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# Determination operation Time Risk of Box Spinning Components-oe Spinning Machine

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***Abstract:*** Based on the constructed dependency diagram reliability of the exploitation operation time of each constituent components of the analyzed frame in the case of selected statistical distributions, areas of the operation exploitation and repair intervals are determined. This is done by determining the first inflection points. Based on these points analysis to determine the time of safety operation of frame components with allowable risk to the segmental linear function of the intensity of failure from empirical data components. Mathematical dependence dependability is determined on the basis of universal quadratic equation based on will determine the allowable risk time in operating the components of the analyzed frame.

***Keywords:*** *reliability, depending diagrams, inflection points, universal quadratic equations.*

## I. INTRODUCTION

**BASIC PRINCIPLE OE - spinning**

Basic Principles of the rotor - bezvretenskog spinning procedure consists in the formation of individual fibers, yarns, which were previously isolated from the output tape (tape carded). Display labels R1 OE spinning machines whose circuits are analyzed in this dissertation was carried out on **picture 1**.

Phases of this type of spinning (spinning classic bezvretenski way) consists of the following operations:

- bed (I and II), the operation of discretization of fibers (separation of individual fibers) from the output carded strip,
- transport of individual fibers with the air stream,
- stacking of individual fibers (group) at the entrance to the report,
- spinning fibers in the report and
- finished winding the yarn at the exit of the rotor.

Picture (1) Showing OE - spinning label R1 (Rieter)

Table 1: Comparison of phase spinning

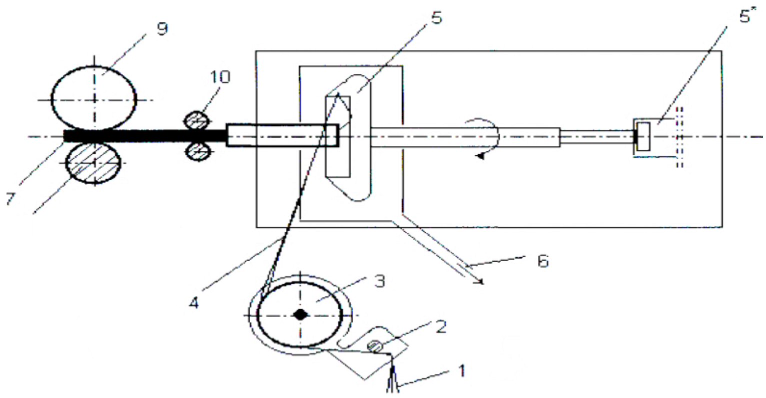
| CLASSIC without spindles PROCEDURE | CURRENT PROCEDURE without spindles |
|---|---|
| **1. CLEANING**<br>**Second carding**<br>**Third bed and**<br>**Stretch II**<br>without spindles<br>**SPINNING** | **1. 1. Automatic line Interrelated:**<br>**• OPENING**<br>**• Mixing**<br>**• CLEANING**<br>**• carding**<br>**• REGULATORY**<br>**2. Stretch Second** without spindles<br>**SPINNING** |

One of the main advantages without spindles spinning procedure for the processing of cotton and chemical fibers, cotton is a type in the number of phases. In the classical process of spinning the ring spinning machine, spinning process occurs in seven stages of work, while in modern without spindles spinning process occurs in two stages of spinning, which are shown in Table 1.

According without spindles spinning process, the material in the form of strips (1) with the other passages stretch over the opening roller (2) into the zone of action devices bed (3). Bed roller whose speed of 7000-8000 rpm (r / min) was coated with special serrated set so that the pull tapes from a single fiber (4), which is followed by electricity in the air transport for the spinning rotor (5). Individual fibers extracted with the help of air flow entering tangentially to the wall of the rotor. The high-speed rotor (rotor with a diameter ϕ 32 and the rotor 115 000 (o / min)) fibers are packed into the groove of the rotor in the form of wedge-beam parallel. Rotating rotor due to the effects of centrifugal force and effect Koriolisovog acceleration ie. force, formed by some form of the yarn balloon. Yarn spun from the rotor through the outlet rollers (10) wound on the spool (9). Cross drainage Speed ranges from 25-220 (m / min), the capacity of the coil to 5 (kg) with yarn wound on it (usually a coil capacity up to 2 (kg) with a wound yarn). Scheme without spindles ways of spinning the OE spinning type R1, manufacturer of Swiss company Rieterr is shown in **picture 2**.

## II. CHARACTER MECHANICAL OSCILLATIONS (VIBRATIONS) IN THE ANALYZED OE - SPINNING

The analysis of mechanical oscillations, given the importance of character formation that these phenomena. types of events that cause failures of component parts and components analyzed OE - spinning machine. The character (s) of the mechanical oscillations of the control points on the power transmission assemblies for spinning boxes and assembly of the finished yarn winding coils appear in three forms, namely as (**picture 2.**).




1.First Ribbon fiber, 2. The opening roller, 3. Roller bed fiber, 4. Oriented fibers, 5. Rotor, 5 '. Aerobed, 6. Dust extraction nozzle out of the box, 7. Yarn, 8. Guide or, 9 Coil. , 1.0 Rollers for tensioning the yarn before winding the bobbin Picture (2) A simplified view of how to obtain yarn spinning method without spindles

1. First Stochastic (random) oscillatory processes;
2. Second Oscillation of the oscillatory processes - pan;
3. Third Oscillation of the oscillatory processes - harmonic motion.

**CHARACTER mechanical oscillations (vibrations) At the analyzed circuit components TRANSMISSION POWER OE - spinning**

**First STOCHASTICAL (randomly) oscillatory process**
- the electromagnetic coupling (kumplung);
- locks on the openers bands;
- the rotors (turbines); • the wheels to run the yarn;

**Second Orbital - Straight PROCESSES**
- the yarn tensioners;
- guides the threads.

**Third Orbital harmonic process**
- on devices for lifting / lowering of the finished yarn full of coils; mechanisms for waxing yarn;
- the brake coil (spring system).

