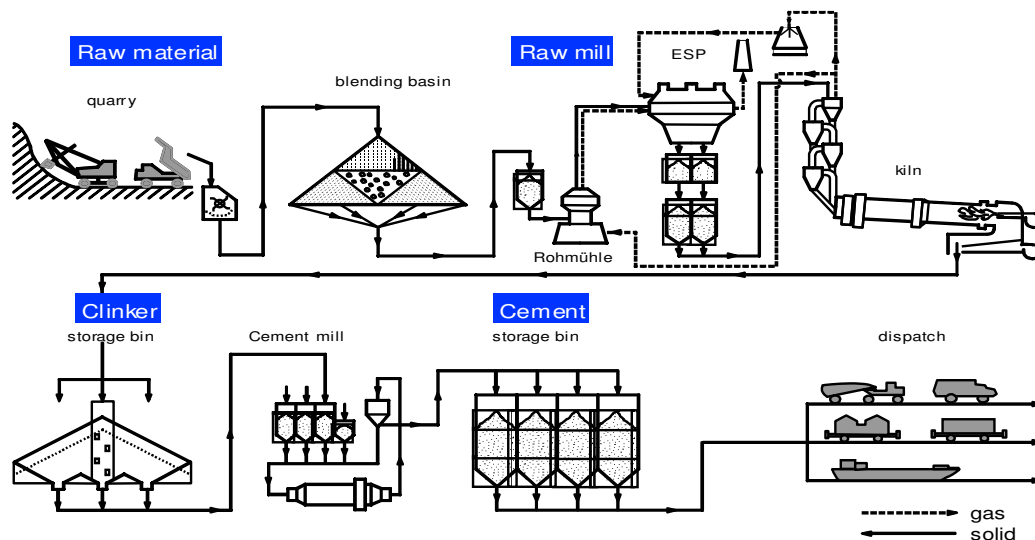


<p>Name of Process: Cement Kiln Co-Processing (High Temperature Treatment)</p> <p>Applicable Pesticides and related POPs wastes: Cement kilns are in principle capable of treating wastes consisting of, or contaminated with, any POP.</p> <p>Cement kilns can be designed and adapted to accept wastes in any concentration or physical form (Chadbourne, 1997)</p>	<p>Status: Portland cement was invented in the late 18th century and is manufactured in huge high temperature kilns (Roy, 1985). The cement industry is today widely distributed throughout the world and produced in 2006 approximately 2.2 billion tons of cement (Karstensen, 2006); i.e. many thousands of kilns are in daily operation in most countries of the world.</p> <p>Cement kiln co-processing of hazardous wastes provides high temperatures, long residence time, surplus oxygen, good mixing conditions and an alkaline environment, as well as efficient recovery of any energy and raw material substitutes in the hazardous waste.</p>
<p>Co-processing of hazardous wastes in cement kilns has been practiced for more than 30 years and is acknowledged to be feasible for sound hazardous waste treatment in both EU and US regulation, as well as in numerous other countries (Council Directive, 2000; Federal Register, 1999). The US Environmental Protection Agency (EPA) has done numerous studies on the influence of co-processing hazardous wastes in cement kilns. Cement kiln operators in the US began recovering energy from organic waste materials, including hazardous chlorinated compounds, as early as 1974. That practice became commonplace by 1987 and since 1991 US cement kilns have used roughly 1,000,000 tons per year of hazardous waste as fuel. Some of these kilns are permitted to replace up to 100% of their conventional fuels with waste-derived fuels (Branscome et al., 1985; Garg, 1990; Gorman et al., 1986; Cement Kiln Recycling Coalition Comments CKRC, 2002).</p> <p>Testing of cement kiln emissions and cement products for the presence of organic chemicals during the burning of hazardous materials has been undertaken since the 1970s, when the practice of co-processing hazardous wastes in cement kilns was first considered. Lauber (1982), Ahling (1979) and Benestad (1989) describe some of these early tests on US, Swedish and Norwegian kilns, which confirmed the ability of cement kilns to destroy the organic component of a waste feed in an environmentally sound manner. Numerous tests around the world have demonstrated that there is essentially no difference in the emissions or the product quality when hazardous waste materials are used to replace parts of the fuels and ingredients needed to produce cement clinker, provided that this is done properly and responsibly (Karstensen, 1994; Chadbourne, 1997; Karstensen, 2001; Karstensen et al., 2006; GTZ-HOLCIM, 2006; Karstensen, 2008a).</p>	
