wjert, 2021, Vol. 7, Issue 6, 220-236. Research Article ISSN 2454-695X

World Journal of Engineering Research and Technology

WJERT

www.wjert.org Impact Factor Value: 5.924

CALCULATION OF NOZZLE FLOW COUNT VALUE UNDER LARGE LOAD

Guo-Qing Zhao*, Bo-Jie Xu, Gong He, Sen-Da Qi, Feng Wang, Zi-Yan Hu, Yao-Qian Wang, Shi-Shi Jiang, Hao Chen and Li-Xin Chen

College of Mechanical Engineering, Quzhou University, China, 324000.

Article Received on 04/10/2021 **Article Revised on 25/10/2021** **Article Accepted on 15/11/2021**

***Corresponding Author**
Guo-Qing Zhao
College of Mechanical Engineering, Quzhou University, China, 324000.

ABSTRACT

This paper mainly uses three factors and three levels orthogonal experiment method to analyze the static stress of the fixed standard nozzle. The standard nozzle is divided into three regions of the A、B、C, and two groups of large loads of 8000 N and 10000 N are used to make the standard nozzle core. According to the test results, the maximum stress and strain of the key parts of the nozzle Flowmeter with large load appear in the position R1 the arc of the standard nozzle core tangent to the plane entrance, and the minimum stress appears in the standard nozzle core arc The outlet plane of the quasi-nozzle forgings, the maximum displacement appears at the end of the standard nozzle core. From this we can see that the R1、R2 and tail end of the standard nozzle core need to pay more attention to the selection of casting materials and processing technology.

KEYWORDS: Keywords nozzle; flowmeter; load; SolidWorks.

0. INTRODUCTION

The standard nozzle is a differential pressure generator to measure the flow rate. With various differential pressure gauges or differential pressure transmitters, the flow rate of various fluids in the pipeline can be measured. Standard nozzle throttling device and differential pressure transmitter can measure the flow rate of liquid, steam and gas. Standard nozzle is widely used in petroleum, chemical, metallurgical, electric power, light industry and other departments. When they flow through the throttling device in the pipe, the flow beam will form a local contraction at the throttling part of the throttling device, thus increasing the flow rate and reducing the static pressure, resulting in a pressure drop before and after the throttling piece, that is, a pressure difference. The greater the flow rate of the medium, the greater the flow rate before and after the throttling piece The greater the pressure difference, the standard nozzle can measure the flow rate by measuring the pressure difference. This method is based on the law of energy conservation and the law of flow continuity. Intelligent throttling device (standard nozzle) is a new generation Flowmeter which integrates the function of flow, temperature and pressure detection and can automatically compensate temperature and pressure. The orifice plate Flowmeter adopts advanced microcomputer technology and new technology of micro-power consumption. It has strong function, compact structure, simple operation and convenient.[1] Based on this, this paper explores the influence of different materials, load size and position of load on the standard nozzle It is helpful to find the parts of the standard nozzle which are prone to fracture and damage, and to improve the performance of the standard nozzle in the future can provide strong data.

1. physical model

Using the simulation plug-in in the SolidWorks, the static stress model is established, and the stress-strain analysis based on finite element method is carried out. The analytical model is shown in figure 1.

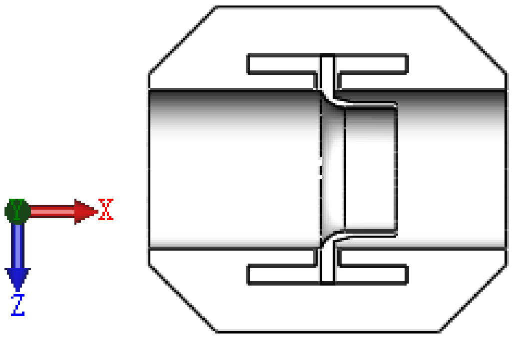


Fig. 1: Calculation of Key Components.

1.1 Use of materials

(1) Steel material

Stainless steel is chosen in the material selection of standard nozzle forgings, and stainless steel is also used in the material of standard nozzle core. Because stainless steel itself has weldability, raw material welding performance is required in the welding process. At the same time, stainless steel also has corrosion resistance, which can resist the corrosion of air, steam, water and other media with weak corrosion properties. It has the advantages of better comprehensive mechanical properties, shorter construction period, longer design life, lower life cycle cost and higher comprehensive social benefit, especially for engineering structures with higher corrosion resistance.[2] Its basic parameters are shown in Table 1 below.

Table 1: Basic Properties of Stainless Steel Materials.

