Experiences from other international processes; Basel and Stockholm convention

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Launching of Cement Industry Sector Partnership under the UNEP Global Mercury Partnership.
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UN chemicals and waste conventions

Chemicals contribute to many advantages to today's world; however their use can also pose risks to human health and the environment. To reduce this harmful global impact, three conventions have been established that regulate chemicals and hazardous waste at global level; the Basel, Rotterdam and Stockholm convention.
Origin of the UN chemicals and waste conventions

• Movements of hazardous wastes from industrialised to industrialising countries for ‘treatment’ or ‘disposal’.

• Hazardous waste disposal costs in industrialised countries were high, regulations becoming stricter.

• Disposal costs in developing economies were low, few regulations, low standards.

• No legal framework to control ‘dumping’.

• Lack of awareness and lack of technical knowledge.
Rotterdam Convention

Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade currently regulates information about the export/import of 43 hazardous chemicals listed in the Convention’s Annex III, 32 of which are pesticides (including 4 severely hazardous pesticide formulations) and 11 of which are industrial chemicals.

The Convention was adopted in 1998 and entered into force in 2004. It currently has 152 Parties.
Stockholm Convention

The Stockholm Convention on Persistent Organic Pollutants currently regulates 22 toxic substances that are persistent, travel long distances, bio-accumulate in organisms and are toxic.

The Convention was adopted in 2001 and entered into force in 2004. It currently has 179 Parties.
Endocrine disrupting chemicals have probably worse impacts than earlier anticipated....
Objectives of the Stockholm Convention on Persistent Organic Pollutants (POPs)

“elimination or restriction of production and use of all intentionally produced POPs, disposal of stockpiles and wastes, and the continuing minimization and, where feasible, ultimate elimination of releases of unintentionally produced POPs such as dioxins and furans”
Basel Convention

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal regulates the export/import of hazardous waste and waste containing hazardous chemicals.

The Convention was adopted in 1989 and entered into force in 1992. It currently has 180 Parties.
Objectives of the Basel Convention

- To protect human health and the environment against adverse effects of hazardous wastes.
- Reduction of transboundary movements of hazardous wastes.
- Minimisation of generation - quantity and degree of hazard.
- Promotion of local solutions and environmentally sound management of hazardous wastes.
The problem is that most emerging economies have limited or no disposal capacity for hazardous wastes…
Danish burn fingers on cement kiln project

Controversy is growing over a Danish funded project to convert a cement kiln in Mozambique for the incineration of obsolete pesticides. Danish aid agency DANIDA is investing DKK 42 million (US$ 6 million) in upgrading the cement kiln, collecting 540 tonnes of obsolete pesticides from 69 locations and managing the disposal operation.

Disposal of obsolete pesticides in developing countries has usually relied on repackaging the chemicals and transport for incineration in dedicated toxic waste facilities in Europe. In this case DANIDA believed that it is helping to solve Mozambique’s obsolete pesticides problem while making the cement kiln more economically viable. Therein lies the root of criticisms targeted against the project.

South African Based Environmental Justice Networking Forum (EJNF) alleges that the contractor hired to collect the pesticides in Mozambique and deliver them to the cement kiln has tried to import waste from other countries for incineration in Africa. This raises concerns that the Mozambique facility will be seen as a regional resource and will attract toxic waste from elsewhere.

Incinerator operators charge for the destruction of toxic waste, and in cement kilns the waste can often augment or replace regular fuel which needs to be purchased. However, emission controls are less sophisticated on cement kilns than on dedicated toxic waste incinerators and there is a risk that seriously hazardous pollutants such as dioxins will be emitted.

Advocates of cement kilns claim that the higher incineration temperatures (up to 2000°C in cement kilns; around 1200°C in dedicated incinerators), longer residence times of the waste at those temperatures and the emission controls which are in place prevent the formation and emission of dioxins or other pollutants. Norway for example, uses cement kilns to incinerate all its toxic waste and claims to meet the most stringent emission standards. Others are less convinced.

