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SUSTAINABLE DEVELOPMENT IN STEEL INDUSTRIES AFTER THE IMPLEMENTATION OF GREEN MANUFACTURING

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Abstract

The iron and steel industry is one of the largest industrial energy consumers, accounting for 20-45% of total industrial energy demand in many countries. It plays a significant role in the economic growth of developing countries Recent year have seen rapid industrialization and infrastructure development leading to higher steel consumption and consequently increased production requirement in Asian industrializing nations. Although production has increased mainly due to extended plant capacities and introduction of new factories, little attention had been paid to efficient energy utilization and environmental pollution control. The main causes for energy inefficiency and environmental pollution are outdated production technology in use, aged industrial infrastructures, lack of management skills and coal dominated energy structures. Therefore, there is a need for an integrated approach like green manufacturing technology towards energy and environment management of the industry so that better energy efficiency and environmental friendliness can be achieved. This research work provides information on control techniques and measures that are available to mitigate greenhouse gas (GHG) emissions describes the process technology in use, energy saving opportunities, Environmental benefits of recycling & Sustainable development related to the iron and steel manufacturing sector through green manufacturing technology.

Keyword: *Green manufacturing, CO_2 emission, energy saving technologies, recycling, Sustainable development & Steel industries.*

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1. INTRODUCTION

Steel Industries have always played a crucial role in the socio-economic development of a country. They have contributed primarily to increased prosperity, greater employment and livelihood opportunities. On the other hand, industries are accused of accelerating the consumption of scarce fossil fuels and of polluting the local, regional, and global environment by releasing solid, liquid and gaseous pollutants to their surroundings.

Steel is one of the pillars of the well being of modern societies and it will definitely continue to play an important role in the 21st century. Steel is also a mature basic material and is one of the most environmentally benign mass products due to its high recycling rate and comparatively low quantities of energy required for its making. However, the emission of CO_2, is a serious problem for steel industry because steel industry relies heavily on fossil fuels as energy source and limestone for the purification of iron oxides. Steel industry contributes around 6 % - 7% to total anthropogenic emission of CO_2. Steel works now face with the increasing demand to minimize emission of GHGs. This situation is intensifying the pressure on steel makers and will certainly impact the direction of the development of steel industry in the 21st century.

The iron and steel industry presents one of the most energy intensive sectors within the Indian economy and is therefore of particular interest in the context of both local and global environmental discussions. Increases in productivity through the adoption of more efficient and cleaner technologies in the manufacturing sector will be effective in merging economic, environmental, and social development objectives.

In this paper we contribute to the discussion on productivity growth, Sustainable development against global warming, reduced Co_2 emission and the role of technological change within the context of environmental change. We will introduce the iron and steel industry in more detail taking into account industry, production, technologies, energy consumption within processes, environmental impacts of steel recycling etc.

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2. WHAT IS THE GREEN MANUFACTURING

Green manufacturing is a modern manufacturing mode considering both the environmental impact and the resource consumption during the whole product life cycle from design, fabrication packaging, transportation, usage, recycling, to waste disposal, and its objective is to minimize the negative environmental impacts and maximize the utilization rate of resource, and harmonize optimization of economic benefit and social benefits with the maximum integrated benefits. Substantively, green manufacturing is the embodiment of the sustainable development strategy and the cycle economy mode in modern manufacturing.

Green Manufacturing is a method for manufacturing that minimizes waste and pollution. These goals are realized through product and process design. Green Manufacturing is actually more of a philosophy rather than an adopted process or standard. In Green Manufacturing, environmental impact of all stages of production is considered. The manufacturer will not use any materials which are harmful to the ecosystem in the design, production, field application and end of life disposal stages of the product.

3. ROLE OF GREEN MANUFACTURING IN IRON & STEEL INDUSTRIES

i. Green Manufacturing is all about using process improvement to maximize the yield and to help minimize the waste that is produced.

ii. GHG reduction in Iron & Steel Industries and Providing a cleaner source of energy though new technology.

iii. Decreasing energy consumption in process by using Energy saving technologies & Productive efficiency.

iv. Environmental regulation and production structure for the iron and steel industry.

v. Increase iron resource efficiency in the steel manufacturing process.

vi. Emission Mitigation of CO_2 by CO_2 captures technologies.

vii. Converting pollutants and wastes into byproducts and promote their utilization and recycling along with the use of the product.

viii. Finally making the process much better for the environment and better use of the materials that are being used.