Material name	Elastic modulus	Poisson's ratio	Mass density
Stainless steel (ferrite)	2×10^{11}N/m^2	0.28	7800kg/m^2

(2) Iron Material

Stainless steel is still used in the selection of materials for standard nozzle forgings, while gray cast iron is used for standard nozzle cores. Gray cast iron refers to cast iron with flake graphite, which is called gray cast iron because of its dark gray fracture. The main components are iron, carbon, silicon, manganese, sulfur and phosphorus. It is the most widely used cast iron, and its output accounts for more than 80% of the total output of cast iron[3], Gray cast iron has good casting performance, good damping, good wear resistance, good cutting performance, low notch sensitivity.[4] The basic parameters are shown in Table 2 below.

Table 2: Basic Properties of Gray Cast Iron Materials.

Material name	Elastic modulus	Poisson's ratio	Mass density
Grey cast iron	6.617×10^{10}N/m^2	0.27	7200kg/m^2

(3) Aluminium Material

In the selection of materials for standard nozzle forgings, we still use stainless steel, while the standard nozzle core is replaced by 1060 aluminum alloy. Because 1060 aluminum alloy is the highest aluminum content, up to 99.6. Low density, but relatively high strength, close to or more than high quality steel, good plasticity, can be processed into various profiles, with excellent electrical conductivity, thermal conductivity and corrosion resistance, widely used in industry, the use of second only to steel. At the same time, the surface of 1060 aluminum alloy has a dense solid alumina protective film, which can resist acid and weak alkaline medium. The basic parameters are shown in Table 3 below.

Table 3: Basic Properties of 1060 Aluminum Alloy Materials.

Material name	Elastic modulus	Poisson's ratio	Mass density
1060 aluminum alloy	6.9×10^{10}N/m^2	0.33	2700kg/m^2

2. GEOMETRIC FIXATION

In order to make the standard nozzle core have better static stress analysis, the standard nozzle core should be properly constrained so that there is no movement in the analysis. In this static stress analysis, the fixed geometry under the fixture consultant plug-in in the simulation is used to fix the standard nozzle core to ensure that the standard nozzle core will not move in all directions after the applied load. As shown in Figure 2.

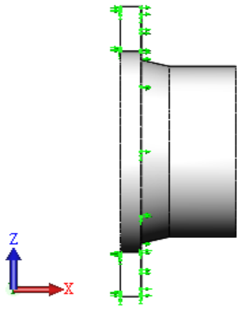


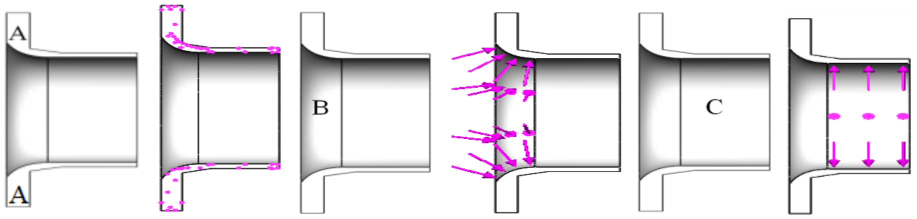
Figure 2: Add Figure of Standard Nozzle Core Fixture.

3. LOAD ADDITION

After fixing the step bottom of the standard nozzle core, the load is applied to the standard nozzle core, and the external pressure is applied to the standard nozzle core in real life. However, in this static stress analysis, in addition to changing the material of the standard nozzle core, it is necessary to change the load size and the position of the applied load. make more different cases for subsequent analysis of different materials, same load and same load position or different load, same material and same load position or different load position, same material and same load position to better analyze whether changing material, load and load position will have some effect on the performance of standard nozzle core.

3.1 Load position

For this time, the applied load position will be divided into three cases, applied in different three regions, as shown in (a),(b),(c) of figure 3 below.



(a) **(b)** **(c)**

Figure 3 Application of standard nozzle core load.

3.2 Load size

The applied load will be divided into two cases, 8000 N、10000N, different loads in the A、B、C three areas will be applied three times. The specific load applied is shown in Table 4 below.

The method used in this design is three factors and three levels orthogonal test. A design method that can select a few representative test conditions in many tests and infer the best process conditions through a few test conditions. It is a method of arranging experiments and analyzing data by using —— orthogonal tables that have been made.[5] its orthogonal factor table is shown in Table 4 below, the orthogonal test table is shown in Table 5 below.

Table 4: Level of Factors (Level of factor 3).

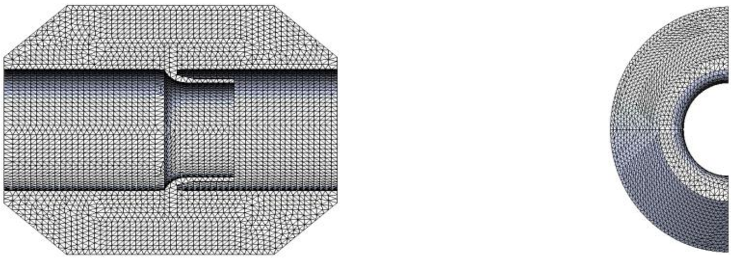
Level	Factors		
	Standard nozzle core material	**Load size**	**Load position**
1	Stainless Steel	5000N/8000N	A Area
2	Grey cast iron	5000N/8000N	B Area
3	1060 aluminum alloy	5000N/8000N	C Area

Table 5: Orthogonal test tables.

