Research Progress of High Temperature Filter Materials in Bag-hose Precipitation

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Abstract. Bag-hose precipitation for its efficient, reliable, low energy consumption and simple maintenance has been widely recognized in various industries. The application of bag-hose precipitation in more than twenty fields presents rapid development trend, such as electric power, cement, steel, non-ferrous metals, machinery, chemical industry and municipal. The research status of bag-hose precipitation technology is reviewed. The application situation and developing trend in the electric power, cement, waste incineration and steel are summarized. The developing direction of high temperature filter materials in bag-hose precipitation is anticipated.

1. Introduction
As high technology of removing dust, bag-house filter can reduce the release of smoke and dust in a large range, which is a very important technology and equipment for China to solve issue of release of smoke and dust. In the latest decade, along with the development in the industry of electrical power, steel, concrete and incineration, bag-house filter had big development with a gross output of 13.267 billion yuan, a profit of 1.187 billion yuan and a rate of profit of 8.94percent[1]. At present, series of bag-house filters cover most industry, becoming the major dust removing equipment in control of air pollution, especially PM_{2.5}[2,3].

2. Progress on bag-house filter
Bag-house filter was first put into application at 1880’s. 1881, Betch Factory invented Mechanical vibration dust remover, which won a patent and soon began commercial production. 1930, reverse airflow dust removing method was first used. 1954, HJ Hersey invented reversed blowing ring[4-6], which made the filter be able to work continually, could improve effectiveness of dealing with smoke and dust significantly under a stable pressure.1957,T.V.Reinauer invented pulse bag house filter, which could continually work large amount input air under stale pressure with a long life and simple structure. In 1950’s bag-house filter was began to be used to gather dust on boiler in developed countries. In 1970’s bag-house filter are widely used. In USA, electrostatic precipitation were gradually replaced by bag-house filter. More over, In Japan, Australia and many Europe countries more and more large bag-house filter applied on coal fired power station[7].

China import whole bag-house filter from Russia in 1950s and try to develop her own brand under the research and development of few designers and institutes. The set up of bag-house filter cooperation in later 1970s is a milestone and in followed 80s and 90s, 2 and five of this filter are
separately applied on electric boiler, 5 power stations in Huainan, Nanding and others, but it not a success limited to the technology and filter material[8]. In later 1990s, bag-house filter began to be widely used in coal-fired power station under the success development of large pulse bag-house filter. In 2001, 2 rotary low pressure pulse bag-house filter were equipped on two 200MW units’ 2X670t boiler in Fengtai power station Huhehot, Mongolia, which was really a breakthrough as it could dealt with 1,738,000m3/h of smoke at 140~170℃, the input smoke density is 25~30g/m3, speed of airflow is 1.13m/min, total resistance less than 2100Pa, leakage rate less than 1.5%. The filter used 25600m2 fiber, kept the release density at 14~25mg/m3 in 29600h, nearly 4 years. From then on, widely used bag house filter can keep the release density under 30mg/m3, even under 10mg/m3.

Bag-house filter can be classified into 3 types according to its dust removing style, namely mechanic vibrating, returning reverse airflow, pulsed blowing. The first suitable for litter input air occasion, while the last high efficiency and capability of dust removing, can work timely.

3. Dedust Mechanism of bag-house filter

3.1 Screen effect
The common size of filter mesh is 5μm to 50μm. The dust could not pass it when its size large than it. For new filter, the space between the fiber is usually large than dust’s, so it has little effect. However, when more and more dust deposited, which forms a dust lay, the filter function increase remark.

3.2 Effect of inertial impact
Generally, big dust are gathered mainly by their inertial impact. When the air flow approaching the fiber, the air flow will run around the fiber, while the large size dust (diameter>1μm) will run almost direct as result of the effect of inertial and it will be gathered once impact the fiber. These could be increase remarkable by accelerate the air flow.

3.3 Effect of intercept
Dust in the airflow will flow around the fiber when they approaching it, while the dust will be intercepted when its radius large than the distance between its center and fiber.

3.4 Effect of diffusion
For dust with diameter <1μm, especially those <0.2μm, under the impact of gas molecules will move irregularly just like Brownian movement. The dust will be separated from the air flow when encountered fiber. It is so called effect of diffusion, which will be more remarkable in slower speed airflow with smaller diameter fiber and dust.

3.5 Effect of static electricity
Most fiber screen will generate static electricity when encounter airflow, simultaneously, dust also generate static electricity as result of rub or other reason, which generate The Coulomb Force make the screen and dust attract interact when airflow across the screen.

Not all these mechanism work during the dust removing, but a joint function of several ones. Huge dust will be natural deposit by its weight when it go into the dust removing equipment along with the slow airflow. All these mechanism begin to work along with the change of space between screen, speed of airflow and diameter of dust.

