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Problems Of Restoration Of Main Bearing Beds And Study Of Deformation And Strength Properties Of Polyurethane Adhesives

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Annotation: The Article Discusses The Problems Of Increasing The Durability Of Main Bearings And Methods Of Restoration Using Polymer Materials. The Deformation And Strength Properties (Specific Work, Breaking Stress And Relative Elongation) At Rupture Of A Polyurethane Adhesive Were Investigated Depending On The Ratio Of Components, Test Temperature, Curing Temperature And Curing Time.

Keywords: Increasing The Durability Of Fixed Joints, Main Bearings, Deformation And Strength Properties, Polymeric Materials, Specific Work, Breaking Stress, Elongation, Polyurethane Adhesive, Test Temperature, Curing Temperature, Curing Time.

1. INTRODUCTION.

The Need To Restore The Beds Of The Main Bearings Of The Engine Cylinder Block, Increase The Durability Of The Fixed Joints Of Plain Bearings And Reduce The Cost Of Maintaining Them In Working Order Has Led To The Development Of A Significant Number Of Methods For Restoring Fixed Joints. Promising Methods Of Restoring The Beds Of The Main Bearings Of The Cylinder Block Are Methods Of Restoring Using Polymeric Materials [1, 2, 3].

Polymer Materials Can Reduce The Labor Intensity Of Machine Repair By 20 ... 30% And The Cost By 15 ... 20%, While Reducing The Consumption Of Metals By 40 ... 50% [3].

Epoxy Resins Ed-16 And Ed-20, As Well As Powder Epoxy Compositions Pep-177 And Pep-534 Are Used In Repair Enterprises To Restore The Beds Of The Main Bearings Of Cylinder Blocks. However, The Use Of Epoxy Compositions Based On Ed-16 And Ed-20 Resins In The Restoration Of The Bed Of The Indigenous Beds Is Associated With Certain Technological Difficulties. Liquid Epoxy Compositions Have Insufficient Pot Life. After Preparation Of The Composition, It Is Necessary To Use It Within 20 ... 25 Minutes. At Operating Temperatures Of Engine Bearing Assemblies, Epoxy Compositions Have Low Elasticity, Which Reduces The Durability Of The Restored Fixed Joints. Epoxy Compounds Are Toxic, Therefore, All Operations For Their Preparation And Use Must Be Performed In Special Rooms With Enhanced Ventilation. To Restore The Beds Of The Main Bearings With Powder Compositions Pep-177 And Pep-534, Their Preliminary Boring, Block Heating, The Presence Of An Apparatus For Electrostatic Charging Of The Polymer Material And Mechanical Processing After Coating Are Required.

2. METHODS.

In Recent Years, The Country's Chemical Industry Has Mastered The Production Of Polyurethane Adhesives, Which Are Two-Component Compositions. The Components Are Easy To Mix And Do Not Contain Highly Toxic Substances. They Have Good Vibration, Oil, Petrol Resistance, Resistance To Low Temperatures And Thermal Shock; It Has Good Adhesion To Various Substrates. The Polyurethane Adhesive Can Be Cured At Temperatures Ranging From Minus 10 To Plus 120 ° C. However, At Present, There Are No Scientifically Substantiated Recommendations For The Use Of These Materials, Which Hinders Their Widespread Use In Repair Production [1].

The Deformation And Strength Properties Of The Vilad-11 Polyurethane Adhesive Were Studied On Films With A Thickness Of 90 ... 150 μm. The Films Were Molded On Fluoroplastic Plates. The Plate Was Installed At An Angle Of 45 ° And Poured With An Adhesive Solution, And Then Kept In Air For 15 ... 20 Min At A Temperature Of 20 ° C. In This Way, Three To Five Coats Were Applied. Curing Was Carried Out At Temperatures Of 20 ° C For 7 Days And At 100 ° C For 3 Hours, And Then The Films Were Separated From The Ptfe Plates. Samples Were Cut From The Films In The Form Of Rectangular Strips 35 Mm Long And 5 Mm Wide. The Physical And Mechanical Properties Of The Films At Different Test Temperatures Were Determined By The Method Of The Institute Of Physical Chemistry [4]. Breaking Stresses And Relative Elongations Were Investigated On A Laboratory Vertical Tensile Testing Machine Equipped With A Thermal Cryochamber. Heating Was Carried Out With An Electric Coil, And Cooling - With Liquid Nitrogen. The Test Was Carried Out In The Temperature Range From 40 To 100 ° C. The Temperature Was Controlled With A Chromel-Copel Thermocouple In The Immediate Vicinity Of The Test Sample And Maintained In The Specified Mode With An Accuracy Of ± 2 ° C. Tests At Elevated And Lowered Temperatures Were Carried Out After Thermostating The Samples For 15 Min.

