## ТЕХНИКАЛЫҚ ҒЫЛЫМДАР
## ТЕХНИЧЕСКИЕ НАУКИ
## TECHNICAL SCIENCES

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# TECHNOLOGICAL PROPERTIES OF URETHANE RUBBER MODIFIED WITH XYLITANE POLYESTER

**Abstract**

A method for producing urethane rubbers based on polyester xylitane has been developed. Industrial peroxide vulcanizates based on urethane rubber SUR-8IG crystallize at room temperature, therefore, agents forming a more developed spatial structure are used to vulcanize this rubber. The presence of a dense transverse structure reduces the rate of crystalli-zation of vulcanizates.

Urethane rubbers based on known copolymer polyesters do not crystallize and can be vulcanized with organic peroxides, diazocyanates, and a mixture of vulcanizing agents.

The nature of the selected vulcanization system largely determines the properties of the obtained rubbers – their hardness, modulus, residual deformation and other properties, therefore, industrial urethane rubber SUR-8PG can be used to manufacture parts for various purposes. The significant content of methyl groups in polyurethane SUR-8PG prevents crystallization and other intermolecular interactions. Rubber based on SUR-8PG rubber has a good glass transition temperature (Tc), but a relatively low elasticity.

The main task of this work is the synthesis of polyurethane rubber based on xylitane polyesters (SUR – 8TBk), obtained from waste from the hydrolysis and fat-and-oil industries, which has frost resistance and high elasticity.

**Keywords:** technological properties, urethane, rubber, glass transition temperature, vis-cosity, polyester, xylitane.

## Introduction

Urethane rubbers of the SUR brand are one of the types of polyurethane – high molecular weight compounds containing macromolecules in the main chain – repeating urethane groups –O-CO-NH-.

Urethane rubbers differ from plastics, which have properties closest to polyamides, in their molecular weight and structure.

Over 150 brands of SUR are produced in the industry, differing in chemical composition (SUR based on esters are known under the brands SUR -PF, SUR -PFL, based on esters – SUR -8, SUR -8P, SUR -7, SUR -7L, SUR -7, SUR -7P).

The classification of ICS according to the methods of their processing into products has been adopted.:

- injection molding (vulcollans) liquid compositions from which products are obtained by combining molding with the synthesis of a solid "crosslinked" polymer – rubber;
- rolled, solid linear or branched products;
- thermoelastomers processed into thermoplastics

SUR is used in mechanical engineering, automotive, aviation, petroleum, coal, and sheet

stamping industries for the manufacture of parts and plates, as well as as an anti-corrosion coating that is resistant to abrasive and waterjet wear. Products made of urethane formopolymers are characterized by increased wear resistance, high strength, oil and gas resistance, good shock absorption properties, and resistance to oxygen and ozone.


Fig.1. Urethane rubber products

Urethane rubbers can be divided into 3 types:

Rolled rubbers are solid linear or branched polymers. Rolled SUR rubbers are used to make rubbers with high modulus and hardness, which are used for steering rod liners, sealing cuffs and gaskets.

Low–modulus injection-molded soft low-molecular-weight injection urethane rubbers are used in the printing industry, friction phthulas, parts in the radio engineering industry, as a sealing material in radio electronics, etc.

High–modulus injection molding - high-strength and high-modulus injection molding machines are used as optically active rubbers, for the manufacture of sealing cuffs to cylinders in the automotive and other industries, various diaphragms, brake rollers and gears of silent transmission, wear-resistant coatings. They are used to make screen elements and wear-resistant coatings, parts for various types of cars, etc.

**Materials and methods**

Technological properties of rubber produced by different vulcanization systems (hydrogen peroxide, dimension hydrogen peroxide) were tested to characterize SUR -8ТВ$_k$ raw rubber; its resistance to the aggressive conditions was also studied (laboratory samples).

The following properties were used to characterize raw rubber samples SUR -8ТВ$_k$ based on the xylitane polyether:

1. solubility in the ethyl acetate (State Norms 33034-2014)
2. glass casting temperature (State Norms R 57931-2017)
3. viscosity according to Muni (State Norms R 24552-2011)

**Results and discussions**

SUR -8ТВ different raw rubber samples technological properties were studied. The main part of the raw rubber samples were completely dissolved in the ethyl acetate, this testifies to the fact that

it is of linear structure and there are no cross links. Some dissoluble polymer samples were obtained, and this may be explained by the fact that the ratio of some starting components has been changed. SUR -8TB$_k$ raw rubber glass casting temperature is in the limits of -40/-43$^0$ C. Comparing SUR -8TB$_k$ with SUR -8PG, glass casting temperature of which is in the limits -34, 5/-35,5$^0$C, we may say, that raw rubber SUR -8TB$_k$ has much more low Ts values [5].

