The Research on the Crucial Techniques of PLC Rack Grinding Machine

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Abstract: This article presents new types of rack grinding machine (TSKM) in relation to the focus of high-speed precision machining. We have designed and integrated a set of grinder PLC system, refitted an experimental PLC rack grinder and researched into the control core of the NC grinder-open Programmable Multi-Axis Controller (PMAC), linear motor feed unit and high-speed electrical spindle unit. The numerical PID principle was used to adjust the system; dynamic and static performance. Time-base method of PMAC and the linear motor is micro-feed motion and the electrical spindle's high-speed performances were used to accomplish the grinding manufacture of high-speed performance of non-circular parts. To improve a good production efficiency of rack grinding machine, several obstacles have complicated the task of optimizing a grinding process. The automation of modern production machinery becomes ever demanding: increased production efficiency; more flexibility; and easier plant integration; extensional capability; combined with lower engineering and production costs.
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Key word: Grinding Process, motion control plc, linear motor.

1. Introduction:

This grinding machine consists of a power driven grinding wheel spinning at the required speed (which is determined by the wheel's diameter and manufacturer's rating, usually by a formula) and a bed with a fixture to guide and hold the work-piece. The grinding head can be controlled to travel across a fixed work piece or the work piece can be moved whilst the grind head stays in a fixed position. Very fine control of the grinding head or table's position is possible using a fernier calibrated hand wheel, or using the features of plc controls.

To meet a specific purpose the Tskm machine have been choice as model to support this research; the Tskm has been designed for rack grinding generation with a thread-formed grinding wheel, The plc offers automatic precision grindings of complex forms on long workpieces such as for broaches, dies & tools, gears, racks etc…with faster speed and greater flexibility. PLC Rotary contouring axis which can give you 5 Axes for shaft grinding, keyways, gear teeth, round broaching with center piece support.

5 Axes CNC provides the following automatic feeds:

1. Wheelhead vertical feed (Y axis).
2. Wheelhead cross feed (Z axis).
3. Dresser cross feed (X axis).
4. Index head rotary feed (C axis).
5. plc index head

The grinding wheel can be trued to any necessary form with the X & Y axes simultaneously controlled. The Y & Z axes are simultaneously controllable to position the wheelhead for profile grinding of the workpiece. Center supported workpiece such as round broaches and gears can be ground with the plc index head which is controlled by the C axis (Figure 1).

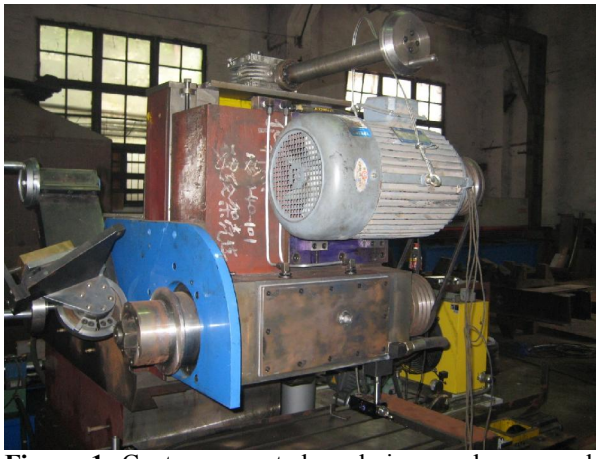

Figure 1. Center supported workpiece such as round broaches and gears can be ground with the plc index head which is controlled by the C axis

2. Materials and methods

2.1. Grinding System

It's based on machine that going to be able to simultaneously control up seven independent processes and the PLC tasks is communicating diagnostics and performance data. The Tskm command multiple machining operations involving various spindles and slide groups while coordinating

automated handling and measuring systems including main spindle, rotary axis-capable main spindle, linear axes, rotary axes, and combined spindle/turret axis, and it performs all functions required for circular, and helical interpolation, polar coordinate transformation, main spindle synchronization, and follower (synchronous) and gantry axes (Figure 2).

