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THE PROCESS AND EFFECTS OF REMOVING SOLID PARTICLES FROM FLUE GASES USING BAG FILTERS TYPE FVU-P

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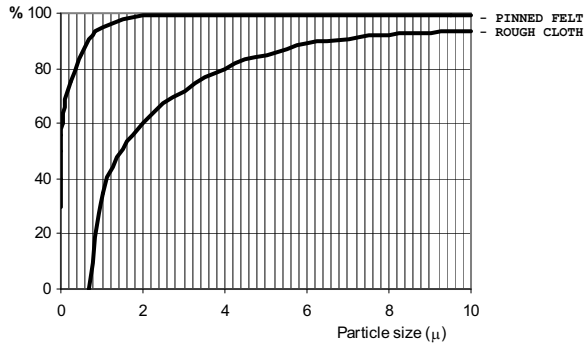
SUMMARY
Reduction of undesirable particles emission into the air is one of the main tasks for the environment protection. A particular problem is the emission of solid particles from the flue gases that are the product of combustion in the thermal power plant. There are several ways to reduce the emission of those undesired particles, such as using the separators, cyclones, dust chambers, various filters and so on.
This paper presents the process of removing solid particles from the flue gases by installation of bag filters type FVU-P *in blocks 5 and 6 of the Thermal Power Plant "Kakanj". The basic characteristics and components, application area, principle of operation and automatic ways of shaking bags off are presented in the paper as well as the effects of its installation to the air pollution parameters.*
Keywords: bag filters, thermal power plant, solid particles, emission, environmental protection

1. INTRODUCTION
Environmental protection is one of the most challenging and complex activities. Complete protection of environment in the modern world implies the meaningful policy for air protection which requires an adequate management of processes, with a focus to maintain the authenticity of the environment, biodiversity and environmental stability. Therefore, the environment protection must be imperative for human activities and must be the obligation and the basis of every entrepreneurial activity.
Contemporary electrical filters achieve high efficiency in dust removing with low power consumption, low pressure drop and low operating costs. However, the efficiency of electrical filters in removing of smaller particles significantly decreases. In case of using the bag filters, flue gases pass through the cloth bags that are commonly 120 - 300 mm in diameter and 6 - 10 m in length, [1]. Hybrid filters are the combination of electrical and bag filters, which combines the benefits of both dust removing techniques. Actually, electrical filter removes significant amount of larger particles, while the bag filter separates finer particles of harmful dust, [2].

2. BAG FILTER TYPE FVU-P
Until 2010, Thermal Power Plant "Kakanj" had used only electric filters for purification of flue gases from blocks 5 and 6. Unfortunately, the reduction in concentration of dust particles in output emissions using this method was not sufficient. In order to achieve better dust removing rate, bag filters were additionally installed in 2010 so the deficiencies of electric filters were significantly compensated.
Bag filter type FVU-P is fully automated high-capacity dust collector with pneumatic bag cleaning. It is a single-chamber dust collector with continuous work, so that all bags participate during operation. The process of bag cleaning is pneumatic and lasts very short time. The filtering area of these filters ranges from 42 m^2 to 252 m^2 for single-row design, and up to 500 m^2 for two-rows version.
The bag filter of FVU-P type is shown in Figure 1, [3, 7].

Figure 1. Bag filter type FVU–P

For instance, bag filters are also used in the Cement Plant Kakanj to collect harmful particles of ash produced by burning tires, which is then used for cement production. The rate of dust filtering for bag filters, expressed in percentages, in dependence of particles size for pinned felt and rough cloth, is shown on diagram in Figure 2, [3, 7]. The domain of bag filters application depending on the size of solid particles is shown in Figure 3, [7].



