India: developing co-processing

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As India considers the co-processing of industrial and hazardous wastes in energy- and resource-intensive industries such as cement, its central Pollution Control Board (CPCB) and Norway's Foundation for Scientific and Industrial Research (SINTEF) consider the regulatory requirements and co-processing experiences in the country. In the second part of our focus on co-processing in India, recent projects are highlighted.

In February 2010, India's Central Pollution Control Board (CPCB) released guidelines for the co-processing of hazardous waste in cement plants. According to the guidelines, a cement plant considering co-processing must submit an application for a test burn to the State Pollution Control Board (SPCB). The SPCB grants test burn permission within 60 days of receipt of the application. The cement plant must then also inform the CPCB about the test burn at least 15 days in advance so the latter can monitor the trial run. The test lasts five days starting with a baseline test (with no waste feeding), followed by three days with waste and, finally, on the last day another baseline test is carried out. The test burns are usually conducted with the CPCB, SPCB and a third-party consultant.

Tables 1 and 2 provide detailed specifications for hazardous wastes to be used as alternative raw materials and for energy recovery, respectively.

After the successful completion of the test burn, the cement plant needs to submit an application for regular co-processing along with the test burn report. The report needs to be submitted to the CPCB via the SPCB and must contain data on emissions monitoring during the trial as well as before and after the test. Cement plants will need to send some of their samples abroad as certain emissions such as dioxins have limited analytical capacity in India. Once the SPCB receives the report, it may grant or refuse permission within 30 days.

Stack gas sampling during waste test burn in Madhya Pradesh

Table 1: specification of hazardous waste for use as alternative raw material (CPCB, 2010)

Parameter	*Limit*
Volatile organic hydrocarbon (ppm)	<5000
Total organic carbon (TOC) (ppm)	<1000
In ash: $CaO + SiO_2 + Al_2O_3 + Fe_2O_3 + SO_3$ (%)	>80
Chloride (%)	<1.5
Sulphur (%)	<1.5
PCB/PCT (ppm)	<5.0
Heavy metals (ppm):	
Hg	<10
Cd+Tl+Hg	<100
As+Co+Ni+Se+Te+Sb+Cr+Sn+Pb+V	<10,000

Emission values during co-processing should not exceed the baseline emissions for:

- particulates, CO, TOC, NO_x, HCl, SO_2, HF, total dioxins and furans
- Cd, Tl and their compounds
- Hg and its compounds
- Sb, As, Pb, Co, Cr, Cu, Mn, Ni, V and their compounds (see also Table 3).

Emissions of dust shall not exceed the limit prescribed by SPCB.

SPM, RSPM, SO_2 and NO_x need to be monitored in ambient air at three areas around the plant: one in an upwind and two in a downwind direction. Monitoring needs to be carried out on a 24-hour basis during the whole test period.

Authorisation by SPCB usually takes 2-3 months. Therefore, it can take up some time from a plant's decision to implement co-processing to the point when actual permission is granted by the CPCB/SPCB. If a new waste stream that has not been

previously tested by the CPCB is to be introduced for co-processing, the same procedure has to be repeated.

The guidelines require a detailed reporting of the process, ie the waste to be used and its manufacturer, all handling and management steps, as well as comprehensive testing of all input and output streams, clinker quality, and advise to set up a mass balance. As an example, for the hazardous waste to be used, the following needs to be established:

- gross and net calorific value of the waste (kcal/kg)
- approximate analysis (content of moisture, ash, volatile matter and fixed carbon)
- ultimate analysis (content of carbon, hydrogen, sulphur, nitrogen and oxygen)
- characteristics of the waste (chlorine, fluorine and metal content lead, zinc, tin, cadmium, arsenic, mercury, chromium, cobalt, nickel, thallium, copper, vanadium, antimony, manganese, selenium, iron)
- total organic carbon (TOC)
- TCLP test
- total petroleum hydrocarbon
- organo-chlorine compounds
- VOCs and semi-VOCs
- polychlorobiphenyls (PCBs)
- polychlorophenols (PCPs)
- viscosity and water content (for liquids)
- solid content (for liquid hazardous wastes).

