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Plastic Waste of Jabalpur City used for Energy Recovery

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Abstract-- **This work proposes the decomposition of plastic waste & energy recovery in cement factory. Cement industry ranks 2nd in energy consumption among the industries in India. It is one of the major emitter of CO_2, due to combustion of fossil fuel and calcination process. As the huge amount of CO_2 emissions cause severe environment problems, the efficient and effective utilization of energy is a major concern in Indian cement industry. The main objective of the research work is to assess the energy consumption and energy conservation of the Indian cement industry and to predict future trends in cement production and reduction of CO_2 emissions. In order to achieve this objective, a detailed energy and reduction of CO_2 emission analysis of a typical cement plant in katni was carried out.**

The purpose of this study was a quantitative analysis of the energy, environmental and greenhouse gas effects of replacing fossil by plastic waste in the Jabalpur Municipal corporation project model initiative in M/S ACC Ltd, Kymore, and Katni cement production factory. The use of plastic waste was examined with a focus on this practice at ACC cement plant. The total cost saving per day is Rs. 9705 (Rs.3542, 325 per annum) and 9 tons coal save per day. The co-incineration of coal and waste plastics reduces the overall CO_2 emissions, after replacement of coal by plastic waste the total reduction of CO_2 is17.81 tons/day or 6500 tons/annum. It is also remarkable that the non recyclable plastic waste generated from Municipal Corporation contributes around 25% of the total generation of the whole state; hence, its management through Jabalpur Model will help a major quantity to convert it into a useful resource and will generate source of income for around 12 lacs urban population of the state.

A basic forecasting model in Jabalpur plastic waste for the cement production trend was developed by using the system dynamic approach and the model was validated with the data collected from the selected M/S ACC Ltd, Kyomore, Katni cement production factory. The cement production and CO_2 emissions from the industries were also predicted with the base year as 2010. The sensitivity analysis of the forecasting model was conducted and found satisfactory.

I. INTRODUCTION

1.1 Present Scenario & Challenges

India generates about 6.2 million tons of hazardous wastes annually, out of which around 3.09 million tones is recyclable, 0.41 million tonnes is incinerable and 2.73 million tonnes is land-fillable (Central Pollution Control Board).

With increase in population and increase in per capita consumption, increasing quantum of hazardous waste is generated every year. The local administration, civic bodies and policy makers are posed with a serious concern of its effective & safe disposal.

All developed nations globally have utilized cement kilns in their countries as an effective option for industrial, municipal and hazardous waste disposal as this creates a WIN-WIN situation for both the local administration and the cement plants. However, the current thermal substitution rate (TSR) in Indian cement industry is less than 2% as compared to some European countries that have a thermal substitution rate as high as 40% (Perspectives and limits for cement kilns as a destination for RDF).

1.2 Plastic Waste Management in India

Plastic products have become an integral part in our daily life as a basic need. It produced on a massive scale worldwide and its production crosses the 150 million tonnes per year globally. In India approximately 8 Million tonnes plastic products are consumed every year (2008) which is expected to rise 12 million tones by 2012. Its broad range of application is in packaging films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household and industrial products, and building materials. It is a fact that plastics will never degrade and remains on landscape for several years. The recycled plastics are more harmful to the environment than the virgin products due to mixing of colours, additives, stabilizers, flame retardants etc.It is to mention that no authentic estimation is available on total generation of plastic waste in the country however, considering 70% of total plastic consumption is discarded as waste, thus approximately 5.6 million tons per annum (TPA) of plastic waste is generated in country, which is about 15342 tons per day (TPD).

1.3 Total Potential of MSW in Jabalpur City

Jabalpur is one of the four major cities in Madhya Pradesh (India) with a population of approximately above 24 lacks produces 1, 59,826 tonnes per annum and 450 tonnes per day of MSW. This waste is disposed by open dumping site at the Ranital dumping site MSW problem is a major concern in major cities Jabalpur.

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The organic fraction of solid waste composition comprised about 71%. The waste generation rate has increased from 0.23kg/capita/day in 2004-05 (NEERI 2004-05) to 0.48kg/capita/day in 2009 indicating an increase rate of 3.8% per year. MSW is the waste generated in a community with the exception of industrial and agricultural wastes. Hence MSW includes residential waste (e.g., households), commercial (e.g., from stores, markets, shops, hotels etc), and institutional waste (e.g., schools, hospitals etc). Paper, paperboard, garden and food waste can be classified in a broad category known as organic or biodegradable waste.

