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Review on Steel Industry in India: Potential & Technologies for Reduction of CO2 emissions

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Abstract: Steel Industry is complex and highly pollution intensive. Way ahead, the sector is growing rapidly, so at every stage of steel making, better efficiency and pollution control is inevitable.
Indian steel sector is a strong element of the Indian economy. Since its commercial beginning, the industry has come a long way to reach a production. Indian Steel sector is one of highest energy consuming and carbon dioxide (CO_2) emitting industry designated as one of the 17 highly polluting industries in India.
This paper summarizes recent developments Potential & Technologies for reduction of CO_2 emissions. Modernization & Technological up gradation of the existing plants to phase out old/ obsolete/ energy inefficient/ polluting production facilities.

Index Terms— **CO_2 Emission, Steel Sector, CO_2 Reduction**

I. INTRODUCTION

Steel provides the solutions to infrastructure and construction needs around the world. It is the material to build climate resilient cities and coastal protection. Steel protective design minimizes the impacts of natural disasters. Steel is at the heart of delivering solutions to many of these challenges. Steel is infinitely recyclable and its by-products and waste energies are valuable resources. The steel industry is integral to the global circular economy and thus the successful delivery and maintenance of a sustainable future.
The steel industry has made significant reductions in greenhouse gas emissions in the past decades by improving energy efficiency and deploying new technologies and practices resulting in benefits to the environment and economies.

II. LITERATURE REVIEW

Indian steel sector is a strong element of the Indian economy. Since its commercial beginning, the industry has come a long way to reach a production of above 70 Mt steel today. At this rate the sector is expected to produce nearly 325Mt of steel by 2030 (Green Rating Project, 2012, CSE). Indian Steel sector is one of highest energy consuming and carbon dioxide (CO2) emitting industry designated as one of the 17 highly polluting industries in India. IT is highly raw material intensive which requires 3.5-5.0 tonnes of raw material to produce only one Tonne of raw material of crude steel. The balance amount of material (2.5-4.0 tonnes) from the process either comes out as by-products, wastes or emissions in air and water. [1]

Integrating environmental considerations into the product traditional process design is now the major challenge for steel industry. Life Cycle Assessment (LCA) is nowadays considered as an appropriate method for assessing environmental impact and selecting new technologies to reduce CO2 emissions for steel industry. In this paper propose a new methodological concept which combines LCA thinking with process simulation software in order to carry out the life cycle inventory of classical steelmaking process. Using Aspen Plus TM software, a physicochemical model has been developed for the integrated steelmaking route. This model gives the possibility to carry out life cycle inventories for different operational practices in order to optimise the use of energy, to calculate CO 2 and other emissions and to control the mass and the heat balances of processes. It is also shown that such approach can be used to design and assess new technologies for steelmaking without large industrial application [2].

Industrial processes are highly energy intensive and currently account for one-third of global energy use. Around 70% of this energy is supplied by fossil fuels, and CO_2 emissions from industry make up 40% of total CO_2 emissions worldwide. Since the 1990s, the energy consumption of industry per unit of value added in developed countries, has fallen by around 1.3% per year on average (once adjusted for structural changes), but at a lower rate than the average reduction of 2.8% per year during the 1970s and 1980s 1. Moreover, improvements in energy intensity have been more than offset by increased total production, such that energy consumption and CO_2 emissions have continued to rise dramatically. Demand for manufactured goods is expected to at least double by 2050 (relative to 2006 levels), and, if industrial emissions remain unchecked, total CO_2 emissions are projected to increase by up to 90% by 2050 compared to 2007. [3]

The EAF dust is listed as hazardous waste from specific source, K061, according to ABNT 10004:2004 and constitutes one of the major problems of electrical steel plant. This work suggests recycling of the EAF dust by sintering of a composite, pre-cast agglomerate (PCA) consisting of EAF dust agglomerate to coke particles, mill scale and ceramic fluorite into pellets. The work was divided into three stages, in the first stage the technical viability of using only solid waste industrial to produce a PCA was observed, in the second phase, the main effects between the components of the PCA to obtain the optimal formulation was tested. In the third phase the intensity of the variables, coke and fluorite ceramics, for removing zinc of PCA was checked. Every stage was chemically analyzed by X-ray fluorescence spectrometer and X-ray diffraction. The first two stages of the production PCA were carried out in a pilot plant sintering downstream and the third phase in a pilot plant upstream. As a result of the process two by-products were obtained, the pre-cast agglomerated, PCA, with total iron content exceeding 70%, object of the process of sintering and zinc dust, containing more than 50% zinc resulting from volatilization of this metal during the sintering process and collected by bag filter. In addition, approximately 90% of lead and cadmium contained in the initial EAF dust was extracted. [4]

