Improving Paper Machine Operating Efficiency with Direct Drive System

Directly coupled to the PM indrive section, new drive system reduces mechanical components and associated maintenance and energy costs, while improving machine runnability and availability.

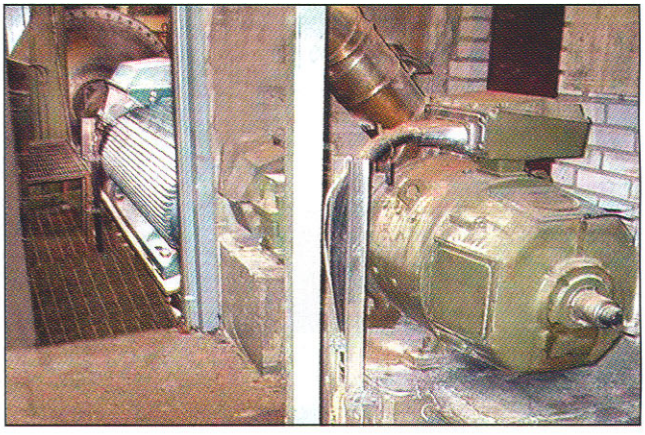
By Tero Huhtanen and Bob Shumaker

Paper companies today strive for more efficient, faster paper machines with higher requirements for control accuracy, system availability and functionality, as well as lower lifecycle cost. Constant development in these areas has placed increased demand on electrical drive systems, and development of electrical drives has reduced the need for mechanical drive components. Reducing mechanical components significantly improves the overall efficiency of paper machines, and adds value to the bottom line.

A new paper machine drive system, directly coupled to the indrive of the paper machine section, limits the mechanical drive, in most cases, to the coupling between the drive motor and the paper machine section. Known as the DriveIT Direct Drive, this high torque system developed by ABB has been installed on three Finnish paper machines, and is currently being installed as part of a board machine rebuild in Finland to startup later this year.

These mill installations are showing that the new drive system can further increase reliability and decrease overall lifecycle cost. Mill benefits include:

- Lower plant engineering and installation costs due to fewer mechanical drive components
- Better machine runnability due to the synchronous drive with minimal shaft resonance and no gear play
- Higher machine availability due to fewer mechanical components and no pulse encoders
- Reduced maintenance costs, as a result of a simpler system with fewer components and spares
- Lower energy costs due to lower overall losses.



Direct Drive running in a PM 1 dryer section at the Metsä-Serla Kirkniemi mill in Finland since July 1999 replaced the old DC motor and gear in front

Successful Installations

The Direct Drive was first installed at Metsä-Serla's Kirkniemi mill Finland in mid-1999, and the machine has been running successfully since. The drive power is 90 kW (120 hp) at 234 rpm. ABB is currently replacing the mechanical gearbox with a 'virtual digital' gearbox.

January 2001 saw the second startup using this technology on two paper machines in another Finnish mill. The startup was trouble-free and the drives are running well. The section powers are 37 kW (50 hp) and 99 kW (130 hp), and the corresponding speeds are 600 rpm and 425 rpm.

This past October, M-real ordered the new drive system to control and monitor the board machine being rebuilt at its Äänekoski mill, Finland. The system, scheduled to start up in autumn 2002, includes 102 drive sections, 29 permanent magnet motors, and application software including all related services as installation commissioning and training. The Voith Paper board machine will have an operating speed of 800 m/min.

(2,600 fpm) and the annual production capacity will increase to 160,000 metric tons.

"New technology was the main reason for our order," says Jyrki Ahonen, director of the rebuild project of Äänekoski. "The board machine will produce folding boxboard used for health care products, a grade that has very high quality requirements. In the board machine being rebuilt, the new innovations of ABB and M-real are combined."

The Direct Drive

In the Direct Drive, the motor is directly coupled to the paper machine section with a conventional low speed coupling. The hardware of the converters is the same as for conventional AC drives, and both air-cooled and water-cooled designs are available. The drive control system, application software, and man-machine control are similar for all ABB drive solutions for paper machines. The new drive can therefore be used in parallel with other ABB drive solutions and old ACS 600 converters can easily be upgraded to the new system.

The new drive runs well in parallel with existing AC or DC drives. Rebuilding a conventional ABB AC paper machine drive to a Direct Drive requires new motors for the direct driven sections and the upload of new software into conventional ABB converters.

Tachometers for motor speed feedback have proved to be generally reliable. However, they need regular preventive maintenance because of their permanently greased bearings. On a 50-section paper machine, all tachometers need replacing at certain intervals to prevent unexpected shutdowns. Tachometer-free operation was therefore one target in the development of the Direct Drive.

New Motor Design

The geared motor speeds are normally about 1,500 rpm to 1,800 rpm on a conventional paper machine drive. The indrive speeds needed for the paper machine are set by selecting an appropriate gear ratio. The corresponding motor speeds with a direct drive would vary from 300 rpm to 600 rpm. Using a conventional induction motor for these speeds, the motor frame would need to be at least twice the size as that for a 1,500 rpm motor. This is clearly neither practical nor cost efficient, and this is one reason why the new type of motor has been developed. In this motor, permanent magnets in reshaped slots replace the squirrel cage conductors of an induction motor.

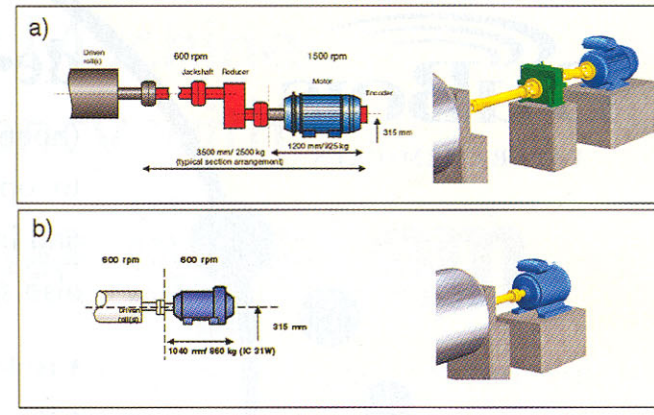


Figure 1. Drive configurations with: a) conventional induction motor drive, gear and jackshaft; and b) remarkable weight reduction with the Direct Drive.

In the rotor design, special attention has been paid to minimizing torque harmonics to obtain the smooth running characteristics needed in paper machine applications. Since the rotor is practically loss-less, the motor can be designed for higher output power and even higher stator loss dissipation can be allowed. The active, torque producing part of the stator current can also be increased since almost no magnetizing current component is needed as the magnetizing flux is produced by the permanent magnets in the rotor. A further increase in loadability can be achieved by using water cooling for the stator where almost all losses are produced.

The stator winding is basically the same as the winding for an induction motor, but as already stated, the current loading can be considerably higher. This enables the new reduced-size motor to meet the requirements of a direct drive.

Figure 1 shows the size and weight of a conventional drive including gear and shafting and the new Direct Drive. Guards for rotating parts and other auxiliary equipment are not shown. Improvements of the new motor include almost unity power factor and high efficiency, especially when output and speed are reduced. This is of interest in paper machines where motors for many sections are sized according to the starting power requirements and the design speed is achieved only after years of operation. ■

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