CB05 - Sustainable CPC Production at the Vizag Calciner

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Abstract

Rain Carbon is a global producer of calcined petroleum coke (“CPC”) and operates its largest coke calciner at Visakhapatnam (“Vizag”) in India. The objective of this paper is to review the operation at Vizag with a focus on systems designed to minimize the impact on the environment. The paper will describe the equipment used to handle the flue gas stream from the kilns which includes a waste heat recovery boiler, steam turbine generator, SO_2 scrubber, and baghouse. The calciner achieves benchmark emission levels for SO_2 and particulate matter and demonstrates what is possible with modern pollution control equipment. The SO_2 scrubber routinely operates with an efficiency above 97 % and the byproduct is used for local brick manufacture. The power generated at the calciner helps offset the plants’ CO_2 emissions. A carbon footprint analysis is presented showing the potential impact from CPC production on climate change as well as on anode production and use in an aluminium smelter. This further enhances the sustainability of the calciner operation and its contribution to the positive aluminium life cycle story.

Keywords: Petroleum coke, CPC, calciner, anode, carbon footprint.

1. Introduction

Rain CII Carbon Vizag Limited (RCCVL) operates a 500 000 t/annum petroleum coke calcining plant at Visakhapatnam (“Vizag”) in Andhra Pradesh, India. RCCVL is part of Rain Carbon Inc., a global producer of carbon and chemical products. The company is split into two business units – Carbon Calcination (CC) and Carbon Distillation and Advanced Materials (CDAM). CDAM produces a wide range of products and is the world’s largest producer of coal tar pitch (CTP) which is combined with calcined petroleum coke (CPC) to make carbon anodes used in aluminum production. The coal tar (CT) and green petroleum coke (GPC) raw materials used by Rain Carbon are byproducts from other industries which are transformed into value-added products. This prevents them from being disposed of as waste or burned as a low-grade, high-carbon fuel.

Vizag is the company’s largest calciner and supplies CPC to aluminium smelters both domestically and outside India. The two 68 m long rotary kilns form the heart of the calcination process, but the plant features an extensive waste heat recovery and flue gas treatment system that generates electrical power from surplus heat. The system significantly reduces the impact of the calciner on the environment and enhances the sustainability of the operation. SO_2 scrubbers remove most of the SO_2 that would otherwise be emitted from the exhaust stacks and a baghouse removes particulate matter to benchmark low levels.

CPC along with CTP and alumina, are essential raw materials for aluminum production and the carbon footprint of these materials needs to be considered along with the CO_2 footprint of the electric power needed to operate the smelter. The objective of this paper is to report on the calcination process and the product carbon footprint (PCF) of CPC to show the benefits of an integrated waste heat recovery system. The lifecycle, including raw material production, will be considered to quantify the contribution of CPC on anode production and smelter operations.

2. Overview of the CPC Production Process and Vizag Flowsheet

During the calcination process, GPC is fed to one end of the kiln and discharged from the other end at a temperature of ~ (1250-1350) °C. Moisture in the GPC is driven off first followed by volatile matter (VM) which is typically in the range of (9-12) %. Most of the VM is combusted inside the kiln and provides the heat for calcination which is necessary to densify the coke structure and make it electrically conductive. A more detailed description of both GPC and CPC production can be found in [1].

GPC loses some sulfur during calcination with typical losses in the range of (8-12) % of the starting sulfur level. The high counter-current flue gas flow inside the kiln contains a significant amount of heat along with un-combusted VM, combustion products including CO_2, CO, SO_2 and H_2O, and coke fines that get entrained in the flue gas stream. A typical fines loss is ~ 10 %, but it can be higher for finer particle size GPC.

The flue gas from the kiln cannot be exhausted to atmosphere due to the presence of un-combusted VM and particulate material and these must be combusted in a large refractory lined chamber called a pyroscrubber. Many calciners exhaust the hot gas from the pyroscrubber directly to the atmosphere via a tall "hot" stack. Combustion of coke fines in the pyroscrubber produces additional CO_2 and SO_2 and these add to the total emissions of the calciner. CO produced in the kiln is converted to CO_2 in the pyroscrubber.

