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Co-processing of PCB, other POP's and (Hazardous) waste in cement kilns

A local solution for a global topic

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Co-processing PCB & other POP's in cement kilns

A local solution

14th HCH & Pesticide Forum
21 - 24 February, 2023 – Zaragoza, Spain
Ed Verhamme
Managing Partner Alternate Resource Partners

Content Presentation

- Introduction Alternate Resource Partners
- Manufacturing of cement
- Co-processing in cement kilns
- Co-processing of POP's in cement kilns
- Advantages & test results of co-processing POP's
- International development & recognition of solution
- Observations & Conclusions on way forward
- Take home messages
- Developments since IHPA Forum 2015

Introduction ARP I

- Company started in 2009
- Network of Consultants, engineers, trainers, coaches & field operators for resource/waste management and cement manufacturing
- Worldwide experience in both mature and emerging countries replacing all fossil fuels by “waste - to – AFR” as well as POP’s handling
- ARP & partners have > 150 years experience in all aspects of resource & waste management and cement manufacturing when it comes to (Hazardous) waste-to-AFR

Introduction ARP II

Main activities ARP:

- ✔ Resource management business development in cement, lime & electric power industry,
- ✔ Waste – to – AFR market research, feasibility studies, etc.,
- ✔ Pre- & Co-processing Marketing & Sales training & coaching,
- ✔ Technical & Commercial support with set up of pre processing activities (= to process waste so it's suitable for co processing)
- ✔ Consulting, reviews & audits on health, safety & environmental behaviour,
- ✔ HAZOP Studies on waste/AFR Installations
- ✔ Support POP's handling & pre-/co-processing
- ✔ Development of specialized recycling machines for waste to AFR activities,
  example: oil - filter recycling machine for emerging countries

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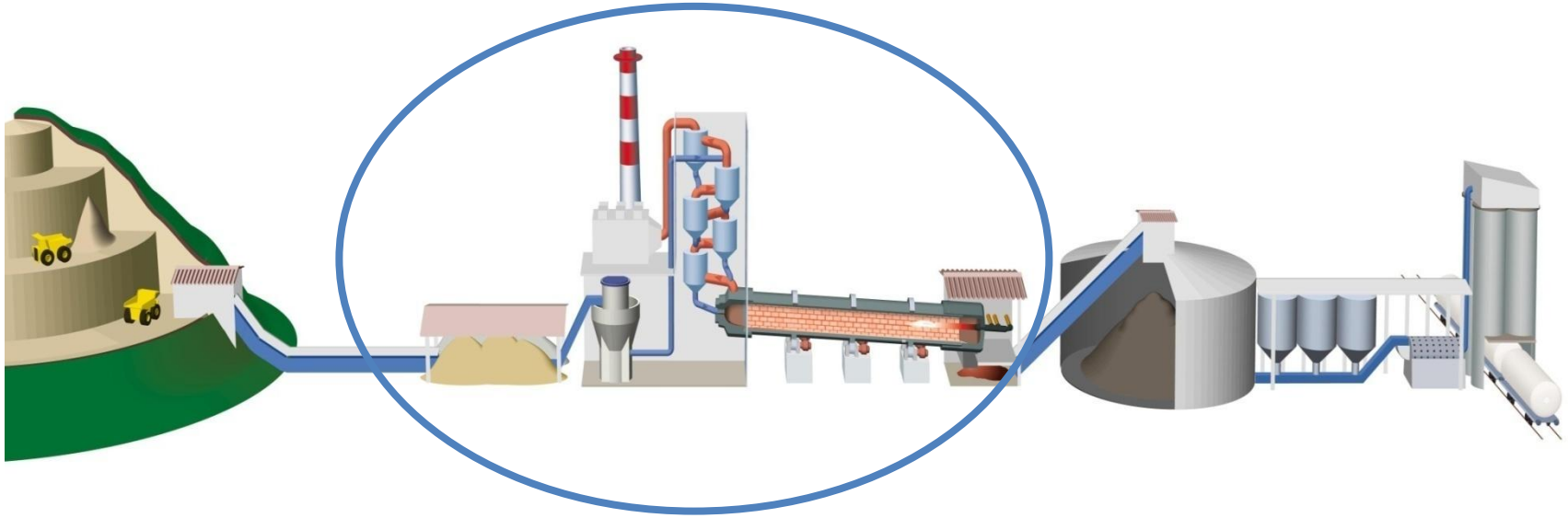
CEMENT MANUFACTURING – 3 MAIN PHASES

