Questions from the OPTOCE Academic Collaboration Webinar

23 June 2021

Questions to Professor Yan Dahai:

Question: Do you practise any cut-off limits (upper content limit) for the heavy metal contents in the incoming waste feed stock (from Christian J. Engelsen, SINTEF)?

Answer: In the Chinese co-processing standard, there are feeding rate limits for heavy metal, Cl, F and S including all materials into the kiln (coal, raw materials and waste), not only the incoming waste.

Question: 200 t/d floating material is quite a lot, what brand and estimate investment of bio dry technology applied in the Yangtze River pilot (Boonchai, Ecocycle Thailand)?

Answer: The investment of a bio-dry project (including RDF making and feeding) for MSW with the capacity of 350t/h is about 70 million RMB.

Questions to Professor Visu:

Question: What is the microplastic sampling and analysis procedure (Professor Trinh)?

Answer: The leachate and run-off samples collected from the dumpsite is subjected to Wet sieving through 0.3 mm sieve. The sieved solids are then subjected to Wet peroxide Oxidation to degrade organic matter present in them. The mass of microplastics are determined and examined under the microscope.

Question: How can drones identify and quantify plastic waste at the dumpsites (Professor Trinh)?

Answer: The total quantification of plastics among the various other fractions is carried out by two stages.

a) The first stage involves waste composition analysis of excavated MSW fractions dumped at different layers of depth. In addition to that, categorization of various polymer types of plastics such as PET, HDPE, PP, etc. are calculated.

b) The second stage involves dumpsite volume quantification using DJI Phantom 4 Pro Drone with accurate GPS points.

The total quantified volume is correlated with the field density and compositional analysis to estimate the plastics along with its polymer types.

Questions to Professor Ghosh (and/or Dr Karstensen):

Question: I have a question on the co-combustion of plastic waste in cement industry. Did you measure air pollutants in the emissions, especially the dioxin/furan to conclude safe process (Professor Trinh)?

Answer by Professor Ghosh: The team of researchers have not air pollutants in the emissions, especially the dioxin/furan. However, the plant has a continuous emission monitoring system which measures as the emission parameters including the dioxin/furan which have been noted by the researchers. With respect to the emission including the dioxin/furan, the co-processing is safe and at well below to the compliance limits of the applicable rules and regulations.

Complementary answer by Dr Karstensen: There is no continuous emission monitoring system available for PCDD/PCDFs in stack gases from cement plants (or others). The current emission limit value (ELV) for PCDD/PCDFs in Europe today 0.1 ng I-TEQ PCDD/PCDFs/Nm3 and the quantification of PCDD/PCDFs in stack gas requires sophisticated sampling equipment/procedures and subsequent analysis by high-resolution gas chromatograph/high-resolution mass spectrometer (HR GS/LC-MS) at an advanced laboratory, complying with the European Standard EN-1948:2006. The clean up and quantification is costly and time consuming at these low concentration levels and can only be carried out at accredited laboratories; hence, there is no continuous emission monitoring system available for PCDD/PCDFs in stack gases. A "long-term" automated **sampling** system has however been tested where exit gas is sucked continuously from the stack over a period of 15-30 days; the subsequent absorbent is then sent for analysis and the result will represent a longer period than a normal 6–8-hour sampling campaign. The performance and reliability of this system has however not been satisfactory, and the system is not in practical usage for the time being.

Extensive information about Co-processing of wastes in cement kilns and its possible impact on dioxin emissions can be found in the article: *Karstensen, K. H., 2008. Formation, release, and control of dioxins in cement kilns – A review. Chemosphere, 70 (2008) 543–560. ISSN: 0045-6535* (this article can also be found on our webpage).

Cement plants Co-processing of wastes in Vietnam, and many other countries, must measure and report their PCDD/PCDF emissions to the authorities twice a year, i.e., one sampling and analysis every six months. Some plants must carry out a separate Test Burn or make additional sampling and measurement if they want to treat Persistent Organic Pollutants (POPs).

