Failure Analysis and Research of Washing Nozzle in Front of Automobile

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Keywords: Front washing nozzle, Failure, Improved design, Finite element analysis.

Abstract: Xiangtan geely automobile production base, the author of this paper wiper washing system failure occurs, the washing ball core fracture problem of the nozzle, combined with the actual production, based on product failure reason analysis, found the ball core fracture basic appear in the winter, the temperature decrease after the plastic shrinkage, the matching of the nozzle and the spool too tight, the user without the use of special debugging tools debug copper ball, caused the ball core fracture, for this reason, put forward to increase before initial washing nozzle spray Angle 6.5 o, and adjust the structure of the nozzle core ball, the ball core from square to V groove root, enhance the strength of ball core groove, using the method of 3D modeling, According to former car washing nozzle design parameters, through the Pro/E 3D software to complete before washing nozzle and improving design of 3D model, using the finite element analysis of ANSYS Workbench before washing nozzle improvement before and after the deformation and stress distribution, the improved deformation from 0.0023643 mm to 0.0012954 mm, the improved maximum stress value from 472.87 MPa to 259.09 MPa, ultimate strength less than 300 MPa, improve the rationality of the design is verified, for enterprises to solve the quality problem, have a very good reference value.

1 INTRODUCTION

Each major automobile giant has formed its own characteristic wiper washing system, which has advantages in reliability, economy or advanced technology (Li guoqing, 2017). The investigation found that xiangtan geely automobile production base before the emergence of automobile washing nozzle spray column spray problem, after inspection for the ball core fracture. After investigation, during the loading and production of this model, 7 front nozzles were found to be broken when the injection Angle was adjusted. According to the on-site physical investigation and fault reproduction, it is preliminarily determined that the interference amount between the nozzle body and the ball head is too large, leading to the fracture of the ball head during adjustment (product consistency problem). Interference fit is adopted between the nozzle body and the ball head, and the interference amount is 0.05mm.

Figure 1. Nozzle regulating method.

Figure 2. Failure parts.

Li, G., Zuo, C., Ma, Y. and Huang, Q.
Failure Analysis and Research of Washing Nozzle in Front of Automobile.
DOI: 10.5220/0008867900590063
In *Proceedings of 5th International Conference on Vehicle, Mechanical and Electrical Engineering (ICVMEE 2019)*, pages 59-63
ISBN: 978-989-758-412-1

After dismantling of the old parts and test analysis, confirm the main failure reasons might be: ball core fracture basic appear in the winter, the temperature decrease after the plastic parts of a contraction, the matching of the nozzle and the spool too tight, the user without the use of special debugging tools debug copper ball, caused the ball core fracture, this problem has become a problem to be solved in practical production, it has a strong production of practical significance.

2 FAILURE ANALYSIS OF AUTOMOBILE WASHING NOZZLE

2.1 Present Situation Investigation and Cause Analysis

After the dismantling and test analysis of the old parts, it is confirmed that the main failure reasons are as follows:

(1) The core fracture basically occurs in winter, and the plastic parts shrink after the temperature decreases in winter, which leads to the over-tight cooperation between the core and the nozzle.

(2) The root of the nozzle center groove is designed to be at right angles, and the strength is insufficient. Besides, users do not use special tooling for debugging, which results in the fracture of the ball core.

(3) The spraying Angle of the nozzle has been fully adjusted in the factory inspection, and our company used special tooling for debugging, without considering the possibility of some users adjusting the Angle of the nozzle.

The diameter of the ball head of the nozzle of the fault part is 4mm, which meets the design requirement of 4.1mm. Therefore, the root cause of the non-ball head fracture problem is the ball head size. Shrinkage rate of nozzle body material PA6 and nozzle ball head material POM varies with temperature, and the actual shrinkage of plastic parts is related to material thickness, so it is difficult to control the interference amount of 0.05mm by adjusting injection molding parameters such as injection pressure, pressure holding time and temperature.