Serial number	Standard nozzle forgings	Standard nozzle core	Load size	Load position
1	Stainless Steel	Stainless Steel	8000N	B Area
2	Stainless Steel	Grey cast iron	8000N	B Area
3	Stainless Steel	Grey cast iron	8000N	C Area
4	Stainless Steel	1060 aluminum alloy	8000N	A Area
5	Stainless Steel	1060 aluminum alloy	8000N	B Area
6	Stainless Steel	Stainless Steel	10000N	B Area
7	Stainless Steel	Stainless Steel	10000N	C Area
8	Stainless Steel	Grey cast iron	10000N	A Area
9	Stainless Steel	Grey cast iron	10000N	B Area
10	Stainless Steel	1060 aluminum alloy	10000N	B Area

4. GENERATING GRIDS

Now we divide the key parts into a limited number of tiny units. Mesh parameter selection standard mesh, mesh size 8 mm, tolerance 0.4 mm. The finer the mesh, the more accurate the static stress analysis will be. On the contrary, the thicker the mesh, the rougher the static stress analysis will be. The grid division of key parts is shown in figure 4.



(a) Gridding of face-to-face maps for key components **(b) Left-view grid of key components**

Figure 4: Mesh of Standard Nozzle Core.

5. RESULTS ANALYSIS

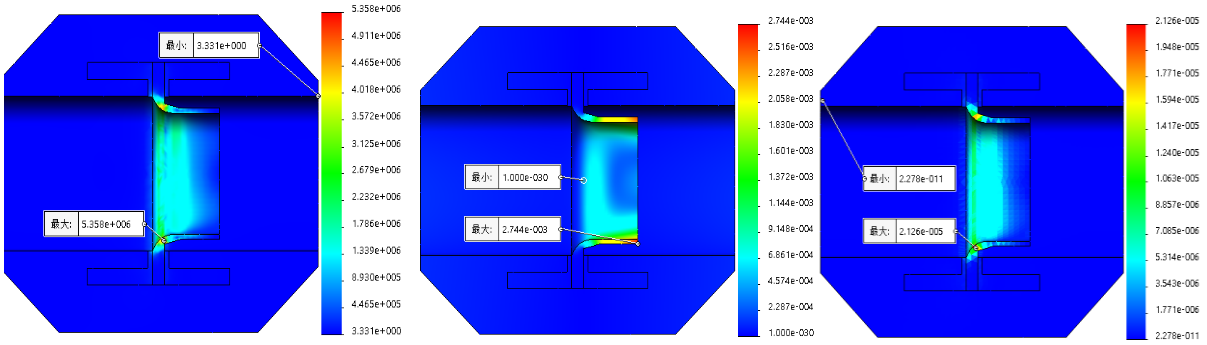
5.1 Case 1: Load N 8000

(1) Standard nozzle forging material stainless steel, standard nozzle core material stainless steel, load applied position B zone, other conditions unchanged, the standard nozzle core material selected as stainless steel ,8000 N of load applied in the B zone, running examples, get the standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 5.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig. 5(a) standard nozzle core stress diagram, The maximum stress is $5.358\times10^{6}N/\mathrm{m}^{2}$, the minimum stress occurs in the outlet plane of the standard nozzle forging, that is, the minimum stress is $3.331N/m^{2}$, yield force $1.723\times10^{8}N$。

As shown in Fig.5(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the tail end of standard nozzle core, the maximum displacement is 2.744×10^{-3}mm, the minimum displacement occurs at the median entrance of the standard nozzle core, Minimum displacement $1.0\times10^{-3}\mathrm{mm}$.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig .5(c) standard nozzle core strain diagram, the maximum strain 2.126×10^{-5}, Minimum strain occurs at the inlet plane of the standard nozzle forgings, the minimum strain is 2.278×10^{-11}.



(a) Efforts **(b) Displacement map** **(c) Strain map**

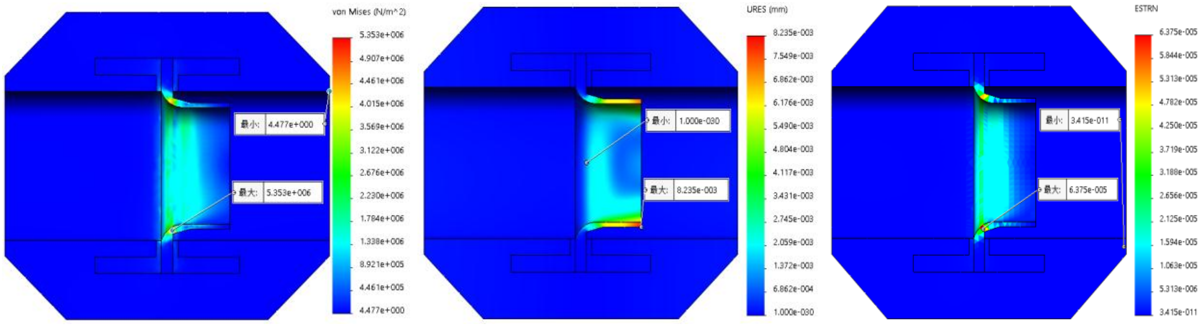
Figure 5: Analysis of results.

