MEC3

5-7 June 2006
Katowice, Poland
AGENDA

DAY 1

08.00	Registration	Coffee sponsored by IEA CCC
09.00	Opening remarks and welcome on behalf of the sponsors/organisers:	
	Jozef Pacyna	NILU POLSKA
	John Topper	IEA CCC
	Session 1:	**Legislation and emissions**
	Chair:	Milena Horvat, Jozef Stefan Institute
	Rapporteur:	Lesley Sloss, IEA CCC

09.30 Mercury strategy development within the UN and EU; current global emissions and their future scenarios
Jozef M. Pacyna and Elisabeth G. Pacyna

10.00 Atmospheric mercury fluxes from anthropogenic sources in Poland and possible emission reduction measures
S Hlawiczka (Poland)

10.20 Mercury emissions and trends in Australia
P Nelson (Australia)

10.40 Questions and answers

11.00	Coffee	Sponsored by Gasmet
	Session 2:	**Mercury measurements in coal and flue gases**
	Chair:	Kazimierz Szynol, Podudniowy Koncern Energyczny
	Rapporteur:	Will Quick, Eon UK

11.30 Concentrations of mercury in Polish hard coals
K Bojarska (Poland)

11.50 Mercury emission from combustion of coal in SCIs
K Kubica, R Kubica (Poland), J Pacyna (Norway), S Pye, M Woodfield (UK)

12.10 Status of gaseous mercury calibration standards
S Mandel, Gerry Mitchell, J Ryan (USA)

12.30 Gasmet CMM: new continuous mercury monitoring system
P Jaakola, K Larjava, J Lehtomaki, T Rajamaki, J Roine, J Rasanen, I Salomaa, F Stenman (Finland)

12.50 Questions and answers

13.00	Lunch	Sponsored by Spectra Gases
	Session 3:	**Mercury behaviour in coal-fired power plants**
	Chair:	Tom Feeley, US DOE
	Rapporteur:	Wojciech Jozewicz, Arcadis

14.30 Oxidation of Mercury across SCR Catalysts in Electric Utility Power Plants
C Senior (USA)

14.50 Influence of Sewage Sludge Co-Combustion on Mercury Behaviour
H Thorwarth, G Scheffknecht (Germany)

15.10 Mercury behaviour in coal-fired power plant with sewage sludge co-combustion
J Tembrink, H-J Dieckmann (Germany)

15.30 Questions and answers

16.00	Coffee	Sponsored by Mitsui Babcock UK

16.30 Open forum and discussion – moderated by T Feeley and D Cousens
17.20 Discussion of location and date for MEC4

17.30 End of DAY 1

19.00 DINNER
A feast of traditional Silesian Fayre! Sponsored by Alstom
Slovenian wine Donated by Esotech d.d, Valenje, Slovenia

DAY 2

Session 4: Mercury control strategies and technologies
Chair: Nick Hutson, US EPA
Rapporteur: Ravi Srivastava, US EPA

09.00 An update on the US Department of Energy's Phase II and Phase III mercury control technology R&D program
T J Feeley (USA)
09.20 CEA mercury programme
D Cousins (Canada)
09.40 The removal of mercury in coal-fired power stations
R Meij. H te Winkel (Netherlands)
10.00 Questions and answers

10.30 Coffee Sponsored by NILU Polska

11.00 A summary of US EPA's Mercury Control Program and recent results
R Srivastava, N Hutson (USA)
11.20 Simultaneous removal of mercury and fine particulate matter from flue gas
J Korell, H-R Paur, H Seifert (Germany)
11.40 Efficient removal of mercury by auto-thermal fuel upgrading technology
R Kobylecki, M Wichlinski, Z Bis (Poland)
12.00 Questions and answers

12.30 Lunch Sponsored by Eon UK Ltd

Session 4: continued
Chair: Kari Larjava, VTT Processes
Rapporteur: Jens Korell, Forschungszentrum Karlsruhe

