass fraction of 20% coming from the upper part of the absorber. After stage I absorbers, Congas enters the dispersion separator at a temperature not higher than 50 0C and a volume fraction of SO_2 in it not higher than 5%, where drops of MEA solution are released due to changes in the direction and speed of gas movement. Phase I absorbers are filled from the dispersant of the IEA solution in cubic portions, and the Congas is filled with a gas scrubber cooler for cooling with circulating condensate and rinsing from the vapors of the IEA solution.Drops to 350.

Congas gas scrubber-gas compressors at a temperature not exceeding 45 ^{0}C from the cooler enter the suction pipeline of the first stage and into a dead-end congas gas generator with a capacity of 20,000 m^3.

The Kong is compressed in the gas compression compartment to a pressure not higher than 2.94 MPa (30 kgf /cm^2) and at a temperature not higher than 45 ^{0}C is lowered into parallel phase II absorbers and treated with an IEA solution with a mass fraction not higher than 14% until the volume fraction of carbon monoxide (IV) remains no higher than 40 ppm.

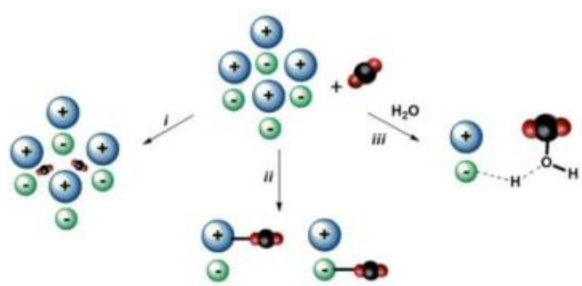
The use in various sectors of the national economy by processing hydrogen sulfide extracted from natural gas is one of the issues of rational use of modern resources. A 30% methyldiethanolamine solution of acid gases containing sulfur is widely used by absorption purification from natural gas. This means that the use of local absorbents to purify sulfurous acid gases from the natural gas content is one of the first problems. At the oil refineries and gas processing plants of Uzbekneftegaz JSC, the use of mdea in the extraction of hydrogen sulfide and carbon monoxide (IV) from natural gases has shown great importance.

In addition, purification of natural gases by polymers from CO_2 has several advantages:

- High selectivity. At the same time, they can be produced specifically selectively.
- Polymers can be synthesized with any molecular weight.
- Polymers can be synthesized from cheap raw materials or waste products.
- Ease of application of polymers and their selective solubility in water.
- Easy reuse and desorption process, as well as low energy cost.
- It can be environmentally friendly compared to the substances currently used, as well as easily adaptable at various scales.

These advantages point to the prospects of solving problems such as an increase in the concentration of CO_2 emitted into the atmosphere by polymers and its negative impact on the climate.

Carbon dioxide capture by polymers involves several stages and technologies. Of these, processes such as the selection of polymer materials, modification, selection of the optimal pressure, concentration and temperature for CO_2 capture, polymer regeneration, storage and processing of the resulting CO_2 can be distinguished.



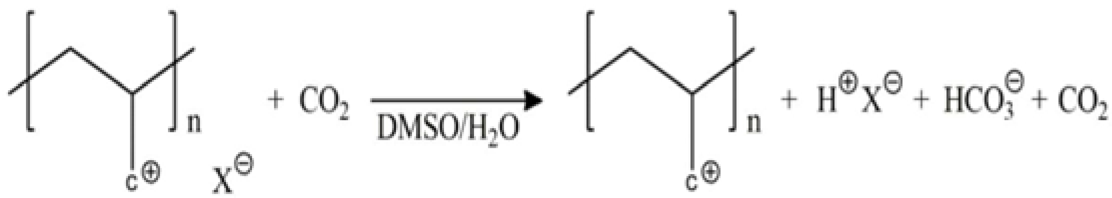
Several monomers were selected for the study and polymers were synthesized from them.

Poly-1-vinyl-3-ethylimidazole bromide: taking 2,044 grams of 1-vinyl-3-ethylimidazole bromide into a 100 ml flask, 40 ml of $CHCl_3$ was added to it. 0.044 g of azobisobutyronitrile was added as an initiator. They were stirred with a magnetic mixer for 6 hours and heated in the reverse flow. Then the excess solvent evaporated.

