FTIR SPECTROSCOPIC ANALYSIS OF POLYESTER RESINS MODIFIED WITH POLYMETHYLENE NAPHTHALENE SULFONIC ACID

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Abstract: This research work investigates the spectral analysis of modified polyester resins based on poly(diethylene glycol adipinate) and polymethylenenaphthalene sulfonic acid, including studies using IR spectroscopy. Based on the obtained results, the absorption peaks were analyzed.

Keywords: poly(diethylene glycol adipinate); polymethylenenaphthalene sulfonic acid; modification process; polyester resins; spectral analysis methods; IR spectroscopy; absorption bands.

Currently, industrial-scale polyester dispersants and plasticizers are widely used in the production of construction, polymer, and composite materials due to their high efficiency, low dosage requirements, and ability to improve the rheological properties of materials [1–2]. It is particularly noteworthy that products obtained by incorporating aromatic compounds into polyesters are characterized by superior physical-mechanical, thermal, and rheological properties, which gives them significant scientific and practical importance today [3].

During the study, FTIR spectroscopic analyses were carried out to investigate the molecular composition and structural changes of samples synthesized from polymethylenenaphthalenesulfonic acid and poly(diethylene glycol adipate) at a molar ratio of 70:1. The FTIR spectra of PMNSP resins modified with polymethylenenaphthalenesulfonic acid and poly(diethylene glycol adipate) at a 70:1 mol/mol ratio were recorded and analyzed. The obtained results are presented in Figure 3.24.

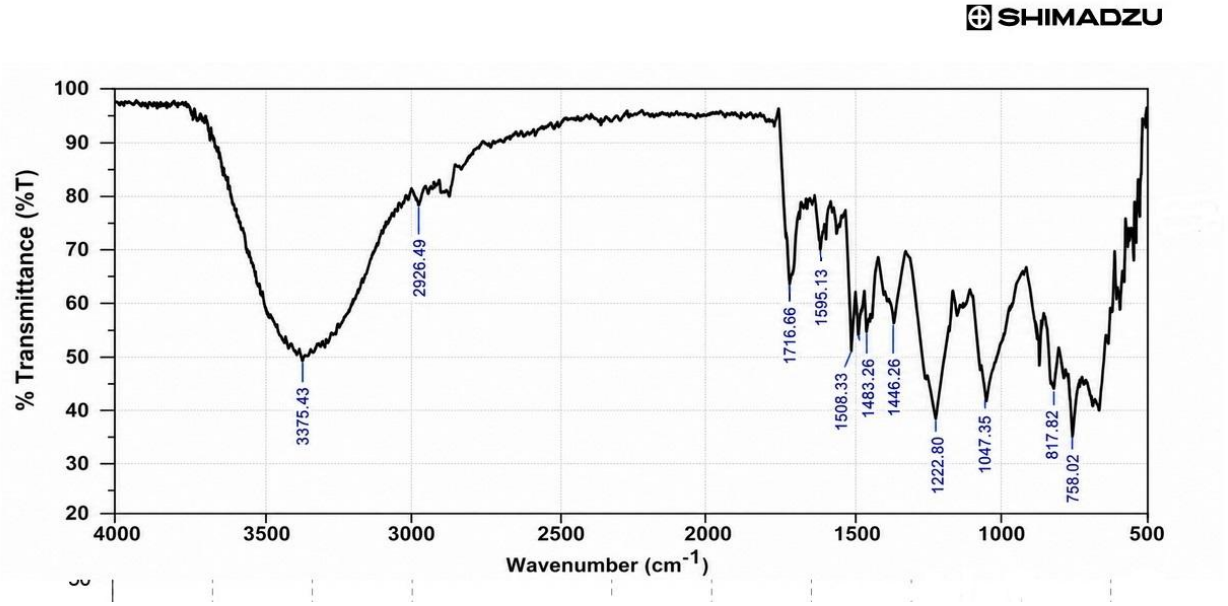

Figure 1. FTIR Spectrum of PMNSP Resin Modified at a 70:1 mol/mol Ratio.