The combustion of coal in power plants generates solids (e-g., fly ash, bottom ash) and flue gas (e.g., SOX, C02). New Clean Air Act mandated reduction of SOX emissions from coal burning power plants. As a result, a variety of Clean Coal Technologies (CCT) are implemented to comply with these amendments. However, most of the CCT processes transfer environmentally sensitive elements (e.g., As, Cd, Pb, Se) from flue gas to CCT ash. The objective of this study was to determine the effect of a pressurized CO_2 treatment on the chemistry of CCT ash. Three CCT ash samples, produced from lime injection, atmospheric fluidized bed combustion, and sodium carbonate injection processes were reacted under different CO_2 pressure treatment conditions. [5]

The steel industry is under pressure to reduce its CO_2 emissions, which arise from the use of coal. In the long-term, the injection of pulverized particles of charcoal from biomass through blast furnace tuyeres, in this case called Bio-PCI, is an attractive method from both an environmental and metallurgical viewpoint. The potential of Bio-PCI has been assessed in terms of its CO_2 abatement potential and economic viewpoint. A cost objective function has been used to measure the impact of biochar substitution in highly fuel-efficient BF among the top nine hot metal producers; estimations are based on the relevant cost determinants of iron making. [6,8,9]

The capture of carbon dioxide at the point of emission from coal-or gas-burning power plants is an attractive route to reducing carbon dioxide emissions into the atmosphere. To commercialize carbon capture, as well as transport of liquefied carbon dioxide and its storage in exploited oil fields or saline formations, many technological, commercial, and political hurdles remain to be overcome. Urgent action is required if carbon capture and storage is to play a large role in limiting climate change. Carbon dioxide emissions from fossil fuel combustion are a major contributor to climate change (1). The current low price of fossil fuel energy is partly subsidized by unprized CO_2 emissions, exploiting the degradation of natural atmosphere and ocean. Even if the debate on climate change is over, the actions to limit CO_2 emissions have barely started. One step toward reducing CO_2 emissions is to capture the CO_2 generated during combustion and store it in a suitable place. This process of carbon capture and storage (CCS) has the potential to reduce future world emissions from energy by 20% (2). CCS is already operating in trials, with 3 mega-tons of CO_2 (Mt CO_2) per year from power plants or natural gas cleanup being captured and stored. CCS technologies are now in a scale-up period.[10]

Reducing CO_2 emissions from energy sector and other fossil fuel-intensive industrial applications is of main importance today. The iron and steel industry is one of the largest industrial sources of CO_2 (about 6% of total CO_2 emissions). Two post-combustion CO_2 capture methods based on reactive gas-liquid and gas-solid systems are evaluated to be used in an integrated steel mill in conjunction with the plant sub-systems with the highest CO2 emissions e.g., captive power plant, hot stoves, coke ovens, lime kilns, etc. The gas-liquid absorption using chemical solvents (e.g., alkanolamines) and Calcium Looping (CaL) are assessed. The carbon capture rate is set to be at least 90%. The paper evaluates a conventional size of integrated steel mill emphasizing the energy integration aspects and the influence of various carbon capture options on the overall steel mill performances. [11,12,13]

Technological state of the art and anticipated developments There are two main routes to produce steel. The first route is called the "integrated route", which is based on the production of iron from iron ore. The second route called " recycling route " , uses scrap iron as the main iron-bearing raw material in electric arc furnaces. In both cases, the energy consumption is related to fuel (mainly coal and coke) and electricity. The recycling route has a much lower energy consumption (about 80%). The "integrated route" relies on the use of coke ovens, sinter plants, blast furnaces and Basic Oxygen Furnace converters. Current energy consumption for the integrated route is estimated to lie between 17 and 23 GJ per tonne of hot-rolled product