The deviations stated are explained by the fact that poly ethers with larger molecular mass were used for the synthesis of these raw rubbers. Ratio viscosity according to Muni was used for the technological evaluation of the raw rubber. It should be noted, that this ratio is in the broad limits depending on the synthesis temperature and correlation of the starting components. We may state that poly urethane SUR -8TB$_k$ (viscosity limits from 20 to 150 conditional units) is easily processed in the cold rolls.

Determination of the processing period influence on the SUR -8TB$_k$ technological characteristics was fulfilled by measuring viscosity value according to Muni at different rolling periods.

Pelt for determining viscosity according to Muni was manufactured in the laboratory rolls of 160 x 320 mm size, friction was 1: 24/ 1, 27; the front roll rotation velocity was 23 – 27,5 revolutions per minute, the gap between the rolls was 1,0 – 0, 05 mm.

Raw rubber was processed in the rolls, where the rolls' temperature was 25$^0$ C; the processing period varied from 5 to 20 minutes.

Variations of SUR-8TB$_k$ viscosity according to Muni depending on the processing period at 25$^0$ C were investigated.

The curve testifies that if the processing period is increased, viscosity according to Muni is lowered; it may be connected with the partial destruction of the polymer. It was also necessary to clarify the possibility of the SUR -8TB$_k$ raw rubber processing by casting under pressure, because this method turns to be the most productive. This method is possible for using if the viscosity according to Muni ratio is higher than 70 conditional units [6-7].

To achieve this xylitane poly ether P-6 BA (the amount is 1,5 and 10 mass parts) was added to the sample of SUR -8TB$_k$ raw rubber with the starting viscosity according to Muni, equal to 113 conditional units. Data of P-6 BA additives influence on the viscosity according to Muni is given in the table 1.

Table 1 - Influence of xylitane poly ether P-6 BA on the technological properties of SUR -8TB$_k$ raw rubber

| Quantity of P-6 BA, introduced into the raw rubber, mass part | Viscosity according to Muni, conditional units |
|---|---|
| 0 | 131 |
| 1, 0 | 94, 5 |
| 5, 0 | 76, 7 |
| 10, 0 | 70, 7 |

As it is clear from the table, introduction of 5-10 mass parts of the plasticizer leads to the lowering of the viscosity according to Muni from 131 to 70 conditional units it enables us to use this method with different values of viscosity according to Muni.

Physical – mechanical indexes of the vulcanizors, filled with the xylitane poly ether up to 10 mass part., meet the requirements of the State Norms for the raw rubber SUR -8TB$_k$.

**Conclusion**

1. The composition of polyurethane rubber based on polyesters of xylitane SUR -8TBk, obtained from waste from the hydrolysis and fat-and-oil industry, has been developed.

2. The addition of plasticizer to polyurethane rubber based on xylitane polyesters SUR -8tb

reduces the viscosity index according to Muni, which makes it possible to use the injection molding method for processing SUR -8TBk rubber.

3. Polyurethane rubber based on xylitane polyesters SKU-8TBk has good physical and mechanical properties and can be used in various conditions, which significantly expands the scope of application of urethane rubber based on xylitane polyesters.

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## КСИЛИТ ПОЛИЭФИРІМЕН МОДИФИКАЦИЯЛАНҒАН УРЕТАНДЫ РЕЗЕҢКЕНІҢ ТЕХНОЛОГИЯЛЫҚ ҚАСИЕТТЕРІ

**Түйін**

Ксилитан полиэфиріне негізделген уретанды каучуктарды алу әдісі жасалды. СКУ-8ПГ уретанды каучук негізіндегі пероксидті өнеркәсіптік вулканизаттар бөлме температурасында кристалданады, сондықтан бұл каучукты вулканизациялау үшін дамыған кеңістіктік құрылымды құрайтын агенттер қолданылады. Тығыз көлденең құрылымның болуы вулканизациялардың кристалдану жылдамдығын төмендетеді.

Белгілі сополимерлі полиэфирлерге негізделген уретанды каучуктар кристалданбайды және органикалық пероксидтермен, диазоцианаттармен, вулканизация агенттерінің қоспасымен вулканизациялануы мүмкін.