Table 1:
Jabalpur Zone wise & Month wise analysis of Waste Generation in tons

Table 4.4.1 (a): Resources potential zone wise quantity of MSW (in tones) in Jabalpur city

(Historical data calendar year 2010)

Months	Zone1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
January	2137	1680	839	1870	1502	1176	2189	884
February	1765	1401	754	1324	1531	758	2160	1052
March	2004	1852	871	1633	1736	956	2470	1073
April	2581	2204	1036	1924	1950	1156	3636	1239
May	1955	2110	1173	2385	1815	812	2548	1089
June	1375	2164	1230	2152	1952	1024	2897	1094
July	2341	1935	778	1670	2465	963	2639	918
August	1834	1966	1232	1913	2181	1212	2203	933
September	2135	2060	1170	2979	2019	1105	2790	1102
October	2080	1919	1054	2383	1958	801	2703	1314
November	1696	1360	691	1703	1672	804	1689	1057
December	2204	1769	1035	1747	1880	1209	1224	1308
Total	24113	22425	11869	23688	22626	11979	30005	13070

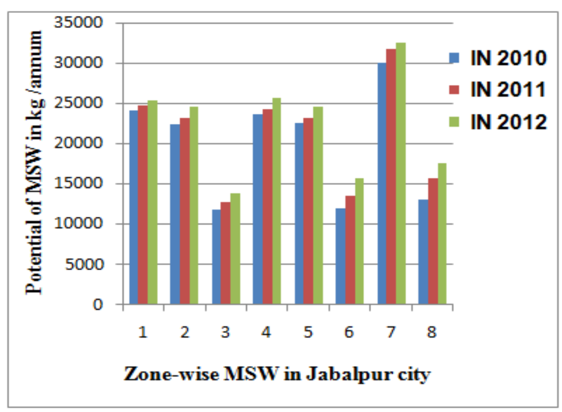
(Source : Municipal Cooperation Jabalpur M.P.)

Table 2:
Jabalpur Zone wise Waste Generation in tons

Table 4.4.1(b): Jabalpur zone wise waste generation in tonnes.

Zones	Source of generation	Population	Waste Generated (tons/Day)	Waste Generated (tons/years) In 2010	Waste Generated (tons/years) In 2011	Waste Generated (tons/years) In 2012
Zone 1	Garha	1,55,261.00	65	24113	24725	25431
Zone 2	Gorakhpur	140,032	58	22425	23123	24598
Zone 3	Sanjay Gandhi Market	83,999	35	11869	12775	13768
Zone 4	Civil lines	84,036	35	23688	24342	25678
Zone 5	Ghanta Ghar	79,939	33	22626	23124	24567
Zone 6	Bhantallaiya	120,274	50	11979	13456	15678
Zone 7	Cherital	172,551	72	30005	31678	32543
Zone 8	Ranjhi	115,355.00	48	13070	15643	17654

Fig 4.4.1(c) The Zone-wise MSW in Jabalpur city



(Source: Jabalpur Municipal Corporation, 2012)

Fig 1: Zone wise MSW in Jabalpur City

We collect the MSW from the proposed dumped site is located at village Kathonda towards North West direction of Jabalpur city with a spread of over 24.60 hec.

II. Materials And Methods

2.1 Requirements for co-processing of waste

1. An approved national/local licenses, permits, authorizations and permissions.
2. Suitable location, technical infrastructure, storage and processing equipment.
3. Adequate air pollution control devices and emission monitoring of identified parameters ensuring compliance with regulation and permits.
4. Exit gas conditioning/cooling and low temperatures (< 200°C) in the air pollution control device to prevent dioxin formation.
5. Clear management and organizational structure with unambiguous responsibilities, reporting lines and feedback mechanism.
6. Qualified and skilled employees to manage wastes and health, safety and environmental issues with effective error reporting system.
7. Adequate emergency and safety equipment and procedures, and regular training.
8. Adequate facilities for plastic waste acceptance and feeding control.
9. Adequate record keeping of wastes and emissions.
10. An environmental management and continuous improvement system certified according to ISO 14001, EMAS or similar internationally accepted standard.
11. Independent audits, emission monitoring and reporting.
12. Stakeholder dialogues with local community and authorities, and mechanisms for responding to comments and complaints.
13. Open disclosure of performance and compliance verification reports on a regular basis.