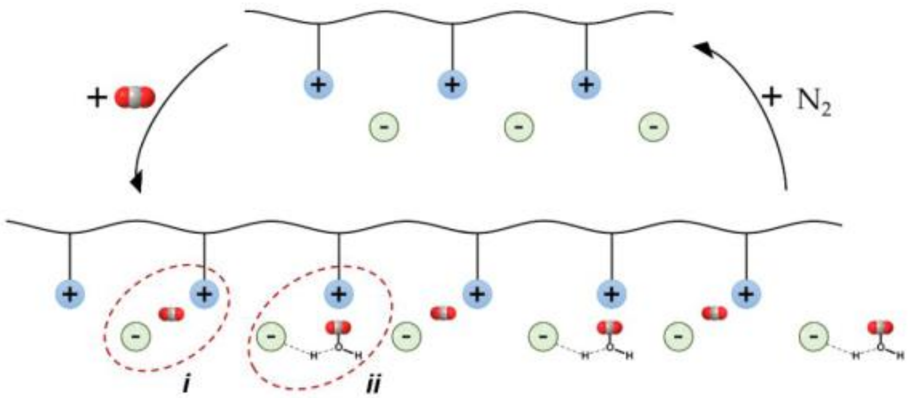
Poly-1-vinylimidazole: 1,902 grams of 1-vinylimidazole were taken into a 50 ml flask and 40 ml of $CHCl_3$ were added to it. Azobisobutyronitrile 0.068 grams was added as the initiator. They were stirred with a magnetic stirrer for 8 hours and heated in 20 reverse flows. The excess solvent was removed by filtration, and the rest was evaporated. The $CHCl_3$ polymer was then washed with 30 ml and dried, synthesizing a water-soluble polymer in flour compared to 33% 1-vinylimidazole.

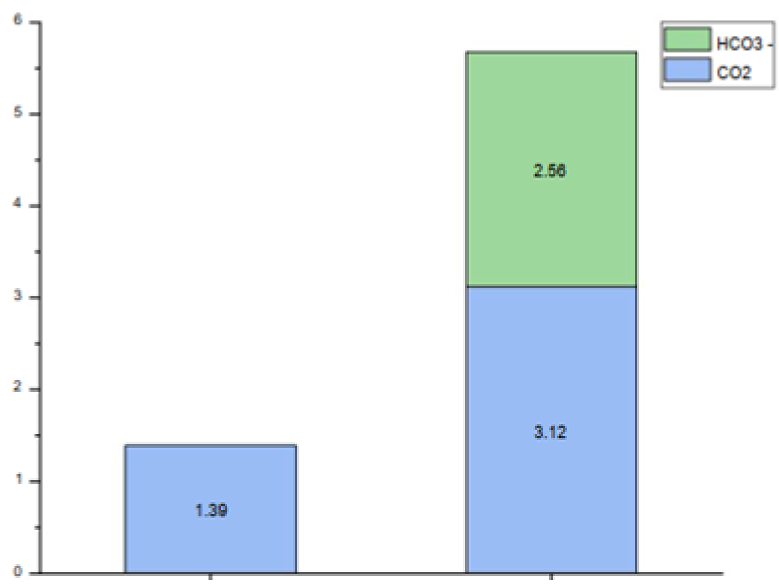
Poly-1-vinylimidazole acetate: 10 ml of water and 231.4 g of acetic acid were added to a 50 ml flask, taking 0.282 g of 1-vinylimidazole acetate. The solvent was then evaporated under low pressure to form a water-soluble ionic polymer of 74% Poly-1-vinylimidazole acetate.

It has been investigated that synthesized water-soluble ionic polymers capture CO2. Studies have found that the absorption of CO_2 in three ionic polymers is best for Poly-1-vinylimidazole acetate.



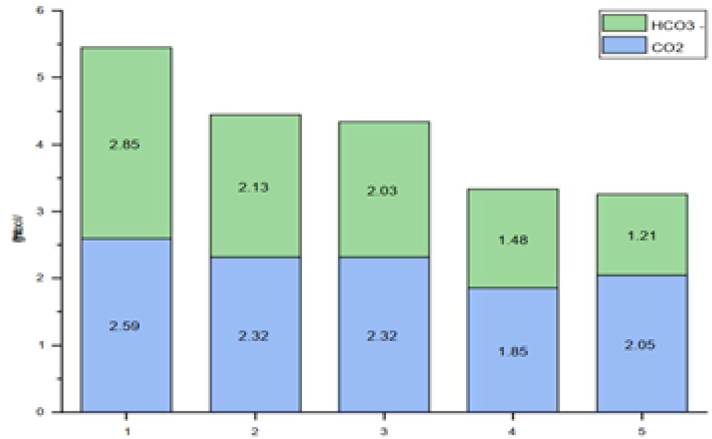
In order to study the effect of polymerization on CO_2 absorption, it can be concluded that the monomer of Poly-1-vinylimidazole acetate, if absorption occurs only by an ionic mechanism (Fig.1), in addition to ion absorption in polymers, also affects the ability of water itself to absorb CO_2.





Picture 1. The effect of the degree of polymerization on the absorption of carbon dioxide.

Poly-1-vinyl-3-imidazole acetate and Poly-1-vinylimidazole were studied in order to study the regeneration process and the ability of polymers to absorb and recycle CO_2. It is theoretically known that while the first water-soluble ionic polymer has demonstrated the best absorption capacity under optimized conditions, the second can easily release absorbed CO_2, meaning it can be used over and over again. The experiment showed that the amount of absorbed CO_2 in poly-1-vinyl-3-ethylimidazole hydroxide was the highest and that the chances of its reuse were high (Picture.2).



Picture 1. The amount of absorbed CO_2 in poly-1-vinyl-3-ethyl imidazole hydroxide and the possibility of its reuse

The result of repeated experiments shows that after each cycle, CO_2 capture in polymers decreases. This can be explained by an increase in the concentration of the polymer due to a decrease in the amount of solvent during the repetition of cycles.

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