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Abstract: oxygen is an essential element of human life.However, in some special cases, it will lead to hypoxia and threaten health.Therefore, portable oxygen supply device which can work continuously has become an urgent demand for oxygen supplement.Pressure swing adsorption oxygen production method has the advantages of low energy consumption and no pollution, and has been widely used in small and medium-sized oxygen production equipment.At present, the household portable PSA oxygen generator is usually large in volume, heavy in weight and single in oxygen supply mode, which can not meet the oxygen supply needs of different hypoxia groups.Therefore, the development of portable oxygen generator is of great significance to improve the technical level in the field of micro oxygen production in China and meet the needs of oxygen supplement for people with hypoxia.

Traditional medical molecular sieve oxygen generator limits its portability due to its size and weight, which brings a lot of inconvenience to the people who need oxygen in a specific place in life. In order to meet the demand of today's market, the portable medical molecular sieve oxygen generator greatly reduces the volume and weight on the premise of ensuring the oxygen output performance, and uses two bed molecular sieve structureIt is possible to supply oxygen continuously in a specific place (outdoor or on the car) by using pressure swing adsorption technology.

Keywords: medical; oxygen; oxygen generator; portable; pressure swing adsorption

0 introduction

At present, oxygen inhalation has become an indispensable medical means, especially with the continuous improvement of people's living standards and the increasing demand for health, oxygen inhalation will gradually become an important means of family and community rehabilitation[1].In the treatment process of patients, if the long-term inhalation of oxygen deficiency, it will reduce the aerobic metabolism rate of patients, enhance anaerobic glycolysis, reduce the metabolic efficiency of the human body; long term severe hypoxia can cause pulmonary vasoconstriction, cause pulmonary hypertension and right ventricular burden increase, long-term can cause pulmonary heart disease and so on.In life, when some pregnant women or the elderly suffer from long-term hypoxia, it will lead to increased respiratory rate, dyspnea, chest tightness and asphyxia.Symptoms such as nocturnal sleep disorders, decreased sleep quality, daytime sleepiness, dizziness and headache can also occur[2].

At this stage, the oxygen inhalation method is to use the traditional oxygen bottle and oxygen generator to inhale oxygen.As a backup gas, oxygen bottle is a way for patients to inhale oxygen in mobile therapy and transfer therapy.Irregular oxygenation is needed to meet the patient's long-term oxygen inhalation.The oxygen bottle is bulky and can not meet the oxygen inhalation requirements of patients during exercise.The oxygen concentration in the inhaled gas cannot be controlled.Using oxygen concentrator for oxygen inhalation can meet the oxygen demand of

patients.However, due to the complex and bulky structure of most oxygen generators, it can not meet the needs of patients to inhale oxygen, and most of them use the main power supply, resulting in outdoor inhalation.Oxygen cannot be reached.On this basis, a new type of portable oxygen generator is designed, which is powered by high efficiency lithium battery and equipped with watch strap structure, so that patients can inhale oxygen during exercise.The oxygen generation system is novel in structure, simple in use and easy to carry. It can be used in battlefield, accident scene, field investigation, medical care and the needs of people at all levels[3].

1 Structure and principle

The portable medical oxygen generator is mainly composed of gas source unit, oxygen generation unit and control system.The air source unit includes filter, air compressor, air storage tank, etc.The oxygen generating unit includes air distribution valve, molecular sieve bed, one-way valve, flushing dimension hole, oxygen storage tank, flow regulating device, etc.The control system includes program controller, indication device, alarm device, etc.

Using two bed structure molecular sieve pressure swing adsorption technology to produce oxygen, the air collected from the ambient air enters the gas distribution valve through the filter, air compressor and air storage tank, and is distributed to the molecular sieve bed group under the monitoring of the program controller. Through the pressure swing adsorption, oxygen and nitrogen are separated, the adsorbed rich nitrogen in the bed is desorbed through the nitrogen outlet of the distribution valve, and the concentrated rich oxygen is separated from the single bedIt enters into the oxygen storage tank through the oxygen delivery port of the valve, and finally outputs through the pressure reducing valve and the flow regulating device.

2 Technical scheme and features

2.1Technical proposal

The technical scheme of the portable oxygen generator should reflect the miniaturization of the system and the on-board use function. The above technical characteristics can basically realize the miniaturization of the system. Considering that the on-board and field use functions of the system involve the design of the power consumption characteristics of the system, the following two schemes are available:

Indoor AC 100v-240v to DC 12V power adapter is used to convert the commercial power into 12V DC power to supply power for all parts of the oxygen generator; in the car, 12V DC power output from the cigarette lighter is introduced into the system for power supply; in the outdoor environment, battery power supply (built-in lithium battery + external battery pack) can be used, and the system includes air compressor, cooling fan and other functional parts, all of which are DC 12VV specification.

2.2Technical features

The basic technical principle of oxygen production of oxygen generator is similar to that of traditional medical molecular sieve oxygen generator. The electric control and detection part are strengthened. In order to ensure the portability of the product, the following measures are proposed in the design:

(1) Development of pulse oxygen supply device

The traditional oxygen generator adopts the continuous flow oxygen supply mode, no matter whether the user exhales or inhales, it supplies oxygen, causing a lot of waste. Now we develop a

pulse oxygen supply device, which supplies oxygen only when the user inhales. This technology can save oxygen consumption, improve the utilization rate of oxygen, and further reduce the weight of the system.

(2) Newly developed light electromagnetic pneumatic distribution mechanism

The volume and weight of the two position four-way electromagnetic pneumatic distribution valve used in JH-I medical molecular sieve oxygen generator is too large, which is not suitable for portable oxygen generator. It is necessary to develop a light pneumatic electromagnetic control valve. Through the combination structure of electromagnetic valve and pneumatic servo valve, its weight can be further reduced and its reliability can be improved.

