CIRCULAR PELLETIZING TECHNOLOGY – A REVOLUTIONARY SOLUTION[1]

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Abstract

As the quality of raw materials worldwide is constantly decreasing, affordable ore and ultra-fine ore grades will dominate the future of iron and steel making. The share of pellets in total iron production has increased steadily over the last ten years and the trend is expected to intensify in the mid-term and long-term. For this reason, more and more steel producers are looking for a future-proven solution to produce the pellets in the steel plant site – to become independent from the steadily rising prices for pellets in the world market and to achieve exactly the chemical properties that they need for an optimized production and improved product quality. Additionally, mine operators seeking specific ranges of pellets output were not able to relay on an efficient, compact and feasible technology. Siemens VAI‘s Circular Pelletizing Technology is the next step in the evolution of highly efficient, ultra-compact pelletizing plants. It is by significantly smaller than conventional plants and offers a completely new flexibility in integration and pellet production. Freeing iron and steel producers from rising costs for pellet supply – with the world‘s most compact pelletizing plant.

Key words: Pelletizing; Iron ore; Manganese; Circular; CPT; Mining.

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1 INTRODUCTION

Easy access to affordable, high-quality raw materials is continually decreasing on a worldwide basis. This means that fine and ultra-fine iron ores will command an ever-larger share of available iron ores in the future. Consequently, the portion of pellets used in global iron production is also steadily increasing, and this trend is expected to continue in the future. For this reason, a growing number of iron and steel producers are looking into the possibility of introducing pellet production directly at the iron and steel production site in order to become independent of escalating prices for pellets on the world market. Furthermore, this step allows producers to flexibly adjust pellet chemistry and quality as the basis for an optimized iron and steel production. However, up to now, the space required for a conventional pellet plant was too large for an efficient and cost-effective integration within an existing iron and steel works site. This meant that producers either had to purchase pellets from commercial suppliers or operate their own pellet plants near the iron ore mine. The latter often incurs complicated transport logistics and the related higher costs.
In response to this challenge, Siemens Metals Technologies recently developed Circular Pelletizing Technology or CPT. The process is based on and is virtually identical to well-proven travelling-grate pelletizing technology, however, a circularly designed induration furnace greatly reduces the footprint size of the pelletizing plant. The overall space requirement for a CPT plant is approximately one half of that needed for a conventional pellet plant. Capital expenditures for civil works, equipment and steel structure are reduced accordingly and plant erection can be completed far more quickly. Annual production capacity of a CPT plant ranges between 0.6 and 3.0 million tons of typical pellet types to meet the requirements of iron and steel producers worldwide.

2 PROCESS AND PLANT DESCRIPTION

A CPT plant comprises the pre-processing facilities for the grinding, storage, mixing, balling and screening of the iron ore and other input materials; the green pellet charging area; the circular induration furnace; a combustion system; process gas cleaning; the service area for material feeding and product discharge; a plant dedusting system; and the respective transport and conveying systems up to pellet storage (Figure 1).

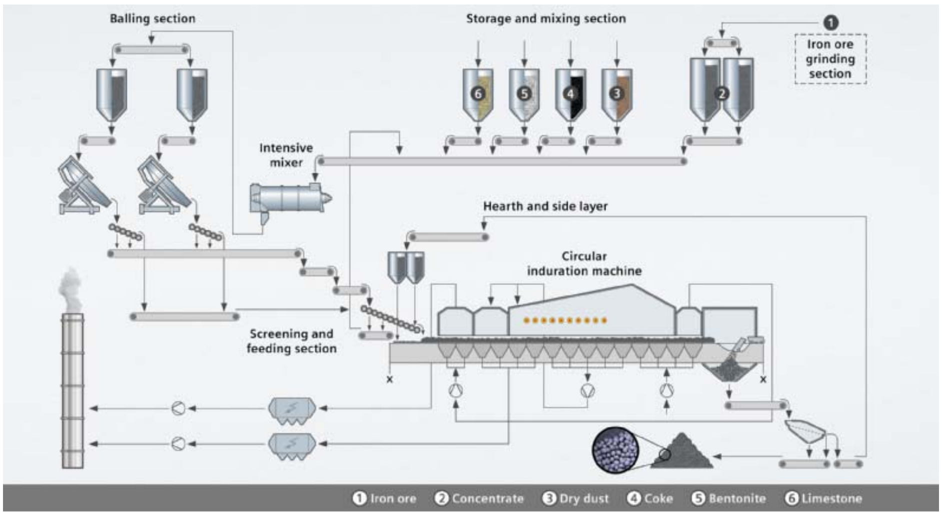

Figure 1. Typical flowsheet of a CPT plant.