(2) Standard nozzle forging material stainless steel, standard nozzle core material gray cast iron, load applied position B zone, keep nozzle forging material unchanged, select standard nozzle core material as gray cast iron, apply 8000 N load to B zone, run example, get standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 6.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig. 6(a) standard nozzle core stress diagram, the maximum stress is $5.353\times10^6 N/\mathrm{m}^2$, Minimum stress occurs in the outlet plane of the standard nozzle forgings, the minimum stress is $4.477N/m^2$.

As shown in figure 6(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the end of the standard nozzle core, the maximum displacement is 8.235×10^{-3} mm, Minimum displacement occurs at the center entrance of the standard nozzle core, Minimum displacement $1.0\times10^{-3}\mathrm{mm}$.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in figure 6(c) standard nozzle core strain diagram, the maximum strain 6.375×10^{-5}, the minimum strain appears on the outlet surface of the standard nozzle forgings, the minimum strain is 3.415×10^{-11}.



(a) Efforts **(b) Displacement map** **(c) Strain map**

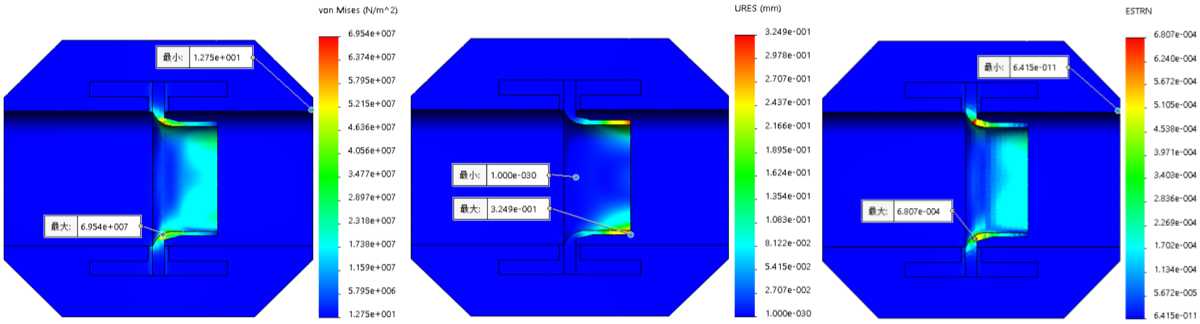
Figure 6: Analysis of results.

(3) Standard nozzle forging material stainless steel, standard nozzle core material gray cast iron, load applied position C zone, other conditions remain unchanged, the material of standard nozzle core is selected as gray cast iron, the load of 8000 N is applied to the C zone, and the operation example is given.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig. 7(a) standard nozzle core stress diagram, the maximum stress is $6.954\times10^{7} N/\mathrm{m}^2$, Minimum stress occurs in the outlet plane of the standard nozzle forgings, the minimum stress is $12.75 N/m^2$, The diagram shows that the R1 and R2 of key parts need more attention.

As shown in figure 7(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the end of the standard nozzle core, the maximum displacement is 3.249×10^{-1}mm, Minimum displacement occurs at the middle entrance of the standard nozzle core, Minimum displacement $1.0\times10^{-3}\mathrm{mm}$.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in figure 7(c) standard nozzle core strain diagram, The maximum strain 6.807×10^{-4}, the minimum strain appears on the outlet surface of the standard nozzle forgings, the minimum strain is 6.415×10^{-11}.



(a) Efforts **(b) Displacement map** **(c) Strain map**

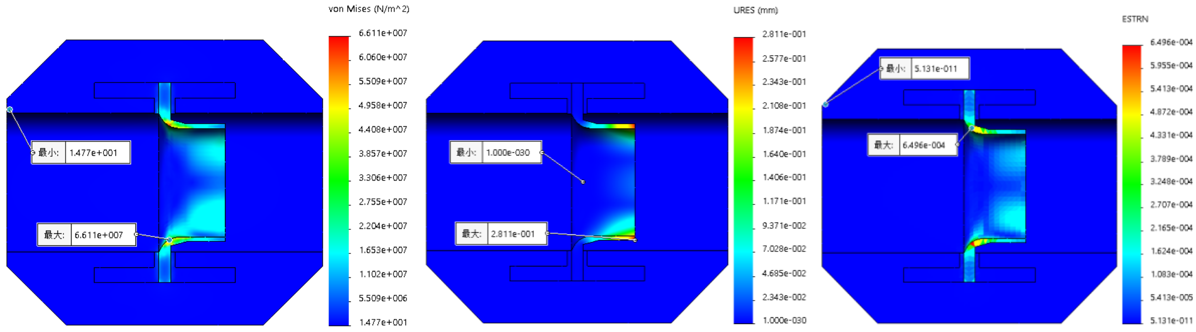
Figure 7: Analysis of results.