<p>Technology description: Portland cement is made by heating a mixture of limestone, silica, alumina and iron materials to a temperature of about 1450°C. In this process, partial fusion occurs and nodules of so-called cement clinker are formed. The cooled clinker is mixed with a few percent of gypsum and ground into a fine meal – cement (Duda, 1985). In the clinker burning process it is essential to maintain kiln charge material temperatures of approximately 1450°C and gas temperatures of up to 2000°C. Also, the clinker needs to be burned under oxidising conditions (IPPC, 2007).</p> <p>Fuel and wastes fed through the main burner of a cement kiln will be decomposed under oxidising conditions in the primary flame burning zone at temperatures up to 2,000°C and a retention time up to 8 seconds. Fuel and waste fed to the secondary burner, kiln inlet or precalciner will be burnt at temperatures up to 1,200°C. Cement kilns are equipped with either electro static precipitator (ESP's) or bag house fabric filters, or both, for particulate matter control. Acid gas pollution control devices are not used at cement kilns (except for SO₂ in some instances) since the raw materials are highly alkaline and provide acid gas control. In preheater kilns, the finely ground alkaline raw material acts as a huge dry lime scrubber as it is fed counter-currently to the exit gas from the kiln (Environment Agency, 2001).</p> <p>Studies on PCDD/PCDF emissions have come to the conclusion that co-processing of hazardous wastes doesn't seem to influence the emissions (Branscome et al, 1985; Lauber, 1987; Garg, 1990). In a study performed for the World Business Council for Sustainable Development data from more approximately 2200 PCDD/F measurements from wet and dry kilns, performed under normal and worst case operating conditions, and with the co-processing of a wide range of hazardous wastes fed to both the main burner and to the precalciner shows that most cement kilns can meet an emission limit of 0.1 ng TEQ/Nm³ (Karstensen, 2008a).</p> <p>These findings are confirmed by the UNEP Standardized Toolkit (UNEP, 2005) which has developed three classes of default emission factors for cement production, differentiating between type of kiln and ESP temperature. The Toolkit also acknowledges the US EPA statement from 1999 "that hazardous waste burning does not have an impact on PCDD/F formation, PCDD/F is formed post combustion" (Federal Register, 1999). The Toolkit emphasizes that the more detailed investigations of the US EPA study has suggested that provided combustion is good, the main controlling factor is the temperature of the dust collection device in the gas cleaning system, and says further "the plants equipped with low temperature electrostatic precipitators appear to have well controlled emissions with or without waste fuels".</p> <p>In a sampling and analysis program of different industrial sources for UPOP's emissions in Thailand (UNEP, 2001), the cement plant investigated had the lowest emissions among the industrial sources investigated and the results demonstrated that the addition of tyre and/or liquid hazardous waste had no effect on the emissions results. The concentrations measured were all below 0.02 ng I-TEQ/m³ and as low as 0.0001 ng I-TEQ/m³; the means were 0.0105 ng I-TEQ/m³ and 0.0008 ng I-TEQ/m³ for the normal operation conditions and 0.003 ng I-TEQ/m³ and 0.0002 ng I-TEQ/m³ for the test performed with substitute secondary fuels, respectively (UNEP, 2001).</p>	

