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Mechanical Analysis on Main Transmission Gear of High Efficiency Saw Blade Polishing Machine

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Abstract. A structure scheme of a high efficient saw blade polishing machine was proposed. The machine was vertical and could polish two saw blades at the same time, and the polishing machine has a small area and high polishing efficiency. The 3D model of the main drive is established by using Pro/E 3D software, and the mechanics and vibration of the driving gear are analyzed by ANSYS software. And the formation diagram of order 7-12, equivalent stress and strain diagram are obtained. The results show that the vibration frequency of the driving gear is much higher than the frequency of the vibration source, and the resonance will not occur, and the strength of the gear is sufficient. It provides theoretical guidance for the development of high efficiency saw blade polishing machine. The practice shows that the high efficiency saw blade polishing machine developed on this basis runs well and improves the production efficiency of enterprises.

Keywords. Saw blade, polishing, gear, mechanical analysis

1. Introduction

Diamond circular saw blades are widely used in the stone industry, according to the specification classification, the domestic stone processing saw blade matrix specifications start from φ150mm, up to φ4800mm. At present, φ1600mm saw blade matrix is the most commonly used. With the increasingly fierce competition, the processing requirements for medium diameter saw blades are getting higher and higher, which requires improving the production process, improving product quality, increasing the added value of products, while reducing production costs and improving production efficiency. At present, the saw blade polishing machines on the market all adopt single-side polishing. After polishing one side of the saw blade, the saw blade is turned over to polish the other side. The production efficiency is low, and most of them are horizontal and occupy a large area (figure 1) [1]. This project intends to use the double saw blade polishing scheme, under the premise of constant power, two saw blades can be polished at the same time, but also can be processed separately, so that the production efficiency can be nearly doubled; And the original horizontal structure is improved to vertical structure, and the floor area is reduced. Because abrasive belt grinding can grind or polish the workpiece according to the shape and processing

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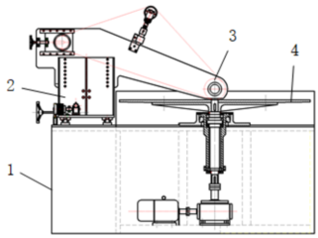
requirements of the workpiece with the corresponding contact mode and appropriate grinding parameters [2-3], the operation is simple, safe and reliable; Less auxiliary time [4]. Therefore, this polishing machine adopts abrasive belt grinding. At present, the structural design and optimization of machine tools have entered the modeling, optimization and dynamic design stage from the previous experience, analogy and static design stage [5-8]. Therefore, this paper uses ANSYS mechanical analysis software to optimize the key components, and completes the development of efficient saw blade polishing machine on this basis, and carries out practice verification, and achieves the expected purpose.

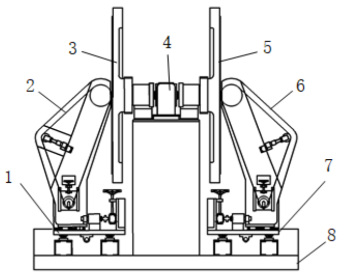


1- Frame 2- Feed device 3- Grinding device 4- Saw blade base

Figure 1. Horizontal single-side polishing machine.

2. Overall Scheme

The high efficiency saw blade polishing machine is designed for medium-sized saw blades produced by specific enterprises, with a thickness of 8-20mm and a diameter of less than 2100mm.The basic structure of the high efficiency saw blade polishing machine is shown in figure 2, including the frame, the left feed grinding device, the left saw blade seat, the main transmission device, the right saw blade seat, the right feed grinding device. The frame is composed of shaped steel frame and flat base plate. The left and right feed grinding devices realize axial and radial feed, control the grinding thickness of the saw blade and realize the grinding head from the outer circle of the saw blade to the center of the saw blade or from the center of the saw blade to the outer circle; The left and right grinding devices can grind the saw blade surface; The main drive is used to drive the saw blade rotation.



1- Left feed device 2- Left grinding device 3- Left saw blade seat 4- Main drive device 5- Right saw blade seat 6-Right grinding device 7- Right feed device 8- Frame.