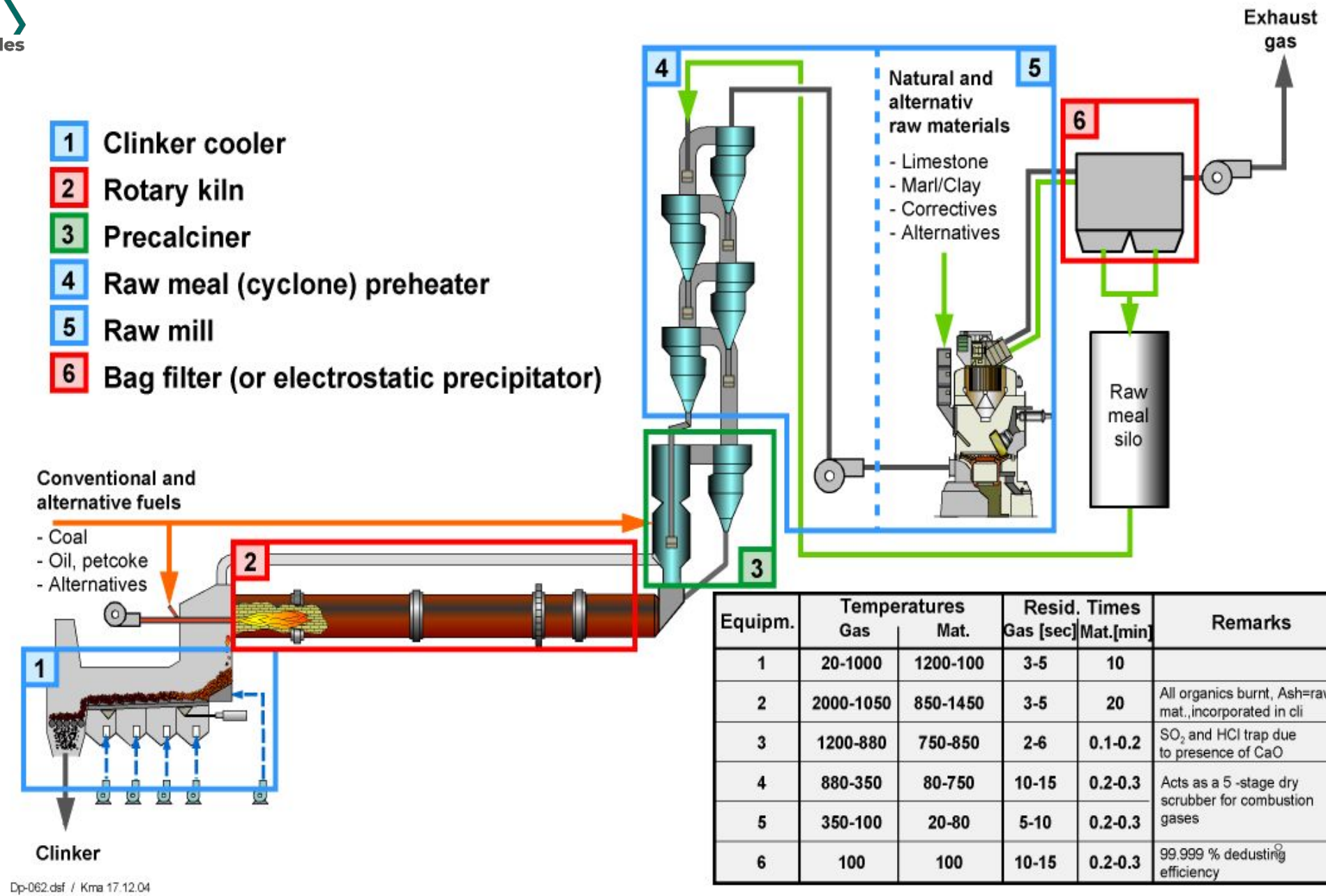


1) Preparation of raw materials into raw meal (Extraction – Crushing – Pre-homogenisation - Dosing – Grinding – Homogenisation)

2) Clinker production – pyro-processing of raw materials (calcination of the raw meal into the rotary kiln – energy supplied by burning fuels)

3) Cement production - grinding of clinker and mineral components to obtain cement

The (Cement) Clinker Process and its Special Characteristics (Example: Precalciner Kiln)



Equipm.	Temperatures Gas	Temperatures Mat.	Resid. Times Gas [sec]	Resid. Times Mat.[min]	Remarks
1	20-1000	1200-100	3-5	10	
2	2000-1050	850-1450	3-5	20	All organics burnt, Ash=raw mat.,incorporated in cli
3	1200-880	750-850	2-6	0.1-0.2	SO_2 and HCl trap due to presence of CaO
4	880-350	80-750	10-15	0.2-0.3	Acts as a 5 -stage dry scrubber for combustion gases
5	350-100	20-80	5-10	0.2-0.3	
6	100	100	10-15	0.2-0.3	99.999 % dedusting efficiency

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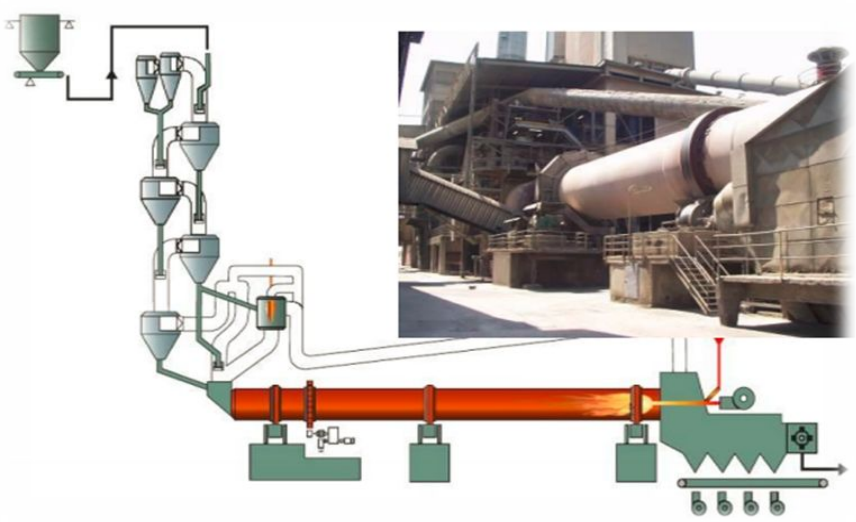
Co-processing – what is it ?