(4) Standard nozzle forging material stainless steel, standard nozzle core material 1060 aluminum alloy, load applied position A area, keep nozzle forging material unchanged, select standard nozzle core material as 1060 aluminum alloy, apply 8000 N load to A area, run example, get standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 8.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in figure 8(a) standard nozzle core stress diagram, the maximum stress is $6.611\times10^{7}\,N/\mathrm{m}^{2}$, Minimum stress occurs in the inlet plane of the standard nozzle forgings, the minimum stress is $14.77N/m^{2}$, From the diagram, we can see that the entrance of the standard nozzle core, that is, the small area of the B area stressed.

As shown in Fig.8(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the tail end of standard nozzle core, the maximum displacement is 2.811×10^{-1} mm, The minimum displacement occurs at the median entrance of the standard nozzle core, Minimum displacement $1.0\times10^{-3}\mathrm{mm}$, From the diagram, we can see that the end of the key parts need more attention.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in figure 8(c) standard nozzle core strain diagram, the maximum strain 6.496×10^{-4}, The minimum strain appears on the inlet surface of the standard nozzle forgings, the minimum strain is 5.131×10^{-11}, The diagram shows that the R1 and R2 of key parts need more attention。



(a) Efforts **(b) Displacement map** **(c) Strain map**

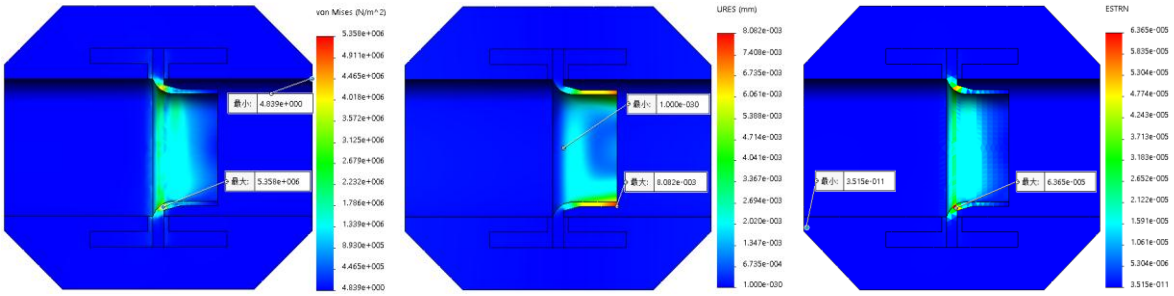
Figure 8: Analysis of Results.

(5) Standard nozzle forging material stainless steel, standard nozzle core material 1060 aluminum alloy, load applied position B area, keep nozzle forging material unchanged, select standard nozzle core material as gray cast iron, apply 8000 N load to B area, run example, get standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 9.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig .9(a) standard nozzle core stress diagram, the maximum stress is $5.358\times10^{6} N/\mathrm{m}^{2}$, Minimum stress occurs in the outlet plane of the standard nozzle forgings, the minimum stress is $4.839 N/m^{2}$. According to Fig .1-9(a), except for some changes in the stress at the entrance of the standard nozzle core, the other stresses are almost constant $4.839 N/m^{2}$.

As shown in Fig .9(b), the maximum displacement of the key parts of the nozzle Flowmeter appears at the end of the standard nozzle core, that is, the maximum displacement is 8.082×10^{-3} mm, Minimum displacement occurs at the center entrance of the standard nozzle core, Minimum displacement $1.0\times10^{-3}\mathrm{mm}$, Figure 1-9(b) shows that there are some changes in displacement except at the outlet of the standard nozzle core, the other displacements are almost constant $1.0\times10^{-3}\mathrm{mm}$.

Fig .9(c) shows that the maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, that is, the maximum strain is 6.365×10^{-5}, The minimum strain appears on the inlet surface of the standard nozzle forgings, i.e. the minimum strain is 3.515×10^{-11}.



(a) Efforts **(b) Displacement map** **(c) Strain map**

Figure 9: Analysis of results.