3.6 Effect of intercept
Dust in the airflow will flow around the fiber when they approaching it, the dust will be intercepted when its radius large than the distance between its center and fiber.
4. Application of bag-house filter in industry of electric power, concrete and incineration and steel

Dust in coal-fired power station is with high density, temperature and moisture, also with a certain oxygen contents. Dust in concrete and incineration industry is also with high density and temperature, and it also has strong sticky friction ans a certain moisture. Dust in steel industry is with high temperature and oxygen contents but with low density. So different fiber and non-woven method should be applied according to different industry.

4.1 Coal - fired power station

As one of key air pollution source, dust release by generator in coal-fired power station in recent decade account for 10 to 20 percent of the whole release in China. Bag-house filters are still not common applied in this industry, but it has been regarded as a potential method to decrease dust release in this industry. Among all equipment, application of bag-house filter is developed fasted recent years. There are many examples, like transformation from electrostatic precipitation to bag-house filter on 200MW unit in Jiaozuo power station, 350MW unit in Baogang’s own power station, 4x300MW unit in Shanghai Wai Gaoqiao, and application of bag-house filter on 600MW unit in Zhangjiagang Shazhou power staiont, 660MW unit in Jiujiang power station and 1000MW unit in Zhimi Power station. All these bag-house filter used for 5 years and keep the friction under 1200pa and concentration of dust less than 20mg/m3, which shows that this technique has a potential development in power station industry[9]. At present, major used in the filter are PPS+PPS, PPS+PTFE, PPS/P84+PTFE, PTFE/84+PTFE. And major cooperation are Fujian Longking, Zhejiang Feida Environmental Science Technology Co. Ltd., Jiangsu Xinzhong Environmental Protection Equipment Co., Ltd., Jiehua Holdings Co.,Ltd, Tsinghua Tongfang Co., Ltd and so on.

4.2 Concrete and incineration industry

Concrete and incineration industry is also a sever pollution source. In recent years, transformation from electrostatic precipitation to bag-house filter on kiln head and kiln tail make the factory area of concrete industry clean. Major fibers used on bag-house filter in this industry are glass fiber loom(lamination), short glass fiber/glass fiber base cloth, short glass fiber+P84short fiber( glass fiber base cloth), major fibers used in incineration industry are PPS, P84, glass fiber+PTFE, PTFE. Major cooperation in concrete and incineration industry are including Hefei Cement Research & Design institute Cooperation Ltd., Sinoma Technical Service Co.Ltd., Sinoma (Henan) Environmental Protection Co.ltd., Jiehua holdings Co.,Ltd, Xian Xikuang Environmental Protection Co. Ltd, Anhui Shengyun Machinery Co., Ltd.and so on[10].

4.3 Steel industry

Steel Industry is also a sever pollution source. A typical development of bag-house filter in Steel Industry is the application of dust removing on blast furnace gas. present, major used fiber on the screen are glass fiber(short fiber) + glass fiber( base cloth), glass fiber/ P84( short fiber)+ glass fiber(base cloth) . major cooperation are Kelin China, Zhonggang Tiancheng, Changzhou Dongfang Dust Removal Equipment Plant and so on[11].

5. Conclusion

5.1 Existing problem

The filter material gradually become the bottleneck of the development of bag-house filter.Priority research should be the function of the filter material rather than the technology of filter. Here are some existing problems according to current research.
5.1.1 Further research on material should be adopted. The temperature of the dust usually higher than the ones of smoke air, however, at present, selection of filter fiber is according to the temperature of the smoke, which is a major reason that shorten the life of filter fiber. So research on the temperature tolerance of filter fiber, especially on China made fiber.

5.1.2 Current researches of filter material are focus on a certain products. More research on the material, fiber and function should be adopted.

5.1.3 More research on the structure of fiber should be adopted at the sight of dust removing of high temperature air flow.

5.1.4 The selection of fiber and its structure used at high temperature condition is still not objective as decided by experiment together with Subjective judgment. More objective evaluating method should be set up.

Different of coal and combustion mode could affect temperature flue gas and content of corrosive gas. Regard to these complicated situations, more problems should be taken into consideration like what fiber and what construction of filter should be used, whether the filter adapt to the certain condition. More research should be adopted to increase the function of filter fiber and reduce costs of manufacturing bag-house filter.

5.2 Develop prospect

5.2.1 Set up a evaluation model for filter fiber used in high temperature condition. The evaluation model will provide theoretical foundation for design of filter fiber and its construction according to the character of fiber, yarn, filter material used in high temperature and their filtration character under their working condition.

5.2.2 Set up a mode to analyze the effect of fabric construction on filtration efficiency to calculate the dimensionless expression for its filtration efficiency. The mode will provide theoretical foundation for design of gradient filter.

5.2.3 Do research on the chemical, physical and filter character of the fiber used on high temperature case, together with the actual working condition to design new filter fiber used in high temperature condition.

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