

Brief write-up on S&T (Mines) completed projects

1. **Project Title:** Synergistic Utilization of Aluminium Industrial Wastes for Development of Geopolymeric Building Materials (**S-21**).

File No: 14/34/2015-Met.IV

2. **Objective:**

- To develop marketable building materials such as brick, block and tiles from geopolymerized raw material combinations.
- To study the environmental impact of geopolymerized building materials
- To explore the scope of value addition of the products with respect to market and demand based on the input from entrepreneur.
- To carry out the mini pilot plant trial for verifying scope for commercialization.

3. **Background:**

In the recent past JNARDDC has developed simple and cost-effective process for management of major solid wastes generated at the aluminium industry. Subsequently the R&D efforts were focused on the development of viable products that consume bulk volumes of different solid rejects. Since the infrastructural development across the land is booming with great potential of consuming large volumes of solid rejects, the above R&D work was undertaken for development of economically viable products.

A wide variety of solid rejects viz., fly ash, red mud and other mining rejects such as saprolite, lateritic overburden, partially lateritic khondalite (PLK) and kaolinitic khondalite (KK) etc. were used for making geopolymer based building materials. Other locally available waste materials such as variety of clays, ash, effluents, sediments as well as major solid wastes from other industries (steel, power, oil, and biomass) were also found useful for making green building materials.

Exploitation of by-product synergy is a growing practice worldwide. It consists in the maximization of resources utilization with the replacement of natural or costly raw materials by by-products as inputs for industrial processes. Successful utilization of rejects is the best option for resource augmentation and management especially with the participation of an industry partner.

4. **Outcome:**

- The concept of synergistic utilization of these materials has been successfully achieved for generation of quality building products suitable for urban and rural

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building application. The present study verified impact of atmospheric moisture, effect of soda content and efflorescence, improvement of crushing strength and value addition of product based on physical modification.

Developed the following products:

- a) Hard geopolymer bricks (non-fired, crushing strength ranging 5-15 MPa)
 - b) Light weight geopolymer bricks (non-fired, crushing strength ranging 5-10 MPa))
 - c) Hard fibre reinforced geopolymer blocks/ bricks (non-fired, crushing strength ranging 30-45 MPa)
 - d) Hard high strength paver blocks ((non-fired, crushing strength ranging 30-42 MPa)
 - e) Light weight foamed geopolymer bricks (non-fired, crushing strength ranging 5-8 MPa)
 - f) Light weight foamed and layered geopolymer bricks (non-fired, crushing strength ranging 5-8 MPa)
 - g) Sandwich type geopolymer (multi layered, non-fired, crushing strength ranging 4-8 MPa)
- **Mini pilot plant studies and cost estimation of geopolymer products were carried out successfully in collaboration with Entrepreneur (M/s. Swarnalatha Holding, Raipur, Chhattisgarh) Capacity 300 bricks per cycle (4 cycles per 8 h)**
 - **The process is ready for the next level production viz setting up of a pilot plant by the Entrepreneur for commercializing the technology after working out the techno-economics.**

5. Research Publication

1. Assessment of Aluminum Industrial Wastes: Synergistic Utilization for Production of Geopolymeric Building Materials; **P.A.Mohamed Najar**, M.J.Chaddha, P.G.Bhukte, K.R.Rao, K.Janbandhu, M.T.Nimje, S.P.Puttewar, A.Agnihotri and S. Jain, International Seminar on “Emerging Building Materials and Construction Technologies”, BMTPC, New Delhi during March 21-22, 2016.
2. Synthesis and properties of inorganic polymers Derived from Industrial wastes; Kishore Kulkarni, **Mohamed Najar P A**, Mukesh Chaddha and Anupam Agnihotri, National Seminar on Geopolymer an Innovative Technology in Civil Engineering Materials (GITCE) , University, Bangalore, February 24-25, 2017.
3. Effect of Molar Concentration of Alkali Activators on Strength of Geopolymeric Bricks; Shama Wadsariya, Vishakha V Sakhare, Numanuddin Azad, **Mohamed Najar P A**, Mukesh Chaddha, Kiran Janbandhu, P G Bhukte, S P Puttewar and Anupam Agnihotri, National Seminar on Geopolymer an Innovative Technology