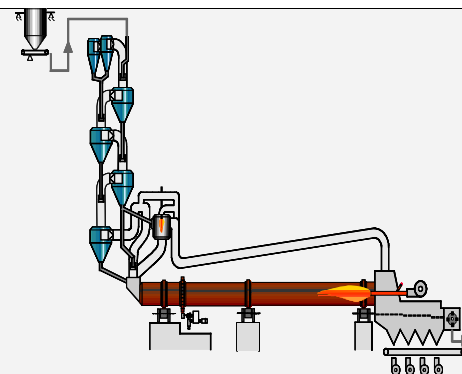
For new cement plants and major upgrades the best available technique for the production of cement clinker is a short dry process kiln with multi-stage preheating and precalcination (IPPC, 2007; Environment Agency, 2001). A smooth and stable kiln process, operating close to the process parameter set points, is beneficial for all kiln emissions as well as the energy use. Quick cooling of kiln exhaust gases to a temperature lower than 200°C is considered to be the most important measure to avoid PCDD/F formation and emissions in wet kilns (process inherent in suspension preheater and precalciner kilns), as well as careful selection and control of substances entering the kiln through the raw material feed. Primary measures have been shown in most cases to be sufficient to comply with an emission level of 0.1 ng TEQ/Nm³ in existing suspension preheater and precalciner kilns under normal operating conditions (UNEP, 2007; Karstensen, 2008a)

Process diagram for dry preheater process (example Germany):



Temperature and residence time during cement production

Characteristics	Value
Temperature at main burner	>1450°C: material >1800°C: flame temperature.
Residence time at main burner	>12-15 sec > 1200°C >5-6 sec > 1800°C
Temperature at precalciner	> 850°C: material >1000°C: flame temperature
Residence time at precalciner	> 2 - 6 sec > 800°C
Residence time at precalciner	> 2 - 6 sec > 800°C



PART I: Criteria on the Adaptation of the Technology to the Country

A. Performance

1. Minimum pre-treatment:

Some waste categories have to be pre-treated in order to comply with the technical specifications of cement production and to guarantee that environmental standards are met. This can involve grinding, blending, mixing and homogenization processes. High concentration POPs should always be fed to the high temperature burning zone, i.e. main burner or precalciner burner. The method of introducing liquid and solid hazardous waste into the kiln is a key factor to enable complete destruction of the waste during the combustion of the primary fuel. Liquid hazardous waste is usually injected in a separate channel in the burner or blended with oil. Solid waste is mixed and burned along with the primary fuel. The use of hazardous wastes should not detract from smooth and continuous kiln operation, product quality, or the site's normal environmental performance. Therefore, a constant quality and feed rate of the hazardous waste materials must be ensured (Karstensen, 2008b).

Operating requirements should be developed to specify the acceptable composition of the waste feed, including acceptable variations in the physical and/or chemical properties of the hazardous waste. For each hazardous waste, the operating requirements should specify acceptable operating limits for feed rates, temperatures, retention time, oxygen etc.

The general principle of good operational control of the kiln system using conventional fuels and raw materials should be applied. In particular, all relevant process parameters should be measured, recorded and evaluated continuously and should cover:

- a) Free lime;
- b) Oxygen concentration;
- c) Carbon monoxide concentration.

Fuel and wastes fed through the main burner will be decomposed under oxidising conditions in the primary flame burning zone at temperatures up to 2,000°C and long residence times. Fuel and waste fed to the secondary burner, kiln inlet or precalciner will be burnt at temperatures between 900°C and 1,200°C. The US TSCA PCB incineration criteria require a temperature of 1,200°C and 2 seconds retention time at 3% oxygen (Lee et al., 2000; Dempsey and Oppelt, 1993; Federal Register, 1999); the EU Directive 2000/76/EU require a temperature of 850°C for at least 2 seconds for the incineration of non-chlorinated hazardous waste and 1,100°C and 2 seconds retention time for organic substances containing more than 1% halogen at 2% oxygen (Council Directive, 2000).

