

Study on Virtual Assembly and Disassembly Technology in Practical Teaching of Fuel Injector of Marine Auxiliary Boiler

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Abstract—The fuel injector of marine auxiliary boiler burner was taken as the research object in this paper. Firstly the UG NX_8.5 software was used to establish the 3D model of the boiler injector and related components, then the virtual assembly and disassembly system of the boiler injector was researched and developed according to the actual teaching process. In the developed system, the virtual assembly and disassembly sequence, and integral assembly and disassembly of the injector were realized, which can be operated repeatedly, meet the requirements of practical teaching, and also be used for classroom teaching demonstration.

Keywords—marine auxiliary boiler; fuel injector; solid modeling; virtual assembly and disassembly

I. INTRODUCTION

The electrical principle, assembly and disassembly of the marine auxiliary boiler fuel injector are professional contents which must be mastered by the students of marine engineering, marine electrical and electronic engineering and related majors. In the routine practice teaching and training, there are many students to participate in the assembly and disassembly training, due to the limit of number of experimental sites and equipment, it is difficult to ensure that each student can get enough and effective training time. However, the technology of virtual assembly and disassembly training has the advantages of safety, multi-person unlimited training, and training at any time etc. It can enable students to simulate the assembly and disassembly training of real equipment in the virtual environment, to meet the students' multiple orientations. Moreover, this method has a wider application range and is not limited by the venue. It can meet the daily teaching requirements with less investment and is conducive to improve the teaching quality and effect.

II. INTRODUCTION OF MARINE AUXILIARY BOILER INJECTOR

A. Basic Types of Marine Auxiliary Boiler Injectors

At present, the fuel injectors commonly used in marine auxiliary boilers can be divided into three types, namely: steam atomization type, mechanical atomization type and ultrasonic atomization type according to the principle of fuel atomization.

the fuel injector, which uses the high-speed movement of steam to atomize the fuel, is called a steam injector. The device which uses the sound waves of high-frequency vibration to atomize the fuel is called an ultrasonic atomizing injector. In the absence of any atomizing agent, the fuel gets energy from oil pressure or rotating equipment and then sprays out from the nozzle is called a mechanical injector. Mechanical injectors can also be divided into three types, namely: centrifugal type, direct-flow type and rotary-cup type. The centrifugal type of injector concludes of simple centrifugal type and oil returning type. This paper takes a simple centrifugal injector as the research object.

B. Composition and Working Principle of Simple Centrifugal Injector

The simple centrifugal injector is mainly composed of a compression nut, a core, an atomizing sheet, a strainer and a fuel injector body. The main component for achieving fuel atomization is the atomizing sheet, which is composed of a tangential passage, a swirl chamber, a spout, and the like. Simple centrifugal injector is shown in Figure 1.

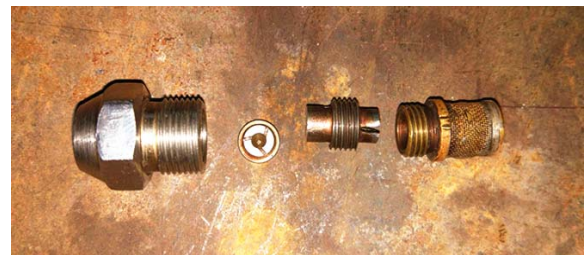


FIGURE 1. THE NOZZLE OF SIMPLE CENTRIFUGAL INJECTOR

The working principle of the simple centrifugal injector is that the fuel enters the injector body from the high pressure oil pipe, flows through the filter and enters the T-shaped passage in the core, then flows from both sides of the T-shaped passage to the outer wall of the core. The core and the atomizing sheet are tightly pressed together, and a chamber is provided between the outer wall of the core and the upper end portion of the atomizing sheet, high-pressure fuel flows therein, by way of the tangential groove on the atomizing sheet enters the conical vortex chamber, then the high-pressure fuel flows with rotating into the center of the swirl chamber, at last sprays out from the

orifice of injector. After the oil is discharged from the center of the injector orifice, it will be atomized into fine oil droplets immediately due to centrifugal force.