Co-Processing is…

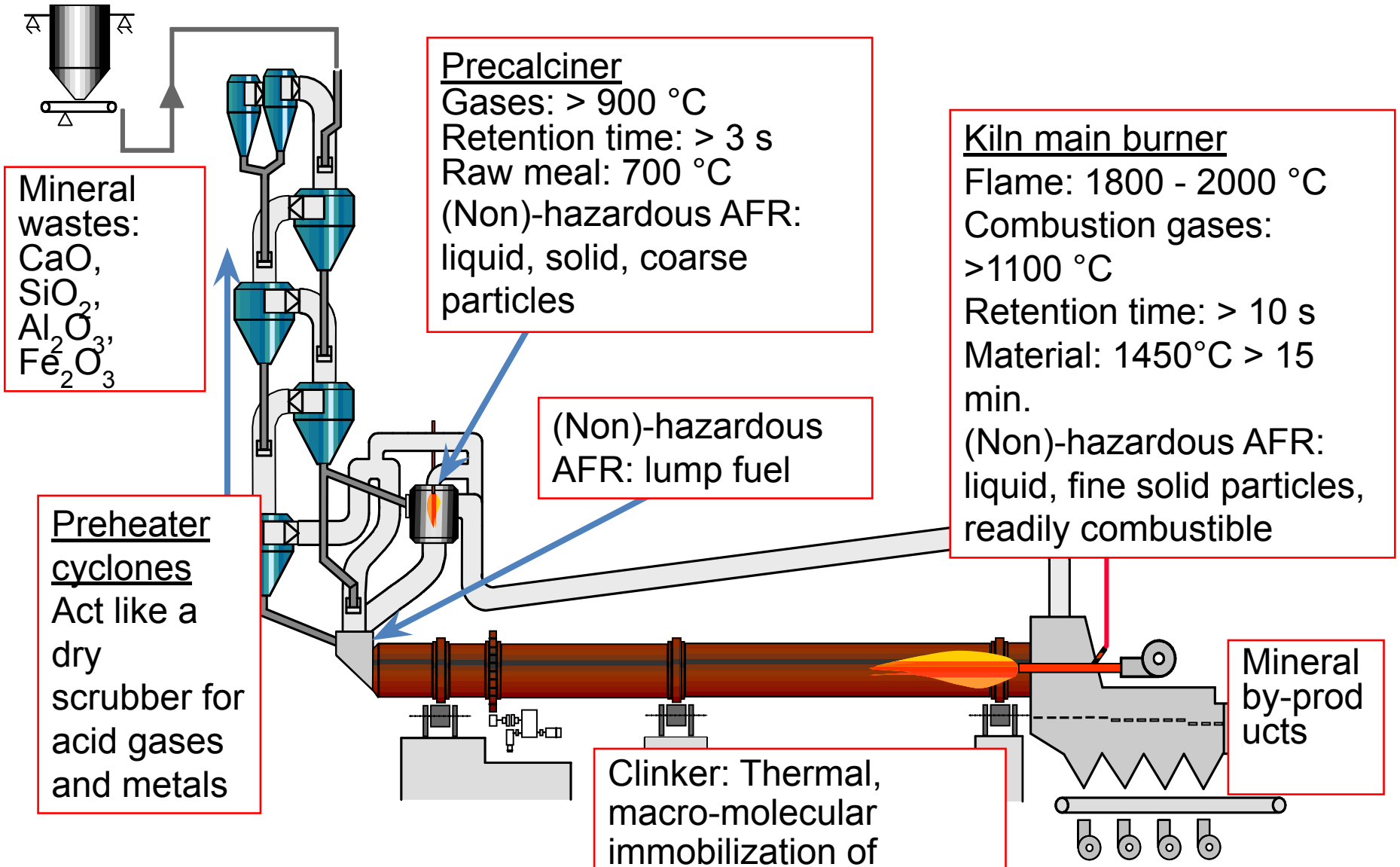
…the use of waste materials in Resources Intensive Industrial Processes such as cement, lime, steel, glass, power generation, etc.

..instead of fossil fuels & natural resources

Co-processing is a main alternative to improve the environment and improve the industry ecological footprint



Technical characteristics cement kiln



Mineral wastes: CaO, SiO_2, Al_2O_3, Fe_2O_3

Precalciner
Gases: > 900 °C
Retention time: > 3 s
Raw meal: 700 °C
(Non)-hazardous AFR: liquid, solid, coarse particles

(Non)-hazardous AFR: lump fuel

Kiln main burner
Flame: 1800 - 2000 °C
Combustion gases: >1100 °C
Retention time: > 10 s
Material: 1450°C > 15 min.
(Non)-hazardous AFR: liquid, fine solid particles, readily combustible

Preheater cyclones
Act like a dry scrubber for acid gases and metals

Clinker: Thermal, macro-molecular immobilization of metals

Mineral by-products

Co-processing in cement kiln:

