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Session 6: Scenarios to counter plastics litter by overcoming barriers and identifying enabling measures

STRATEGY AND FACILITATION TO ENCOURAGE CO PROCESSING OF PLASTIC WASTE IN CEMENT KILN

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PLASTIC WASTE GENERATION IN INDIA

- Plastic Waste Generation: **9.4 MTPA** (26,000 tonnes per day as per CPCB
  - **5.6 MTPA** (15600 tpd) i.e. 60 % is recycled
  - Remaining **3.8 MTPA** (9400 tpd is uncollected, littered and ends up in landfills or oceans or clogs drains).
  - Littered plastic gets mixed up with other waste in form of MSW. Average plastic waste generation is around **6.92%** of MSW.

PLASTIC WASTE MANAGEMENT RULES 2016

- Local bodies shall encourage the use of plastic waste for road construction as per Indian Road Congress guidelines or **energy recovery** or waste to oil etc.
- Responsible for development of infrastructure set up for waste segregation, collection, storage, processing and disposal
- Waste segregation is also waste generators responsibility
- The standards and pollution control norms specified by the concerned prescribed authority for these technologies shall be complied with.

BEST OPTION FOR DISPOSAL OF PLASTICS CO-PROCESSING IN CEMENT PLANT

- High flame Temperature
- Long residence time
- Alkaline environment
- Oxidizing atmosphere
- Complete scrubbing of exhaust gases
- Inclusion of ash and residual metals within the clinker structure.
- Kiln lines equipped with ESP / Bag filters.
- Intense contact between solid and gas phases.
  - condensation of volatiles
  - absorbs SO_2
  - neutralizes acid gases.
- Destruction and Removal Efficiency of 99.9%.
- No waste is generated that requires subsequent disposal.

IDEAL CONDITIONS FOR CO-PROCESSING OF PLASTICS IN KILN SYSTEM

Characteristics	Values
Temperature in kiln	>1450 ^{o}C Burning Zone > 1800 ^{o}C flame temperature
Residence time in kiln	5 - 6 seconds
Temperature at calciner	> 850 ^{o}C material temperature > 1000 ^{o}C flame temperature
Residence time at calciner	4-6 seconds and > 800 ^{o}C

FEEDING OF PLASTIC WASTE MATERIAL FOR CO-PROCESSING

- The main burner at the rotary kiln outlet end
- The rotary kiln inlet end
- The pre-calciner
- The mid kiln (for long dry and wet kilns)

Unsegregated/ unprocessed waste send to landfills cannot be directly used by cement plants co-processing

FUTURISTIC SCENARIO FOR PLASTICS CO-PROCESSING IN INDIAN CEMENT INDUSTRY

Fuel consumed by cement industry *	40	million tonne coal/yr
Total heat requirement for Clinkerisation	180	Tera kcal/yr
Littered plastic	3.8	million tonne plastic/yr
Considering avg CV of 3000 kcal/kg	13.3	Tera kcal/yr
% Thermal Substitution Rate	~6	%

***Assumed Average CV of Fuel mix: 4500 kcal/kg**

Anticipated 6% TSR by co-processing uncollected/littered plastic by Indian cement industry which is achievable. Some cement plants have achieved more than 15% TSR through AFs

CALORIFIC VALUE OF DIFFERENT TYPES OF PLASTICS

PARAMETER	CALORIFIC VALUE (kcal/kg)	
PET	5100	**Recyclable**
HDPE	13000	
PVC	4500	
LDPE	11000	
PP	12500	
PS	10700	

Cement Plants in India are getting plastic waste having a calorific value of 2500 – 3500 kcal/kg from the local bodies

PREREQUISITE FOR PLASTICS CO-PROCESSING IN CEMENT INDUSTRY

PARAMETER	PRE-REQUISITE	SOURCE
Net Calorific Value	> 2500 kcal/kg	Co-processing guidelines CPCB
Feed Size	< 20 mm for burner < 50 mm for calciner	Plastic Co-processing guidelines, MoHUA RDF guidelines
Ash content	< 15 %	MoHUA RDF guidelines
Moisture content	< 20 %	
Chlorine content	< 1 %	
Sulphur content	< 1.5 %	

PROCESS MONITORING PARAMETERS FOR PLASTICS CO-PROCESSING

- Waste consumption
- Kiln feed
- Conventional fuel consumption
- Burning zone temperature
- Kiln inlet temperature, O_2, CO, NOx
- Preheater exit temperature,O_2,CO
- Shell radiation temperature in burning zone
- Clinker temperature in cooler exit
- Kiln speed, torque
- Preheater fan speed
- Specific thermal and electrical energy consumption

PARAMETERS NEEDS TO BE MONITORED AT CEMENT PLANTS

Test Parameter↓	Clinker
Free Lime	3% (max.)
C_3S	35% (min.)
$C_3S + C_2S$	70%
C_3A	3 to 12%
Total SO_3 % (max.)	2.70
Total Alkalies as Na_2O % (max.)	0.60
Chloride % (max.)	
For prestressed concrete	0.05
For other uses	0.10

