

Case note

ACS 1000 variable speed drive improves availability of kiln in the mineral processing industry

Worsley Alumina in Australia installed a large capacity kiln as part of an expansion project to increase the refinery production.

An ACS 1000 drive system rated at 500 kW was selected to provide controlled torque and speed to the kiln.



View of the 58 m long rotary kiln at Worsley.

Background

The Worsley Alumina Project lies in the Darling Ranges in the southwest of Western Australia. Bauxite is mined and crushed near Boddington and transported 51 km by a two-flight conveyor belt system to the refinery site, 20 km north west of the town of Collie. Worsley is one of the most modern and efficient alumina producers in the world and directly employs more than one thousand people. At the refinery, alumina is extracted from bauxite using the Bayer Process. Worsley has undergone expansion to increase the refinery production to 3.1 million tons of alumina per annum. This expansion was completed in June 2000. ABB LV and MV AC variable speed drives were specified by Worsley for this expansion.

As a part of the expansion project, a new liquor burning facility was added, in which a large capacity kiln was an essential requirement.

Highlights

95% reduction in maintenance costs
Improved kiln availability
Improved process control

Kiln characteristics

The rotary kiln consists of a steel tube with refractory brick lining which rotates at an angle of 1.26 degrees on two steel tyres which ride on two sets of rollers. Approximate dimensions are 58 m long with a diameter of 4.5 m.

The steel tube rotates slowly at the following speeds

- Minimum speed 0.2 rpm
- Normal speed 0.8 rpm
- Maximum speed 2 rpm

The material is slowly transported down to the burner end of the kiln.

The refractory is 240 mm thick and weighs approximately 600 tons while the kiln shell is also 600 tons when empty and without refractory.

Figure 1 shows the arrangement of the kiln. A burner fired with gas is located at the lower end of the kiln. The temperature at the burner end is approximately 1000 °C.

Kilns are normally driven by single or twin drives. In this instance a single drive was selected.

A special design criterion is the required starting torque. It is typically 250% of full load torque for the first 3 to 5 seconds then dropping to around 200% and gradually dropping further during the next 15 to 20 seconds at the end of which period the full speed is attained. This can be seen in figure 2. The physical size of the kiln and the weight of its contents mean that its inertia is very large.

The eccentricity of the loaded material inside the kiln also substantially adds to the required starting torque. In this instance the 250% starting torque was specified to last for 60 seconds. The nominal power requirement of the system is only 280 kW but as a result of all the considerations stated earlier, the power rating of the kiln drive system was increased to 500 kW for the motor and converter.

Some special requirements for this kiln drive were:

- High torque was required at starting. For the nominal starting period the rotary kiln must be driven with low speed until the temperature becomes sufficiently high.
- A wide range of speed control was required. During normal operation the rotary kiln had to be driven with the most suitable speed which is decided by the condition of the material combinations and the combustion even if a load variation occurred.
- High control accuracy

Drive solution

Many different motor drive systems have been used for kilns over the years. These include Ward Leonard sets, squirrel cage motors with eddy current couplings and DC drives.

The motor drive system best suited for the kiln is the ACS 1000 AC drive system. For the Worsley kiln a 12-pulse 3.3 kV drive rated at 500 kW was selected.

