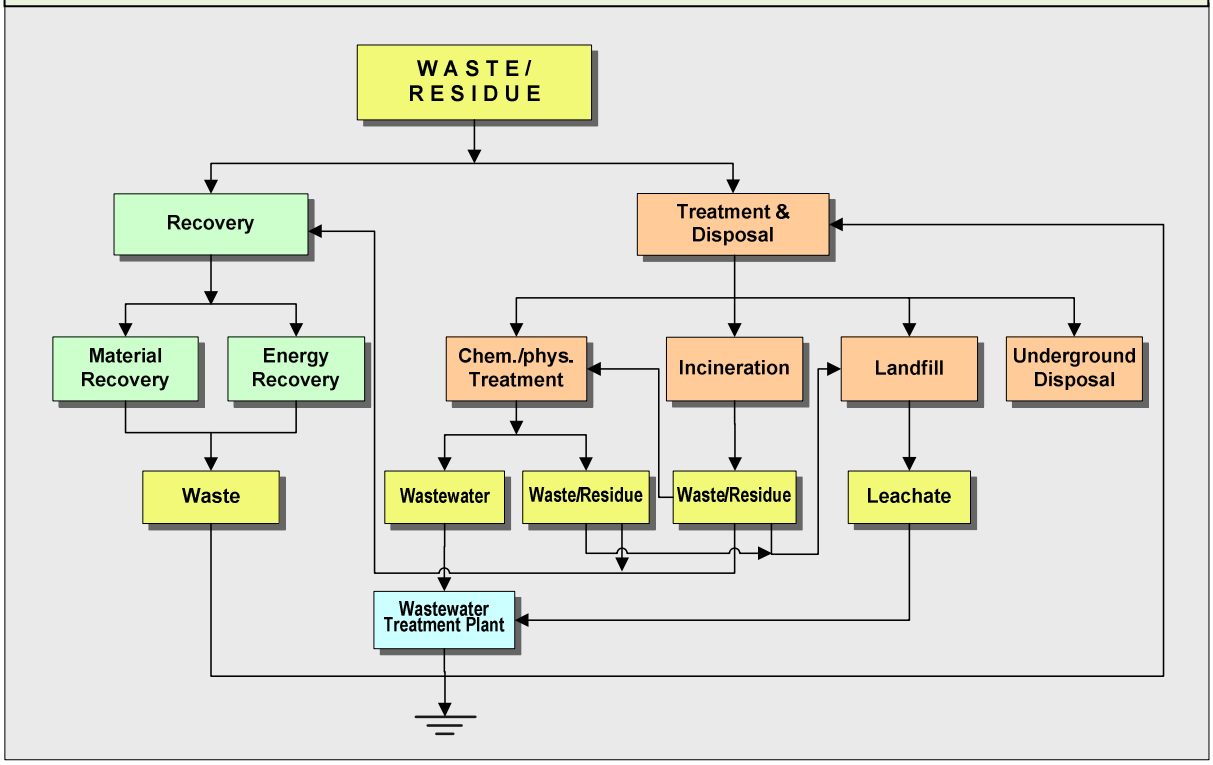


- **Module 6b**

- **Co-processing: a hazardous waste incineration option**

giz CHS Convention Project Chemical Safety

On behalf of Federal Ministry for Economic Cooperation and Development

## • 10.8. Co-Processing

Inadequate waste management due to lack of infrastructure is a frequent problem in developing countries and in countries in transition. In many of such countries, waste is discharged to sewers, buried or burned on company premises, illegally dumped at unsuitable locations or taken to landfills that fail to meet requirements for the environmentally sound final waste disposal. One possible alternative and possible solution for the poor waste management in many countries is the **co-processing of selected waste materials in the cement industry**.[188]

### 10.8.1 Co-processing in cement industry

Co-processing is the use of waste material as raw materials or as a source of energy, or both, to replace natural mineral resources and fossil fuels such as coal, petroleum and gas in industrial processes. An efficient cement kiln can provide an environmentally sound and cost-effective treatment or recovery option for a number of wastes.[189]

The high temperatures and residence times in the rotary kiln of a cement plant have a high capacity to destroy persistent organic chemicals, so that they are mineralized. The use of alternative fuels and raw materials (AFR) in cement kilns decrease greenhouse gas emissions, can decrease waste management costs and save money in the cement industry.

Co-processing of waste materials in properly controlled cement kilns provides energy and material recovery while cement is being produced. It offers an environmentally sound recovery option for many waste types. Particularly in developing nations, which may have little or no waste management infrastructure, properly designed and operated cement kilns can provide a practical, cost-effective and environmentally preferable option to landfill and incineration, through the co-processing of waste.