Таңдалған вулканизация жүйесінің сипаты негізінен алынған резеңкелердің қасиеттерін анықтайды-олардың қаттылығы, модулі, қалдық деформациясы және басқа қасиеттері, сондықтан

әртүрлі мақсаттағы бөлшектерді жасау үшін өнеркәсіптік уретан каучук СКУ-8ПГ қолданылуы мүмкін. СКУ-8ПГ полиуретанындағы метил топтарының едәуір мөлшері кристалдануға және басқа молекулааралық өзара әрекеттесуге кедергі келтіреді. СКУ-8 ПГ резеңке негізіндегі резеңкелер жақсы әйнектеу температурасына ($T_c$) ие, бірақ салыстырмалы түрде төмен серпімділікке ие.

Бұл жұмыстың негізгі міндеті-суыққа төзімділігі мен жоғары икемділігі бар гидролиз және май өнеркәсібінің қалдықтары негізінде алынған ксилитан полиэфирлері (СКУ-8ТБк) негізіндегі полиуретанды каучукты синтездеу.

**Кілттік сөздер:** технологиялық қасиеттері, уретан, резеңке, шыны ауысу температурасы, vis-cosity, полиэстер, ксилит.

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## ТЕХНОЛОГИЧЕСКИЕ СВОЙСТВА УРЕТАНОВОГО КАУЧУКА, МОДИФИЦИРОВАННОГО КСИЛИТАНОВЫМ ПОЛИЭФИРОМ

**Аннотация**

Разработан способ получения уретановых каучуков на основе полиэфира ксилитана. Перекисные промышленные вулканизаты на основе уретанового каучука СКУ-8ПГ кристаллизуются при комнатной температуре, поэтому для вулка-низации этого каучука применяются агенты, образующие более развитую простран-ственную структуру. Наличие плотной поперечной структуры снижает скорость кристал-лизации вулканизатов.

Уретановые каучуки на основе известных сополимерных полиэфиров не кристал-лизуются и могут вулканизоваться органическими перекисяями, диазоцианатами, смесью вулканизирующих агентов.

Характер выбранной системы вулканизации в значительной мере определяет свойства полученных резин – их твердость, модуль, остаточную деформацию и другие свойства, поэтому промышленный уретановый каучук СКУ-8ПГ может быть применен для изготоввления деталей самого различного назначения. Значительное содержание метильных групп в полиуретане СКУ-8ПГ препятствует кристаллизации и другим межмолекулярным взаимодействиям. Резины на основе каучука СКУ-8ПГ обладают хорошей температурой стеклования ($T_c$ ), но сравнительно низкой эластичностью.

Основная задача настоящей работы – это синтез полиуретанового каучука на основе полиэфиров ксилитана (СКУ-8ТБ$_к$ ), полученного на основе отходов гидролизной и масложировой промышленности, обладающей морозостойкостью и высокой эластич-ностью.

**Ключевые слова:** технологические свойства, уретан, каучук, температура стеклования, вязкость, полиэфир, ксилитан.

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# STUDY OF PROTECTIVE PROPERTIES AND CHARACTERISTICS OF MEDICAL GLOVES

**Abstract**

In this article, we will analyze the main stages of production of medical gloves, including latex and nitrile gloves. Acrylonitrile butadiene rubber is an elastomer with a fairly impressive set of properties: increased resistance to oils and solvents, tensile strength, abrasion resistance, bending resistance, increased residual deformation under compression and resistance to migration and loss of volatile substances, color retention, weather resistance, and aging resistance. The article also provides the results of studies of the stages of the glove production process. The following production stages are defined: preparation of glove molds; immersion of molds in solution; vulcanization; leaching; formation of a cuff bead; finishing process (chlorination, polymer coating); removal from molds. The article provides the results of quality tests carried out in laboratory conditions.

**Keywords:** medical, latex, nitrile, vinyl, chainmail gloves chlorination, polymer, powder.

**Introduction.** At the beginning of the process, it is necessary to rid the mechanical hand forms of any dirt , using soapy water , and then in a chlorine-containing solution. Any foreign substance on the surface of the form can lead to the formation of tears in the glove. After this, the caramic forms pass through a series of rotating brushes [1] . This is necessary to clean the hard-to-reach areas between the fingers. Then the forms are dipped in a container with hot water and then dried a little. Still slightly damp forms are immersed in a chemical solution, which forms a film on their surface. After this, the ceramic forms are immersed in a warm solution. To increase chemical To increase the durability and elasticity of the gloves, the molds are immersed in a tank containing an acrylonitrile butadiene compound, which may include other additives and colorants. Reacting with the film, it acquires a gel-like structure. Rotation allows excess drops to be removed from the molds before heat treatment. Under the influence of heat, the solution dries [2]. The vulcanization process also occurs in the oven, increasing the strength and elasticity of the glove.