Picture (3) Diagram of classification character of mechanical oscillations of the analyzed components, fluid power components OE – spinning

## III. INTRODUCTION TECHNICAL DESCRIPTION OF SPINNING BOX

The basic components are:

**INTRODUCTORY CHANNEL(A6)**

serves to introduce carded strips in spinning box. Introductory channel or sprayer for removal carded strip is made of sintered ceramic which has high resistance to abrasion and wear. The sprayer is universal for all types of removal carded strip (Fig. 2).

**LOCKS BAND OPENER (A7)**

a steel cylinder in which a larger diameter is pulled a assembly for combing (comb carding strips) which performs parallelization of the fiber bundle. On the one hand this roller is over bearing and it is supported. Roller diameter is Ø 80 mm. This construction of roller allows properly opening (combing) with full preservation of their own carded fibers from the strips. Gear profile is optimal for smooth and complete opening of strip locks. Set with gear is resistant to the occurrence of friction for improved performance when working circuit and a longer duration. When mixed fiber yarn which themselves have anti-static (usually titanium dioxide is added to the yarn to shine) comb set is much faster wore out, respectively the gear set is quickly wore out, and 3-5 times faster than without antistatic yarn processing (Figure 6.).

**ELECTROMAGNETIC COUPLING (KUMPLUNG) (E1)**

its design provides security retraction of carded strip into the comb roller. If comes to a withdrawal of the carded strip mass it responds and stops the spinning process. Coupling rotational speed range is from $v_{ob} = 0,2 \div 0,8$ (m/min). Carded strip that introduces by electromagnetic coupling, is in range: for cotton 5,88 tex, for mixture 5,0 tex. These values are constant for all carded strip (Fig. 3.).

**NOZZLE (Dekle) (A3)**

perform material feed (individual fibers in the rotor - turbine) and is called the rotor lid.

**SYSTEM OUTLET PIPE FOR VACUUM DIRT (A4)**

constructively through compressed air outlet pipe increases separation of impurities utilization by 15-25% and avoiding an increase in waste good fiber compared to other manufacturers of these spinning machines. This aims to reduce the the ability to break of yarn during the spinning because a total separation of impurities affect the reduction of the ability to break yarn to 55%. Through the outlet pipe stand out all the dirt from carded strip, and it is constantly during operation of OE – spinning machine (Figure 6.).

**ROTOR (TURBINES) (A1)**

rotor diameter of the analyzed transmission system is Ø 32 mm, and is used for quality yarns 10-120 tex (8 - 100 Nm). The material of the rotor is specially alloyed titanium steel with high resistance to abrasion and high hardness up to 70 HRC. Rotor speed is 115 000 (r/min). The construction of this type of rotor has the following advantages: less rotor weight compared to conventional systems non spindle spinning, the lower consumption of this solution rotor, use is universal for all types of yarn, high resistance against the appearance of friction when reclining operation strip.

**AIRCRANK (A2)**

constructively is a combination of bearing with protective plates and consists of AERO static bearing in air. This is the first construction so far this kind of bearings. Constructive solutions of aircranks so far were performed with conventional plates where the bearing for axially moving is permanently lubricated, and in this way of performing all processes take place over an air, over a layer of air. This layer of air is compressed air and brings it to the rotor and the ends of the rotor. Such constructive aircrank performance not allow any effect of mechanical friction. This layer of air is intended to keep leading to the ends of the rotor, so that at the highest rotor speed can prevent vibrations. Because of this structural solution, aircrank and the rotor have quiet operation with virtually no noise. Because of all the above mentioned advantages this type of construction ensures the self future as a constructive solution to the largest number of spinning rotor speed (to 130 000 r/min). Also, cleaning of aircranka and the rotor during operation is performed with compressed air, which is carried out safely remove the tiniest bit of dirt. It should be noted that in the rotor is forming yarn with a number of turns.

- The previously explained, reliance of rotor and centricity in the radial direction on the pads - friction wheels, while in the axial direction his reliance and centricity is on air-cushion which is forcing air construction.
- **INTAKE BOX (A5) -** perform removal of dirt which is in carded stripe at its entrance to the roller for combing.
- **ELECTRONIC READERS (E2) -** controls the quality of yarn per cycle spinning in box spinniung. Certainly, at any time signalize quality of the yarn by the party, and automatically provides information if there is ability to break or to inadequate or yarn characteristics. Also controls measurement of the yarn length which is made in spinning box. The main types of errors that it finds and registers are: N-nope, S-short thick places, L-long thick places, T -thin places, Mo-moire, C-number of yarn.
- **WHEEL RUNNING YARN (A8)** – is made of special type of Ebonite (hard rubber), which crafted the pressure evenly to tensioner could function properly. When the wheel is taken for such material coating which is resistant to mechanical damages (cutting and lining) due to cross the yarn, and it is also resistant to the occurrence of friction.
- **TENSIONER YARN (A9) -** is structurally designed as a simple spring system that tightens the yarn evenly with any numerous yarn. Tensioner movement is oscillatory harmonic, with its deflection angle $\alpha = 8\text{-}12\,°$.
- **WAXING YARN MECHANISM (A10) -** at the individual plant in each spinning box. The mechanism causing the paraffin yarn stops at each break yarn. The mechanism has a closed housing with a large block of paraffin in it, which is good thing from the standpoint with the smooth operation of making large quantities of yarn with one battery housing. Installation and removal so as replacement of paraffin is very simple. Waxing the yarn is necessary due to a decrease in the influence of electrostatic friction yarn.

## IV. Diagrams Of Reliability Of Operation Of Spinning Box Components On Which Are Not Implemented Preventive Maintenance Technologies Procedures In Case Of Lognormal Statistical Distribution

Shown diagrams of reliability give an accurate determination of the proper operation dependency of each constituent component and the reliability of inflection points in the transition state of repair (views in Figures 4. – 12.).

