Development of ceramic range with sustainable product by technique of transfer printing.

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Abstract
Waste recycling ideas are very appealing to the ceramics industry. A growing number of studies have shown that traditional raw materials, such as the most popular ternary clay-quartz-feldspar system, may be manufactured using alternative materials as a result of this eco-friendly trend during the past two decades. Studies reveal that the ceramics industry has a large potential for using waste to replace natural raw materials. Converting garbage into ceramics with additional value not only addresses disposal issues but also preserves natural resources. The study described in this article aimed to identify and compile the sustainable procedures used by ceramics manufacturers in the extraction and transportation of clay in a particular area. The industry's noise and pollution, which create conflict between businesses and impacted neighbor hoods, further the negative societal effects of the sector. Tests on surface roughness and slip resistance were done in the lab. The environmental performance of ceramic tile was examined when surface qualities were being optimized, with an emphasis on the manufacture and upkeep of its life cycle, utilizing a study of Environmental Product Declarations (EPD). This methodology aids manufacturers in making the best design choices while adhering to sustainability. A mix of technical, economic, and environmental assessment is shown by a complicated correlation system when it comes to the life cycle assessment of a structure. Due primarily to expansion in the power, construction, and housing sectors, the ceramic industry has experienced rapid growth in rising and developing nations.
Index Terms - Ceramics, Product development, Pottery, Sustainability, Ceramic industry

I. Introduction

Fig 1.1

Fig 1.2

Fig 1.3

In contrast to metals and other materials, ceramics possess a number of unique properties, including a high melting point, strong chemical inertness, brittleness, high-temperature stability, and the capacity to withstand heat and electricity. Natural clay is the first and most common raw material used in ceramics. Typically, basic elements like clay, silica, and a small amount of alkali-bearing minerals (feldspar) are combined to create pottery as fluxes. One can confirm that the ceramics industry can recycle all of its primary by-products and some of the waste from refining treatment because the waste-incorporation potential in this sector is so high. Pottery gets its name from the French word "poeteric" or the Latin word "potium." A drinking vessel is its literary importance. It's a comical art of making of making work of art from clay.Pottery is one of the ancient arts of humankind and according to Perani and Smith, previous to the 20th century, Africans of South Sahara had no knowing of potter's wheel and, So Pottery was made by hand. It has been an essential part of the human life since the start-up of human memorials. India is known for its religion and philosophy more than its craft to other countries on the trade route. Its delicate beauty and aesthetical characteristics have made pottery a modern form of Indian decoration and utility, not just history. Like all art and all other handicrafts, the tradition of making pottery in India is very old. The roots of pottery can also be marked back to the Indus Valley civilization, the Mughal and Vedic periods. Pottery is very famous in most Asian countries and is slowly- slowly spreading all

over the world. History says that India is the essential source for the art of pottery and far more responsible. It is believed that pottery remains from prehistoric sites in India date back to the Neolithic period (c.8000-2500BCE), but later with the help of better dating techniques it was discovered that pottery was manufactured in the Upper Paleolithic. It was also done in the middle age. There was a time when pottery was the primary source of income for the Indian traditional merchant class, Therefore, the development of the pottery business in India is very evident. Hand-made porcelain utensils like pots, bowls, utensils, were in abundance in various color and were also available in India. Slowly pottery became a profession for the Indians because of its usefulness. The traditionally objects of the ceramic industry are crops made using topically available unprepared materials and using the traditionally techniques. This product is made of clay, and it is colored with red clay (RatoMato). To make ceramics, manufacturers use cartwheels or individual keys (molds). Ceramics has long been regarded as one of India's most iconic arts. Until then, the technique of making pottery was limited to earthenware fired at low temperatures over open flames.

Fig 1.4

Fig 1.5

Ceramic objects are modeled in advance using the 3D printing technique, and then the design and molding process is carried out using specialized 3D printing equipment. Because 3D printing technology can accurately materialize imaginative artists and designers, it is being used more and more in the production of ceramic goods and current ceramic works.

The ceramics industry of today is proof of this. The government's support for company development and increasing use of technology has prepared the path for India's ceramic sector to grow.

