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# *MANUFACTURING ENGINEERING AND AUTOMATED PROCESSES*

# *МАШИНОБУДУВАННЯ, АВТОМАТИЗАЦІЯ ВИРОБНИЦТВА ТА ПРОЦЕСИ МЕХАНІЧНОЇ ОБРОБКИ*

**UDC 658.567.3:629.3.027.514:504.054:504.064.4**

## SELECTING CUTTING MODES FOR HIGH-SPEED TITANIUM-TUNGSTEN INSTRUMENTS AT CUTTING PNEUMATIC TIRES

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***Summary.*** *Results of experimental researches of technical processes of used pneumatic automobile tires utilization are given to determine the most effective cutting tool's material and cutting mode during their cutting in half.*

***Key words:*** *utilization, cutting tool, pneumatic tire, cutting mode.*

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**Problem setting**. Primary shredding of used tires consists of two operations: cutting a tire in half along the treadmill and cutting bead rings out [1]. The choice of geometry and angle of the cutting tool is an important factor that will result in significant facilitation of the process and its economic benefits. The wrong choice of cutting tool geometry and cutting conditions causes increased wear of cutting tools, and sometimes its damage as well as rising energy costs. To overcome these difficulties it is necessary to conduct experimental research of specifics of used tires shredding processes, namely the impact of material, geometry and shape of the cutting tool on the cutting forces. The other reason why it is necessary is the impossibility just using existing publications on this subject to come to a definite conclusion on the required geometry, shape and material of the cutting tool as well as cutting modes and conditions.

**Analysis of the known research results**. The study of the issue was conducted by the following scientists: O.M. Korobochka, O.O. Sasov, Yu.A. Korzhavin, Ya.O. Yakovenko, S.Yu. Sychov [2,3,4]. Experimental studies of the impact of both material and cutting tool geometry on cutting forces while cutting the tires in half were conducted. The cutting tool was presented by chisels of various types and made of different materials. The issue of cutting tool wear during the tire shredding process was directly studied by V.O. Postnikov, B.U. Sharipov and L.Sh. Schuster. [5].

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The purpose of the work. Based on experimental studies and their results to identify the cutting mode, which ensures minimum effort and wear on the cutting tool made of BK8 and T5K10 materials at cutting pneumatic tires in half during their disposal.

**Formulation of the problem**. Cutting tools made of BK8 and T5K10 materials, that showed better results compared to R6M5 and T15K6 materials during experimental research of cutting forces, the results of which are published in works [2,3], were used in this study to determine the cutting modes.

Cutters made of R6M5 and BK8 materials shaped as the parting-off tool, threaded tool and the cutting knife were used for the first experiment. In other case cutters made of T5K10 and T15K6 materials and having the shape and appearance similar to that used in the first experiment. To determine the smallest error during the experiments the calibration of $P_y$ and $P_z$ cutting forces was conducted.

$P_z$ and $P_y$ cutting forces calibration charts, where cutters made of BK8 and R6M5 materials and those made of T5K10 and T15K6 materials were used, are shown in Fig. 1.