Based on the constructed diagram dependency of the reliability of the constituent components of the analyzed frame $f(R_e(t), t)$ (views in Figures 3. – 21.) are determined the area of the operation exploitation and interval repairs. This was necessary in order to implement the timing analysis of the constituent components of the mean interval to failure.

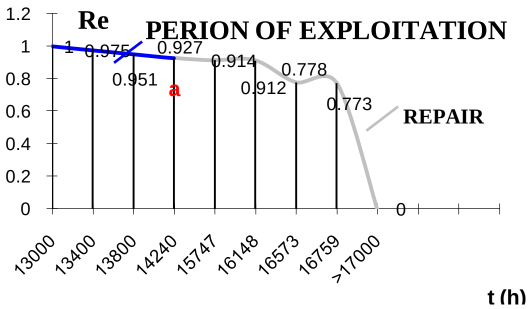



Figure (4) Reliability diagram for the constituent component rotor (turbine) – A1

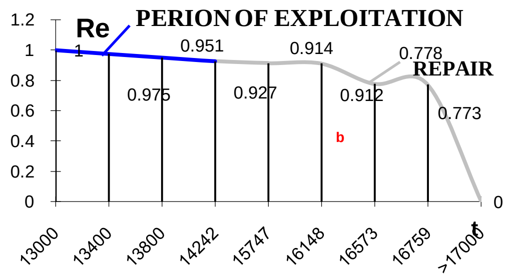



Figure (5) Diagram of reliability for component aircrank - A2

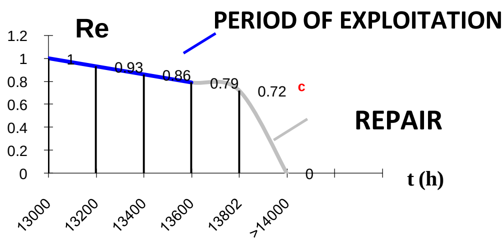



Figure (6) Diagram of reliability for constituent component dekla (rotor lid) - A3

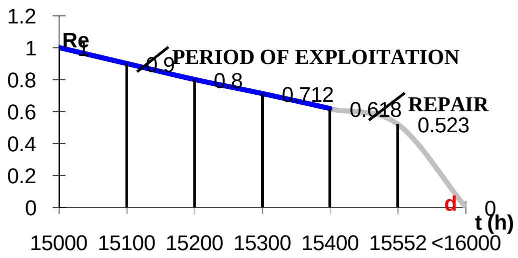



Figure (7) Diagram of reliability for constituent component outlet pipe spout - A4

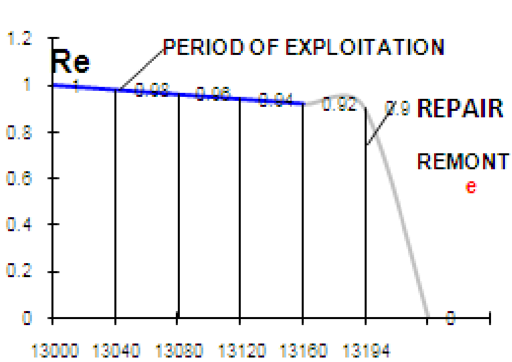



Figure (8) Diagram of reliability for constituent Component intake box - A5

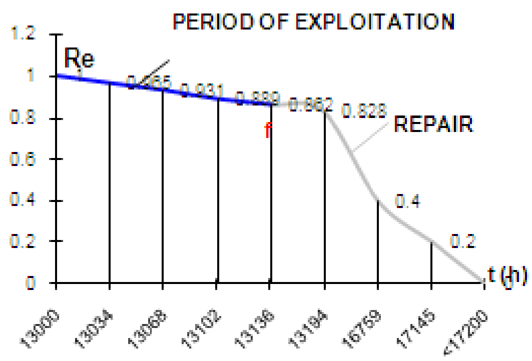



Figure (9) Diagram of reliability for constituent component introductory channel - A6

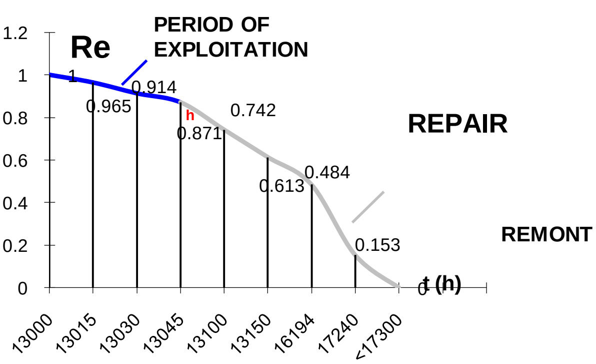



Figure (10) Diagram of reliability for constituent component locks band opener - A7

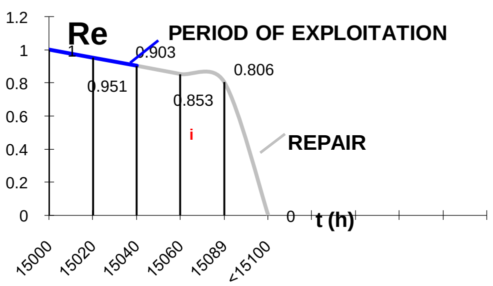



Figure (11) Reliability diagram for the constituent component electromagnetic coupling - E1

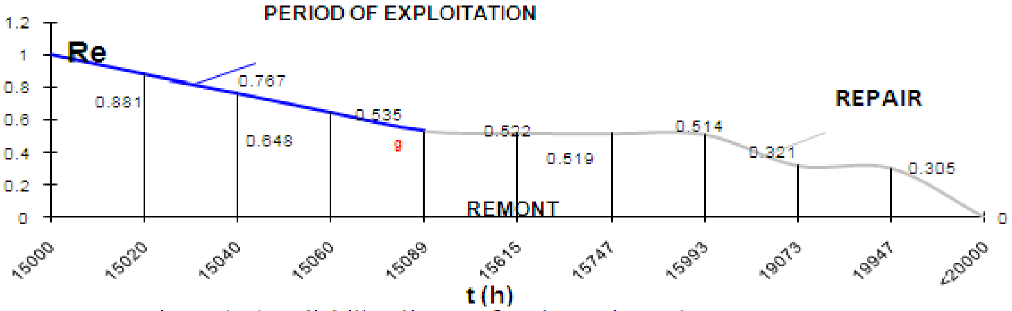


Figure (12) Reliability diagram for elecronic reader – E2

Based on shown reliability diagrams crossing points are visible, and basis of them a table dependency of boundary intervals to analyze the reliability of each constituent component (Table 2.) is formed. Also in these intervals to monitor the value of the amplitude of oscillation at selected measuring points. Based on these intervals in its boundaries, we come to the field of monitoring of each constituent component. Further analysis of the security of function of the constituent components of the analyzed frame is committed within the limits of these intervals, respectively to border monitoring their work to repair.