2.1 Pre-Process Facilities

The pre-processing facilities include storage, dosing, mixing, balling of the raw materials, and the transport facilities between these plant sections to and from the induration furnace. The raw and input materials, which include ground ore, bentonite, hydrated lime or limestone, coke or anthracite, and dry dust, are stored in a series of bins. Grinding mills for iron ores and additives can also be provided. The different materials required for the pelletizing process are extracted from the bins and charged onto a belt conveyor by dosing devices. The material is then conveyed to an intensive mixer. After the mixing step, the homogenized material is transported to the top of the balling building where balling is carried out by means of balling discs, each with a diameter of 7.5 m. The green pellets are transferred to the induration furnace. The undersize and oversize green pellets are separated at the roller feeder directly before the induration furnace. After fluffing, both the oversize and undersize green pellets are recycled to the process.

2.2 Green Pellet Charging Area

The green pellets are charged onto a reciprocating conveyor that distributes the pellets across the width of the wide-belt conveyor in accordance with the requirements of a circular-type grate. The green pellet feed is charged from the belt conveyor onto a double-deck roller-feeder where the undersize and oversize green pellets are screened and recycled to the process as outlined above. Properly sized pellets roll off the roller feeder and are deposited in a uniform layer onto a 100-mm hearth layer of the travelling grate. The height of the green ball bed is approximately 350 mm, which gives a total bed height of approximately 450 mm. Side layers of pellet material are deposited by chutes installed on each side of the belt to protect the sidewalls and improve air distribution. The actual bed height is continuously measured by ultrasound probes to ensure the proper speed of the travelling grate.

2.3 Induration Furnace

The induration furnace is of circular design that allows the furnace hood to cover more than twice as many pallet cars compared to a straight-type induration furnace. A far more efficient utilization of installed equipment is thus achieved.

The furnace hood is divided into four sections. The number and distribution of wind boxes installed below the induration furnace is based on process requirements. The induration furnace, which has a variable speed drive system, is comprised of the following equipment: pallet cars with exchangeable grates; wheels and side wall blocks; grate bars; wind boxes with double pendulum flaps; a discharge hopper with a dust-collection system; and a pallet-car-dumping section.

The induration time for pellets in the CPT furnace is 40–55 minutes, depending on the iron ore fines and concentrates. The induration process steps include conventional up- and down-drafting; pre-heating; firing; after-firing; primary and secondary cooling; and a highly efficient recuperation of hot gases. The length of each zone is designed on the basis of the results from pot grate tests conducted on the ores to determine their pelletizing characteristics. Exhaust gases from the wind boxes and hood are cleaned in electrostatic precipitators (ESP) or in a bag filter system. Figure 2 shows the various process zones of the induration furnace and the respective temperature levels.