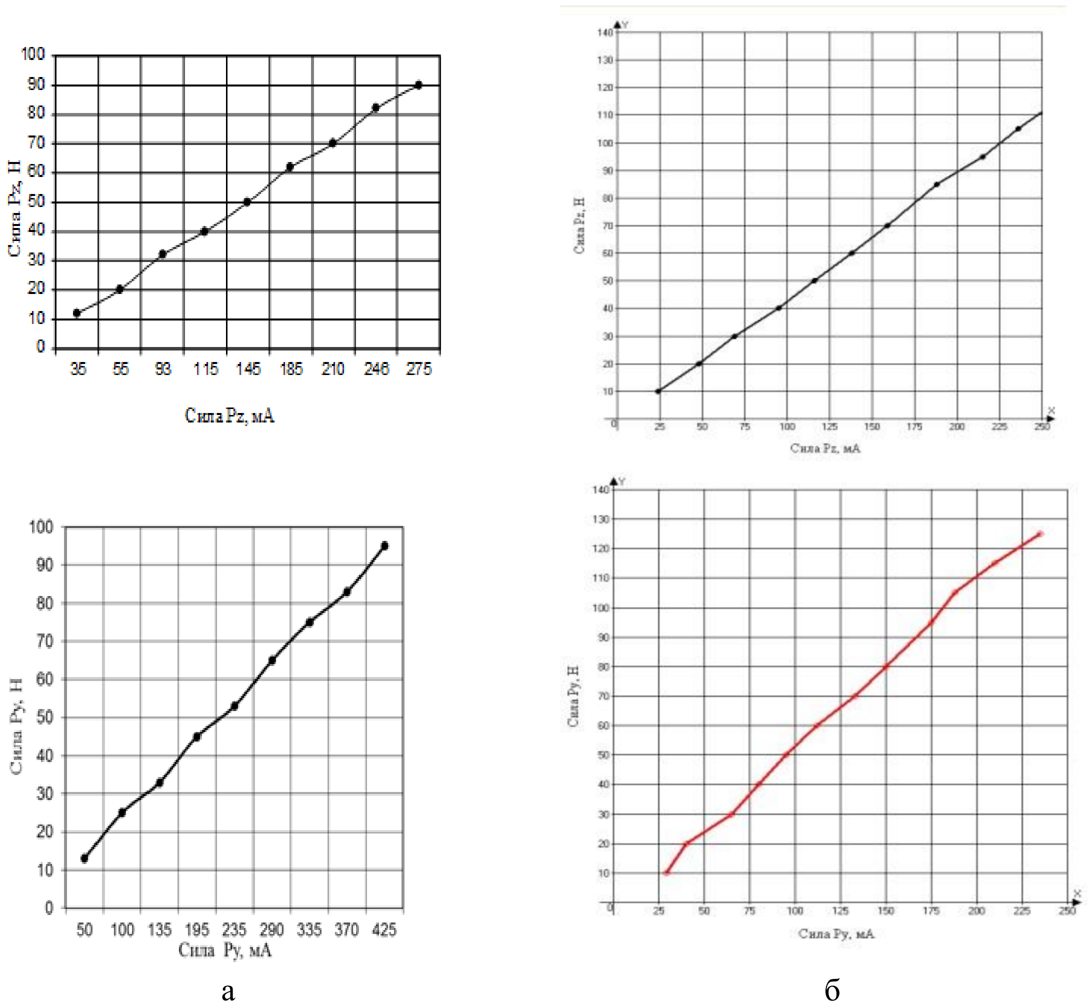


**Figure 1.** Chart of cutting forces $P_z$ and $P_y$ calibration using cutting tools mk. VK8 and R6M5 (a) and mk. T5K10 and T15K6 (b)

Based on the graphs presented in Figure 1, differences in the calibration of cutting forces were found. This is due to the fact that the experimental stand is operated in a slightly different conditions, each of which is close to real conditions (temperature, humidity, pressure etc.).

The next stage of experimental research was to determine the cutting forces. Corresponding measurements and graphs of dependencies of cutting forces on the material and shape of the cutting tool have been done. Relevant dependencies are presented graphically below.

Figure 2 shows the cutting forces dependence on the spindle speed and cutting tool traverse using the cutting tool of different shapes made of R6M5 material.

Figure 3 shows the dependence of cutting forces on the spindle speed and cutting tool traverse using the cutting tool of different shapes made of BK8 material.

Figure 4 shows the dependence of cutting forces on the spindle speed and cutting tool traverse using the cutting tool of different shapes made of T5K10 material.

Figure 5 shows the dependence of cutting forces on the spindle speed and cutting tool traverse using the cutting tool of different shapes made of T15K6 material.

