

# The FlexoDirect – the Fast Driving Solution

## Progress Report Packaging Plant Delkeskamp

Recurring problems with the existing closed gear wheel drive triggered the rebuild at Delkeskamp Verpackungswerke GmbH (Nortrup, Germany). Damages on the intermediate gears, difficulties in the procurement of suitable spare parts and the permanent stress on employees and machine due to noise and vibration led to the decision to fundamentally improve the drive and to increase the availability. For this reason, Delkeskamp contacted AS Drives & Services GmbH (Reken, Germany) to find a short-term and sustainable drive solution.

### The old drive system

In 2011 time was pressing when AS received the first call from Delkeskamp. The post dryer group of the PM1 in Nortrup could only withstand the necessary production speed of 1.100 m/min with the last ounce of strength. Damages at the intermediate gears and bearing points of the existing drive system became increasingly harsh. The original manufacturer of the gear wheels already disappeared which leads to procurement problems of the gear wheels. Therefore, Delkeskamp spent some time looking for a reliable and sustainable drive solution for the future. General characteristic of the closed gear wheel drive is that the input of drive power occurs centrally at one intermediate gear.

The power is provided by a combination of motor and pre-gearbox, which are installed outside the dryer group. Depending on the version, twelve cylinders and more in one dryer group can be connected in one drive train. All cylinders are form-lock connected to each other via the intermediate gear wheels. Because of this configuration a constant drive speed for all dryers was achieved (Fig. 1, 2, 3).

Due to the form-lock connection of all dryers, the mechanical parts are subject to tremendous loads. Especially considering the different cylinder temperatures and normal wear of the cylinder surfaces, different peripheral speeds occur. Due to the forced form-locking drive speed, the felt, and the paper web mechanically overdetermined the system, so that resulting tensions, which occur gradually, destroy the drive. This mechanism takes place between the upper and the lower felt as well as within the felt section and can be absorbed via slipping on the paper web. Increased production speeds and aging felt accelerating the wear process.



Fig. 1: Standard motor with pre-gear and console outside of the hood



Fig. 2: Old gear wheel housing

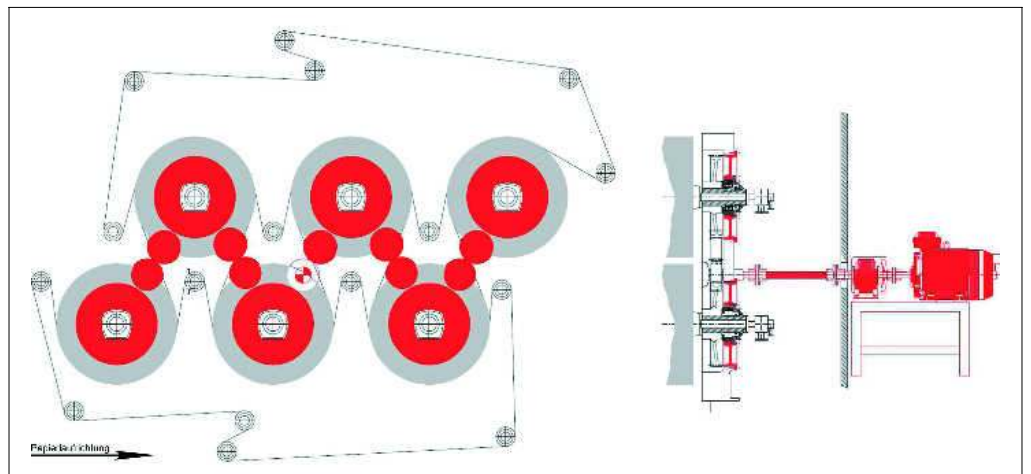


Fig. 3: Drive layout of the gear wheel housing of the fourth dryer group

## The solution concept

For more than 15 years AS Drives & Services GmbH has been offering rebuilds to increase efficiency and to improve the performance. The FlexoGear®, which has been introduced in 1997, has been installed more than 400 times successfully in dryer groups. Based on this experience AS developed a direct motor solution called FlexoDirect.