According to the Vietnamese Regulation QCVN 41, the current emission limit value (ELV) D/F is 0.6 ng I-TEQ PCDD/PCDFs/Nm3, but location and capacity of the plant must be taken into consideration. Our collaborating partner INSEE has an ELV of 0.384 ng I-TEQ PCDD/PCDFs/Nm3 for the plant in Hon Chong, which might be revised to 0.1 ng in 2024.

Question: Follow up to above question: what measures in relation to emission legislation are in place for those emissions and toxic combustion products (Simon, AIT)?

Answer: Cement industry contributes to environmental pollution in the environment in the form of emissions of Particulate Matter, SOx, NOx, VOC, etc. The major release of CO2 happens from the calcination of limestone. By using already calcined lime bearing wastes in the cement manufacture, the limestone usage gets reduced and hence the CO2 emissions. Moreover, CO2 emission reduction is achieved by the use of wastes as Alternative Fuels and Raw materials in co-processing.

The major emission concerns from cement plant are NOx & SOx from the use of sulfur containing raw materials. The SOx can be converted into gypsum using the FGD technology. Both SOx and NOx can be converted into Ammonium Sulphate and Ammonium Nitrate fertilizer. This technology development has been done in Japan. Commercial application of this Process has also been achieved.

Less than 10 years ago it was believed that the cement industry was the main contributor of PCDD/PCDFs to air; however, data collected from around the world indicates however that the industry contributes with less than 1% of total emissions to air (see below: Karstensen, K.H., 2006). Data from operating units show that most modern cement kilns co-processing waste meet an emission level of 0.1ngI-TEQ/Nm3, when well managed and operated. Proper and responsible use of waste including organic hazardous waste to replace parts of the fossil fuel does not seem to increase formation of PCDD/PCDFs. Modern preheater/precalciner kilns generally seems to have lower emissions than older wet-process cement kilns. It seems that the main factors stimulating formation of PCDD/PCDFs is the availability of organics in the raw material and the temperature of the air pollution control device. Feeding of materials containing elevated concentrations of organics as part of raw-material-mix should therefore be avoided and the exhaust gases should be cooled down quickly in long wet and long dry cement kilns without preheating. References to further reading:

Karstensen, K.H., 2006. Formation and Release of POPs in the Global Cement Industry - Second Edition. Report to the World Business Council for Sustainable Development. 30 January. *file:///C:/Users/khk/Downloads/FormationAndReleaseOfPOPsInCementIndustry_2ndEdition.pdf*

Karstensen, K. H., 2006. Co-processing of hazardous wastes in cement kilns - an important factor in the formation of dioxins? Norwegian University of Science and Technology, Faculty of Natural Sciences and Technology, Department of Chemistry. ISBN 82-471-8192-4 (printed version) ISBN 82-471-8191-6 (electronic version) ISSN 1503-8181. October.

Karstensen, K. H., Kinh, N. K., Thangc, L. B., Viet, P. H., Tuan, N. D., Toi, D. T., Hung, N. H., Quan, T. M., Hanh, L. D., Thang. D. H., 2006. Environmentally Sound Destruction of Obsolete Pesticides in Developing Countries Using Cement Kilns. Environmental Science & Policy, Volume 9 - Issue 6 - October 2006, 577-586. ISSN No. 1462-9011.

Questions to Dr Karstensen:

Question: Regarding plastics in cities, and discussion separation aspects. I wonder if source of plastics at households will account for education of the general population regarding use, separation and disposal which I think is the root (besides well... production of course). Both questions come from my reading on the information I see on the main goals and research lines at the website (Simon, AIT).

Answer: Yes, that is correct. In few cases, the academic collaboration under OPTOCE project has conducted perception surveys, for example, in India and Vietnam. In Vietnam, SINTEF collaborates with UNDP which is conducting such outreach and awareness campaigns at household level.

