Thermal Energy Consumption in Gas Suspension Calciners

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Abstract

Since the first unit were designed in 1984, Gas Suspension Calciners (GSC) were equipped with four (4) stages of direct heat recovery from hot alumina. This is the most energy efficient heat recovery flow sheet compared to other stationary calciner flowsheets, resulting in an average specific heat consumption as low as 2722 KJ(NHV)/kg SGA, reported for GSC units operating with a Calciner Furnace temperature of 1025 - 1050 ^{o}C and a few seconds of solids retention time. This paper reports the analysis of the thermal energy consumption of operating GSC units equipped with a fluidized holding vessel providing a few minutes of additional retention time, and operating at 100 - 150^{o}C lower temperature in the Calcination Furnace. The analysis confirms even lower thermal energy consumption than previously reported, with significant potential for further improvements with an optimized design for refractory lining. The retrofit of a coal gas fired GSC with a fluidized holding vessel is also analyzed with respect to increased thermal energy efficiency and productivity.

Keywords: Alumina, calciners, thermal energy consumption.

1. Introduction to Gas Suspension Calciner with 4 Direct Heat Recovery Stages

The first oil fired Gas Suspension Calciner (GSC) unit equipped with an Electrostatic Precipitator was successfully commissioned at Hindalco, India in 1986, replacing three rotary kilns [1].

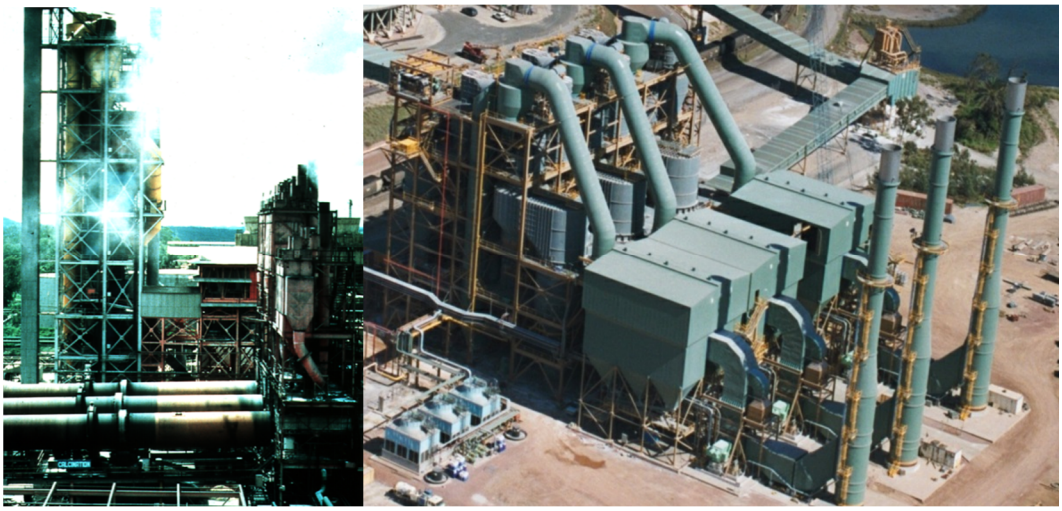

Figure 1. 850 tpd GSC, Hindalco, and 3 x 4500 tpd units Queensland Alumina.

Over time, FLSmidth Minerals has supplied and started up many more GSC units, including the world's largest Natural Gas fired stationary calciners: 3 x 4500 tpd GSC units equipped with Fabric Filters (Bag House) at Queensland Alumina Limited, Australia in 2003 - 2004 [2]. The new GSC units were replacing nine (9) rotary kilns.

Gas Suspension Calciners (GSC) are designed with four (4) stages (CO1 - CO4) of direct heat recovery from hot alumina since the first units were designed in 1984 as seen from the GSC flow sheet in Figure 2 below.