Table 2: Depending on the limit of the interval to analyze the reliability of each constituent component of analyzed frame where are not implemented preventive maintenance technology procedures

| Components mark | Mark inflection points in the diagram reliability $p_{t_i}$ | The marginal value of the exploitation time of the components of $\Delta t_{g_i}$ | The marginal reliability value of the exploitation time of the components of $\Delta p_{g_i}$ |
|---|---|---|---|
| A6 | f | 13136 | 0,862 |
| A5 | e | 13160 | 0,92 |
| A7 | g | 15089 | 0,535 |
| E1 | h | 13045 | 0,871 |
| A3 | c | 13600 | 0,79 |
| A4 | d | 15400 | 0,618 |
| A1 | a | 14240 | 0,927 |
| A2 | b | 14240 | 0,927 |
| E2 | i | 15040 | 0,903 |
| A8, A9, A10 | | > 20000 | 1,0 |

## V. Correction Value Of Operation Reliability Of Components Spinning Box Frame In Case Lognormal Statistical Distribution Where Preventive Maintenance Technology Procedures Are Applied

### 1. Introductory channel

The procedure for determining the reliability of this constituent component will be detail processed. Procedures for obtaining reliable values for the time intervals of the constituent components to failure, where preventive maintenance technology procedures are implemented. The basic parameters are taken:

• The time interval t = 15 750 (h) operation component to failure,

• The breakdown frequency $f_{e(A6\ 1)}(t) = 1{,}33 \cdot 10^{-6}$,

• Correction value of reliability obtained from empirical patterns $P_{e_{A6}}(t) \cong \varphi(z)$.

Correction standard deviation obtained from the form:

$$\sigma \approx \frac{\varphi(z)}{t \cdot f_z(t)} \approx \frac{0{,}8}{15750 \cdot 1{,}33 \cdot 10^{-6}} \approx 3{,}819(h);$$

Admitted: $|\sigma = 3{,}8(h) \Rightarrow \varphi(z) = 0{,}796 \Rightarrow R_{A6-o}(t) = \varphi(z) = 0{,}796$.

From the table of values for the area under the standard normal statistical distribution of reliability is adopted: $z = 0{,}84 \Rightarrow \mu = \ln t - z \cdot \sigma = \ln 15750 - 0{,}84 \cdot 3{,}8 = 6{,}47(h)$

**Note**: Further should not be analyzed reliability values $R(t) = P_z(t) \leq 0{,}5$ because the surfaces are covered in the confidence interval had no significant value by default Lognormal standard distribution.

The values of the parameters that deal with the reliability of the constituent components spinning box frame (introductory channel) in the case logonormal reliability distribution (Table. 3.).

Table 3: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (introductory channel) in the case of Lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component to failure $\Delta t, (h)$ | $f_{A6-o}(t)$ | z | $\mu$ | $\sigma$ | $R_{A6-o}(t) = \varphi(z)$ |
|---|---|---|---|---|---|---|---|
| Introductory channel | A6 | 14 001 | - | - | - | - | **1,0** |
| | | 14 300 | $1.33 \cdot 10^{-6}$ | 2,32 | -2,495 | 5,128 | **0,989** |
| | | 14 600 | $1.33 \cdot 10^{-6}$ | 1,17 | 1,17 | 5,0 | **0,9563** |
| | | 14 900 | $1.33 \cdot 10^{-6}$ | 1,38 | 3,23 | 4,79 | **0,916** |
| | | 15 200 | $1.33 \cdot 10^{-6}$ | 1,16 | 4,6 | 4,595 | **0,877** |
| | | 15 500 | $1.33 \cdot 10^{-6}$ | 0,98 | 4,05 | 4,394 | **0,836** |
| | | 15 750 | $1.33 \cdot 10^{-6}$ | 0,84 | 3,8 | - | **0,796** |
| | | 16 850 | $1.33 \cdot 10^{-6}$ | 0,25 | 2,7 | - | **0,5987** |

Table 4: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (intake box) in the case of Lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component to failure $\Delta t, (h)$ | $f_{A5-o}(t)$ | z | $\mu$ | $\sigma$ | $R_{A5-o}(t) = \varphi(z)$ |
|---|---|---|---|---|---|---|---|
| Intake box | A5 | 14 001 | - | - | - | - | **1,0** |
| | | 15 850 | $7{,}14 \cdot 10^{-6}$ | 1,22 | 0,094 | 7,85 | **0,888** |
| | | 16 902 | $7{,}14 \cdot 10^{-6}$ | 0,77 | 7,43 | 3,11 | **0,7794** |

## 2. Locks band opener

Table 5: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (locks band opener) in the case of Lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component to failure $\Delta t, (h)$ | $f_{A7-o}(t)$ | z | $\mu$ | $\sigma$ | $R_{A7-o}(t) = \varphi(z)$ |
|---|---|---|---|---|---|---|---|
| Lock band opener | A7 | 15 630 | - | - | - | - | **1,0** |
| | | 15 730 | $3{,}64 \cdot 10^{-5}$ | 1,31 | 7,595 | 1,579 | **0,904** |
| | | 15 830 | $3{,}64 \cdot 10^{-5}$ | 0,85 | 8,186 | 1,392 | **0,8023** |
| | | 15 930 | $3{,}64 \cdot 10^{-5}$ | 0,53 | 9,034 | 1,21 | **0,7019** |
| | | 16 030 | $3{,}64 \cdot 10^{-5}$ | 0,26 | 9,413 | 1,0327 | **0,6026** |
| | | 16 330 | $3{,}64 \cdot 10^{-5}$ | 0 | 9,7 | 0,841 | **0,5** |
| | | 16 820 | $3{,}64 \cdot 10^{-5}$ | 0 | 9,73 | 0,651 | **0,3989** |