Greenpeace and the Basel Action Network in support of EJNF claim that DANIDA has “refused to conduct a true comparison of all available
"Perceptions" about cement kilns treating hazardous wastes treatment ten years ago – two examples

1. A cement kiln project was stopped in Mozambique in 2001 due to a combination of fear, active opposition, inferior preparation, lack of communication, improper technical knowledge and the absence of internationally accepted guidance documents.

2. The Stockholm Convention mention cement kilns firing hazardous was to be an “industry source having the potential for comparatively high formation and release of dioxins to the environment”.

We wanted to explore the feasibility of using local cement kilns for treatment of organic hazardous chemicals – especially in emerging economies where other treatment options were absent.
Policy principles vs. waste treatment in cement kilns

Co-processing in cement kilns shall primarily be about recovery of energy and recycling of materials in wastes, i.e. substitution of fossil fuel and virgin raw materials.

However, in lack of available treatment options and urgent needs, a feasible cement kiln can be used for treatment of organic hazardous constituents provided that this is done under strict Government control and guidance.
US EPA Toxic Substances Control Act (TSCA) PCB Incineration Criteria

“...more complex organic halogens such as PCB requires 1200°C and 2 seconds residence time ”

A DRE of 99.9999% is required by TSCA for the incineration of PCB’s

“...if more than 1 % of halogenated organic substances, expressed as chlorine, are incinerated, the temperature has to be raised to minimum 1100°C during at least two seconds”. 
Environmental aspects

Co-processing of wastes should only be performed if the cement kiln operates according to the best available techniques and best environmental practice.

If certain provisions for waste quality and waste feeding are met, co-processing of waste will not change the emissions from a cement kiln stack significantly.
Fuel feed point in cement kiln systems

- Precalcer firing or secondary firing (SP kilns)
- Kiln inlet firing
- Main firing
Co-processing practice

Alternative fuels have to undergo a rigorous acceptance and inspection procedure before being used. It is necessary to avoid/limit mercury inputs into the kiln system.

Emission monitoring is obligatory in order to demonstrate compliance with existing laws, regulations and agreements.
Waste acceptance

Operators need to ensure that only wastes originating from trustworthy parties will be accepted, considering the integrity of all participants throughout the supply chain.

The traceability of the wastes needs to be ensured prior to reception by the facility, with deliveries of unsuitable wastes refused.
Operational aspects

Materials transport, handling and storage must be effectively monitored, and full compliance with existing regulatory requirements must be assured.

This includes analysis and reporting of parameters such as the heating value, the content of water, heavy metals, ash, sulphur and chlorine. Also retained samples should be stored for a certain period of time.
Process optimization

Characterize the parameters that correspond to good operation and use these as a basis to improve other operational performance.

Having characterized good kiln operating parameters, establish reference data by adding controlled doses of waste, and assess what are the changes and required controls and practices to control emissions.
Stable fuel feeding is important

Manage the kiln process to achieve and maintain stable operating conditions, i.e. by optimizing process control (including implementing computer-based automatic control systems) and using modern, gravimetric solid fuel feed systems.
Best available techniques

Minimize fuel energy use by employing preheating and pre-calcination to the extent possible considering the existing kiln system configuration; and use of modern clinker coolers, enabling maximum heat recovery from the exhaust gas.
Stable operating conditions is crucial

Monitoring and stabilisation of critical process parameters, i.e. homogenous raw mix and fuel feed, regular dosage and excess oxygen, stable kiln operation and monitoring of CO.

Ensure rapid cooling of exhaust gases to a temperature lower than 200 °C.
Supply of wastes

Consistent long-term supply of a given waste or alternative fuel (e.g. a supply of a month or more) is required in order to maintain stable conditions during operation.

Substances entering the kiln should be carefully selected and controlled; specifications should be set based on product/process or emission considerations and monitored.
Pre-treatment of heterogeneous wastes

Pre-treatment of waste, including hazardous waste, for the purpose of providing a more homogeneous feed and thus more stable combustion conditions may, depending on the nature of the waste-derived fuel, involve drying, shredding, mixing or grinding.
Halogenated wastes

The feeding of raw mix containing waste with organic compounds that could act as precursor should be avoided.