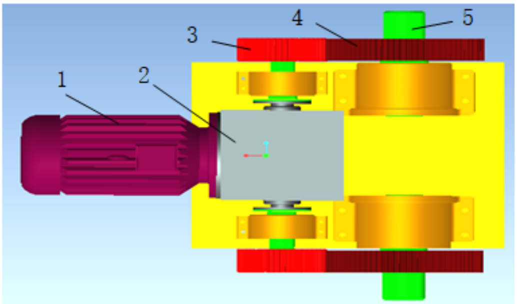
Figure 2. Overall schematic diagram of high efficiency saw blade polishing machine.

3. Working Process

The initial position of the grinding head of the grinding device is outside the circumference of the saw blade matrix to be ground, the saw blade matrix is installed on the saw blade mounting disc, and the axial feed handwheel is rotated to make the grinding device move axially close to the saw blade matrix. According to the thickness of the saw blade matrix and the grinding depth, the axial feed handwheel is continued to rotate, so that the grinding head of the grinding device exceeds the grinding surface of the saw blade matrix. Starting the main drive motor reducer makes the saw blade installation rotate, and the saw blade matrix rotates accordingly. Starting the sand belt drive motor makes the sand belt rotate, starting the radial motion drive motor makes the entire axial feed device do radial motion, and the grinding device also moves accordingly. In this way, the grinding head makes radial feed from the periphery of the saw blade matrix to the center to achieve grinding and polishing of the saw blade matrix. Since the grinding device, radial feed device and axial feed device are left and right sets respectively, when one grinding device grinds and polishes, the above process is repeated, so that the other grinding device grinds and polishes the other saw blade matrix, so that two saw blade matrix can be polished at the same time. When a certain side of the saw blade matrix polishing is completed, the electromagnetic clutch on this side can be separated, so that the saw blade mounting disc on this side stops rotating, the grinding device grinding head returns to the initial position, after re-installing the new saw blade matrix, and then the electromagnetic clutch on this side is combined, the saw blade mounting disc drives the new saw blade matrix to rotate, grinding and polishing, and the cycle is carried out.

4. Main Transmission Device

The main transmission device (figure 3) is composed of: the main drive motor, reducer, driving gear, driven gear (big gear), and saw blade spindle. The main drive motor reducer is a double output shaft, the pinion rotates through the electromagnetic clutch, the big gear rotates accordingly, the saw blade seat and the big gear are coaxial, so the saw blade seat rotates, the saw blade seat material is cast aluminum, the internal uniform Mosaic of magnets, you can suck the saw blade with the saw blade seat rotation.



1-Main drive motor 2-Reducer 3-Driving gear 4-Driven gear 5-Saw blade spindle

Figure 3. Schematic diagram of the main transmission device.

5. Gear Analysis

The main transmission gear is the main force part, whether it meets the strength and stiffness requirements is very important for the use requirements and operation stability of the efficient saw blade polishing machine, so it is necessary to carry out vibration analysis and static analysis.

5.1. Vibration Analysis

Main drive motor reducer output speed n=118r/min. The working frequency of the reducer is:

$$f=1/T=1/[1/(n/60)]=n/60=1.97\text{Hz}$$

By using Pro/Engineer 5.0 modeling, the driving gear solid model is imported into ANSYS through the special interface with ANSYS14.0 to build the finite element model. Material set to 45 steel, elastic modulus, 2.1×10^{11} Pa, Poisson's ratio, 0.31, the density is 7.85×10^{3} Kg/m^3. The tetrahedral unit (solid186) with 10 nodes of the driving gear adopts intelligent grid division, the grid accuracy is 6 levels, and the grid division is shown in figure 4, with a total of 152241 nodes and 100,675 units. The analysis result data is shown in figure 5.

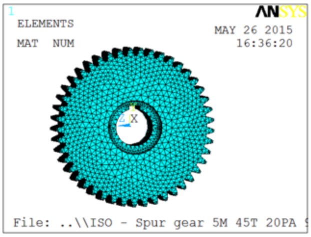
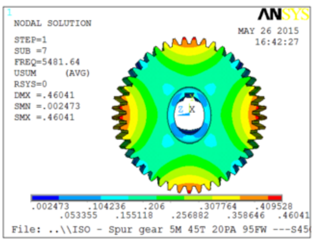


Figure 4. Grid division of driving gear.

