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STUDY OF THE SYNTHESIS OF POLYMETHYLENAPHTHALINECARBONATE AND ITS SODIUM DERIVATIVES.

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ABSTRACT

The study also examines the characterization of polymethylenenaphthalinecarbonate and its sodium derivatives, including their chemical structure, physical properties, and thermal behavior. It discusses various analytical techniques used to analyze and confirm the structure and composition of these compounds, such as spectroscopy, microscopy, and thermal analysis. Furthermore, the study investigates the potential applications of polymethylenenaphthalinecarbonate and its sodium derivatives. It explores their use as materials for various industries, such as in the production of high-performance polymers, coatings, and electronic devices.

Introduction.

Polymethylenenaphthalinecarbonate (PMNC) and its sodium derivatives are a class of polymers that have garnered considerable interest in materials science and chemical engineering. These polymers possess exceptional characteristics, including high thermal stability, excellent mechanical strength, and good chemical resistance. The synthesis process of PMNC and its sodium derivatives, their applications, and their significance in various industries will be explored in this article.

PMNC is synthesized through a condensation polymerization reaction between naphthalene diol and a carbonate precursor. The reaction typically takes place under high temperature and pressure conditions, resulting in the formation of a polymer chain with repeating units of methylenenaphthalinecarbonate. The introduction of sodium ions into the polymer structure leads to the formation of PMNC sodium derivatives.

The unique properties of PMNC and its sodium derivatives make them suitable for a wide range of applications. In the field of materials science, these polymers are used in the development of high-performance composites, coatings, and adhesives. Their high thermal stability allows them to withstand elevated temperatures, making them ideal for applications in aerospace and automotive industries.

PMNC and its sodium derivatives also find applications in the field of chemical engineering. Their excellent mechanical strength makes them suitable for the fabrication of membranes used in gas separation and water purification processes. Additionally, their good chemical resistance enables their use in corrosive environments, such as in the production of chemical storage tanks and pipes.

The significance of PMNC and its sodium derivatives extends beyond materials science and chemical engineering. These polymers have the potential to contribute to advancements in various industries, including electronics, energy storage, and biomedical applications. Their unique combination of properties opens up new possibilities for the development of innovative technologies and products. [1-9]. .

Materials and methods

Synthesis of Polymethylenenaphthalinecarbonate

The synthesis of polymethylenenaphthalinecarbonate involves a condensation reaction between naphthalene dicarboxylic acid and a diol. The most commonly used diol in this process is 1,6-hexanediol. The reaction is typically carried out in the presence of a catalyst, such as a tin compound or an organic base.

The synthesis process can be summarized as follows:

Preparation of the diol:

The diol, in this case, 1,6-hexanediol, is prepared by reacting adipic acid with an excess amount of a suitable alcohol, such as ethanol. This step involves esterification followed by hydrogenation to obtain the desired diol.

Esterification:

The naphthalene dicarboxylic acid is reacted with the diol in the presence of a catalyst, such as p-toluenesulfonic acid. This step involves the formation of ester linkages between the carboxylic acid groups of the naphthalene dicarboxylic acid and the hydroxyl groups of the diol [1]. Polycondensation:

The esterification product is then subjected to polycondensation, which involves the elimination of water molecules and the formation of carbonate linkages. This step is typically carried out under high temperature and reduced pressure to facilitate the removal of water.

Polymerization:

The resulting polymethylenenaphthalinecarbonate is then subjected to further polymerization to achieve the desired molecular weight and properties.

Sodium Derivatives of Polymethylenenaphthalinecarbonate:

The synthesis of sodium derivatives of polymethylenenaphthalinecarbonate involves the neutralization of the carboxylic acid groups in the polymer with sodium hydroxide. This process results in the formation of sodium salts of the carboxylic acid groups, which imparts new properties to the polymer.

The synthesis process can be summarized as follows:

Preparation of PMNC:

Polymethylenenaphthalinecarbonate is synthesized using the condensation reaction described earlier.

Neutralization:

The PMNC is dissolved in a suitable solvent, such as dimethyl sulfoxide (DMSO), and then reacted with an equivalent amount of sodium hydroxide. This reaction results in the neutralization of the carboxylic acid groups in the polymer, forming sodium salts.