The FlexoDirect is the only drive solution that allows the installation of a steam head together with the motor on the drive side. This direct drive as well as the peripherals required for operation of the machine, consisting of a heating and cooling aggregate (Cooliflex®) and the inverter (FlexoDynamic) was developed and produced by AS.

They are especially designed to fit the quality requirements of the paper industry (Fig. 4, 5, 6).

In 2009 during the ZELLCHEMING exhibition, the latest generation of this high compact dryer group drive was presented to an exclusive selected audience. Christian Austermühle (operations manager paper at Delkeskamp) and Andreas Gövert (deputy master electrician at Delkeskamp) were among the first to hear about the FlexoDirect System. Two years later, they have visited the plant in Reken to find a solution concept for the problems of the existing closed gear wheel drive. Delkeskamp chose the FlexoDirect and Christian Austermühle justified the choice as follows: "As we have decided to rebuild the machine, we want to install the latest drive technology to improve our production sustainably." In contrast to closed gear wheels, the FlexoDirect drives only individual cylinders of the felt group.

At Delkeskamp two FlexoDirect drives are sufficient for each dryer group to keep the machine at a speed of 1.200 m/min without any tensions.

## The rebuild

The workflow plan for the rebuild was developed in co-operation with Delkeskamp and AS and the decision was made to rebuild initially the fourth post dryer group with the two new FlexoDirect drives.

The Cooliflex® was already designed for eight motors so that it allows later on the rebuild of the whole post dryer group (no. 1–4) in the future. In the summer of 2011, just ten weeks after the meeting at AS, the rebuild of the dryer group 4 took place. To dismount the existing intermediate gears wheel the cover of the paper machine frame was opened.

Once opening the cover of the machine frame it became immediately clear how critical the situation really was. "The closed gear wheels and the driving wheels were nearly completely destroyed" Andreas Gövert remembers. After disassembling the intermediate wheels, the old drive, the pre-gearbox, and the drive shaft were removed.



Fig. 4: The FlexoDirect and steam head

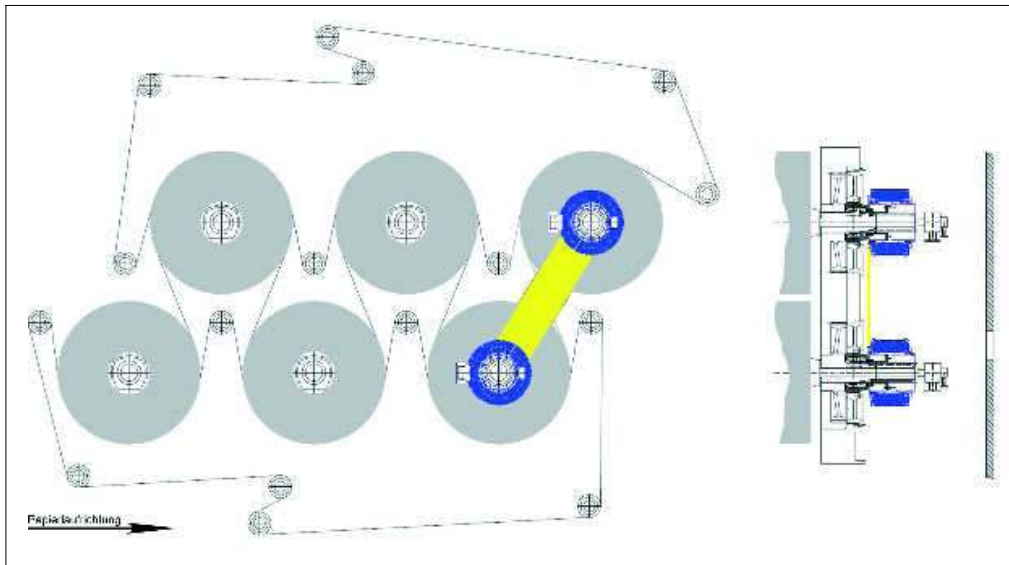


Fig. 5: The cooling and heating aggregate Cooliflex®



Fig. 6: View inside the cabinet with the frequency converter FlexoDynamic





**Fig. 7: Drive layout with FlexoDirect. Significantly reduction of mechanical drive parts, which are all inside the hood right now**

Subsequently, AS installed two FlexoDirect (hollow shaft motors) with 3.350 Nm each (nominal torque) and two inverter (FlexoDynamic) within three days.

