

Design of Ionic Fog Filter for AC- 1 Machining Center

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Abstract. In the process of modern NC machine tool processing, a large number of oil fog, smoke, containing polychlorinated biphenyls (PCBs) are produced, which is easy to cause toxic fog and seriously harm the health of staff. This paper introduces the design of an oil mist suction device to avoid the diffusion of toxic fog for a long time, to create a comfortable working environment, to prolong the life of machine tool equipment and to improve the production efficiency. It has been proved by application that it meets the performance requirements of modern NC machining center and obtains good social and economic benefits.

1. Introduction

In air purification, how to collect oil fog gas efficiently and how to purify gas efficiently are the key problems, which directly affect the cleanliness of the purified gas.

2. Design Background and Significance

2.1. Design Background

Because of the late start of China's automation industry, there is little knowledge of the aerosol pollution produced in the process of mechanical processing, and the treatment of the aerosol is not valued, so the research on the aerosol treatment is only in the primary stage, and the theoretical study is lacking. The simple collection and simple treatment of the processed fog can only be carried out by virtue of the accumulated experience, and the blindness and the uncertainty exist to a certain extent. In that domestic market oil mist filter, the purpose of the invention is to realize only the oil mist gas generated by the collection device and to condense and discharge the oil mist gas, and the fine particle solid and the harmful gas cannot be truly recovered and processed.

2.2. Design Significance

In order to meet the national development concept, adhere to green development, promote low-carbon cycle development, and build a clean and low-carbon, safe and efficient modern energy system. The project team independently developed and designed a fully closed ionization aerosol filter, which collected the fog and oil fog produced in the machining process, and then collected it through high



voltage electrostatic ionization. The filter layer can be used for a long time, and the filter layer can be replaced regularly to achieve 99.8% purification effect.

3. Design Scheme

The fog filter adopts sealed cabin mechanism, which is mainly composed of oil fog collection tank, front filtration system, electrostatic high voltage ionization system, electrostatic collection system, rear filtration system and electrical control system. According to Coulomb's law, the interaction force between two charged bodies is proportional to the product of the electric quantity and inversely proportional to the square ratio of the distance between them. The electric field intensity of any point on the electric field is equal to the force acting on the unit positive charge at that point in value and direction. The picture shows the effect of electrostatic high voltage aerosol filter.

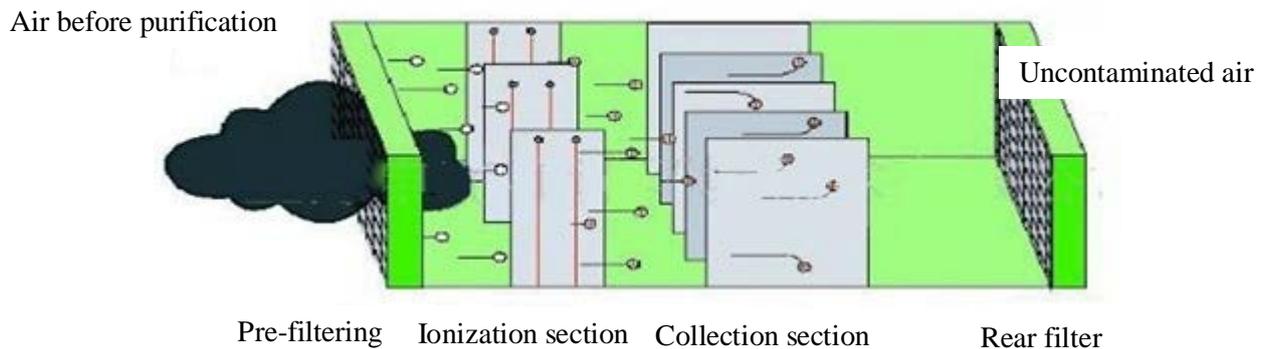


Figure 1. Effect Diagram of Electrostatic High Voltage Aerosol Filter

3.1. Front, Rear Filtering System

In view of the reliable operation and low maintenance cost of the whole filtration system, the collection and treatment bureau of the system adopts separate type, which avoids the erosion of the system by oil fog. In the front filtration system, the centrifugal fan is used to drive the high polishing whirlpool collector to collect the range of oil fog efficiently.

The pre-filter uses stainless steel wire filter to collect most of the large particle oil fog, and different configurations can be selected according to the type and concentration of oil mist on the spot. The rear filter adopts ultra-dense filter and charcoal to form a sandwich filter, and the ionized gas is filtered and purified again to meet the standard discharge requirements. All stainless steel filters and ultra-dense interlayer filters are used for cleaning, maintenance and maintenance in the later stage.