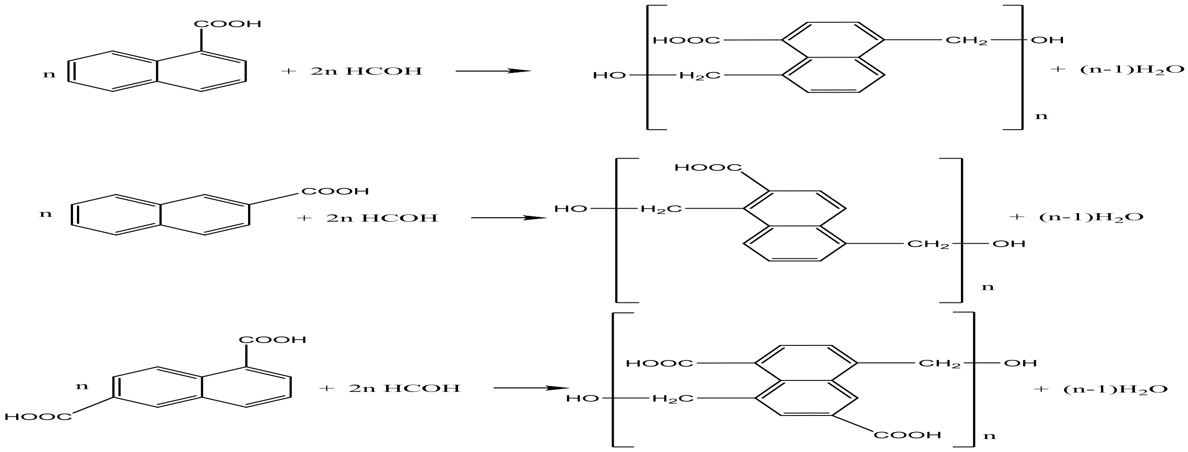
Purification:

The resulting sodium derivative of PMNC is typically purified by precipitation or filtration to remove any unreacted sodium hydroxide or other impurities.

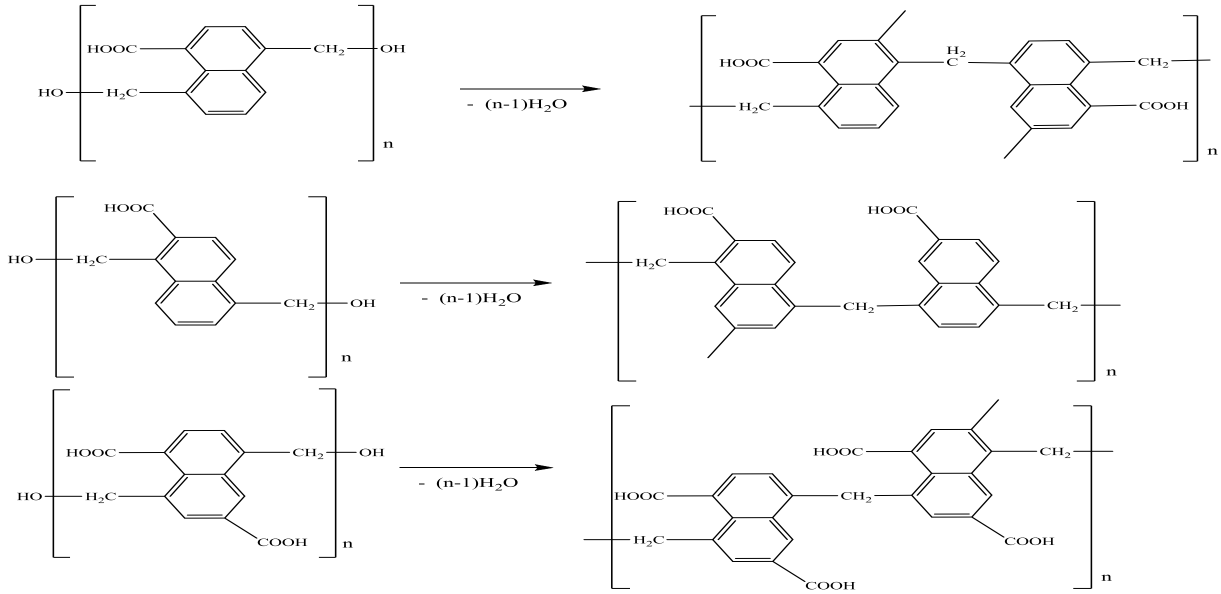
Naphthalene Polycondensates:

A mixture of carboxylic acids with formalin (1:2 molar ratio of carboxylic acids and formaldehyde) under high pressure, and the polycondensate is heated at 95-100°C for 24 hours. This process involves reactions I and II (EP0002401B1, 1981).