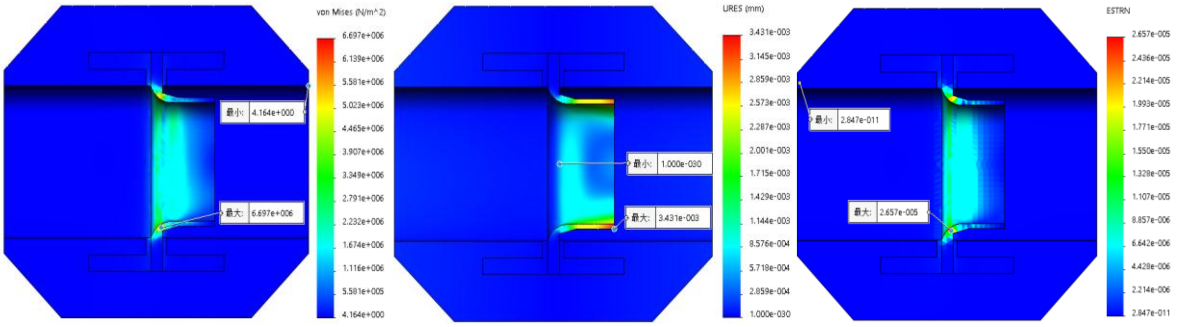
5.2 Case 3: Load N 10000

(1) standard nozzle forgings material stainless steel, standard nozzle core material stainless steel, load applied position B other conditions remain unchanged, the material of standard nozzle core is selected as stainless steel, the load of 10000 N is applied to the B area, and an example is run to obtain the standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 10.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig. 10(a) standard nozzle core stress diagram, The maximum stress is $6.697\times10^{6} N/\mathrm{m}^{2}$, The minimum stress occurs in the outlet plane of the standard nozzle forging, that is, the minimum stress is $4.164 N/m^{2}$, Its yield force is $1.723\times10^{8} N$.

As shown in Fig.10(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the tail end of standard nozzle core, The maximum displacement is 3.431×10^{-3}mm, The minimum displacement occurs at the center of the inlet of the standard nozzle core, and the minimum displacement is $1.0\times10^{-3}\mathrm{mm}$. From the diagram, the end of the standard nozzle core needs more attention when working.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in figure 10(c) standard nozzle core strain diagram, the maximum strain 2.657×10^{-5}, The minimum strain appears on the inlet surface of the standard nozzle forgings, the minimum strain is 2.847×10^{-11}. The R1 and R2 of the standard nozzle core need more attention.



(a) Efforts **(b) Displacement map** **(c) Strain map**

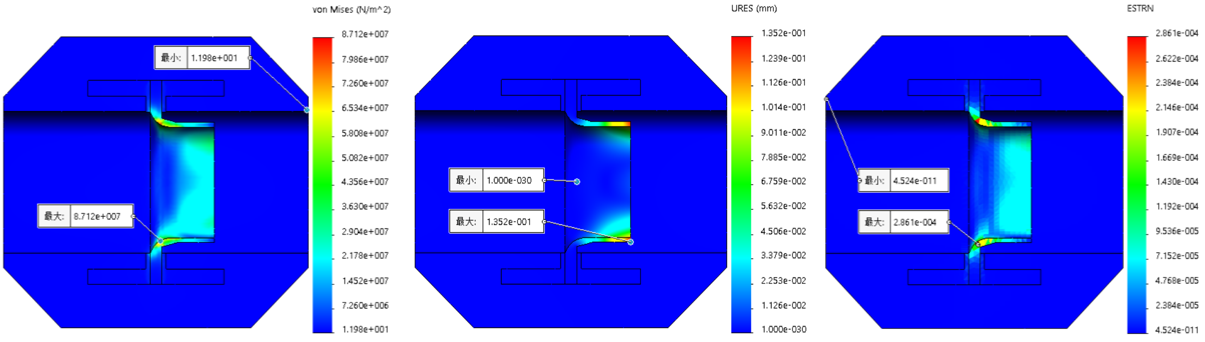
Figure 10: Analysis of results.

(2) standard nozzle forgings material stainless steel, standard nozzle core material stainless steel, load applied position C zone select both standard nozzle forgings and standard nozzle core material as stainless steel, apply 10000 N load to C zone, run an example, get standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 11.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig .11(a) standard nozzle core stress diagram, the maximum stress is $8.712\times10^{7}\,N/\mathrm{m}^{2}$, Minimum stress occurs in the outlet plane of the standard nozzle forgings, the minimum stress is $11.98N/m^{2}$, yield force $1.723\times10^{8}\,N$.

As shown in Fig. 11(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the tail end of standard nozzle core, the maximum displacement is 1.352×10^{-1}mm, The minimum displacement occurs at the positive middle entrance of the standard nozzle core, that is, the minimum displacement is $1.0\times10^{-3}\mathrm{mm}$.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig .11(c) standard nozzle core strain diagram, the maximum strain 2.861×10^{-4}, The minimum strain appears on the inlet surface of the standard nozzle forgings, The minimum strain is 4.524×10^{-11}.