14.00 Pilot-scale testing of low-cost multi- pollutant control in Poland
M A Gostomczyk (Poland)
14.20 Bromine based mercury abatement – promising results from further full scale testing
B Vosteen (Germany), L Lindau (Sweden)
14.40 Effects of Halides on Mercury Retention in Wet FGD
R Kanefke, B Vosteen, H Koser (Germany)
15.00 Questions and answers

15.30 Coffee Sponsored by IEA CCC

16.00 Open forum and discussion - moderated by J Pacyna and L Sloss

17.30 End of DAY 2

19.00 DINNER Sponsored by NILU (Norway)

DAY 3

09.45 Pease meet in the hotel foyer for the Site Visit

ABSTRACTS

Session 1: Legislation and emissions

Mercury strategy development within the UN and EU; current global emissions and their future scenarios

Jozef M. Pacyna and Elisabeth G. Pacyna
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Review of strategies to reduce global emissions of mercury from anthropogenic sources has been made. In 2002, the Governing Council of UNEP initiated a global assessment of mercury and mercury compounds, carried out by UNEP in cooperation with other members of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC). The report describing the results of the UNEP global mercury assessment is available electronically from the following website: http://www.chem.unep.ch/mercury/Report/Final%20Assessment%20report.htm.

Main outcome of this report is discussed. Policy makers in Europe have taken the advantage of improved information on emissions available now in a number of the European countries. Following the preparation of a Position Paper on Ambient Air Pollution by Mercury (http://europa.eu.int/comm/environment/air/background.htm#mercury), the EU adopted the European Mercury Strategy Concerning Mercury. The main issues of this strategy are presented.

The largest emissions of Hg to the global atmosphere in 2000 occurred from combustion of fossil fuels, mainly coal in utility, industrial, and residential boilers. As much as two thirds of the total emission of ca. 2190 tonnes of Hg emitted from all anthropogenic sources worldwide in 2000 came from combustion of fossil fuels. The Asian countries contributed about 54% to the global Hg emission from anthropogenic sources in 2000, followed by Africa (18%) and Europe, including the European part of Russia (11%). China heads the list of the ten countries with highest Hg emissions from anthropogenic activities. With more than 600 tonnes of Hg, China contributes about 28% to the global emissions of mercury.

It is expected that future changes of Hg emissions from anthropogenic sources worldwide until the year 2020 should be within 20% of the current estimates, although this assessment should be treated with great caution.

Atmospheric mercury fluxes from anthropogenic sources in Poland and possible emission reduction measures

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The following processes are anthropogenic sources of Hg emission in Poland:
(i) energy production sector – combustion of hard and brown coal, fuel oil and coke in public and industrial power plants as well as in commercial, residential and institutional plants;
(ii) industry – processes of lead, zinc and copper production, processes in iron and steel industries and collieries, processes in coke, chlorine and cement production;
(iii) waste incineration – combustion of hospital and municipal wastes.

In 2004 the estimated atmospheric mercury emission from the country anthropogenic sources was 19.8 Mg. Fuel combustion for heat and power generation together with cement production were the most significant sources of the emission, with 60% and 29% of Hg emission, respectively. Mercury emission from metallurgy (8%) and the mercury cell process for chlorine production (2%) were much lower; others, including waste incineration, contributed only about 1%.

Hg emission reduction measures need to be focused on the energy generation sector. Main reason of great amount of Hg emitted from energy production sector in Poland is very high consumption of coal in Poland. In 2004 hard and brown coal consumption in the country was 1516625 TJ (ca 67.7 mln Mg) and 519368 TJ (ca 58.7 mln Mg) respectively. That is why application of primary methods of Hg emission reduction from energy production sector seems to be promising in Polish conditions. Switching from coal to liquid and gaseous fuels shows the highest potential not only for reducing Hg emission. Sorbent injection upstream of an electrostatic precipitator or fabric filter, mercury oxidation upstream of a wet or dry FGD and Hg capture on carbon sorbents should be also considered as priority in Polish conditions. Application of sorbents refers not only to coal combustion processes but also to the production of cement. For economic reasons it seems advisable that, apart from activated carbons as sorbents, application of zeolites obtained from power plant dust should be also considered. For chlorine production using the mercury cell electrolysis method, strict monitoring of Hg emissions and good housekeeping of Hg releasing processes is a recommendable approach. However, the main activity should focus on changing mercury-based technologies into membrane cell methods.