### 3. Electromagnetic coupling

Table 6: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (electromagnetic coupling) in the case of Lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component tofailure $\Delta t, (h)$ | $f_{E1-0}(t)$ | z | $\mu$ | $\sigma$ | $R_{E1-0}(t)=\varphi(z)$ |
|---|---|---|---|---|---|---|---|
| **Electromagnetic coupling** | **E1** | 14 001 | - | - | - | - | **1,0** |
| | | 14 151 | $5{,}12 \cdot 10^{-5}$ | 1,36 | -7,8 | 12,6 | **0,913** |
| | | 14 251 | $5{,}12 \cdot 10^{-5}$ | 0,94 | -1,07 | 11,32 | **0,826** |
| | | 14 351 | $5{,}12 \cdot 10^{-5}$ | 0,64 | 3,17 | 10 | **0,738** |
| | | 14 451 | $5{,}12 \cdot 10^{-5}$ | 0,38 | 6,25 | 8,75 | **0,648** |
| | | 14 501 | $5{,}12 \cdot 10^{-5}$ | 0,16 | 8,38 | 7,55 | **0,563** |
| | | 14 751 | $5{,}12 \cdot 10^{-5}$ | - | - | - | **0,472** |
| | | 15 001 | $5{,}12 \cdot 10^{-5}$ | - | - | - | **0,384** |
| | | 15 501 | $5{,}12 \cdot 10^{-5}$ | - | - | - | **0,296** |
| | | 15 751 | $5{,}12 \cdot 10^{-5}$ | - | - | - | **0,2107** |
| | | 16 001 | $5{,}12 \cdot 10^{-5}$ | 1,13 | 6,67 | 2,57 | **0,21** |

### 4. Dekla (Nozzle) - rotor lid

Table 7: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (dekla - rotor lid) in the case of lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component tofailure $\Delta t, (h)$ | $f_{A3-0}(t)$ | z | $\mu$ | $\sigma$ | $R_{A3-0}(t)=\varphi(z)$ |
|---|---|---|---|---|---|---|---|
| **Dizna - Dekla** | **A3** | 14 128 | - | - | - | - | **1,0** |
| | | 14 300 | $6{,}66 \cdot 10^{-5}$ | 1,59 | 7,992 | 0,991 | **0,944** |
| | | 14 600 | $6{,}66 \cdot 10^{-5}$ | 1,21 | 8,486 | 0,911 | **0,886** |
| | | 14 900 | $6{,}66 \cdot 10^{-5}$ | 0,96 | 8,80 | 0,837 | **0,831** |
| | | 15 200 | $6{,}66 \cdot 10^{-5}$ | 0,75 | 9,056 | 0,764 | **0,773** |
| | | 15 500 | $6{,}66 \cdot 10^{-5}$ | 0,43 | 9,371 | 0,645 | **0,666** |
| | | 15902 | $6{,}66 \cdot 10^{-5}$ | 0,42 | 9,41 | 0,625 | **0,6628** |
| | | 16 830 | $6{,}66 \cdot 10^{-5}$ | 0 | 9,7 | 0,356 | **0,3989** |

### 5. Outlet pipe

Table 8: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (outlet pipe) in the case of Lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component tofailure $\Delta t, (h)$ | $f_{A4-0}(t)$ | z | $\mu$ | $\sigma$ | $R_{A4-0}(t)=\varphi(z)$ |
|---|---|---|---|---|---|---|---|
| **Odvodna cev** | **A4** | 15 995 | - | - | - | - | **1,0** |
| | | 16 150 | $4{,}16 \cdot 10^{-5}$ | 1,59 | 7,455 | 1,405 | **0,944** |
| | | 16 300 | $4{,}16 \cdot 10^{-5}$ | 1,22 | 8,10 | 1,309 | **0,888** |
| | | 16 450 | $4{,}16 \cdot 10^{-5}$ | 0,97 | 8,525 | 1,219 | **0,834** |
| | | 16 600 | $4{,}16 \cdot 10^{-5}$ | 0,74 | 8,892 | 1,115 | **0,7703** |
| | | 16 750 | $4{,}16 \cdot 10^{-5}$ | 0,43 | 9,31 | 0,961 | **0,67** |
| | | 16 900 | $4{,}16 \cdot 10^{-5}$ | 0 | 9,735 | 0,948 | **0,6664** |

**6. Rotor (turbine)**

Table 9: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (rotor- turbine) in the case of Lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component tofailure $\Delta t,(h)$ | $f_{A1-o}(t)$ | z | $\mu$ | $\sigma$ | $R_{A1-o}(t)=\varphi(z)$ |
|---|---|---|---|---|---|---|---|
| **Rotor** | **A1** | 13 983 | - | - | - | - | **1,0** |
| | | 14 100 | $4{,}52\cdot10^{-5}$ | 1,41 | 7,518 | 1,44 | **0,9207** |
| | | 14 200 | $4{,}52\cdot10^{-5}$ | 1,0 | 8,56 | 1,312 | **0,8423** |
| | | 14 300 | $4{,}52\cdot10^{-5}$ | 0,71 | 9,0014 | 1,177 | **0,7611** |
| | | 14 400 | $4{,}52\cdot10^{-5}$ | 0,47 | 9,08 | 1,046 | **0,6808** |
| | | 14 500 | $4{,}52\cdot10^{-5}$ | 0,26 | 9,34 | 0,919 | **0,6026** |
| | | 14 600 | $4{,}52\cdot10^{-5}$ | 0,06 | 9,54 | 0,794 | **0,5239** |
| | | 14 700 | $4{,}52\cdot10^{-5}$ | 0 | 9,6 | 0,662 | **0,44** |
| | | 14 830 | $4{,}52\cdot10^{-5}$ | 0 | 9,605 | 0,547 | **0,3668** |