Since clay raw materials are readily available throughout Europe, nearly all of the continent's member states produce ceramic goods like bricks, which are reasonably priced but have substantial shipping costs due to their weight. From one country to the next, different units of tradition and heritage are established. Certain nations create more specialized goods that fetch higher prices because they have the specialized raw materials needed as well as—and this is crucial—traditions of skill and knowledge.

Since the middle of the 18th century, ceramic transfer printing has made it possible to apply a wide variety of printed aesthetic effects to the surface of ceramics, including images, patterns, and text. As the name suggests, transfer printing enables the conveying of an image from one surface to another. ‘Decal ', an alternative term for ' transfer often used in the USA, is derived from the French word decalquer, meaning to trace or copy. In simple terms, transfer printing involves printed imagery being transferred from paper to objects such as glass and ceramics. These prints are then fused to the surface of the objects through the action of heat. This requires the use of pigment that can withstand high temperatures. For clarity, the term ' transfer ' is used throughout this book. One of the most popular ways to decorate ceramics is through printing. A print has the advantage of being more accurately and quickly duplicable than hand painting, which makes it particularly appealing for industrial production. However, the individual artist or designer may be drawn to the variety of aesthetic that print may provide and be less concerned with high-volume production. Hand - painting tends to look hand painted, whereas a print can take many forms, from the painterly to the Transfer printing represents a sizable portion of the variety of printing options available for ceramics. The majority of this book is devoted to screen printing because it is currently the most adaptable print technique for printing on ceramics.Transfer printing represents a sizable portion of the variety of printing options available for ceramics. The majority of this book is devoted to screen printing because it is currently the most adaptable print technique for printing on ceramics. Of course, direct printing also has a lot of promise, but using a transfer allows for the printing of finer, more precisely registered images onto paper, which is subsequently applied to the product. Registration refers to the precise 'fit' of colors during printing. This is simply because it is much easier to print fi ne imagery onto paper than onto a piece of ceramic. In addition, unlike direct printing, a transfer is capable of decorating complex multi - curvature objects. . Another benefit of transfers is that they may be freely torn up and collaged onto ceramics to create a variety of interpretations, whereas a direct print may be more constrained.

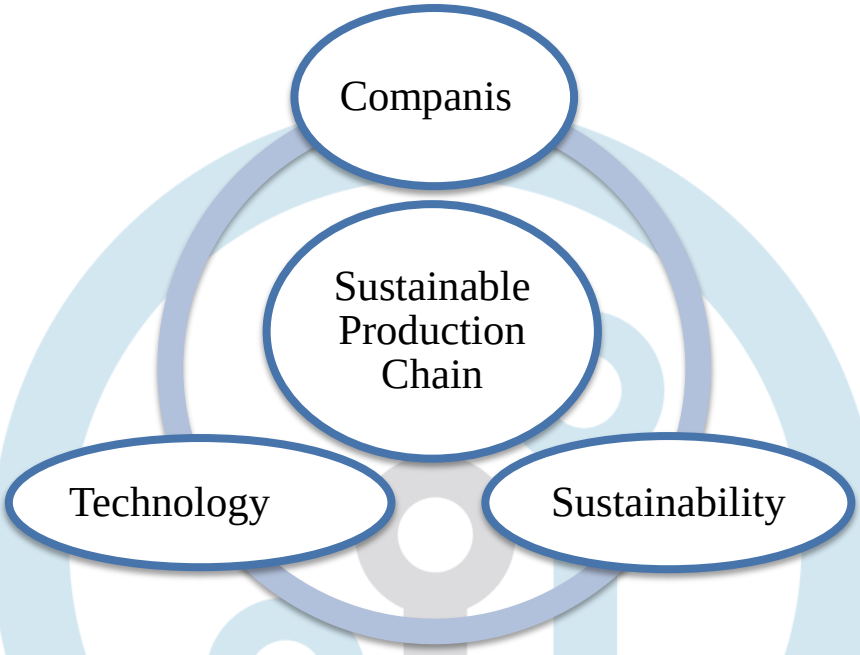
II. Waste management and the ceramics industry

In light of environmental, ecological, and economic concerns, scientists and technology developers are trying to determine the optimum way to use rubbish for the creation of value-added goods. In these areas, ceramic researchers are also looking at the possibility of using recycled industrial waste or byproducts to create ceramics. As a result, a lot of study publications have been released recently. However, commercial ceramics made from waste materials are still in their early stages of development.

