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DESIGN AND TESTING OF ABRASIVE BELT GRINDER

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Abstract: The belt grinding machine, presented in this paper, was designed and tested for grinding any shape of object like circular, rectangular, or polygon. In this project, the work abrasive belt is used to grind the various types material of material such as metal, plastic, wood etc. The abrasive belt is rotated by a three-phase induction motor. The particular abrasive belt grinding machine has been developed for the purposes of experimental research. Hence this project namely adjustable belt grinder. The machining accuracy and surface quality of workpieces are the key factors that ultimately determine the performance of the equipment. The test workpieces are presented in the paper and their characteristics are commented. The paper concludes with comments on achieved results and directions for further research on this topic.

Key words: Belt grinder, Industrial design, Surface quality, Wear

1 INTRODUCTION

In the modern industry, there are still some pieces of the equipment that are attractive for various types of the research. One of those examples which is attractive for various type of investigation is grinding machines and wider grinding process. One of the most spread machines used for grinding are belt grinders. Belt grinding machines have their own advantages in lots of types of work, such as preparation parts for welding, sharpening tools, cleaning parts from rust, parts free form shaping and etc. The development of belt grinding in aspect of modularity to cover more production operations is necessary. This is because if a belt grinder in that way can gain more functions. Belt grinder modularity will certainly make the attraction of wider range of

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users. Using the belt grinder, user can gain very good efficiency in certain operations [1].

The process of industrialization and modernization of life is accompanied by the increasingly widespread application of advanced technology, which among others is increasing rapidly using a variety of machines and mechanical work equipment that is run by electric motor drives [2]. In all technological processes huge and important role is reserved for surface quality. Surface quality directly effects on further production processes, like is quality and strength of boned elements [3-4]. The surface profile and roughness of a machined workpiece are two of the most important product quality characteristics and in most cases a technical requirement for mechanical products. Achieving the desired surface quality is of great importance for the functional behaviour of a part. The process-dependent nature of the surface quality mechanism along with the numerous uncontrollable factors that influence pertinent phenomena, make it important to find a straightforward solution and an absolutely accurate prediction model. Belt grinding machine is technical equipment that has effectiveness and efficiency that is quite good in the process so that it can produce a smooth surface of the workpiece [5-9].

Abrasive grinding is a widely employed finishing process, with abrasive grains being used as the cutting edge to accomplish close tolerances and excellent dimensional correctness and surface integrity. Abrasive belt grinding is a modification of the traditional grinding processes in which the contact wheel is made of polymer backing material. The grinding belt is formed of abrasives coated on a backing material and fastened around at least two rotating polymer contact wheels, which make it a compliant tool. A compliant belt grinding resembles an elastic grinding in its operating principle, and it offers some potentials like milling, grinding and polishing applications. The abrasive belt grinding process essentially is a two-body abrasive compliant grinding processes wherein the abrasive belt is forced against the components to remove undesired topographies, such as burrs and weld seams, to achieve the required material removal and surface finish [10-11]. In order to understand the process and achieve a good result of the final processing, it is necessary to take care of the details and parameters of the process as they are abrasive type of grinding belt, belt speed, contact wheel hardness, serration, and grinding force. Changing these process variables will affect the performance of the process [12-13].

The goal of this paper is for the future product to have good features, to be useful, safe and innovative. That's why the authors are focused a lot on product quality, functionality and modularity. The quality of the product is more and more considered a decisive factor every day competitiveness, which concerns the survival and development of every industrial enterprise, industrial branches, that is, industry as an economic activity [14-15].

2 BELT GRINDER DESIGN

In this study the new concept of belt grinder was developed. The most influential factor in concept developing was the belt grinder frame rigidity. The frame rigidity is necessary in order to get the best grinding results. Before the concept developing the main functions of the future product was determinated such as:

- the grinder work table must have ability to rotate from 0 degree to 180 degree,
- the work table must have adjustable height,

