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External Meshing Gear Pump Internal Flow Field Simulation as The Object of Artificial Intelligence Teaching Assistant Assisted Classroom Cases to Expand the Teaching and Research Mode

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Abstract This paper takes the classroom case of artificial intelligence teaching assistant assistance as the core goal of expanding the teaching and research mode innovation, and conducts practical research on the typical engineering case of internal flow field simulation of external meshing gear pump. In order to build an intelligent case resource system suitable for professional course teaching, Fluent software is used to simulate the flow field, establish a refined model through hexahedral grid division, and systematically explore the internal liquid flow characteristics and pressure distribution laws. Based on this achievement, this paper focuses on exploring the application path of artificial intelligence teaching assistants in the whole process of case teaching, and constructs a closed-loop teaching and research model of "simulation case development, intelligent teaching assistant push, and teaching feedback optimization" in view of the lag in case update, low resource reuse rate, and insufficient technical empowerment in professional course teaching and research. This research not only provides a theoretical basis for the optimal design of external meshing gear pumps, but also forms a generalizable professional course case to expand the teaching and research paradigm through the deep integration of engineering cases and artificial intelligence teaching assistants, and provides practical reference for the intelligent teaching reform and teaching and research model innovation of higher engineering education.

Keywords: artificial intelligence teaching assistant; classroom case expansion; innovation in teaching and research models; external meshing gear pump; Engineering simulation transformation

1 INTRODUCTION

The external meshing gear pump is an important power element of the hydraulic system, mainly relying on the change of working volume formed between the pump cylinder and the meshing gear to transport liquid or increase its pressurization, with the advantages of simple structure, convenient maintenance, strong self-priming ability, insensitivity to oil pollution, etc., widely used in metallurgy, mining machinery, aerospace and deep sea exploration and many other fields, but at the same time it also has disadvantages such as leakage, oil trap and radial unbalance. The internal flow field of the external meshing gear pump is more complex. Therefore, this paper analyzes the flow and pressure distribution of the internal flow field of the external meshing gear pump based on Fluent (computational fluid dynamics software) to provide a reference for the optimization of the pump structure and the design of the new gear pump [1].

In the context of the current digital transformation of education, although the application exploration of artificial intelligence teaching assistants in teaching scenarios has made preliminary progress, there are still significant shortcomings in the level of classroom case expansion teaching and research mode. Existing research mostly focuses on the functional realization of artificial intelligence teaching assistants in basic teaching links such as answering questions and correcting homework, and their in-depth involvement in the development of case teaching resources, dynamic expansion, and teaching and research model

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innovation is insufficient. In the traditional teaching and research model, the case expansion of professional courses often relies on the accumulation of individual experience of teachers, and there are problems such as lagging case update, weak pertinence, and low resource reuse rate, while artificial intelligence technology has not yet formed a teaching and research mechanism that is deeply integrated with the whole process of case expansion. In addition, for key links such as intelligent case generation, adaptability push of learning conditions, and closed-loop evaluation of teaching effects of complex engineering cases (such as internal flow field simulation of external meshing gear pumps), there is a lack of systematic teaching and research model design, which makes it difficult for the technical advantages of artificial intelligence teaching assistants to be transformed into the core driving force for teaching quality improvement.

Carrying out classroom case expansion teaching and research models assisted by artificial intelligence teaching assistants has distinct necessity and practical value of the times. On the one hand, with the acceleration of knowledge update in professional fields such as intelligent manufacturing and fluid mechanics, traditional case teaching is difficult to meet students' needs for the cultivation of complex engineering problem analysis ability, and it is urgent to build a dynamic and accurate case expansion system with the help of artificial intelligence technology. On the other hand, the current teaching and research of professional courses in colleges and universities generally face pain points such as high case resource development costs, insufficient technical application ability of teachers, and poor timeliness of teaching feedback. From the perspective of teaching and research reform, this study helps to build a closed-loop mechanism of "technology empowerment, case innovation, and model upgrading", promotes the transformation of professional course teaching from experience-driven to data-driven, and provides a replicable teaching and research paradigm for the intelligent development of complex case teaching in higher engineering education.