Atmospheric emissions of mercury from Australian point sources

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The UN Global Mercury Assessment (GMA) estimates that atmospheric emissions of mercury from Australian stationary combustion sources were 97.0 tonnes for the year of 1995. This is more than 90% of the estimated emissions from stationary combustion for the whole of North America, and seems an extraordinarily high number for a country with a population of around 20 million, in spite of the fact that most of Australia's stationary energy supply is provided by coal. New estimates of Australian mercury emissions, based on both a top down and bottom up approach, are presented. These estimates can be reconciled for black coal fired power stations, but suggest that the bottom up approach (the Australian National Pollutant Inventory) significantly under-estimates emissions from brown coal fired plant, if mercury capture efficiencies in these plants are low, as observed for lignite fired plant. Based on these estimates, Australian emissions of mercury from stationary energy are currently 2-5 tonnes/year, significantly lower than the GMA estimate.

Session 2: Mercury monitoring and modelling in combustion systems

Concentration of mercury in Polish hard coals

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The Department of Environmental Monitoring in Central Mining Institute, Katowice, Poland has been dealing with the analysis of mercury determination in hard coal for almost 20 years.

The mercury is determined by the flameless cold vapor atomic absorption technique followed by the digestion of coal sample in the mixture of sulfuric and nitric acids.The analytical results are collected in the database. Now the database has almost 1000 results of mercury determination. The results of statistical evaluation of mercury concentration in analyzed coal samples are presented in the paper. Only the results from the last 10 years and for the coals from the existing mines were taken into account for the calculation. There were only 620 such results.The mean concentration of mercury in Polish hard coals is 0,141 mg/kg. No correlation was found between mercury concentration and the concentration of ash in coal.

Mercury emissions from combustion of coal in SCIs

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In small combustion installations (SCIs) wide variety of fuels are used and several combustion technologies are applied. In particular the technologies for solid fuels and biomass utilization widely vary due to different fuel properties and technical possibilities. Different kind of solid fuels are used e.g.: hard coal, brown coal, solid coal fuels such as charcoal, coal patent fuels, coke, peat, solid biofuels such as virgin biomass (wood, straw), biomass briquettes and pellets. In solid fuels small combustion sources different techniques are applied than in large plants, due to technical and economic reasons. This is in particular valid for installations with thermal capacity less than 1 MWth.

The mercury content of coal fuels as well as solid biomass fuels varies widely, based on its origin (where it was extracted) and any processes it undergoes prior to sale on the market.

EF of mercury split for sectors and combustion technology of coal and biomass as well as speciation profiles split totals mercury emissions into elementary form (elemental Mercury vapour Hg0), reactive gaseous form (Reactive Gaseous Mercury, RGM), total particulate form (Total Particulate Mercury, TPM) are presented that were estimated under EC project *[Pye S., Jones G., Woodfield M., Kubica, K., Kubica R., Pacyna J.; at al; Costs and environmental effectiveness of options for reducing mercury emissions to air from small-scale combustion installations, AEAT/ED48706/ Final report v2, January 2006].*

Status of Gaseous Mercury Calibration Standards

Jeff Ryan (US EPA), Gerry Mitchell (NIST), Stephen Mandel (Spectra Gases)

The presentation will cover the status of calibration standards for mercury continuous emissions monitors. This will include both elemental Hg0 and oxidized Hg+2 standards. The development of these standards is being expedited due to the enactment in the United States of the CAMR (Clean Air Mercury Rule) which establishes a cap and trade program for mercury emissions from coal fired power plants.

