JPRS: 4888

16 August 1961

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by F. I. Yashunskaya, V. A. Berestnev nnd I. P. Nagdasev

- USSR -

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WASHINGTON 25, D. C.

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WASHINGTON 25, D. C.

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JPRS: 4888

CSO: 1879-S

CREATIVE DISCUSSION ON THE PROBLEM OF THE IMPROVEMENT OF CHEMICAL FIBERS USED IN THE RUBBER INDUSTRY

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/Following is the translation of an article by F. I. Yashunskaya, V. A. Berestnev, and I. P. Nagdasev in Kauchuk i rezina (Caoutchouc and Rubber), No 5, 1961, pages 54-55./

On 20-22 February a creative discussion was held on the problem of improving the chemical fibers for tire cords and technical fabrics used in the rubber industry.

The discussion was organized by the Central Board of the Vsesoyuznoye khimichestvoye obshchestvo /All-Union Chemical Society/ imeni D. I. Mendeleyev, by sections on rubber and chemical fibers, by scientific research institutes -- VNIIV /Vsesoyuznyy nauchno-issledovatel'skiy institut volokon -- All-Union Scientific Research Institute of Fibers/ and NIIShP /Vsesoyuznyy nauchno-issledovatel'skiy institut shinnoy promyshlennosti -- All-Union Scientific Research Institute of the Tire Industry/ -- and was initially organized by the VKhO imeni D. I. Mendeleyev through the NIIShP.

The discussion was opened with the following reports.

Member-correspondent of the Academy of Sciences USSR, V. V. Korshak, characterized the most important directions for scientific research work in the synthesis of new and the improvement of existing polymers for the production of fibers with desired properties. For this purpose it is possible to employ any linear or uncomplicated branched monomers. The fibers of the future, along with a strong supporting core, must have a coating serviceable under special kinds of deformation or for protection from oxidation or other destructive factors. The most promising synthetic methods for polymers to be used as fibers include:

1) stereospecific polymerization for the production of such fibers as polypropylene or polytributylethane;

2) grafting and block-copolymerization (the addition of acrylic acid or its salts to cord fibers for increased heat-resistance may be taken as a typical example);

3) cyclopolymerization of non-conjugated diene hydrocarbons;

4) dehydration and recombination polymerization, yielding polymers very resistant to oxidative changes;

5) polycondensation on the boundaries of phase regions, as a chemical method of the direct formation of finished fiber;

6) hydrolytic polymerization;

7) polycoordination using complex compounds with metals, for example, beryllium, and with the production of high-molecular chelate polymers possessing high heat resistance, semiconductor or magnetic properties.

The paper outlined a number of promising polymers, such as polyvinyl alcohols, from which there can be produced fibers with exceptionally high strength, polyacrylic polymers possessing good heat resistance, elemento-organic materials,etc.

In conclusion the speaker emphasized that in the future in the main copolymers and various complicated polymeric structures will be drawn upon, rather than homopolymerization. This will extensively expand the possibilities of producing fibers with desired properties.

A report by Prof N. V. Mikhaylov was devoted to the features of the most important tasks and to the directions of scientific progress, especially for physics and physical chemistry in the field of polymeric fibers.

Chemical composition and molecular structure, and their orientation -- these are far from being the only factors determining the properties of fibers. Very important is molecular weight, the nature of the intermolecular forces, and supermolecular structure.

Among the properties which determine the type of promising fibers are included strength under tearing stress, and the modulus (high or average, which for a variety of future fibers must include fiber-elastomers with an average modulus); the elastic properties of fibers; the appropriate heat characteristics, minimum reversible and irreversible losses upon heating; molecular weight and fractional composition; chemical properties related to adhesion, non-flammability, resistance to oxidation and to various aggressive media, etc.

The temperatures of vitrification, flowing, and of melting are related to the intermolecular forces. For increased heat-resistant fibers it is necessary to create either molecules with a special assembly of functional groups, or to create molecules with rigid chains.

Calculations of the theoretical strength of maximumly oriented cellulose fibers carried out by V. A. Karginyy and N. V. Mikhaylovyy have indicated values of the

order of 300 kg/mm^2 or about 200 mm of tearing length. This theoretical calculation evidently is valid to a certain approximation for chemical fibers of any composition.

Fibers are already known at the present time with a tearing strength of 175 kg/mm^2, for example, polyesters; in the laboratory experiments have yielded strength indices which are equal to half of the assumed theoretical limit.

The delay in achieving technical attainable strength compared to that theoretically feasible is occasioned by the indeterminate structural defects, especially in the field of supermolecular structure (as has been shown by studies of the NIIShP), insufficient orientation, and insufficiently high molecular weight. Illustrations of the structural defectness of fiber structure can serve as an indication of the difference between its apparent and its actual density.

Touching on the problems of bundling structure, the speaker emphasized that supermolecular structure is not related to the molecular weight of the polymer in the fiber.

In conclusion, it was shown that the industry of artificial and synthetic fibers has already set the bounds to scientific research and experimental studies which will enable the achieving of an understanding of the nature of fibers, in the very near future, to the extent envisaged by the appropriate resolutions of the Party and the Government.