1) 100% energy content of waste recovered, mostly as heat to produce clinker
2) High & stable temperature, gas temperature up to ~ 2000 °C
3) Self cleaning process (CaO)
4) Long residence time (gas ~10sec, solids 30min)
5) **No ash, all material retained in clinker,** no landfill
6) **$C02_2$** emission reduction
7) Continuous emission **real-time monitoring**

- Co-processing in cement kilns often not sufficiently incorporated in legislation and therefore legal bottlenecks exists.
- Pre-processing requirements for the waste streams more stringent than for co-incineration in WtE or HTI of hazardous waste due to quality control procedures of cement plants

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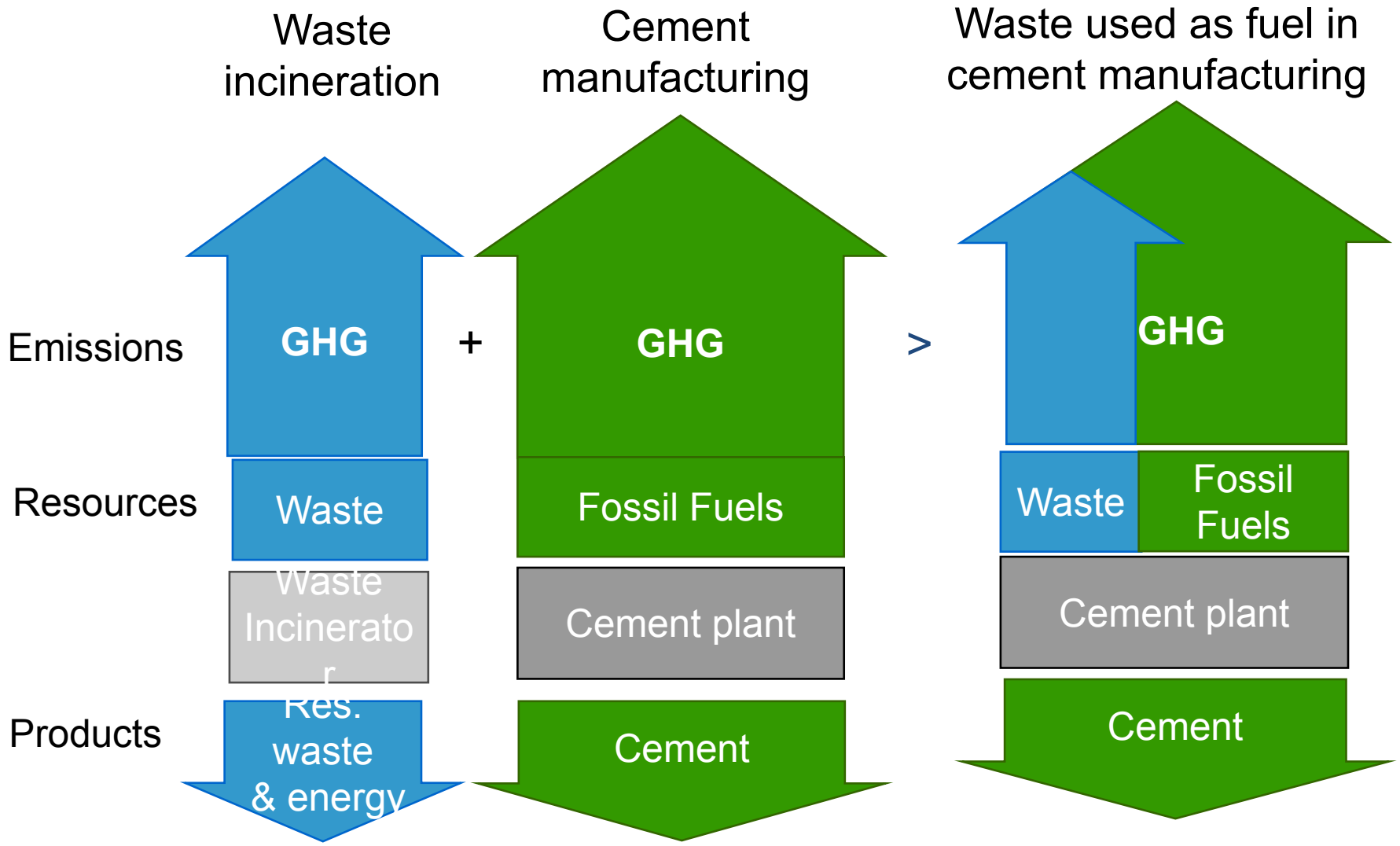
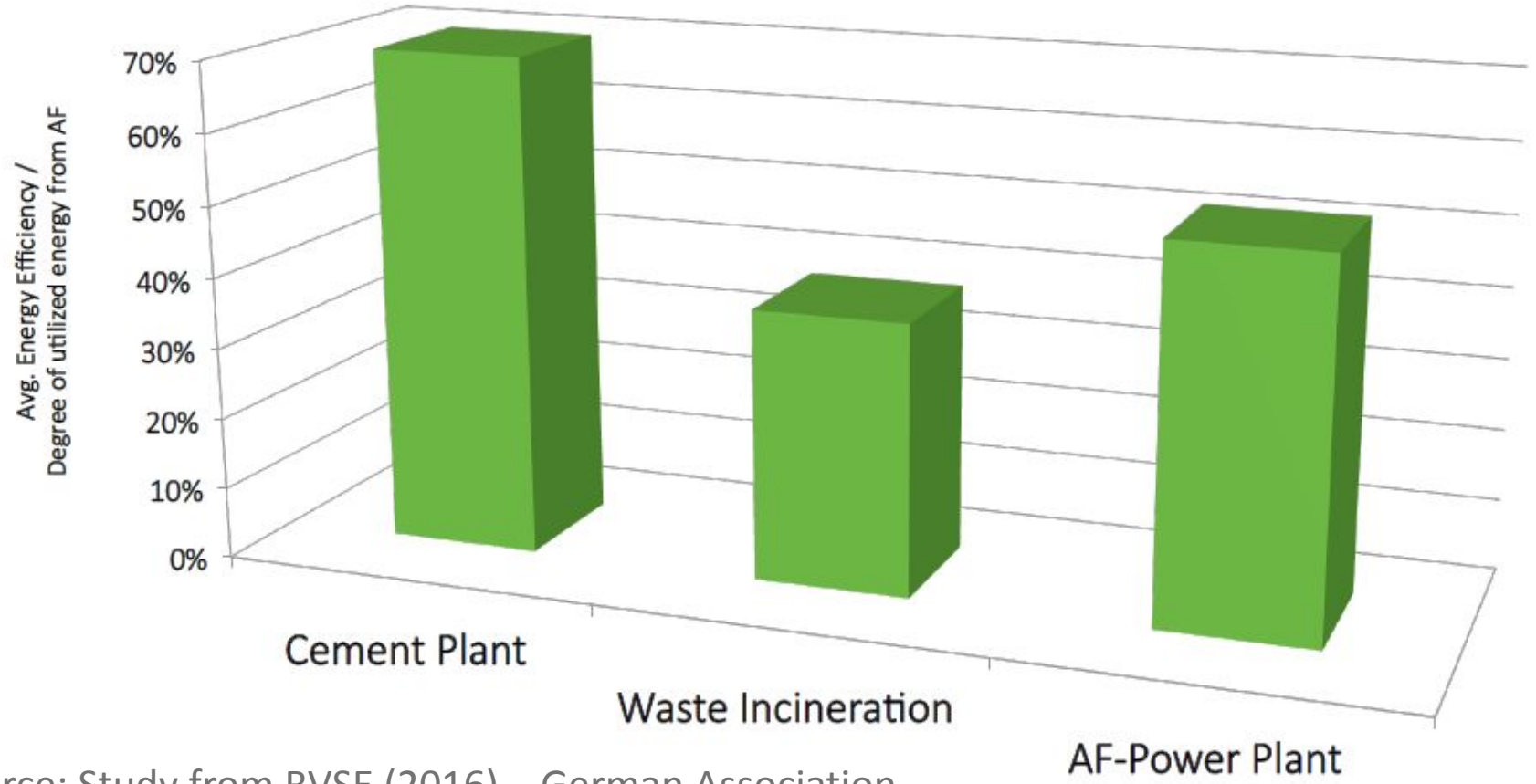
Overall, Green House Gas (GHG) emissions are reduced when replacing fossil fuels by wastes