**Experimental part.** Working with various substances and chemical reagents determines the choice of the appropriate type of gloves [3]. Modern medical gloves differ in the characteristics of the material from which they are made, its chemical composition, production and processing technology, as well as the possibilities of their intended use. Figure 1 shows the stages of production of medical gloves. During the final processing, the gloves undergo special treatment to make them easier to put on. Traditionally, glove manufacturers used powdering. Nowadays, this technology is considered obsolete and is used mainly in the production of latex gloves [4] . Modern methods for making it easier to put on nitrile gloves most often undergo one of two procedures: chlorination and polymer coating . The technical characteristics of the resulting gloves (length of the gloves and thickness of the material used to make them) comply with SS 3-88 [5].

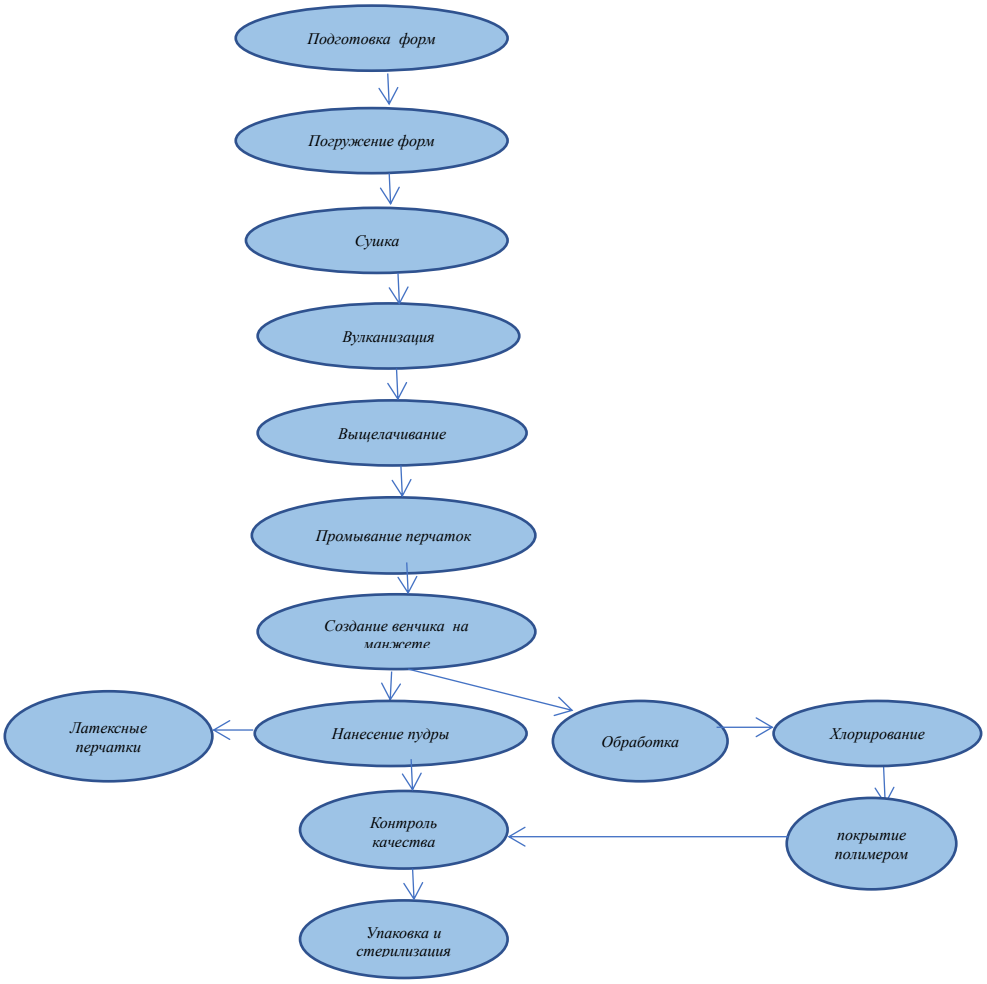


Figure -1. Stages of production of medical gloves

**Results and discussion**

Tests, conducted in laboratory conditions , showed good chemical resistance and physical characteristics of gloves . Resistance to cuts, punctures and abrasion were also taken into account as a critical factor when using the product. Contact of gloves with aggressive environments always operates in two cases: permeability and degradation [6] . When a glove comes into contact with a conditionally aggressive substance, its degradation begins and, as a result, the penetration coefficient increases. Table 1 lists several chemical substances for medical gloves.