The subject of a paper by V. F. Yevstratov was the requirements for promising tire cord. The paper characterized the prospects for the development of the domestic tire industry over an extended period, both as for volume of products and for quality indices. The speaker gave a detailed analysis of conditions of the study, the character, and the values of deformations during the stressing of cords in tires through the free play of motion under various conditions of use. In this regard there was considered the necessary reserves of carcass strength when driving speed is increased, the loads on the tire, and the long-term decrease in the number of layers in the tire carcass. On the basis of this analysis concrete requirements were formulated for the mechanical indices of cord used in important tire types.

A paper by S. Ye. Strusevich was devoted to the requirements of promising fabrics in the production of technical rubber articles. Characterizing the variety of modern fibers available in the production of RTI, and emphasizing the unacceptably small f oportion of chemical fibers actually found in these articles in relation to cotton fibers, and emphasizing the technical advantages of

chemical fibers, the lecturer presented the technical needs of the RTI industry in the future.

The use, in the production of conveyor belts, flat and curved straps, and a number of most important others technical rubber articles, of fabrics made of chemical fibers in place of cotton significantly increases the longevity of the articles. Thus, the period of service of conveyor belts from anide fibers is double that of belts made from cotton belting, and curved straps from anide cords is four times more long-lived that those made from cotton.

The majority of technical rubber articles containing textile threads or fabrics, for example, driving straps, conveyor belts, etc., operate under a regime of frequent small-amplitude deformations and must preserve their dimensions with practically zero or negligible residual deformations. Therefore, for technical rubber articles, there are required, preferably, fabrics or threads from high-molecular fibers, for example, polyesters, fortisan, or other high-molecular hydratecellulose fibers.

Low-molecular polyamide fibers with significant residual elongation (not subjected to a hot infusion) are not promising in the production of a number of technical articles. Out of the polyamide fibers sampled the anide and the enanth were indicated as more suitable for the RTI industry than caproic fiber.

For heat-resistant articles special fibers are necessary, of the type containing fluorine, which can endure temperatures of the order of 300° and higher.

The subject matter of the reports provoked lively discussion. There were 17 representatives of scientific organizations and plants from various cities taking part -- Moscow, Leningrad, Kalinin, Yaroslavl', Klin, Krasnoyarsk, Kiev, Barnaul, etc.

Comrade Lyubimova, researcher in the Nauchno-issledovatel'skiy institut bumagi (VNIIB) /Scientific Research Institute of Paper/ discussed means of increasing cellulose quality for the manufacture of viscose fibers of the highest quality.

Representatives of industry and of scientific research institutes of artificial and synthetic fibers, and also of research centers for the study and synthesis of polymers, Comrades Serkov, Pakshver, Konkin, Sokolov, Frenkel', Mayborod, Radchenko, Kudryavtsev, Perepelkin, Petukhov, and Rogovin devoted their contributions to a study of a number of genuine problems: study of fiber structure and its effect on fiber properties; methods of increasing strength, elasticity, heat characteristics, chemical and other fiber properties; a number of questions of fiber physics and chemistry; and also the technology of producing

fibers with desired properties.

Very good prospects in this direction lie in the use of intermolecular seams /sshibki/, modifiers, and other agents.

It is necessary to aim at the minimum polydispersion in polymers synthesized.

A number of discussion participants stated that the relation of polymeric structures with the physicomechanical properties of the polymers has not been sufficiently studied, and that in the field of the synthesis of polymers with desired properties science and technology are yet in the initial stages of development.

Evidently, the most promising studies are those on the bases for the improvement of fiber-forming polymers already in use, and those still in the stage of experimentation, including polyvinylalcohols.

Representatives of the tire industry also participated in the exchange of views, namely: Comrades Epshteyn, Lin'kov, Yashunskaya, Seleznev, and Badenkov.

V. G. Epshteyn spoke of experimental cordless tires in which rubber-resin compositions served as reinforcing layers on the basis of combination with high styrene, aniline-formaldehyde, or other resins.

N. N. Lin'kov and I. I. Seleznev presented a paper by V. G. Yevstratov, which analyzed in detail the regime of cord thread performance in the tire. In particular, I. I. Seleznev emphasized that the regime of cord thread performance in the tire is divided into two areas: about 90 % of the deformation cycles occur with a mean amplitude of 2-4 %, and about 10 % of the deformation cycles -- with a mean amplitude of 5-8 %. The elongation of the cord threads by 16-20 % can be considered as the optimal percentage, but the specific indices are determined by the road type and type of cord thread materials.

F. I. Yashunskaya made more precise the requirements for cord threads as concerns fatigue durability and shock strength as a function of specific usage regimes of tire deformation, as a function of the tire types, and as a function of the road variety. Briefly examined were several conclusions of papers on viscose and polyamide cords which were read at the International Conference in West Berlin in 1960. Also introduced was the question of the need for more accuracy and unification of terminology as relates to the physicomechanical, especially thermal, characteristics of fibers and cords.

P. F. Badenkov emphasized that the volume of scientific research work in the field of improving fibers for tire cords lags considerably behind the requirements for improved tire quality. The appropriate studies can be

secured by a significantly greater number of specialist cadres and by a more powerful material-technical basis.

F. I. Yashunskaya, V. A. Berestnev,
and I. P. Nagdaseva

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