I-reaction.



II-reaction.



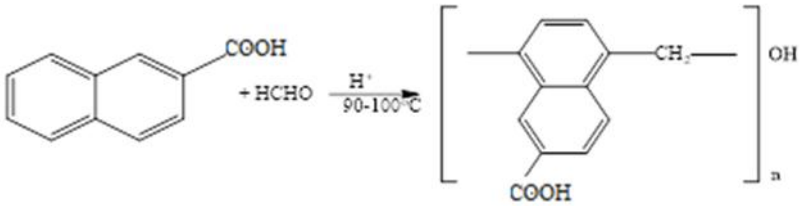
As a result of the oxidation of naphthalene homologs, 1-naphthalene carboxylic acid was synthesized with 91% yield, 2-naphthalene carboxylic acid with 89% yield, 2,6-naphthalene dicarboxylic acid with 25% yield, and 2,7-naphthalene dicarboxylic acid with 40% yield.

The process of synthesizing sodium polymethylenenaphthalenecarbonate oligomer with a linear structure in the research department of the synthesis of sodium polymethylenenaphthalenecarbonate oligomer consists of the following stages.

I. The naphthalene homologs obtained from the naphthalene homolog fraction (220-

240^{o}C) isolated from the pyrolysis oil were purified and oxidized.

II. The obtained naphthalene carboxylic acids were polycondensed with formalin (35% strength). The polycondensation reaction scheme is as follows:



Process mechanism:

$$H_2SO_4 + H_2O \rightleftharpoons HSO_4^- + H_3O^+ \qquad I.$$

$$H_2SO_4 + H_2SO_4 \rightleftharpoons HSO_4^- + H_3SO_4^+ \qquad II.$$

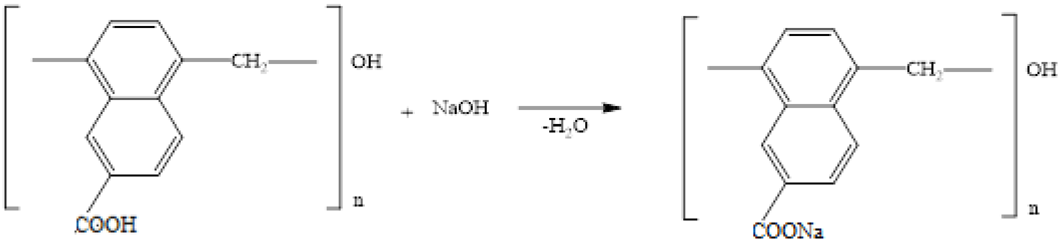
$$H_3SO_4^+ \rightleftharpoons H_2SO_4 + H^+ \qquad III.$$

$$CH_2O + H^+ \longrightarrow {}^+CH_2OH \qquad IV.$$

$$ArH + {}^+CH_2OH \longrightarrow \begin{cases} Ar\text{-}CH_2^+ + H_2O \\ Ar\text{-}CH_2\text{-}OH + H^+ \end{cases} \qquad V.$$

$$Ar\text{-}CH_2^+ + Ar\text{-}H \longrightarrow Ar\text{-}CH_2\text{-}Ar + H^+ \qquad VI.$$

III. The synthesized oligomer was neutralized with a 40% solution of caustic soda. As a result, a 35-36% aqueous solution of PMNC-Na was obtained. The reaction equation of the process is as follows;



Results and discussion

Significance of Polymethylenenaphthalinecarbonate and its Sodium Derivatives

The synthesis and study of polymethylenenaphthalinecarbonate and its sodium derivatives are of significant importance due to the following reasons:

Enhanced properties: The incorporation of sodium groups into PMNC can significantly enhance the properties of the polymer, such as solubility, ionic conductivity, and hydrophilicity. This opens up newavenues for the development of advanced materials with tailored properties.