**The process itself has some differences from the process of the previously described hazardous waste incineration plant, which limits the application of this technique in certain areas.**

Heavy metals, if they are not volatile, are shifted in the product clinker (cement). If the hazardous waste has a high heavy metal contamination, this will lead to contamination of the product.

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[188] http://www.coprocem.com/holcim-qtz-alliance
[189] http://www.coprocem.com/Guidelines

Volatile heavy metals, such as mercury, are not retained, so they are released almost completely into the exhaust gas and are then emitted. Thus, it is to be ensured that only wastes with no or very little content of volatile heavy metals are used in the cement plant.

There are heavy metals, such as thallium, which evaporate in a certain temperature range, so that it leads to an enrichment in the process, which can cause an intermittently emission of the heavy metal.

Chlorine in turn, contained in the PVC plastic in high concentrations and also in chlorinated solvents, accumulates also as a chloride in the product. This chloride has no toxic effect, but it is still very problematic, because it degrades the material properties of the clinker / cement. Cement with high chloride content may lead to corrosion of the concrete and the steel reinforcement, which greatly affects the life of buildings and can even cause damage to buildings.

Further, working staff is exposed to high danger in the context of reception, storage and discharge. This is especially true if hazardous or infectious waste is to be treated.

**These brief examples illustrate the fact that the use of cement kilns for incineration should only be made and can be operational when requirements for co-processing of hazardous waste are clearly defined. These include in particular limits which are to be respected, and of course input monitoring.**

| | Austria[1] | | | Switzerland[2] | | Germany[3] | |
|---|---|---|---|---|---|---|---|
| | In general combustible wastes[4] | Plastic, paper, textile waste, wood, etc. high calorific fraction from common waste | Solvents, spent oil, waste lacquers | In general combustible wastes[5] | Other wastes for disposal | Plastic, paper, textile waste, wood, etc. high calorific fraction from common waste[6] | Solvents, spent oil |
| | Maximum values [mg/kg] | | | | | | |
| As | 15 | 15 | 20 | 15 | | 13 | 15 |
| Sb | 5 | 20 (200)[7] | 100 | 5 | 800[4] | 120 | 20 |
| Be | 5 | | | 5 | | 2 | 2 |
| Pb | 200 | 500 | 800 | 200 | 500 | 400 | 150 |
| Cd | 2 | 27 | 20 | 2 | 5 | 9 | 4 |
| Cr | 100 | 300 | 300 | 100 | 500 | 250 | 50 |
| Cu | 100 | 500 | 500 | 100 | 600 | 700 | 180 |
| Co | 20 | 100 | 25 | 20 | 60 | 12 | 25 |
| Ni | 100 | 200 | | 100 | 80 | 160 | 30 |
| Hg | 0,5 | 2 | 2 | 0,5 | 5[8] | 1,2 | 1 |
| Tl | 3 | 10 | 5 | 3 | | 2 | 2 |
| V | 100 | | | 100 | | 25 | 10 |
| Zn | 400 | | | 400 | | | |
| Sn | 10 | 70 | 100 | 10 | | 70 | 30 |
| Cl (total) | 1% | 2% | | | | 1,5% | |
| PCBs | 50 | | 100 | | | | |

1 voluntary self-commitment of the cement industry with authorities and concerned ministry
2 BUWAL, Co-processing Guidelines from Switzerland
3 voluntary self-commitment from the waste industry and regulations from the Government North Rhine Westfalia (NRW) Germany
4 net calorific value 25 MJ/kg
5 net calorific value average value 18 MJ/kg
6 PET
7 PET, Polyester
8 special case, flue gas cleaning for Hg

Table 28: Limit emission values in different permits and regulations in Austria, Switzerland and Germany for wastes used for co-processing in cement plants [190].

The co-incineration of hazardous waste in particular should only be allowed if the following emission limits are observed (table 29):

[190] See annex 7 at: http://www.coprocem.com/Guidelines/unterordner/guideline_coprocem_v06-06.pdf/view

Table 29: Limit emission values according to the Directive 2000/76/EC incineration of waste (Daily average 10% $O_2$, all values in mg/m$^3$ dioxins and furnans in ng/m$^3$) that have to be observed for waste combustion in cement plants[191]

| Pollutant | C |
|---|---|
| Total dust | 30 |
| HCl | 10 |
| HF | 1 |
| $NO_x$ | 500[1]/800[2] |
| Cd + Tl | 0.05 |
| Hg | 0.05 |
| Sb, As, Pb, Cr, Co, Cu, Mn,Ni, V | 0.5 |
| Dioxins and Furans | 0.1 |
| $SO_2$ | 50[3] |
| TOC | 10[3] |