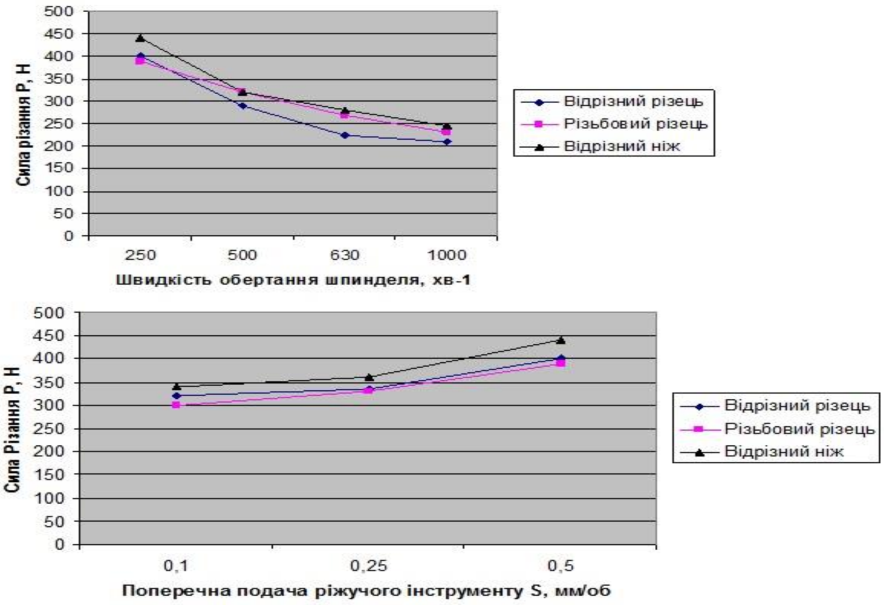


**Figure 2.** Dependency of cutting powers and arbor's spinning speed from cutting tool's transverse batting using cutting tool R6M5 in its different forms

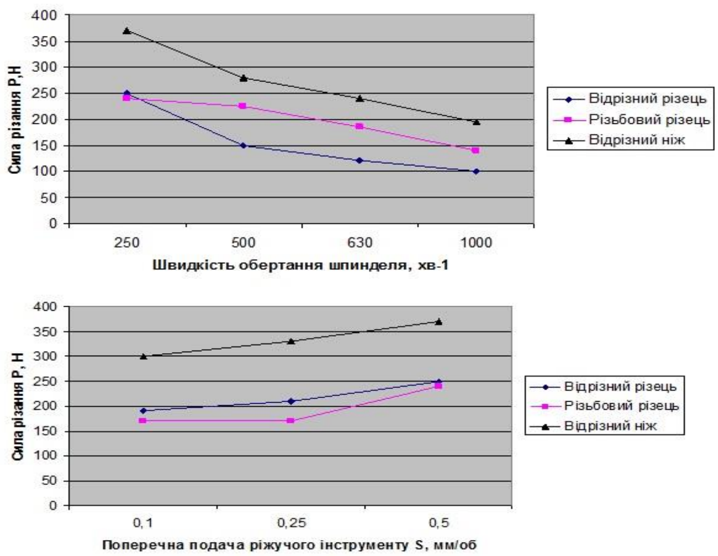


**Figure 3.** Dependency of cutting powers and arbor's spinning speed from cutting tool's transverse batting using cutting too lVK8 in its different forms