However, some tile-producing firms have begun using waste in the process. The transfer of technology is being discussed from a variety of angles, including those of ethics, knowledge, and sustainability issues. Therefore, industrial manufacturing needs to be encouraged more to recycle garbage. The government may also help to stimulate interest by writing regulations and hiring programmers. In addition to assisting the ceramic sector, sustainable production protects society and the environment from pollution.

III. Structure of sustainable production chains

Fig 3.1



The sustainable production chain aims to enhance the business model, by giving products that produce more economic and social value. Therefore, the bio economy is seen as an opportunity to improve production standards and strengthen relationships among agronomic activists, transformation industries, governmental bodies, and research and development organizations. All throughout the world, businesses and governments are attempting to create rules and regulations that are more explicit about how they will use biological resources in support of a more sustainable business model. Scientific expertise, inventiveness, and organisational experience (tacit knowledge) are necessary for the production, marketing, and distribution of competitive and sustainable goods.

IV. **The ceramic ware can be classified into the following categories:**

Terracotta:

- The basic clay used to make the terra-cotta items becomes crimson when baked. These items are unglazed and cooked at a relatively moderate temperature. Terracotta pottery has a porosity of about 8%. These items were created by potters in the 18th century for everyday use.

Earthen Ware:

- After terracotta, Earthen wares came in trend because they used for a long time while terracotta break soon. The earthenwares are covered in a glaze layer and composed of typical white clay.

Stone Wares:

- Stoneware is a term used to describe white clay products that have been fired at a relatively high temperature and have been given a glaze. Stoneware has an impact strength of 0.28 Nm and a water absorption capacity of less than 3%.

Vitreous China Table ware

- These are totally baked, constructed of white clay, have less than 5% porosity in their physical makeup, and have an impact strength of around 0.22 Nm. These are traditional art which are being used now a days.

Porcelain Tableware

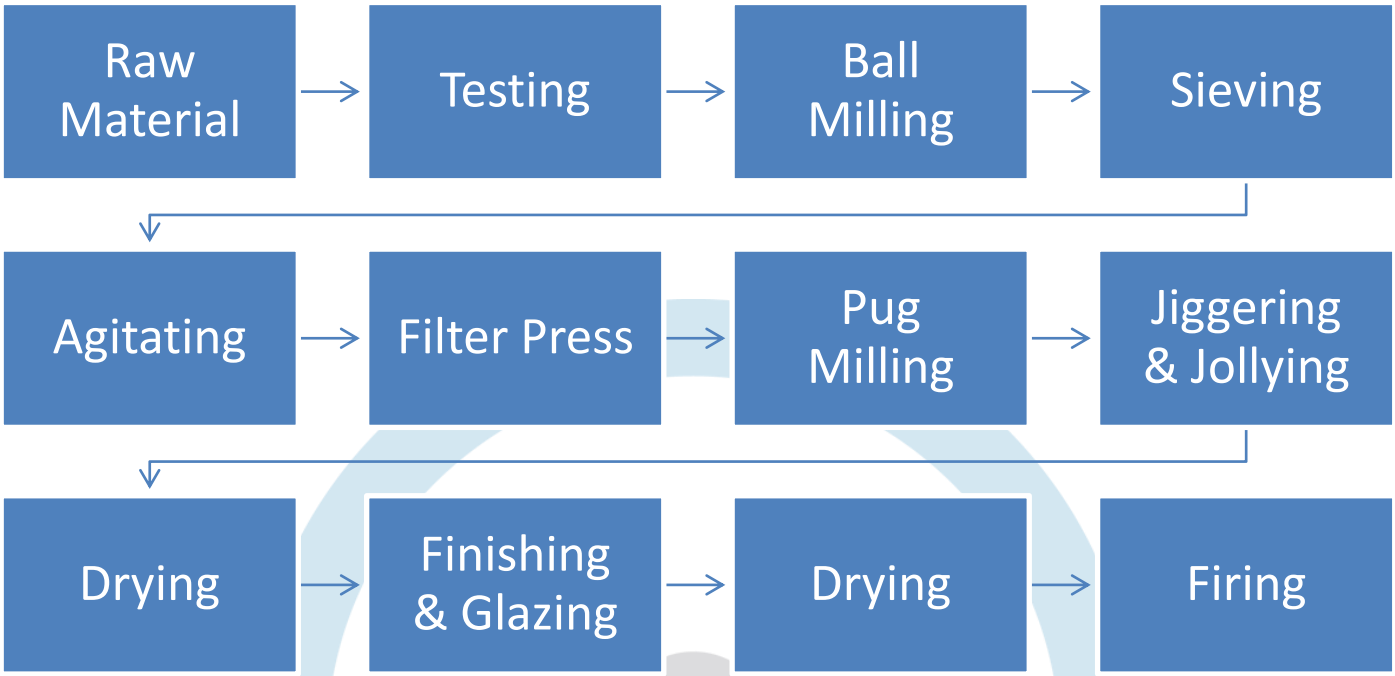
- These glass items are crafted of pure feldspar, quartz, and china clay. This category of ceramics has almost little porosity and greater heat absorption and endurance. These items are baked at a temperature that is comparatively greater than other items.