**7. Aircrank**

Table 10: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (aircrank) in the case of lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component tofailure $\Delta t,(h)$ | $f_{A2-o}(t)$ | z | $\mu$ | $\sigma$ | $R_{A2-o}(t)=\varphi(z)$ |
|---|---|---|---|---|---|---|---|
| **Aerole□aj** | **A2** | 13 983 | - | - | - | - | **1,0** |
| | | 14 100 | $4{,}11\cdot10^{-5}$ | 2,58 | 5,436 | 1,596 | **0,925** |
| | | 14 200 | $4{,}11\cdot10^{-5}$ | 1,04 | 7,95 | 1,548 | **0,8508** |
| | | 14 300 | $4{,}11\cdot10^{-5}$ | 0,76 | 8,56 | 1,321 | **0,7764** |
| | | 14 400 | $4{,}11\cdot10^{-5}$ | 0,53 | 8,946 | 1,186 | **0,7019** |
| | | 14 500 | $4{,}11\cdot10^{-5}$ | 0,32 | 9,246 | 1,049 | **0,625** |
| | | 14 600 | $4{,}11\cdot10^{-5}$ | 0,13 | 9,47 | 0,919 | **0,5517** |
| | | 14 830 | $4{,}11\cdot10^{-5}$ | 0 | 9,6 | - | - |

**8. Reader**

Table 11: Includes all the parameters that determine the operation reliability of the constituent components spinning box frame (electronic reader) in the case of lognormal reliability distribution

| Name system constituent component | Component mark | Time operation interval of component tofailure $\Delta t,(h)$ | $f_{E2-o}(t)$ | z | $\mu$ | $\sigma$ | $R_{E2-o}(t)=\varphi(z)$ |
|---|---|---|---|---|---|---|---|
| **□ita□** | **E2** | 15 905 | - | - | - | - | **1,0** |
| | | 17 230 | $5\cdot10^{-5}$ | 0,85 | 8,96 | 0,93 | **0,8023** |

For other frame components of spinning box reliability is $R_{A8}(t)=R_{A9}(t)=R_{A10}(t)=1{,}0$ and at the same did not show any cancellations during the period of their work.

## VI. Operation Reliability Diagrams Of Frame Component Spinning Box Where Preventive Maintenance Technologies Procedures Are Implemented In Case Of Lognormal Statistical Distribution

Certain reliability diagrams are shown in Figures 13. – 21.

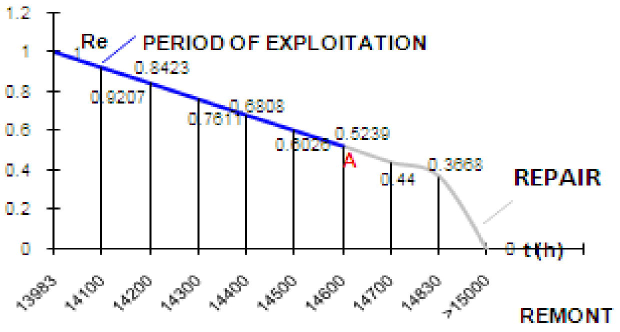



Figure (13) Reliability diagram for the component rotor (turbine) - A1

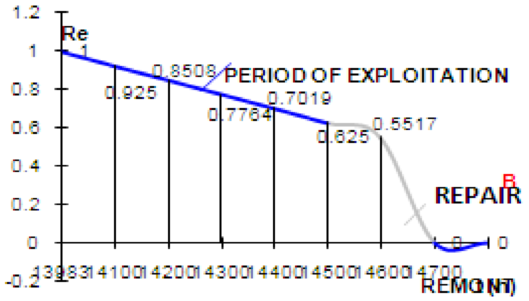



Figure (14) Diagram of reliability for component aircrank - A2

**Note:** Low limit value for the reliability of the components of the rotor (A1) and aircrank (A2) spinning box frame are because it does not make any substitution of these components with new ones, but they carried out the repair that included grinding the rotor shaft and cleaning the openings (holes) on aircranks. This was done because of the high price of these components on the market.