2.2 Co-processing: Upgrades waste management within the waste hierarchy - Reduces global environmental impacts, Decreases (largely) the costs of waste management, Regional job creation in waste collection and pretreatment etc., Zero-emission technology. ACC Non recyclable plastic waste Management Rag Capacity: 4 MT per Hr.

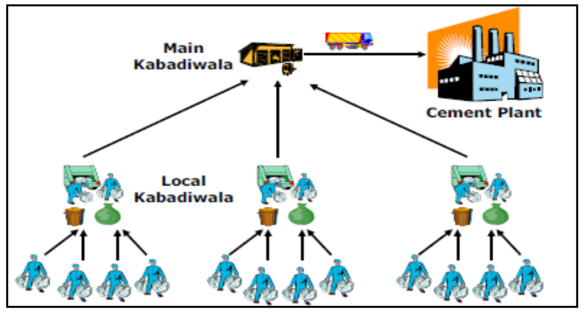


Figure 2 : ACC AFR Feeding System -Starter Kit

2.3 Steps of processing in ACC:

1. Transportation of AFR Material-Construction hoist/Monorail hoist
2. Drop the material in Hopper.
3. Belt Weigher
4. Feeding Chute
5. Flap damper
6. Slide Gate
7. Fire sensor
8. Pressure sensor
9. Small Storage Shed.
10. Cost: 10 mio. Rs. Approx.

2.4 Regular disposal through co-processing at ACC Kymore Works

Municipalities will be relieved of all liabilities, short term and long term, with respect to the plastic wastes after the same is disposed through co-processing in our cement kiln

1. The combustible portion of the waste will be completely destroyed and the non-combustibles are immobilized in the clinker matrix. It means once the waste is co-processed, it does not exist in the environment anymore.
2. Co-processing at cement kiln is the best available disposal option than conventional options of land filling and incineration.
3. This technology will prove to be cost effective in long term(operation & maintenance of SLF is costly and entails liability) and also provides intangible benefits as land availability and good housekeeping.
4. The waste is being handled and managed by experts distilling the experience of 18 years and from more than 35 countries around the world.

5. Waste will be managed according to local requirement and conditions ensuring highest service standards and environmental compliance.
6. ACC will assure a complete record and audit trail, CRADLE TO GRAVE, on the management of the industrial wastes generated by Haldia Petrochemicals Limited.

2.5 Required Support required from Municipal Authorities

1. Unwanted materials like –leather pieces, iron pieces, stones, X ray films not to be sent along with the plastic wastes .
2. Ensure minimal inert materials to be transported along with the plastic wastes (like clay, sand etc).
3. Quantity and Frequency of supply of plastic wastes to be regularized
4. Non-uniform supply and feeding of wastes causes process related issues.
5. Consistent supplies helps in planning and engineering process controls in cement process
6. Develop and strengthen the rag picker network and formalize their scope and activity.
7. Providing proper incentive to rag pickers ensures satisfactory collection rates and proper segregation

III. Results And Discussion

Assessment of energy recovery and reduction of CO_2 through the Plastic Waste in Jabalpur, Jabalpur and Katni city

1 tonne cement production = 120 kg coal (1 tonne = 1000kg)
The Capacity of Cement Production in M/S ACC Ltd, Kyomore, Katni
= 1.7 MT per annum

3.1 Energy Recovery and cost saving

The average consumption of coal at the plant is 2,500 tons/day.

(CV of coal = 4500)
6 T of Plastic waste from Jabalpur City & 1 T of Plastic waste from Katni
Of this, on an average 7 tons/day of plastic (CV of plastic =6000)

Quantity of Non recyclable plastic waste from Jabalpur city = 7 T/day
Total production 1.7 MT per annume = 17000000 Tons
Utilisation of 1 kg of waste plastics in cement kilns, displacing =1.3 kg Coal
1 million tonne = 1,000,000 tonne
1 tonne = 1000kg
The average consumption of coal at the plant is = 2,500 tons/day=1000x2500

= 25, 00,000 kg /day
(CV of coal = 4500 kcal/ kg)

1 kg of coal =4500 kcal
25, 00,000 kg of coal = 1125 x 10^7 Kcal
(Cost of coal with transportation Rs. 0.81/ 1000 kcal) ACC cement 2012
Cost of 1000 Kcal coal = Rs. 0.81
Cost of 1125 x10^7 kcal of coal = Rs.9112500 actual per day coal consumption cost.

