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SYNTHESIS OF COPOLYMERS BASED ON NITROGEN-CONTAINING HETEROCYCLIC COMPOUNDS AND THEIR PROPERTIES

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ABSTRACT

It is conceivable to demonstrate high molecular products based on derivatives of nitrogen-containing heterocyclic compounds as components for creating hybrid organic-inorganic compositions. Such compounds may act as an organic matrix for composite sorbents, proton transfer membranes, emulsifiers, pharmaceutical preparations, etc. due to their useful physicochemical qualities (possibility of chemical modification, harmlessness, solubility in water). In terms of relevance, vinyl derivatives of heterocyclic compounds containing nitrogen demand particular consideration. Because nitrogenous monomers have a high polymerization activity during copolymerization operations, it is simple to alter the composition and, as a result, the characteristics of the resulting polymer products. In many instances, the kind of monomer used in a copolymer will determine the application area for that polymer. In order to make varnishes, sealants, adhesive mixtures, and sorbent materials, for instance, substances based on 2-hydroxyethyl methacrylate, methyl methacrylate, vinyl acetate, and nitrogen-retaining monomers are often utilised. Proton transfer membranes based on nitrogen-containing heterocyclic molecules have gained more attention recently. Therefore, from the perspective of practical application, the quest for novel polymers based on vinyl derivatives of heterocycles containing nitrogen is a highly important issue.

KEYWORDS: ***vinyl derivatives of heterocyclic compounds containing nitrogen, copolymerization process, methyl methacrylate, vinyl acetate, proton transfer membrane.***

INTRODUCTION

In the globe, a new class of composite materials known as polymer composites that are created by combining components with various chemical properties. They offer special mechanical, magnetic, and optical-electronic capabilities, excellent chemical and thermal stability, and increased UV radiation resistance due to their compositional features. The nanoscale displacement of the components in the system has a significant impact on the characteristics of such composite compounds[1-4].

A large class of organic-inorganic composites are silicon dioxide-based materials made using the sol-gel method and including colloidal silica and organic compounds[5-7]. This method enables the composition of manufactured composites to include a nearly infinite number of useful chemicals, including those that are thermodynamically incompatible[8]. The significance of organosilicon compositions in such systems lies in their ability to control the size of nanoparticles, the physicochemical characteristics of the material, and the creation of the composition's structure. Simultaneously, silicon dioxide, a component of the composition, lacks functional groups[9–12]. Functional organic lower or higher molecular molecule functions as the transporter of chemically active components.

METHOD AND MATERIALS

The matrix of the silica block in the hybrid composite was made of colloidal silica. In contrast to the colloidal silica produced by the hydrolysis of tetraethoxysilane, a famous sodium silicate gelation product was produced. As organic building components in the sol-gel synthesis, vinylmorpholine and methyl

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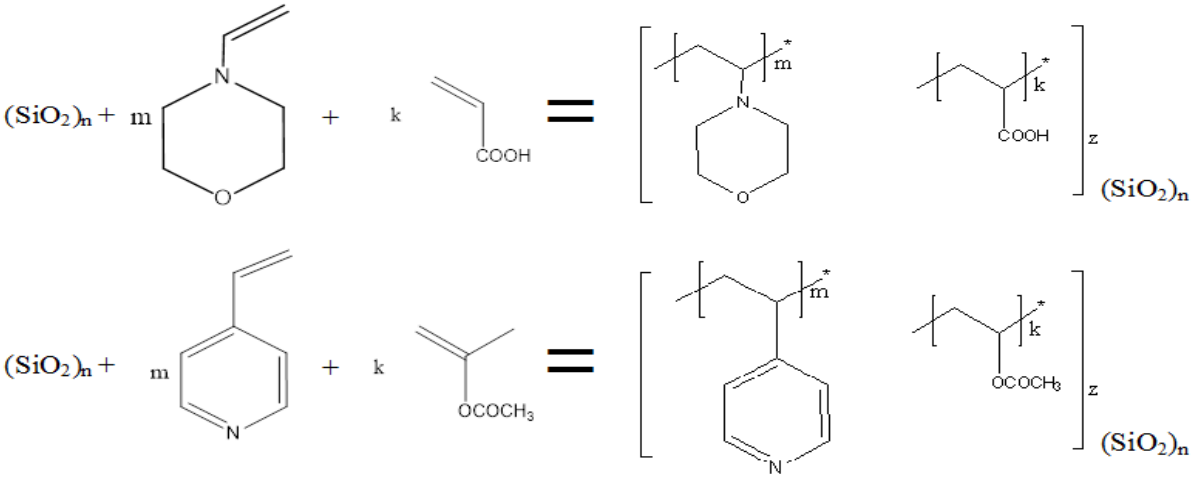
methacrylate (MMA) copolymer were used. The radical copolymerization method was used to incorporate Pyr-MMA copolymer as ready-made copolymers into the gel forming procedure.

The VPyr-MMA system was copolymerized in dimethylformamide (DMFA) solution for six hours at 60 °C while dinitrile azobisisobutanoic acid (DAA) was present. It was possible to get white powdered compounds that were soluble in alcohol, DMFA, DMSO, and tetrahydrofuran (THF). Along the vinyl group, radical copolymerization takes place. The following scheme describes how vinylmorpholine, vinyl pyridine, and vinyl piperidine react with acrylic acid in the matrix of colloidal silica.



