Types of industrial air filtration system assisted with static charge

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Abstract- *Industrial air pollution is one of the severe problem which has been affecting science and technology throughout the world. Various way outs have been taken worldwide to efficiently control the particulate matters emitted from different industries, especially submicron particles like* PM_1, $PM_{2.5}$ *which are more health hazardous with minimum power consumption. One of the most emerging methods to control emission efficiently with minimum power consumption is Hybrid Filtration system i.e. Pulse Jet Filtration system assisted with a static charge. This paper reviews the detail of various case studies done on hybrid filtration systems worldwide and showcasing its advantage by improved particulate collection efficiency and lower energy consumption.*

Keywords*: Pulse-jet filtration system, Electrostatic Precipitator, Pre-charger, Fabric Filter, Hybrid Filter, Differential Pressure Drop.*

1. Introduction

Industrial pollution has a wide range of serious consequences. Industries liberate a different variety of pollutants into the atmosphere polluting both air and water; hence they are the main reason for giving off toxic matters hazardous to human health (Mukhopadhyay A.2009, Mukhopadhyay A.2010). Survey has proved that industries are responsible for 50% of the overall pollution affecting the ecosystem (Ray T.K., 2004). To control industrial pollution and its harmful effect one of the most effective technique used by various industries during present day is pulse jet filtration using fabric filter media, which has the advantage of achieving very high particulate collection efficiency up to 99.99% especially collection of extremely fine particles such as $PM_{2.5}$ i.e. aerosol particle size smaller than 2.5 micron (Mukhopadhyay A.2009, Mukhopadhyay A.2010). Another technology frequently used by various industries for capturing particles is Electrostatic Precipitator (ESP), which works on the concept of particle charging by ionic current (Neundorfer- Electrostatic Precipitator Operation, H.J. White. 1963)**,** it is capable of handling large volume of gas with an extensive variety of inlet temperatures, pressures, dust volumes, and gas conditions (Neundorfer- Electrostatic Precipitator Operation and Jaworek. A et al 2007). ESP can collect a wide range of particle sizes in both dry and wet states, the collection efficiency for ESP can go up to 99%., particle size larger than 3µm diameter are efficiently removed but fractional efficiency is minimum between the range 0.1 to 1 µm(A. Mizuno, 2000), generally less than 90% (A. Mizuno, 2000 and J. Hautanen et al, 1986). The Overall collection efficiency of ESP can be determined by following equation (H.J. White.1963 and J.C. Mycock et al 1995)

$$\eta = 1 - e^{-vmA/V} \qquad (1)$$

Where VM the migration velocity of the aerosol flowing across the precipitator channel, A is the cross-sectional area of the channel, V is the flow rate of the gas. Alongside advantages, both Pulse Jet Filtration system and Electrostatic precipitator have distinct disadvantages that are undesirable from

the economic point of view in industries. Pulse Jet Filtration gives higher pressure drop which requires high power consumption and also maintenance cost of filter media is very high, the media requires to be replaced after a certain interval which finally effects the marginal profit of industries (Tomitatsu. K.et al,2014). In Electrostatic Precipitator the collection rate is effected by aerosol composition and the equipment size is very large thus requires thus a lot of space is required (Ueda .Y et al 2014 and Neundorfer- Electrostatic Precipitator Operation) ,to counter these problems some of the countries have tried the concept of hybrid filtration i.e. E.S.P. followed by Pulse Jet Bag house or Pulse Jet System assisted with pre-charger, both the systems gave high collection efficiency at low-pressure drop (Tomitatsu. K.et al,2014, Jaworek. A and Krupa. A.2007, Li.H, Wang.Z and Ye.Y.2016, Robert. F and Kenneth. M. 2003) .