Halogenated waste should preferably be fed through the main burner.

Waste-derived fuel should never be used during start-up and shutdown.
Waste feeding

In general, organic waste should be fed through either the main burner or the secondary burner for pre-heater/pre-calciner kilns.

For the secondary burner it should be ensured that the combustion zone temperature is maintained $> 850 \, ^\circ C$ for a sufficient residence time ($>3 \, s$).
Combustion and process stability can be ensured by:

Consistency in fuel characteristics (both alternative and fossil).

Consistency in fuel supply rate or frequency of introduction of batch-charged materials.

Keeping adequate excess oxygen to achieve good combustion.

Keeping CO concentrations of in exhaust gases stable.
The following should be fulfilled in a test burn:

The destruction and removal efficiency for hazardous compounds should be at least 99.99%. Chlorinated aromatic compounds should be chosen as a test compound if available because they are generally difficult to destroy.

For POPs, a DRE/DE of $\geq 99.9999\%$ should be demonstrated.
Normal performance

The cement kiln should meet an emissions limit for PCDD/PCDFs of 0.1 ng TEQ/Nm$^3$ both under baseline and co-processing conditions and needs to be in compliance with national emission limit values.
Scope of safety audits

• Material control (product quality & health/safety).

• Auditing of waste generators/collectors.

• Occupational health and safety.

• Design safety (installation design & equipment).
Cement manufacturing is a sensitive process

All materials (in the form of AFRs) introduced into a cement production process should ideally resemble the homogeneity, particle size distribution, heat and water content and chemical composition as normal fine coal and raw meal used in cement manufacturing.

As waste materials often are heterogeneous, pre-treatment and pre-processing are often necessary.
Cement manufacturers are vulnerable

Co-processing is still controversial among some stakeholders and one accident may under worst case conditions undermine co-processing acceptance in the entire industry, i.e. all players have the responsibility to minimize risks and strive towards excellence and best practice to protect the reputation.
"Investigations" were initiated

1. A systematic and comprehensive investigation of the feasibility of using cement kilns in developing countries for destruction of POPs and other hazardous wastes – thorough documentation.

2. A project with WBCSD CSI to gather and evaluate formation, release and control of U-POPs from the cement industry.

Outdated Emission Factors?

The global dioxin emission inventory for 1996 applies an emission factor for hazardous waste burning cement kilns of 2,600 µg TEQ/t and 200 µg TEQ/t for non-hazardous waste burning cement kilns……

….. implying an exit gas concentration of >1800 ng TEQ/Nm³ and 87 ng TEQ/Nm³ for hazardous waste burning and non-hazardous waste burning cement kilns respectively.
More than 2200 PCDD/PCDF measurements, many PCB and some HCB measurements were compiled from cement companies around the world.

The data showed that most modern cement kilns can meet an emission level of 0.1 ng TEQ/Nm³, or an average flue gas concentration of 0.021 ng I-TEQ/m³, also when co-processing wastes and treating hazardous wastes.
From 1420 kg to 77 grams......

Using the Emission factors cement made by Brzuzy and Hites (1996) of 4160 μg TEQ/ton would imply that the cement industry released 1420 kg PCDD/PCDF per year, or 60% of estimated total global emissions....

Assuming a global cement production of approximately 2 billion tons and using the emission factors of the UNEP Toolkit, 0.05 μg TEQ/ton, would imply a cement industry contribution of 100 g/y.

Using the average flue gas concentration of 0.021 ng I-TEQ/m³ from the 500 latest measurements, and assuming a global clinker production of 1.6 billion t/y and an exhaust-gas volume of 2300 Nm³/ton clinker, implies that the contribution from the global cement industry would constitute 77 grams per year.
Findings confirmed by the UNEP “Standardized Toolkit”, 2005

“In the USA, earlier tests indicated that higher emissions were found for some wet kilns where hazardous wastes were fired"

"More detailed investigation suggested that – provided combustion is good - the main controlling factor is the temperature of the dust collection device in the gas cleaning system”

