

## Teaching Model Design of Gas-gas Jet Pump

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**Abstract.** As a common vacuum pump for the transportation of solids, liquids and gases, jet pump is widely utilized in the fields of water conversance, electric power, metallurgy, chemical engineering, environment protection and fire protection. The structure and working principle of jet pump is always the emphasis of the teaching of fire protection technology and equipment. Using teaching model of jet jump, the whole inner structure and the operation process of the machine can be demonstrated easily and repeatedly, which can make students understand the working principle and process of jet pump better.

### Introduction

Jet pump is commonly used for the transportation of solids, liquids and gases in the fields of water conversance, electric power, metallurgy, chemical engineering, environment protection and fire protection. At present, the working principles of many fire equipments, such as foam proportional mixer, low expansion foam generator, foam gun, ejector primer pump, exhaust-haustillum and so on, are as the same as that of jet pump. Thus, the structure and working principle of jet pump is the teaching emphasis of the lessons about fire technologies and equipments.

**Present situation and problems in the teaching of jet pump.** Nowadays, the teaching type of jet pump is mainly lecture, in which the inside structure, working principle, operation process of jet pump are always lectured in the styles of functional diagram, profile and process chart. Although some practical teaching has been arranged in the teaching process, it is still difficult to carry out the practical teaching due to the limitations of teaching place, teaching staff, vehicles and placement of teachers etc. Consequently, due to the present teaching style, the perceptual knowledge of students about jet pump is deficient and the teaching effect is not good.

On the other hand, the jet pump model used in teaching as model is always made of non-transparent stainless steel, so it is impossible for students to see the inner structure and the operation process from the outside. Furthermore, the present jet pump model is generally water jet pump with a water pump or steam jet pump with a steam generator, which has large volume and is inconvenient to carry out spot demonstration indoor. Thus, the teaching effect is reduced by the deficient perceptual knowledge of students about the working principle of the jet pump.

However, with visual jet pump model in teaching, not only the inner structure and the operation process of jet pump can be demonstrated completely, but also the demonstration can be repeated conveniently. As a result, the students understand the jet pump better. Therefore, it is necessary to design, research and produce a new visual jet pump model for teaching.

**Structure of gas-gas jet pump teaching model.** The structure of gas-gas jet pump is shown in Figure 1. In Figure 1, it can be seen that the model is composed of two gas generators (1 and 4), two gas chambers (2 and 5), gate valve, gas input pipe, sucker, diffuser, connector, gas output pipe and

the main part of jet pump (3).

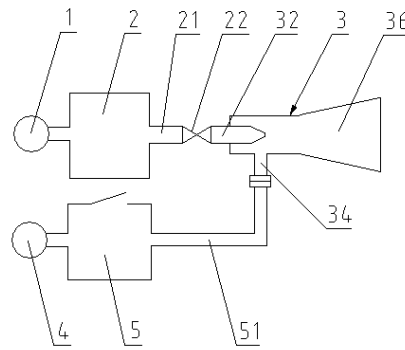


Figure. 1 Structure of gas-gas jet pump teaching model

1-gas generator I; 2-gas chamber I; 21- gas output pipe;  
22-gate valve; 3-jet pump; 32-gas input pipe; 34-sucker; 36-diffuser;  
4-gas generator II, 5-gas chamber II, 51-connector

The working principle and the operation process of the gas-gas jet pump are as follows: The first kind of colorful gas produced in the gas generator I(1), and after reaching a certain pressure in gas chamber I(2), the gate valve is opened and the colorful gas can be jetted at high speed from nozzle(33) and drive away the air around nozzle to produce a certain vacuum value. The second kind of colorful gas produced in gas generator II(4) is stored in gas chamber II(5) which is connected with the environment and has a atmospheric pressure. When the vacuum around nozzle has been produced, the second kind of colorful gas can be sucked and mixed with the first kind of colorful gas in diffuser(36) automatically before reaching the output.

The structure of jet pump, which is the main part of the teaching model, is shown in Figure 2.