(a) Efforts **(b) Displacement map** **(c) Strain map**

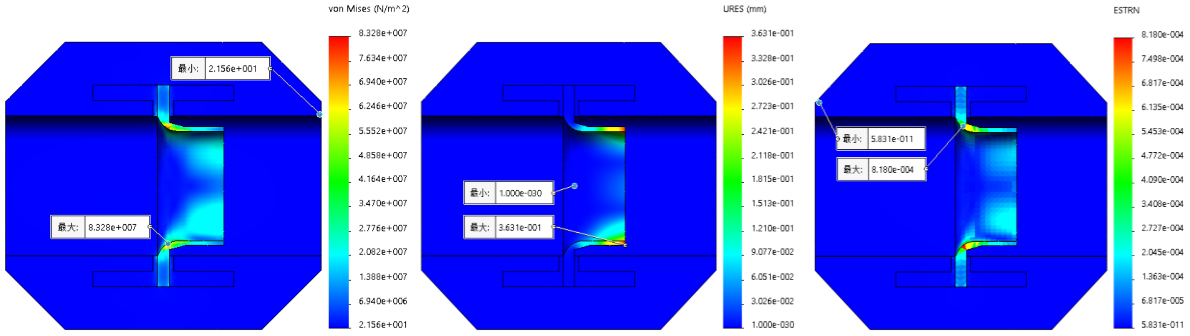
Figure 11: Analysis of results.

(3) standard nozzle forging material stainless steel, standard nozzle core material gray cast iron, load applied position A other conditions remain unchanged, the material of standard nozzle core is selected as gray cast iron, 10000 N of load is applied to the A zone, and an example is run to obtain the standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 12.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig .12(a) standard nozzle core stress diagram, the maximum stress is $8.328\times10^{7}\,N/\mathrm{m}^{2}$, Minimum stress occurs in the outlet plane of the standard nozzle forgings, the minimum stress is $21.56N/m^{2}$, The stress of the standard nozzle core also occupies half of the outlet of the standard nozzle core, mainly near the two ends of the standard nozzle core outlet, Its value is $2.082\times10^{7}\,N/m^{2}$.

As shown in Fig.12(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the tail end of standard nozzle core, the maximum displacement is 3.631×10^{-1}mm, The minimum displacement occurs at the center of the inlet of the standard nozzle core, Minimum displacement $1.0\times10^{-3}\mathrm{mm}$, The displacement change is mainly concentrated at the end of the core of the standard nozzle, but the displacement deformation is not large. If it is applied in real life, the displacement change can not be distinguished by the naked eye.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig .12(c) standard nozzle core strain diagram, the maximum strain 8.18×10^{-4}, The minimum strain appears on the inlet surface of the standard nozzle forgings, the minimum strain is 5.831×10^{-11}.



(a) Efforts **(b) Displacement map** **(c) Strain map**

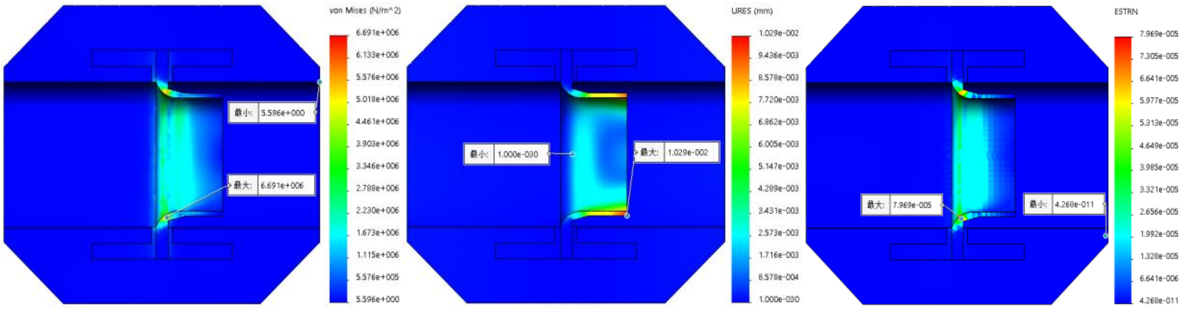
Figure 12 Analysis of results.

(4) standard nozzle forging material stainless steel, standard nozzle core material gray cast iron, load applied position B zone to keep nozzle forging material unchanged, select standard nozzle core material as gray cast iron, apply 10000 N load to B zone, run example, get standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 13.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig.13(a) standard nozzle core stress diagram, the maximum stress is $6.691\times10^{6} N/\mathrm{m}^{2}$, The minimum stress occurs on the outlet surface of the standard nozzle forging, that is, the minimum stress is $5.965 N/m^{2}$.

As shown in Fig .13(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the tail end of standard nozzle core, the maximum displacement is 1.029×10^{-2}mm, The minimum displacement appears in the middle of the standard nozzle core inlet, Minimum displacement 1.0×10^{-3}mm.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in Fig. 13(c) standard nozzle core strain diagram, the maximum strain 7.969×10^{-5}, The minimum strain appears on the outlet surface of the standard nozzle forgings, the minimum strain is 4.268×10^{-11}.