On an average 7 tons/day of plastic waste = 7 x 1000 = 7000 kg
(CV of plastic =6000 kcal/kg)
1 kg of plastic waste = 6000 kcal
7000 kg of plastic waste = 6000 x 7000 = 42 x 10^6 kcal

(Cost of plastic waste with transportation = Rs.0.55 /1000 kcal)
Cost of 1000 Kcal of plastic waste = Rs. 0.55
Cost of 42 x 10^6 kcal of plastic waste = Rs. 23100
If 7 tons / day plastic waste replacement = 9.1= 9 tons/day coal = 9 x1000= 9000 kg
= 9000 x 4500 =405 x 10^5

= 405 x 10^5 kcal
Cost of 1000 Kcal of coal= Rs. 0.81
Cost of 9 tons of coal= 405 x 10^5 x.81 = Rs. 32,805
Total saving per day = 32805 - 23100 = Rs. 9705 = Rs.3542, 325 per annum

Total coal saving per day = 9 tons/day

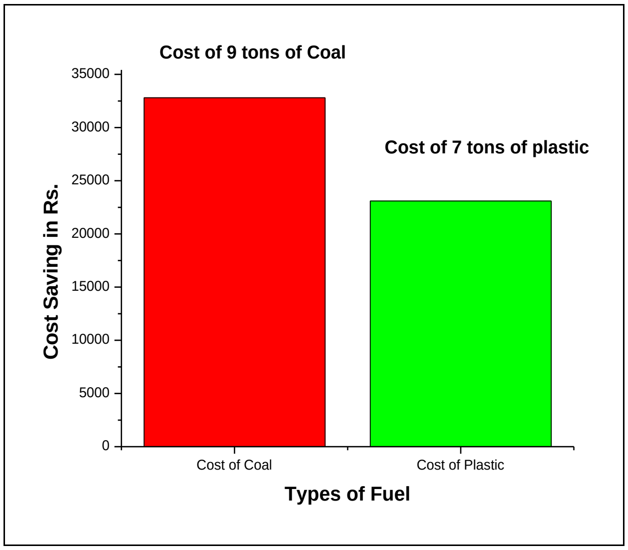


Fig 3: Total Cost saving per day by fuel replacement

[B] CO_2 emission reduction per year

For every tonne of coal burned, approximately 2.5 tons of CO_2e are produced.

CO_2 emissions from combustion of 1 t Coal is 2.5 tons

CO_2 emissions from combustion of 2500 t of coal = 2500x 2.5= 6250 tons /day

Actual CO2 emission in cement factory =6250 x 365=2, 28,125tons /annum

CO_2 emissions from combustion of 1 t Coal is 2.5 tons

CO_2 emissions from combustion of 9 t Coal = 9 X 2.5 = 22.5 tons

CO_2 emissions from combustion of 1 t plastic waste is 0.67 tons

CO_2 emissions from combustion of 7 t plastic waste = 7 X 0.67 = 4.69 tons

After replacement of coal by plastic waste the total reduction of CO_2

= 22.5 – 4.69 = 17.81 tons/day = 6500 tons/annum

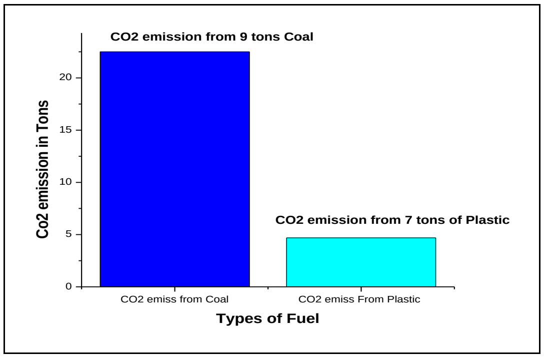


Fig4: Total CO2 emission from Coal & Plastic

IV. Conclusion

The co-incineration result shows that there is no unfavorable impact on the environment, clinker and cement properties. Hence co- incineration of plastic waste is one of the best alternatives for its disposal, saving of energy resource, in ecological sustainable and environmental friendly manner. The total cost saving per day is Rs. Rs. 9705 (Rs.3542, 325 per annum) and 9 tons coal save per day. The co-incineration of coal and waste plastics reduces the overall CO_2 emissions, after replacement of coal by plastic waste the total reduction of CO_2 is17.81 tons/day or 6500 tons/annum. The cost of collection and treatment may limit the use of waste plastics.

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