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A Literature Review on Material Handling System Design for Incineration of Waste Materials in Cement Kiln

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Abstract

The cement business has grown to become one of the most important sectors of the global economy in recent decades. Calcium silicates are produced in a cement plant's kiln by heating calcium carbonate and minerals rich in silica. This study provides the conceptualization and academic elements of the research effort related to the increasing trend of using cement kilns for garbage incineration. This study summarises previous studies on the topic of waste incineration in cement kiln material handling system design, highlights key findings, and concludes with a discussion of research gaps and objectives of the proposed research.

Keywords: Cement, kiln, waste materials, incineration.

1. Introduction

The ever-growing industrial sector and garbage produced by the 21st century's wasteful consumer culture add up to enormous amounts each day. As a result of fast economic development, nations like India are producing ever more garbage without the infrastructure in place to deal with it in a sustainable manner. Although garbage incinerators are an improvement over landfills, they are not without their flaws. High initial investment for plant infrastructure, high fuel consumption for incineration, low but inevitable emission of hazardous compounds, and extremely hazardous leftover ash and incinerator slag that must be disposed of again are all issues with incineration. Considering these facts, the present research work focuses on the contributions of researchers, the gaps in the current research, and the aims of the suggested research, all of which are based on the material handling system design for the burning of waste materials in a cement kiln.

2. Literature Review

Present section is devoted to the contributions of research in the field of material handling, the details of which are presented in upcoming sub-sections.

- **Björnsson et al. (2018)**

The aim of this paper is to highlight the challenges associated with automated handling of these materials and to analyze the main design principles that have been employed for pick-and-place systems in terms of handling strategy, gripping technology and distribution of gripping points etc. The review shows that it is hard to find generic solutions for automated material handling due to the great variety in material properties. Few cases of industrial applications in full-scale manufacturing could be identified.

- **Gupta and Gupta (2018)**

Material handling (MH) is an important facility in any manufacturing system. It facilitates the transport of in-process material from one workstation (WS) to another. MH devices do imply incurring capital costs and, therefore, minimizing their deployment without compromising on smooth material flow will ensure savings in addition to the optimal use of productive shop floor space and, avoid space cluttering. The purpose of this paper is to evaluate the minimal network that connects all the WSs, therefore ensuring economic and safe manufacturing operations.

- **Furmans & Gue (2018)**

Despite decades of research in material handling, the academic community still has no accepted way of describing material handling requirements in a way that machines and algorithms can process them. Such a "way of describing" requires a language with which to describe requirements, objects, relationships between objects, and so on. We propose a modeling framework that differs from existing research in two ways: First, we address material handling modeling from the bottom up rather than from the top down, meaning we define a set of elementary functions and then combine them into processes and more complex relationships that allow us to describe any material handling activity or requirement. Second, the framework assumes material handling devices and objects can make decisions and therefore that control can be decentralized, as might be required in an Industry 4.0 environment. The ultimate goal is to be able to create truly flexible material handling systems, where expansion or redesign of the system is feasible and easy. This requires a system architecture, where the design of the systems components, the software architecture, and the language are congruent.

- **Jayakrishnan et al. (2018)**

Many of the production and manufacturing firms adopt workspace automation for fast and economic production. Automation can be accomplished through hydraulics, pneumatics and robotics. This paper present the design and manufacturing of a portable pneumatic material handling system that can rise and move weight up to 3 kg. Such a machine can be used as a transport or positioning equipment in small scale production units. The design procedure includes the design of pneumatic cylinders, gears and arms. Then different components were manufactured according to the designed data and finally the assembled pneumatic framework is tried with the required weight.

- **Walker et al. (2018)**

Hybrid micro-machines are increasingly in demand for the manufacturing of miniature 3D products made of hard-to-machine materials. A high-precision material handling system for such miniature products can increase the overall efficiency significantly. This paper proposes the design of a machine vision based handling system, which is capable of handling various

miniature 3D products. A cloud-based innovative integration method is also developed, a cloud server is deployed to collect and process data from the machine and the material handling system, their actions are coordinated based on the predefined protocol. This method can enhance the reconfigurability of the whole system.

- **Termiz and Calis (2017)**

In the year 2017, Termiz and Calis Proposed that selecting proper construction equipment is a challenging task in the construction industry due to the broad array of available equipment in the market and a large number of criteria required to be taken into account during decision making.

- **Rajesh (2016)**

In the year of 2016, Rajesh proposed ergonomic analysis of Manual Material Handling (MMH) which was mostly based on task analysis approach wherever the job are broken down into easier tasks and studied.

- **Schröder *et al.* (2016)**

In the year of 2016, Schröder *et al.* performed a research that the automated handling of electrodes for manufacturing lithium-ion battery cells for automotive applications may be a bottleneck of the productivity.

- **O'Sullivan *et al.* (2015)**

In the year of 2015, O'Sullivan *et al.* proposed a Robo mate project. Funded under the 7th research Framework Programme of the European Commission, the goal of the Robo-Mate project was to develop an intelligent, easy-to-maneuver, and wearable body exoskeleton for manual handling work.

- **Nurmianto *et al.*(2015)**

In the year of 2015, Nurmianto *et al.* proposed ergonomic process on mining. The data bestowed in this research demonstrates, however, that an ergonomics process can even be implemented in a setting like mining where working conditions frequently change and employees are periodically exposed to extreme conditions.

- **Schwake and Wulfsberg (2014)**

In the year of 2014, Schwake and Wulfsberg proposed that the described system may be a cost-effective approach for handling pliable aircraft shell components. The objective is the preparation for assembly to larger sections.

- **Tsarouchi *et al.*(2013)**

In the year of 2013, Tsarouchi *et al.* carried out a research which presents the development of a technique for the calculation of coordinates of a part's features in a world reference frame (WRF), using pictures acquired from a camera.

- **Mansouri and Calay (2012)**

In the year of 2012, Mansouri and Calay proposed that there are many challenges to wide-spread commercialization of the technology hydrogen fuel-cell technology; including reliability and cost implications, infrastructure requirements, and safety aspects of the upcoming technology.

3. Gaps in the Research and Objectives of the Proposed Research

Following section presents the gaps in the research and objectives of the proposed research, the details of which are presented in upcoming sections.

3.1 Gaps in the Research

Following points represent gaps in the research work:

a) There is very limited research which focuses on reduction of fossil fuel consumption;
b) There is very limited research which focuses on material handling of industrial waste of cement industry; and
c) There is also very limited research available which focuses on waste reduction in cement industry.

3.2 Objectives of Research

Following points represent objectives of proposed research work:

a) **Selection of forms for different types of wastes;**

For all types of wastes, selection of most appropriate form is necessary.

b) **Selection of most suitable design of material handling systems for different types of wastes**

Selection of material handling system is necessary for different types of wastes.

4. Conclusion

This study's emphasis was on the academic community's contributions to the design and selection of material handling systems for waste incineration in a cement kiln. Considering the pressing demand for trash disposal in the present, the study's findings should benefit both business and society.

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