Advanced Science and Technology Letters
Vol.31 (ACN 2013), pp.58-61
http://dx.doi.org/10.14257/astl.2013.31.14

Influence of Temperature distribution of Reinforcing plate arrangement on the Heavy-duty Vertical Lathe Workbench

Yanqin Zhang [1] , Zeyang Yu [1], Weiwei Li [1], Junpeng Shao [1],
Xiaodong Yu [1] and Hui Jiang [2]

[1.] College of Mechanical & Power Engineering, Harbin University of Science and Technology, Harbin150080, China
[2.] Qiqihar CNC Equipment corp, LTD., Qiqihar 161005, China
Yanqin Zhang, yinsi1016@163.com

Abstract. During the heavy-duty vertical lathe work and the system operation, due to the workbench oil film friction and the self-generated heat will be transmitted to the workbench through the contact surface between oil film and workbench, make workbench temperature distribution uneven and produce large thermal deformation which can affect the machining accuracy. The article on different locations of the workbench Reinforcing plate temperature field simulation analysis, based on heat transfer theory and the actual working conditions, calculating the workbench of the convective heat transfer coefficient and the initial boundary conditions, analyzing the simulation results, it reveals the influence of reinforcing plate arrangement to the workbench temperature distribution law, and get the best position of reinforcing plate on the heavy-duty vertical lathe workbench. These study results would provide a theoretical basis for the structural design of the workbench.

Keywords: vertical lathe, temperature field, thermal deformation, convective heat.

1 Introduction

In recent years, domestic and foreign scholars have study on the vertical lathe workbench and hydrostatic guideway temperature fields in different degrees. Scholar Jin Jen Wang and So.H calculated the three-dimensional temperature field and the corresponding deformation field of the precision grinding of the work-piece [1]. Hefei General Machinery Research Institute Yang Dingjun, using the response surface method, combined experimental temperature values to calculate the convective heat transfer coefficient and heat distribution situation.Scholars Shao Junpeng, Yu Xiaodong, etc. using many oil pad hydrostatic bearing which is widely used in CNC equipment as the study object,use the numerical simulation method Contrasted the hydrostatic bearing lubricating properties.

ISSN: 2287-1233 ASTL

2 Heavy-duty vertical lathe workbench model

2.1 Workbench layout of three-dimensional model and rib

The simplified model is shown in Figure 2.

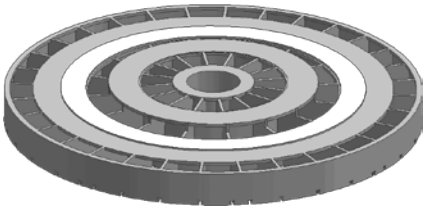

Fig. 1. UG model of worktable

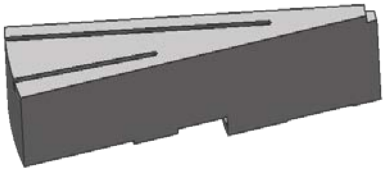

Fig. 2. Simplified model of worktable

2.2 Workbench ribs arranged

Figure 3 is no reinforcing plates sectional view of the workbench. In order to study the influence of the circumferential reinforcing plates location to the workbench, the plane plate divided into 11 parts from oil chamber to the center, each of 50mm, 11 positions were added in the circumferential reinforcing plate, Figure 4 is the location where is position 1, Figure 5 is position 6, Figure 6 is a position 11, followed by the oil chamber to the center is 1,2, ... 11.

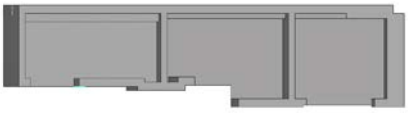

Fig. 3. Section plan of worktable

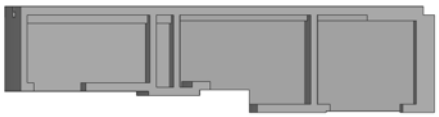

Fig. 4. Changed worktable in position 1

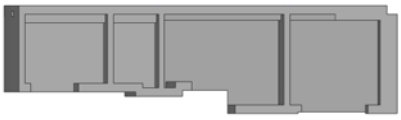

Fig. 5. Changed worktable in position 6

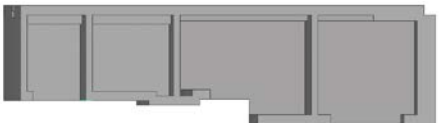

Fig. 6. Changed worktale in position 11

3 Convective heat transfer coefficient calculation

There are many factors affecting convective heat transfer coefficient, such as the cause of flow and the stable flow status, physical properties of heat transfer fluid and solid, geometry and location of heat transfer surface, whether phase transition occur

would caused coefficient changes in the process of heat exchange, the specific manifestation is using different formulas to calculate.