The shrinkage rate of nozzle body and ball head material varies with the temperature. When the temperature changes, the shrinkage rate of nozzle body PA6 is larger than that of ball head bronze, leading to the increase of interference amount and the increase of regulating power. In view of the above situation, according to the requirements of the nozzle and the adjustment process of the nozzle Angle, it is proposed to calibrate the initial injection Angle of the former nozzle according to the laws and regulations, and make adjustment tools according to the calibration samples. The nozzle Angle is adjusted before the nozzle leaves the factory, so as to avoid the ball head breaking when the assembly factory adjusts the nozzle Angle.

2.2 Automobile Front Washing Nozzle Improvement Program

The demand for automobiles is very high, and the output of automobile enterprises keeps climbing, and the quality requirements of products are very high (M. Unno, A, 2017). Improving the structure and strength of washing nozzle is an effective method to improve the quality of nozzle (Shao wei, 2016). The improvement of the nozzle must meet the service conditions and meet the requirements of contact surface injection. According to the characteristics of the nozzle model, the main improved parts focus on the size and shape of the nozzle, so as to achieve the improvement aimed at improving the nozzle strength.

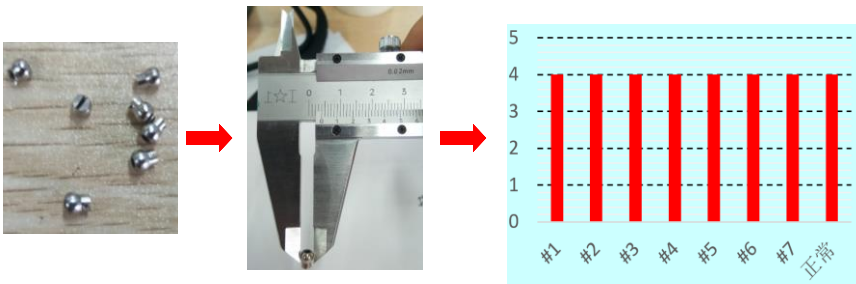


Figure 3. Nozzle ball head diameter measurement data.

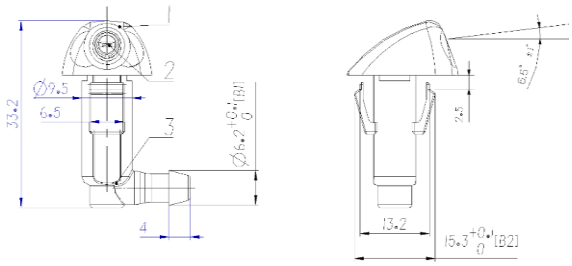
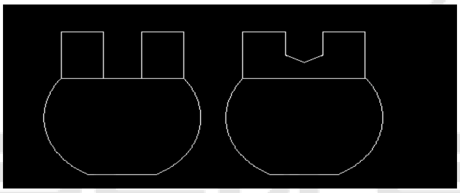


Figure 4. Nozzle Angle change diagram.

(1) It is required to increase the initial injection Angle of the nozzle in the front nozzle, and its value is 6.5o, as shown in FIG. 4.

(2) The current state of the nozzle is rectangular, with low strength and concentrated stress at the root of the groove. Therefore, adjust the structure of the nozzle core, change the root of the core groove from square to V-shaped, and enhance the strength of the core groove. FIG. 5 is a brief comparison of the nozzle before and after improvement.



To improve the former   The improved

Figure 5. Schematic diagram of nozzle structure change.

3 STRUCTURAL ANALYSIS AND IMPROVEMENT DESIGN MODELING OF AUTOMOBILE WASHING NOZZLE

3.1 Design Parameters of Pre-Wash Nozzle

(1) Installation arrangement

In general, a number of nozzles should be arranged on the annular pipe, which should be arranged according to certain rules to ensure that all surfaces can be covered by spraying materials, and nozzles should be evenly distributed in the entire spraying area (Shao gang, 2012). The distance between the nozzle and the workpiece is required that the workpiece should be in the area where the liquid flows from the nozzle, so the layout between the nozzle and the nozzle must follow a scientific way. The distance between nozzles is usually 250mm to 300mm. When the two are misaligned, the distance between the nozzle and the workpiece should be greater than or equal to 250mm.

(2) Selection of nozzle profile size

The inner diameter of the nozzle ball core is 2mm ~ 3mm, the length of the nozzle is 2mm ~ 5mm, the length of the body is 9mm~11mm, the width of the body is 14mm~16mm, and the length of the nozzle tube is 5mm~8mm.