“The plants equipped with low temperature electrostatic precipitators appear to have well controlled emissions with or without waste fuels“
No differentiation on firing hazardous wastes; only on technology and the temperature in the APCD!
Review

Formation, release and control of dioxins in cement kilns

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Abstract

Co-processing of hazardous wastes in cement kilns have for decades been thought to cause increased emissions of PCDD/PCDFs – a perception that has been evaluated in this study. Hundreds of PCDD/PCDF measurements conducted by the cement industry and others in the last few years, on emissions and solid materials, as well as recent test burns with hazardous wastes in developing countries do not support this perception. Newer data has been compared with older literature data and shows in particular that many emission factors have to be reconsidered. Early emission factors for cement kilns co-processing hazardous waste, which are still used in inventories, are shown to be too high compared with actual measurements. Less than 10 years ago it was believed that the cement industry was the main contributor of PCDD/PCDFs to air; data collected in this study indicates however that the industry contributes with less than 1% of total emissions to air.

The Stockholm Convention on POPs presently ratified by 144 parties, classifies cement kilns co-processing hazardous waste as a source category having the potential for comparatively high formation and release of PCDD/PCDFs. This classification is based on early investigations from the 1980s and 1990s where kilns co-processing hazardous waste had higher emissions compared to those that did not burn hazardous waste. However, the testing of these kilns was often done under worst case scenario conditions known to favour PCDD/PCDF formation.

More than 2000 PCDD/PCDF cement kiln measurements have been evaluated in this study, representing most production technologies and waste feeding scenarios. They generally indicate that most modern cement kilns co-processing waste today can meet an emission level of 0.1 ng I-TEQ/m³, when well managed and operated. In these cases, 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 PCDDs/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.

PCDD/PCDFs could be detected in all types of solid samples analysed: raw meal, pellets and slurry; alternative raw materials as sand, chalk and different ashes; cement kiln dust, clinker and cement. The concentrations are however generally low, similar to soil and sediment.

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GUIDELINES ON BEST AVAILABLE
TECHNIQUES AND PROVISIONAL GUIDANCE
ON BEST ENVIRONMENTAL PRACTICES
relevant to Article 5 and Annex C
of the Stockholm Convention on
Persistent Organic Pollutants

Cement kilns firing hazardous waste

BASEL CONVENTION
TECHNICAL GUIDELINES

Technical guidelines on the
environmentally sound
co-processing of hazardous
wastes in cement kilns
Results of the "investigations"

1. Recent test burns have revealed several benefits of using cement kilns compared to other treatment techniques, e.g. superior destruction performance, low and controlled emissions of POPs, large treatment capacity, availability, affordability, local job creation and sustainability – provided responsible operation.

2. The data gathering of POPs from the cement industry showed that the contribution from the industry was significantly less than anticipated and showed that most modern cement kilns can meet an emission level of 0.1 ng TEQ/Nm$^3$, also when co-processing wastes and treating hazardous wastes.

Review

Environmentally sound destruction of obsolete pesticides in developing countries using cement kilns

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ABSTRACT
The accumulation and inadequate management of obsolete pesticides and other hazardous chemicals constitutes a threat for health and environment, locally, regionally and globally. Estimates indicate that more than 500,000 tonnes of obsolete pesticides are accumulated globally, especially in developing countries. FAO has been addressing this issue and disposed of approximately 3000 tonnes of obsolete pesticides in Africa and the Near East since the beginning of the 1990s. These pesticide wastes have mainly been shipped to Europe for high-temperature combustion in dedicated incinerators, a treatment option usually not available in developing countries.