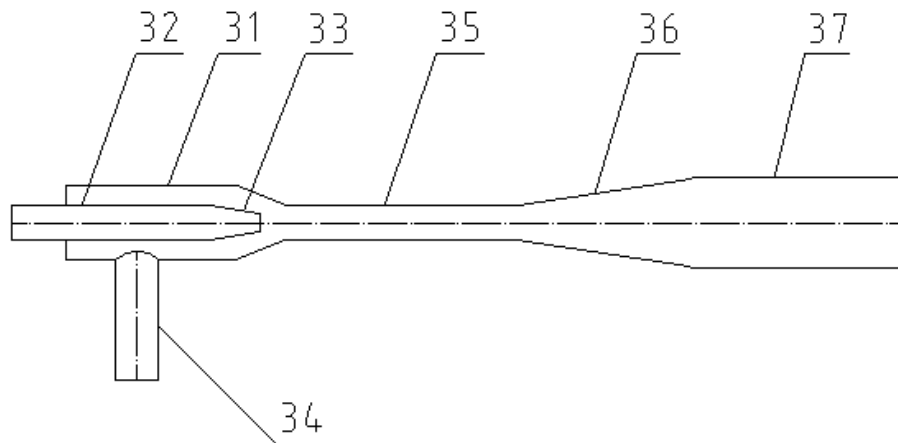


Figure 2. Structure of jet pump

31-throat sucker pipe; 32-input pipe; 33-nozzle;  
34-sucker, 35-throat, 36-diffuser, 37-output pipe

As shown in Figure 2, there is a throat sucker pipe(31) in jet pump which has a concentric input pipe(32) inside. One end of the input pipe is just out of the endwall of the sucker pipe, and the other end has a nozzle. The external diameter of the input pipe is smaller than the inner diameter of the throat sucker pipe. There is a sucker(34) in the inner wall of the throat sucker pipe. The front end of throat(35) is connected with the throat sucker pipe, and the back end is connected with diffuser(36). The inner diameter of the diffuser increases with the distance from the throat. The back end of the diffuser is connected with output pipe.

## Design of gas-gas jet pump teaching model.

**About Gas generator and gas chamber.** Enough amount of colorful gas I should be produced by gas generator I(with CO<sub>2</sub> dry ice) and stored in gas chamber I which is connected with a gas output pipe having a gate valve. When the pressure in gas chamber I reaches certain value(3~4 atmospheric pressure), the gate valve is opened to charge the gas in chamber I into the input pipe quickly. The requirements of design are as follows: In order to observe conveniently, the gas should have some color with or without pretreatment. The chamber should bear certain pressure. The gas produced in generator I should be transported under sealing condition to prevent environmental pollution or harm to the health of the staff and students. The model should be operated easily and repeatedly, and portable for demonstration at different places.

Enough amount of colorful gas II should be produced by gas generator II(with tobacco pad to produce a red gas) and stored in gas chamber II which is connected with atmosphere and with jet pump using connector pipe. When the gate valve is opened, the gas in chamber I can be charged into jet pump through nozzle with the help of high pressure and form a vacuum around nozzle which leads to the gas can be sucked into the jet pump through the connecting pipe. The requirements of design are as follows: In order to observe conveniently, the gas should have some color with or without pretreatment. The chamber should be connected with the atmosphere. The gas produced in generator II should not have either environmental pollution nor harm to the health of the staff and students. The model should be operated easily and repeatedly, and portable for demonstration at different places.

**About Jet pump.**To the convenience of the observation of students, the jet pump should be made of transparent materials and the inner structure can be observed without dismantling. The mixing and following of two different gases with different colors should be observed clearly, so the working principle and the operation process. of the jet pump can be understood well by students. The requirements of design are as follows: The materials should be transparent. The area ratio of the round nozzle(33) to the throat(35) should be 0.28~0.3 to get a relative high efficiency of jet pump, when the jetting velocity at the nozzle is 2.0~3.2 L/s, the demonstration effect of the model is the best.

## Conclusion

Due to the spot demonstration of the teaching model, not only the perceptual knowledge but also the cognitive ability of students about the jet pump can be improved greatly. Meanwhile, students can operate the model in person, the interest and the passion of study can be increased through indoor teaching. Moreover, the courses turn out to be friendly with the gas-gas jet pump teaching model, which can make students understand their specialty better and increase their professional sense of approval.

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