3. RESULTS.

The Results Of Studies Of The Deformation And Strength Properties Of The Vilad-11 Polyurethane Adhesive Show That They Largely Depend On The Ratio Of Components A And B.

The Influence Of The Ratio Of Components On The Breaking Stress, Elongation And Specific Work At Break Of The Vilad-11 Polyurethane Adhesive Is Shown In Fig. 1.

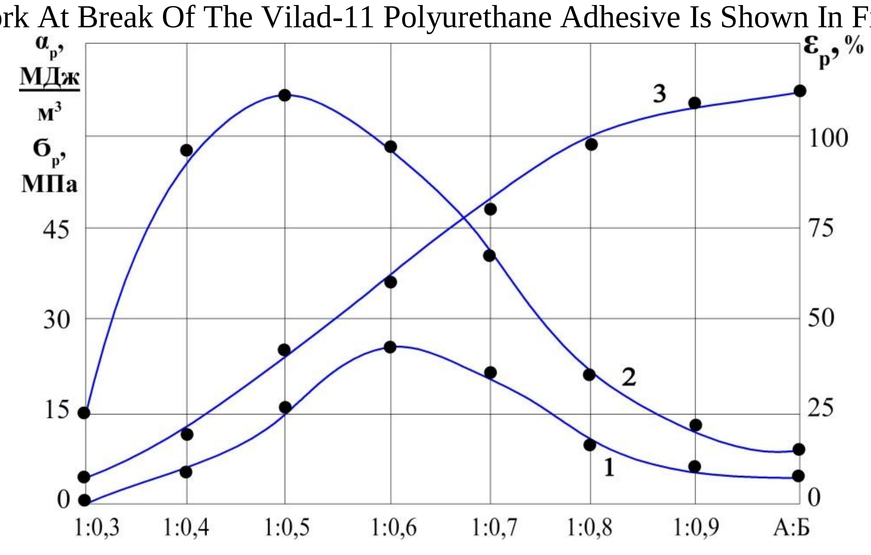


Fig. 1. Dependencies Of Specific Work At Break A_p *(1)*, Breaking Stress σ_P (2) And Relative Elongation ε_P (3) From The Ratio Of Components A And B Of Polyurethane Adhesive Vilad-11

The Strength Of The Polyurethane Adhesive, Depending On The Ratio Of Components, Fluctuates Over A Wide Range Of Values. Thus, The Breaking Stress At A Component Ratio Of 1: 0.3 Is 3.0 Mpa. With An Increase In Component B To 0.8, The Strength Increases Sharply. A Further Increase In Components B Leads To A Decrease In The Rate Of Increase In Strength. With A Component Ratio Of 1: 1, The Strength Reaches A Maximum Value Of 68.7 Mpa. With An Increase In Component B From 0.3 To 0.5, The Relative Elongation Sharply Increases And Reaches A Maximum Value Of 111.7%. A Further Increase In Component B Leads To A Sharp Decrease In The Relative Elongation When The Ratio Of Components Is 1: 1, The Relative Elongation In Comparison With The Maximum Decreases By 8.9 Times.

Films With A Component Ratio Of 1: 0.6 Have The Maximum Specific Work At Break, Equal To 26.8 Мдж/ М3. With An Increase Or Decrease In Component B, A Decrease In The Specific Work Is Observed. With A Component Ratio Of 1: 1, The Specific Work At Break Decreases By 6.8 Times, And With A Component Ratio Of 1: 0.3, By 17 Times.