V. Technology

Since ancient times Ceramics have been accompanying the human races. The man- made ceramics was unearthed by the Archeologist during the 25,000 BC. Primitive ceramic was created with basic earthen materials such as clay and was used to be burning at domes. Human creativity started by firing they material at a highest temperature in order to attain harder ceramics material, the desire by getting harder substance started the human races at invent superior firing techniques. The human zest also mystery of perspective has gate a long path from the basic earthenware of modern world promoted ceramics.

Technology plays a very important role for the development of an industry, market, cluster, and nation. A nation is considered strong with it is strong on the technology front, infrastructure, defense, education, communication, transport, maritime, medical and engineering etc. The manufacture of pottery using a wooden hand operated potter's wheel for general pottery that was sun dried and pit- fired using locally available firewood has seen several turning points in the development.

VI. Process

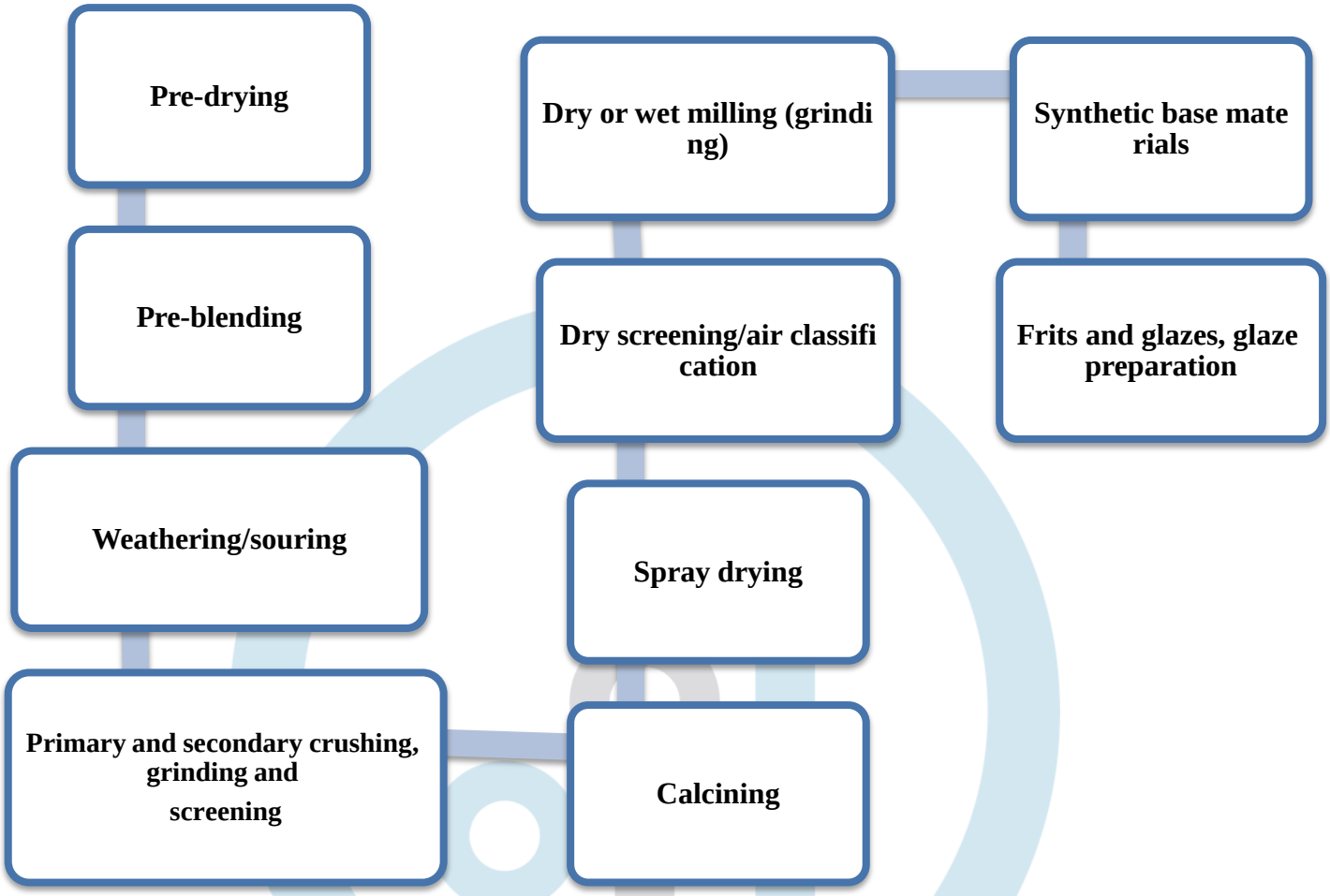


VI.I. Raw material

Ceramics is a labor intensive mineral based industry. The main raw materials used in the industry are non- metallic and inorganic in nature and are formed in the lower crust of the earth as the result of geological processes. Clay is the basic raw material traditionally used; it has the property of getting hard when fired at higher temperatures.

Fig. VI.I.

VI.II. Preparation of raw materials



VII. What do we mean by sustainability?

The study of the environment, Sustainability is defined "the quality of not being harmful to the environment or depleting natural resources, and thus supporting a long-term ecological balance". It requires making use of resources in a way that makes them eternal. Once the planet reaches stability, human life will continue to exist there.

Given its significance, the United Nations adopted the Sustainable Development Goals in September 2015. (SDGs). SDG is a 17 point plan to tackle injustice and inequality, end poverty, and stop climate change by 2030. Together, the 169 aims that all nations must accomplish are represented by these 17 goals, which cover various facets of human existence.