Gasmet CMM: new continuous mercury monitoring system

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Gasmet CMM is a complete equipment to confront the forthcoming regulations for continuous mercury measurement standards in different combustion sources, like coal fired power plants or waste incinerators. Relying on proven technologies it is a robust, reliable, and cost-effective measurement system to meet the latest standards. Operation of the Gasmet CMM is based on atomic fluorescence spectroscopy and thermal catalytic conversion of ionic mercury compounds to atomic mercury. No wet chemistry is needed.

High inherent sensitivity of the atomic fluorescence spectroscopy enables extensive dilution of the sample gas. This is carried out in a probe unit, which employs an inertial filter for effective extraction of the sample flow from the stack gas. After instant thermal catalytic reduction of the mercury compounds in the diluted sample the dry gas containing only atomic mercury is transported to the analyzer. Calibration of the system is performed with a calibration unit combined with the probe unit. The system has low need for maintenance and provides an excellent solution for demanding industrial measurement conditions.

Oxidation of Mercury across SCR Catalysts in Electric Utility Power Plants

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A kinetic model for predicting the amount of mercury oxidation across Selective Catalytic Reduction (SCR) systems in coal-fired power plants was developed and tested. The model incorporated the effects of diffusion within the porous SCR catalyst and the competition between ammonia and mercury for active sites on the catalyst. Laboratory data on mercury oxidation in simulated flue gas and slipstream data on mercury oxidation in flue gas from power plants were modeled. The model provided good fits to the data for eight different catalysts, both plate and monolith, across a temperature range of 280°C to 420°C, with space velocities varying from 1,900 to 5,000 hr-1. Space velocity, temperature, HCl content of the flue gas, ratio of ammonia to NO and catalyst design all affected mercury oxidation across SCR catalyst. The model can be used to predict the impact of coal properties, catalyst design and operating conditions on mercury oxidation across SCRs. The model has been applied to full-scale mercury oxidation by comparing model predictions with data obtained from measurements at full-scale power plants.

Influence of Sewage Sludge Co-Combustion on Mercury Behaviour

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Measurements at full-scale power plant installations in the past have shown co-beneficial effects of existing flue gas cleaning technologies on the removal of heavy metals. However, the behaviour of trace elements along the flue gas path and the effects of operational parameters influencing the removal efficiencies are not fully understood. Especially the behaviour of mercury, due to its high volatility and interaction with different flue gas and fly ash components represents a challenge for researchers, system manufacturers and plant operators.

Thereby, the use of existing air pollution control devices is the most cost effective way. E.g. the mercury separation efficiency of single flue gas cleaning plants depends strongly on the shares of elemental (Hg^0) and ionic mercury ($HgCl_2$). While $HgCl_2$ gets due to its water solubility separated in the wet Flue Gas Desulphurization (FGD) plant, Hg^0 passes the wet scrubber unaffectedly. Another important sink for mercury is the fly ash filtering system, which is even more important in power plants without FGD-systems. It is therefore important to increase the shares of ionic and particle bound mercury in flue gases prior to and within the mentioned air pollution control devices. Co-combustion of secondary fuels like straw and sewage sludge influences the mercury behaviour and is therefore potentially able to reduce or increase the mercury emissions from coal fired power plants.

Within the framework of the EU-project TOMERED (Reduction of Toxic Metal Emissions from Industrial Combustion Plants – Impact of Emission Control Technologies), studies have been carried out at a 0,5MWth pilot plant. At these tests the role of SCR-Catalysts, Electrostatic precipitators and Fabric Filters regarding their influence on mercury behaviour have been investigated with a special emphasis on the influence of secondary fuels.

The proposed paper will cover the following aspects:
1 Behaviour of mercury in power plants.
2 Effect of commercially available air pollution control devices on mercury removal.
3 Results of experimental investigations on the influence of applied emission control technologies on mercury speciation, related to the influence of sewage sludge co-firing.