The feed point selected must ensure that a complete and irreversible destruction is achieved. The feed point for hazardous wastes into the kiln should be selected according to the nature (and, if relevant, hazardous characteristics) of the hazardous wastes used. Hazardous wastes should be introduced in the high-temperature combustion zone of the kiln system, i.e. the main burner, the precalciner burner, the secondary firing at the preheater, or the mid-kiln (for long dry and wet kilns). The following is valid (Karstensen, 2008b):

1. 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. Other feed points are appropriate only where test have shown high destruction and removal efficiency rates;
2. Alternative raw materials with volatile organic components should not be introduced with other raw materials in the process, unless tests have shown that undesired emissions at the stack do not occur;
3. Mineral inorganic wastes free of organic compounds can be added to the raw meal or raw slurry preparation system. Mineral wastes containing significantly quantities of organic components are introduced via the solid fuels handling system, i.e. directly to the main burner, to the secondary firing or, rarely, to the calcining zone of long wet or dry kilns;
4. Mineral additions such as granulated blast furnace slag, fly ash from thermal power plants or industrial gypsum can be fed to the cement mill.

The plant should characterize a good operation and use this as a basis to improve other operational performance.

Having characterized a good kiln, establish reference data by adding controlled doses of waste, and look at changes and required controls and practice to control emissions. The impact of hazardous wastes on the total input of circulating volatile elements such as chlorine, sulphur, or alkalis must be assessed carefully prior to acceptance as they may cause operational troubles in the kiln system.

Input limits and operational set points for these components should be set individually by the site based on the process type and on the specific site conditions.

The kiln process must be operated to achieve stable conditions, which may be achieved by applying process control optimization (including computer-based automatic control systems) and use of modern, gravimetric solid fuel feed systems.

Energy use should be minimised by means of preheating and precalcination as far as possible, considering the existing kiln system configuration. Modern clinker coolers are recommended to enable maximum heat recovery from waste gas.

For start-up, shut-down, or upset conditions of the kiln, written instructions should be issued, describing conditions of use of hazardous wastes. Kiln operators should know and understand these instructions.

Procedures for stopping hazardous waste feed in the event of an equipment malfunction or other emergency must be implemented and the set points for each operating parameter that would activate feed cut-off must be specified. The waste feed must also be cut off when operating conditions deviate from limits established in the permit.

No hazardous waste burning should take place unless the cement kiln is operating at normal temperatures in the range of 1100 °C to 1600 °C and instrumentation must be provided to record continuously the rate of flow of these wastes (Karstensen, 2008b).

2. Destruction efficiency (DE):

The choice of acceptable compounds depends primarily on potential occupational exposures and material-safety criteria. Virtually any organic compound can be completely destroyed at the elevated temperatures in a properly operating cement kiln. Process operating constraints may become significant when certain compounds are present in excessive quantities, as for example circulating volatile elements such as chlorine, sulphur, or alkalis (Karstensen, 2008b).

A wide variety of hazardous wastes containing organic compounds, including aldehydes, esters, alcohols, ketones, phthalates, alcohol ethers, aromatic compounds, phenols, amines, amides, ethers, nitriles, freons and other halogenated organic compounds are commonly found in hazardous waste fuel mixtures used in the cement industry. More than 250 organic compounds have been approved for use in hazardous waste fuel in the US (Chadbourne, 1997).

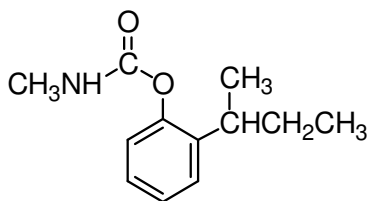
Two typical examples are given below:

One older performance example from Sweden (Ahling, 1979):

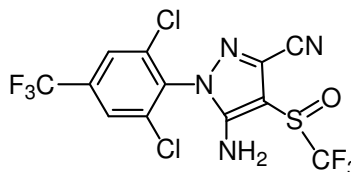
In 1978, various chlorinated chemical wastes were burned at a test in the Stora Vika Cement plant, near Stockholm in Sweden. The kiln was a 620 ton/day coal-fired wet process cement kiln, where chlorinated aliphatics and aromatics like PCB, chlorophenols and phenoxyacids were burned during these tests. The average chlorine concentration of these chemical wastes, was 17%. Chlorine addition averaged 0.35% of clinker weight. At up to 0.6-0.7% chlorine input, there were no kiln operational problems; at an input of 0.8-0.9% a chlorine clinker ring was formed, which later disappeared when chlorine feed rates were reduced. Waste destruction efficiencies of chlorinated aliphatics was measured to be better than 99.995-99.9998%. The Destruction and removal efficiency (DRE) of PCB was greater than 99.99998%. Analyses were also conducted for dioxins and furans but no detectable quantities of dioxins or furans containing four or six chlorines were found.