Co-processing, economical advantages

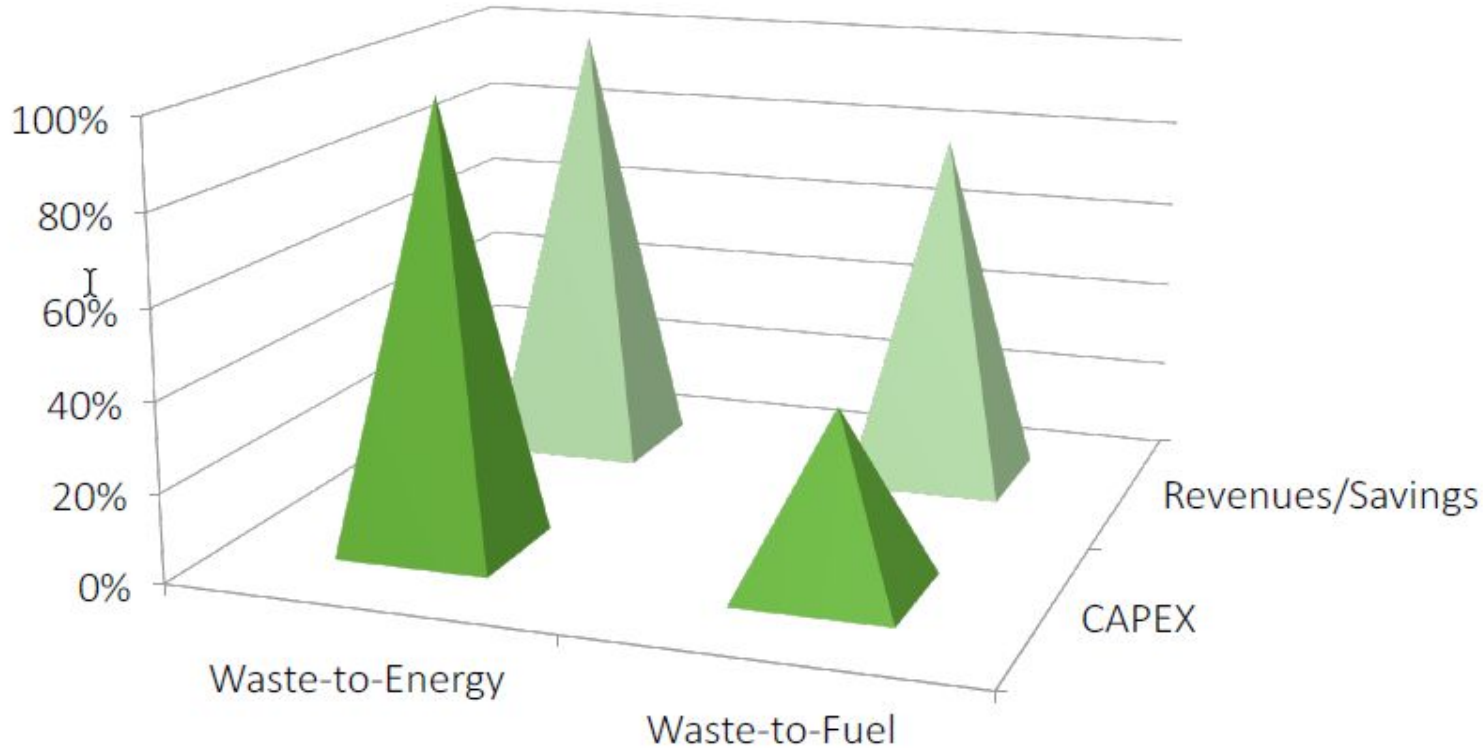
Comparison of waste disposal technologies