Mercury behaviour in coal-fired power plant with sewage sludge co-combustion

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Secondary fuels like wood, straw and sewage sludge are more and more common in coal-fired power plants. Especially during co-incineration of municipal sewage sludge mercury is one of the main topics. Other relevant heavy metals in the flue gas stream are widely bound in the fly ash particles and are effectively removed from the flue gas by the installed ESPs. For mercury separation in coal-fired power plants the effectivity of particle precipitation is less important. In many investigated plants in Germany the main mercury removal takes place in the flue gas desulphurisation device (FGD). Hereby a widely oxidation of elemental mercury in the flue gas is essential for a sufficient purification of the flue gas. In coal-fired power plants the oxidation of mercury is supported by SCR-DENOX catalysts.

In the framework of the EU-project TOMERED (Reduction of Toxic Metal Emissions from Industrial Combustion Plants) test campaigns with co-incineration of bio-mass in coal-fired power plants were performed in The Netherlands, UK and Germany. The scope of the investigations covered all relevant mass flows including the flue gas path. The results were evaluated as element specific mass-balances.

This presentation describes the results of measuring campaigns in German power plants with dry ash and wet bottom furnaces. Both plants were equipped with high-dust SCR DENOX plants, ESPs and lime stone based wet scrubber FGDs. The results describe the mercury mass flows in full-load operation of the power plants and the distribution of the mercury species at major locations along the flue gas path.

Session 4: Mercury control strategies and technologies

An update on the US Department of Energy's Phase II and Phase III mercury control technology R&D program

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Mercury exists in trace amounts in coal. In the United States, coal-fired power plants emit about 48 tons of mercury and are the largest point source of emissions. The U.S. Environmental Protection Agency determined the need to control mercury emissions from power plants and issued regulations on March 15, 2005 under the Clean Air Mercury Rule.

Recognizing the potential for mercury regulations, the U.S. Department of Energy/National Energy Technology Laboratory (DOE/NETL) has been carrying out a comprehensive mercury research and development (R&D) program since the early 1990s. Working collaboratively with EPRI, industry, academia, and EPA, DOE/NETL has helped to advance the understanding of the formation, distribution, and capture of mercury. However, uncertainty remains, particularly related to the overall cost and effectiveness of controlling mercury from a diverse population of coal-fired boilers, as well as the ultimate fate of mercury once it is removed from the flue gas.

This presentation will provide an update on DOE/NETL's Phase II and Phase III mercury field testing program directed at full-scale and slip-stream evaluation of sorbent injection (e.g., activated carbon) and oxidation processes and technologies that have the capability to achieve 50%-70% capture (Phase II) and +90% capture (Phase III) of mercury from operating coal-fired power plants. In addition, results from the characterization of mercury in coal combustion byproducts collected from the Phase II field testing program will be presented.

Planning for management of a blended fuel system: use of coal and petroleum coke blends under the Canada-wide Standard for Mercury emissions from Electricity Power Generation: Update 2006

Des Cousens, Senior Specialist, Environment (Policy and Operations), Nova Scotia Power Incorporated, Halifax, Nova Scotia, Canada, des.cousens@nspower.ca

A Canada-wide Standard will require that certain facilities must meet a system-wide cap on Mercury Emissions from coal-fired electricity generation by 2010. Nova Scotia Power purchases Coal and Petroleum Coke from world markets to fire with indigenous coals in various blends within 1250 MW of capacity at four facilities. The optimal design of system operations, including the use of controls for Mercury emissions, is discussed. Issues related to Design and Operation for management of Mercury emissions are complicated by the use of fuel blends with variable concentrations of both Mercury and relevant other attributes. The measurement of Mercury emissions for compliance determination is discussed in the context of the new Canada-wide Standard for Mercury Emissions from the Electricity Power Generation systems. The Canada-wide Standard is expected to be signed by Canadian regulators in 2006