4. ENERGY SAVING TECHNOLOGIES AND PRODUCTIVE EFFICIENCY APPROACHES TO CO_2 EMISSION REDUCTION IN THE IRON AND STEEL INDUSTRIES

The iron and steel sector is one of the largest industrial energy consumers in the world. Certain technologies are identified as being energyefficient, because in addition to reducing energy consumption, they increase the productivity of the firm as well. There are many energy saving technologies in the production of iron and steel. CDQ , TRT, CCS and Sinter plant heat recovery, which are energy efficient technologies and cost more than other energy saving technologies, had not taken by most small and medium sized iron-makers . The efficiency of basic oxygen furnace gas recovery is lower. In contrast to these energy saving technologies, pulverized coal injection technology (PCI) and continuous casting technology (CCT) are easy to carry out for most iron and steel makers. Although SEAFS (Scrap-EAF-Steelmaking) is energy saving and environmental friendly process, the output of SEAFS is still lower at present due to the shortness of scrap resources.

(a)Pulverized Coal injection (PCI) The technology of PCI in blast furnace not only enhances energy utilization efficiency but also increases productive efficiency. PCI is the short form of Pulverized Coal injection. Declining supply of quality coking coal and escalating prices of coke have led iron and steel manufacturers to seek other carbon-based products to reduce the consumption of the more expensive coke. One solution is the technology of injecting pulverized coal into a blast furnace as an auxiliary fuel to reduce the amount of coke consumed and therefore to reduce operating costs in the production of pig iron and then ultimately crude steel. The technology involves injecting very fine particles of coal at high rates into the chamber of the blast furnace as a fuel.

(b)Continuous casting technology (CCT) CCT is an energy-efficient casting method that could enhance energy utilization efficiency greatly. Continuous casting transforms molten metal into solid on a continuous basis and includes a variety of important commercial processes. These processes are the most efficient way to solidify large volumes of metal into simple shapes for subsequent processing. Most basic metals are mass-produced using a continuous casting process, including over 500 million tons of steel in the world each year. The development of CCT not only saves energy, promotes finished steel products rate, decreases cost, but also solves the mutual confining problem of mold casting, initiative roll process.

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(c) Coke Dry Quenching (CDQ) Coke dry quenching appears as a highly reliable system to reduce air pollution, while it can also reduce substantially energy use, especially when it is associated with a coal preheating . In addition, dry quenched coke is harder and stronger, and its moisture content is much lower than that of wet quenched coke. The coke dry quenching (CDQ) process offers distinct advantages of sensible heat recovery, conservation of water and zero air and water pollution. The dry coke produced in the process enhances the productivity of blast furnaces, the work horses of integrated steel plants. Annually, one million cubic metres of water will be saved and, almost three quarters of million tonnes of steam will be generated for use in power plants. This technology, commonly known as CDQ, would have a favorable impact on climate change issues being addressed under the Kyoto Protocol. The carbon dioxide emissions into the atmosphere will come down by 140,000 tonnes per year.

(d)Coke Dry Cooling Plant is a clean technology that uses gas instead of water in an enclosed system to cool the hot coke. The hot gas can be recycled to create electricity. As a result, money is saved from conserving electricity and pollution is reduced from lower emission of CO_2 and other pollutants.

(e)Top Pressure Recovery Turbine (TRT)
TRT is the shortened form of Blast Furnace Top Pressure Recovery Turbine. It is a energy recovery turbine by which the pressure energy and thermal energy of the gas coming from top of the blast furnace is converted to mechanical energy so as to drive generator to recover the electricity, which is not only purify the coal gas, but lower the noise pollution. Besides, it, under normal operation, can replace the septum valves to regulate and stabilize the top pressure, which can benefit the blast furnace production. TRT is the Energy-saving equipment used for a blast furnace of steel plants, which has following two functions. One is to control the top pressure of a blast furnace, and the other is to generate electric power by driving a turbine using blast furnace gas generated in a blast furnace.

(f) Carbon capture and storage (CCS) Technology in iron and steel industries

i. **Carbon capture and storage (CCS)** is a process where CO_2 emitted from large stationary emission sources such as fossil fuel power plants or oil refineries, is captured and stored geologically in the underground.

ii. **StoringCO_2** , also known as CO_2 sequestration, involves compressing the CO_2 and then transporting it by pipeline (or possibly ship if the storage site is far away) to a suitable location where it can be stored permanently.

iii. **Transport CO2** CO2can be transported in a number of different ways, including by road tankers and railway, but for the volumes involved in carbon capture and storage, pipeline and ship are the most practical and economical options.

(g) Sinter plant heat recovery
Heat recovery at the sinter plant is a means for improving the efficiency of sinter making. The recovered heat can be used to preheat the combustion air for the burners and to generate high pressure steam which can be run through electricity turbines.