When the oil mist sprayed enters the combustion chamber, the primary air is supplied to the combustion chamber through small holes distributed in the air distributor and the secondary air enters the combustion chamber through the fixed slicing channel of the air distributor to supply sufficient oxygen and ensure good combustion, so as to avoid that a large amount of carbon deposits generates because of incomplete combustion. By adjusting the position of the pull-up lever of air distributor, the shape and angle of the flame can be changed.

III. 3D MODEL OF MARINE AUXILIARY BOILER INJECTOR

A. Introduction of 3D Modeling Software

This paper uses UG NX_8.5 software for modeling. UG NX was developed by Siemens PLM Software in 1969 to build solid model in 2D and 3D based on C language. UG is widely used in engineering fields such as automotive, aerospace, general machinery, transportation, electronics etc..

B. Entity Modeling Principles

- Model simplification. In order to improve drawing efficiency and ease the later optimization of model created, under the condition of not affecting the vision and the external characteristics of the object, the number of edges of complex graphics is minimized to simplify the model[1].
- The reference plane is single. The sketches can be created according to the specified coordinates, it is conducive to assembly components of model in three-dimensional virtual scene and reduce the redundancy process of the separately re-established coordinate system, and is also beneficial to improve the running speed of the virtual simulation system.
- Maintain a certain distance between surfaces. If the spacing between the surfaces of the two 3D models is too small, when the surfaces of the two models are drawn in real time in the virtual scene, the two surfaces will alternately appear with flash. The two surfaces should remain at least 2 mm.

C. Entity Modeling Steps

The creation of the solid model is mainly divided into three steps: processing of measurement parameters, modeling and post-optimization procedure[2]. The processing of measurement parameters mainly includes measuring the size of each part of the model and collecting the surface texture, material, color and assembly position of the model. After the basic solid modeling is completed, the next step is to optimize the other features of the modeling. The injector body model is shown in the Figure 2.



FIGURE II. THE INJECTOR BODY

D. 3D Model Display

The overall model of the injector is shown as Figure 3.

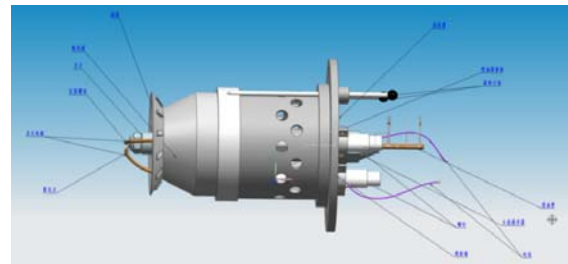


FIGURE III. OVERALL MODEL OF THE INJECTOR

IV. RESEARCH AND DEVELOPMENT OF FUEL INJECTOR VIRTUAL ASSEMBLY AND DISASSEMBLY SYSTEM

A. Virtual Assembly and Disassembly Plan

The development of the virtual assembly and disassembly system uses assembly modeling application module of the CAD(Computer Aided Design) and motion simulation module of the CAE(Computer Aided Engineering).

1) *Application Module of Assembly Modeling:* The assembly modeling application module is part of the CAD module and is mainly used for virtual assembly of the product. According to the assembly tools provided by the module, users can quickly assemble the required components into a whole. The assembly constraints can link the components in the system together, if one component changes, the other component with constraint relationship will change accordingly. UG supports three assembly methods, namely: "bottom up" "top down" and "hybrid assembly"

2) *Motion Simulation Module:* The motion simulation module is an application program in CAE module, which is used to establish a motion mechanism model and analyze the motion laws and motion policies between components. It is mainly used to analyze the interference between the mechanisms, track the movement track of the parts, analyze the moment, acting force, reaction force, speed and acceleration among the parts, so that designers can more clearly analyze the simulation results and make corresponding adjustments.

B. Features of Virtual Assembly and Disassembly Training System

In this paper, a virtual assembly and disassembly training system of marine auxiliary boiler fuel injector is built by use of

UG on the basis of solid model, this training system is mainly composed of the following aspects:

- Assembly of parts. Each component of the injector has its own relative position, The components created can be virtual assembled by use of UG with reference to the real component of the injector so as to realize the manual assembly process from the part to the whole.
- Assembly and disassembly in logical sequence. By use of the assembly sequence function in the UG assembly module, the established model can be made to follow the physical disassembly sequence. Using the operation handle in the scene motion, the model components can be moved according to the set trajectory, and the three-dimensional handle is used for secondary processing, so that the virtual motion of each component of the model can be more realistic, thereby realizing the virtual assembly and disassembly of the model of boiler injector.
- Integral assembly and disassembly. In the motion simulation environment, the dynamics is used as the engine, and the whole animation demonstration is carried out for each component which needs relative displacement [3].
- System Published. It can use UG to export the completed animation into a movie, then select the animation format to be released according to needs, and select Export Movie from File in menu bar, lastly select the movie format in the pop-up dialog box to generate files that can run independently on different platforms.