One recent performance example from a developing country (Karstensen et al., 2006):

In a recent test burn done in a developing country with two obsolete insecticides the destruction and removal efficiency was measured to be better than 99.999997% and 99.999985% for Fenobucarb and Fipronil respectively and showed that the destruction had been complete and irreversible, i.e. no new formation of dioxins, furans or PCB's i.e. all analysis result for PCDD/F's, HCB and dioxin like PCB's were below the detection limit. Raw meal, the product clinker, fine coal, electro static precipitator dust and by-pass dust was analysed for both insecticide compounds and was found to be less than the detection limit for all samples, i.e. <2.0 parts per billion – All electro static precipitator dust are fed back to the process, i.e. only the product and the emissions are outputs from the process and this makes DRE equivalent with the DE, or to be 100% exact: DRE 99.9999719 and DE 99.9999692 for Fenobucarb and DRE 99.99998531 and DE 99.99998321 for Fipronil. This will very often be the case for the cement kilns since they usually don't produce waste or exit gas residues or slags.



Fenobucarb



Fipronil

The insecticides were fed to the main burner of the kiln at a rate of 2,000 litres per hour and approximately 40,000 litres were co-processed and safely destroyed in less than 20 hours. The insecticides were solved in a mix of aromatic solvents and the energy content of the mix substituted the equivalence of 2.5 tonnes of coal; i.e. the destruction also reversed the energy in the toxic waste. The destruction efficiency was measured to be better than 99.999969 % for Fenobucarb and better than 99.999832 % for Fipronil and demonstrated that the hazardous chemicals had been destroyed in an irreversible and environmental sound manner without new formation of dioxins, furans, hexachlorobenzene or PCBs, a requirement of the Stockholm Convention on POPs.

3. Toxic By-products:

Some cement plants produce cement kiln dusts (CKD) which cannot be reintroduced to the process due to process or quality constraints; usually the CKD are reused as a mineral-substitute but some plants landfill their CKD's. Potential contamination needs to be checked.

4. Uncontrolled releases:

Cement kilns are known to release dusts, CO₂, NO_x and SO₂. Modern plants usually comply with emission limit values with good margins. Plants who co-process hazardous waste constituting more than 40% of the energy input must comply with the stringent emission limit values for hazardous waste incinerators in the EU (Council Directive, 2000).

5. Capacity to treat all POPs:

Numerous tests around the world have demonstrated no or little difference in the emissions or the product quality when waste materials are used to replace the fuels and ingredients needed to produce cement clinker (Branscome et al., 1985; Chadbourne, 1997; Garg, 1990; Lauber, 1982 and 1987). Comprehensive emission studies have been performed when hazardous waste was introduced, and these have generally concluded that no significant differences could be measured between usages of the two fuels). Already in 1975 Mac Donald et al (1977) carried out test burns with hazardous chlorinated hydrocarbons containing up to 46% chlorine in a wet cement kiln in Canada and concluded that "all starting materials, including 50% PCB's, were completely destroyed to at least 99.98 percent efficiency in all cases" and emissions of high molecular weight chlorinated hydrocarbons were not detected.