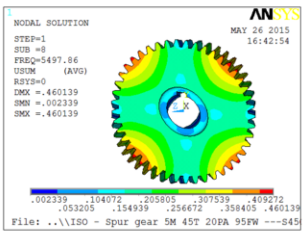
SET	TIME/FREQ	L
1	0.0000	
2	0.0000	
3	0.69211E-03	
4	0.13194E-02	
5	0.22500E-02	
6	0.28231E-02	
7	5481.6	
8	5497.9	
9	7341.7	
10	7445.3	
11	8949.5	
12	11073.	
13	11075.	

Figure 5. Analysis result data.

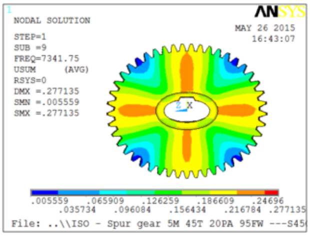
It can be seen from figure 5 that the frequency values generated by modes 1 to 6 are very small and almost do not vibrate. The frequency of mode 7 to 12 shows an increasing trend. The frequencies of order 7 and 8 are close, and those of order 9 and 10 are close. Figure 6 shows that the modes of order 7, 8 and 12 all occur at the edge of the gear. Order 9 and 10 occur at the spoke of the gear wheel; Table 1 shows that the vibration displacement of order 7, 8 and 12 is large.



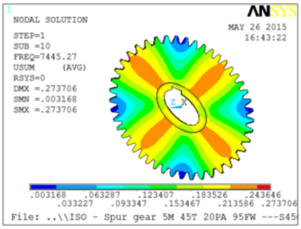
(a) Order 7 mode



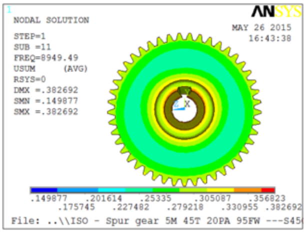
(b) Order 8 mode



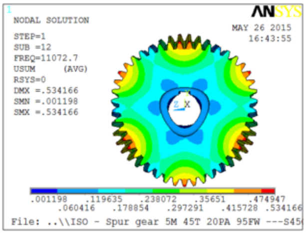
(c) Order 9 mode



(d) Order 10 mode



(e) Order 11 mode



(f) Order 12 mode

Figure 6. Mode diagram.

Table 1. Frequency and maximum displacement of drive gear.

Order	Frequency(Hz)	Maximum displacement(mm)	Mode description
7	5481.64	0.46041	Z swing
8	5497.86	0.460139	Twist about Y
9	7341.75	0.277135	X swing
10	7445.27	0.273706	z-bend
11	8949.49	0.302692	z-bend
12	11072.7	0.534166	The X direction is S-shaped

5.2. Static Analysis

It can be seen from figure 7 that the maximum stress of the driving gear is 0.1315MPa. The gear material is 45 steel, and the yield limit is σs=355MPa. The stress on the driving gear is far less than the yield limit of the material, and the strength is sufficient. It can be seen from figure 8 that the maximum strain generated by the driving gear during normal operation is 6.81×10^{-5}mm, with minimal deformation, which meets the requirements. Strain increases with the increase of stress.

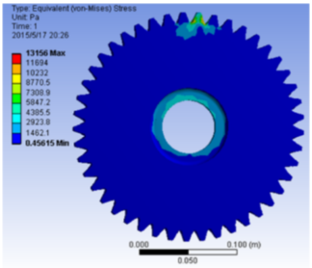


Figure 7. Strain diagram.

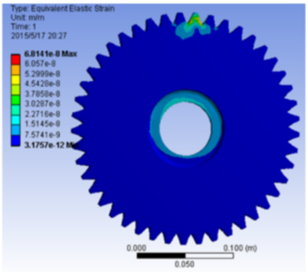


Figure 8. Strain diagram.

6. Concluding Discussion

The high efficiency saw blade polishing machine adopts vertical structure, sand belt grinding, and can polish two saw blades at the same time, and the floor area is only equivalent to a horizontal polishing machine that polishes the same specifications of saw blades. The results of static analysis show that the strength and stiffness of the driving gear meet the requirements. On the basis of the above design and analysis, a high-efficiency saw blade polishing machine is developed and applied to a saw blade company in Tangshan. The production efficiency is increased by 35% and the expected effect is achieved.

Acknowledgments

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