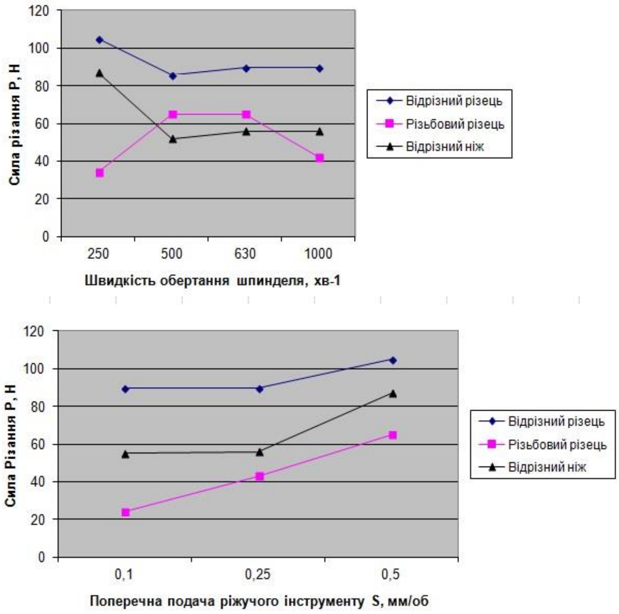


**Figure 4.** Dependency of cutting powers and arbor's spinning speed from cutting tool's transverse batting using cutting tool T5K10 in its different forms

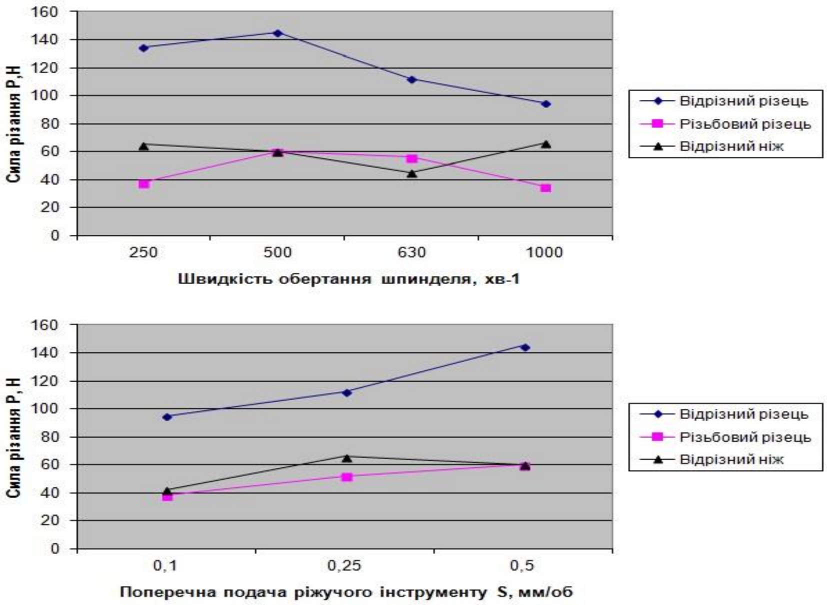


**Figure 5.** Dependency of cutting powers and arbor's spinning speed from cutting tool's transverse batting using cutting tool T15K6 in its different forms

**Research results.** As it can be seen from the graphs, the dependencies are significantly different from each other. Significant differences are caused also by different shapes of the cutting tool. The highest values of cutting forces on the charts in almost all cases are presented by a cutting tool shaped as a cutting knife. The first experiment resulted in recommendation to use the cutting tool with a shape of cutoff blade made of BK8 material. Result of the second experiment is the recommendation to use cutoff blade shape of the cutting tool made of T5K10 material. On comparing the tabulated values of cutting force numerical values while using cutting tools made of different materials, one can notice a significant discrepancy between the numerical values of the cutting forces. The data are presented in tables 1 and 2.