Question: I wonder if the EU green deal includes assisting the giant plastic producers into a transition to alternative materials? I feel the finance hold producers have in a large number of industries including packaging, is a huge obstacle to shift production systems into bio-based materials. I've read about many projects about this, been a part of one, but it just never takes off from a practise, legislation point of view. So reuse and incorporation of plastic in circular economy models is great and needed, but the production root will however remain at this rate and indeed the private sector is always in the dark feeling their business is under "attack" and the transition is halted (Simon, AIT).

Answer: The European Green Deal, a radical project aiming to make the world's second-largest economy, climate-neutral by 2050. By that date, the European Union is expected to have no net emissions of greenhouse gases and its economic growth should be decoupled from resource use. The European Green Deal is a policy initiative that will result in a legislative firestorm centred around nine policy areas which are key to achieve the ambitious goals: biodiversity; from farm to fork; sustainable agriculture; clean energy; sustainable industry; building and renovating; sustainable mobility; eliminating pollution; and climate action.

Another target area to achieve the EU's climate goals is the introduction of the Circular Economy Industrial policy, which also entails the "decarbonisation and modernisation of energy-intensive industries such as steel and cement." A 'Sustainable products' policy is also projected to be introduced which will focus on reducing the wastage of materials. This aims to ensure products will be reused and recycling processes will be reinforced. The materials particularly focused on include "textiles, construction, vehicles, batteries, electronics and plastics." The European Union is also of the opinion that it "should stop exporting its waste outside of the EU" and it will therefore "revisit the rules on waste shipments and illegal exports".

The 'Zero Pollution Action Plan' that aims to be adopted by the commission in July 2021 intends to achieve no pollution from "all sources", cleaning the air, water, and soil by 2050. The Environment Quality standards are to be fully met, enforcing all industrial activities to be within toxic-free environments. Agricultural and urban industries water management policies will be overlooked to suit the "no harm" policy. **Harmful resources such as micro-plastics** and chemicals, such as pharmaceuticals, that are threatening the environment **aim to be substituted** to reach this goal.

Questions that were answered in the webinar:

Question to Dr Karstensen: is there any estimation of CO2 emission reductions overall if we replace fossil fuels (coal) with non-recyclable plastics? E.g. treating 50kt per year in one cement plant that traditionally uses coal (Bruno Fux, Ecocycle Vietnam)?

Answer: Direct emissions need to be further investigated as plastic is basically fossil fuel based; however indirect emissions reduction (by avoiding landfilling) will be significant. Following the IPCC default emission factors, considering PW CV as 4000 kcal/kg; for a 50 kt PW co-processing plant, the direct reductions can be calculated in the range of 15 -20 ktCO2.

Question to Professor Visu/Dr Karstensen: when talking about plastic mining at dumpsites and landfills, is the concern of methane emissions considered when disturbing the high organic carbon loaded sites (Simon, AIT)?

Answer: This needs further investigation, i.e. what is the differential Methane emissions on account of landfill mining to extract valuable materials such as Plastics, recyclable concrete, organic matter (for composting) and soil/stone like materials. But if the landfill is not mined and valuable materials extracted the Methane emissions will be continuous anyway.

Question to Professor Trinh: what procedure was followed while collection of samples (Sourya, Jadavpur University)?

Answer: We collected waste samples from generation sources (households, household businesses, schools, supermarkets, public parks) and those from dumpsites/landfills.

Regarding the collection of samples from generation sources, we sent a plastic sac to collect waste to each household… at around 5-6 pm and collected them at around 5-6 p.m of the next day to make sure that there were people present at home and that we collected a representative amount of solid waste, including plastic wastes for a day (24 h). The collected samples were manually sorted in the lab to select plastic wastes for further studies, and to figure out the proportion of each faction (organics, wood, brick, glass…).

As regards the collection of samples at dumpsites/landfills, we used an excavator at each site to collect samples at different depth from the surface (1 m, 2 m, and 3 m). each depth level a sample was collected from the bucket. The mixture in the bucket was then separated by hands to figure out the proportion of different types of wastes, especially the plastic waste fraction. The leachate was also sampled at 1 m, 2 m, and 3 m depth. The practical sampling guideline can be found in the CEN/TR 15310.