Particulate and Mercury Emissions Control by Non-traditional Conditioners

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Abstract: Despite significant progress made in reducing the installed costs of bag houses, Electrostatic Precipitators (ESP) remain the most accepted device all over the world. Similarly advances in the design and electronics have been made in ESP. Still ESPs continue to become limited, on occasions, for multiple reasons. This limitation is widely overcome by conditioning the fly ash prior to its collection in the ESP. In many cases traditional conditioning with SO_3 or SO_3 & ammonia is a good choice, (particularly in the USA where expenses on capital costs are more acceptable than operating costs.) However, non-traditional conditioners are especially favorable where the conditioning is needed only on an intermittent basis both in and out of USA. Non-traditional conditioners bring extra value when other components can be incorporated into them for multi pollutant control. In the area of mercury control, particularly in the USA, use of non-traditional conditioners outweighs the value of traditional conditioners when activated carbon injection (ACI) is selected as the method of choice. Contrary to the experience with traditional conditioning, laboratory and small scale field tests have clearly shown that the mercury removal capacity of injected carbon is not adversely affected when non-traditional conditioners are used. Switching the traditional with non-traditional conditioning can bring significant cost advantage to mercury control by ACI. This paper discusses some of the novel conditioners which alone or in conjunction with others are useful in opacity and multi pollutant control.

Keywords: Electrostatic Precipitator, particulate, emissions, opacity, sulfur trioxide, flue gas conditioner, mercury, activated carbon, injection

1 INTRODUCTION

Particulate emissions from fossil fired operations manifest itself as smoke, soot, fume or plume bellowing out from a chimney or stack. At the turn of the industrial revolution, plume coming out from manufacturing operations was acceptable. As a matter of fact it was regarded as a sign of progress and cities with most stacks were considered industrially advanced and its citizens progressive.

Over the years, it slowly became a sign of air pollution, bad health and respiratory difficulties. Scientists developed many correlations that linked quantifiable evidence of pollution to health problems which became reasons for the Government and the legislators to control it.

Engineers began developing particulate emission control devices such as drop out chambers, cyclones, electrostatic precipitators (ESP), scrubbers and bag houses to minimize the particulate emissions and to keep industrial operations in compliance with regulatory laws.

In the USA, the Congress created an agency called Environmental Protection Agency (EPA) and entrusted it with the responsibility of ensuring control of pollution and promulgate regulations based on effects of pollution to people's health. Today the awareness of pollution and the necessity to control it for maintaining good health is a household world and is appreciated by all walks of people.

The oil and coal fired power plants and boilers are the largest sources of particulate emissions. Coal is and shall be providing the largest means of producing energy because of its abundance but it is also one of the dirtiest fuels. It contains impurities that get emitted as fine particulates, sulfur dioxide, oxides of nitrogen (NO_x) (both contributing to acid rain), mercury, arsenic, selenium, etc. Electrostatic precipitator, bag houses, and combinations were primarily developed to control particulates, whereas scrubbers became a necessity to control sulfur dioxide emission. Catalytic methods were developed to control NO_x. In addition, methods are always being evolved to refine and make the mentioned equipment more efficient, less costly to install and operate almost everyday. The awareness to control Mercury emissions is new where technologies are being developed and proven. In addition to the above mentioned health affecting pollutants, saving earth from green house gas accumulation in the atmosphere, for which coal and other fossil and carbonaceous fuels are responsible, is rapidly becoming a necessity to mitigate.

This paper focuses on improving the performance of existing electrostatic precipitator so that less amount of particulates leave the coal fired operations. It particularly talks about a chemistry based solution than making mechanical or electrical improvements. The first chemistry based solution to improve ESP performance started to be proposed when the mechanisms responsible for good versus bad performance began to be delineated. Use moisture, sulfur trioxide and later a combination of sulfur trioxide and ammonia became available in the sixties. The power plant operators in the USA accepted SO_3 and SO_3 & NH_3 based systems very well, even though they are quite expensive to install and troublesome to operate and maintain. Systems utilizing SO_3 or SO_3 & NH_3 are known as traditional conditioning.

2 FLUE GAS CONDITIONERS

Any material or compositions that make the flue gas amenable to become easy to conduct some beneficial process on it is a flue gas conditioner (FGC). However, traditionally, it is associated with treatments that help remove particulate materials by exiting down stream equipment such as ESP or bag house.

For the purpose of this paper FGC shall mean synonymously to condition the flue gas or fly ash so that the conditioning helped the ESP for a better removal of fly ash from the gas stream.

The ARKAY conditioners are non-traditional conditioners and help improve the performance of existing ESP. With ARKAY conditioners one can lower the particulate emission to less than 50 mg/m^3. This is being done in the USA, on sub-bituminous, bituminous and combinations of sub-bituminous and bituminous coal firing power plants and industrial plants.

Data presented will show the effectiveness of ARKAY conditioning technologies. It lowers the opacity from highs of 40%-60% (corresponding to particulate emissions of > 200 mg/m^3) down to 5%-7% (or < 30 mg/m^3)! In addition to actual measurement on mass emissions, plants routinely depend for compliance by routinely monitoring the stack opacity and ESP power level. They even automatically control the ARKAY conditioners treatment level by monitoring these parameters on a continuous basis.

In addition to excellent plant experience ARKAY backs and develop new products by laboratory tests such as electrical resistivity as measured by IEEE mandated test methods and its own means of testing ash agglomeration of the laboratory treated ash. All these data are presented.

The ARKAY technologies also provides system or has developed systems on how to feed the conditioners in the most effective way so your cost of conditioning can be as minimal or most optimized as possible.

In the arena of mercury control where plants currently use traditional conditioning, ARKAY non-traditional conditioning agents show no interference to mercury removal by activated carbon injection (ACI). With ARKAY, plants which have to use ACI for mercury control and are currently using the traditional SO_3 and SO_3 & NH_3 conditioning for PM control, can have significant cost savings.

ARKAY is also developing technologies to control mercury emissions from coal fired plants in the USA, on its own. Its technologies have shown in full scale plant tests its effectiveness for controlling more than 80% of the mercury present in the gas streams and simultaneously control stack opacities (or projected mass opacities below 50 mg/m^3) to less than 10%! There is no system that can claim control of PM and mercury pollutions simultaneously at much lower costs than the currently most accepted technologies of activated carbon injection (ACI)!

It has also developed very low cost products and methodologies to control emissions of mercury for those plants that don't use conditioners for PM control. ARKAY mercury control products, known as Merc X, don't interfere with fly ash quality.

The data and experience on all these new technologies and products are presented.