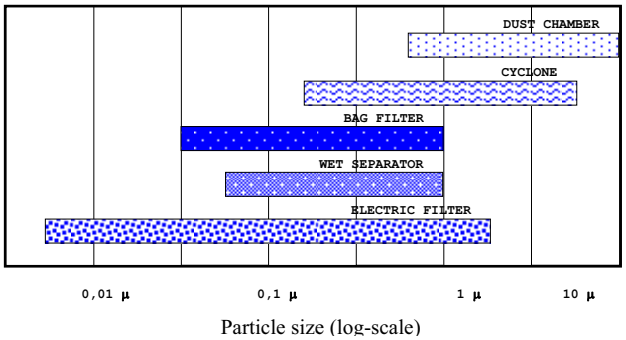


Figure 2. Dust filtering rate of bag filters

Figure 3. Application domain of different filters

The rate of dust solid particles filtering by bag filters significantly increases with increasing the size of particles for most fabrics that are used for filtering, Fig.2. The expected lifetime of a bag is about 5-7 years. The mechanism for shaking the filter bags out consists of the following components: a compressor unit, a pipeline for compressed air with necessary fittings, electromagnetic membrane valves, and an electronic controller. Shaking the bags out is an automatic process which is done line by line and lasts from 0.2 to 5 seconds.

3. MAIN CHARACTERISTICS OF BAG FILTERS IN BLOCKS 5 AND 6 OF THERMAL POWER PLANT „KAKANJ“

3.1. Main characteristics of bag filter in block 5

The upgrade of electrical separator of solid particles in block 5 is made by installing a bag filter in a separate housing behind the separator. Besides the bag filters, radial fans for flue gases with variable speed control are also installed. The present system of ash dispatching from electric filter is kept on. Scheme of the hybrid filter in block 5 is shown in Figure 4, [4].

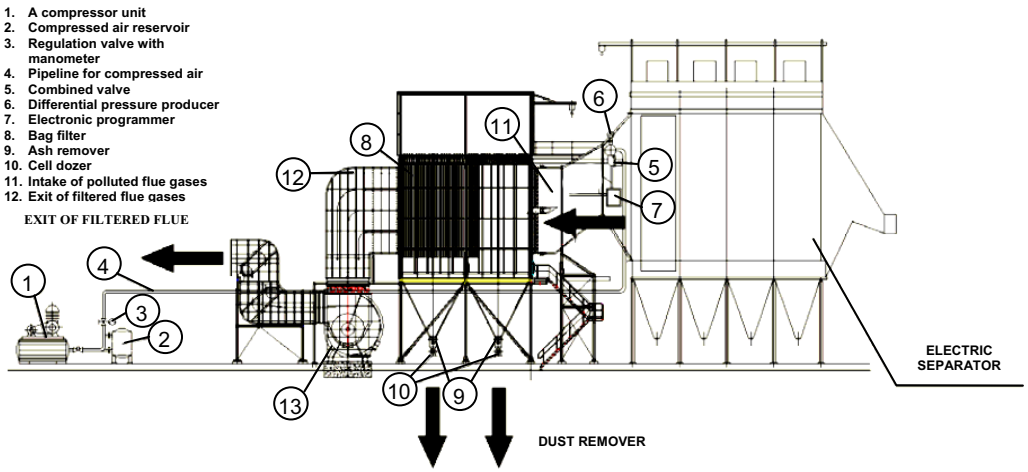


Figure 4. Hybrid filter in block 5 in TPP „Kakanj“

Bag filter in block 5 has 2880 cylindrical bags with a diameter of 145 mm and a length of 7 m, which gives the area of filtration in amount of 9178 m^2. All bags in both blocks 5 and 6 are coated by protective membrane of polytetrafluoroethylene (PTFE). The dusting off the bags is performed by pulses of compressed air which is blown into the bag through a tube placed above the rows of bags. The operating air pressure for shaking off the bags is 350 kPa. The shaking process is automatic on the basis of the drop in pressure in front of and behind the bag filter. Operating pressure drop in filter is 1.2-1.5 kPa, [4].

3.2. Main characteristics of bag filter in block 6

The reconstruction of the electrical separator in block 6 is carried out by replacing its last two electric fields with bags. Behind the filter, radial fans with frequency regulated capacity are mounted. As in block 5, the existing system of ash transportation is kept on and extended below the bag filter. Scheme of the hybrid filter in block 6 is shown in Figure 5, [5].