Ceramic industry can innovate the manufacturing process and reuse waste/by-products caused during ceramic tiles or other products, developing circular economy strategies and industrial symbioses. The ceramic tile industry contributes to the Circular Economy by optimizing selection criteria for raw material, product design, implementing strategies for resource efficiency, reusing the water in the same manufacturing process or other industries, reusing the residues such as broken ware mass residues.

VII.I. Sustainability in the world of ceramics

The following are the main environmental effects of ceramic production: (European Commission, 2007)

Air emissions

- particle, soot, and gas emissions (carbon oxides, nitrogen oxides, sulphur oxides, inorganic fluorine and chlorine compounds, organic compounds and heavy metals)

Process waste water

- mostly consisting of minerals and other inorganic components, with minor levels of numerous organic components and heavy metals

Process losses/waste

- mostly made up of various sludges, broken objects, plaster moulds that had been utilised, sorption agents that had been employed, ashes, dust, and packaging waste.

Energy consumption/CO2 emissions

- Energy is used extensively throughout the ceramics industry because drying is done after firing, which takes place at temperatures between 800 and 2000 °C. The two major fuels used for combustion today are natural gas and fuel oil, along with solid fuels like coal and petroleum coke, heavy fuel oil, liquefied natural gas, biogas, and biomass.can contribute even though they don't offer much in the way of cash reward.

VIII. Applied Process and Techniques

Ceramic items come in a vast variety of shapes, sizes, and colors and are produced in a variety of kilns using a wide range of raw materials. Although the overall procedure for making ceramic products is the similar, sanitary ware, technological ceramic, wall and floor tiles, and domestic ceramics softening are made using a multi-stage fire process. Typically, raw materials are combined and shaped by casting, pressing, or extrusion. It is common practice to thoroughly combine and shape things using water. The materials are loaded manually into the kiln—especially in the case of occasionally functioning shuttle kilns—or by carriages transported through constantly operating tunnel or roller hearth kilns, and the drier where this water evaporates is kept running. For the products to be treated properly during the firing, a very precise temperature gradient is required. In order for the product to slowly release its heat and maintain its ceramic structure, regulated cooling is therefore required. After that, the goods are kept and packaged for shipping.

