Impact Factor: 9.9 ISSN-L: 2544-980X

Analysis of Basalt Fabrics in Filters of Dust and Gas Cleaning Systems Used in Cement Production

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Abstract: Dust collection in the process of cement production is especially important for Fergana due to the increase in the number of cement plants, since this is one of the areas of technogenic pollution of the environment. Therefore, it is important to capture the dust that gets into the air during this process. The article analyzes the materials of fabrics used in bag filters used at cement plants in the region. The analysis of works on the state of the synthetic filtering apparatus, which removes air from the dust stream, is presented. The studied methods and procedure of filter regeneration without tissue damage are presented.

Key words: cement production, dust collectors, dust and gas cleaning, bag filters, regeneration, filter cloths, ecology.

Introduction

As presented in [1], the cement industry in Uzbekistan is developing rapidly, which is due to a sharp increase in demand for cement both within the country and in neighboring states. Currently produced cement provides 70% of domestic demand. The current volume of cement is 11 million tons it is planned to increase it to 21 million tons by 2025. Considering that more than 20 factories are currently operating, more than 40 factories will be involved when the planned production volumes are reached. In this regard, the **goal was** set - **to** examine the dust and gas cleaning systems of the operating plants of the Fergana region, on the territory of which their largest number is located - 6 operating and 5 under construction.

These enterprises use the currently generally accepted dry dust and gas cleaning systems for cleaning their emissions, the technical characteristics of which were presented earlier. These cleaning systems are based on filtering dusty gases with fabric filters, which are one of the oldest technical solutions to achieve effective dust collection at a relatively modest capital and operating cost. The increased requirements for the degree of gas purification in cement production revealed a tendency towards an increase in the share of used filtration devices in comparison with devices for wet gas cleaning.

Fabric filters use two types of filter media: regular fabrics made on looms and felts) or other non-woven fabrics obtained by felting or mechanically entangling fibers using a needle-punched method.

The development of filtration technology is mainly directed along two paths: the creation of regeneration methods for filter materials of the felt type, allowing to work at an increased speed while maintaining the efficiency of dust collection, and the development of new types of filter materials, primarily of the felt type, allowing to reduce the hydraulic resistance, to increase the productivity of devices for gas and increase the service life of the filter elements [2, 3, 4].

The following requirements are imposed on fabrics used as filter materials [5]:

1) high dust holding capacity during filtration and the ability to retain, after regeneration, such an amount of dust, which is sufficient to ensure high efficiency of gas cleaning from fine particles;
2) maintaining high air permeability in an equilibrium dusty state;

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3) high mechanical strength and resistance to abrasion at multiple bends, dimensional stability and properties at elevated temperatures and aggressive effects of chemical impurities in dry and moisture-saturated gases;
4) minimal moisture absorption and the ability to easily remove accumulated dust;
5) Possibly low cost.

The materials used do not satisfy all of the listed requirements, therefore, each material is used in certain, most favorable conditions for it.

In recent years, these materials have replaced cotton and wool materials due to their high strength, resistance to high temperatures and aggressive influences, especially since their cost in most cases is lower than the cost of woolen fabrics.

Nitron fabrics have good filtering properties, high mechanical strength, can be used for a long time at temperatures of 120-130 ° C and can withstand short-term exposure to temperatures up to 180 ° C. Due to their chemical and thermal resistance and low moisture absorption, they are widely used for cleaning hot gases of cement dust. Service life of sleeves made of this material is 9-12 months or more (depending on filtration conditions).

Lavsan fabrics are used for cleaning hot dry gases in the cement industry. Their strength is 3-5 times higher than that of woolen ones. In humid hot gases, especially in an alkaline environment, the strength of fabrics at high temperatures decreases sharply. In acidic environments and oxidizing agents, the resistance of fabrics is very high, but concentrated sulfuric acid destroys fibers.

When using lavsan fabrics in high temperature conditions, it is necessary to pre-treat them at 220 ° C for 30 s or 1 min, respectively, in water vapor or in dry hot air. As a result of such processing, shrinkage occurs along the base by 15% (no shrinkage occurs along the west, since the fabric is usually fixed). Nitron and nylon fabrics are subjected to a similar heat treatment. The wear of mylar and nitrone fabrics increases with sharp temperature fluctuations.

In addition to the listed materials, fabrics made of nylon, polypropylene and polyvinyl chloride fibers are also used. All of them have high chemical resistance in specific environments and low moisture capacity, but they do not withstand higher temperatures than fabrics based on lavsan and nitron.