Similar tests with chlorinated and fluorinated hydrocarbons conducted in a wet kiln in Sweden showed that the DRE of PCB's were better than 99.99998% and that there were no change in product quality or any influence on process conditions with a chlorine input up to 0.7% of the clinker production (Ahling, 1979). Also, "no TEQ dioxins or furans could be detected". Viken and Waage (1980) carried out test burns in a wet kiln in Norway feeding 50 kg PCB's per hour, showing a DRE better than 99.9999% and no traces of PCB in clinker or dusts could be detected and "PCDD and PCDF have not been detected". Benestad (1989) carried out studies in a dry preheater cement kiln in Norway in 1983 and 1987 and concluded that the "type of hazardous used as a co-fuel" does not influence the emissions and that the destruction of PCB's were better than 99.9999%. "0.2 ng PCDD/Fs TEQ/m³ and 0.1 ng PCDD/Fs TEQ/m³ were measured when feeding hydrocarbon waste (fatty acid esters, solvents and paint residues) and PCB-waste respectively".

Seen from a process technical and chemistry viewpoint it is easier to dispose liquid POPs like PCB contaminated oils than solid materials. Independent of the state of the material, pre-treatment, analysis and control, and cautious feeding of POPs material is necessary. The chlorine tolerance of the process needs to be known

5.1 Capacity to treat hazardous wastes

Cement kilns can be an option for the management of a wide variety of industrial and hazardous wastes. The raw materials used to produce cement often contain trace quantities of virtually every natural element, including alkali chlorides and sulfates; heavy metals, such as lead, cadmium, chromium and arsenic; and organic materials. Many of these constituents are also contained in fossil fuels, such as coal, oil and petroleum coke, and in the water used to prepare slurry for wet-process kilns (Chadbourne, 1997).

Materials present in the feed, fuels or hazardous waste introduced into the kiln become part of the cement product and a waste material known as cement-kiln dust is formed, or they are converted to other forms within the kiln. With few exceptions, materials introduced into cement kilns will be oxidized and stabilized, requiring no further treatment (Chadbourne, 1997).

5.2 Capacity to treat POPs

The potential for using cement kilns to destroy PCBs have been investigated in several countries (Lauber, 1982 and 1987). Since PCBs are such stable compounds, the ability of a cement kiln to destroy these compounds indicates the overall ability to destroy organic constituents in hazardous wastes. The DRE's determined from several trial burns conducted in many countries indicate that cement kilns are effective at destroying PCBs (Lauber, 1987; Karstensen, 2004: http://www.chem.unep.ch/pops/pcb_activities/PCB_proceeding/pcb_proceeding.htm , see also Annex, Table 2 and 3)

Many cement kilns burning hazardous waste as fuel have chosen not to burn PCB wastes for the reasons of perception, bad mention and fear for market implications (Chadbourne, 1997).

6. Throughput:

6.1 Quantity [t/day, L/day]

Cement kilns produce from a few tons cement clinker per hour and up to several hundred tons per hour, which means that the fuel-firing requirements vary from a few tons to several tens of tons of fuel per hour. Yearly capacities vary from a few thousand to more than 10 million tonnes per year. Usually fine coal is used as the primary fuel.

6.2 POPs throughput: [POPs waste/total waste in %]

The waste throughput will be dependent on the total mass flow of fuel: there are kilns which are licensed to substitute 100% of its conventional fuel with organic hazardous wastes in the US. For POPs waste a responsible throughput from a few tens of kg per hour to a few thousand kg per hour can be expected. As rule of thumb, chlorine should usually be limited to 300 to 500 g/t cement clinker for a kiln without by-pass and 400 to 750 g/t for a kiln with by-pass, but the chlorine tolerance must be known in each instance. See also under 2, 3 and 5. Important is that the process owner needs to know the chlorine tolerance of the process in question.

7. Wastes/Residuals:

7.1 Secondary waste stream volumes:

In the cement industry levels of alkalis, sulphur and chlorides (volatile components) in the product clinker are controlled to achieve the required quality of the product cement. In some cases, construction standards impose an alkali specification of 3 kg/m³ of concrete because of the risk of alkali-aggregate reactions and thus the alkali content of the cement is limited. Volatile components can also be a problem in the kiln system, as high levels can cause blockages in pre-heater cyclones or form rings in the in the rotary kiln inlet zone.