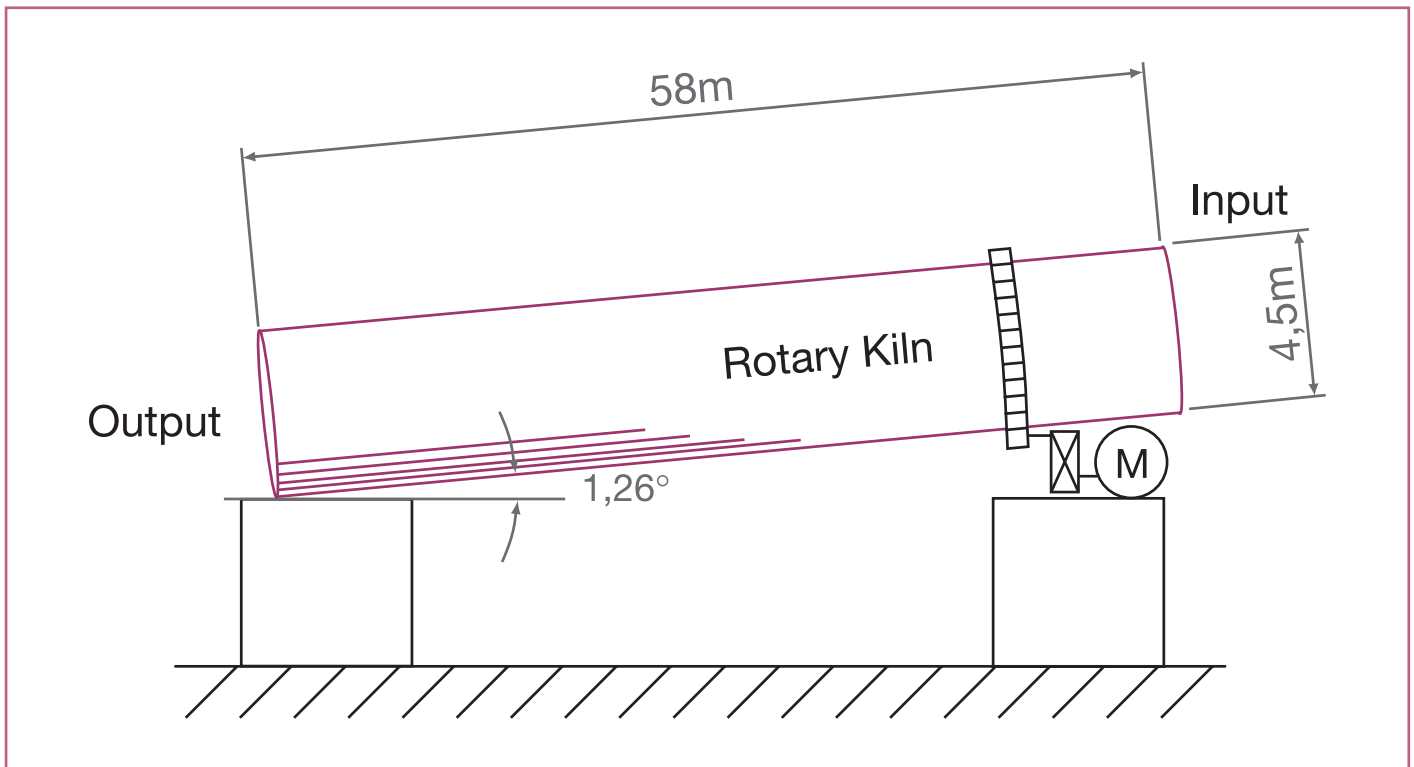


Figure 1: Arrangement of kiln

Benefits

The main benefits for Worsley Alumina resulting from the use of the ACS 1000 in this application are:

- Reduced maintenance costs;
 - Based on previous experience with DC drive solutions on similar constant torque applications, it was estimated that typical cost of maintenance would be in the region of \$ 15,000 per annum.
 - With the ACS 1000 AC drive solution, maintenance is performed once per year at a cost of approximately \$ 1000.
 - There is little, if any, maintenance (no brushes as in DC drives and no moving parts other than motor bearings)
- The acceleration and deceleration is controlled from zero speed up to maximum speed using ABB's high performance Direct Torque Control principle (DTC).
- The starting current is proportional to the speed and a true soft start is achieved. This means reduced stress on electrical supply, supporting rollers, gear train and foundations.
- The kiln speed can be varied to match that of other process objects.
- High-speed control accuracy resulting from DTC control
- Compact size
- Reduction in network harmonics due to 12-pulse design