2 Simulation Of The Internal Flow Field Of The External Meshing Gear Pump

2.1 Working Principle And Basic Parameters Of Gear Pump

The external meshing gear pump consists of a front and rear end cap and a housing. The casing is equipped with a pair of conjugated meshing gears, with the same number of teeth and the same modulus, which forms a sealing volume cavity between the two end covers of the pump and the pump body, and the sealing cavity is divided into two parts that are not connected to each other, namely the oil suction cavity and the oil pressure cavity, as shown in Figure 1

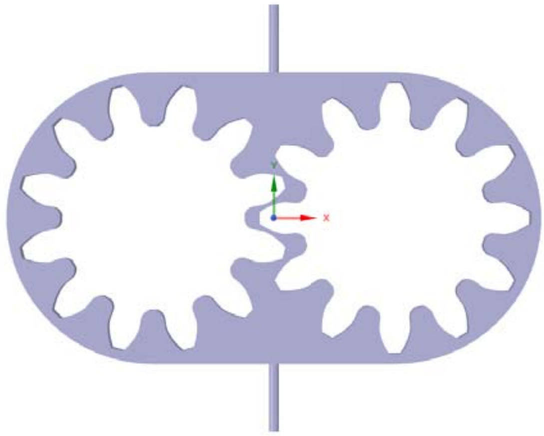

FIGURE 1 STRUCTURAL DIAGRAM OF GEAR PUMP

2.2 Simulation Analysis Of The Internal Flow Field Of An External Meshing Gear Pump Based On Fluent.

When the gear rotates, the negative pressure generated by the oil suction port sucks in the low-pressure oil and fills the oil suction cavity surrounded by the gear profile, and is brought from the low-pressure part to the high-pressure part along the shell with the rotation of the gear, and finally discharged from the oil discharge port when the two gears are engaged again. The end face of the two sides of the internal gear is in almost no gap contact with the end cover of the pump body and the top of the tooth and the wall of the shell.

When the active gear of the gear pump rotates counterclockwise, the teeth on the upper side of the gear pump gradually disengage and engage, so that the volume of the sealing volume cavity gradually increases, forming a local vacuum, that is, forming an oil suction cavity, and the oil in the oil tank enters the oil suction cavity through the oil pipe under the action of external atmospheric pressure. Then with the rotation of the gear, the oil between the cogging is brought to the left side and enters the oil drain cavity, at this time, the gear teeth gradually enter the meshing to gradually reduce the volume of the lower side, and the pressure in the cavity increases, forcing the pressure oil between the cogging into the hydraulic system. The motor of the external meshing gear pump has a rated speed of 3000r/min and a pressure of 5MPa. The gear modulus is 3.5, the number of teeth is 12, the indexing circle diameter of the gear is 42mm, and the tooth thickness is 3mm.

2.3 Steady-State Simulation Of Trapped Oil Pressure Of External Meshing Gear Pump

2.3.1 Model Building

According to the parameters shown in Table 1, a pair of external meshing gears and housings of the gear pump were modeled and assembled using SOLIDWORKS 3D drawing software, and the

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volume of the fluid region simulated by the gear pump in Fluent was extracted in SOLIDWORKS for subsequent meshing [3].

TABLE 1 GEAR PUMP PARAMETER TABLE

	Numbe r of	modulu s	Teet h are	Tooth top height	Top gap coefficien
Gea r 1	12	3.5	3mm	1	0.25
Gea r 2	12	3.5	3mm	1	0.25

The 3D model is shown in Figure 2.

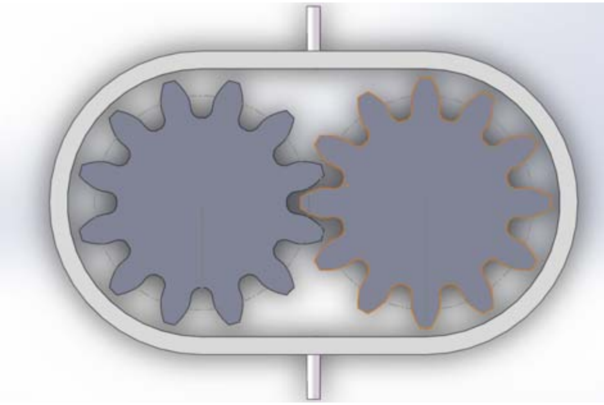

FIGURE 2 THREE-DIMENSIONAL MODEL OF THE GEAR PUMP

2.3.2 *SIMULATION CONDITIONS*

Import the 3D model into Fluent for volume extraction, and after the extraction is completed, divide the mesh, the mesh size is 1mm, and pay attention to the parameter of Skewness in MeshMetric, the maximum distortion of the mesh is controlled below 0.8, and the size of the mesh size is continuously adjusted according to the size of its value, so that the mesh can be better optimized[2] . The inlet condition is set to the speed inlet, the inlet speed is 10m/s, the pressure is 1.01325MPa, the outlet condition is set to the pressure outlet, the outlet pressure is set to 5MPa, and the fluid viscosity is set to 0.001003mm/s. The parameters of the simulation are shown in Table 2.