The cement industry has several options to control clinker alkali content. The control of the alkali content of the input raw materials can be used but the practicality of this depends on the availability of low alkali raw materials.

7.2 Off gas treatment

In wet cement kilns, some of the volatile components evaporate in the sintering section but condense in the drying zone on the fine particulate matter. Hence, if an electro static precipitator (ESP) is used for particulate arrestment, the finer proportion of the cement kiln dust (CKD) containing the highest concentration of volatile components can be removed whilst the remaining dust is recycled. Complete recycling can be achieved by introducing CKD into the rotary kiln by using specially designed scoops in the cylindrical walls of the kiln or, more frequently by injecting CKD into the burning zone of the kiln (insufflations). In dry process kilns, CKD is usually reintroduced into the raw meal or may be fed directly to the cement mill.

The inherent absorption capacity of pre-heater dry cement kilns can cause problems with blockages in the cyclone systems caused mainly by build-ups of volatile components. One option to curtail volatile component levels is by bypassing part of the particulate laden gas stream out of the kiln inlet away from the cyclone system and condensing the volatiles by cooling. Bypasses of 10-30% of the kiln gas flow are typical. This bypass stream can be high in pollutants (particulates and sulphur oxides) and must be treated separately.

Both kiln dust and bypass dust are in most cases returned to process providing clinker alkali levels are controlled. When this is not possible dust is sent to controlled landfills or sold as binder for waste stabilisation or other purposes.

7.3 Complete elimination:

See under 2, 3 and 5.

Reliability:

Cement production is a continuous process and a cement kiln is normally shut down a few weeks per year due to maintenance.

Limitations:

The feasibility of a cement kiln for treatment of POPs should be investigated by experts on a case by case basis. There are kilns which are not recommended to use for POPs treatment, for example vertical shaft kilns or kilns with improper environmental performance. The chlorine tolerance of a kiln differs widely due to process constraints, but as rule of thumb, chlorine should usually be limited to 300 to 500 g/t cement clinker for a kiln without by-pass and 400 to 750 g/t for a kiln with by-pass.

Transportability:

Cement kilns are fixed constructions.

Detailed information:

See for example World Business Council for Sustainable Development, Cement Sustainability Initiative, which has links to the major companies:

<http://www.wbcsd.ch/templates/TemplateWBCSD1/layout.asp?type=p&MenuId=MTI2&doOpen=1&ClickMenu=LeftMenu>

Full Scale treatment examples:

See under Performance

Conclusion:

POPs can be destroyed safely and environmentally sound in technical and chemical feasible cement kilns with trained staff.

Detailed information and treatment examples:

In the separate Annex the following information is given:

Table 1: Technology Overview – Summary Technical Details

Table 2: Overview Project Experience per Technology Supplier

Table 3: Overview detailed project information per project – Project name (from Table 2)

PART II: Criteria on the Adaptation of the Country to the Technology

Note: This part or any present gaps have to be filled in every time the "suitability" of the technology has to be examined for a certain country situation!!

Part II is not applicable for cement kilns for the following reasons:

A cement plant is already in place and the purpose of the plant is to produce cement, but by coincidence rotary cement kiln possess 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 by high flows of high temperature materials, counter currently dry scrubbing of the exit gas by alkaline raw material in dry preheater and precalciner kilns, fixation of the traces of heavy metals in the clinker structure, no production of slag, ashes or liquid residues from exit gas cleaning and complete recovery of energy and raw material components in the waste (Karstensen, 2007).

A cement plant can be used to destroy POPs if found **suitable** and sound, preferably by independent experts. Together with sufficient competence and personal protective equipment, this is the key question. The factors listed in part II are already present for the production of cement and cannot be changed.

Questions on energy use or water consumption are not relevant in this case. Investigations are commonly made by authorities or companies for existing cement kilns if they are suitable to treat certain hazardous wastes. The cement kiln has to be investigated further because raw material conditions, technology, chemistry etc. will be site specific.

Therefore only a limited number of issues have been dealt with in this part.