The cost of filtering fabrics based on polypropylene is close to that of cotton. Polypropylene fibers are characterized by low density, high strength and abrasion resistance. Polytetrafluoroethylene (polyphene) fabrics have extremely good chemical and thermal properties, but their disadvantages are low strength (fluidity) and high cost.

When cleaning dry gases from dusts with high electrical resistance, filter cloths made of synthetic and glass fibers are charged, for example, up to 60 kV, and this creates a risk of fire in the filter as a result of electrical breakdown of the air gap between the sleeve and the filter housing. To protect against electrification, thin metal wires are sometimes woven into fabrics or impregnated with antistatic electrically conductive compounds.

To prevent the formation of hard-to-remove deposits on fabrics, especially when processing hygroscopic dusts (in soda and cement plants, during lime burning and other operations), fabrics are given water-repellent properties. To do this, they are treated with methyl or phenyl silicones. Hydrophobic coatings retain their properties for a long time at a temperature of 200 ° C.

Fiberglass is resistant at 150-250 ° C, at which natural and synthetic fibers are destroyed; they are obtained from aluminoborosilicate alkali-free glass. Continuous fibers with a diameter of 5-8 microns are obtained from the melt using dies, staple fibers 20-40 cm long - by spraying the melt with intermittent jets of hot air. The obtained glass fibers are greased with a paraffin emulsion and twisted into threads (10-15 twists per 10 cm), from which filter cloths are obtained on weaving machines.

To increase the resistance to repeated bending, glass fabrics are subjected to a thermochemical treatment, i.e. get finished glass fabrics. A protective coating is applied to a harsh fabric after removing the lubricant from it (at 300 ° C) by impregnation in an aqueous emulsion of organosilicon compounds, followed by polymerization of the film at a high temperature. The impregnated glass fabric becomes elastic, acquires a smooth and hydrophobic surface, from which the layer of trapped dust can be easily removed.

The service life of such a fabric depends on the organosilicon polymers included in it, which usually begin to deteriorate at 175-225 ° C; with a further increase in temperature, the durability of the fabric sharply decreases, but even at 250 ° C, the durability of fabrics in comparison with untreated ones becomes several times higher and reaches 24 months.

Method

Filter woven materials are weaves of threads (yarns), twisted from short (staple) or filament (continuous) fibers up to 40 microns in diameter. Thicker (heavier) fabrics made from natural or synthetic fibers are often combed, and woolen fabrics are also rolled. As a result, on the surface of the weave, a pile or overlap is formed from individual fibers entangled with each other in different directions. Thinner (lighter) fabrics made of glass and synthetic continuous or staple fibers do not undergo tufting, but the degree of twist of the threads and their density is much higher than in thick fabrics made only of staple fibers.

In typical fabrics, the distance between the weft and warp threads 300-700 μm in diameter is 100-200 μm. The fibers of the pile form a porous layer overlapping the holes between the threads (Fig. 1 shows a cross-section of the naped fabric, and Fig. 2 shows the structure of the fabric) [6].

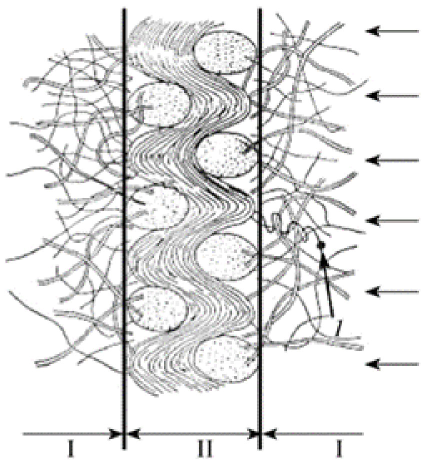

Fig. 1. **Cross section of the filter cloth:**

I - sections with pile; II - section of interwoven threads of the fabric; 1 - dust particle

For filter fabrics, three types of weaves are used: plain, twill and satin. Sometimes, to obtain particularly durable fabrics with increased filtering properties, they resort to complex double weaves.

Plain weave is characterized by dense packing of threads, as a result of which the fabric has an increased hydraulic resistance. Twill and satin weaves provide the most favorable structure.

The twill weave, which makes the fabric more elastic, is often used to make filter fabrics. It externally differs in diagonal lines, which are formed as a result of the location of the base overlaps. Satin weave, less durable and dense in the arrangement of the threads, is sometimes used in glass fabrics. The overlapping of the threads in the satin weave is almost invisible, and due to this, the fabric acquires its characteristic shiny appearance.

