Mercury Removal from Waste Incineration Flue Gas: Heterogeneous Oxidation and Capture by Waste-Derived Fly Ashes.

Rumayor, Marta
2017

18360 (25/7/17)

SCR catalyst was converted to enhanced Hg oxidation catalyst by means of the SCR catalyst regeneration process.

RP-179

SIMULTANEOUS REMOVAL OF NO AND HG0 FROM COAL-COMBUSTION FLUE GASES USING RICE HUSK SIO2 MODIFIED BY COPPER RECYCLED FROM INDUSTRIAL WASTE.

CHEN, Ming-Yin[1]; HSI, Hsing-Cheng[1]; TSAI, Yun-Chih[2]; LIN, Hong-Ping[2];
(1) Graduate Institute of Environmental Engineering National Taiwan University, Taipei, Taiwan; (2) Department of Chemistry National Cheng Kung University, Tainan, Taiwan

mingying1225@gmail.com

Mercury (Hg) and NOx discharged from coal-fired power plants (CFPPs) have both received special concern owing to the high toxicity and long retention time in the environment of Hg and the formation of acid rain, photocatalytic smog and secondary PM2.5 from NOx. In this research, rice husk derived SiO2 impregnated by copper recycled from industrial waste was tested under a simulated flus gas condition for simultaneous removal of NO and Hg. CuOx of 10, 25, and 50 wt% was impregnated onto the rice husk derived SiO2. The BET result showed that the presence of CuOx increased the surface area as compared to the raw SiO2. 50 wt% CuOx/SiO2 having the highest BET surface area may lead to its best Hg and NO removal efficiency. Surface-treated catalysts were analyzed with XRD; however, there is no significant peak at high angle of 35.8° and 38.2° among all the samples, indicating that CuOx was highly dispersed on the surface, which can enhance the contact with the pollutants and lead to a greater conversion in catalytic oxidation of Hg0 and reduction of NO.

CuOx/SiO2 showed great NO removal efficiency between 200 and 400°C under the tested condition. 50% CuOx/SiO2 can achieve more than 60% NO removal efficiency under a broad operation temperature (250-400°C). The CuOx-modified SiO2 showed excellent Hg removal ability under 150°C. These results indicate that using rice husk derived SiO2 impregnated with copper recycled from industrial waste can be a feasible way for multipollutant control of Hg and NOx.

RP-180

PILOT-SCALE CAPTURE OF MERCURY, ARSENIC, AND SELENIUM FROM WARM SYNGAS AT ELEVATED PRESSURES BY PALLADIUM SORBENTS

HAMILTON, Hugh[1]; GRANITE, Evan[2];
(1) Johnson Matthey Technology Centre, Reading RG4; (9) NH, United Kingdom; (2) USDOE - NETL, Pittsburgh, PA, USA

hhamil@mathey.com

Warm gas cleanup of fuel gas from integrated gasification combined cycle power plants is important in order to preserve both their higher thermal efficiencies and to eliminate dirty water circulation and treatment systems. Ten pilot-scale tests of palladium on alumina sorbents for the removal of trace contaminants from several types of coal-derived syngas at elevated temperatures and pressures were conducted at the Southern Company National Carbon Capture Center. Between 96 – 100% removal of mercury, arsenic, and selenium from all syngas types, sour and sweet, was observed at 500 °F and elevated pressures of 150 – 200 psig. The results indicate that the Pd sorbents exhibit large capacities for the capture of Hg, Se, and As under varying conditions and over extended test periods. Current preliminary work also shows that the sorbent is not only regenerable, but that the sorbent is just as effective at capturing these contaminants after regeneration. Future work and tests will focus on use of lower loadings of Pd, higher syngas flow rates, and further regeneration cycles in the removal of the trace contaminants, as well as the possible removal of other contaminants.

RP-183

CONTROL OF MERCURY EMISSIONS – ALTERNATIVE METHODS

MEIER, John[1]; CHEN, Tommy[1]; ESPINOSA, Raul[1];
(1) NALCO Water | An Ecolab Company, Naperville, IL, USA

jmeier@nalco.com

With implementation of the EPA Mercury Air Toxics Standard (MATS) in the United States, electric generating units (EGUs) are required to achieve high levels of mercury reduction (excess 90% in most cases). While activated carbon is widely utilized to reduce mercury emissions to meet the MATS regulation, it often results in high operational costs and significant maintenance expense. With mercury emission limits approaching in the European Union, it is important to recognize alternative methods that utilize existing capital equipment to minimize mercury control impacts. Nalcos MerControl Technologies reduce mercury emissions via liquid based reagents, reducing operational costs and greatly increasing ease of application. Nalcos presentation will provide full-scale results achieved with novel MerControl technologies; including MerControl 8034 Plus (designed for wFGDs) and MerControl SD-Hg (designed for semi-dry scrubbers).

RP-184

MERCURY REMOVAL FROM WASTE INCINERATION FLUE GAS: HETEROGENEOUS OXIDATION AND CAPTURE BY WASTE-DERIVED FLY ASHES

RUMAYOR, Marta[1,2]; POHOŘELÝ, Michal[2]; ŠYC, Michal[2]; SVOBODA, Karel[2]; ŠVEHLA, Jaroslav[2];
(1) Department of Chemical & Biomolecular Engineering, University of Cantabria, Avda. Los Castros s/n, Santander, Spain; (2) Institute of Chemical Process Fundamentals of Czech Academy of Sciences, Prague, Czech Republic

marta.rumayor@unican.es

Among all heavy metals, mercury (Hg) is a pollutant of special concern due to its major impact on human health and the environment.

