Structural Optimization Design of Automobile Engine Intake Pipe

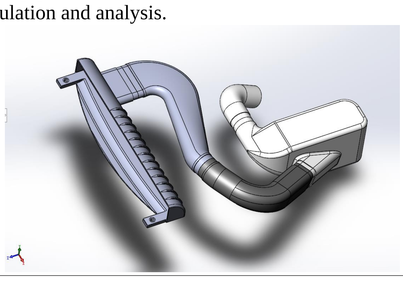
Jianxin Xie and Zimeng Liu
Qingdao Huanghai University, Qingdao 266427, China

Introduction

The engine intake pipe is an important part of the automobile intake system and the first channel to guide the air flow into the combustion chamber for mixed fuel function transformation (Li, 2018; Gao et al., 2017). Although the electronically controlled fuel injection engine simplifies the structure of the intake pipe to a certain extent and reduces the considerations in the design of the intake pipe, the structural design of its inner wall directly affects the flow law of the air flow and thus the amount of intake air (Zhang et al., 2019, Yi et al., 2018; Wahono et al., 2019). When designing the intake pipe, in addition to considering the performance requirements of different engines, we should also pay attention to the economy and emission of the engine, and consider the atomization and evaporation effect of fuel and fuel distribution. Therefore, the design of engine intake pipe should be considered in many aspects and coordinated in many aspects. According to the flow law of air in the intake pipe of the engine, measures are taken to improve the charging efficiency, improve the uniformity of intake air, and make the engine better match with the intake pipe (Dhital et al., 2019; Karthickeyan, 2019; Khoa and Lim, 2019).

Establishment of intake pipe model

Using parametric modeling, firstly, this paper selects SolidWorks as the three-dimensional model modeling software, uses SolidWorks to establish parts, establishes a single intake pipe part through parameters, and uses the cooperation steps in SolidWorks to assemble the intake pipe assembly for numerical simulation calculation and analysis.



Simulation Analysis of intake pipe

1. Velocity contour analysis

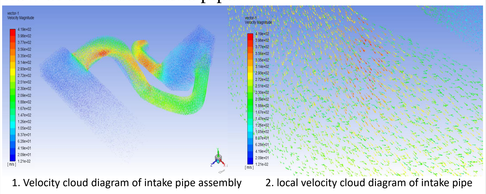
Based on the perfect creation of three-dimensional model, accurate meshing of fluid control domain, accurate setting of fluid domain boundary value and correct fluid physical parameters, the numerical simulation of fluid control domain is carried out with the help of fluent module of ANSYS software according to the calculation method given in Chapter 2.

2. Pressure cloud analysis

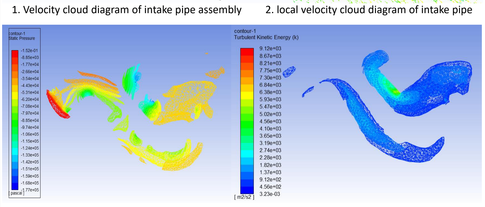
Under the cloud image option in fluent of ANSYS, find the pressure cloud image and analyze the pressure cloud image of the intake air flow in the engine intake pipe

3. Turbulent flow energy analysis

Turbulent kinetic energy is a kind of flow potential energy generated by the swirling inertia of the air flow in the intake process of the intake pipe . Turbulent kinetic energy is divided into turbulent component kinetic energy and total turbulent kinetic energy. In the engine combustion chamber, intake turbulence can increase the mixing degree of combustible mixture, but in the intake pipe, larger intake turbulence is more likely to cause intake turbulence, which is not conducive to the rapid flow of air in the intake pipe.



1. Velocity cloud diagram of intake pipe assembly　2. local velocity cloud diagram of intake pipe



3. Pressure cloud of intake pipe　4.Cloud diagram of inlet turbulence

Analysis and improvement of intake pipe structure

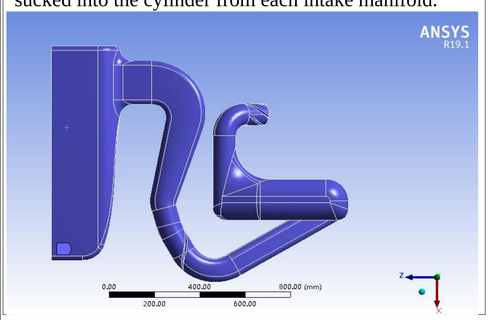
Improvement measures for intake pipe

1.An appropriate vortex guide groove is applied at the sharp bend in the middle of the pipe. To help the air take the central axis of the pipe as the rotation center, and use the rotation of vortex to quickly pass through the curved pipe to reduce the generation of turbulence or turbulence.

2. Guide and optimize the inlet of the engine intake pipe.Modify the inner wall of the inlet of the intake pipe to a fillet with a radius of 100mm inclined to the direction of the narrow inlet of the intake pipe, and pass it with a smooth and smooth curve, so as to help the vehicle obtain more air brought by the oncoming wind during driving. At the same time, the air inlet obstruction caused by edges and corners is reduced. the narrow inlet of the engine intake pipe is set with a radius of 60mm, and the fillet is optimized to increase the inlet area, increase the fluency of the upwind intake and reduce the intake resistance.

3.The improvement of the filter housing. The excessive fillet improvement is cancelled at the inlet of the filter to provide necessary airflow guidance support to help the airflow smoothly enter the air filter. Large arc fillets with a half diameter of 150mm and 100mm are added on the air filter housing to help the airflow change direction and achieve the purpose of rapid filtration.

4.A vortex guide groove is applied at the inlet of the pressure stabilizing chamber of the intake pipe . So that the intake air flow enters the large angle curved pipe in front of the pressure stabilizing chamber in the form of vortex under the action of the guide groove, so as to improve the flow rate of the intake air into the pressure stabilizing chamber, and then increase the flow rate of the air into the intake manifold, so that the air is quickly sucked into the cylinder from each intake manifold.



Conclusion

In this paper, The fluent module of ANSYS is used to simulate and analyze the air flow state of the engine intake pipe, and the deficiencies in the design of the existing engine intake pipe are found out: apply appropriate fillet improvement for the pipe with too large angle; Where there is a lack of necessary support or excessive fillet, the fillet improvement shall be cancelled or reduced, and the position of the air inlet shall be surrounded by the inner wall of the pipe as far as possible to increase the pressure effect of the facing air flow; The innovation puts forward the improvement measure of setting a guide groove at the position with too large angle to help the intake air flow pass through the intake pipe bend quickly and evenly, and establishes the three-dimensional model of the improved intake pipe fluid control domain. Through simulation and comparative analysis, the optimized engine intake pipe has good intake response, which is more conducive to the engine to inhale more air in a short time. The maximum and low speeds in the intake pipe are increased by 106m / s and 0.01m/s respectively, and the air intake per unit time is increased by 0.4kg/s. The cross-sectional velocity distribution perpendicular to the pipe wall is more uniform, which improves the intake efficiency of the intake pipe.