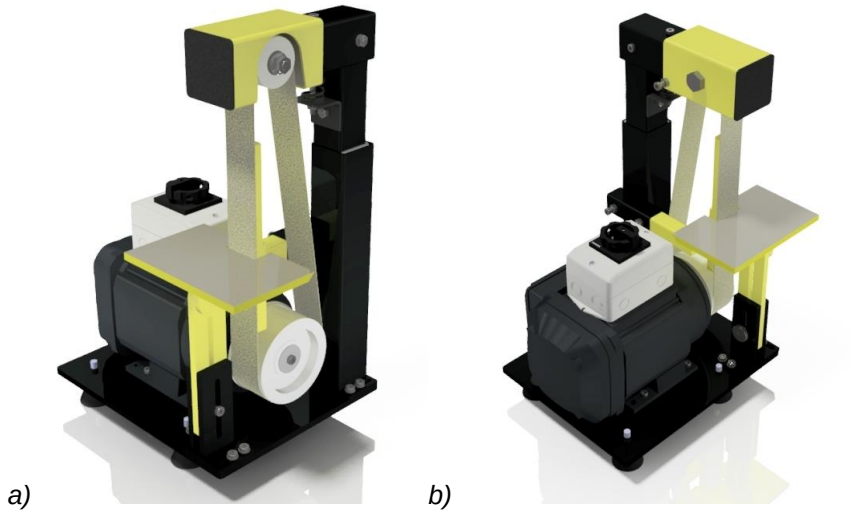
- the grinder must have ability to accept various sizes of grinding belts (papers),
- easy change of the grinding belts (papers)
- safety of operator must be fulfilled and
- future product must have enough rigidity.

After main functions the part of grinder was listed:

- driving unit (electric motor),
- driving pulley,
- driven pulley,
- belt tensioning mechanism,
- grinder frame and
- work table.

The belt grinder was designed and fabricated to be very simple for usage, with improved rigidity and numerous abilities for adjustments, as previously requested. The belt grinder presented in this paper has abilities to be used for grinding any shape of object like circular, rectangular and polygon. In this project the abrasive belt is used to grinding the material. In presented design it was paid attention that belt grinder has the ability to use various lengths of abrasive belts. The abrasive belt is rotated by three phase induction motor.

Frame of the presented solution was done from steel plate with 10 mm thickness. Steel plate was cut on laser cutting machine. Frame of the belt grinder is shown in Figure 1.

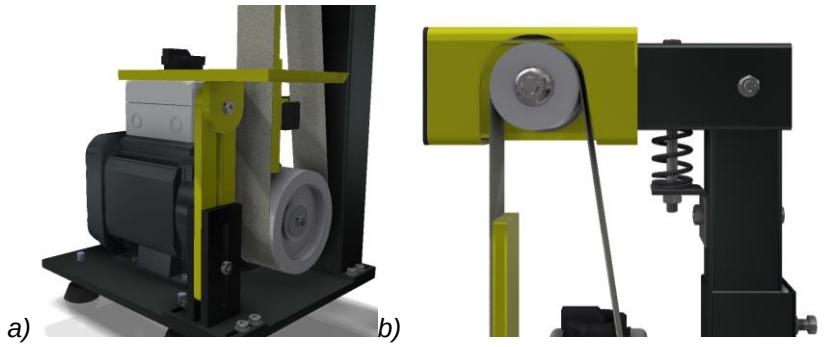


a) *b)*

Figure 1. *Frame of the solution a) front view; b) back view*

The frame of the presented solution has much better rigidity related to the frames of the other belt grinders that could be found on the market. Frame of the presented belt grinder is easy to be made, because of the big amount of the steel plates and square steel pipe. However, it is more expensive than solutions that could be found on the market, because a bigger amount of steel is used.

Worktable of the belt grinder is given in Figure 2a. The only difference between given worktables that could be found on the market is easier ability for the adjusting. The belt tension solution is acceptable and durable. The belt tension solution is given in Figure 2b.



a) *b)*

Figure 2. *a) Work table of the belt grinder; b) Tension mechanism of the abrasive belt*

The state of the produced and assembled belt grinder is given in Figure 3. As in model the parts that is movable is painted in yellow color to give the user the additional attention on the work process and possible machine adjustments.

Figure 3. *The fabricated belt grinder from different angles*

The special attention is paid to have the electric switch moved away from worktable, but still close enough for turning machine on and shutting down.

3 BELT GRINDER TESTING

As material samples for belt grinder testing are given in table 1.