Significant Effect On Strength σ_P And Elongation ε_P Films Have The Density Of The Spatial Network Of The Polymer, Which Is Determined By The Molecular Weight And The Ratio Of The Components / 5 /.

An Increase In The Degree Of Crosslinking Due To A Decrease In The Molecular Weight Of The Hydroxide-Containing Oligimer Leads, As A Rule, To An Increase In Strength And A Decrease In Elongation In Tension. The Properties Of Polyurethanes Largely Depend On The Ratio Of Isocyanate Hydroxyl-Containing Groups In The Original Compositions. With An Increase In The Proportion Of The Trifunctional Isocyanate Component, The Concentration Of Urethane And Urea, Allophanate And Biurethane Bonds Changes, Which Leads To Changes In The Polymer Structure / 129 /.

Thus, The Physical And Mechanical Properties Of Polyurethane Adhesives Are Mainly Determined By The Ratio Of The Initial Components And The Presence Of Chemical And Physical Bonds In The System.

The Conditions For The Formation Of Polyurethane Coatings, In Particular The Temperature Regime Of Curing, Have A Significant Effect On Their Physical And Mechanical Properties. The Deformation And Strength Properties Of Polyurethane Adhesives Cured At Room Temperature Are Inferior To Those Of Polyurethane Adhesives Cured At Elevated Temperatures. This Is Due To The Peculiarities Of The Formation Of A Polyurethane Network At Low Temperatures, The Presence In The Polymer Of A Significant Amount Of Extractable Substances, With Defective Physical Structure, Insufficient Removal Of The Solvent From The System / 6 /.

The Optimal Heat Treatment Mode, In Which The Specific Work At Rupture Reaches The Maximum Value, Was Determined By Optimizing This Parameter Using The Theory Of Planning A Multifactor Experiment According To The Optimal Compositional Plan Of Type B_2. As A Result Of Processing The Experimental Data, A Mathematical Model Of The Dependence Of The Specific Work At Break On The Heat Treatment Parameters Was Obtained, Which Adequately Describes The Optimum Region.

The Mathematical Model Has The Form Of A Second Order Polynomial:

$$У=29,578-0,888x_1-5,595x_2-4,6776x_1x_2-2,7275x_1^2-7,9075x_2^2 , \quad (1)$$

Where X_1- Heat Treatment Time;

X_2- Heat Treatment Temperature.

The Results Of Studies Of The Deformation And Strength Properties Of Films Obtained From The Vilad-11 Polyurethane Adhesive Show That They Largely Depend On The Heat Treatment Mode. The Influence Of The Heat Treatment Mode On The Specific Work At Rupture Is Shown In Fig. 2.

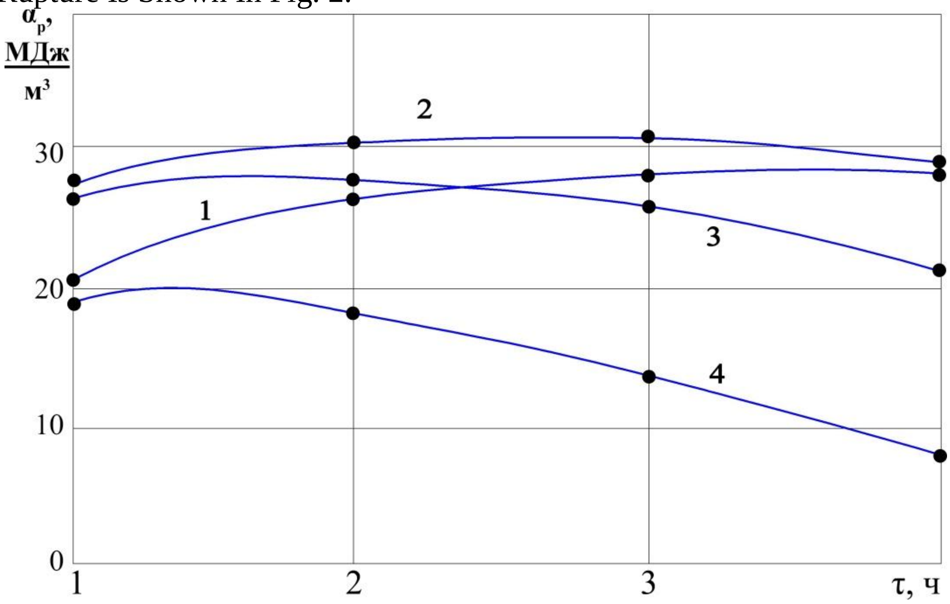


Fig. 2. Dependencies Of Specific Work At Break A_p From Heat Treatment Time τ Polyurethane Adhesive Vilad-11 At Various Temperatures T: 1,2,3,4, Respectively, At A Heat Treatment Temperature Of 60, 80, 100 And 1200c.