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- in Civil Engineering Materials (GITCE), University, Bangalore, February 24-25, 2017.
4. Physical Characteristics of Geopolymeric Building Materials Derived from Mix Designs Comprising Various Industrial Rejects; Numanuddin Azad, Vishakha V Sakhare, Shama Wadsariya **Mohamed Najar P A**, Mukesh Chaddha, K R Rao, P G Bhukte, S P Puttewar and Anupam Agnihotri, National Seminar on Geopolymer an Innovative Technology in Civil Engineering Materials (GITCE), University, Bangalore, February 24-25, 2017.
 5. Assessment of Physical and Chemical Characteristics Geopolymeric Building Materials Developed from Steel Industry Rejects; **P A Mohamed Najar**, Numanuddin Azad, Shama Wadsariya, S P Puttewar and A Agnihotri; NMD-ATM 2017, BITS Pilani Campus, Goa.
 6. Development of Sustainable Construction Materials: Value Addition and Utilization of Industrial Rejects for Resource Augmentation; **P A Mohamed Najar**, Numanuddin Azad, P G Bhukte, M J Chaddha, S P Puttewar and A Agnihotri; International Conference on Mining Industry Vision 2030 & Beyond, MEAI, Nagpur, 2017.
 7. Processing of Bauxite Mine Wastes for Value Added Products; Pravin G Bhukte, **P A Mohamed Najar**, G Daware, S P Puttewar and A. Agnihotri; International Conference on Mining Industry Vision 2030 & Beyond, MEAI, Nagpur, 2017.
 8. Effective Use of Fly Ash Binder: Preparation of Vitrified and Non-vitrified Structural Materials from Industry Rejects; **P A Mohamed Najar**, Numanuddin Azad, Shama Wadsariya, Amrita Karn, M J Chaddha, Suresh Puttewar and Anupam Agnihotri; International Conference of Fly Ash Utilization, Green Ashcon-2017, December 15-16, 2017, Nagpur
 9. Utilization of Metallurgical Solid Wastes for Development of Construction Materials Based on Green Process Route; M.J. Chaddha, **P.A. Mohamed Najar**, Shama Wadsariya, Numanuddin Azad, K.J. Kulkarni and A. Agnihotri WWMMI-2018 IIMT, Bhubaneswar, March,2018.
 10. Value-Added Geopolymer Products to Offset Expenditure on Waste Management and Sustainability, **P A Mohamed Najar**, Vishakha Sakhare, Shama Wadsariya, Numanuddin Azad, Sneha Dwivedi, Amrita Karn, P.G.Bhukte, S P Puttewar and A Agnihotri, for INCAL -2019, Bhubaneswar.
 11. Supporting Low-Carbon Infrastructure: Consolidation of Industrial Rejects by Geopolymerization and Immobilization of Toxic Components for Utilization, **P A Mohamed Najar**, Vishakha Sakhare, Amrita Karn, Sayali Waghmare, S P Puttewar and A Agnihotri, IBAAS 2019
 12. Value-Added Geopolymer Products to Offset Expenditure on Waste Management and Sustainability, **P A Mohamed Najar**, Vishakha Sakhare, Shama Wadsariya, Numanuddin Azad, Sneha Dwivedi, Amrita Karn, P.G.Bhukte, S P Puttewar and A Agnihotri, Journal of Sustainable Metallurgy (SUME), 2019, Under revision.

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6. Patent Filed:

- A light weight foamed geopolymer (LWFGGEO) and its preparation, vide No. 201621038525, dt 10.11.2017.

7. Product Exhibitions:

- Green Ashcon 2017, Nagpur
- Raman Science Centre, Nagpur 2018 & 2019

8. Academic outcomes:

M Tech: 1

Use of Industrial Rejects / By-products for development of Geopolymer Building bricks, KDK College Nagpur

UG Projects (BE): 2

VNIT Nagpur

PG Projects: 2

Hislop College, Nagpur

9. Conference Organised:

- A national seminar "**Geopolymer based Innovative Technologies in Civil Engineering Materials**" organized at Christ University, at Bangalore Campus during 23-24th February 2017. Three research papers presented based on the project (research) work.

10. Invited Lecture

- Aluminium Industrial Rejects: A Potential Resource for Development of Geopolymeric Building Materials