Test Parameter↓	Cement (PPC)
Fineness, m2/kg (min.)	300
Setting Time, min.	
Initial (min.)	30
Final (max.)	600
Comp. Strength N/mm2 (3, 7, 28 days)	(16, 22, 33)
Total SO_3 % (max.)	3.50
Total Alkalies as Na_2O % (max.)	0.60 0.90
Chloride % (max.)	
For prestressed concrete	0.05
For other uses	0.10

Test Parameter↓	Effect on Concrete
KCl	Effect on setting time and strength
NaCl	
CaCl2	
K2O	Alkali-Aggregate Reactivity
Na2O	
Leachability	for hazardous plastic

OPERATIONAL CONSIDERATION FOR PLASTICS CO-PROCESSING IN CEMENT PLANTS

- Feeding of plastic waste is not to be carried out during kiln start up and kiln shut down conditions
- Feeding of plastic waste needs to be initiated only after the kiln attains its stable operating conditions.
- The Feeding of plastic waste should not be continued in case the continuous emission monitoring system (CEMS) is not connected with CPCB and SPCB servers.
- The cement plants shall ensure that the emission parameters are monitored as per the prescribed monitoring protocol provided by regulatory bodies like CPCB, SPCB/PCC and MoEFCC.

(Source: Guidelines for Co-processing of Plastic Waste in Cement Kilns 2017 (As per Rule '5(b)' of Plastic Waste Management Rules, 2016)

EMISSION LIMITS FOR INDIAN CEMENT INDUSTRY

Parameters	Limit		Remarks
PM	**30**	mg/Nm^3	All the plants
NOx	**600**	mg/Nm^3	For New Cement kilns commissioned on or after 25.08.14
	800	mg/Nm^3	Rotary kiln with In Line Calciner Technology
	1000	mg/Nm^3	Rotary kiln using mixed stream of ILC, SLC and suspension pre-heater technology
SO_2	**100**	mg/Nm^3	When pyritic sulphur in the limestone is less than 0.25%
	700	mg/Nm^3	When pyritic sulphur in the limestone is in between 0.25% to 0.5%
	1000	mg/Nm^3	When pyritic sulphur in the limestone is more than 0.5%.

EMISSION LIMITS FOR INDIAN CEMENT INDUSTRY

Parameters	Limit		Remarks
HCl	10	mg/Nm^3	In addition to above parameters while co-processing of waste like plastics
HF	1	mg/Nm^3	
TOC	10	mg/Nm^3	
Hg and its comp	0.05	mg/Nm^3	
Cd +Tl and their compounds	0.05	mg/Nm^3	
Sb + As + Pb + Co + Cr + Cu + Mn + Ni + V	0.5	mg/Nm^3	
Dioxins and Furans	0.1	ngTEQ/Nm3	

INFRASTRUCTURAL REQUIREMENT FOR PLASTICS CO-PROCESSING IN CEMENT PLANTS

- Coal feeding circuit and raw material feeding circuits of the cement plant must not be utilised to feed any type of wastes for co-processing
- Therefore, Separate feeding arrangement is required. In case it is already there, then the same can be utilised for plastics as well.
- Proper covered storage along with conveying mechanism to move plastic waste from storage area to kiln
- Equipment such as double flap valves, shut off gates etc. are implemented to ensure uniform feed and safety in operation.
- A lab facility to carry out the calorific value, ash content, moisture content and chloride content.

Source: Guidelines for Co-processing of Plastic Waste in Cement Kilns 2017 (As per Rule '5(b)' of Plastic Waste Management Rules, 2016)

SOME LARGE PLANTS HAVE SHREDDING & FEEDING SYSTEM OF PLASTIC WASTE

Waste Polythene & Plastic Shredder

Unloading The Polythene And Plastic Waste

Feeding Of Plastic Waste Into The Shredder

Shredded Waste Polythene & Plastic

AF FEEDING SYSTEM AT A CEMENT PLANT

Step – 1 Unloading of RDF (Refuse Derived Fuel into hoppers)

Step – 2 Storage and Feeding Hoppers

Step – 3 Storage and Feeding Hoppers

Step – 4 Alternate Fuel Feeding System

CONSTRAINTS FACED

- Lack of effective Pre-processing facilities like shredding
- High chlorine content
- High moisture content
- Impurities present in plastic/littered plastic
- Firing through kiln main burner is one of the major constraint
- Unavailability of plastic waste on consistent basis
- Large Investment to operate at a TSR level of about 15%.

STRATEGY TO ENCOURAGE CO-PROCESSING IN CEMENT INDUSTRY

- Perception of Co-incineration as a dump-yard of any kind & size of waste – Needs to be changed
- Plastic waste specifications to be formulated for co-processing
- Most of the cement plants don't have any shredding facilities. This will require local bodies to establish Material Segregation & Recovery Facilities (MSRF) to pre-process the littered plastics
- Some Large cement plants have shredding facilities and they can pre-process the incoming segregated waste.
- Implementation of Extended Producer Responsibility
- Strong database of types of plastics and their composition and region wise availability

FACILITATION

- Segregated plastics handling & storage facility nearby cement plants cluster
- Viable Economic model to be developed for transportation of pre-processed plastic waste
- E-CERTs based system for % TSR
- Linkage of cement industry, plastic manufacturers, municipalities, research bodies

Cement plants also needs to upgrade their co-processing systems for firing in kiln and calciner if good quality plastic waste is ensured in the vicinity.

Thank You!

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