High-temperature cement kilns, however, are commonly available in most countries and have shown to constitute an affordable, environmentally sound and sustainable treatment option for many hazardous chemicals if adequate procedures are implemented. Cement kilns have been used for disposal of obsolete pesticides in developing countries earlier but no study has been able to verify the destruction efficiency in an unambiguous way. Lessons learned from earlier experiences were used to carry out a test burn with two chlorinated insecticides in a cement kiln in Vietnam. The destruction efficiency was measured to be better than 99.999990% for fenoxycarb and better than 99.999982% for pyrimethanil and demonstrated that the hazardous chemicals had been destroyed in an irreversible and environmentally sound manner without new formation of dioxins, furans, hexachlorobenzene or PCBs, a requirement of the Stockholm Convention on PCPs.
Emission of dioxins/furans and other U-POPs from test burns of non-POP pesticides in a hazardous waste incinerator

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ABSTRACT

This paper presents the results of test burns for obsolete pesticides (OPs) of the permethrin group in a high temperature incinerator (HTI) in Southeast Asia. Three test burn runs were conducted: a baseline run when no OP was fed to the incinerator, and two test runs with different mixtures of OP compounds (formula 1 and 2, refer to Table 1 for detail) containing chlorine in the feeding wastes. The unintentionally formed persistent organic pollutants (U-POPs) including 17 dioxins/furans, 12 dioxin-like PCBs and 12 chlorobenzenes (CBs) were monitored in all input materials and all discharges (flue gas, scrubbing liquid and solid residues). The results show relatively high levels of the U-POPs in the flue gas emission with total dioxins/furans of 4.4, 3.4, and 8.4 ng I-TEQ/m³ in the baseline, test run 1 and test run 2, respectively, which are above international acceptable emission levels. The PCB levels in flue gas were, respectively, 0.01, 0.3 and 0.4 ng I-TEQ/m³. The baseline thus had similar U-POPs levels with the OP test runs.

In stack emission, approximately 90% of the U-POPs and 100% of CBs were present in gas phase. The emission factors, mass of pollutants per metric ton (tonne) of input waste, of U-POPs associated with fly ash (from bag house) were the highest, followed by flue gas and bottom ash while those associated with scrubbing liquid were relatively low. Among the waste input material only the black toner powder contained U-POPs, but at low levels. The profiles of the dioxins/furans and PCBs in the toner waste were significantly different from that in the discharges. Despite the overall good destruction and removal efficiency of permethrin (better than 90%) the high emission of U-POPs and CBs from the test burn is of another more serious concern. To our best knowledge the findings of this study are the first of this kind for the Southeast Asia. The findings emphasize that if not properly conducted a standard destruction technology of a non-POP chemical can lead to a release of a range of more dangerous U-POPs into the environment.
Test burn with PCB-oil in a local cement kiln in Sri Lanka

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ABSTRACT
The production and use of polychlorinated biphenyls (PCBs) have ceased and most developed countries have disposed off their stocks long time ago. PCBs can however still be found in the environment and one important source is accumulated stocks in developing countries. Sound treatment of PCB is costly and most developing countries do not have dedicated hazardous waste incinerators or non-combustion technologies available for domestic disposal and can usually not afford export.

High temperature cement kilns have been used to treat organic hazardous wastes in developed countries for decades and shown to constitute a sound option if well managed and controlled. In contrast to dedicated hazardous waste incinerators and other treatment techniques, cement kilns are already in place in virtually every country and may constitute a treatment option. The objective of this study was therefore to carry out the first test burn with PCB-oil in a developing country cement kiln and to assess its feasibility and destruction performance.

The 3 d test burn demonstrated that the Sri Lankan cement kiln was able to destroy PCB in an irreversible and environmental sound manner without causing any new formation of PDD/PCDF or HCB. The destruction and removal efficiency (DRE) was better than 99.9999% at the highest PCB feeding rate.

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Cement manufacturers can contribute

Cement manufacturers can contribute to a successful implementation of the Basel and the Stockholm Convention by solving hazardous waste problems in feasible local kilns; by substitution of fossil fuels and virgin raw materials with wastes and biomass, and thereby reduce their carbon footprint; by minimizing risks and strive towards excellence and best practice; by reducing their over-all emissions proactively.
Successful co-processing

by Jean-Pierre Degré, Cemencis, Switzerland & Kåre Helge Karstensen, Sintef, Norway