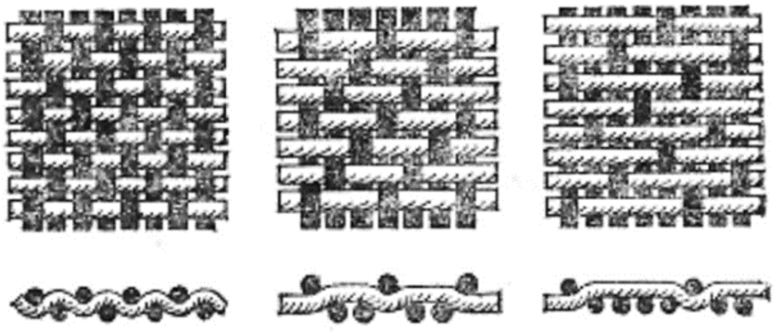

Fig. 2. **Types of fabric weaves: a - plain; b - twill; в - satin**

The deposition of dust particles during the initial period of the filter operation due to the mechanisms of touch, inertia, diffusion and electrostatic interaction occurs on the fibers located on the surface of the threads, as well as in the pile. Fibers inside the twisted filaments practically do not participate in the deposition of particles, since the gas flow almost does not pass inside such filaments.

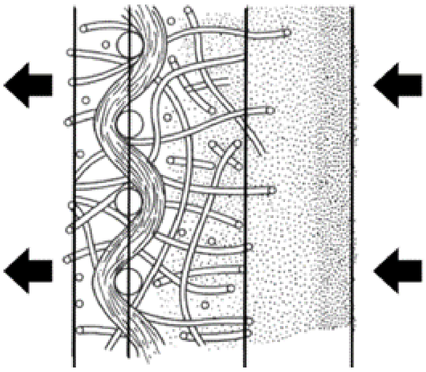

Fig. 3. **Distribution of dust in the felted filter material**

Subsequently, the process of particle co-precipitation is observed, as a result of which the cleaning efficiency increases sharply and a continuous layer of dust can form, which itself becomes a secondary filtering medium (Fig. 3) [2].

Table 1 shows the data [3] on the efficiency of gas cleaning with fabric filters in different periods of their operation (the efficiency was determined by particles with a size of 0.3 microns).

Influence of the deposited dust layer on the efficiency of the fabric

Table 1

Textile	**Cleaning efficiency,%**		
	clean the cloth	**after dusting**	**after backflush cleaning**
Thin synthetic	2	65	13
Thick brushed synthetic	24	75	66
Thick brushed woolen	39	82	69
Basalt roving	35	87	72

It can be seen from the table that the cleaning efficiency with a thin cloth after its regeneration decreases sharply in comparison with a dusty one, while the difference in cleaning efficiency when using thicker bulky cloths is much smaller. If a continuous layer of dust forms on the fabric between regenerations, a very high dust collection efficiency can be expected, even in the form of submicron particles.

Thus, the clean cloth of fabric filters itself is not a highly effective filtering medium in the literal sense, and in some cases it only serves as a supporting surface, i.e. serves as the basis for the formation and retention of the filtering dust layer.

Since the layer formation process takes a long time at low concentration, the best results are obtained when cleaning gases with high dust content. The ability of most particles less than 5 microns in size to coagulate with the formation of strong loose aggregates in the gas flow, in the tissue and on its surface makes it possible to use even rare tissues as an effective filtering medium [7].

When cleaning the fabric, a significant part of the dust sediment is removed, but a significant amount of it remains inside the fabric between the threads and fibers, therefore, a high cleaning efficiency remains. When regenerating dusty fabrics, do not allow them to be re-cleaned.

It is advisable to use small gas loads in these filters - usually 0.3-1.2 $m^3/(m^2 \cdot min)$. At high speed, excessive compaction of the dust layer can occur, accompanied by a sharp increase in resistance. Since the particles penetrate deep into the layer and tissue, a disturbance of the dust layer is observed, accompanied by a secondary entrainment of dust, especially from the holes between the threads.

Conclusion

Table 1 shows that the cleaning efficiency with the use of a cloth made of basalt roving is higher. Synthetic fabrics can withstand temperatures up to 280 ^{0}C, and the dust and gas flow at the outlet has a temperature of over 1000 ^{0}C, therefore, the technological conversion is equipped with a rather complex cooling system. The operating temperature range of basalt roving is from -200 to +850 ^{0}C. Based on the above, we are conducting experimental research work on replacing synthetic bag filters for cleaning cement dust gas with a material made of basalt roving. The results of the work will be published.

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