According to the actual production conditions and the workbench geometry, calculate the upper surface forced convection heat transfer coefficient formula, as formula (1).

$$h_{uf} = \frac{\lambda Nu_{uf}}{r_x} \tag{1}$$

When workbench rotating, in addition to forced convection heat transfer is also accompanied by natural convection, owing to great range of workshops, the space of natural convection heat will not be limited, it becomes a large space natural convection heat. Upper surface natural convection heat transfer coefficient as formula (2).

$$h_{un} = \frac{\lambda Nu_{un}}{0.9d_x} \tag{2}$$

4 Temperature Field Simulation Analysis Workbench

After changing the circumferential reinforcing plates position, through simulation analysis the workbench temperature field, get the impacting data of the temperature change various surface of reinforcing plate position on the workbench. Due to limited space, only lists 20r/min speed of the temperature field in position 1.

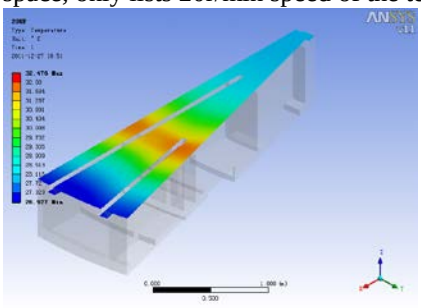

Fig. 7. Temperature on the upper Surface

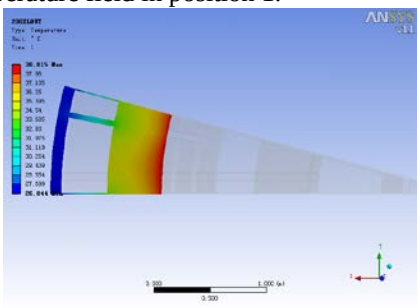

Fig. 8. Temperature on the lower surface

When finishing speed 20r/min, the upper and lower surface of reinforcing plates in various positions show the maximum temperature and the difference between the two. The statistics as shown in table 1.

Table 1. Temperature variation with chaning position of reinforcing plate.

	0	1	2	3	4	5
Upper surface	31.541	2.476	32.342	32.177	32.039	31.933
Lower surface	39.059	38.815	38.793	38.758	38.805	38.843

Temperature difference	7.518	6.339	6.451	6.581	6.766	6.91
Position	6	7	8	9	10	11
Upper surface	31.852	31.791	31.738	31.697	31.663	31.635
Lower surface	38.858	38.895	38.909	38.905	38.931	38.925
Temperature difference	7.006	7.104	7.171	7.208	7.268	7.29

The relation was made a graph as shown in Figure 9, using the reinforcing plate position as abscissa, the surface temperature as ordinate.

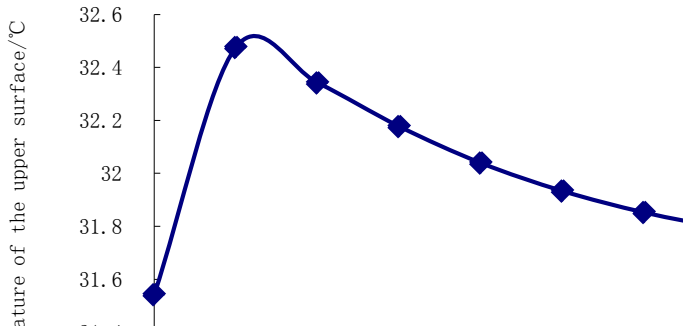

Fig. 9. Relationship curve between temperature of the uppersurface and position

5 Conclusion

Establish a CNC vertical lathe workbench three-dimensional model, determine the position of the reinforcing plate, and calculate the convective heat transfer coefficient on the surface of the workbench, through the equation shows that the rotating speed and the radius are the main factors affecting the heat transfer coefficient.

To analysis the temperature field of the workbench, the analysis of the calculation results shows that there is a temperature difference between top and bottom surfaces on the workbench, the uneven temperature distribution of the workbench, in order to reduce the workbench temperature difference between the upper and lower surfaces, proposed to increase reinforcing plate in the circumferential direction. Analysis the increased circumferential reinforcing plate, the temperature field shows that the method plays a positive effect role in homogenization temperature.

References

1. Jin Jen Wang，So.H.: The effects of thermal deformation on flatness in precision grinding. J. Journal of Thermal Stresses. 344, 394-409(2011)