Maximum Value Of Specific Work 30, Мдж/М^3 Have Films Heat-Treated At 80° C For 3 Hours. In This Case, The Breaking Stress Reaches 48.2 Mpa, And The Relative Elongation Is 98.4% (Fig. 3).

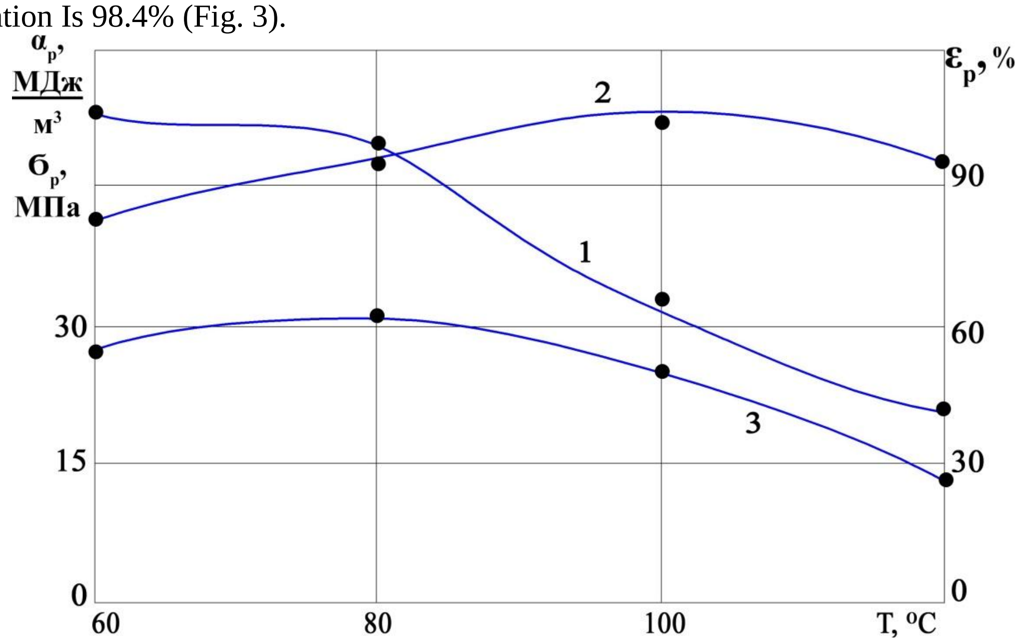


Fig. 3. Dependencies Of Specific Work At Break A_p (1), Breaking Stress σ_P (2) And Relative Elongation ε_P (3) From The Temperature Of Heat Treatment Of Polyurethane Adhesive Vilad-11 For 3 Hours.

Strength Reaches Its Maximum Value Of 52.3 Mpa At A Heat Treatment Temperature Of 100^0c, Which Is 1.5 Times Higher Than The Strength Of Films Heat Treated At 60c (Fig. 3). An Increase In The Curing Temperature To 120^0c Will Also Lead To A Decrease In Strength. With An Increase In The Temperature Of Heat Treatment To 120^0c For 3 Hours, The Specific Work Decreases To 14.0 Мдж/ $М^3$ And Within 4 Hours - To 8.1 Мдж/ $М^3$.

Films Cured At 60^0c Have A Maximum Elongation At Break Of 105%. With An Increase In The Temperature Of Heat Treatment, The Relative Elongations Decrease And At A Temperature Of 100^0c Are 66% (Fig. 3).

The Response Surface Of The Specific Work On The Heat Treatment Temperature Is Shown In Fig. 4. After The Canonical Transformation Of The Model, A Two-Dimensional Section Of The Response Surface Was Constructed, Which Is Shown In Fig. 5.