The removal of mercury in coal-fired power stations

Dr. Ruud. Meij, Henk te Winkel
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Coal-fired power stations in the European Community have to be equipped in the year 2008 with flue gas cleaning systems for removal of nitrogen oxides, particulates and sulfur oxides. KEMA research since 1980 at Dutch coal-fired power stations shows that these cleaning systems also influence and/or remove other compounds than nitrogen oxides, particulates and sulfur oxides, respectively. One of the compounds investigated in detail is mercury. The removal of mercury is measured in cold side ESPs 44 times, in wet FGD's 58 times, in combination of ESPs and FGD 15 times and in combination of SCR type of DeNOx, ESP and FGD 11 times. In most cases all the relevant parameters were monitored: Cl content of the coal, temperature ESP, LOI in the ash and calcium content of the ash. It appears that on average 56% of the mercury was removed in the ESP, 48% in the FGD and 78% in the ESP and FGD together. 84% was removed in the combination SCR, ESP and FGD. The removal in the ESP can be quantified by the speciation of the mercury, which could be explained by the above mentioned parameters.

In the ToMeRed program, subsidized by the EU, mercury removals in power stations of Germany, Italy, UK and the Netherlands were determined The removal of gaseous total mercury in the wet scrubber of the FGD, as found in the ToMeRed campaigns, is on average 59±15% (n=9). This is in agreement with the ICR data from the USA for bituminous coal of 54±18% (n=11) and with Dutch figures of KEMA (n=59). The removal rate for mercury across FGDs depends on the speciation of mercury entering the FGD. The speciation depends on a lot of parameters (as mentioned above) therefore it is better to compare the removal rate in FGD for Hg(0) and Hg^{2+}. The increase of Hg(0) in the FGD, as is sometimes found, can be caused by redox reactions in the scrubber liquid and/or the results of subtraction of two small figures with large uncertainties.

A summary of US EPA's Mercury Control Program and recent results

R Srivastava, N Hutson, US Environmental Protection Agency, USA

No abstract available.

Simultaneous removal of mercury and fine particulate matter from flue gas

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At Forschungszentrum Karlsruhe, different flue gas cleaning processes have been developed. In the MercOx process, elemental water insoluble mercury is oxidised by hydrogen peroxide and adsorbed in a packed column. In the CAROLA process, submicron particles are charged by corona discharge. The charged particles are precipitated in a field-tree collector stage downstream of the ionisation stage. The compact collector consists of a grounded tube bundle.

A pilot scrubber for the simultaneous removal of mercury and fine particles has been operated in the bypass of a waste incineration plant. A dry speciation method for gaseous mercury developed at Forschungszentrum Karlsruhe was used for the experiments at the pilot plant. The speciation system consists of a serial connection of selective adsorbents. The adsorbent for oxidised mercury is the basic Dowex exchange resin loaded with chloride ions. Elemental mercury is collected on Anasorb C300, a mixture of metal oxides. After the sampling each adsrobent is extracted by HNO_3/HCl and the mercury concentration in the solutions is determined by atomic absorption spectroscopy.

By manual sampling of raw and clean gas of the scrubber, the removal efficiencies for mercury and submicron particles have been determined. Mercury removal efficiencies of up to 95% have been determined. A number of aerosol removal experiments were conducted with different settings of the ESP module CAROLA. Depending on the set voltage and the flue gas conditions, a certain current was established at the ionizer. At the lowest ionizer power 96% aerosol removal efficiency was determined.

With the described multifunctional scrubber, high removal efficiencies for mercury and aerosols can be achieved. The advantages of this combined process are its compact construction and a low pressure drop, which make it easy to retrofit in existing wet scrubbers. In coal-fired power plants, this combination for the removal of mercury and fine particles could be added to the flue gas cleaning on top of the SO2 scrubber (FGD).

Efficient removal of mercury by auto-thermal fuel up-grading technology

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Since coal fired power stations are major sources of atmospheric mercury emission, the problem of cheap and efficient removal of mercury from coal combustion flue gases is becoming a more and more serious issue.

After implementation of EPA's mercury emission limits for the power stations in the US, more and more countries have started preparations to set up their own standards. However, before proposing a technically acceptable efficient method of effective mercury removal from the flue gases a detailed investigation of local power market conditions must be conducted. Accordingly, in the present paper the results of detailed investigations on the concentration of Hg in Polish coals are presented. Some of the results for main Polish 'power plant coals' are shown in Fig. 1. Although generally the mercury concentration in those coals is quite low, some of them contain relatively large amount of Hg. Accordingly, burning those 'mercury-rich' coals for power production is probably associated with quite high concentration of Hg in the flue gas, and countermeasures must be performed in order to provide an efficient, cheap and reliable technology of mercury removal in a large-scale.