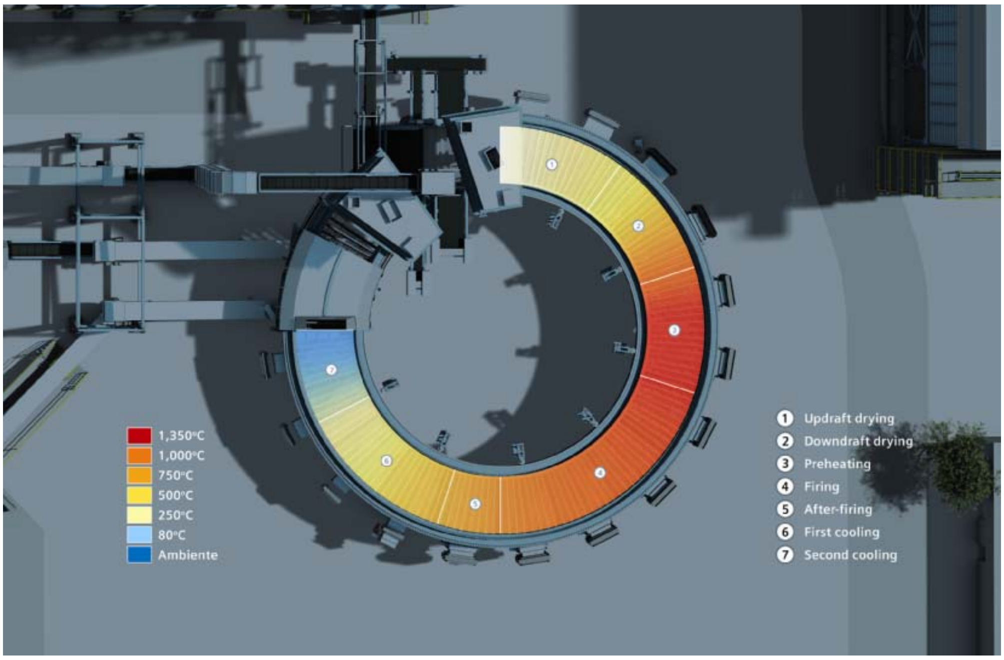

Figure 2. Process zones of the CPT induration furnace and respective temperature levels.

In the first zone of the CPT induration furnace, hot gases recuperated from the second cooling zone are used for updraft drying of the green pellets. This also increases the pellet strength, enabling the pellets to better withstand the down-draft drying phase. After passing through the pellet bed, the humid air is exhausted through an ESP or bag filters for cleaning before being emitted to the atmosphere through the stack.

In the second zone of the induration furnace, hot gases recovered from the firing and after-firing zones by the wind box recuperation fan are used for down-draft drying of the pellet bed. The gases are sucked through the green pellet bed and also cleaned in an ESP or a bag filter system. This completes the drying cycle.

In the third zone, the green pellets are pre-heated by gases recuperated from the firing zone. If required, additional heat can be supplied by burners.

In the fourth zone, the firing burners located on each side of the induration furnace heat the upper layer of pellets to the induration temperature of about 1,350°C. This promotes recrystallization and slag bonding, which gives the pellets their compressive strength.

After-firing takes place in the fifth zone where the heat front migrates downwards from the upper pellet layer towards the hearth layer. This completes the firing process.

The last zone of the machine, the cooling zone, is divided into two sections where air at ambient temperature is forced by the cooling-air fan to pass through the bed from the bottom to the top to cool the pellets. Hot gases exiting the first cooling zone are directly recovered for improved heat transfer to the lower bed layer in the after-firing zone. The greater portion of the recovered hot air is used in the preheating and firing zones of the CPT induration furnace. Hot gas exiting from the second cooling zone is used in the up-draft drying zone.

An overview of the process gas flow of a CPT plant is depicted in Figure 3.

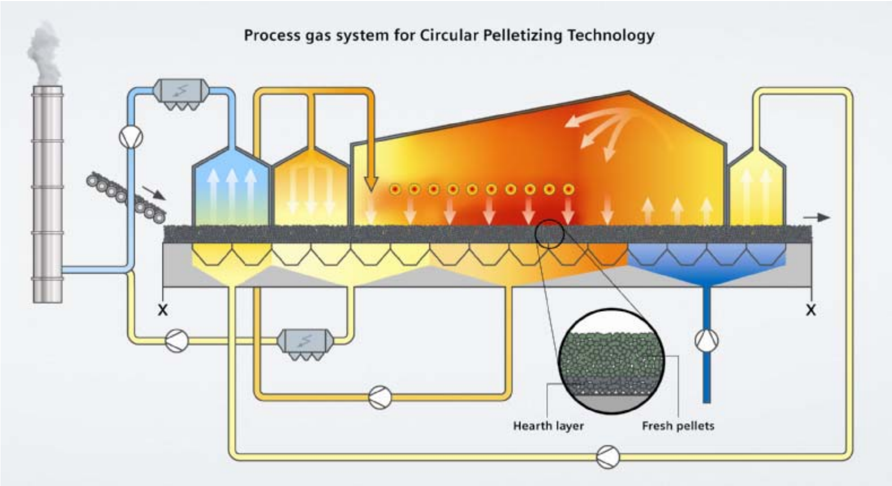

Figure 3. Schematic overview of the process gas flow in a CPT plant.