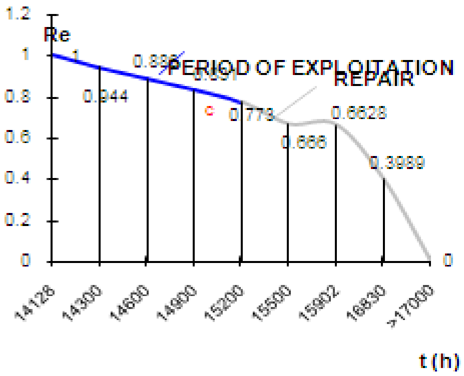



Figure (15) Reliability diagram for the component nozzle (dekla - rotor li) - A3

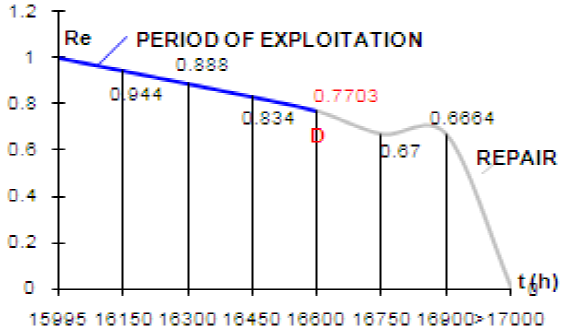



Figure (16) Diagram of reliability for outlet pipe - A4

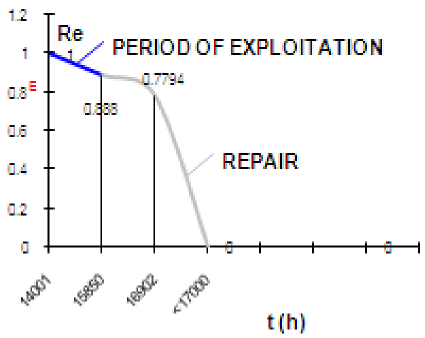



Figure (17) Diagram of reliability for intake box-A5

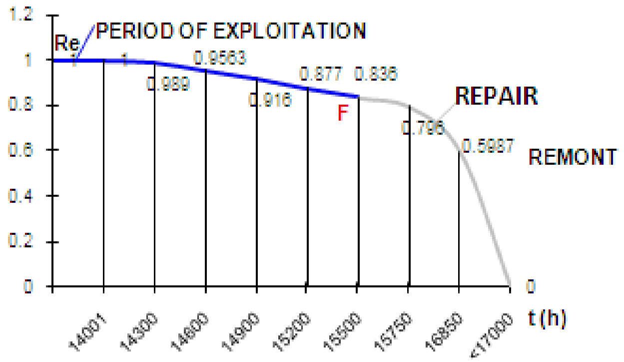



Figure (18) Diagram of reliability for component introductory channel - A6

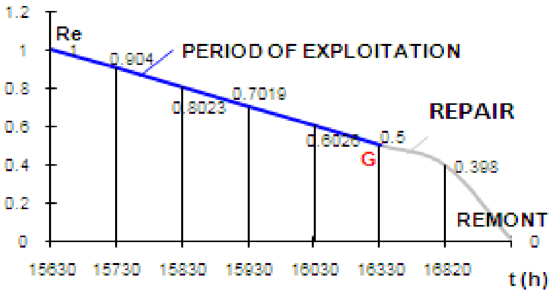



Figure (19) Diagram of reliability for component Locks band opener-A7

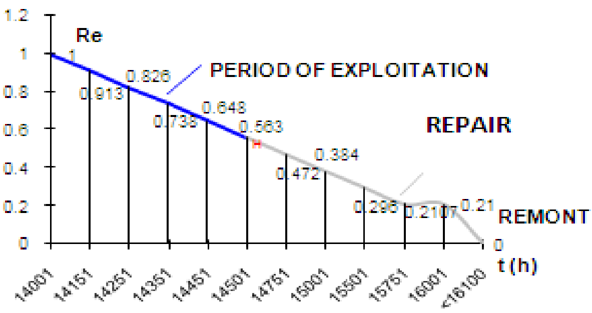



Figure (20) Reliability diagram for the component electromagnetic coupling-E1

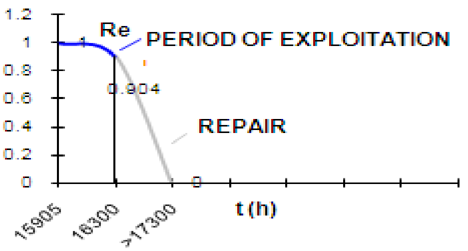



Figure (21) Reliability diagram for component electronic reader - E2

On the basis of the diagrams is completed tabulation (Table 12.) limits the state of exploitation of the constituent components of the analyzed frame where preventive maintenance technology procedures are applied.

Based on the values in Table 12. clearly are defined limits dependency on the reliability of exploitation operation for each component of analyzed frame. These values are authoritative and will be used in determining the correlation dependence.

Table 12: Dependency on the limit interval to analyze the reliability of each constituent component of analyzed frame where preventive maintenance technology procedures are implemented

| Component frame mark | Mark inflection points in the reliability diagram $p_{t_i}$ | The marginal value of the exploitation operation time of the constituent components $\Delta t_{g_i}$ | The marginal value of the reliability for exploitation operation time of the constituent components $\Delta p_{g_i}$ |
|---|---|---|---|
| A6 | F | 15500 | 0,868 |
| A5 | E | 15850 | 0,888 |
| A7 | G | 16330 | 0,5 |
| E1 | H | 14501 | 0,563 |
| A3 | C | 15200 | 0,773 |
| A4 | D | 16600 | 0,7703 |
| A1 | A | 14600 | 0,5239 |
| A2 | B | 14500 | 0,625 |
| E2 | I | 17230 | 0,904 |
| A8, A9, A10 | | >20000 | 1,0 |

## VII. TIME SEQUENCE OF SAFETY COMPONENTS CIRCUITS ANALYZED WITH ALLOWED RISK

Time sequence of the components of security frame with allowable risk is determined at intervals of components including: a safe time to failure of the frame components ( $t_2$ ) and time of when the first cancellation of frame components ( $t'_2$ ).

The author has chosen for this analysis because it can be determined and allowed risk of components frame to the planned time for the repair and continued productivity regardless of the risk of falling under allowed.

Analysis of the timing of safety frame components to the allowable risk being carried by segmental linear function of the intensity of failures from empirical data to time interval $t_2 \le t_R \le t'_2$, in which the $t_R$ - components of allowable time (during the allowed risk).

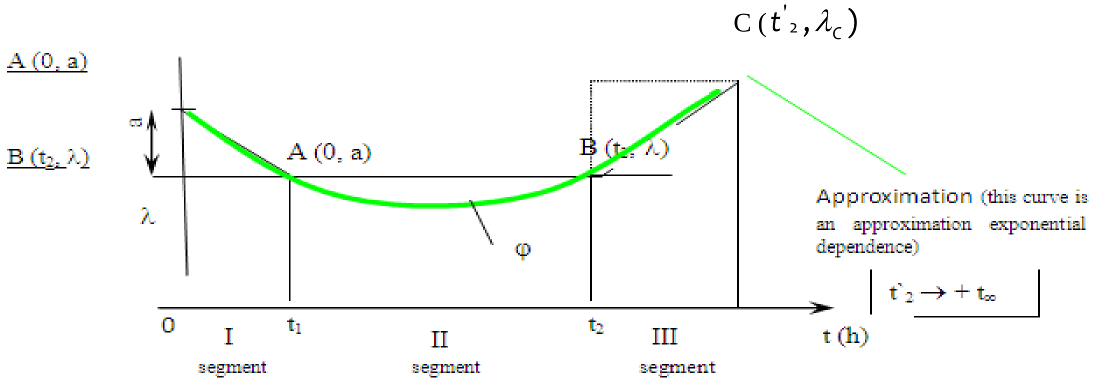
Any failure intensity function can be approximated in a way that its graph divided into a number of segments (shown in Figure 19.).