The development of a proper hazardous waste and low-grade resource management infrastructure is not only required to protect human health and the environment but it is also necessary to sustain further development of their economies. Many countries do not have a proper hazardous waste management infrastructure in place. Often, generating industries and/or public authorities have limited options available to treat their wastes in a cost-effective and environmentally sound manner. For example, liquid organic hazardous wastes, including oily wastes, are frequently used in small furnaces and boilers without any control or treatment. Human and industrial activity leads to increased levels of waste generation, long-term storage and disposal options are available. Sometimes, temporary solutions are implemented, such as on-site storage or short-term landfarming. Countries are therefore, faced not only with the management of current waste production, but also with the management of stockpiles of stored hazardous wastes. On the other hand, with concrete being a basic construction and development element, many larger cement plants are built, requiring huge amounts of energy and minerals resources. If professionally managed and perfectly controlled, the cement industry can offer a complete service, which is a viable, economical, local and environmentally sound option for treating many hazardous and non-hazardous industrial and municipal wastes. As compared to other treatment processes, co-processing in cement kilns requires no major investments as proper infrastructure is already in place. Moreover, it creates no liquid or solid residuals. Therefore, cement kiln co-processing can be extremely attractive under proper guidance, regulation and control everywhere, including in emerging economies. However, the practice needs to be anchored in a national policy.

In October 2011, the UN COP10 endorsed the proposal by the Secretariat of the Basel Convention for “Technical guidelines on the environmentally sound co-processing of hazardous wastes in cement kilns” (www.basel.int).

The cement industry

In 2010, worldwide cement production was over 3.5 billion t, with China responsible for at least 60% of this figure. Estimates put world cement consumption at over 3.5 billion t by 2020 with the corresponding increase in energy, raw materials and pollutant mass emissions. As shown in Figure 1, the most important ways to reduce the environmental and CO2 impacts of the cement sector are:

- maximise the efficiency of the manufacturing process and associated equipment to use fuels and materials as efficiently as possible. With the development of Best Available Techniques (BAT) technologies, this savings potential will remain marginal in the future
- reduce the amount of traditional natural resources and fossil fuel used in the process by increasing the use of low-grade resources and wastes

Hazardous wastes co-processing

Hazardous wastes should be introduced in the high-temperature combustion zone of the kiln system, as the main burner, the precalcer burner, the secondary firing at the preheater, or the mid-kiln (for long dry and wet kilns). Persistent organic pollutants (POPs) and highly-chlorinated organic compounds should be introduced at the main burner to ensure complete combustion due to the high combustion temperature and long retention time.

Assessment of possible impacts

When a cement plant operator and the pre-processing facility have received information about the waste, they must:

- assess the potential impact of transporting, unloading, storing and using the materials on the health and safety of employees, contractors, and the community
- ensure that equipment or management practices required to address these impacts are in place
- assess what personal protective equipment will be required for employees to safely handle the waste on site
- determine the compatibility of wastes as reactive or non-compatible wastes must not be mixed
- assess the effect the waste may have on the process operation
- optimise the use of limited resources
- control dust and fumes
- control noise
- reduce the potential impact on process stability and quality of the final product
- judge the effect the waste may have on plant emissions and whether new equipment or procedures are needed to ensure that there is no negative impact on the environment

Wastes pre- and co-processing

The use of wastes must not decrease the air quality. In general, a continuous cement kiln operation, product quality, or the site’s normal environmental performance, implying that wastes used in cement kilns must be homogenous and have a stable chemical composition and heat content, and a predefined size distribution.

Homogeneous feed and more stable combustion conditions may therefore be necessary. Techniques used for waste pre-processing and mixing are wide ranging, and may include:

- mixing and homogenising of liquid wastes to meet input requirements, eg viscosity, composition and/or heat content
- shredding, crushing, and sieving of packaged wastes and bulky combustible wastes, eg tyres
- mixing of wastes in a bunker using a grab or other machine (eg spreading machines for sewage sludge)
- production of refuse-derived fuel (RDF), usually produced from source separated waste and/or other non-hazardous waste.
DESTRUCTION OF POPS IN DEVELOPING COUNTRIES BY USING LOCAL CEMENT KILNS