IX. High rate making approach for making ceramic prototypes

Molding technology professionals simply use the product's size and years of modelling experience to finish the mould before the ceramic mould is produced. Lack of direct experience with the results of the initial design concept idea and effect causes error. High rate 3D printing forming technology introduces a new method of product development. Designers gain intuitive design experience with 3D sample models: View Product composition and appearance.

Therefore, the product's development is more logical, accurate, and intuitive. In order to make future design and development easier, change the virtual data model designed for ceramic items used on a daily basis.

1. Digital and 3D printing technologies.
2. The 3D high rate forming technology principle.
3. Effect of 3D printing technology on ceramic objects used every day.

IX.I. Digital and 3D printing technologies

The highly advanced digital technology provides the foundation for the development of 3D printing technology. The novel addition processing approach is distinct from the conventional "remove" material processing method.

IX.II. The 3D high rate forming technology principle.

When the file was prepared, the printer started to read the file and determine the mechanical path and precise height of the print head.

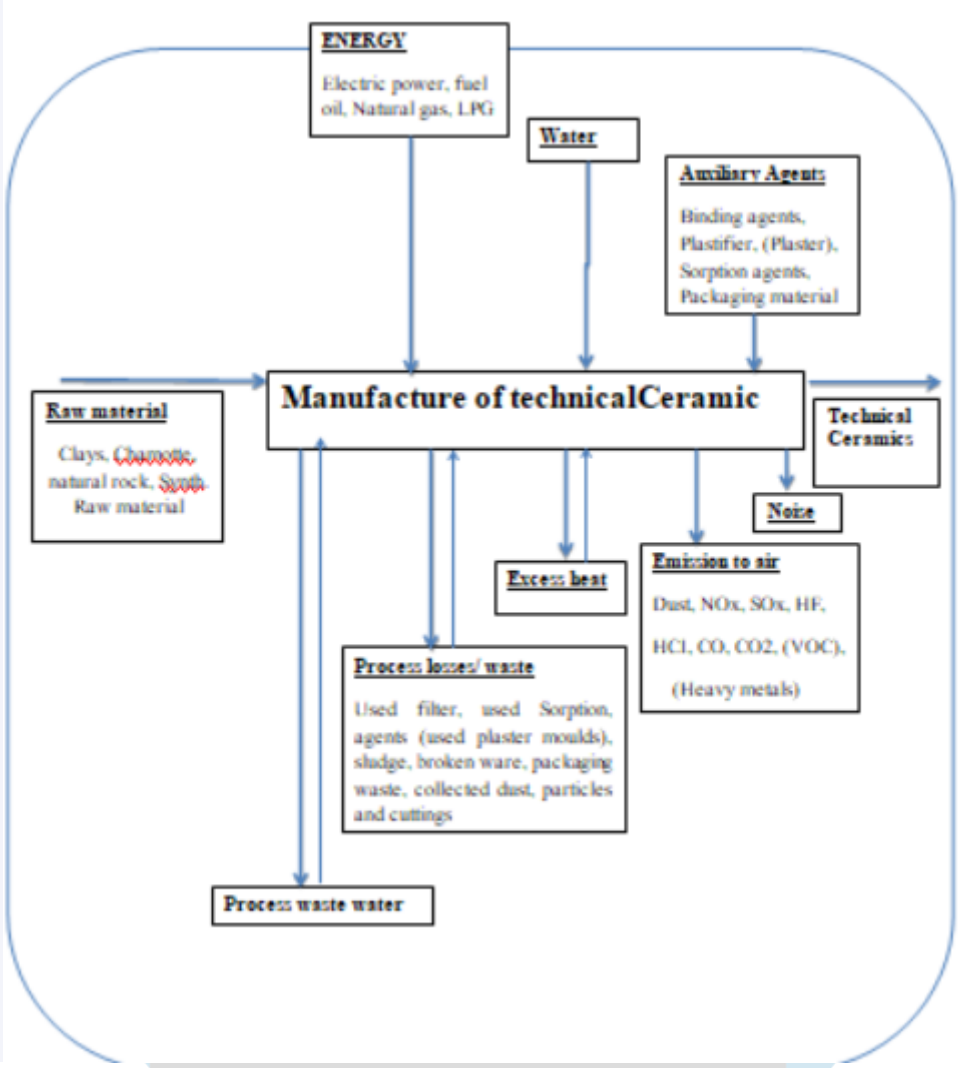
1. Digital and 3D printing technologies
2. The 3D high rate forming technology principle.
3. Effect of 3D printing technology on ceramic objects used every day.