The Regression Equation In Canonical Form Is:

$$У=30,6394-4,2047x_1^2-6,4303x_2^2 . \qquad (2)$$

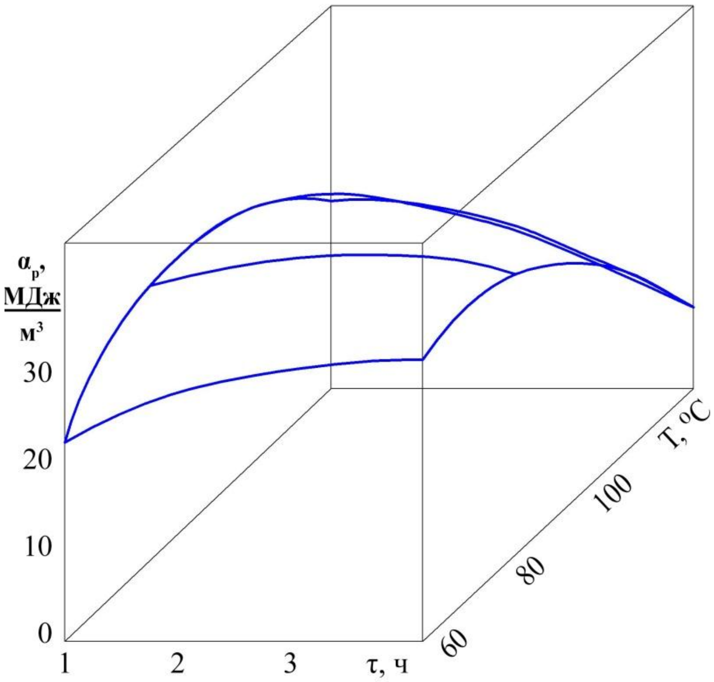
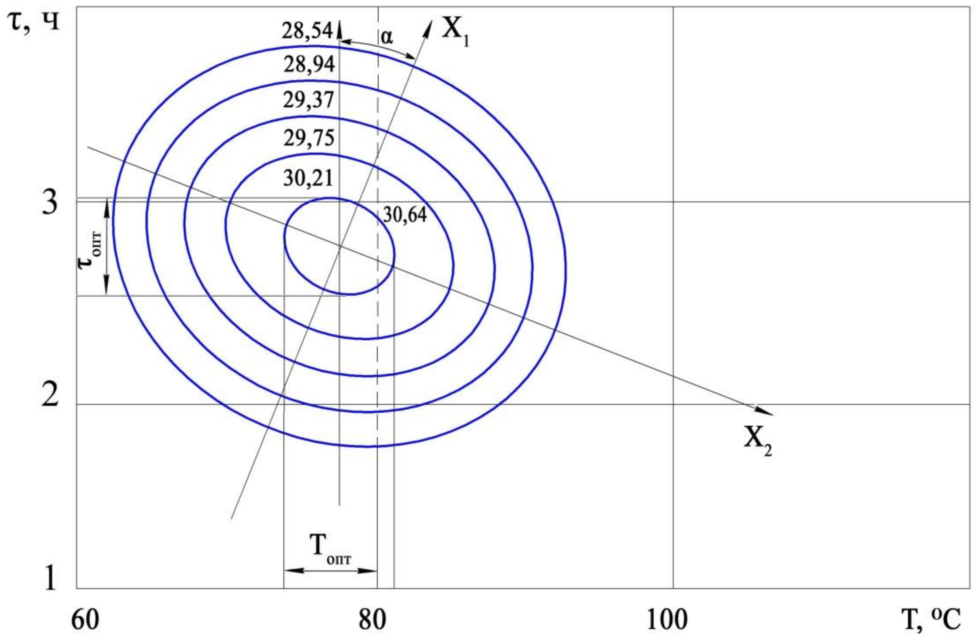


Fig. 4. Dependence Of Specific Work At Break A_p Polyurethane Adhesive Vilad-11 On Temperature T And Heat Treatment Time



Rice. 5. Two-Dimensional Section Of The Response Surface Characterizing The Specific Work At Break Of Thermally Treated Films Of Polyurethane Adhesive Vilad-11: T_{onm} And T_{onm} – Ranges Of Optimal Values, Respectively, Of Temperature And Time Of Heat Treatment Of Polyurethane Adhesive

On The Basis Of Its Analysis, The Optimum Area Of The Optimization Criterion Was Determined And The Optimal Mode Of Heat Treatment Of The Polyurethane Adhesive Was Selected: Heat Treatment Temperature - 80^0c And Heat Treatment Time - 3 H.