The cooled pellets are discharged from the induration machine at a temperature of 100°C or less. An automation system controls the fan speeds, individual burner power, and the positions of the system dampers to regulate the temperatures and pressures in the hoods and ducts. Fans and dedusting units are protected from overheating by air bleed-ins.

2.4 Combustion System

Multiple fuel burners are installed in the induration hood. An important feature of the CPT combustion system is its flexibility to use various energy sources either individually or simultaneously. For example, coal gas from a coal gasifier in combination with liquid or other gaseous fuels can be used. If required, a complete tailor-made coal-gasification system can be supplied by Siemens Metals Technologies to meet the combustion requirements of a CPT plant.

2.5 Process Gas Cleaning

The electrostatic precipitators installed in the hood-exhaust and windbox-exhaust ducts clean the waste gas. Alternatively, a bag filter system can be supplied to satisfy the most demanding environmental requirements. The separated dust is pneumatically transported to the dry dust bin in the storage area from where it is recycled to the pelletizing process.

2.6 Machine Service Area of the Induration Furnace

The service area includes the green-pellet-feeding and product-pellet-discharging section. After the pallets exit the second cooling zone, the burned pellets are discharged into a hopper. The pellets from the hopper are fed onto a conveyor belt. A special control system ensures that the hopper filling level is kept within a defined minimum and maximum range. Following transport to the screening building, the material required for the hearth layer is screened and returned to the induration machine. The bulk of the pellets is conveyed to the product storage pile or bins. The removable discharge hood that covers the service area can be shifted in the direction of the feeding area for maintenance purposes, for example, to exchange the pallet grates.

2.7 Plant Dedusting System

The dust that is generated at all material transfer points is exhausted and collected either in a central bag-filter system or in an electrostatic precipitator (ESP). The extracted dust is recycled to the process.

3 PRODUCTION AND CONSUMPTION FIGURES

The expected consumption and production figures of a CPT plant with pellet capacity between 800,000 t/a and 3 million t/a are based on a hematite iron ore concentrate with typical physical and chemical properties (Tables 1 and 2).

Table 1. Typical characteristics of the CPT pellet product

Product quality parameter	Value
Product size <5 mm	<5%
Product size >16 mm	<3%
CCS (cold crushing strength)	2,500 N/pellet
TI (tumble index) >6.3 mm	92%
Reducibility (ISO 7215)	70%
Swelling index	max. 15%

Table 2. Typical consumption figures of the CPT process

	Value
Coke	<11 kg/t pellets
Bentonite	<7 kg/t pellets
Limestone	<11 kg/t pellets
Compressed air	<25 m^3/t pellets
Water requirements	<0.2 m^3/t pellets
Electric energy requirements	<40 kWh/t pellets
Heat energy requirement	<150 Mcal/t pellets
Refractories	<0.1 kg/t pellets

4 WORLD'S FIRST CPT PLANT

The first order for a CPT plant is currently being implemented in Orissa State, India, together with an Indian supplier of beneficiation plants. The plant will have a nominal production capacity of 1.2 million tons of pellets per year. Total space requirements of the complete facility, which extends from raw material dosing and balling to process gas cleaning – and which also includes a coal-gasification plant for energy generation – is less than two hectares. The CPT induration furnace will be fired using a combination of coal gas and heavy fuel oil. Plant start-up is scheduled for 2014 and the produced pellets will be primarily used by the Indian iron and steel industry. A schematic 3-D aerial view of the plant is seen in Figure 4.