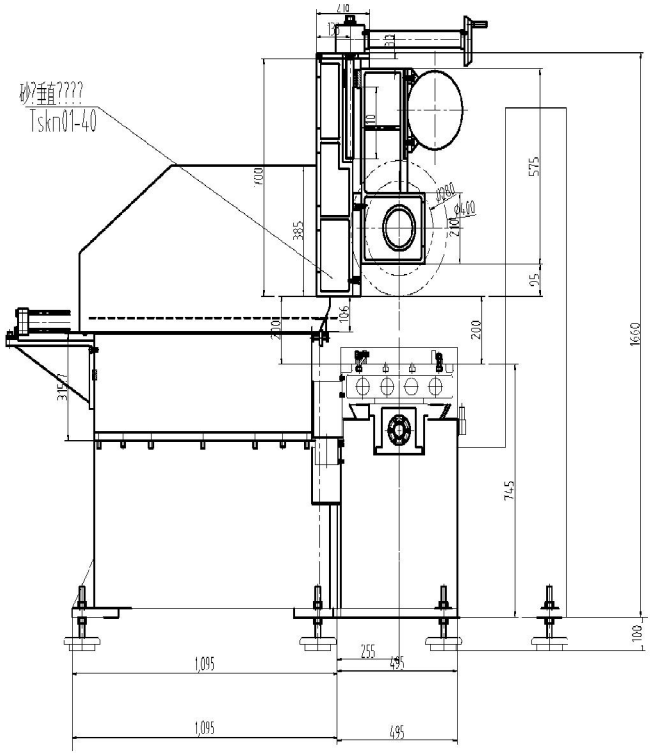

Figure 2. Grinding System

2.2. Machine Technical Data (Table 1)

Table 1. Machine Technical Data

最大加工长度（mm）max.machining length		1100
加工模数 module (mm)		0．25~2
最大加工齿宽（含根装夹）max.machining width (mm)		260
工作台（横向分齿运动）	最大行程 max.length(mm)	1200
	分齿运动速度 working speed (mm/min)	30~600
	快速运动速 fast move speed mm/min)	2000
	工作台光栅测量精度 precision of graving(mm)	0.020/全行程
	工作台分齿精度 precision of production(mm/min)	0.040/全行程
动力滑台（纵向运动）	最大行程 length (mm)	460
	进给运动速度 work speed (mm/min)	10~300
	快速运动速度 fast move speed(mm/min)	2000
垂直进给运动	垂直进给最大行程 length (mm)	100
	垂直光栅测量精度 precision of grating ruler（mm）	0.002/全行程
	垂直进给精度 precision of vertical feed（mm）	0.004/全行程
主轴转速范围	高速 high speed(r/min)	1500~3000

2. 3. Machine Works process

The abrasive cuts the surface of the workpiece in three phases. The first phase is when the abrasive first contacts the workpiece surface the dull grains of the abrasive fracture and fall away, which produces a sharp new cutting surface. In the second phase the abrasive "self dresses", where a most of the stock is removed. Finally, the abrasive grains dull, which improves the surface geometry.

The average rotational speed of abrasive wheel and/or workpiece is 1 to 15 surface m/min, with 6 to 14 m/min preferred; this is much slower compared to grinding speeds around 1800 to 3500 m/min. The pressure applied to the abrasive is very light, usually between 0.02 to 0.07 MPa (3 to 10 psi), but can be as high as 2.06 MPa (299 psi). Honing is usually 3.4 to 6.9 MPa (490 to 1,000 psi) and grinding is between 13.7 to 137.3 MPa (1,990 to 19,910 psi). When a stone is used it is oscillated at 200 to 1000 cycles with amplitude of 1 to 5 mm (0.039 to 0.20 in). Superfinishing can give a surface finish of 0.01 µm.