The Temperature Regime Of Curing Has A Significant Effect On All The Deformation And Strength Properties Of The Coatings. The Nature Of The Dependence Of The Breaking Stress And Relative Elongation On The Curing Temperature Of The Vilad-11 Polyurethane Adhesive Is Due To The Peculiarities Of Its Structure And The Ability To Undergo A Structuring Reaction At Elevated Temperatures. A Polyurethane Adhesive, Heat Treated At Temperatures Below 100^0c, Deforms Significantly Due To The Straightening Of Coiled, Long, High Molecular Weight Molecules. In This Case, The Total Deformation Consists Of Elastic, Highly Elastic Deformation And Flow Deformation. In This Case, Strength Is Provided By A Relatively Weak Intermolecular Interaction. At Curing Temperatures Above 100^0c, Cross-Linked Chemical Bonds Are Formed Between Polymer Molecules. An Increase In The Curing Temperature To 20^0c Leads To A Decrease In The Strength Properties Of The Films Due To The Destruction Of Biurethane And Alophanate Bonds.

In Fig. 6 Shows The Dependences Of The Specific Work At Break, Breaking Stress And Relative Elongation Of The Vida-11 Polyurethane Adhesive, Cured At A Temperature Of 20^0c For 36 Hours. On The Test Temperature. Films Have The Greatest Strength, 87.5-81.3 Mpa, In The Temperature Range Minus 40 - Minus 20^0c. With An Increase In The Test Temperature To 40c, The Strength Decreases Sharply. With A Further Increase In Temperature, The Rate Of Decrease In Strength Decreases. At 100^0c, The Strength Of The Films, Compared With The Maximum, Decreases By 14.5 Times.

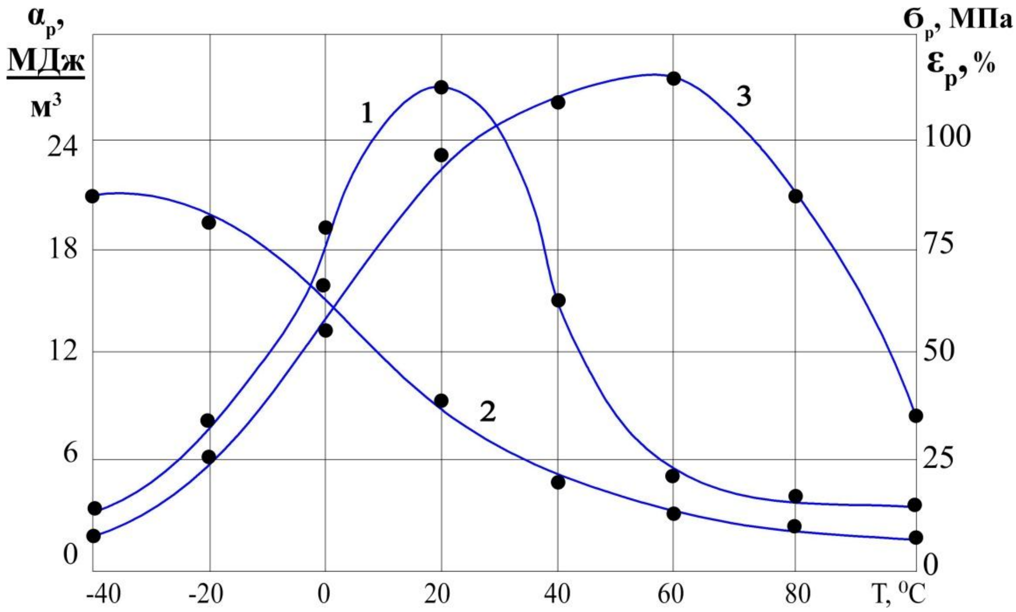


Fig. 6. Dependencies Of Specific Work At Break A_P (1), Breaking Stress σ_P (2) And Relative Elongation ε_P (3) From The Test Temperature Of The Vilad-11 Polyurethane Adhesive, Cured At A Temperature Of 20^0c For 36 Hours.