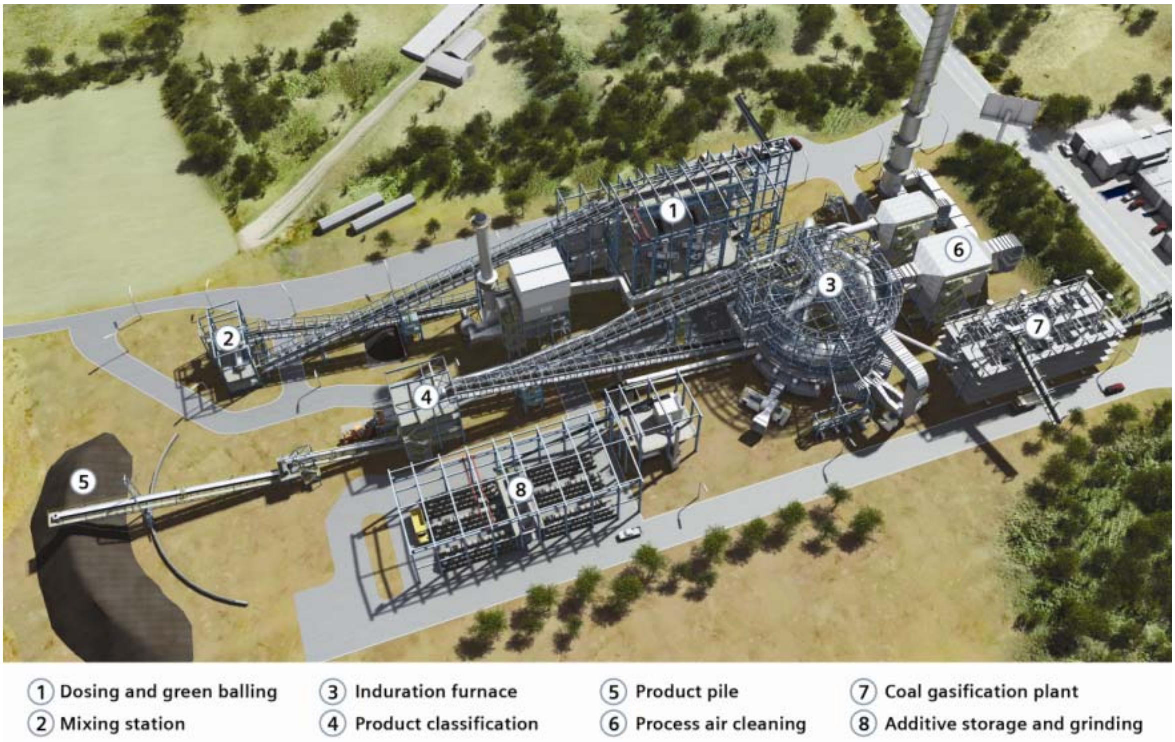

Figure 4. Schematic view of the 1.2 million t/a CPT plant currently under construction in Orissa State, India.

5 MAIN FEATURES AND BENEFITS OF CPT PLANTS

CPT represents the world's most compact plant for pelletizing and sets new benchmarks for cost-efficient iron and steel production on the basis of iron ore pellets. Plant modules are available for pellet-production capacities ranging from 600,000 t/a to 3 million t/a. Thanks to the circular design of the induration furnace, space requirements for a complete CPT facility are less than 50% of those needed for a conventional pelletizing plant of similar capacity. Capital expenditures for civil works, equipment and steel structure are reduced accordingly. Faster plant completion and start-up allows producers to more quickly commence with profitable pellet production.

The circular induration furnace results in a far more efficient utilization of installed equipment because more than 75% of the pallet cars are in use within the induration furnace. This is in contrast to a conventional pelletizing plant where due to the linear layout of a straight-type induration furnace, the pallet car strand returns empty to the green-pellet charging area. This means that less than 40% of the pallet cars are actually involved in productive pellet production. The optimized utilization of recovered hot process gases minimizes the energy consumption required for pelletizing. Plant operation is based on the use of well proven Siemens automation systems for equipment control and process tracking. Total recycling loops for waste materials and steel mill reverts leads to a low environmental impact by the process.

Figure 5. CPT – A highly compact and cost-efficient solution for the production of quality pellets.

6 CONCLUSION

CPT represents a new generation of pelletizing plants that allows both iron ore producers and operators of iron and steel mills to quickly and profitably respond to the ever-increasing ratios of fine iron ores available on the global iron ore market. At the time, a number of technical plant evaluations and offers are being prepared for CPT plant installations at various mining sites and iron and steel mill complexes throughout the world.