TABLE 2 THE PARAMETERS OF THE SIMULATION

method	size	unit
Hex Dominant	1	mm

3 ANALYSIS OF THE SIMULATION

RESULTS OF THE INTERNAL FLOW FIELD OF THE EXTERNAL MESHING GEAR PUMP

To get steady-state pressure distribution cloud map, the grid cell size is 1mm and the step size is 1, and the pressure distribution cloud of the gear pump is obtained.

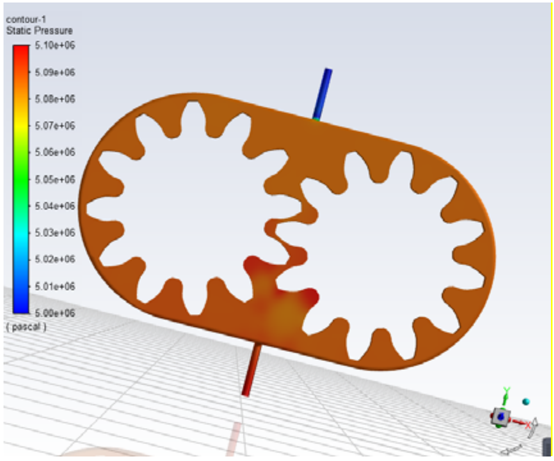

FIGURE 3 PRESSURE DISTRIBUTION CLOUD MAP

Set the grid element size to 1mm and the step size to 1, and obtain the trace diagram of the gear pump.

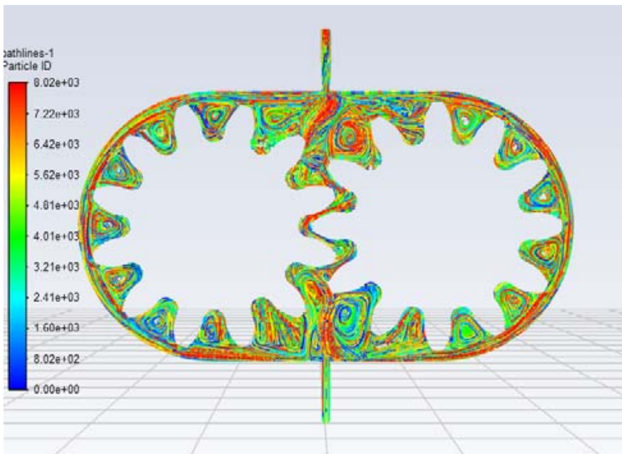

FIGURE 4 TRACE MAP

4 CONCLUSION

In this study, the liquid flow law and pressure distribution characteristics obtained by the simulation of the internal flow field of the external meshing gear pump provide solid engineering practice support for the classroom case expansion of the teaching and research mode assisted by artificial intelligence teaching assistants. The simulation results show that the liquid enters the interdental space driven by the pressure difference and is transported to the discharge cavity with the rotation of the gear, and the volume between the teeth at the meshing is reduced to achieve liquid discharge, and the pressure at the oil inlet is the smallest, the pressure at the meshing is the largest, and the pressure at the oil outlet is higher than that at the oil inlet and is affected by the viscosity of the liquid. From the perspective of teaching and research model innovation, the above simulation conclusions can be transformed into hierarchical and progressive teaching case resources through artificial intelligence teaching assistants: constructing a visual teaching module based on pressure distribution data, designing interactive inquiry tasks combined with the influence law of viscosity, and developing a case push system based on the flow mechanism. This closed-loop mechanism of "simulation conclusion - case transformation - intelligent push" effectively solves the problem of static and insufficient adaptability of traditional professional course cases, and verifies the technical feasibility of artificial intelligence teaching assistant in the expansion of complex engineering cases. The research results not only enrich the teaching case library of external meshing gear pumps, but also construct an intelligent teaching and research path for the transformation of engineering simulation results into teaching resources, and provide a generalizable model example for the deep integration of theoretical teaching and practical innovation in higher engineering education.

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