Sustainable materials: Polymethylenenaphthalinecarbonate and its sodium derivatives offer potential alternatives to conventional petroleum-based plastics. These polymers can be synthesized from renewable sources and exhibit good biodegradability, making them environmentally friendly options.

Versatility: The unique properties of polymethylenenaphthalinecarbonate and its sodium derivatives make them versatile materials that can be used in various industries. Their applications range from engineering plastics to membranes, coatings, films, and energy storage devices, offering a wide range of possibilities for innovation and technological advancements.

Research and development: The synthesis and characterization of polymethylenenaphthalinecarbonate and its sodium derivatives present exciting research opportunities. Scientists and engineers can explore different synthesis methods, investigate the structure-property relationships, and develop new applications for these polymers.

The technological parameters of the synthesis process were changed in such a way that, as a result, these changes caused an increase in the molecular mass of the oligomer. The main conditions of the synthesis of PMNC-1-Na-0.8 obtained on the basis of 1-naphthalene carboxylic acid are given in Table 1.

Table 1

Main indicators of PMNC-1-Na-0.8 synthesis

The name of the polymer	NSK/CH2O Ratio. mol	Duration of reaction, hours			Concentration after reaction. %		Cone subsidence in mm according to GOST 10181
		oxidation	condensation	neutralization	SO_4^{2-}	PMNC-1-0,8	
PMNS C1-0.8	1/0,8	4	3	0.5	2.7	33.8	60-58
			4	0.5	2.5	35.0	62-60
			5	0.5	2.3	36.0	58-56
			6	0.5	2.1	34.0	68-72
		5	3	0.5	2.6	36.0	64-66
			4	0.5	2.2	35.0	66-68
			5	0.5	2.1	34.0	72-62
			6	0.5	2.2	34.0	68-62
		6	3	0.5	2.7	33.8	65-68
			4	**0.5**	**2.7**	**35.0**	**82-70**
			5	0.5	2.7	36.0	78-70
			6	0.5	2.7	34.0	65-74

The IR spectrum of the oligomer (PMNC-1-Na-0.8) synthesized as a result of polycondensation of 1-naphthalene carboxylic acid with formalin was obtained.

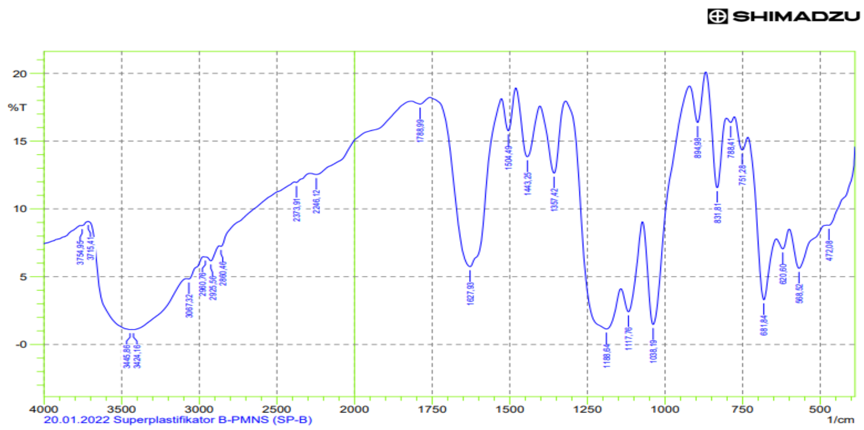


Figure 1. Polymethylenenaphthalene sodium carbonate with a linear structure IR spectrum of oligomer (PMNC-1-Na-0.8).

IR spectrum analysis of oligomer (PMNC-1-Na-0.8) valence vibration of –OH group at 3445.86 cm-1 region, Valence vibration of the C-H bond in the aromatic nucleus in the 3067.32 cm-1 area, -CH2- asymmetric valence vibration in the area of 2925.59 cm-1, -CH2- symmetric valence vibration in the area of 2860.46 cm-1, -CH2- deformation vibration in the 1443.25 cm-1 area, In the 1117.76 cm-1 region, we can see the -COONa valence vibration.