In this analysis we have taken three segments:

**Part I**: The component frame operation during his run-in period (the time $t_1$). Running assemblies is also running OE – spinning machine, and it lasted 500 (h).

**Part II**: Operation of the frame components (time interval $t_1 < t \le t_2$).

**Part III**: Operation of component assemblies with allowed risk (time interval $t_2 < t \le t'_2$).




A and B are the coefficients of the line direction
Figure (19) Sectional divisions failure intensity function

Failure intensity function is shown in segments:

1. $\lambda_{(t)} = a - \mathrm{A} \cdot t, 0 \le t \le t_1 = const.$ during this period did not cause any failure of any component parts assemblies, and this period is called the initial period.
2. $a = \lambda(t)$, $t_1 < t \le t_2 = const.$ This is the period of safe operation of the frame components.
3. $\lambda'_{(t)} = \lambda_{C(t_2)} + \mathrm{B}(t' - t_2)$, $t_2 < t' < t'_2$ The period of occurrence of the first failure (risk period).

Analysis of the timing of safety components assemblies with allowed risk is related to the analysis of period created of first failures (segment III in Figure 19.), and for this period the reliability function is expressed by the formula:

$$R_i(t') = e^{-\left[at_1 - \frac{\mathrm{A}t_1^2}{2} + \lambda_{C(t_2)}(t' - t_2) + \frac{\mathrm{B}}{2}(t' - t_2)^2\right]}$$

where as $a, A = 0,$ because in the initial period components did not cause failures of the analyzed constituent components.

Rearranging equation reliability to time, we get the final expression of the universal quadratic equation that characterizes the allowed time travel:

$$\boxed{\frac{B}{2} t'^2 + \left(\lambda_{C(t_2)} - B \cdot t_2\right) \cdot t' + \left(\ln R_i(t')_{sr} - \lambda_{C(t_2)} \cdot t_1 + \frac{B}{2} t^2{}_2\right) = 0,}$$

whose solutions are: $t_{I,II}$, where are the allowable travel time $(t_R)$ is calculated as the sum of the time to the first failure $t_2$, and the time $t_{I,II}$ (one of the solutions to the time value of universal quadratic equations)

$$t_R = t_2 + t_{I,II}.$$

The universal values which the quadratic equation in figuring it (make it) are as follows: $\frac{\mathrm{B}}{2} \longleftarrow$ the coefficient of the quadratic term, and direction of the line coefficient is determined by the expression

$B = tg\varphi = \dfrac{\lambda_{C(t'_2)} - \lambda_{C(t_2)}}{t_2 - t_1}$, of which was $\lambda_{C(t'_2)} = \dfrac{f_C(t)}{R_i(t)}$, until the value of reliability $R_i(t'_2)$ is taken from Lognormalne statistical reliability distribution for the period of risk ( time $t'_2$ ) and is expressed as the mean value for the reliability $R_i(t_2')_{sr.}$ for time interval of risk time $t'_2$ , in other words

$R_i(t'_2)_{sr.} = \dfrac{\sum_{i=1}^{n} R_i(t'_2)}{n}$. $\lambda_{C(t_2)} - \mathrm{B} \cdot t_2 \leftarrow$ coefficient that goes along with the linear member;

$\left(\ln R_i(t')_{sr.} - \lambda_{C(t_2)} \cdot t_1 + \dfrac{B}{2} \cdot t_2^2\right)$ - Constant coefficient.

## VIII. CONCLUSION

On the basis of universal quadratic equation can be formed tabulation of the values of its solutions, which leads to the determination of the allowable operation time of components of the analyzed frames (Table 13.). Tabular presentation included the value of the two methods of analyzing safety work time of components to the allowable risk as follows:

1. Without implementing the preventive maintenance technology procedures in operation of the components analyzed frame and
2. With implementing the preventive maintenance technology procedures in operation of the components analyzed frame.

Table 13: Safety operation time of components of analyzed frame with allowable risk where the preventive maintenance technology procedures are not implemented

| Values | $A_6$ | $A_5$ | $A_7$ | $E_1$ | $A_3$ | $A_4$ | $A_1$ | $A_2$ | $E_2$ |
|---|---|---|---|---|---|---|---|---|---|
| $\lambda_{C(t_2)}$ | $1{,}428\cdot10^{-5}$ | $7{,}93\cdot10^{-}$ | $4{,}16\cdot10^{-}$ | $5{,}49\cdot10^{-6}$ | $2{,}38\cdot10^{-5}$ | $4{,}166\cdot10^{-5}$ | $5\cdot10^{-5}$ | $4{,}54\cdot10^{-5}$ | $1{,}428\cdot10^{-5}$ |
| $t_1(h)$ | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| $t_2(h)$ | 13 000 | 13 000 | 15 000 | 13 000 | 13 000 | 15 000 | 13 000 | 13 000 | 15 000 |
| $t'_2(h)$ | 13136 | 13160 | 15089 | 13045 | 13600 | 15400 | 14240 | 14240 | 15060 |
| $R_i(t'_2)_{sr}$ | 0,931 | 0,971 | 0,767 | 0,9335 | 0,895 | 0,809 | 0,963 | 0,963 | 0,903 |
| **Quadratic equation solutions** $t_{I,II}$ | 68 | 80 | 40 | 23 | 300 | 190 | 600 | 600 | 300 |
| **Time allowed risk limits** $t_R$ | **13068** | **13080** | **15040** | **13023** | **13300** | **15190** | **13600** | **13600** | **15040** |

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