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Research on Air Filter Monitoring System of Oxygen Generator

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Abstract: Zeolite is an expensive consumable material in oxygen generator which needs to be replaced regularly. The life of zeolite is mainly determined by dust, humidity and temperature. Among which, dust has a great influence on the life span of zeolite. In the process of oxygen production, the dust in the air will be adhered to the molecular sieve, and shorten the life of zeolite. PSA (Pressure Swing Adsorption) oxygen generator has a filter at the air inlet end, which is used to filter out the dust particles in the air. The filters of PSA oxygen generator are disposable regularly. The replacement cycle depends on the air environment, and the cycle is short if under much dust particles.This thesis investigates the architecture of the filter failure detection. The architecture can detect the air environment dust condition, detect the filter failure, prolong the life of the filter.

Keywords: PSA; Oxygen generator; Zeolite; Monitoring system.

1. Overview

Molecular sieve is a catalyst with sponge-like structure, characterized by selective adsorption and separation of molecules, which is widely used in various chemical reactions. The lifetime of molecular sieve is an important parameter that determines the performance and economic benefits of the catalyst. Temperature, humidity and dust can weaken the function of the molecular sieve, resulting in low oxygen flow, low oxygen concentration or even no oxygen. Poor air quality and dust will damage the molecular sieve. Filters that have not been replaced for a long period of time will also reduce the life of the molecular sieve.

In addition to the above factors, there are two other things that affect the life of the molecular sieve of the oxygen generator: one is the working environment (oil-free), and the other is the adsorption pressure. The molecular sieve contaminated by oil will have reduced adsorption capacity and cannot be regenerated. Dry and oil-free working environment can avoid molecular sieve contaminated by water and oil. At the same time, the molecular sieve under lower adsorption pressure is subjected to less impact, and the molecular sieve is not easily pulverized. At present, the oxygen generator can basically avoid oil contamination and control pressure. Currently, the existing oxygen generator has the following problems:

(1). The existing oxygen generator will not warn the dust particles in the use environment, which will affect the life of the molecular sieve of the oxygen generator.

(2). The existing oxygen generator does not test the effectiveness of the dust filter, once the filter has damage or failure, will cause zeolite loss.

(3). The existing oxygen generator does not maintain the filter or clean the filter automatically. The air inlet side of the filter is prone to accumulate dust, which greatly reduces the life of the filter.

The proposed architecture in this thesis aims to solve the above problems.

2. Architecture

The key to solving the above problem is to investigate a novel architecture. This architecture can monitor the condition of the filters and detect and issue warnings in real time. The proposed architecture of the oxygen generator maintenance device includes 11 parts: high-speed turbofan, dust sensor 1, dust sensor 2, motorized valve 1, motorized valve 2, air filter, water tank (containing ultrasonic nebulizer), motorized valve drive circuit 1, motorized valve drive circuit 2, turbofan drive circuit, and STM32. The schematic is shown in Figure 1.

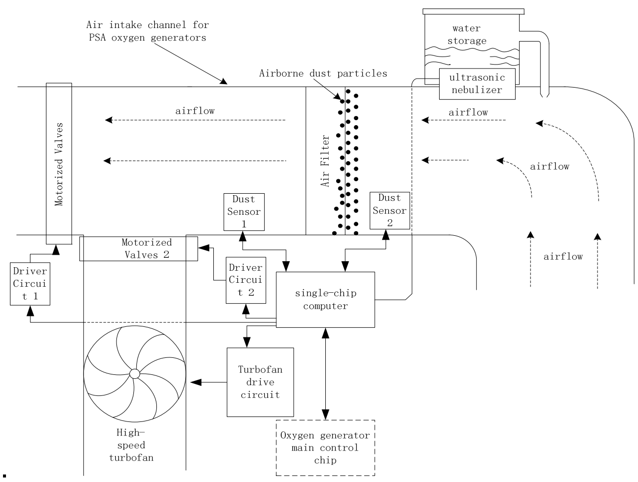

Figure 1. Schematic diagram of the oxygen generator air filter monitoring system

The specific models are as follows: control STM32 is model STM32F103RCT6, dust sensors 1 and 2 are both GPZY1014AU. PA4 and PA5 pins of STM32F103RCT6 STM32 are configured as ADC function. PA2 and PA3 pins of STM32F103RCT6 STM32 are to control driver circuit 1 and 2. Thus, it is used to control motorized valve 1 and 2.

The ADC value of GPZY1014AU sensor 1 and 2 is obtained by STM32, and it will calculate the dust concentration A1 and A2. If A2 $\geqslant$ 10mg/m^3 , STM32 sends the a command to the main control chip via UART port to indicate that the current environment is not suitable for oxygen production. If A1/A2 $<$ 70%, the STM32 sends a command to the main control chip to indicate that the filter has low efficiency.

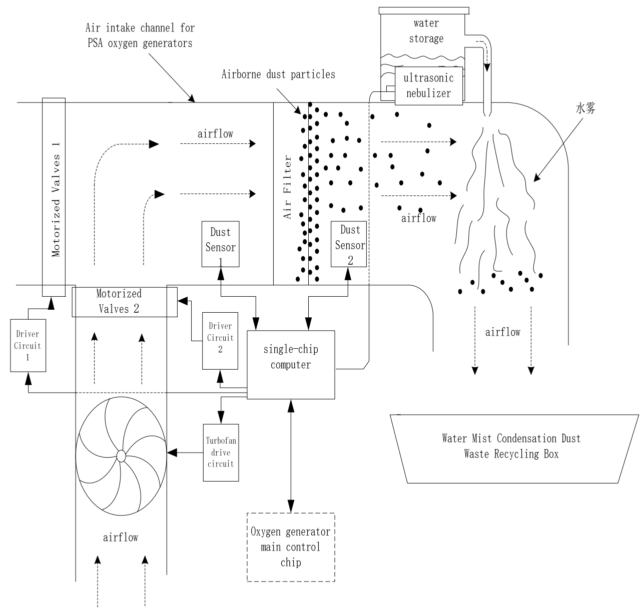

Figure 2. Oxygen generator air filter maintenance schematic

3. Conclusion

According to the national standards of the People's Republic of China, GB/T14295-93 Air Filter and GB12554-92 High Efficiency Air Filter, the filtration efficiency is E. E is calculated as follows:

$$E=\frac{A2}{A1}$$

A1: Dust particle concentration of inhaled air

A2: concentration of dust particles in filtered air

According to the standard, the filter is considered high efficiency when 70% $\leqslant$ E < 99%. Therefore, when E is lower than 70%, the filter is considered to be low efficiency and the user is reminded to replace the filter.

This architecture and method of dual dust sensor detection of filters can effectively detect filter failure. The filter can be maintained automatically, which increases the life of the filter and reduces the user's operating cost. It can effectively prevent dust accumulation on the inlet side of the filter element and improve the life of the filter element.

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