Source: Study from BVSE (2016) – German Association for Secondary Raw Materials and Waste Management

Co-processing, economical advantages

Comparison waste-to-energy versus waste-to-fuel (co-processing)



Source: Study from BVSE (2016) – German Association for Secondary Raw Materials and Waste Management

Several AFR waste samples

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Requirements and prerequisites treating (obsolete) pesticides contaminated waste in cement kilns I

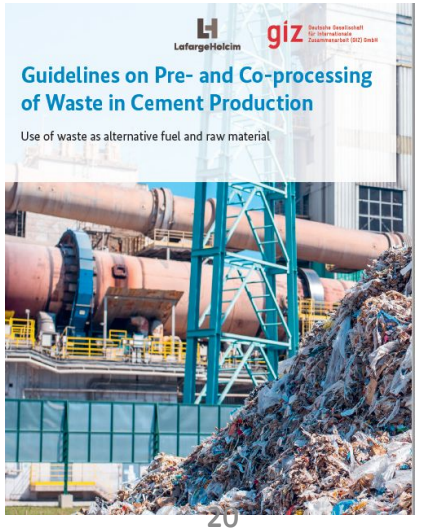
- ✔ Compliance with Basel and Stockholm Conventions;
- ✔ Co-processing as waste treatment (including destruction) included in national waste management legislation;
- ✔ Regular stakeholder dialogues with local community and authorities for responding to comments and complaints; stakeholders, especially government agencies need to address local political and community concerns;
- ✔ An approved Environmental Impact Assessment and all necessary national/local licences meeting international standards;
- ✔ An approved location, technical infrastructure and processing equipment;
- ✔ Reliable power and water supply;
- ✔ Adequate air pollution control devices (APPCD) and continuous emission monitoring ensuring compliance with regulation and permits;
- ✔ Exit gas conditioning/cooling and low temperatures in the APCD to avoid dioxin and furan formation;
- ✔ Clear management and organisational structure with unambiguous responsibilities, reporting lines and feedback mechanism;

Requirements & prerequisites treating (obsolete) pesticides contaminated waste in cement kiln II

- ✔ An error reporting system for employees and penalties for non-compliance;
- ✔ Qualified and skilled employees to manage AFR and Health, Safety and Environment;
- ✔ Adequate emergency & safety equipment, procedures; regular training;
- ✔ Authorised and licensed collection, transport and handling of AFRs;
- ✔ Safe and sound receiving, storage, preparation and feeding of AFRs;
- ✔ Adequate laboratory facilities and equipment for AFR control;
- ✔ Demonstration of AFR destruction performance through test burns;
- ✔ Adequate record keeping of AFRs and emissions;
- ✔ Adequate product quality control routines;
- ✔ An OH&S & Environmental management and continuous improvement system certified according to ISO 14001 &18001 or similar;
- ✔ Regular independent audits, emission monitoring and reporting;
- ✔ Open disclosure of performance reports.

Assessment cement plant for compliance with environmental standards

- The first step in a cement kiln assessment will be a technical, operational, Quality , H&S and Environment assessment of the suitability for POPs co-processing of a cement plant/kilns and their compliance with:
  - "UNEP/BC technical guidelines" (2012),
  - "EU co-incineration directive" (2010),
  - "GTZ-LafargeHolcim-FHNW Guidelines on pre- and co-processing of waste in cement production" (2020) and
  - National regulations.