It was investigated how much of the initial reacting ingredients had an impact on the yield, viscosity, and molecular mass of the finished product. From 1:9 to 9:1, the reactants were in different proportions. As was already indicated, DAA was utilised as an initiator, and 60 °C was the reaction's operating temperature. The study of how the reaction's characteristics (yield, viscosity, and molecular mass) vary depending on the initial ratio of reactants supported the earlier findings. The steric effect makes the reaction with methyl methacrylate somewhat more challenging than the one with acrylic acid. Therefore, more research was done when acrylic acid was present.

RESULT

Cryoscopic analysis was used to estimate the molecular masses of copolymers, and it was discovered that their sizes varied from 110,000 to 300,000. (Table 1).

Table-1. compounds heterocyclic with nitrogen (M1) copolymerization using vinyl monomers that retain carbonyl (M2). (6 hours, 60 °C, 1.5% by weight of DMFA and DAA)

The mole ratio of reactants		The yield of reaction %	The molecular weight of the copolymer (M)
M_1	M_1		
Vinylmorpholine-acrylic acid			
0.10	0.90	44	110 000
0.20	0.80	47	130 000
0.30	0.70	52	145 000
0.40	0.60	53	155 000
0.50	0.50	58	165 000
0.60	0.40	59	177 000
0.70	0.30	61	200 000
0.80	0.20	65	266 000
0.90	0.10	70	300 000

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The molecular mass of the copolymers increases as the starting mixture's fraction of vinyl monomer that retains carbonyl increases. This is further explained by the vinyl group's strong propensity to polymerize.

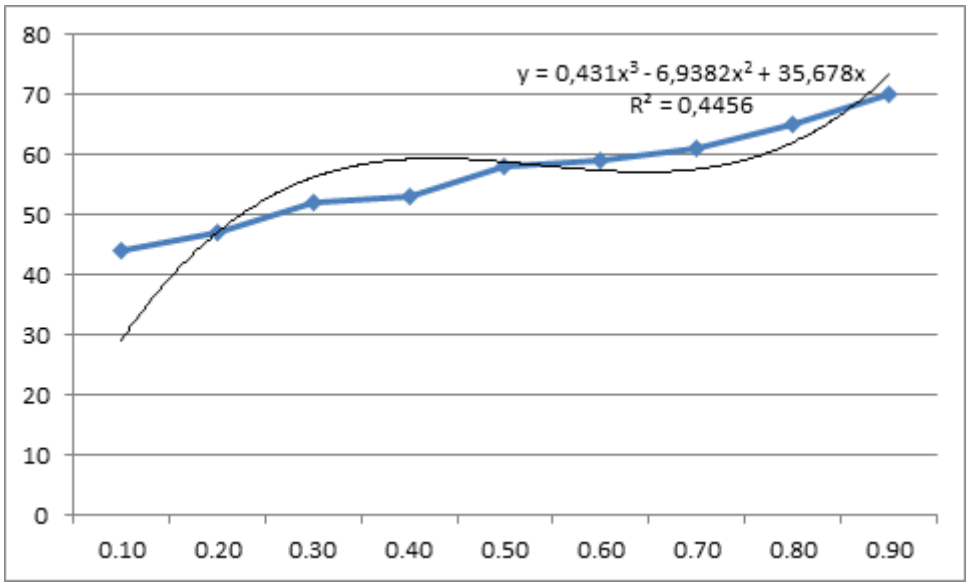

Diagram 1 shows how the yield of the copolymerization reaction between acrylic acid and vinyl morpholine depends on the quantity of vinyl morpholine used.

Copolymers with nitrogen heteroatoms are capable of forming complexes, as shown by their existence. In order to generate extremely elastic membranes based on these blocks of long chains of nitrogen-containing monomers, carbonyl-containing fragments are required. The production of hybrid composites based on developed copolymers is made possible by all of this.

DISCUSSION

The property of absorption of various intermediate components was investigated based on the property of complex creation. According to the research's findings, intermediate metals may be employed for separation, purification, and collection in an efficient manner. We may draw the following conclusion from the information presented above: radical copolymerization of VPyr-MMA and related systems in dimethylformamide solution was investigated for the first time. By using the sol-gel process, new hybrid composites were created using system copolymers and silica gel. Composites are three-dimensional silicon dioxide that is strongly bonded with organic copolymers and have good thermal and chemical stability. In the presence of synthetic nitrogen-retaining copolymers, hydrolytic polycondensation products of colloidal silica were used to create new hybrid membranes with the characteristics of proton-conducting materials. It was discovered that the composites made of the aforementioned system's copolymers adsorb intermediate metal ions, and this is because the intermediate metal ions form a complex with the chemically active groups of the copolymers in the composites.

CONCLUSION

One technique for creating hybrid organic-inorganic composites is sol-gel synthesis. This technology is one of the new and quickly growing methods for producing hybrid composites. High thermostability and mechanical strength are two qualities that distinguish the products of sol-gel synthesis, which are extensively utilised in analytical practise, natural and wastewater treatment, and enrichment processes. A nearly infinite variety of functional chemicals, even those that are thermodynamically incompatible, may be added to the produced materials using this method. By combining the matrix with the completed organic copolymer, composite materials were created. By skipping the step

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of polymerization of the organic monomer, a high degree of material homogeneity has been attained in this approach of creating hybrid composites.

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