[1][SET_Plan_Workshop_2010]. The lower value is considered by the European sector as a good reference value for an integrated plant. A value of 21 GJ/t is considered as an average value throughout the EU27 [1][SET_Plan_Workshop_2010]. [14]

III. Conclusion

The issues of pollution with steel plants are manifold, therefore proper regulation and monitoring is important. A number of policies are required to achieve the abatement potential in industry. Like, improve benchmarking through standardised measurement and data capturing protocols, identify barriers and develop approaches to improve uptake of energy efficient technologies, incentivise fuel switching, maximise energy efficiency which is indirectly responsible for CO2 emission have potential by replacing older, inefficient processes with current best available technologies and best practice technologies. Like adopt most efficient steel recycle EAF technologies, implement industrial CO2 and capture and storage plants, etc.
Future of the sector demands for reductions of natural resource consumption, more recycle and reuse and efficient land use.

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References

[1] Sanjeev K. Kanchan, "Pollution and Control in Steel Industry", Special Article, Steel Scenario (India), June 2013.

[2] Iosif, Ana-Maria, Birat, Jean-Pierre, Mirgaux, Olivier,Ablitzer, Denis, "Reduction Of Co $_2$ Emissions In The Steel Industry Based On LCA Methodology", Journal Article, 2009.

[3]Brown, Tamaryn, Gambhir, Ajay Florin, Nicholas,Fennell, Paul, "Reducing CO 2 emissions from heavy industry: a review of technologies and considerations for policy makers", Journal Article, Year 2012.

[4]Gupta, Murlidhar, Coyle, Irene, Thambimuthu, Kelly, "CO 2 Capture Technologies and Opportunities in Canada " Strawman Document for CO $_2$ capture and Storage (CC&S) Technology Roadmap", Journal Article, Year 2012.

[5]Tawfic, T A, Reddy, K J Gloss, S P Drever, J, "Reaction Of C02 With Clean Coal Technology Ash To Reduce Trace Element Mobility", Research Gate of In Water, Air and Soil Pollution, Vol. 40, Pages 358-398, October 1995.

[6]Feliciano-Bruzual, Cristobal, "Charcoal injection in blast furnaces (Bio-PCI): CO 2 reduction potential and economic prospects",Journal of Materials Research & Technology, Integrative Medicine Research, Vol. 3, Pages 233-243, August 2014 .

[7] Adriano, D.C., Page, A.L., Elseewi, A.A., Chang A.C., and Straughan, I.R.: 1980, J. Environ. Qual. 9, 333-334

[8] Adriano, D.C., Page, A.L, Elseewi, A.A., and Chang, A.C.: 1982, J. Environ. Qual. 11, 197-203.

[9] Brown, D.S., and Allison, J.D.: 1992, MINTEQA2, An Equilibrium Metal Speciation Model. Envi- Carlson, C.L., and Adriano, D.C.: 1993, J. Environ. Qual. 22, 227-247.

[10] Venkatesh .V, C Jaya pal Reddy, "Modeling and Simulation of Supersonic nozzle using Computational Fluid Dynamics", International Journal of Novel Research in Interdisciplinary Studies, Vol. 2, Issue 6, pp: (16-27), 2015, www.noveltyjournals.com

[10] Haszeldine, R Stuart, "Carbon Capture and Storage: How Green Can Black Be?", Science 325,1647 (2009), http://www.sciencemag.org/cgi/content/full/325/5948/1647.

[11] Cormos, Calin Cristian, "Evaluation of reactive absorption and adsorption systems for post-combustion CO2 capture applied to iron and steel industry", Applied Thermal Engineering 105(2016) 56-64

[12] World Steel Association (WSA), 2008 Sustainability report of the world steel industry, Brussels, 2008

[13] ULCOS project – Ultra Low Carbon dioxide (CO2) Steelmaking, 2016 < http:// www.ulcos.org > (Accessed 25.02.16)

[14] SET-Plan Information System (SETIS) Chapter on Energy Efficiency and CO 2 Emission Reduction in the Iron and Steel Industry
[SET_Plan_Workshop_2010] SET-Plan workshop on Te chnology Innovations for Energy Efficiency and Greenhouse Gas (GHG) emissions reduction in the iron and Steel Industries in the EU27 up to 2030. Brussels, January 2010.