**Table № 1**

Numerical values of cutting forces at using cutting tool mk. VK8 in detachable cutter form

| Номер | n, об/хв | $S_p$, мм/об | $P_z$, Н | $P_y$, Н | β, град | γ, град | α, град |
|---|---|---|---|---|---|---|---|
| 1. | 250 | 0,1 | 140 | 70 | 60 | 8 | 24 |
| 2. | 250 | 0,25 | 170 | 75 | 60 | 8 | 24 |
| 3. | 250 | 0,5 | 240 | 90 | 60 | 8 | 24 |
| 4. | 500 | 0,1 | 105 | 50 | 60 | 8 | 24 |
| 5. | 500 | 0,25 | 150 | 60 | 60 | 8 | 24 |
| 6. | 500 | 0,5 | 225 | 80 | 60 | 8 | 24 |
| 7. | 630 | 0,1 | 100 | 40 | 60 | 8 | 24 |
| 8. | 630 | 0,25 | 130 | 55 | 60 | 8 | 24 |
| 9. | 630 | 0,5 | 185 | 60 | 60 | 8 | 24 |
| 10. | 1000 | 0,1 | 90 | 30 | 60 | 8 | 24 |
| 11. | 1000 | 0,25 | 115 | 40 | 60 | 8 | 24 |
| 12. | 1000 | 0,5 | 140 | 55 | 60 | 8 | 24 |

**Table № 2**

Numerical values of cutting forces at using cutting tool mk. T5K10 in detachable cutter form

| Номер | n, $хв^{-1}$ | $S_p$, мм/об | $P_z$, Н | $P_y$, Н | a, мм | α, град | γ, град |
|---|---|---|---|---|---|---|---|
| 1. | 250 | 0,1 | 25 | 18 | 1,05 | 30 | 0 |
| 2. | 250 | 0,25 | 43 | 20 | 1,05 | 30 | 0 |
| 3. | 250 | 0,5 | 105 | 32 | 1,05 | 30 | 0 |
| 4. | 500 | 0,1 | 76 | 15 | 1,05 | 30 | 0 |
| 5. | 500 | 0,25 | 86 | 15 | 1,05 | 30 | 0 |
| 6. | 500 | 0,5 | 65 | 24 | 1,05 | 30 | 0 |
| 7. | 630 | 0,1 | 15 | 6 | 1,05 | 30 | 0 |
| 8. | 630 | 0,25 | 90 | 20 | 1,05 | 30 | 0 |
| 9. | 630 | 0,5 | 86 | 22 | 1,05 | 30 | 0 |
| 10 | 1000 | 0,1 | 90 | 18 | 1,05 | 30 | 0 |
| 11 | 1000 | 0,25 | 65 | 4 | 1,05 | 30 | 0 |
| 12 | 1000 | 0,5 | - | - | 1,05 | 30 | 0 |

In the second case, when compared to the first one, the cutting force numerical values are 1.5 – 3 times (147 – 340%) lower. That is, a cutoff blade made of T5K10 material shows better results than the same cutter made of different material. On this basis, it makes sense to recommend its use in practice and in industry.

**Conclusions.** Minimum cutting force occurs when cutting the tires in half during their utilization is done using the cutting tools made of T5K10 material and shaped as a cutoff blade having the following geometric parameters: width and cutting edge = 1.05 mm, the angles γ = -60º, α = 15º at spindle speed 1000 min-1 and feed 0.25 mm/rev. Its cutting force is 1.5 – 3 times lower compared to the same shape cutting tool made of BK8 material. The research results are important in choosing the material and geometric parameters of cutting tools as well as the parameters of pneumatic tires shredding during their disposal. Further research should be directed at expanding the cutting tool material range.

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# ВИБІР РЕЖИМІВ РІЗАННЯ ПРИ ВИКОРИСТАННІ РІЖУЧОГО ІНСТРУМЕНТА З ШВИДКОРІЖУЧИХ І ТИТАНО-ВОЛЬФРАМОВИХ МАТЕРІАЛІВ ПРИ РОЗРІЗАННІ ПНЕВМАТИЧНИХ ШИН

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***Резюме.*** *Наведено результати експериментальних досліджень технологічних процесів утилізації відпрацьованих пневматичних автомобільних шин для визначення найефективнішого матеріалу різального інструменту та режиму різання при розрізуванні їх навпіл.*

***Ключові слова:*** *утилізація, ріжучий інструмент, пневматична шина, режим різання.*

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