Table -1- Selection of a specific aggressive environment for medical gloves

| Chemical substance | Latex gloves | Vinyl gloves | Nitrile gloves |
|---|---|---|---|
| Acetaldehyde | F | N | N |
| Acetamide | F | N | N |
| Acetate is a solvent | N | F | F |
| Acetic acid 80% | F | F | F |
| Acetic acid 20% | N | G | G |
| Acetyl chloride (dry) | N | F | N |
| Acetylene | G | E | G |
| Acrylonitrile | G | G | N |
| Acrylic acid | G | - | G |

Designations accepted in the table:
E ( excellent ) - absolutely safe work
G ( good ) - safe work
F ( fair ) - can work, conditionally safe work
N ( not recommended ) - it is not recommended to work - no data

Some glove materials may become hard, rigid, brittle, or they may become softer and swell, increasing in volume to several times their original size. If a chemical significantly affects the physical properties of the glove material, its resistance to penetration will rapidly deteriorate.

**Conclusions**

In accordance with the Sanitary Rules " Sanitary and Epidemiological Requirements for Facilities in the Sphere of Circulation of Medicines and Medical Devices" [6] , the minimum thickness of smooth examination gloves must be 0.08 mm, and textured 0.11 mm ; the thickness of smooth surgical gloves is 0.1 mm, textured 0.13 mm. The minimum length of examination gloves is 220 mm, and that of surgical gloves is 255 mm. The size of medical gloves must correspond alphabetic and numeric glove size designations . Size XS corresponds to sizes 5.5 and 6; S – 6, 6.5 and 7; M – 7, 7.5 and 8; L – 8 and 8.5. The rules for the use of medical gloves must comply with SS 12.4.307-2016 [7] .

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## МЕДИЦИНАЛЫҚ ҚОЛҒАПТАРДЫҢ ҚОРҒАНЫШ ҚАСИЕТТЕРІ МЕН СИПАТТАМАЛАРЫН ЗЕРТТЕУ

**Түйін**

Бұл мақалада біз медициналық қолғаптарды, соның ішінде латекс пен нитрилді қолғаптарды өндірудің

негізгі кезеңдерін талдаймыз. Акрилонитрилді бутадиенді каучук-бұл өте әсерлі қасиеттері бар эластомер: майлар мен еріткіштерге төзімділіктің жоғарылауы, созылу беріктігі, тозуға төзімділігі, иілуге төзімділігі, сығымдау кезінде қалдық деформацияның жоғарылауы және ұшпа заттардың миграциясы мен жоғалуына төзімділігі., түсті сақтау, ауа райына төзімділік және қартаюға төзімділік. Мақалада қолғап өндіру процесінің кезеңдерін зерттеу нәтижелері де берілген. Өндірістің келесі кезеңдері анықталған: қолғап қалыптарын дайындау; қалыптарды еріткіштерге батыру; вулканизация; сілтілеу; манжетті моншақ қалыптастыру; әрлеу процесі (хлорлау, полимерлі жабын); қалыптардан шығару. Мақалада зертханалық жағдайда жүргізілген сапа сынақтарының нәтижелері келтірілген.

**Кілттік сөздер:** медициналық, латекс, нитрил, винил, шынжырлы қолғаптар хлорлау, полимер, ұнтақ.

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# ИССЛЕДОВАНИЕ ЗАЩИТНЫХ СВОЙСТВ И ХАРАКТЕРИСТИК МЕДИЦИНСКИХ ПЕРЧАТОК

**Аннотация**

В этой статье мы проанализируем основные этапы производства медицинских перчаток, включая латексные и нитриловые перчатки. акрилонитрилбутадиеновый каучук - это эластомер с довольно впечатляющим набором свойств: повышенной стойкостью к маслам и растворителям, прочностью на растяжение, истиранию, изгибу, повышенной остаточной деформации при сжатии, стойкостью к миграции и потере летучих веществ, сохранению цвета, атмосферостойкости и старению. В статье также приводятся результаты исследований этапов процесса производства перчаток. Определены следующие этапы производства: подготовка форм для перчаток; погружение форм в раствор; вулканизация; выщелачивание; формирование бортика манжеты; завершающий процесс (хлорирование, полимерное покрытие); извлечение из форм. В статье представлены результаты испытаний качества, проведенных в лабораторных условиях.

**Ключевые слова:** медицинские, латекс, нитрил, винил, кольчужные перчатки, хлорирование, полимер, порошок.

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