Based on the spectrum shown in Figure-1 and the data presented in Table-1, it can be concluded that the polyester resin modified with PMNS and PDAT contains several characteristic functional groups. The broad absorption band observed at 3381.21 cm^{-1} corresponds to the stretching vibrations of hydroxyl (–OH) groups, indicating the presence of hydroxyl fragments originating from both the poly(diethylene glycol) residues and the sulfonic acid groups. The absorption bands at 2974.23 and 2877.79 cm^{-1} are attributed to the stretching vibrations of methylene (–CH_2–) groups, confirming the presence of aliphatic fragments within the polymethylenenaphthalene and poly(diethylene glycol) chains.

The strong absorption band observed at 1728.22 cm^{-1} is characteristic of the stretching vibrations of carbonyl (C=O) groups in the polyester resin structure, indicating the formation of ether- or ester-type linkages during the modification process. The signal at 1456.26 cm^{-1} is associated with the bending vibrations of methylene groups and characterizes the aliphatic segments of the polymer chain. The intense absorption band at 1045.42 cm^{-1} corresponds to the stretching vibrations of C–O–C groups in ether linkages as well as S=O bonds in sulfonic groups. This signal confirms the incorporation of poly(diethylene glycol) fragments into the polymer structure and indicates that the sulfonic groups originating from polymethylenenaphthalenesulfonic acid were retained during the modification process.

Table-1.
Comparative Analysis of FTIR Spectral Data.

№	Types of Functional Groups and Chemical Bonds.	FTIR absorption band position, cm^{-1}	Absorption band position reported in the literature, cm^{-1}	Absorption band intensity and vibrational assignment
1.	Hydroxyl (–OH) functional group.	3381.21	3200-3450	ν(O-H), b., s.
2.	Methylene (–CH_2–) group.	2974.23	2920-2980	νas(C-H), w.
3.	Stretching vibrations of aliphatic (-C–H-) bonds	2877.79	2850-2890	νs(C-H), w.
4.	Carbonyl (C=O) functional group.	1728.22	1720-1750	ν(C=O), b.
5.	Aromatic (-C=C-) bonds of the naphthalene ring	1590-1600	1500-1600	d(C=C), m.
6.	Methylene bridge linkages (–CH_2–)	1456.26	1440-1470	d(C-H), m.
7.	Dimethylene ether linkage (–C–O–C–).	1222.80	1200-1275	νac.(–C–O–C–), C
8.	Sulfonic acid (–SO_3H) substituent on the naphthalene ring.	1170-1200	1150-1250	νas(S=O), b.
9.	Sulfoxide (S=O) Group.	1042.45	1030-1070	ν(C-O), m.
10.	1,2,6-Substituted Naphthalene Ring	758.02-820	740-830	d(C-H), s.

Overall, the FTIR spectral analysis confirms the presence of aromatic naphthalene rings, methylene bridges, sulfonic groups, hydroxyl groups, as well as ether and carbonyl functional groups in the polyester resin modified with

PMNS and PDAT. The obtained results indicate that the modified polyester resin possesses the expected chemical structure and verify the successful incorporation of the modifying components into the polymer matrix.

References:

1. Камаев Д. Н. Высокомолекулярные соединения. – 2021.
2. JURAEV A. et al. INVESTIGATION BY IR SPECTRAL METHOD OF THE CURING OF UNSATURATED POLYESTERS BASED ON SECONDARY POLYETHYLENE TEREPHTHALATE OBTAINED IN PRODUCTION CONDITIONS //CHEMISTRY AND CHEMICAL ENGINEERING. – 2024. – Т. 2022. – №. 3. – С. 4.
3. SAYIDOV B. U. et al. SYNTHESIS OF HIGH MOLECULAR MASS RESINS BASED ON FURFURYL ALCOHOL //CHEMISTRY AND CHEMICAL ENGINEERING. – 2024. – Т. 2024. – №. 1. – С. 7.