By Dr. Kåre Helge Karstensen, Chief Scientist, Foundation for Industrial and Scientific Research, Norway

Introduction

Environmentally sound disposal of POPs is costly and complicated, and export may not be affordable to many developing countries. In contrast to incinerators and other treatment techniques, cement kilns already exist in virtually every country and inserting to them may be feasible and cost-efficient for the treatment of POPs wastes and other types of wastes. For almost thirty years, the only treatment option in Norway for organic hazardous wastes and POPs has been high temperature cement kilns. The Foundation for Industrial and Scientific Research (SINTEF) has been instrumental in this development and the Norwegian Government wants to share and disseminate this knowledge within developing countries.

Co-processing of alternative resources and treatment of hazardous wastes in cement kilns should be restricted to BAT/BEP kilns. Emerging markets have the highest demand for construction and subsequently the highest ratio of modern newly built cement kilns, e.g. BAT/BEP kilns. In addition, China and India produce nearly two billion tons of cement (two-thirds of the world production), emitting approximately two billion tons of CO2. Waste treatment in cement kilns implies complete recovery of energy and valuable raw material components in the wastes, i.e. reducing the need for non-renewable fossil fuel and virgin raw materials and thereby contributing to overall reduced CO2 and other greenhouse gas emissions, compared to land filling, building a new incinerator or exporting.

Problem statement

A cement kiln has many inherent features which makes it ideal for hazardous waste treatment: high temperatures, long residence time, surplus oxygen during and after combustion, good turbulence and mixing conditions, thermal inertia, dry scrubbing of the exit gas by alkaline raw material (neutralises acid gases like hydrogen chloride), fixation of the traces of heavy metals in the clinker structure, no production of by-products such as slag, ashes or liquid residues and complete recovery of energy and raw material components in the waste.

It is however of utmost importance to apply best practice and lessons learned when implementing such practices and SINTEF, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and Holcim, one of the world’s leading suppliers of cement and aggregates, developed best practice guidelines for co-processing of wastes in cement kilns during the period 2003-2006.
HAZARDOUS CHEMICALS MANAGEMENT: A STRATEGIC COOPERATION BETWEEN SINTEF AND AIT

By Dr. Kåre Helge Karstensen, Chief Scientist, Foundation for Industrial and Scientific Research, Norway

Introduction

The Global Environment Outlook of 2008 addresses increased waste generation as one of the biggest environmental challenges in Asia. Indeed, most Asian countries have weak knowledge and awareness about this issue, dispersed institutional responsibility and capacity, inadequate legislative and regulatory frameworks, and weak enforcement procedures when it comes to waste management.

Problem statement

As a result, Asian countries face some of the largest challenges regarding POPs management. For example, China has the world’s biggest emissions of dioxins, while the southern and central parts of Vietnam have the highest dioxin-contaminated areas in the world. The spreading of semi-volatile chemicals such as POPs is further enhanced by global warming: rising temperatures will also make target organisms more vulnerable and worsen the negative impacts. Currently, according to the National Population and Family Planning Commission (NPPFC) of China, every 30 seconds a baby is born with physical defects due to chemical waste pollution. Professor Pan Jiaping at the Women and Child Health Research Office in Xi’an Jiaotong University has warned that the increasing rate of birth defects among Chinese infants would soon become a social problem, which “will influence economic development and the quality of life.”

How the issue was addressed

The School of Environment, Resources and Development of the Asian Institute of Technology (AIT) gives comprehensive courses in the field of Environmental Engineering and Environment. The Foundation for Industrial and Scientific Research (SINTEF) is one of Scandinavia’s largest independent research institutions and has wide experience in solving practical hazardous waste related problems in several Asian countries.

Both AIT and SINTEF possess unique competences and experience with “immediately” available and affordable technologies which can significantly reduce the burden of hazardous chemicals in Asia, e.g. cleanup of contaminated soil by a combination of bio- and phytoremediation, or by using existing industrial facilities, e.g. cement kilns.

AIT for example has shown that phytoremediation, which exploits the ability of some plant species to remove, extract and/or mineralize contaminants and xenobiotics, can successfully remove and/or detoxify several contaminants in the soil. Local and fast-growing plant species with deep fibrous roots, such as grasses, are particularly useful.