Dust, HCl, NOx, $SO_2$, and Hg and TOC should be measured continuously; 1) new plants; 2) existing plants; 3) exceptions may be authorized by the competent authority in cases where $SO_2$ and TOC do not result from the incineration of waste

Co-processing should only be applied if not just one but all tangible preconditions and requirements of environmental, health and safety, socio-economic and operational criteria are fulfilled. As a consequence not all waste types are suitable for co-processing. The following negative and positive lists show respectively lists of waste not recommended or allowed for co-processing in cement plants:

**Negative waste list for co-processing in cement plants**

Waste that cannot be disposed in a cement plant form part of a negative list e.g.: nuclear waste; electronic waste; explosives; mineral acids; asbestos waste or wastes containing asbestos; chlorinated solvents; high-concentration cyanide waste; infectious medical waste;

[191] http://www.coprocem.com/Guidelines/unterordner/guideline_coprocem_v06-06.pdf/view

chemical or biological weapons destined for destruction; entire batteries; unsorted municipal garbage and other waste of unknown composition.

**Positive waste list co-processing in cement plants**

The positive list specifies which wastes can be disposed of in cement plants. For detailed information see positive lists included in guidelines for co processing at cement plants from the Swiss Federal Office for the Environment (FOEN) for: 1-) alternative fuels, 2-) raw materials, 3-) corrective raw materials, 4-) grinding additives and 5) process materials at: http://www.bafu.admin.ch/publikationen/publikation/00444/index.html?lang=en

## Conclusion

The co-incineration of certain hazardous wastes in cement kilns is an option, especially in developing countries where a high-quality waste management structure is not yet available. Because of the risks and possible negative impacts on the environment, and also the health, safety and product quality, this option should only be used with careful planning and monitoring in order to minimize these negative effects. For more information on Co-processing in cement plants use the following link[192]

**Case study Switzerland**[193]

In 2008, there were 6 cement plants operating in Switzerland, producing around 4.2 million tons of cement. The production of 1 tone of clinker requires about 135 kg of coal or 86 kg of heavy oil.

In principle, cement plants can use suitable types of waste as an alternative fuel or raw material. However, this must not increase the emission of air pollutants from kilns or reduce the quality of the cement produced. Accordingly, guidelines on waste disposal in cement plants were developed by (FOEN) in close collaboration with the industry and the cantonal authorities. These guidelines prohibit the incineration in cement plants of municipal waste and problematic special wastes (e.g. chlorinated solvents or paint residues with high heavy metal content). However, bulk wastes with a low pollution potential and high calorific value - such as used oil, sewage sludge, animal flour/animal fat, low-chlorinated solvents, plastics, used tires etc. - may be used as alternative fuels. In 2008, the cement works consumed a total of around 270,000 tons of combustible waste.

[192] http://www.coprocem.com/trainingkit/pages/home.html
[193] http://www.bafu.admin.ch/abfall/01495/01506/index.html?lang=en

**Combustible Waste (in tones) in Cement Works in Switzerland (2002 – 2008)**

| **combustible waste:** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
|---|---|---|---|---|---|---|---|
| used oils | 48.735 | 45.926 | 42.276 | 39.714 | 36.299 | 25.247 | 24.285 |
| solvents / distillation residues | 29.629 | 31.292 | 31.455 | 39.458 | 42.209 | 53.396 | 62.420 |
| car tires / rubber waste | 17.437 | 21.490 | 20.530 | 24.323 | 21.326 | 19.295 | 28.548 |
| plastics | 20.860 | 20.695 | 28.791 | 32.126 | 40.232 | 41.905 | 42.544 |
| animal fats / animal meal | 54.034 | 63.580 | 64.906 | 45.309 | 42.239 | 38.974 | 38.331 |
| sewage sludge (95% dry weight) | 38.296 | 40.980 | 39.878 | 47.920 | 54.964 | 57.696 | 53.152 |
| other | 15.098 | 14.935 | 21.158 | 15.915 | 16.314 | 16.355 | 19.900 |
| **Total** | | | | | | | **269.180** |

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Registered offices
Bonn and Eschborn, Germany

Friedrich-Ebert-Allee 40
53113 Bonn, Germany
Phone: +49 228 44 60-0
Fax: +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
Phone: +49 61 96 79-0
Fax: +49 61 96 79-11 15

Email: info@giz.de
Internet: www.giz.de

Convention Project Chemical Safety
Responsible: Dr. Frank Fecher

Authors: Jochen Vida, Adi Heindl, Ulrike Potzel, Peter Schagerl, Franziska Frölich, Ferdinand Zotz, Anke Joas, Uwe Lahl and Alberto Camacho

Contact person at the Federal Ministry for
Economic Cooperation and Development (BMZ):
Heiko Warnken

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