(3) Using new molecular sieve material

Oxysiv-5 zeolite is commonly used in JH-I medical molecular sieve oxygen generator and other domestic oxygen generators. Oxysiv-mdx lithium molecular sieve, the latest material of UOP company, is proposed to be used in this product. The oxygen production performance of this new molecular sieve is three times that of zeolite molecular sieve, which makes the oxygen generator lighter and smaller.

(4) Development of matching molecular sieve bed

The structure of the molecular sieve bed is studied and improved, and the constant flow rate design is carried out. Through theoretical calculation and experimental exploration, the structural parameters of the new molecular sieve bed, such as the overall size and length diameter ratio, are determined, so as to make the gas flow in the molecular sieve bed more reasonable, reduce the loading amount of molecular sieve, and improve its oxygen production efficiency.

3 Technical optimization measures

(1) Application of pulse oxygen supply technology

The function of pulse oxygen supply device is to make the system supply oxygen only when the user inhales. This technology can save at least half of the oxygen consumption, so as to reduce the weight of the system. This technology has been used in foreign countries, but it is the first time in China, which has certain technical difficulty.The way to solve this problem is to research and develop it by referring to foreign technical conditions.

(2) Development of light electromagnetic pneumatic distribution mechanism

The research and development of small, stable, reliable and long-life electric pneumatic servo distribution valve is a key technology. 12V DC solenoid valve is purchased from the market.Pneumatic distribution valve is a new product developed by ourselves. Its research contents include: effective area of diaphragm, flow capacity (opening degree and diameter of diaphragm valve), response time (size matching of flow limiting hole and pressure charging chamber), stability of diaphragm valve and spring assembly in working process, reasonable configuration of inlet, outlet and air passage, etc.

(3) Optimization of oxygen production technology

The oxygen production performance of the system needs to be optimized, that is, to use as few molecular sieve materials as possible, to coordinate and match the matching conditions of various components in the smallest space volume, to minimize the hardware conditions required by technical indicators, and to solve the problem through a large number of experiments in the development process of oxygen production module.

(4) Structural optimization design

Structural optimization design: it not only includes the structural optimization of molecular sieve bed components and gas source components, but also includes the structural optimization of all components of the whole machine, so as to make the system structure as compact as possible, so as to realize the characteristics of portable system. Structural optimization design runs through the whole process of system development.

(5) Design of negative pressure desorption device

Adding a negative pressure desorption device at the product nitrogen outlet can make the nitrogen desorption process of molecular sieve more fully, further improve the oxygen generation efficiency, reduce the filling amount of molecular sieve, so as to achieve the purpose of reducing the weight of granulator.This technology has been used in military industry.The disadvantage of civil products is that the cost increases, so the products must be developed by themselves in the development process.

4 Medical clinical testing

Oxygen inhalation plays an irreplaceable role in pregnant women, the elderly and patients with dyspnea.For some sub-health people, oxygen inhalation can also relieve brain fatigue, relieve cranial nerve pressure and improve memory function[4].The new portable oxygen generation system designed in this study is powered by high efficiency Ni MH battery, equipped with small compressor and adsorption tower, which can perform pressure swing adsorption on the air, and then output the oxygen needed by patients.The whole system has an integrated packaging design, weighing less than 3kg, which is convenient for patients to carry or carry oxygen when walking; the system is equipped with an oxygen concentration regulating valve, which can adjust the oxygen concentration according to the needs of patients.The system is equipped with oxygen inhalation time, oxygen concentration and battery parameter information, such as power detection, system failure, etc., which is convenient for patients to pay attention to the status of oxygen inhalation[5].Compared with the traditional central oxygen generation system and oxygen cylinder, the whole system has obvious advantages.The comparison with traditional oxygen making equipment is shown in Table 1

project	Traditional oxygen system equipment	Oxygen bottle	Portable oxygen generation system
Principle of oxygen inhalation	Pressure swing adsorption	Pure oxygen	Pressure swing adsorption
Oxygen inhalation time	No time limit	According to the volume of oxygen cylinder It depends on the quantity	≥3 h
Oxygen concentration regulation	Adjustable	Not adjustable	Adjustable
Oxygen environment	Oxygen inhalation in fixed environment	Mobile oxygen inhalation	Mobile oxygen inhalation
Mode of carrying	Not portable	Not portable	Portable
Power supply mode	Municipal power supply	No power supply is required	Mains supply and batteries power supply

Table 1 Analysis and comparison of new portable oxygen generation system, traditional oxygen generation system and oxygen cylinder

In the process of clinical test, using fluke gas flow detector (vt-plus standard device) to monitor the oxygen concentration in the system, the error is less than ± 2%, which is in line with the national measurement control standard.In the process of clinical use, 100 pregnant women, 100 elderly patients and 100 patients with dyspnea were given oxygen inhalation test. The oxygen concentration can be as high as 95%, and the oxygen inhalation time is more than 3 hours, which can meet the oxygen demand of patients who inhale outdoors[6].

5 conclusion

For emergency patients, timely and long-term oxygen inhalation can relieve bronchospasm, reduce dyspnea, improve ventilation dysfunction, improve physical fitness and brain function, improve exercise endurance and quality of life; at the same time, it can also improve chronic obstructive pulmonary disease, prolong life, reduce hospitalization times, save medical expenses and reduce postoperative infection.Aiming at the disadvantages of traditional oxygen generation system, a new type of portable oxygen generation machine is designed.Patients can set the oxygen concentration according to their own needs, and freely choose the oxygen inhalation environment, which can best meet the oxygen inhalation needs of patients anytime and anywhere.It has important clinical significance to improve the vitality of patients.

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