(3) Radius of rounded corner of nozzle

The minimum radius of the nozzle is 2mm~4mm, depending on the specific situation, some special nozzle size will be slightly larger.

(4) Design angles on both sides of the nozzle

Generally used for cleaning function of the nozzle, can choose a strong impact of the jet nozzle: injection Angle generally 60° or so, this Angle design, the nozzle has a larger impact force.

After measuring the pre-washing nozzle, the main size data of the nozzle are shown in table 1.

Table 1. Main size data of nozzle (unit: mm).

Ball core diameter	Body width	Body length	Total nozzle height
2	15.3	9.5	33.2

3.2 The Establishment of the Model before and after the Improvement of the Former Washing Nozzle

3D software Pro/E was used to establish the model before and after improvement of the ventilation pipe, as shown in FIG. 6 and FIG. 7.

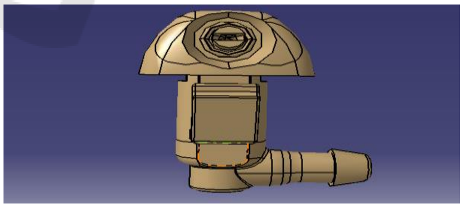


Figure 6. Improved previous nozzle model.

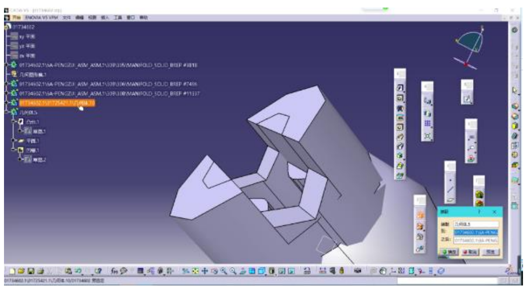


Figure 7. Improved nozzle model.

4 COMPARATIVE ANALYSIS OF THE FINITE ELEMENT STRUCTURE BEFORE AND AFTER THE IMPROVEMENT OF THE FORMER WASHING NOZZLE

The finite element model material properties of the pre-washing nozzle are shown in table 2 below.

Table 2. Nozzle material properties.

elasticity modulus (N/mm2)	poisson ratio	density (kg/m3)	load (N)	ultimate strength (MPa)
105	0.25	7.45	10	300

4.1 Finite Element Analysis before the Improvement of the Former Washing Nozzle

Finite element analysis was conducted on the former washing nozzle by ANSYS Workbench, and the deformation amount and stress cloud diagram were obtained as shown in figure 8 and figure 9 respectively.

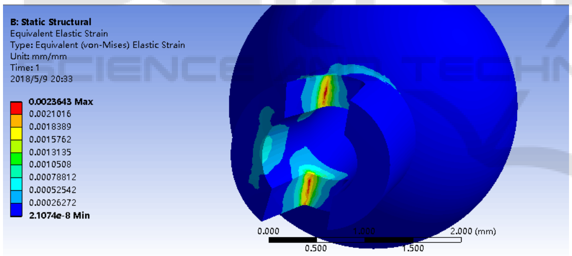


Figure 8. Nozzle deformation before improvement.

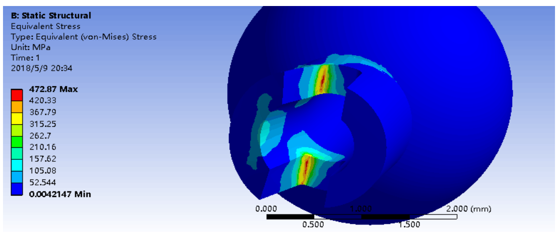


Figure 9. Nozzle equivalent stress cloud diagram before improvement.

According to the deformation amount in FIG. 8 and the front of the nozzle, the deformation amount of the nozzle is not too large. It can be known that the nozzle bottom has the maximum deformation, which is 0.0023643mm. It can be seen from the equivalent stress cloud diagram in FIG. 9 that no supports at the bottom of the nozzle groove bear the maximum stress, with the stress value of 472.87mpa and the ultimate strength value of 300mpa. Therefore, fracture occurs when non-special tooling is used for adjustment. Combined with the damage of automobile nozzles in actual working conditions, the results of this analysis are consistent with the actual situation of fracture failure of ball core of automobile washing nozzles before xiangtan geely.

