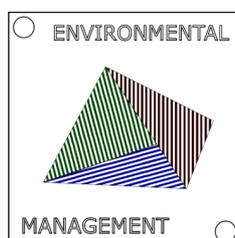


CHARCOAL ADSORPTION FILTERS FOR NOX ANALYZER VACUUM PUMP PROTECTION

Ján ILKO - Miroslav RUSKO



ABSTRACT

The following study deals with the implementation of special charcoal filters for use in analytical field. It was designated by a Czech company to increase performance and reliability of the monitoring systems. In this study the experience with this kind of filters in the vacuum line of the pumps used for the air quality monitoring analyzers.

KEY WORDS: Filter, Adsorption, Vacuum pump

Introduction

For several application in the analytical and laboratory systems and devices the ozone generators are used. This is important for the reactions during the measuring process. The ozone is then sucked out with a vacuum pump. To protect the pump, there are put a charcoal adsorbent filters into the line. In some cases, the original filters are very small and do not allow the adsorbance of ozone for longer time as two or three weeks.

In real, maintenance of monitoring systems is being done in period of three months or half a year. This caused problems with the pumps at the outlets of devices with implemented ozone source. For this reason, there was a cartridge with robust body and easy and quick integration into the racks or another construction of the system designed. The charcoal or another adsorbent replacement is very easy and fast.

Charcoal adsorbent

Activated charcoal has a very fine network of pores with large inner surface area on which many substances can be adsorbed.¹The pore structure limits the size of molecules that can be adsorbed, and the surface area limit the amount of material that can be adsorbed, assuming suitable molecular size.²The process of adsorption allows carbon air filters to filter organic chemicals (gases) from the air. The problem with the activated carbon bed is that over time, the gaseous pollutants increasingly fill up the adsorption sites of the activated carbon. Once the bed is saturated, the filter can no longer trap pollutants. In fact, chemicals with a greater affinity for an adsorption site can displace those with lesser affinity, and the affinity of a given chemical for the sorbent is highly dependent on ambient conditions such as temperature and relative humidity.³Activated carbon filters can be very effective at ozone removal, although not indefinitely because chemical reactions of ozone and carbon change the

¹THOMAS, T. Dennis. The role of activated charcoal in plant tissue culture. *Biotechnology advances*, 2008, 26.6: 618-631.- [on-line] available on URL:<https://www.sciencedirect.com/science/article/pii/S0734975008000864>

²MOHAMMAD-KHAH, A.; ANSARI, R. Activated charcoal: preparation, characterization and applications: a review article. *Int J Chem Tech Res*, 2009, 1.4: 859-864.- [on-line] available on URL:<http://www.oxinchemistry.ir/wp-content/uploads/2017/05/ACTIVATED-CARBON.pdf>

³MYERS, P. D. 2018. Activated Carbon Air Filters. - [on-line] available on URL:<https://molekule.science/activated-carbon-air-filter/>

carbon.⁴Ozone is a strong oxidizer. Ozone easily gives up one of Oxygen elements which can alter the chemical composition of gases.⁵

Vacuum pump outlet system

NO_x analysers for air quality measuring use chemiluminescence to evaluate the NO_x concentration. Chemiluminescence (CL) is the emission of light, usually in the visible or near infrared spectral region, as a result of an excited electronic molecular state, formed in a chemical reaction, returning to the ground state.⁶ For the reaction the ozone from ozone generator is used. The ozone residual ozone is pumped out with the analyzed probe using vacuum pump as shown on the Figure 1.

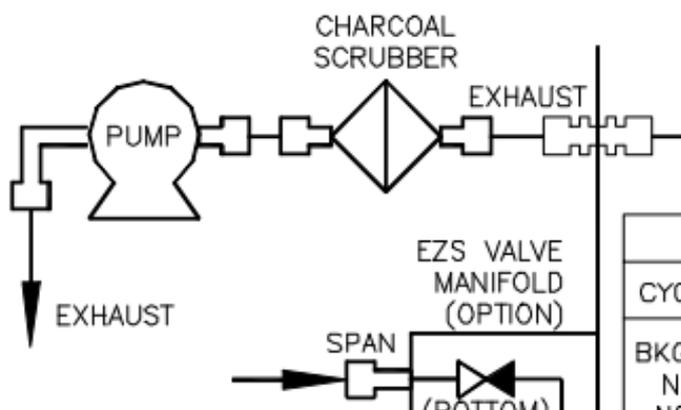


Figure 1 Pneumatic diagram of the NO_x analyzer exhaust⁷

When the charcoal scrubber lost its efficiency caused by high concentrations of ozone or long time work, the ozone starts to disturb the surface of the chamber of the pump, as shown on the Figure 2.



Figure 2 Inlet chamber of the vacuum pump of an No_x analyser with small pack original adsorbents

Vacuum pump loses its power and the flow starts to fall down. This causes the pressure loss in the analyzer and leads to the malfunction of the measurement. The analyzer should have a flow sensor and

⁴LEE, Poshin; DAVIDSON, Jane. Evaluation of activated carbon filters for removal of ozone at the PPB level. *American Industrial Hygiene Association Journal*, 1999, 60.5: 589-600. ISSN: 00028894

⁵PURE AIR SYSTEMS. Carbon VS Ozone. 2009. - [on-line] available on URL: <https://www.pureairsystems.com/2009/10/28/carbon-vs-ozone/>

⁶ZAGATTO, Elias Ayres Guidetti, et al. *Flow analysis with spectrophotometric and luminometric detection*. Elsevier, 2011.

⁷ML@9841AS NO_x Analyzer Service Manual. Internal document of Casella UK.

detect this to switch of the internal ozone generator to avoid damages of the internal system caused by ozone. As example is shown the screen of an analyzer on the Figure 3.

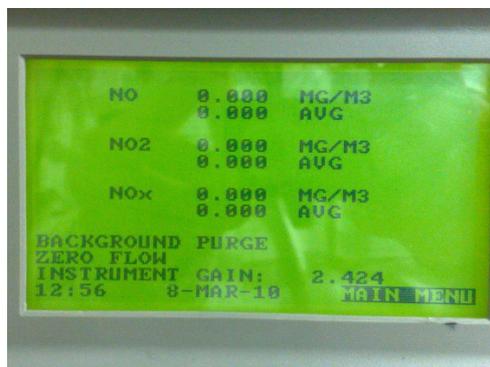


Figure 3 Alarm message ZERO FLOW caused by vacuum pump malfunction

Practice

The experience with the ozone filtering at the outlet of the NOx analyzer is that it is very important to replace the charcoal periodically in a proper period. Small cartridges, sometimes originally supplied with the analyser, need to be refilled or replaced in a short period to keep the pump protected. Cartridge with bigger volume (Figure 4) has been designated to assure longer maintenance periods. This was tested for three years.



Figure 4 Adsorbent cartridges integrated in the rack

The cartridges are used also as zero air filters for other analyzers. Charcoal filters, are relatively inexpensive to produce, and those savings are passed down to the consumer⁸ but the maintenance time is expensive and the long time working of the filter is very important for technical praxis, too.

Conclusion

Such cartridges are very versatile and there is a wide field of use in technics. During 3-years operation, there was no mechanical damage from overpressure noted or a change of internal surface or the surface color caused by the ozone from the internal ozone generators as i.e. the NOx analyzers have.

⁸WATER FILTERS FAST. 5 Benefits of Using Charcoal Water Filters. - [on-line] available on URL:https://www.waterfiltersfast.com/5-Benefits-of-Using-Charcoal-Water-Filters_b_64.html

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