In our further studies, polyethylene naphthalene carboxylic acids (SOF-1 and SOF-2) were synthesized.

SEM Analysis of SOF-1 and SOF-2 Polymethylenenaphthalene Carboxylic Acid

SEM (Scanning Electron Microscopy) was employed to investigate the morphological surface structure and elemental composition of the synthesized SOF-1 and SOF-2 polymethylenenaphthalene carboxylic acids. The results of the SEM analysis of SOF-1 and SOF-2 are presented in two figures.

Figure 1: Morphological Surface Structure of SOF-1

The SEM analysis of SOF-1 revealed the following features:

SEM was used to determine the morphological surface structure and elemental composition of the synthesized SOF-1 and SOF-2 spatially structured polymethylenenaphthalene carboxylic acids.

The results of SEM analysis of SOF-1 and SOF-2 polymethylenenaphthalene carboxylic acid are presented in 2-figures.

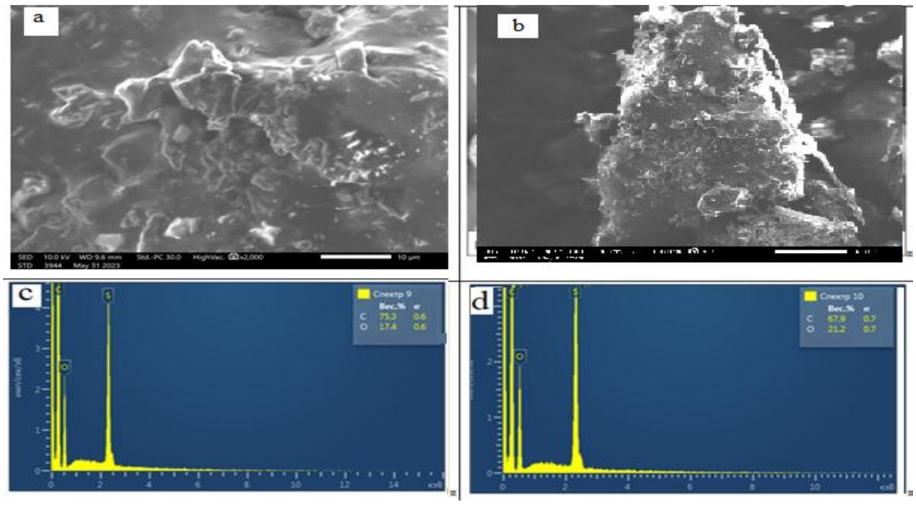


Figure 2. a,c - SOF-1, b,d - surface structure and element composition of SOF-2. The surface of SOF-1 exhibited a distinct spatial structure.

The morphology of SOF-1 appeared to be well-defined and organized.

The surface structure of SOF-1 displayed a regular pattern or arrangement.

Figure 2: Elemental Composition of SOF-2.

The SEM analysis of SOF-2 provided insights into its elemental composition:

The elemental composition of SOF-2 was determined using energy-dispersive X-ray spectroscopy (EDS) in conjunction with SEM.

The presence of specific elements in SOF-2 was identified, indicating the composition of the material.

The elemental composition analysis confirmed the incorporation of polymethylenenaphthalene carboxylic acid in SOF-2.

These SEM analyses of SOF-1 and SOF-2 polymethylenenaphthalene carboxylic acids provide valuable information about their surface morphology and elemental composition, contributing to a better understanding of these materials' properties and potential applications.

Summary.

The study discussed in this annotation focuses on the synthesis of polymethylenenaphthalinecarbonate and its sodium derivatives. It explores the process of synthesizing these compounds, including the reaction conditions and parameters involved. The study also investigates the characterization of these compounds, analyzing their chemical structure, physical properties, and thermal behavior. Additionally, the potential applications of polymethylenenaphthalinecarbonate and its sodium derivatives are explored, particularly in industries such as high-performance polymers, coatings, and electronics. Overall, the study provides valuable insights into these compounds and their potential use in various industries, suggesting opportunities for further research and development.

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