

The contribution of PTFE to air pollution control

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1. Characteristics of PTFE materials

Polytetrafluoroethylene (Polytetrafluoro ethylene) abbreviation PTFE, trade name is "Teflon" (Teflon), commonly known as "plastic king".1938, at DuPont Research Laboratories, New Jersey, USA, R.S. Dr. Plunkett first invented polytetrafluoroethylene (PTFE), which was commercialized in 1946. Polytetrafluoroethylene (PTFE) is a highly crystalline polymer of tetrafluoroethylene (TFE) monomer, white, non-toxic and odorless. Its polymer molecule is made of one (one CF₂ one) one structural unit, the structure is simple- - [-CF₂-CF₂-] n-, is the most advanced engineering plastic used in various industries.

In polytetrafluoroethylene (PTFE), the fluorine atoms replaced the hydrogen atoms in the polyethylene, because the fluorine atoms large volume radius is 0.064nm, greater than the radius of the hydrogen atoms (0.028nm), and the negative charge of the fluorine atoms of the adjacent macromolecules and mutually exclusive, making the C-C chain from the plane of polyethylene, fully extended tortuous configuration gradually twist to the spiral conformation of polytetrafluoroethylene (PTFE), and form a tight complete "fluorine generation" protective layer, which has the chemical stability unmatched by other materials and low cohesive

energy density.

The bond energy of C-C bond is 372kJ/mol, and C-F bond is 347 kJ/mol, which is the known bond binding is strong, high heat resistance, long-term use temperature is -250 °C ~260 °C , while C-C bond bond length is 1.54×10^{-10} m, C-F bond is 1.41×10^{-10} m, is also short of the common single bond, so the chemical properties are stable, it is difficult to react with other substances, showing excellent weather resistance, stain resistance and chemical resistance.

2. Contribution of PTFE in the field of air pollution control

2.1 The main components of air pollutants

The main pollutant of urban air quality is the fine particles floating in the atmosphere, especially PM_{2.5}. PM_{2.5} has a wide range of sources and relatively complex components. Its main sources are man-made emissions, including coal-fired power plants, industrial waste gas, waste gas emissions from human daily life, automobile exhaust, waste incineration, fossil fuel combustion, etc. In addition, some of the emissions are converted into PM_{2.5} through a series of chemical reactions. PM_{2.5} also has natural sources, including wind and dust, volcanic ash, forest fires, floating sea salt, pollen, Fungal spores, bacteria, etc. Compared with PM₁₀, PM_{2.5} sources are basically the same, but the proportion of secondary particles in PM_{2.5} is relatively large. According to data, about 62% of PM_{2.5} comes from combustion processes such as coal,

motor vehicle fuel and industrial fuel, 22% from dust, and 16% from solvent use and other sources.

2.2 Reasons for selecting PTFE as the air pollution control material

Based on the above situation, it is necessary to choose appropriate materials to control air pollution. Because the melt viscosity of polytetrafluoroethylene (PTFE) is as high as $10^{10}\sim 10^{15}\text{Pa}\cdot\text{s}$, it is a typical non-melt flow material, which cannot flow freely even after reaching the decomposition temperature, so it is not suitable for the commonly used processing method of polymer fiber. At different temperatures, through different tensile strength preparation into different pore size of the film, and then through membrane cracking production process, produced poly (PTFE) fiber with approximate regular hexagonal section, effectively increase the specific surface area (unit mass surface area), the fiber in the poly (PTFE) original high temperature resistance, corrosion resistance, also has a very high strength.

The base cloth woven from Teflon long fiber is the "skeleton" of the filter material, providing about 70%~80% strength of the needle felt, and greatly improves the service life of the filter bag. The needle felt prepared by short fiber through the acupuncture process serves as the "filter layer" of the filter material, which greatly improves the efficiency of dust capture. In addition, the performance of polytetrafluoroethylene (PTFE) microporous film, which is composed of island nodes of

polytetrafluoroethylene (PTFE) and fiber filament stretched by crystalline molecules. These filaments cross to form micropores of uniform size, which overlap to form a stereo mesh node.

Structure, under the premise of meeting a certain air volume, greatly improve the strength of the membrane and filtration accuracy.

2.3 Main advantages of PTFE coated filter bag

There are two main ways of filter material: deep filtration and surface filtration. The deep filtration of the traditional filter material mainly depends on the function of the primary dust layer. In order to ensure the continuous work of the filter material, the filter material should be cleaned regularly, and the dust should be cleaned not to destroy the "primary dust layer". In the filtration process, the primary dust layer is only more efficient for a period of time, and the capture efficiency of small particles is very low. The primary dust layer is in a repeated state of stable ash destruction. The coated filter material belongs to the surface filtration, and the use of the microporous structure of the coated filter material changes the filtration mechanism of ordinary filter material, from the deep filtration mechanism of ordinary filter material to the surface filtration mechanism. In the filtration process of coated filter material, the base cloth and needle felt only play a supporting role, unlike the traditional filter material which needs to rely on the dust layer formed on the surface of the filter

material for filtration, the Teflon film layer itself can play the role of a dust layer. In this way, the efficiency of the coated filter material is very high from the beginning, and it does not need a dust layer to improve the efficiency. Film filter material dust removal mainly uses the microfilter effect of the microporous film, which is the difference between the dust removal mechanism of the new film filter material and the traditional filter material.

2.4. Main application fields of PTFE coated filter bag

1) Waste incineration field

Waste incineration is one of the most important application fields of PTFE coated filter bags. Waste incineration process will inevitably produce a large number of pollutants, which have the following characteristics: ① particulate matter, acid gas, heavy metals and organic highly toxic pollutants; ② flue gas has high moisture content, high dew point temperature, and easy filter; ③ high and low temperature flue gas interaction; ④ deacidification leads to moisture removal and pipe blockage; ⑤ flue gas is highly corrosive. The needle felt filter material with PTFE as the base cloth and PTFE staple fiber as the surface layer passes the filter bag after the PTFE microporous film and burns in the garbage.

Good results can be obtained in the flue gas purification of the power plant.

2) Coal-fired power plants

Coal-fired power plants are common in China, and the coal combustion process will produce a large amount of sulfur dioxide, nitrogen oxide and inhalable particulate matter. Due to the excellent characteristics of polytetrafluoroethylene (PTFE), the bag dust collector made of polytetrafluoroethylene (PTFE) membrane and glass fiber needle felt composite filter material in high temperature environment can greatly reduce the dust emission of the power plant. In addition, polytetrafluoroethylene (PTFE) membrane combined with glass fiber needle felt is recognized as the most effective material to overcome inhalable particulate matter.

3) Cement industry field

With China's more and stricter energy conservation and emission reduction requirements, the traditional electric precipitator in the cement industry has been unable to meet the new national emission standards. In the cement production process, the bag dust collector made of the traditional turbed felt and woven filter material surface composite expanded PTFE (ePTFE) membrane filter material can reduce the emission of air pollutants and recycle the cement powder, which can increase the output, reduce the cost and save energy.

4) Laboratory purification field

In biological, food, medicine, medical industry in the air cleanliness

level of clean room field, polytetrafluoroethylene (PTFE) coated filter filter has good stability, corrosion resistance, the same resistance under the condition of large flow characteristics, can meet the requirements of high efficiency air filtration, will play a greater application value in these industries and economic and technical potential.

To sum up, due to its excellent material characteristics, PTFE has been widely used in the air pollution control industry, and compared with other materials, its service life is long, high filtration efficiency, blind replacement of other materials, but the gain outweighs the loss.