Co-processing experiences

While 25 cement plants are currently co-processing wastes in India, the total substitution rate (TSR) is still less than one per cent (see Table 4).

However, a range of hazardous waste categories have been tested and were granted permission by the CPCB to be used for co-processing in the cement industry. The 31 waste categories tested during 2005-11 are detailed in Table 5.

The Indian steel industry currently has no or very limited experience in co-processing and is generally cautious about its implementation due to concerns over the possible negative impacts on the production process and product quality. Therefore, the power industry has only conducted limited testing, as shown in Table 6.

In 2011, the CPCB entered into a four-year institutional cooperation with SINTEF aiming to assist in the safe implementation of co-processing practices in resource- and

Table 2: specification of hazardous waste for use of energy recovery (CPCB, 2010)

Parameter	*Limit*
Calorific value as received basis (kcal/kg)	>2500
Ash:	
Liquid (%)	<5
Solid (%)	<20
Chloride (%)	<1.5
Halogens (F+Br+I) (%)	<1.0
Sulphur (%)	<1.5
PCB/PCT (ppm)	<50
Heavy metals (ppm):	
Hg	<10
Cd+Tl+Hg	<100
As+Co+Ni+Se+Te+Sb+Cr+Sn+Pb+V	< 25,00
pH	4-12
Viscosity (cSt) for liquid	<100
Flash point (°C) (for liquid)	>60

Table 3: detailed emission monitoring schedule to be followed before, after and during test burn of co-processing of hazardous waste in cement kilns (CPCB, 2010)

Parameter	*Frequency (no. samples/day)*
Particulates	4
SO_2	4
HCl	4
CO	4
NO_x	4
Total Organic Carbon	1
HF	4
Hydrocarbons	2
Opacity (continuous dust emission monitoring)	Continuous
VOC	2
PAH	2
Metals (both particulate and vapour phase)	
Cd, Th, Hg, Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Zn, Sn, Se	1
Dioxins & furans	1
Cyanide	1

Table 4: volumes of wastes co-processed, 2006-11 (Gupta, 2012)

Year	*Approx. quantity of hazardous waste co-processed (t)*	*Approx. quantity of non-hazardous waste co-processed (t)*	*Approx. total quantity of waste co-processed (t)*
2006-07	5191	187,305	192,496
2007-08	6891	321,209	328,100
2008-09	12,036	557,264	569,300
2009-10	24,692	904,185	928,878
2010-11	45,995	1,850,018	1,896,013

Table 5: 31 categories of waste tested in the period 2005-11 (Gupta, 2012)

