Advancing Cement Sector Decarbonization via RDF Co-processing – The JSW Cement Case

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***Abstract*—**The cement sector is a critical enabler of infrastructure growth, yet also a significant contributor to global greenhouse gas emissions. Decarbonization of cement manufacturing has, therefore, emerged as a strategic priority in line with global climate commitments. This paper presents JSW Cement's progress in FY 2024–25 towards reducing fossil fuel dependency by enhancing the use of alternative fuels. A key intervention involved the large-scale co-processing of Refuse Derived Fuel (RDF) across our Nandyal Integrated Cement Plant and Shiva Grinding Unit. In total, 1,57,000 tonnes of RDF were co-processed, enabling a Thermal Substitution Rate (TSR) of 16.5%. This initiative translated into a direct avoidance of nearly 1,20,000 tonnes of CO_2 emissions, while simultaneously advancing circular economy principles through the safe disposal of non-recyclable waste. The case demonstrates how industrial symbiosis and robust (W2E) waste-to-energy frameworks can accelerate the transition of cement plants toward net-zero pathways.

***Index Terms*—** Co2-Carbon Dioxide**,** RDF-Refuse Derived Fuel), TSR -Thermal Substitution Rate, , , W2E-Waste to Energy.

I. Introduction

The cement industry accounts for nearly 7–8% of global anthropogenic CO_2 emissions, primarily due to the calcination process and fossil fuel combustion. Decarbonization strategies in the sector broadly focus on three levers: (i) reducing the clinker factor, (ii) enhancing energy efficiency, and (iii) substituting fossil fuels with alternative fuels and renewable energy sources.

In India, alternative fuel utilization remains below global benchmarks, despite the country generating large volumes of municipal solid waste. JSW Cement, committed to its long-term sustainability roadmap, has undertaken pioneering measures to co-process RDF in cement kilns. FY 2024–25 marked a significant leap in this direction, with co-processing emerging as a scalable solution for reducing emissions, conserving fossil fuels, and supporting urban waste management.

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II. Methodology and Intervention

2.1 RDF Sourcing and Preparation

- Feedstock Origin: RDF sourced from municipal solid waste fractions after segregation of recyclables and compostable.
- Pre-processing: Shredding, drying, and homogenization to ensure calorific value consistency.
- Calorific Value Range: 2,500–3,000 kcal/kg.

2.2 Kiln Integration

- Plants: Nandyal Integrated Plant & Shiva Grinding Unit.
- Feeding System: Dedicated RDF handling line, preheater feeding, and combustion optimization.
- Quality Assurance: Continuous monitoring of flame stability and clinker quality.

2.3 Monitoring Systems

- Installed Continuous Emissions Monitoring Systems (CEMS) to track SOx, NOx, CO, and particulate matter.
- Regular third-party audits ensured compliance with Central Pollution Control Board (CPCB) norms.

III. Results and Discussion

3.1 RDF Utilization

A total of 1,57,000 tonnes of RDF were co-processed in FY 2024–25, with Nandyal contributing the largest share as shown in Table 1 below.

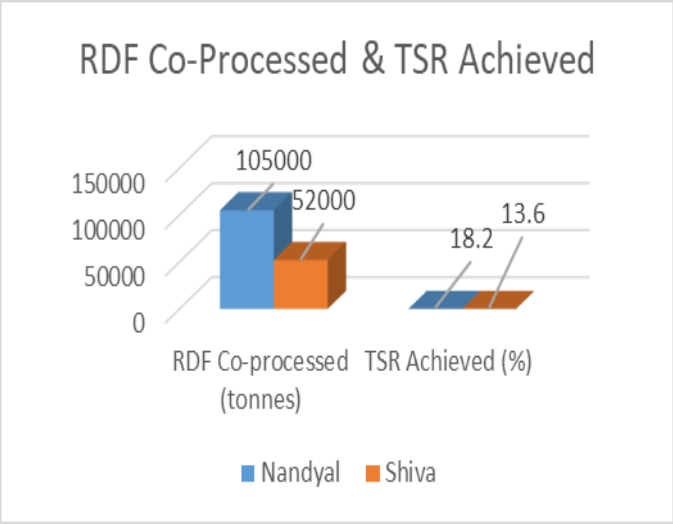
TABLE I: RDF CO-PROCESSED BY PLANT (FY 2024–25)

Plant	RDF Co-processed (tonnes)	TSR Achieved (%)
Nandyal	105000	18.2
Shiva	52000	13.6
Total	157000	16.5(avg)

3.2 Thermal Substitution Rate (TSR)

The initiative delivered an average TSR of 16.5%, with Nandyal achieving 18.2% and Shiva 13.6% as represented below in Fig.1. This is nearly double the Indian industry average

https://doi.org/10.17758/EIRAI21.EAP0426601



3.3 Carbon Emission Reduction

The RDF co-processing intervention avoided nearly 1,20,000 tonnes of CO_2 emissions. The impact equivalence is illustrated below.

- Equivalent to 26,000 passenger cars removed from roads annually, or
- Equivalent to planting 2 million mature trees.

3.4 Circular Economy Benefits

- Reduced coal/pet coke consumption by ~95,000 tonnes.
- Diverted 1,57,000 tonnes of non-recyclable waste from landfills.
- Strengthened partnerships with municipal bodies for sustainable waste management.

3.5 Benchmarking with Global Best Practices

- Global leaders in cement achieve TSR >40%.
- JSW Cement's 16.5% represents a step-change for India, nearly doubling the national industry average.

4 Challenges and Learnings

- Logistics: High variability in RDF supply chain from municipalities.
- Technical: Maintaining calorific value uniformity required advanced feed blending.
- Regulatory: Need for supportive policies to improve RDF quality standards in India.

Despite these challenges, successful scale-up demonstrates operational resilience and cross-sector collaboration potential.

IV. Conclusion

JSW Cement's co-processing initiative at Nandyal and Shiva plants exemplifies how alternative fuel adoption can deliver measurable climate benefits while contributing to circular economy objectives. Achieving a TSR of 16.5% and avoiding 1, 20,000 tons of CO_2 emissions in FY 2024–25, the initiative sets a replicable model for India's cement industry.

Future focus will include:

- Expanding RDF and biomass-based fuel use to other plants.
- Leveraging digital twin models for fuel mix optimization.
- Pursuing TSR levels aligned with global best practices (>30%).

ACKNOWLEDGMENT

The above carried work is supported by the JSW Cement Limited and Shiva Cement Limited, India and I thank our management for the support for accomplishing this research article.

REFERENCES

[1] A. Cichocki and R. Unbehaven, *Neural Networks for Optimization and Signal Processing*, 1st ed. Chichester, U.K.: Wiley, 1993, ch. 2, pp. 45-47.
[2] International Energy Agency (IEA). Technology Roadmap: Low-Carbon Transition in the Cement Industry. Paris: IEA, 2018. https://doi.org/10.1787/9789264300248-en
[3] WBCSD & CSI. Guidelines for Co-processing Fuels and Raw Materials in Cement Manufacturing. Geneva, 2014.
[4] CPCB (2023). Annual Report on Municipal Solid Waste Management in India.
[5] JSW Cement Sustainability Report FY 2024–25

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