Reliability Analysis of CNC Grinder

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Abstract. CNC grinding machine tools is the parent machine in modern machinery manufacturing, our country's machine tools is a certain gap with foreign countries, therefore, it is very urgent to improve the reliability of CNC grinding machine. This article is mainly based on data collected in the factory, using Failure Mode, Effects and Criticality Analysis (FMECA), find out the fault location and the fault reasons of this series of CNC grinding machine, and then identify the weaknesses, provide the evidence for the design and optimization of the CNC grinding machines, and propose appropriate measures for improvement, to improve the reliability of the series CNC grinder.

Introduction

CNC grinding machine is the indispensable digital manufacturing equipment of the CNC machine for finishing, and reflect the level of the machinery manufacturing indirectly. The stage of the market share of CNC grinding machine compare the foreign related products is relatively low, the main reason is that the reliability of the domestic CNC grinding machine is low, the domestic related products constantly broken down, not only reduces the production efficiency, also make enterprise caused enormous economic loss. Thus it can be seen that the urgency to enhance the reliability of CNC grinding machine products.

Failure data collection

In this paper, by analyzing the data of a certain type of CNC grinding machine failure data, the period of one year, according to the required on-site tracking data acquisition in advance. Mainly adopts the following steps:

Numbered the workshop facilities, make the specification of the data collection form, collect the fault data from the corresponding equipment;

In the equipment workshop on-site casing, field data collection for each device;

By manufacturer specialized personnel in charge of field failure records, including the maintenance time, maintenance section, the cause of the problem, and so on;

At the end of the maintenance, the remaining site continue to observe.

If you want to carry on the CNC grinding machine reliability analysis , the source of the data must be reliable, because each factory equipment conditions of use and the environment is different, more uncertainty over the use of equipment. This article adopts the method of field test failure data acquisition to the grinding machine, the real reflect the use of CNC grinding machine.

The analysis of the failure mode and the reason

In all kinds of available methods in fault Analysis, Failure mode Effects Analysis [3] (Failure Modes and Effects Analysis, FMEA) is one of the most basic and most effective method is to analyze the system in each product all possible Failure Modes and all of the possible Effects on the system, and according to the severity of each Failure mode, and more frequent testing easy procedures shall a inductive Analysis method of classification. .Failure Mode, Effects and hazards Analysis (Failure Mode, Effects and Criticality Analysis, FMECA) is summed up in the engineering practice, based on

the Failure Mode, aiming at fault impact or consequences Analysis techniques. It through analyze the influence of the different failure of each component on the system, identify the weak links and key projects in the design , provide basic information for evaluating and improving the reliability of the system .FMECA including the failure mode and effects analysis (FMEA) and criticality analysis (CA).

According to the different parts of CNC grinding machine belong to the different function, CNC grinding machine can be divided into the following eleven subsystems, respectively is: basic parts, CNC system, shaft system, feed system, servo system, electric control system, hydraulic system, cooling system, lubricating system, head frame system and miuoyo system. Data from the field by the workshops, and according to the statistics of the molecular system, such as table 1:

Table 1 CNC grinding machine fault and the proportion of each subsystem

Name of the subsystem	Abbreviation code	Failure frequency	Proportion
basic parts	BS	4	3.48%
CNC system	NC	4	3.48%
shaft system	SD	31	26.95%
feed system	FD	1	0.87%
servo system	SV	1	0.87%
electric control system	EC	7	6.09%
hydraulic system	HY	20	17.39%
cooling system	CL	6	5.22%
lubricating system	LB	4	3.48%
head frame system	HS	24	20.87%
miuoyo system	MI	13	11.3%

From the above may know: the series of CNC grinding machine, shaft system (26.95%), head frame system (20.87%), hydraulic system (17.39%), and miuoyo system (11.3%) account for more than two-thirds of all faults, including shaft system is the series of CNC grinding machine failure rate in the highest subsystem.

Below again for failure mode analysis, classify the fault data in a reasonable way, as shown in table 2:

Table 2 the fault mode and the proportion of each mode

Fault types	Fault reason	Frequency	Proportion
Damage type	Fracture, parts damage, crack etc	61	53.04%
Degradation type	Aging, corrosion, wear etc	19	16.52%
Loose type	Loose, fall off etc	4	3.48%
Imbalance type	Improper pressure, stroke etc	5	4.35%
Blockage or leakage type	Jam, oil leakage, leakage etc	1	0.87%
Functional type	The function is not normal, performance is not stable etc	13	11.3%
Other	Bad lubrication etc	12	10.44%

As can be seen from the table, the series of CNC grinding machine, parts damage, the function abnormal, as well as the parts wear these occupied the main reason, the cause of the problem should be given attention.