2. Pressure Drop behavior of filter media during Pulse Jet Filtration:-

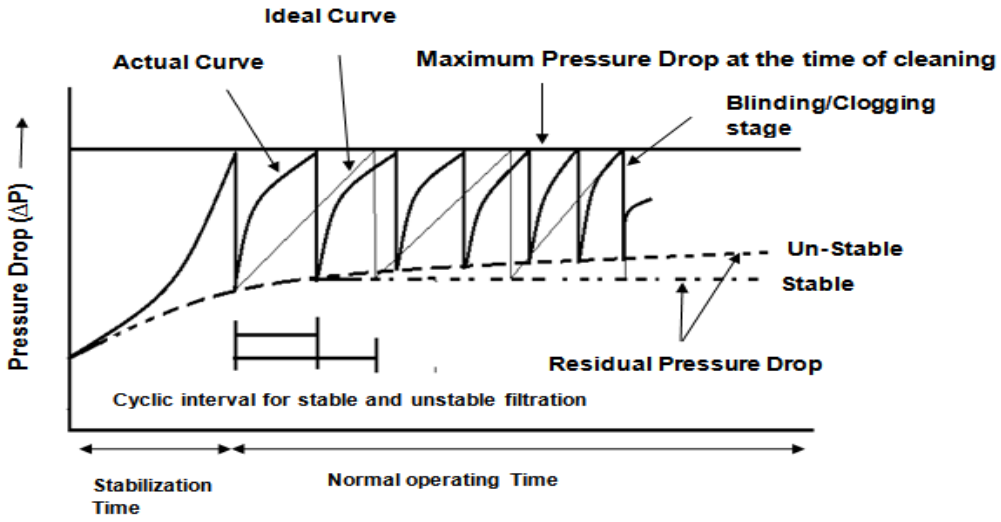

Fig. 1. Pressure behavior of filter media with respect to filtration time (Mukhopadhyay A,2009)

For any industry practicing pulse jet filtration system to cleaning aerosols, the high differential pressure drop is undesirable as it would lead to very high power consumption and large fan will be required to exhaust the gas. For ideal case during filtration the cyclic interval between the pulses should be stable throughout the process and also the residual pressure drop must be as minimum as possible all through the process, but ideal case is practically unachievable because filter media is subjected to wear and tear during successive pulsing actions and also the after every pulsing re-deposition and seepage of particles occur in the media which lowers the cyclic interval time (Mukhopadhyay A.2009). The actual trend for any filtration process is during the initial stages the cyclic interval between two pulses is very high and subsequently as the process continues the interval time keeps on decreasing and finally a stage comes where clogging or blinding occurs and residual pressure drop nears maximum pressure, this blinding or clogging indicates that the bag filter is clogged needs to be replaced. The main reason for clogging is pores of filter media getting

blocked after successive pulsing as more particles seep inside the media and particles getting trapped within; hence depth filtration gets dominant due to which media gets blinded making it no longer usable. In order to prolong bag life, the maximum pressure drop must be achieved as stable as possible which will reduce the residual pressure drop (Mukhopadhyay A.2009, Schuberth.J et. al.2010).

3. Types of hybrid Hybrid Filtration System

Use of hybrid filtration system can help in countering the demerits faced while using ESP and Fabric Filter systems individually. Following table gives the detail of the reason why hybrid filter should be used.

Table No.1

	ESP	**Fabric Filter**		
Merits	Less Pressure Drop Less maintenance Cost	Dust collection rate remains unaffected by aerosol composition. Extremely high collection efficiency can be achieved i.e. up to 99.99%	➡	Hybrid Filters have been designed to get combined benefit ESP and Fabric Filter
De-Merits	Dust collection rate is affected by the aerosol composition Larger space is required to get high dust collection rate.	Higher Differential Pressure Drop High maintenance cost as the bags needs to replaced frequently		

Fig.2 COHPAC SYSTEM

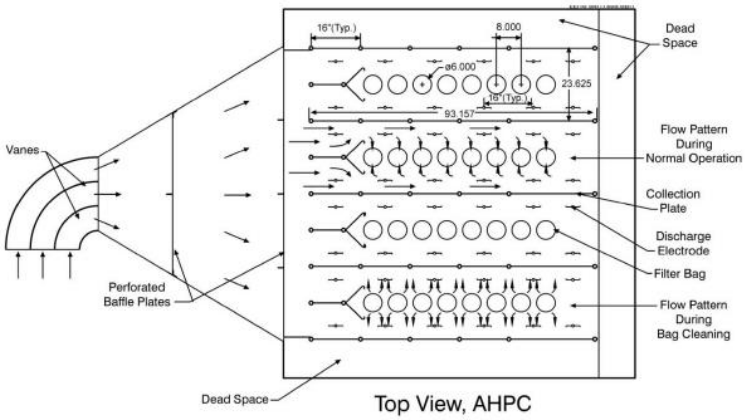

Fig. 2 Advanced Hybrid - Original Concept

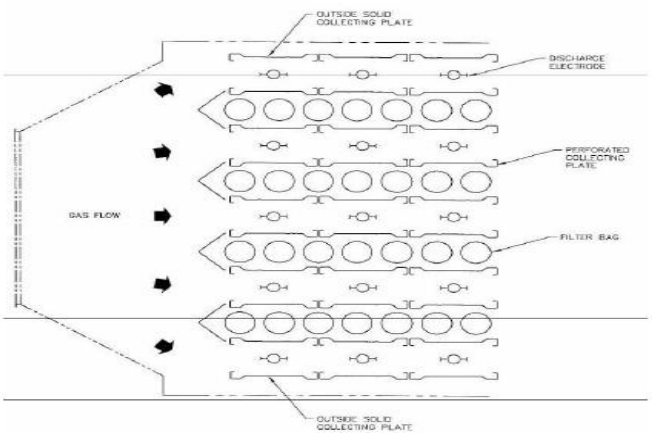

Fig.3 Advanced Hybrid - Modified Concept

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