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Life Cycle Energy Assessment of a Typical Marble Processing Plant

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ABSTRACT

This article describes how marble is one of the most important stone resources in terms of durability. It is aesthetically pleasing, and a decorative material used by many architects, as well as plays an important role in the economy of India. Most of the marble processing activities are performed by small and medium scale industries (SMEs) not only in India but worldwide. These industries have low efficiency and productivity due to lack of new technologies, high productivity cost and a lack of proper sustainable waste management systems, thereby increasing the waste generated during the processing stage. There is a significant need within the sector for increasing production efficiency, combined with the need of a substantial reduction in waste generated that can be achieved by endorsing technological innovations. This is in addition to following best available processing practices, incorporating energy saving technologies and modernizing the sectors management and organization structure which will substantially increase efficiency as well as production. This article provides a systematic approach for assessing the current energy and present environment status of a typical SME processing units of Rajasthan area, and proposes measures for meeting cleaner production principles. An evaluation methodology was developed considering the realistic plant operation scenarios. The total energy inputs for processing the products with their appropriate environmental indices like CO_2 emissions were calculated. Alternatively, the CO_2 emissions were also calculated by Gabi educational software for different industries and the best way of reducing the energy consumption is suggested by following alternate source of energy.

KEYWORDS

Energy Assessment, Marble Processing, Plant Layout, Polishing Operation, Waste Disposal

1. INTRODUCTION

Stone and marble industry of India is one of the oldest ornamental and building material that has history dating back from 3200 BC. These dimensional stones have left deep imprints in the architectural heritage of country. A number of temples, forts, and places of ancient Indian civilization have been carved out locally. These stone architecture has even contributed to the present era with modern buildings like the Presidential house, Parliamentary house and Supreme Court made from a high-quality sandstone from Rajasthan. The increasing fame of Indian stone has forced the demand for its extraction, these stones are also being exported to many countries like USA, Germany, France, etc. Due to its high demand and extraction at the same time has led to tons of waste deposits. Due to the lack of proper waste management has led to the waste being dumped on open lands is causing severe

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threat to the environment in Rajasthan and in nearby areas of the state. Taking note of the situation, and being promoted by a local NGO (Non-government Organization) and other environmental organizations, the Supreme Court ordered a complete ban on marble mining in 2002, over the whole state of Rajasthan. But this ban did not last long, due to various reasons; some of them being: concerns of the state government for development activity, fear of un-employment, changes in the policy and permission regimes.

Over the past decades, there has been a huge rise of concern for environmental protection. Human activity has brought harmful effects on the environment in several ways, and it is a source of concern to deal with issues such as environmental sustainability, preservation of natural resources for the future generations, energy efficiency, change in the climate and many more. Some countries have already undertaken environmental safeguard policies, wither trying to reduce the pollution emissions by minimizing the usage of non-renewable resources. Building activities is the major cause of demand for construction materials. The need for raw materials for building makes quarrying activity strategically important for global economy. Construction materials either aggregates, or dimensional stones are used in the development of all buildup environments, such as housing, building bridges, other civil engineering works like local hospitals, schools, roads, railways and other infrastructures.

Machining waste require careful management to ensure the long-term stability of storage and disposal facilities and to prevent and minimize air, water, soil contamination (Rankin, 2011). The inappropriate or unsafe management of waste at processing units continues to generate opposition from local communities, the general public, and non-government organizations and has contributed to the negative public perception on marble processing's. The technological advances and changes in the regulations have resulted in the significant changes in the waste management practices over the last 10 to 20 years, processing wastes at modern units are better managed than that were in the past (Bhargav Prajwal, Gupta, Kishan, & Mali, n.d.; Aureli, Medei, Supino, & Travaglini, 2016; Jasgurpreet Chohan, Rupinder, & Kamaljit Boparai, 2016; Zyl, Sassoon, Digby, Fleury, & Kyeyune, 2002; White, Sarpong, & Ndrecaj, 2015; Finkbeiner, Schau, Lehmann, & Traverso, 2010). Waste management plans are developed before a processing plant is constructed, and the reclamation of waste dumps and tailing ponds are incorporated into the design of the new processing plant.

As mentioned above, dimension stones are natural stones quarried so as to meet the standards set by the international market for commercial purposes. The important dimension stones produced in the world in terms of market size are marble and granites respectively. Production of marble compared to granite is high so the waste generated is also high in terms of marble waste. Due to this reason, commercially available marble have been chosen for investigation. Marble mining in India is quite old and has been perfected by trial and error method for extracting larger blocks by manual means. With the advent of advanced mining techniques and use of advance machinery and improved methods have led to the increase in productivity. Presently, in India mining of marble is done by manual, semi-mechanized and mechanized means. But most of the mines adopt semi-mechanized means for the extraction.

Processing of marble is done in two stages. The first stage of processing involves cutting the blocks into 2 to 3 cm thick slabs by using gang saws, wire saws and circular saws. In marble tile plant the required thickness of tiles is 10 or 12 mm. For cutting, circular saws are used. In general the slabs are sold as it is but the tiles are further processed using various pneumatically operated or other polishing machines, such as line polishers, trimmed and cut to size, buffed and chamfered using different types of machines before being sold (Ii, 2012). Rajasthan has about 95% processing capacity in the country. There are a number of gang saws and many automatic tiling plants that are in operation. The capacity of marble slab production is around 1000 million sq ft per annum and for polished tiles it is 3000 sq. ft.

When compare to the other type of natural stones like granite, sandstone etc. marble has distinct ornamental value, which makes it more durable compare to others. Hence, its production requires more sophisticated techniques which results in high costs but at the same time it provides more