Waste co-processed	*Cement plant*	*Trial run period*	*Utilisation (%)*	*Calorific value (kcal/kg)*
ETP sludge (BASF India Ltd, Manglore)	Rasashree Cement, Gulbarga, Karnataka	January 2005	5-6	3039
Toluene diisocyanate tar (Narmada Chematur Petrochemicals Ltd, Bharuch)	Gujarat Ambuja Cement Ltd, Kodinar, Gujarat	February 2006	4-7	7635
Toluene diisocyanate tar (Narmada Chematur Petrochemicals Ltd, Bharuch)	Lafarge India Ltd, Raipur, Chhattisgarh	May 2006	5-7	7635
Tyre chips	Grasim Industries Ltd, Reddipalayam, TN	April-July 2006	9-19	11,515
Paint sludge (Automobile sector)	Grasim Industries Ltd, Reddipalayam, TN	April-July 2006	9-17	6755
Refinery sludge (Chennai Petrochemicals Company Ltd, Chennai)	Grasim Industries Ltd, Reddipalayam, TN	April-July 2006	9-17	3763
ETP sludge (Textile industry)	Grasim Industries Ltd Aditya Cement	May 2007	7	1570
Poly residue (SRF Ltd)	Kymore works, MP	March 2008	3.87	5818
Plastic waste	Kymore works, MP	March 2008	1.50	8200
Phosphate sludge (Toyota, Kirloskar, Motor Ltd, Bangalore)	Wadi works, KA	April 2008	0.77	830
Chemical sludge (Toyota Kirloskar Motors Ltd, Bangalore)	Wadi works, KA	April 2008	2.04	1212
Phosphate sludge (Ford India Ltd, Chennai)	Madukkarai works, TN	June 2008	0.93	135
Chemical ETP sludge (Ford India Ltd, Chennai)	Madukkarai works, TN	June 2008	0.93	254
n-butanol salt (Jubillent Organosys Ltd, Mysore)	Wadi works, KA	July 2008	1.01	6517
Spent carbon (Hindustan Coca Cola Beverages Pvt Ltd, Bangalore)	Wadi works, KA	July 2008	2.75	1471
ETP bio solid (Hindustan Coca Cola Beverages Pvt Ltd, Bangalore)	Wadi works, KA	July 2008	2.46	3434
WTP sludge (Hindustan Coca Cola Beverages Pvt Ltd, Bangalore)	Wadi works, KA	July 2008	2.68	317
Solar evaporation pond sludge (Jubillent Organosys Ltd, Mysore)	Wadi works, KA	July-August 2008	1.01	6034
CETP Pali sludge	JK Laxmi Cement, Sirohi, Rajasthan	December 2008	5	804
Oily rags (Ford India Ltd, Chennai)	Madukkarai, Works, TN	December 2008	0.27	7960
Lead zinc slag	Grasim Ind. Aditya Cement	January 2009	5	<150
Grinding muck (Kirloskar Toyada Textile Machinery Pvt Ltd, Bangalore)	Wadi works, KA	February 2009	2.81	784
Grinding dust (SKF India Ltd, Bangalore)	Wadi works, KA	February 2009	0.73	1936
Green mesh with resin (Suzlon Energy Ltd, Pondichery)	Madukkarai, Works, TN	March 2009	0.65	8207
Solid waste mix (GEPIL, Surat)	Lafarge India Ltd, Raipur, CG	Sept-Oct 2009	2.40	4174

Table 5: 31 categories of waste tested in the period 2005-11 (Gupta, 2012) *continued*

Waste co-processed	*Cement plant*	*Trial run period*	*Utilisation (%)*	*Calorific value (kcal/kg)*
Liquid waste mix (GEPIL, Surat)	Lafarge India Ltd, Raipur, CG	Sept-Oct 2009	10.30	3863
Liquid waste mix (GEPIL, Surat)	Ambuja Cement Ltd, Kodinar, Gujarat	November 2009	14.50	3863
Liquid organic solvent (Pharmaceutical industry)	Grasim Industries Ltd, Andhra Pradesh	December 2009	10.44	9098
Solid organic solvent (Pharmaceutical industry)	Grasim Industries Ltd, Andhra Pradesh	December 2009	10.10	9927
Spent wash	Rajshree Cement Ltd, Gulberga, Karnataka	June-July 2010	3.50	2000
Spent catalyst (Oil refinery)	ACC Chaibasa, Jharkhand	March 2011	3.6	<80

In 2011, the CPCB entered into a four-year institutional cooperation with SINTEF aiming to assist in the implementation of safe co-processing practices in resource- and energy-intensive industries in India.

energy-intensive industries in India. The aim of this Norwegian-funded project is to build capacity, carry out training and transfer knowledge as well as to provide input to the development of a robust regulatory system reflecting international best practice. A closer look at the introduction of co-processing is featured in the first part of this article "India: introducing co-processing" on page 91.

Table 6: wastes tested in thermal power plants (Gupta, 2012)

Waste co-processed	*Thermal power plant*	*Trial run period*	*Utilisation (%)*
ETP sludge	CPP of Raymond Ind Ltd, MP	2009	1.0
Spent pot lining	Hindalco, Renukoot, UP& Hirakud, Odisha	2009-10	1.0 & 0.5
Resins	Satpura Thermal Power Plant, Madhya Pradesh	2011	0.03
Anode but	CPP, Vedanta Resources Ltd, Odisha	2012	1.0

Over the past seven years more than 30 types of waste have been tested for co-processing

References

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