The Vizag calciner employs a complex system for handling the pyroscrubber exhaust. The hot gasses (~ 1200 °C) are passed through a waste heat recovery boiler (WHB) which generates high pressure steam (6.37 MPa at 485 °C) as the gas is cooled. The steam is routed to a steam turbine and generator which produces electrical power (50 MW turbine). The cooled flue gas from the WHB (180 °C) passes through an SO_2 scrubber and finally goes to a baghouse to remove any remaining ash and particulate matter before the exhaust gasses are discharged to atmosphere. The Vizag calciner layout showing key process equipment is shown in Figure 1. Photos of equipment in the flue gas stream are shown in Figures 2-3.

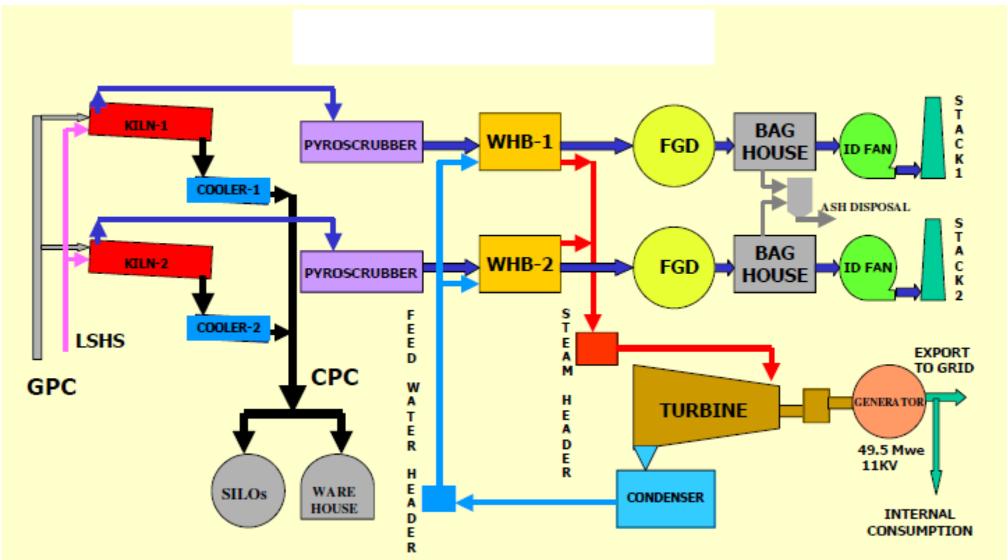

Figure 1. Schematic of Vizag Flowsheet.

smelter operating with coal fired power, but a more significant impact on a smelter operating with hydro-electric power.

Several aluminum producers are pursuing inert anode (IA) technology (Rusal and Alcoa/RioTinto via Elysis) and if successful, this would remove all emissions associated with anode production and consumption at the smelter. IA technology has been under development for more than 50 years, however the pathway to successful commercial implementation remains challenging. A recent publication [15] highlights the negative impact of IA's on the reversible cell voltage and energy requirement of smelting cells. They are projected to be at least 20 % higher with an IA cell relative to today's lowest energy cells. For a hydro-powered smelter, it could be argued that the higher energy consumption would not matter in terms of GHG emissions. For coal-powered smelters however, the increase in energy consumption with inert anodes would increase total GHG emissions.

Today, roughly 30 % of the world's primary aluminum is produced in smelters using low GHG power sources (predominantly hydro and nuclear) [16]. The rest comes from coal-fired power (60 %) and natural gas (10 %). China has dominated global smelting capacity growth since 2000 and most of this has come from coal-fired power. China has been adding some hydro-powered capacity in Yunnan province recently, but the world has a long way to go in reducing its dependence on coal fired power for primary aluminum production.

Rain Carbon remains strongly committed to improving the sustainability of its operations and minimizing the impact on the environment through continuous process improvements and technology changes. The company now has two major projects underway to support this effort. The first is construction of a vertical shaft calciner near Vizag which will offer a lower CO_2 footprint than the existing rotary kiln calciner due to a significantly higher kiln yield. It will also feature an advanced waste heat recovery/power generation system and a high-efficiency ammonia scrubber that will produce a value added, fertilizer byproduct.

The second project involves construction of an innovative new plant and process to produce anhydrous carbon pellets (ACP). Plants are being built in the US and in India at the new shaft calciner site. The technology has been described previously [17] and a key feature is the potential for a significant reduction in fines carryover. The fines are removed and agglomerated to form pellets which densify during calcination rather than being carried over and combusted in the pyroscrubber. This will further reduce CO_2 and SO_2 emissions in the calcining process.

7. References

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