DIRECTIVE 2000/76/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 4 December 2000

on the incineration of waste

(OJ L 332, 28.12.2000, p. 91)

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Trial burn of PCBs

Pyralene oil with 56-62% of PCBs,

(33-38% tri-chloro-benzene, 5-6% tetra-chloro-benzene)

Emptying PCB drums for co-processing

Main cement kiln burner

Emission testing facility on kiln stack

Results

DRE

>99.99999998% & 99.999999995%

In 2 different scenarios

Emissions not effected by PCB

Note: BAT/BEP guidelines of the Stockholm Convention and the Basel Convention, i.e. a DRE of 99.9999%.

Test Burn with PCBs in

Holcim Puttalam Cement Kiln,

Sri Lanka

Daft Test Burn Report

23 January 2007

Environmental Impact Assessment for Proposed Co-processing of Hazardous Waste in Kiln of Cement Plant at Holcim Cement Works-Puttalam

Draft Report
January 2008

EML Consultants
EMLConsultants
68, Davidson Road
Colombo 4
www.emlconsultants.com

Holcim
Holcim (Lanka) Ltd
Puttalam Cement Works
Puttalam
www.holcim.lk

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Main estimated additional equipment and cost for POPs disposal by co-processing in cement kilns

- Cement plants will expect a service fee for disposal by co-processing. This is due to:
  - Unstable supply of these wastes
  - Extra health, safety and environmental requirements
  - Giving no or little advantages on clinker production, etc.
- Next slide shows a typical generic cost estimate for the adjustments required for these waste streams
- Compared to the alternatives of building High Temperature Incinerator (HTI) or exporting to such incinerators abroad, the cement kiln co-processing option is economically more viable and lowers the risk of long-distance transport of these hazardous waste streams and no or neglectable difference in environmental performance

Main estimated additional equipment and cost for disposal by co-processing of POPs waste

Cement plant adjustment	Capex in $ million
Performance	0.15 - 0.25
Main burner replacement *)	0.7 - 1
Calciner burner replacement *)	0.7 - 1
Liquids/sludge feeding system	0.2 – 0.4
Solids feeding system	0.5 – 1
Additional lab equipment	0.25 – 0.5
Receiving and storage facilities	0.1 – 0.2
*) If not yet already covered in the cost for Alternative Fuel use	

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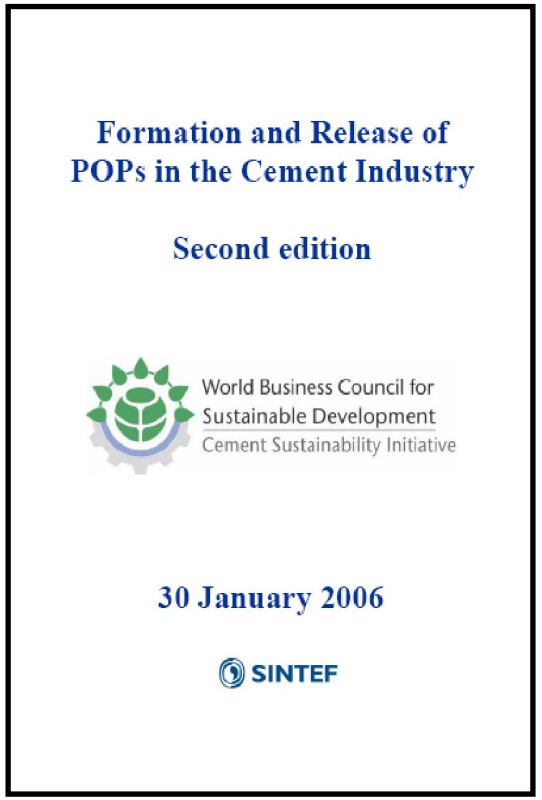
Co-processing of POP's: multiplication of references



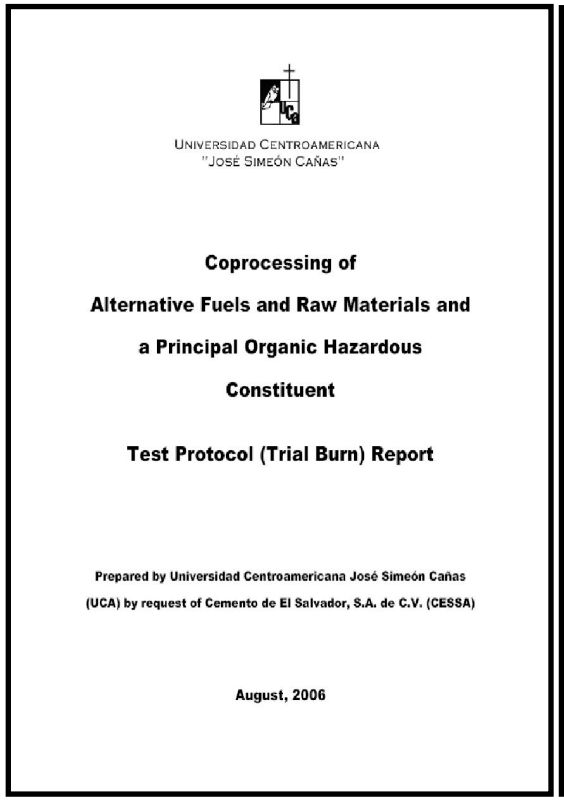
Formation and Release of POPs in the Cement Industry

Second edition

World Business Council for Sustainable Development
Cement Sustainability Initiative