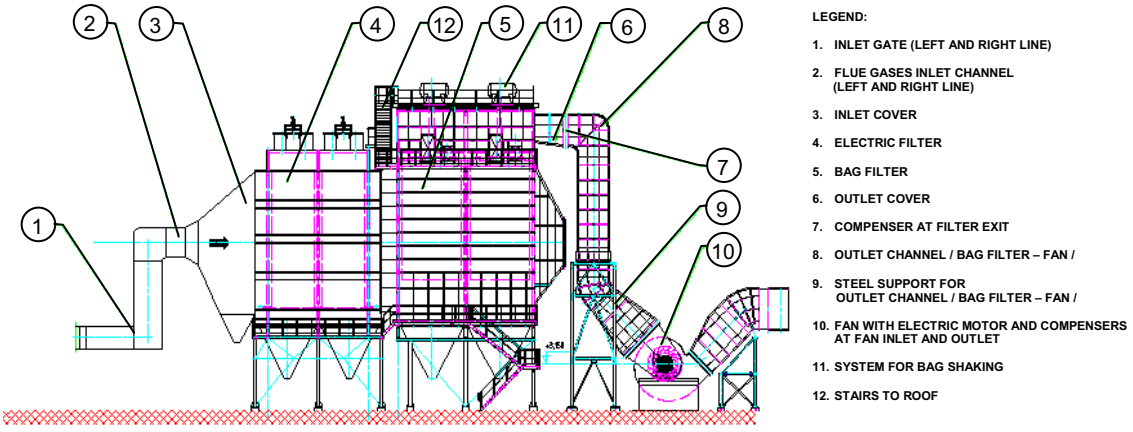


Figure 5. Hybrid filter in block 6 in TPP „Kakanj“

Bag filter in block 6 has 3840 elliptical bags of equivalent diameter of 145 mm and a length of 8 m, grouped into 8 bundles with coaxially arranged bags. The total area of filtering is 12288 m^2. Shaking the bags off is being performed by compressed air pulses. The air is blown into the bag through nozzles located on rotating pipe assemblies. The operating air pressure for shaking the bags is 85 kPa. Automatic bag shaking is enabled by the drop in pressure in front of and behind the bag filter. The operating pressure drop in the filter is 1.0-1.4 kPa.

4. EFFECTS OF BAG FILTERS INSTALLATION AT TPP "KAKANJ"

Installation of bag filters in blocks 5 and 6 resulted in reduction of harmful particles emission as well as in increase in electricity production in TPP "Kakanj". By appropriate analysis and measurements it was found that the emission of harmful particles was 4896 tons in 2009 and, after the installation of bag filters in 2011, the emission was reduced to 1427 tons. On the other hand, the electricity production was 1908 MWh in 2009 and 2234 MWh in 2011, [6, 7]. The same trend has been maintained to these days.

The values of specific emission of harmful solid dust particles from blocks 5 and 6 are given in Table 1, along with the dust emission regulations.

Table 1. Specific emission of harmful solid dust particles from blocks 5 and 6

Block	Heat power [MW]	Specific dust emission [mg/m^3]	Dust emission regulations [mg/m^3]		
			Directive 2001/80/EC	Directive 2010/75/EC	Best available techniques
5	330	8	100	20	5-20
6	330	4	100	20	5-20

Medium pressure drop in the hybrid filter in block 5 after installing the bag filter is 1.6 kPa, while the medium pressure drop in the hybrid filter in block 6 is 1.325 kPa.

5. CONCLUSION

After installing the hybrid filter in TPP "Kakanj" specific emissions of harmful solid particles from blocks 5 and 6 have been decreased from 464 and 397 mg/m^3 to 8 and 4 mg/m^3, respectively. These values are consistent with the best available dust filtering techniques. Positive experiences with bag filters in blocks 5 and 6 created a good basis for the installation of bag filter in block 7 and it was realized in the period September-December 2014. It is realistic to expect to achieve solid particles concentration of 5 mg/m^3 at the exit of the bag filter of block 7. This level of emissions in the block 7 would minimize the harmful impact of the TPP "Kakanj" on the environment, and could create technical preconditions for possible application of some techniques for flue gases desulphurization.

A moderate increase in electricity consumption in amount of 24% is recorded at block 5, while the electricity consumption in block 6 is even decreased by 18%. Mostly, this can be attributed to the introduction of frequency regulated capacity of the flue gas fan instead of capacity regulation by damping at the fan mouth.

No significant maintenance activities or replacement of the damaged bag were needed. However, certain difficulties due to bonding of fine ash particles in the interior of the collector and conveyor pipes have appeared during hybrid filters operation.

6. REFERENCES

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