C. Implementation of Virtual Assembly and Disassembly

Virtual assembly and disassembly is an important part of animation. It mainly uses computer-aided software and related computer hardwares to build a visual and operable virtual system on a computer. It can greatly shorten the time of physical assembly and disassembly, and can also reduce the risk of physical assembly and disassembly, therefore combined with the training of virtual assembly and disassembly, the quality and efficiency of practical teaching of physical assembly and disassembly can be improved[4].

The assembly method includes bottom-up assembly, top-down assembly and hybrid assembly. The hybrid assembly method is adopted in this paper. In the assembly process, the positioning relationship between the components is usually specified by use of the positioning method of the assembly constraints. Assembly constraints are used to limit the freedom of assembly components, which includes of linear degrees of freedom and rotational degrees of freedom. According to the limiting degrees of freedom by the pairing constraint, the assembly constraints can be divided into two categories, amely: full constraint and under constraint. Assembly of components into a complete model in UG is mainly achieved by use of the constraint commands in the assembly environment, which can be used to establish one or several links between the components, which mainly includes of the physical positional

relationship and movement relationship between the components. In addition, components can be quickly assembled in UG, moreover, the relation design of the components can be achieved also during the assembly process. After the assembly model is generated, an exploded view can be created to display the various components in the same view frame. The assembly drawing function of the software can be used to automatically generate the assembly schedule and be able to conduct the local sectioning of the isometric drawing.

The constraint relationship between the assembled components can follow the corresponding components, and there is a certain correlation between all the assembled components. If the properties of the individual component are modified, the corresponding constraint relationship still exists.

The prepared single-step disassembly animation and the whole disassembly animation could be exported into movie format, as shown in Figure 4 and Figure 5, which can be used for classroom teaching and demonstration. Users can understand the logical structure of physical parts more deeply and truly by use of the disassembly animation, which can be used to further improve their practical operation ability of physical assembly and disassembly.

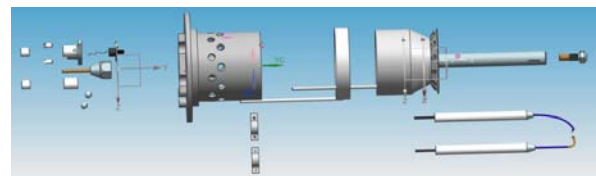


FIGURE IV. OVERALL ASSEMBLY AND DISASSEMBLY EFFECT

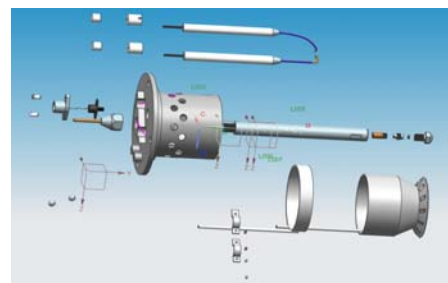


FIGURE V. SINGLE-STEP ASSEMBLY AND DISASSEMBLY EFFECT

V. CONCLUSIONS

In this paper, the marine auxiliary boiler injector is selected as the research object, and the three-dimensional model of the auxiliary boiler injector is established by using UG NX_8.5. On this basis, the virtual assembly and disassembly system of the injector is researched and developed. The system can be used not only for training of assembly and disassembly, but for the purpose of practical teaching. In addition, it can also be used for classroom teaching demonstration or auxiliary teaching, which reduces the cost of facilities and equipment investment and maintenance, broadens the teaching methods and improves the teaching effect.

ACKNOWLEDGMENT

The authors thank the third batch of Provincial Application-oriented Pilot Undergraduate Transformation Major Construction Projects of Hainan Tropical Ocean University for fund support.

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