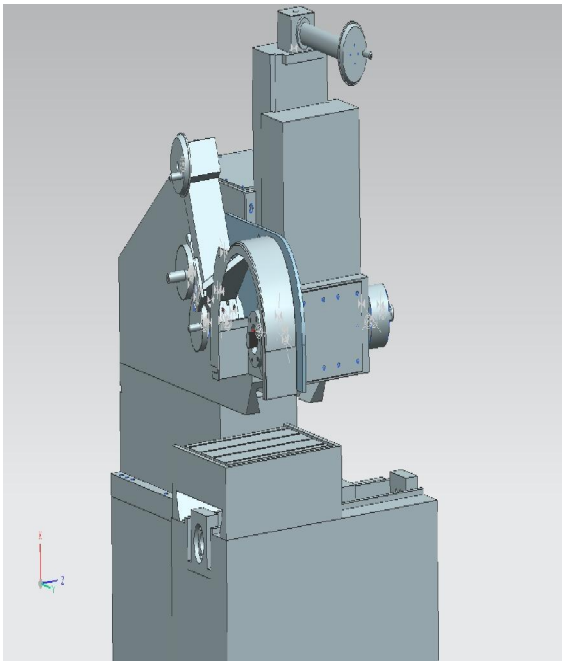

Figure 3. Machine

3. Results and discussion

Analytical rack measurement systems have traditionally measured index, helix, and involutes profiles, but with the TSKM in probing systems and the improvements in the capabilities of plc controls, inspection machines can now take advantage of error compensation that allows related geometric features to be measured with respect to rack features. Perpendicularity and concentricity relationships of gear bores to stamped sheet metal components need to be held to tight tolerances.

Main consideration when trying to better understand the process of rack profile grinding is the constantly changing contact conditions along the profile. In real process trials, only effects resulting from all those contact conditions along the profile can be observed. And since grinding burn, in most cases, occurs only locally, the effect on values like grinding power or grinding forces often cannot be seen initially.

Conclusion

The effects of grinding wheels, grinding fluids, and their different combinations on the grinding ratio, specific energy, grinding efficiency, and surface roughness have been investigated over a wide range of specific material removal rates. Various kinds of rack grinding machine tools have been developed and put into practical use in the past to meet specific purposes or demands. However, there is still not a rational and systematic methodology to determine the configuration of the machine. Effort must be devoted to develop a scientific methodology to design new rack grinding machine tools as their demand is still increasing in order to machine complicated and difficult parts at higher speed with higher accuracy

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References

1. Shaw, M.C., “A new theory of grinding,” Mech. and Chem. Eng. Trans. Institution of Engrs (Australia).
2. Bifano, T.G., Dow, T.A. and Scattergood, R.O., “Ductile-regime grinding: a new technology for machining brittle materials,” Trans. ASME. Journal of Engineering for Industry.
3. Bifano, T.G. and Fawcett, S.C., “Specific grinding energy as an in-process control variable for ductile regime grinding”, Precision Engineering, 1991, 13(4): pp 256–262.
4. Online available at www.iop.org.

5. Lindberg, R.A., Processes and Materials of Manufacture, Prentice Hall of India Pte. Ltd., New Delhi, 1970.
6. HMT, Production Technology, Tata McGraw Hill Publishing Company Limited. New Delhi, 1980.
7. Kalpakjian, S., Manufacturing Engineering and Technology, 3rd Edition, Addison-Wesley Publishing Company. New York, 1995.
8. Rao, P.N., Manufacturing Technology: Metal Cutting & Machine Tools, McGraw-Hill Publishing Company Limited, New Delhi, 2000.
9. Cook, N.H., Manufacturing Analysis, Addison-Wesley Publishing Co. Inc., USA, 1996.
10. Pearce, C.A., Silicon Chemistry and Applications, the Chemical Society, London, 1972.
11. Stephenson, D.A. and Agapiou, J.S., Metal Cutting Theory and Practice, Marcel Dekker, Inc., New York, 1997.

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