AirStream upgrade of the preheater fan at Ciment Québec

Introduction

Ciment Québec Inc operates a dry process kiln line, equipped with a calciner and 4-stage preheater, with an original clinker capacity of 2300 t/d. The plant is located at St-Basile, PQ, Canada and is in partnership with the Essroc Italcementi Group. Modifications to the preheater, firing systems and clinker line have removed bottlenecks over several years, and gradually increased the capacity so that by 2007 a clinker capacity of 3500 t/d had been reached. Several problems with the original fan had to be overcome before this capacity could be achieved.

The original preheater induced draft fan was a single inlet, backward-inclined type and was driven by a 1170 rpm motor. By 2005 the impeller size had been increased to its physical limits and the limit of the motor, allowing a capacity of no more than 3200 t/d. At this point the "paper" performance was a gas volume flow of 172.3 m^3/s with a total pressure of 10.95 kPa at a temperature of 216 °C. However, the fan efficiency was low and power usage was too high. The fan was run almost full out most of the time and any partial plugging or coating in the preheater vessels resulted in a reduced production capacity. The original fan supplier stated that Ciment Québec would have to purchase a completely new fan to obtain more fan capacity.

Over its lifetime the fan had been fitted with various drive configurations, including a variable speed drive, a fixed speed motor with friction clutches, a fluid coupling and finally, a reduced voltage soft starter. More power was required with the gradual increases in capacity and after the impeller size had been increased, so the motor size was increased from 1305 to 2685 kW. The motor was also in danger of overheating during start-up, due to the higher rotational inertia of the new impeller.

Rapid wear of the sleeve bearing thrust plates necessitated frequent replacement and caused production stoppages. Ciment Québec suspected that the fan inlet duct configuration was causing large aerodynamic thrust loads, resulting in bearing overloads. Wear of the impeller increased dramatically at higher production rates. The impeller had to be replaced annually even though chromium carbide blades were used.

Removing the fan bottleneck

Ciment Québec's goals were to increase the capacity of this main process fan by 15 % in volume, reduce the power consumption and impeller wear. Ciment Québec was presented with two possible ways of meeting these goals. Other fan suppliers offered a completely new fan with changes to the duct connections and foundations, but AirStream offered Ciment Québec an innovative concept that made it possible to the reuse the existing fan housing, while increasing the fan capacity and reducing power usage.

AirStream's proposal only required changing the impeller and inlet cone, and modification of the fan outlet. This proposal was preferred over a completely new fan for several reasons:

- Much lower project costs
- Turnkey price that included installation and start-up
- Significant reduction in power usage compared with the old fan and other fan suppliers
- Two to three times longer wear life than the old fan and other fan suppliers
- Fast track delivery of only twelve weeks including design engineering and manufacturing
- Ability to change the impeller within the annual shut-down period

The Airstream fan upgrade project

The fan performance tests conducted in October 2005 and April 2006 are summarized below. In both tests the dust load of 40 g/m^3 is included in the power usage.

Impeller design

The new impeller makes full use of the space available in the existing casing. It is wider and larger in diameter. Its construction is extremely robust, being fully armoured with chromium carbide plates. The impeller geometry has been specially designed and constructed to handle dusty gases from the preheater for dust loads > 70 g/m^3. The special features of the impeller include dust deflectors and control of the flow profiles at the inlet cone. Final design details were customized to suit the requirements of Ciment Québec based on site tests and measurements, computer flow modelling, and mechanical/structural analysis (▸ Fig. 1).

Figure 1: AirStream impeller, loaded for delivery

PRODUCTS

Table 1: Results of fan performance tests in 2005 and 2006

Designation	Temperature [°C]	Total pressure [kPa]	Volume flow [m^3/s]	Motor power [kW]	Fan total efficiency [%]
AirStream impeller tests April 2006	222	9.59	172.7	2129	81.3
Old impeller test October 2005	182	9.88	152.8	2866	50.6
Old impeller based on conditions for April 2006	222	9.59	172.7	3364	
Reduction in power usage at April 2006				1235	

The new impeller is a heavier piece of equipment with a much higher rotational inertia. The existing motor (2685 kW) was not able to start the new impeller so two new drive options were examined.

The use of variable frequency is the modern solution to starting a high inertia impeller. However, the fan was to be used near its full capacity so the energy savings were not significant but the installed costs were very high.

A larger, fixed speed, motor with across-the-line starting was chosen. The motor voltage was changed from 2400 to 4160 V. Calculations indicated that a 3355 kW motor would start the impeller in 16 s, which was also acceptable for the starter.

The new impeller was installed and started by AirStream without problems of any kind. A few weeks later when the production was steady, the fan performance was re-tested and met all AirStream guarantees. The new impeller allowed the plant to increase its production by more than 7 % and reduced the power consumption by over 36 % at full fan flow.

Conclusion

After two years in full operation the plant operators have fully utilized the additional flow of the upgraded fan, which has provided increased flexibility and spare capacity. No noticeable wear has taken place so far. Impeller maintenance during the annual shutdown has been limited to trim balancing; no repairs of any kind were required.

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