The Relative Elongation Of The Vilad-11 Polyurethane Adhesive Increases With An Increase In The Test Temperature To 60^0c And Reaches A Maximum Value Of 113.7%. A Further Increase In Temperature To 100^0c, The Elongation Decreases By 3 Times.

The Vilad-11 Polyurethane Adhesive Has A Maximum Specific Work At Break Equal To 26.8 Мдж/ $М^3$ At A Test Temperature Of 20^0c. With An Increase In Temperature To 100^0c, It Decreases By 8.9 Times.

Figure 7 Shows The Dependences Of The Specific Work, Breaking Stress And Elongation At Break Of The Vilad-11 Polyurethane Adhesive Heat-Treated At A Temperature Of 80 ° C For 3 Hours On The Test Temperature. The Film Has A Maximum Strength Of 82.6 Mpa At A Test Temperature Of Minus 40^0c. A Sharp Decrease In Strength Is Observed In The Temperature Range Minus 20 - + 40c. With A Further Increase In The Test Temperature, The Rate Of Decrease In Strength Decreases. At 100^0c, It Decreases, Compared With The Maximum By 6.6 Times.

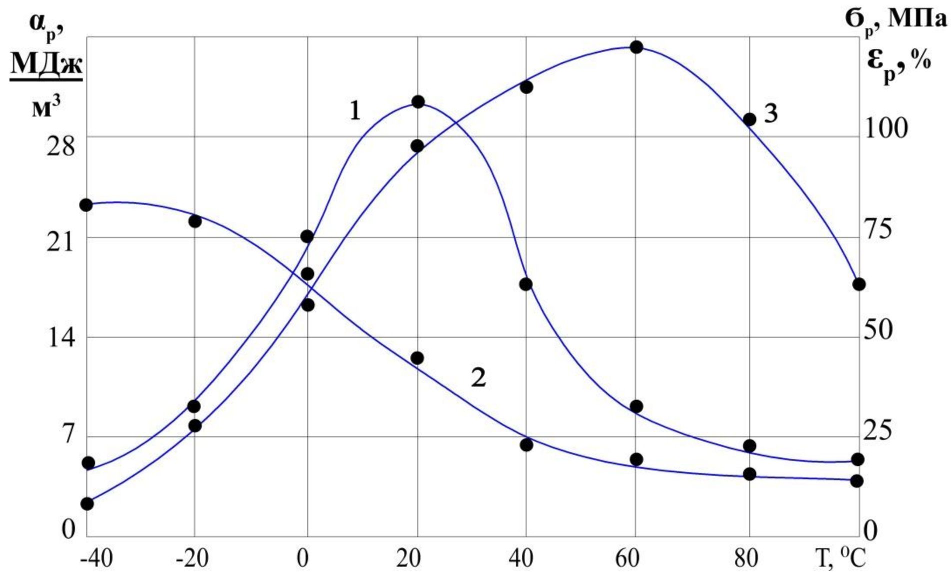


Fig. 7. Dependencies Of Specific Work At Break A_p (1), Breaking Stress σ_P (2) And Relative Elongation ε_P (3) From The Test Temperature Of The Vilad-11 Polyurethane Adhesive, Cured At A Temperature Of 80 ° C For 3 Hours.

4. DISCUSSION.

With An Increase In The Test Temperature From Minus 40 To Plus 60c, The Relative Elongation Of The Vilad-11 Polyurethane Adhesive Increases Sharply And Reaches 122.5%. At A Temperature Of 100^0c, They Decrease 2.4 Times.

With An Increase In The Test Temperature To 20^0c, The Specific Work At Break Increases And Reaches 29.8 Мдж/ $М^3$, A Further Increase In Temperature Leads To A Decrease In The Specific Work At Break. At A Test Temperature Of 100^0c, The Specific Work Compared With The Maximum Is Reduced By A Factor Of 5.7.