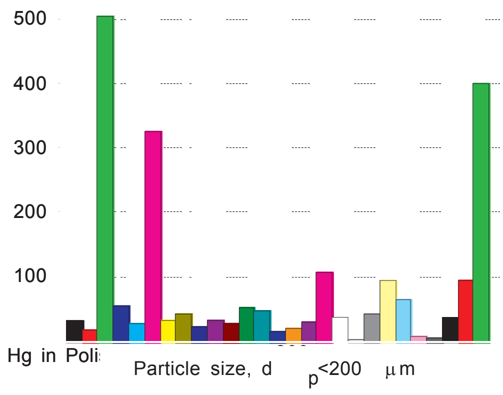

Fig. 1. Average concentration of mercury in main Polish coals used for power production.

Basically, there are two main ways to get rid of mercury, i.e. either to remove it from the fuel before combustion or to separate it from the flue gases. The authors of this paper propose application of the technology of autothermal upgrading for efficient removal of mercury. That technology was chosen since getting rid of Hg before the combustor seems to be more efficient and cheaper than mercury removal from the flue gases in classical installations. This is mainly due to the fact that in traditional gas cleanup systems the mercury is diluted in a large amount of the flue gas, thus resulting in lower efficiencies.

The authors constructed a 170 kW autothermal pilot-scale reactor and demonstrated that by exothermic thermal treatment of the fuel the mercury removal efficiencies of over 99.5% can be achieved. The final products of the fuel upgrading process are gas of mercury concentration much higher than in 'classical' combustion flue gases, and an almost mercury-free upgraded fuel of LHV 25–33.5 MJ/kg.

Pilot-scale testing of low-cost multi- pollutant control in Poland

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Institute of Power Engineering and Fluid Mechanics, Department of Atmosphere Protection, Poland

This paper presents the pilot testing results of multi-pollutant control from pulverized coal-fired boiler OP-430 (317 MWth) performed at pilot plant located at the Wroclaw Heat- Power Station, Poland. The experimental results include sulfur dioxide (SO_2), nitrogen oxides (NOx) and mercury (Hg) emissions control. Low cost multi-pollutant control technology was elaborated on the basis of obtained results, which details are presented herein. This low cost technology is based on process modification of existing dry or semi-dry flue gas desulphurization system by injection of different mineral sorbents and oxidants and collection of by-product on fabric filer. The experimental results described herein combine the use of solution of sodium hypochlorite, calcium hypochlorite, hydrogen peroxide, ozone and dry calcium hydroxide injection in precisely chosen combinations and conditions; provide SOx, NOx, Mercury (Hg) controls. This paper includes also cost analysis of presented solutions, name of technology is MERSI (EEP Award 2005 ten nominee).

Bromine based mercury abatement – promising results from further full scale testing

Prof. Dr.-Ing. Bernhard W. Vosteen, Vosteen Consulting GmbH, Cologne,
Dr. Leif Lindau, ALSTOM Power (Environmental Control Systems), Växjö, Sweden

Prof. Vosteen in Germany invented the bromine based additive technology in 2000. The technology has been commercially applied in some German waste incineration plants since 2001, as already reported at MEC2 (Ottawa, May 2005), further at EUEC (Tucson, January 2006) and lately at IT3 (Savannah, May 2006) [1].

The technology is protected by both patent applications and patents that have been issued in Germany (DE 10233173) and in the USA (US Pat 6,878,358). ALSTOM has been granted an exclusive license from Vosteen Consulting GmbH for joint exploitation and commercialization of the technology on utility and industrial processes in the United States and Canada [2].

In July 2005, US EPRI has been granted a R&D license for testing the technology at coal fired power stations.