By observing the deformation diagram of the nozzle, it can be seen that the nozzle bottom has shifted. In order to solve the insufficient strength of the nozzle, by improving the structure of the nozzle bottom and adding chamfering, it is necessary to check and analyze the improved model in the same way to verify whether the stress value of the nozzle meets the strength requirements of the nozzle.

4.2 Finite Element Analysis after the Improvement of the Former Washing Nozzle

Finite element analysis was conducted on the improved nozzle by ANSYS Workbench, and the deformation amount and stress cloud diagram were obtained as shown in FIG. 10 and FIG. 11 respectively.

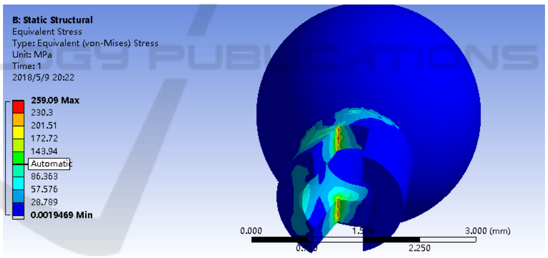


Figure 10. Improved nozzle deformation.

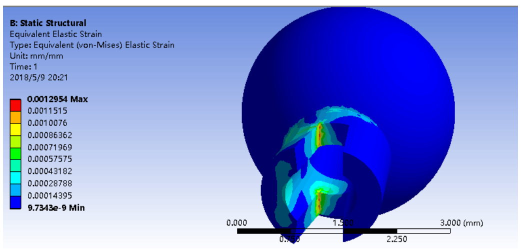


Figure 11. Improved nozzle stress cloud diagram.

According to the deformation amount in FIG. 10, the maximum deformation of the nozzle groove bottom is 0.0012954mm. According to the stress cloud diagram in FIG. 11, the spray Angle of the

Table 3. Deformation and stress of washing nozzle before and after improvement.

Load (N)	Deformation (mm)		Stress value (MPa)	
	before improvement	improved	before improvement	improved
10	0.0023643	0.0012954	472.87	259.09

nozzle is changed. The maximum stress is 259.09MPa after the chamfer is added to the bottom of the "V" groove.

In summary, the displacement and stress values before and after the nozzle improvement are arranged as shown in table 3.

5 EFFECT OF VALIDATION

After the production base improves the structure of the groove bottom of the front washing nozzle according to the above scheme, the product batch is switched, and no feedback on the fracture of the ball head is received after the switch.

Effect verification:

1. Spraying effect: there is no obvious deviation between the spraying effect and the change, as shown in FIG. 12.

Figure 12. Improved nozzle stress cloud diagram.

2. Core strength:

(1) Before the change: use the clamp to clamp the ball core, put the tool into the ball core slot, forced rotation of the ball core fracture.

(2) After the change: clamp the ball core dead, put the tool into the ball core slot, forced rotation of the ball core did not appear broken.

6 SUMMARY

The main purpose of this paper is to find out the reasons for the failure of washing nozzles in front of cars and put forward improvement plans according to the reasons of deformation. By using Pro/E software for car washing nozzle before failure before and after the improvement on 3 d modeling, using the finite element ANSYS Workbench software of finite element analysis was carried out on the car before washing nozzle before and after improvement, through the comparison and analysis of deformation before and after the improved 0.0023643 mm and 0.0012954 mm, the stress value of 472.87 MPa and 259.09 MPa, verified the rationality of the nozzle improvement program, in front of the car washing nozzle optimal design has some reference meaning, to improve the design quality, reduce design cost and shorten the development cycle, It has good engineering practical significance.

ACKNOWLEDGMENTS

Fund projects: outstanding youth project of education department of hunan province (16B235), general scientific research project of education department of hunan province (17C1444 and 16C1432), and CX2016SY015 of postgraduate scientific research innovation project of shaoyang university

About the author: li guangming (1983-), male, born in shaoyang, hunan province, master degree, mainly engaged in vehicle engineering teaching and research of automobile testing technology.

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