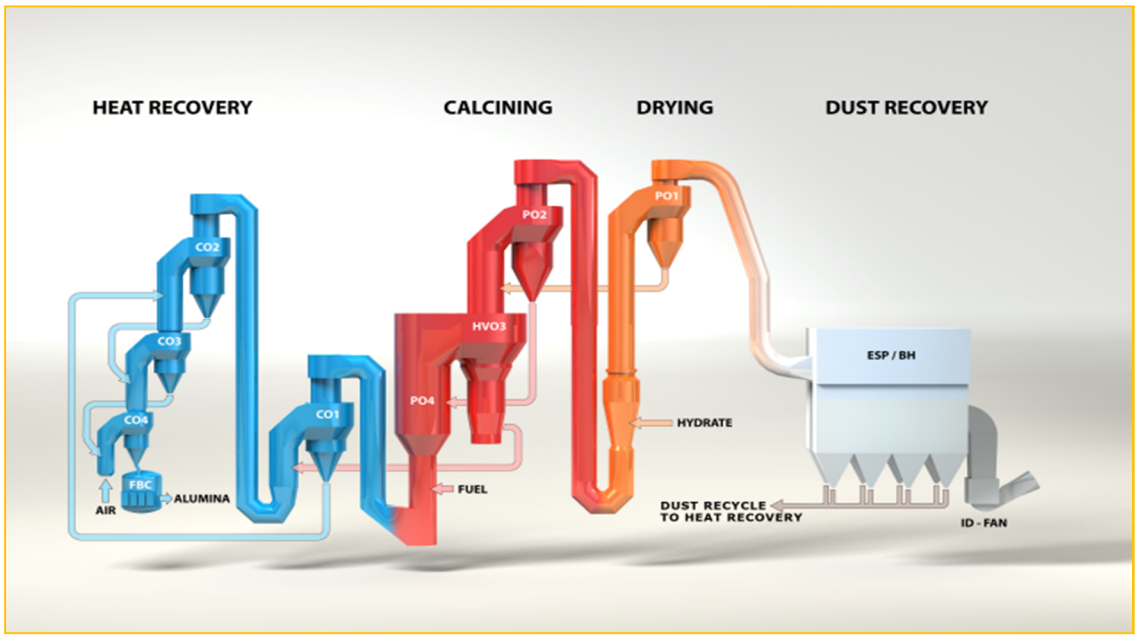

Figure 2. GSC flowsheet with 4 direct heat recovery stages (CO1-CO4).

This is the most energy efficient heat recovery flow sheet compared to other stationary calciner flowsheets, resulting in a yearly average specific heat consumption as low as 2722 kJ (NHV) / kg SGA, reported for two GSC units operating with a Calciner Furnace temperature of 1025 - 1050 ^{o}C and few seconds of solids retention time [3]. The availability, or Operating Factor was 98.8 % for both GSC units in the 32 month periods between the 27 day overhaul period for maintenance [3].

GSC units equipped with a fluidized holding vessel provide a few minutes of additional retention time, operating at 100 - 150 ^{o}C lower in the Calcination Furnace. See Figure 3 (rhs) and Table 1.

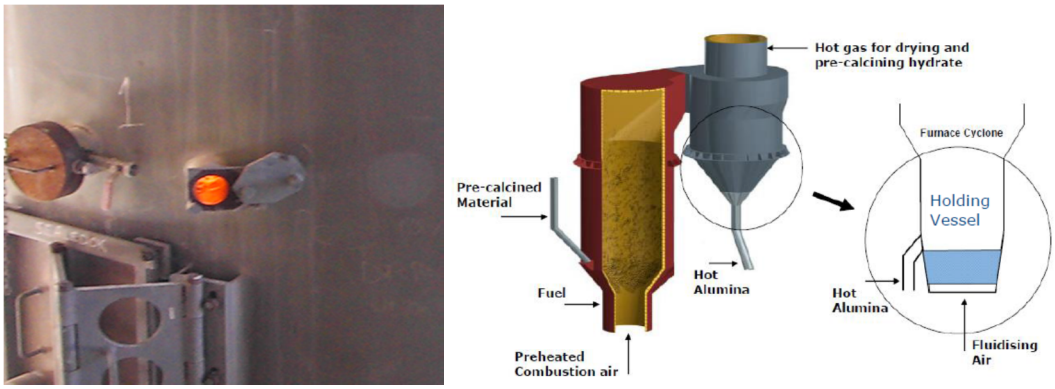

Figure 3. Combustion below Atmospheric Pressure - GSC with/without Fluidized H.V.

The impact on GSC operation of a Holding Vessel is to lower the temperature profile in the GSC unit and thus the specific thermal heat consumption as seen in Table 1, showing the average 2012 thermal energy consumption for each GSC unit in Plant A.

$\Delta h_x = \int C_{px}(T)dT$ from $T_o = 298^o$ Kelvin to T^o Kelvin, is the specific single phase enthalpy of a single component i.e.water (Δh_{wl}) or gas mixture, i.e. like air (Δh_{Air}) or gas products from combustion, evaporation and calcination, (Δh_{Gas}).

9. References

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