In North America , the technology is marketed by ALSTOM under the trade name KNXTM Coal Additive Technology as an ALSTOM proprietary process where a bromine-containing chemical is added to the fuel in a coal-fired boiler. The technology has been tested at different coal fired US power stations, mainly in DOE related projects. Some of the highly promising results will be presented.

In August 2006, the technology will be tested at a PRB-fired unit (700 MWe) in Southern Company's plant Miller (high dust SCR). In co-operation of Southern Company with US EPRI it shall be demonstrated that tiny amounts of KNX TM will assure almost complete mercury oxidation during SCR passage, corresponding to own laboratory results, but in contrast to other findings in the critical case of only PRB coal [3].

[1] Vosteen, B., Kanefke K., Köser, H.: „Bromine-enhanced Mercury Abatement from Combustion Flue Gases – Recent Industrial Applications and Laboratory Research", VGB PowerTech 3/2006, page 70 – 75
[2] Buschmann, J., Lindau, L., Vosteen, B.: "The KNXTM Coal Additive Technology – A Simple Solution for Mercury Emissions Control", white paper at US PowerGen, December 2005
3] Lee, C.W, Srivastava, R. K. et al.: "Pilot-Scale Study of the Effect of Selective Catalytic Reduction Catalyst on Mercury Speciation in Illinois and Powder River Basin Coal Combustion Flue Gases", Journal of the Air & Waste Management Association, volume 56, May 2006, page 643 - 649

Effects of Halides on Mercury Retention in Wet FGD

Prof. Dr.-Ing. Bernhard W. Vosteen, Vosteen Consulting GmbH, Cologne,
Dipl.-Ing. Rico Kanefke and Prof. Dr.-Ing. habil. Heinz Köser, Martin-Luther-University Halle-Wittenberg (MLU), Merseburg

This paper, which was already presented at EUEC in Tucson, January 2006, [1], gives partially new insights into the mercury behaviour in scrubbers as gained by laboratory test runs at the MLU. Mercury complexation by chlorides and bromides was studied in detail. Halides and especially bromide can protect dissolved mercury against reduction back to the highly volatile elemental mercury and thus prevent dissolved mercury from re-emission into the scrubbed flue gas.

[1] Kanefke R., Vosteen, B., Köser, H.: „ Effects of Bromide on Removal of Mercury in Scrubbers", 9th Annual EPA, DOE, EPRI, EEI Conference on Clean Air, Mercury, Global Warming & Renewable Energy , Westin La Paloma Resort, Tucson, Arizona, Track B7, Nr. 4 – Mercury – Wednesday 01/25/2006

Delegates

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Finland	
K Larjava	VTT Processes
Ikka Salomaa	Gasmet Technologies Oy
Germany	
J Korell	Forschungszentrum Karlsruhe
H Thorwarth	Institute for Process Engineering and Power Plant Technology
B Vosteen	Vosteen Consulting
Japan	
N Fujiwara	Idemitsu Kosan Co Ltd
H Moritomi	Gifu University
Netherlands	
R Meij	KEMA
Norway	
J Pacyna	NILU
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K Bojarska	Central Mining Institute, Dept of Environmental Monitoring
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M Gostomczyk	Wroclow University of Technology
A Glodek	NILU Polska
S Hlawiczka	Institute for Ecology of Industrial Areas
R Kobylecki	Czestochowa University of Technology
Z Krzemien	Elektrownia Rybnik SA
A Ksiadz	Institute of Thermal Technology SUT
K Kubica	NILU Polska
A Kucinski	Vattenfall Heat Poland SA
L Sebesta	Voivodship Inspectorate for Environmental Protection in Kracow
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L Rog	GIG
P Rompalski	GIG
A Smolinski	GIG
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A Stevenson	Spectra Gases
John Topper	IEA Clean Coal Centre
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T Feeley	US Department of Energy, National Energy Technology Laboratory
N Hutson	US Environmental Protection Agency
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S Mandel	Spectra Gases
J Pavlish	EERC
C Senior	Reaction Engineering International
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