Table 1. *Materials used for belt grinder testing*

No.	Material	Dimensions
1.	Pine wood	30 x 50 mm
2.	Plastic PA6	Φ 60 mm
3.	Steel square profile S235JRG2	40 x 40 x 2 mm
4.	Steel angle S235JRG2	20 x 20 x 3 mm

The surface preparation before grinding was done on the portable band-saw. The band-saw make surface roughness between R_a=100µm and R_a=400µm [16], which is not acceptable surface finish for the most positions in mechanical engineering. From that fact, there was a need for fast and efficient surface treatment before the further processing. The ideal solution for that is a grinding with belt grinder. Belt grinder presents a very acceptable solution in aspects of efficiency, machine and reproduction material (abrasive belts) costs. The band-saw which is used for samples preparation in this paper is shown in Figure 4.

Figure 4. *Band-saw used for samples preparation*

After samples preparation the grinding on the belt grinder machine is performed. Because the different types of the materials is used (wood, steel and plastics), it is chosen to have a lower speed of the abrasive belt. The speed of abrasive belt was $v \approx 6$ m/s. The electric motor RPM was $n_{EM} = 1400$ min^{-1}, and diameter of the driving pulley was $d = 80$ mm. The grinding operation is shown in Figure 5.

a)  b) 

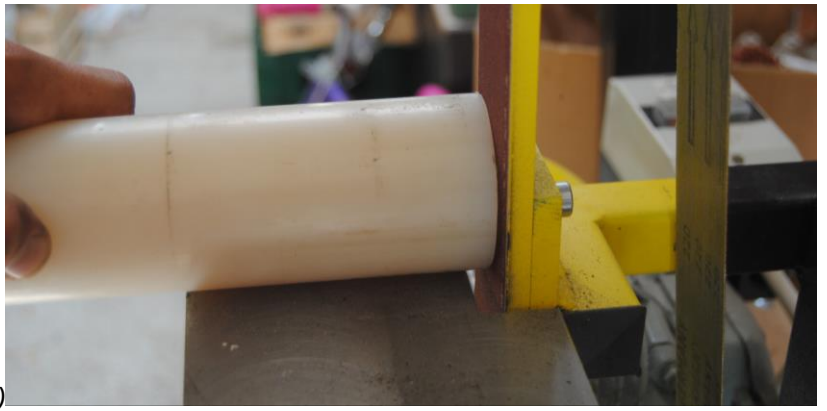
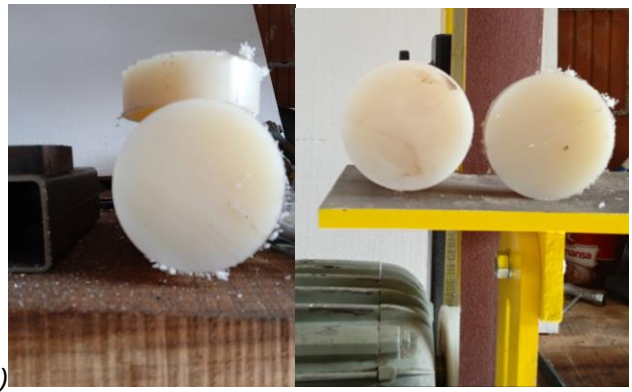
c) 

Figure 5. *Grinding operation a) pine wood; b) steel angle and c) plastics*

The abrasive belt on belt grinder had a granulation P80, [17]. The abrasive belt wears designation LS 309 and it has aluminium oxide grain and cotton cloth. According to the producer this abrasive belt is good for polishing ferrous or non-ferrous metals and hardwoods where belt conformability to the work piece is required. The grinded and un-grinded samples is shown in Figure 6 and figure 7.

Figure 6. *Grinded and un-grinded samples – comparative view*

a) 

b) 

Figure 7. *Grinded and un-grinded samples a) plastics and b) metal square pipe*

According to literature sources [18] the surface roughness after grinding with P80 abrasive belt should be around R_a=20µm. The visual inspection of the shown samples can ensure the viewer that surface has much less roughness related to the band-sawed parts. In the further examination the surface profile will be measured after grinding.

4 CONCLUSIONS

The presented paper shows a multiple approach to the efficient grinding processes in the small workshops. Firstly, the design of novel belt grinder has been made, and later the actual grinding machine was fabricated. Before the worksamples is processed the functionality of the machine was tested. After that, the samples was prepared on band-saw, and processed on the belt grinder. Visual inspection has been made and it is determined that surface roughness after the hand grinding process is improved very much. In the further work, the authors will vary the grinding speeds and make a surface profile measurement in order to determinate acceptable grinding speeds for various types of the materials.

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