Incineration is one of the main waste management strategies used for the treatment of municipal solid waste (MSW), some which, consist of Hg-containing wastes, such as batteries, paint residues, thermometers, thermostats, light switches and others products which are discarded as household waste in MSW. Removal of Hg from MSW incineration flue gas is essential from the stand point of environmental pollution control. After incineration, all mercury content in waste is released as Hg0 which passes into the flue gas and is gradually oxidized (mainly into HgCl2 form), by both homogeneous and heterogeneous reactions. Some degree of Hg removal can be achieved by existing conventional air pollution control devices (APCDs), normally used to control NOx, SO2, and particulate matter. Hg bound to particles (Hgp) is usually the easiest species to be removed from flue gas as a co-benefit in existing emission control devices, such as fabric filters (FFs) or electrostatic precipitators (ESPs). Some Hg interaction/retention mechanisms have already been proposed in fly ashes from coal-fired power plants, however, fewer studies are still available concerned about fly ashes from MSW incineration. It must be taken into account that conditions of both processes are different, and therefore, the composition and characteristics of the resulting fly ashes cannot be always comparable. In this study, several samples of fly ashes (characterized by composition, surface area and carbon content) derived from MSW incineration were assessed for mercury removal under MSW incineration conditions at laboratory scale, using a fixed-bed quartz reactor packed with fly ash. The results obtained showed that unburned content, composition of flue gas (e.g. HCl and SO2 content) and operating temperature are important variables controlling capture of mercury. Fly ash enriched in unburned carbon can both, oxidize Hg0 and capture it effectively in presence of chloride. Surface area together with carbon content of fly ash and content of HCl in flue gas were correlated with the oxidation and adsorption of elemental mercury. The results obtained in this study may help to propose the interaction mechanism and to understand the fate/behavior of mercury in a baghouse, and provide a deeper knowledge of the impacts on fly ash properties in waste incineration.

RP-185

COST EFFECTIVE REDUCTION OF MERCURY USING POWDER ACTIVATED CARBON INJECTION

SATTERFIELD, John[1];
[1] CABOT NORIT Activated Carbon, Marshall/TX, USA

john.satterfield@cabotcorp.com

With more than a decade of user experience at a variety of utility scale coal-fired power plants, powder activated carbon has been thoroughly demonstrated as a powerful tool for the reduction of mercury emissions. Nevertheless, in the past sorbent usage costs required to sufficiently reduce mercury emissions could be prohibitively high due to a variety of factors negatively impacting the efficiency of the activated carbon sorbent. Such factors include Air Quality Control System (AQCS) configuration, fuel type, and the presence of Flue Gas Conditioning (FGC) with SO3. An additional factor which can significantly increase the required sorbent usage rate is the application of Dry Sorbent Injection (DSI) for acid gas (i.e. HCl, SO2) control. With previous generations of sorbent products a combination of these factors could often drive up sorbent usage costs required to meet emissions compliance to the point of being economically unfeasible. In response, new generations of powder activated carbon sorbentsdemonstrating significantly increased mercury removal efficiency and tolerance to DSI have been recently developed. This increased mercury removal efficiency and DSI tolerance has not only allowed a substantial reduction in sorbent usage costs required to meet mercury emissions compliance under both the Mercury and Air Toxics Standards (MATS) and Canadian provincial regulations, but can also reduce compliance costs globally. As demonstrated in both full-scale field trials and long-term usage at standard operating conditions, this represents a significant cost savings to the electric utility.

RP-187

A ZIRCONIUM-BASED METAL ORGANIC FRAMEWORK-CARBON HYBRID SORBENT FOR MERCURY AND OXYANIONIC HEAVY METAL REMOVAL

SOLIS, Kurt[1]; KIM, Moonhyeon[1]; HONG, Yongseok[1];
[1] Daegu University, Gyeongsan-si, Gyeongsanbuk-do, South Korea

kurtlouisbarbasa.solis@gmail.com

Adsorption using highly porous and highly functionalized sorbents is a straightforward removal technology currently being employed in wastewater treatment. Metal-organic frameworks are materials that have been gaining popularity in remediation technology due to their high surface areas, high specificity towards certain pollutants, as well as high structural integrity. Zirconium-based MOF, UiO66, has been shown to remove oxyanionic metal pollutants in water such as selenite, however, this study found out that it has low affinity for mercury. A novel sorbent was synthesized from activated carbon and UiO66 MOF via solvothermal method to remove both mercury and oxyanionic metals from aqueous solutions. The composite was characterized using FSEM-EDS, FT-IR, XRD, and TGA, and showed successful integration of the UiO66 and activated carbon components. The sorbent has a SBET of 1051 m2 g-1. Batch adsorption tests using CV-AFS and ion-chromatography reveal that the Hg 2+ and SeO3 2- uptake of the hybrid follows the pseudo-second order kinetics with observed Qmax values and rate constants of 249.9 mg g-1, k = 5.6E-05 and 177.2 mg g-1, k = 3.16E-05, respectively. The presence of equal concentrations of As, Cr, and Se does not significantly affect the adsorption performance of the hybrid for mercury. There was no definite effect of pH on Hg 2+ adsorption but a decrease in SeO3 2- uptake was observed at pH values higher than 7. The hybrid is a viable sorbent for both anionic and cationic heavy metal contaminants.