(h) Utilizing Iron and Steel Slag's in Environmental Applications
Iron and steel slags from metallurgical processes are widely used in different fields of applica tions, e.g. in the building industry, road and waterway construction or as fertilizer. Nevertheless, also these well established by-products can be improved to ensure and extend their sustainable use. Strictly speaking the utilization of iron or steel slag in any application can be viewed as an environmental application since the reuse or recovery of this material provides environmentally related benefits. For example the substitution of iron or steel slag for natural aggregate in asphalt not only saves on the energy that may be required to mine naturally occurring aggregate, but also eliminates the negative impacts associated with mining such as blight on the land. Other uses of steel slag include ready-mixed concrete, concrete products, road bases and surfaces, fill, cementitious materials, gabions and rip rap, railroad ballast, landfill daily cover material, roofing granules, landscape aggregate, mineral wool (home and appliance insulation), soil remineralization and conditioning, etc.

5. ENVIRONMENTAL BENEFITS OF RECYCLING

Steel scrap has become the steel industry's single largest source of raw material because it is economically advantageous to recycle old steel into new steel. In light of this, steelmaking furnaces have been designed to consume steel scrap. Apart from the huge amount of energy that could be saved through steel recycling, a lot of other benefits are also derived. On this note, the benefits of producing steel through recycling as compared to producing from Iron ore (direct reduction route and blast furnace/ basic oxygen furnace route) are itemized below.

(a)Conservation of Resources
Steel scrap recycling has been identified as an effective means of conserving natural resources. It is more than economically beneficial for steelmakers and also a part of wise management of iron ore resources. It reduces the consumption of valuable minerals like iron ore, coal, limestone and water. For every

metric ton of recycled steel scrap, 1.5tons of iron ore, 0.5ton of coal, 0.054ton (120 pound) of limestone and 40%of water normally used in the production from virgin material is conserved. Through this recycling process, not only the resources that are conserved, the natural habitat is also protected for the future.

(b)Energy saving

Using steel scrap in the manufacturing of new steel uses considerably lesser energy than that required for producing new steel from virgin raw materials (iron ore, coal, limestone). Not only that, there is also extra energy savings because more energy is required to extract, refine, transport and process raw materials ready for industry use compared with providing steel scrap which are ready materials to be charged into the Electric Arc Furnace for easy and faster steel production. Producing one ton of steel from recycling steel scrap saves a total of 14.3 GJ of energy .This amount of energy saving from my analysis is affirmed from data in world best practices energy consumption data.

(c)Environment protection (Air pollution and water pollution)

Manufacturing steel from virgin ore involves the emission of greenhouse gases, which contribute to global warming. Using recycled steel scrap generates 85 percent fewer emissions Recycling reduces the need for extracting (mining, quarrying and logging), refining and processing raw materials all of which create substantial air and water pollution. As recycling saves energy it also reduces greenhouse gas emissions, which helps to tackle climate change. Currently, UK recycling is estimated to save more than 18 million tons of carbon dioxide a year – the equivalent to taking 5 million cars off the road (steel recycling institute).

(d)Reduced landfill

Recycling steel scrap helps in saving landfill space by diverting steel scrap from the waste stream. When we recycle, steel scrap materials are reprocessed into new products, and as a result of this, the amounts of scraps sent to landfill sites are substantially reduced.

(e)Endless Recycling Potential

Steel scraps are 100% recyclable and it does not degrade during the recycling process like other recyclable materials such as paper. As such it can be recycled over and over again without losing its quality. Steel recycling therefore represents one of the most effective and valuable strategies for saving resources. Table 1. below summarizes other saving obtain from producing new steel from recycling of steel scrap.

Savings sources	Percentage savings
Energy	74%
Raw material(iron ore)	90%
Reduction in water use	40%
Water pollution reduction	75%
Air pollution reduction	86%
Reduction in mining waste	97%
Reduction in consumer waste	105%

Table1: Summary of the benefits of using iron and steel scrap instead of virgin ore to make new steel.
Source: Institute of Scrap Recycling Industries

CONCLUSION

On the basis of analyzing the present situation of iron industry points were put out that iron industry in the world is now in a dilemma, and increased wastage & pollution is default. Then analysis of the relationship between green manufacturing and wastage & pollution in iron industries is done. The concept and implication of Green manufacturing are discussed from the viewpoint of sustainable development in the steel industry It is pointed out that adequate environment protection in a “green” iron & steel plant does not just mean a accept disposal of pollutants emitted from its operation units, but rather the effective implementation of a strategy whereby the formation of any polluting agents in any part of this plant is include proper choice and control of raw materials, and a constant endeavor effort to optimize the complete manufacturing process of the whole iron & steel plant. Through the findings of this work, recycling of steel scrap is suggested as an alternative to boost the local content of steel production, reduce energy consumption, carbon dioxide emission (as the world production and manufacturing system is going green). The implementation of green manufacturing focused on investigating the energy saving & co_2 emission from producing steel & effective utilization of recycling of steel scrap as a way of sustainable development in steel industry.

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