The analysis of the grinding machine harm degree

This series of CNC grinding machine is divided into 11 subsystems: basic parts, CNC system, shaft system, feed system, servo system, electric control system, hydraulic system, cooling system, lubricating system, head frame system and miuoyo system. They harm degree with CR_1, CR_2, CR_3, CR_4, CR_5, CR_6, CR_7, CR_8, CR_9, CR_{10} and CR11 to say. Subsystem in failure mode j fails, so that the harm degree of the failure of the subsystem CR_{ij}. Its computation formula is;

$CR_{ij}=\alpha\beta i\ j\lambda i$ (3-1)

The harm degree of subsystem for the whole machine

$CR_i=\sum_{j=1}^{n} CRij$ (3-2)

Put type (2-1) into type (2-2)

$CR_i=\sum_{j=1}^{n} \alpha i\ j\beta i\ j\lambda i$ (3-3)

In the formula: n----the number of the fault mode of subsystem i;

$\alpha i\ j$----the proportion of Subsystem i in failure mode j to cause failure of the subsystem; the formula is;

$\alpha i\ j= n_j /n_i$ (3-4)

In the formula: n_i----the frequency of the subsystem i in failure mode j;

N_j----the frequency of all the subsystem i;

$\beta i\ j$----the proportion of Subsystem i in failure mode j to cause failure of the subsystem;

$\beta i\ j$=1 show the subsystem must happen damage;

$\beta i\ j$=0.5 show the subsystem damage may occur;

$\beta i\ j$=0.1 show the subsystem is rare injury;

$\beta i\ j$=0show there no effect on the subsystem;

λi----the basic failure rate of subsystem; in this paper, the average failure rate $\overline{\lambda i}$ is obtained by field experiment.

$$\overline{\lambda i} = \frac{Ni}{\sum t} \quad (3\text{-}5)$$

In the formula Ni----the frequency of the fault of the subsystem in the set time;

$\sum t$----the accumulation of work time in the set time;

The accumulation of ten of the MKS series CNC grinding machine work time of 58400 (two shifts).From the formula (3-5):

$\overline{\lambda i}$ ={0.0000685,0.0000685,0.000532,0.0000171,0.0000171,0.00012,0.000342,0.00001027,0.0000685,0.0004114,0.000223};

Put$\alpha i\ j$, $\beta i\ j$, λi into (3-3), calculating harm degree of subsystems:

CR_i={0.00005135,0.000059,0.00042,0.0000171,0.0000171,0.0000686,0.000279,0.0001027,0.0000411,0.0003258,0.000223};

From the above data to build the following table 3:

Table 3 the harm degree of each subsystem

Name of the subsystem	harm degree	Name of the subsystem	harm degree
Basic parts	0.00005135	Hydraulic system	0.000279
NC system	0.000059	Cooling system	0.0001027
Shaft system	0.00042	Lubricating system	0.0000411
Feed system	0.0000171	Head frame system	0.0003258
Servo system	0.0000171	Miuoyo system	0.000223
Electric control system	0.0000686		

According to the above form we can know, the harm degree of the shaft system, head frame system, hydraulic system and miuoyo system is bigger than other subsystems for the CNC grinder, these four subsystems accounted for 76.51%, so we can know the weakness of the grinding machine, thus improve the design of the whole machine, so as to improve the reliability of the CNC grinder.

Conclusion

According to the above analysis we can know, shaft system own the highest failure rate among all systems, the second is head frame system, hydraulic system and instrument system failure rate is also high, so improve the reliability of shaft system, head frame system, hydraulic system and miuoyo system for improving the reliability of the whole has a vital role.

Strengthen the outsourcing quality of electronic components. As most of the fault is from the damage of the electronic components, so on the choice of components businesses is very important. Because each of the electronic components using environment and position on the CNC grinding machine is different, select different electronic components to adapt to each position and the environment in a reasonable way, to improve the reliability of the whole. Build the regime to supervise the outsourcing components, and strengthen the detection of the components, to ensure that the quality of the purchased items, improve the overall reliability of CNC machine in a certain way.

Pay attention to daily inspection work. Log the records of daily work, on the daily schedule of work must pay attention to mark the use of the machine every day, and improve the mechanism of using the CNC grinding machine, when found abnormal, report it right way timely, and make records carefully, it is necessary to record in detail for the description of the problem. The factory can cooperate with the manufacturers to build a platform, enterprise users can timely reflect problems feedback to the relevant products manufacturers, it can provide the manufacturer the process of product design and optimization in a direct way, it can play a big role for the manufacturer in the optimal design of CNC machine, it has the extremely significance to improve the reliability of the CNC machine. The customer's feedback reflect the requirements of customer, so it is better for manufacturer to adapt to the demand of the market. This work is very necessary and also very meaningful.

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