ACS 1000 key data

Inverter type	Three-level Voltage Source Inverter (VSI)
Power range	Air cooling: 315 kW - 2 MW Water cooling: 1.8 MW - 5 MW
Output voltage	2.3 kV, 3.3 kV, 4.0 kV, 4.16 kV (optional: 6.0 kV - 6.6 kV with step-up transformer)
Maximum output frequency	66 Hz (optional: 82.5 Hz)
Converter efficiency	Typically > 98%
Type of motor	Induction motor

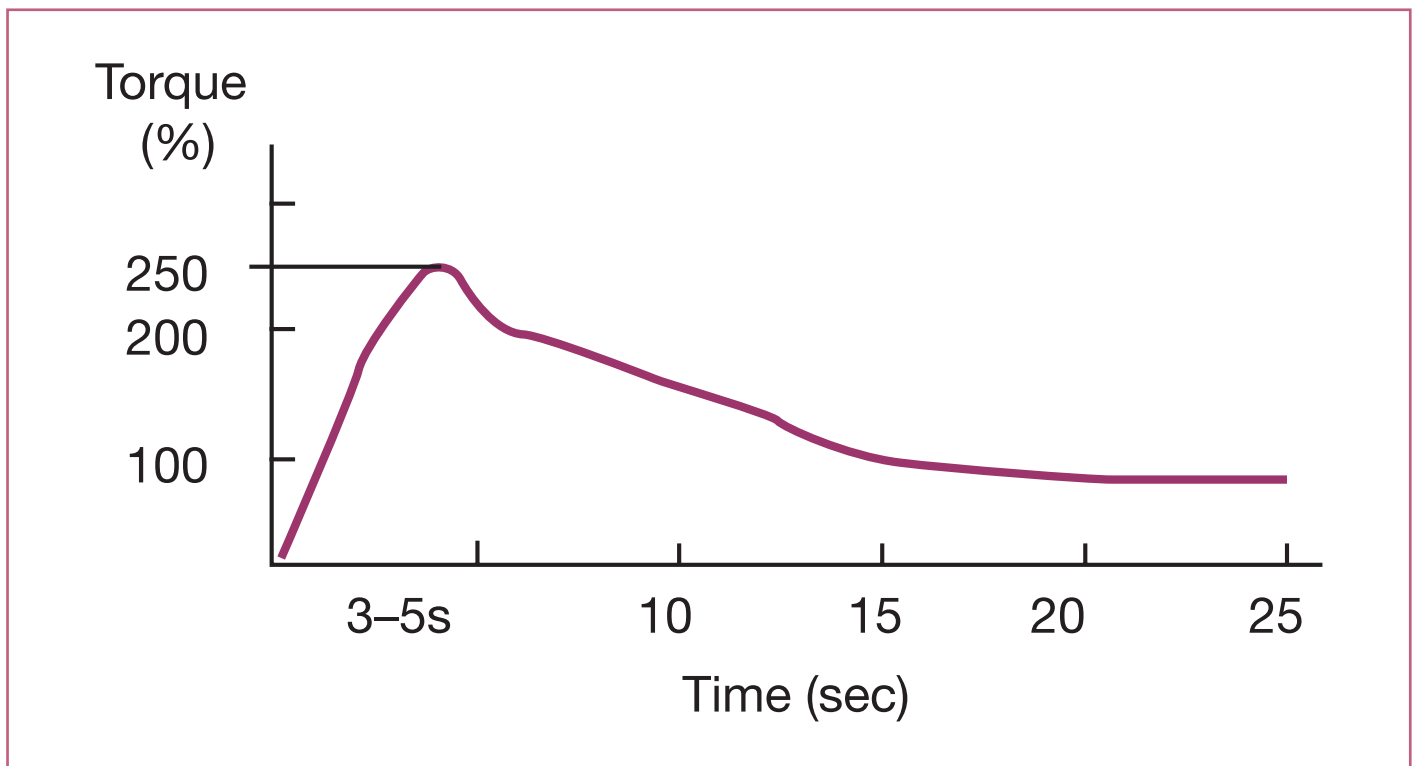


Figure 2: Typical starting characteristic for a kiln

For more information please contact:

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