(a) Efforts **(b) Displacement map** **(c) Strain map**

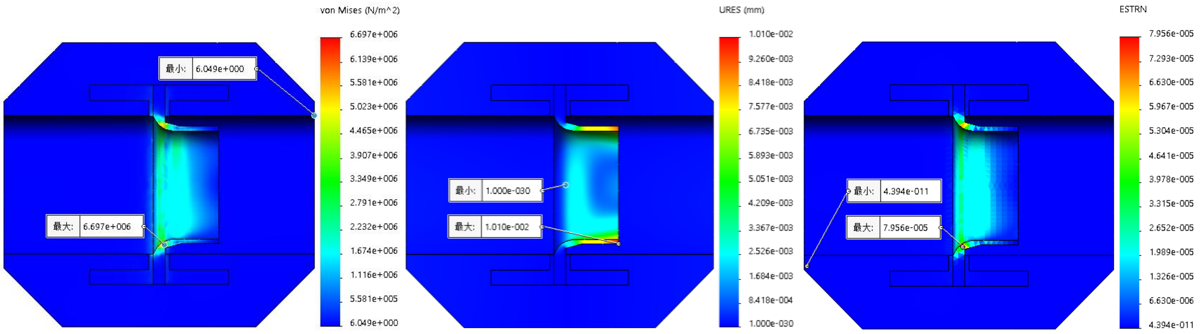
Figure 13 Analysis of results.

(5) standard nozzle forging material stainless steel, standard nozzle core material 1060 aluminum alloy, load applied position B area, keep nozzle forging material unchanged, select standard nozzle core material as 1060 aluminum alloy, apply 10000 N load to B area, run example, get standard nozzle core stress diagram, displacement diagram and strain diagram as shown in figure 14.

The maximum stress of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in figure 14(a) standard nozzle core stress diagram, the maximum stress is $6.697 \times 10^{6} N/\mathrm{m}^{2}$, Minimum stress occurs on the outlet surface of standard nozzle forgings, the minimum stress is $6.049 N/m^{2}$, It can be seen from the diagram that the stress is mainly concentrated on the standard nozzle core.

As shown in Fig.14(b) standard nozzle core displacement diagram, the maximum displacement of key parts of nozzle Flowmeter appears at the tail end of standard nozzle core, the maximum displacement is 1.01×10^{-2} mm, Minimum displacement occurs in the middle of the standard nozzle core inlet, Minimum displacement 1.0×10^{-3}mm, It can be seen from the diagram that the displacement is mainly concentrated on the standard nozzle core.

The maximum strain of the key parts of the nozzle Flowmeter appears in the position R1 the arc of the standard nozzle core is tangent to the plane inlet, as shown in figure 14(c) standard nozzle core strain diagram, the maximum strain 7.956×10^{-5}, The minimum strain appears on the inlet surface of the standard nozzle forgings, the minimum strain is 4.394×10^{-11}, It can be seen from the diagram that the strain is mainly concentrated on the standard nozzle core.



(a) Efforts **(b) Displacement map** **(c) Strain map**

Figure 14: Analysis of results.

6. CONCLUSIONS

This paper first uses the SolidWorks to model the standard nozzle, uses the simulation plug-in to establish a new example of large load, selects three different metal materials as the standard nozzle core, uses two groups of large loads of 8000 N and 10000 N, divides the standard nozzle into three regions, combines the three, and then carries on the finite element analysis to these combinations, Experimental results show that the maximum stress and strain of the key parts of the nozzle flowmeter appear in the position where the arc of the standard nozzle core is tangent R1 the plane entrance, and the minimum stress appears in the position The outlet plane of the standard nozzle forgings, the maximum displacement appears at the end of the standard nozzle core. From this we can see that the R1, R2 and tail end of the standard nozzle core need to pay more attention to the selection of casting materials and processing technology.

ACKNOWLEDGEMENTS

The work was supported by the national college students' science and technology innovation project (No. 202011488018).

REFERENCE DOCUMENTATION

1. Zhang Wenbin, Liu Weihong. A method of selecting standard nozzle is introduced[J]. Petroleum Refining Chemical Automation, 1989; 2: 44-46.
2. Ben Huiyong, Mei Yuxiao, Shi permanent. Advances in Steel Structures of Stainless Steel Composite Steel [D].Beijing: Department of Civil Engineering, Tsinghua University, 2020.
3. Cui Zhongzhi. Metals and heat treatment [M]. Beijing: Machinery Industry Press, 2011.
4. Huang Tianyou. Material processing technology [M].Beijing: Tsinghua University Press,

2004.

5. Zhang Rongshan. Statistical analysis of orthogonal test data for drug analysis [J].Journal of Neuropharmacology, 2000; 4: 13-14.