As for waste treatment in cement kilns, this allows for the complete recovery of energy and valuable raw material components in the wastes, thereby reducing the need for non-renewable fossil fuel and virgin raw materials and contributing to overall reduced CO2 and other greenhouse gas emissions compared to land filling, building a new incinerator or exporting the waste for treatment in another country.

A course on the “State-of-the-art of hazardous chemicals management” was developed jointly between AIT and SINTEF and has been given regularly since 2007. It provides updated and comprehensive training on hazardous chemicals management ranging throughout the whole life-cycle (from the generation of hazardous chemicals and their impact to the operation and performance verification of treatment facilities via the policy aspects). Practical examples are provided from Asian countries.

Implementation

The on-going cooperation between AIT and SINTEF on hazardous chemicals management started in October 2006. As part of this strategic cooperation, regular courses, regional seminars and technical cooperation activities were carried out in South-East Asia.

AIT courses

One of the normal course assignments for the students has been to elaborate how to avoid or minimise dioxin emissions from waste treatment plants and industry in practice. Field trips have been mandatory for the students and entailed visits to contaminated areas, hazardous waste incinerators, cement kilns co-processing wastes, etc.

A complete course description can be found on AIT’s webpage: http://www.ser.dait.ac.th/karstensen

Technology for a better society
A Cement Industry Partnership with UNEP on Mercury

Accountable for 10% of anthropogenic mercury emissions, a partnership with UNEP represents an unique opportunity for the cement industry to address a serious threat to health and environment.

A successful cooperation will require dedication, transparency, willingness to conduct testing, document and share information, and to address possible challenges in a responsible and proactive manner.

A successful partnership will contribute to improve the industry's reputation and to reduce its ecological footprint.
Co-processing alternative fuels and raw materials and treatment of organic hazardous wastes in cement kilns

- Cement kilns are in operation in "all" countries;
- Facilities and infrastructure are already in place;
- Recovers energy & recycle materials; conserves non-renewable resources;
- Inherent features, e.g. time & temperatures, are excellent for organic hazardous waste destruction;
- Usually no residues to dispose of compared to 30% in DI;
- Emissions will normally be unaffected if properly operated;
- Reduces disposal costs and CO$_2$ emissions compared to landfilling and incineration;
- New cement kilns in DCs are always BAT.
Summary of recommendations and best practice for co-processing

• An approved EIA and all necessary national/local licenses.

• Compliance with all relevant national and local regulations.

• Compliance with the Basel and the Stockholm Convention.

• An approved location, technical infrastructure and processing equipment.

• Reliable and adequate power and water supply.
Summary of recommendations and best practice for co-processing

- Adequate air pollution control devices and continuous emission monitoring ensuring compliance with regulation and permits - needs to be verified through regular baseline monitoring and reporting.

- Rapid exit gas conditioning/cooling and low temperatures (<200°C) in the air pollution control device to prevent U-POP formation.

- Clear management and organizational structure with unambiguous responsibilities, reporting lines and feedback mechanism.
Summary of recommendations and best practice for co-processing

- An error reporting system for employees.
- Qualified and skilled employees to manage wastes and health, safety and environmental issues.
- Adequate emergency and safety equipment and procedures, and regular training.
- Authorized and licensed collection, transport and handling of wastes.
- Safe and sound receiving, storage, preparation and feeding of wastes.
Summary of recommendations and best practice for co-processing

• Adequate laboratory facilities and equipment for waste acceptance and feeding control.

• Demonstration of wastes destruction performance through test burns.

• Adequate record keeping of wastes and emissions.

• Adequate product quality control routines.
Summary of recommendations and best practice for co-processing

• An environmental management and continuous improvement system certified according to ISO 14001, EMAS or similar.

• Regular independent audits on all aspects of co-processing and independent emission monitoring and reporting.

• Regular stakeholder dialogues with local community and authorities, and for responding to comments and complaints.

• Open disclosure of performance reports on a regular basis.