A. Resource needs:

1. Power requirements :

2. Water requirements:

3. Fuel volumes:

4. Reagents volumes:

No reagents

5. Weather tight buildings:

6. Hazardous waste personnel requirement:

7. Sampling requirements/facilities:

These requirements are covered in the permits

8. Peer sampling:

9. Laboratory requirements:

10. Communication systems:

On site requirements:

Mobile network:

Requirements in country:

As the plant is co-processing Hazardous waste, it is obligatory that all materials going into the plant are analyzed and a laboratory is necessary

Fixed network:

11. Number of personnel required:

11.1 Number of Technicians required (skilled labour):

11.2 Number of Labourers required (unskilled labour):

B. Costs:

The reason that cement plants are taking waste is usually to save costs. In general the cement plants are cheaper, but this may not be the case with POPs because the monitoring and control requirements will add to the costs significantly. If a plant decides to go in hazardous waste co-processing, the owner will do these investments themselves. The listed experience in Vietnam for example and the prices offered by the cement plant need to be competitive to the market, independent of the investment.

1. Installation and commissioning costs [US Dollars or EUROS]:

See above

2. Site preparation costs [US Dollars or EUROS]:

3. Energy & Telecom installation costs:

4. Monitoring costs:

Must be covered by the owner and will be specified in the permit

5. Complying costs:

6. Reporting costs:

7. Running costs with no waste:

Cement kilns run in principle always without waste as their objective is to produce cement.

8. running costs with waste:

Not relevant for cement kilns

9. Decommissioning costs:

Not applicable

10. Landfill costs:

Depending on local situation – should be filled in for the concerned country

11. Transport costs of residues:

Depending on local situation – should be filled in for the concerned country

C. Impact:

1. Discharges to air:

Cement plant emit CO₂, NO_x, SO₂ and dusts, but these emissions have to comply with emission limit values which are different from country to country, but the emission limits have always to be met independently of the fact if waste co-processing takes place or not.

Normally there are no materials disposed. One has to think that a cement plant is a production plants and most of the materials are fed back into the process instead. If disposal is needed then this is regulated in the permit.

3. Discharges to land:

CKD's are in some plants disposed in landfill (secure)

4. Soil impact (noise etc):

2. Discharges to water:

Usually none

D. Risks

1. Risks of reagents applied:

2. Risks of technology:

3. Operational risks:

E. Constructability:

Cement kilns are already available in the concerned country

1. Ease of installation/construction of plant:

Not applicable here. Plants are in the country when one starts looking for treatment options

2. Ease of shipping/transit:

Not applicable

3. Ease of operation:

A cement kiln co-processing hazardous waste has its own staff and department for this.

4. Ease of processing :

A cement kiln co-processing hazardous waste has its own staff and department for this. They will produce the fuel blend which is proper for the process and the chemistry.

F. Output/generation waste:

1. Generated waste (% of input waste)

Sometimes CKD are disposed.

2. Deposited waste at landfill (% of input waste)

See under C.1.

3. Waste quality properties (pH, TCLP)

**Note: This Technology Specification and Data Sheet (TSDS) does not certify any particular technology, but tries to summarise the state of the art of the concerned technology on the basis of data delivered by the organisations or other sources, which have been made available to the author and refers the reader to original documents for further evaluation. Without the efforts below listed technology suppliers it would not have been possible to set up this TSDS. Date: 18.06.2008*

Technology suppliers that have contributed to this TSDS:

Dr. Kare Helge Karstensen, Foundation for Scientific and Industrial Research, SINTEF, Norway

Web sites:

See for example World Business Council for Sustainable Development, Cement Sustainability Initiative, which has links to the major companies:

<http://www.wbcscd.ch/templates/TemplateWBCSD1/layout.asp?type=p&MenuId=MTI2&doOpen=1&ClickMenu=LeftMenu>

The European Cement Association Cembureau: <http://www.cembureau.be/>

The American Cement Association: <http://www.cement.org/>

The Cement Association of Canada: <http://www.cement.ca/cement.nsf>

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