3.1. Reduce the time it takes to develop ceramic products for everyday usage.

3.2. Reduce the price of developing ceramic items for use.

3.3. Reduce waste and pollution throughout the sample development process.

Fig XI. The flow chart shows significant input and output flows for manufacturing technical ceramics.



XII. Recycling

Clay may be crushed and repurposed into a variety of valuable items, and garbage could be separated from landfills and utilized in the manufacturing process, lowering emissions and harmful waste. This garbage can also be redirected to avoid costly landfill fees.

Ceramic goods, such as floor and ceiling tiles, are common construction and pest control waste crops. By recycling or reusing this clay, a huge amount of garbage is diverted from landfills, reducing demand for natural resources. Emissions from ceramics manufacture can occur because glazes and glazes contain harmful compounds; however they can be reduced by recycling or reusing clay products. When discarded ceramics can be turned into useful items like rock base, drainage materials, roads and walkways, or composite materials, it's a win-win situation. According to our convention theme, we have specified the faced commonly used in play, and they do not recycle after the performance they are disposed of, so we want to point out that we can recycle them and reuse the ceramic of drama mask.

Ceramics that have been used in the production and extermination industries will be collected and crushed. The degree of crushing will be determined by the final use as a product category, such as drainage material or driveway rock basis.

XII. Review and literature

Farid, (2013) Iraqi ceramic electrical insulators were made from waste materials that were easily accessible locally. Used bricks that have been burned locally form the basis of the compositions. Measurements of physical properties, mechanical properties, electrical breakdown, and heat conductivity are performed on the cured ceramic bodies.

Ros-Dosdá et al. (2018) examined the environmental sustainability of the various varieties of porcelain stoneware tile (PST) over their life cycles. The fluctuation in PST thickness had a detrimental impact on all impact categories with the exception of ADP because of the higher energy and material input.

Eight different manufacturing scenarios' firing times and temperatures were studied while accounting for glazing changes. Tests on surface roughness and slip resistance were done in the lab. By analyzing Environmental Product Declarations (EPD) with a focus on the creation and upkeep of its life cycle, ceramic tiles environmental performance was examined while surface qualities were optimized. This methodology aids manufacturers in making the best design choices while adhering to sustainability. A combination of technical, economic, and environmental assessment is shown by a complicated correlation system when it comes to the Life Cycle Assessment of a structure. Terjek, and Dudas, (2020)

The extrusion process is essentially the same whether utilizing an industrial or commercial printer, despite the fact that different 3D printers have differing capacities. Extrusion printing, commonly known as Freeform Fabrication (FFF), is now the most

popular and well-known type of 3D printing. The temperature of the extrusion head where the filament, which is wound on a spool, is heated depends on the type of filament. The molten material is then placed onto the construction platform. As the platform steadily descends, layer after layer is added, extrusion and bonding hardening as the process goes on. (Form labs 2018).

Conclusions

Today, there is an ongoing rise in the creation of toxic and hazardous waste from a variety of sources, which has led to environmental pollution and dumping issues. Because ceramics manufacture uses a significant amount of natural raw materials, recycling waste is advantageous. Even if only a little quantity of trash can be incorporated into ceramics used in high-volume manufacturing, this will result in a sizable absorption of waste. The paper traces the development of the Indian ceramics industry from the Neolithic Age to the present day. The report discusses the techniques used to develop high-grade pottery products and the underlying ideas about them. This section of the analysis traces the evolution and development of technology in ceramics. The way people plan and construct has changed thanks to digital technology and high-speed 3D printing. To give a realistic simulation effect and to make storage administration and change easier, use digital means. Development of digitally-based 3D printing. All in all, 3D printing is a practical design prototyping e-media thanks to digital technology. When combined with support for virtual platforms, traditional ceramic product design, and product production a set of comprehensive research and development systems for ceramic items for everyday use was built based on digital technology and high-speed ceramic sample and prototype production.

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