3.2. Electrostatic High Voltage Ionization System

A stable high voltage power supply module is selected in the electrostatic high voltage ionization system. When the polluted oil mist passes through the ionization section, the electric field is formed between the high voltage electrode wire and the electrode plate, and the small particle oil mist is charged at high voltage to carry on the positive charge. When the electric fog passes through the collection section, a multi-layer cathode plate is set up. Because of the interaction between the charged positive charge small particle oil mist and the cathode electrode, all the small particles in the oil fog are adsorbed in the cathode plate. The particles with a certain thickness fall into the ash bucket under the action of self-weight, so as to achieve the purpose of removing the small particles.

3.3. Electric Control System

The ionization fog filter can be connected with the equipment requiring fog treatment as a single device. The electrical control adopts multiple protection, including power supply voltage stabilization monitoring, motor short circuit, overload, overcurrent protection and protective door switch protection, etc., and reserves the signal interaction interface to interact with the equipment that needs fog

processing to achieve the automatic start and stop of the filter, alarm output and diagnosis. Realize real-time synchronization with the use of equipment.

4. Working Principle and Performance Analysis

4.1. Operational Principle

The working principle of ionized aerosol filter is to ionize the oil mist by high voltage electric field, and the small particle oil mist charge in the air flow is separated from the air flow under the action of electric field. The positive electrode is made of metal conductors with different section shapes and is called discharge electrode. The negative electrode is made of metal plates of different geometric shapes and is called dust collecting electrode.

The performance of the ionization aerosol filter is affected by the properties of oil mist, the structure of the equipment and the gas flow rate. The specific resistance of oil mist is an index to evaluate the conductivity, which has a direct effect on the efficiency of dust removal. When the specific resistance is too low, it is difficult for the dust particles to remain on the dust collecting electrode, causing it to return to the gas flow. When the specific resistance is too high, the charge of dust particles reaching the dust collecting electrode is not easy to discharge, and a voltage gradient is formed between the dust layers to generate a local breakdown and a discharge phenomenon. These conditions will result in a reduction in the efficiency of the dust removal.

The power supply of ionization fog filter consists of control box, boost transformer and rectifier. The voltage output of the power supply also has a great influence on the ionization efficiency. Therefore, the operating voltage of ionized aerosol filter should be kept above $40 \leq 75$ kV or even above 100 kV.

4.2. Performance Analysis

The ionized aerosol filter adopts advanced design concept, fully considers ergonomics, and adopts some modular designs, including: soft connection of fog collecting port, drawer design of each filter device, overload of ionization system, short circuit protection and electrical control system, which can realize real-time monitoring of the working state of the equipment and fault output and diagnosis of the filter. All the modules of the filter adopt double protection of mechanical structure and electrical structure to realize the protection function of the equipment to the greatest extent.

The experimental results show that the performance of the ionized aerosol filter meets the theoretical design scheme, and good economic benefits are obtained. The electrostatic air purification device has the advantages of high purification efficiency, treatment of flue gas, large fog volume, long service life and low operation cost. It is not only used in grinder, gear machining, large machining center, but also suitable for other equipment that produces a lot of oil fog, dust, oil fume and emulsified fog.

5. Epilogue

With the increasing development of science, technology and industry, people's awareness of the environment, the control of air pollution in operation environment, the control of air pollution in workshop and production site is no longer a luxury. After a lot of experimental tests, the impeller is used to enlarge the air flow as an oil mist suction device in the ionization type air mist filter, which fully meets the demand of oil mist suction in terms of performance. And the protection seal between the impeller and the transmission motor is good, and the oil mist will not be introduced into the transmission device, which reduces the maintenance problem in the later stage.

The ionization method is used as the separation method of oil and gas, which has the advantages of simple structure, convenient installation, convenient maintenance, continuous and reliable work, low cost, easy cleaning and easy automatic control. 1um particles can be collected, energy consumption is low, adsorbed oil fog particles can be accumulated and left behind by oil droplets, so that they can be used better.

At present, there are few corresponding theoretical research reports on the treatment of oil fog in China. The fully closed ionization aerosol filter designed by it has made a better breakthrough in the design of structure and performance. Through the addition of air flow science, it has a better effect on the pre-separation of oil mist cooling. The shape of its fully closed ionization aerosol filter can be well integrated into the airport design style, and the mass production can be realized. In a word, the fully closed ionization aerosol filter has great development opportunities, and its market demand and industrialization prospect are good.

6. References

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