30 January 2006

SINTEF



UNIVERSIDAD CENTROAMERICANA
"JOSÉ SIMEÓN CAÑAS"

Coprocessing of

Alternative Fuels and Raw Materials and

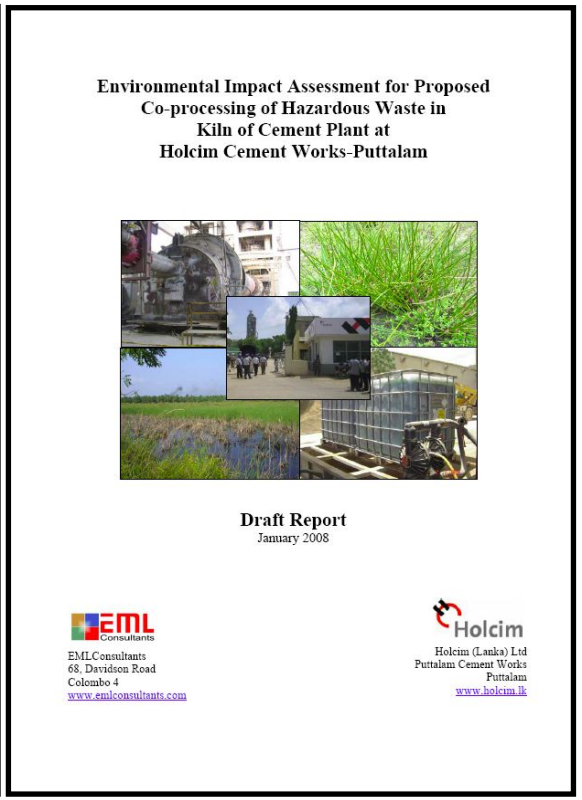
a Principal Organic Hazardous

Constituent

Test Protocol (Trial Burn) Report

Prepared by Universidad Centroamericana José Simeón Cañas
(UCA) by request of Cemento de El Salvador, S.A. de C.V. (CESSA)

August, 2006



Environmental Impact Assessment for Proposed
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Available online at www.sciencedirect.com

ScienceDirect

Chemosphere xxx (2007) xxx–xxx

CHEMOSPHERE

www.elsevier.com/locate/chemosphere

ELSEVIER

Review

Formation, release and control of dioxins in cement kilns

Kåre Helge Karstensen *

The Foundation for Scientific and Industrial Research (SINTEF), P.O. Box 124, N-0314 Oslo, Norway

Received 25 March 2006; received in revised form 20 June 2007; accepted 28 June 2007

International Technical Guidelines - Unep / Basel Convention

The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental treaty on hazardous and other wastes. Basel Convention was negotiated in the late 1980s, and entered into force in 1992.

Basel Convention acts is based on :

- ✔ International and validate agreements, facilitating sound waste management.
- ✔ Technical Guidelines submission, to promoting regulation and control of sound technologies for waste treatment/disposal.

UNEP / Basel Convention

Co-processing Technical Guidelines are now **OFFICIAL RECOMMENDATION** of United Nations:

- Co-processing is officially validated as a sound and recommended technology for hazardous and non-hazardous waste management, pop's related wastes included
- Co-processing is consolidated as recovery operation in the waste management hierarchy,
- International and technical criteria / references are now available for local legal frames,
- Minimum standards are now defined, limiting informal and non or low standard players.

http://www.basel.int/TheConvention/Publications/TechnicalGuidelines/tabid/2362/Default.aspx

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Observations & conclusions I

Co-processing and cement manufacturing

- The cement kiln offers a highly advantageous system for co-processing because…..
  - high gas and material temperatures in addition to long residence times in the kiln, virtually destroy all organic materials potentially present in alternate fuels, *and*
  - alternative raw materials supply necessary chemical constituents of cement (calcium carbonate, silica, alumina, and iron).

Observations & conclusions II

- Cement companies have a local sustainable solution for PCB containing liquids & contaminated solids (like PPM's, cleaning materials etc.),

- No long transport routes with these waste materials lower risk and lower cost or bigger volumes for same budget

- Much lower investments needed in waste disposal infrastructure so, budget can be used for other also much needed infrastructure in emerging countries

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Take Home Messages

- There is a great and urgent global need for the services of the cement industry based on general sustainability principles but in particular for hazardous waste co-processing in emerging countries
- The principles and philosophy/policy developed & adopted by cement industry on AFR practices are currently among the most responsible and advanced in waste to resource management
- The "*only*" way forward is to document and publish the performance and practise, especially from well designed studies in emerging countries

Update since last Forum

- Desktop based FAO study shows initial possibilities to use present cement kilns in Central Asia to solve historical POP's stock as kilns could follow Basel Convention guidelines to dispose of these historical stocks
- In another FAO study based on a field visit of a cement plant in Azerbaijan a recommendation for a performance test (trial burn) of POP's was made, this to show it can be done without or negligible negative environmental effects
- At this moment involved in a UNEP project to set up the conditions for a historical landfill clean up with disposal of POPs and POPs contaminated materials by cement kiln-coprocessing
- Since 2015 over 25 cement kilns in 6 countries have participated in feasibility studies for POPs and other (hazardous) waste

Take home messages II

14th International HCH and Pesticides Forum

THANK YOU FOR YOUR ATTENTION

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Back up slides

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