The Relatively Low Strength Of The Polyurethane Adhesive, Cured At A Temperature Of 200c, Is Explained By The Fact That This Adhesive Has A Low Polyisocyanate Reactivity During The Structuring Process. At A Temperature Of 20^0c, Not All Functional Groups Are Involved In The Formation Of The Mesh. Cured At Elevated Temperatures Leads To An Increase In The Density Of The Adhesive Network Based On Complex And Siliceous Oligoesters. An Increase In The Density Of The Adhesive Network Causes A Monotonic Increase In The Hardness And Strength Of The Coatings, While The Relative Elongation Decreases In This Case [139].

The Rate Of Increase In Tensile Fracture Stresses With Increasing Temperature (Figs. 6 And 7) Is The Greater, The Greater The Tendency Of Oligoester Chains To Intermolecular Interaction And The Lower Their Kinematic Mobility. In The Temperature Range 40-50^0c, There Is A Change In Strength Properties With Conformational Transitions Due To The Disintegration Of Physical (Hydrogen) Bonds And A Characteristic Increase In The Mobility Of Hydrocarbon Chains Is Observed.

The Nature Of The Dependence Of The Relative Elongations On The Test Temperature Is Determined By The Intermolecular Interaction. At A Temperature Close To The Glass Transition Temperature, The Development Of Highly Elastic Deformation Is Hindered By The Existence Of Strong Intermolecular Bonds. With Increasing Temperature, Intermolecular Bonds Weaken [139].

Thus, The Deformation And Strength Properties Of Polyurethane Adhesives Are Mainly Determined By The Ratio Of The Initial Components And The Presence Of Chemical And Physical Bonds In The System. The Deformation And Strength Properties Of Vilad-11 Polyurethane Adhesives Depend On The Ratio Of The Components And The Heat Treatment Mode. They Have Maximum Breaking Stresses At Break At A Ratio Of Components A And B Of 1: 1, Relative Elongations At 1: 0.5 (Vilad-11) And Maximum Specific Work At Break At 1: 0.6. With An Increase In The Heat Treatment Temperature To 1000c, Their Strength Increases, And The Relative Elongations Decrease.

5. REFERENCES

[1] Kurchatkin, Vv Restoration Of Rolling Bearings Of Agricultural Machinery With Polymeric Materials: Dis ... Doc. Tech. Sciences. / Kurchatkin V.V. - M., 1989, - 407 P.

[2] Gvozdev, A. A. Technology Of Increasing The Durability Of Friction Units In The Repair Of Agricultural Machinery Using Modified Polymer Compositions: Dis ... Dokt. Tech. Sciences. / Gvozdev A.A. - M., 2011, - 377 P.

[3] Melnichenko, Im Restoration And Improvement Of Durability Of Bearing Assemblies Of Agricultural Machinery Using Composite Materials And Coatings / Dis. ... Doct. Tech. Sciences. - Gomel, 1991 .-- 370 P.
[4] Sanzharovsky A.T. Physical And Mechanical Properties Of Polymer And Paint Coatings.-M .: Chemistry, 1978. -184 P.
[5] Gost 14236-81. Polymer Films. Tensile Test Method. - M .: Publishing House Of Standards, 1982 .-- 10 P.
[6] Lipatov Yu.S., Kercha Yu.Yu., Sergeeva L.M. The Structure And Properties Of Polyurethanes.-Kiev: Sciences. Dumka, 1970.-280 P.
[7] Boydadaev Mb, Kholmurodova. D.K. Investigation Of The Dependence Of The Physical And Mechanical Properties Of Composite Wood-Plastic Board Materials On The Content Of Polymer Binder At Different Densities. Universum: Technical Sciences. -Moscow, 2019-№9 (66). 31-35. Issn: 2500-1272, Doi: 10.32743 / Unitech.2019.66.9 (02.00.00 # 1)
[8] Negmatov. Ss, Boydadaev Mв Esearch Influence Of Humidity Of Resined Screw-Polymer Weight On Parameters Ofphysical And Mechanical Properties Of Composite Wood And Plastic Plate Materials. International Journal Of Advanced Research In Science, Engineering And Technology. №8 2019 Y