The Cooliflex® had already been installed one week in advance. The closed gear wheel frame remained nearly unchanged for the connection of the FlexoDirect. Only the bearing covers of the cylinders were modified slightly. The feedthrough of steam and condensate through the steam joint and the existing siphon to drain the condensate remain unchanged. The mechanical connection of the steam heads was taken over by the FlexoDirect.

In the final step of the rebuild, the connection of the FlexoDynamic to the PC S7-System was effected via Profibus. Normal operation started without any problems after a successful installation of the components.

### The advantages of the new drive

When comparing the closed gear wheel drive with the new FlexoDirect system after the rebuild, it is apparent that there are less mechanical components now. In total, 22 lubrication points were eliminated when the drive and intermediate wheels were dismantled.

Therefore, the need for lubricant as well as the friction is reduced. Furthermore, the FlexoDirect, as a synchronous motor, has excellent efficiency in the rated range as well as in partial load. No other system offers similar overall efficiency (Fig. 7).

A motor with foundation and frame, a pre-gearbox, as well as a drive shaft via the dryer hood are no longer needed. The space requirement for the FlexoDirect is minimal and could be achieved with consistent application-oriented research and development of that technology.

“The ambient temperatures in a dryer hood can easily exceed 120 °C and the temperature of a cylinder journal can reach 180 °C. A motor has to resist these temperatures for a long time,” indicates André Jagodowski, leading development engineer at AS, who put the system at Delkeskamp into operation.

The steam supply and drainage of accumulating condensate can be realised in conventional manner. The steam joint is fixed via a bracket on the FlexoDirect instead on cover of the dryer bearing. This is the unique advantage of the FlexoDirect, which enables the installation on the tender side as well as on the drive side against conventional solutions.



**Fig. 8: Coupling of two FlexoDirect via patented torque support**

The tender side should have free access for the papermaker without obstacles such as steam joint or a motor.

The FlexoDirect is also characterized by an analogy to the well-proven gearbox concept (FlexoGear®) as two motors can be connected via the patented torque support.

The torque is absorbed between the neighbouring drives and not via the frame of the paper machine. Consequently, the FlexoDirect is vibration and stress-free due to its smooth run (Fig. 8).

To summarize, the following statements characterize the FlexoDirect: As it drives the dryer cylinder directly at the drive side, it combines nearly all the advantages of conventional drive solutions:

- Free access to the dryer group at the tender side
- Connection of the steam heads directly at the FlexoDirect
- Optimal speed quality and adjustment quality by connecting the masses directly
- Maximum efficiency by combining synchronous machines and waiving mechanical components
- No connection to the frame due to the use of the patented torque support
- Maximum security against slippage by driving the drying cylinders
- Reduction of the masses driven by the felt
- No need for high felt tension
- Insusceptible to contamination of the felt or the guide rolls.

### Pursuing rebuilding measures

After the successful start of the PM1 with the new drive system in the summer of 2011, it was clear that it would not take long until the second step of the rebuild would be planned.

At the beginning of 2012, in the second step, the third post dryer group was rebuilt. A planned standstill of two days was enough for AS to dismount the old drive wheels and install two further FlexoDirect. Consequently, four FlexoDirect are now running in Nortrup.

Andreas Gövert commented the rebuild as follows: "The situation after the rebuild cannot be compared to the past. We are sure that due to the omission of the old mechanical drive components, good operational safety can be guaranteed. The control mode and operability of the FlexoDirect are excellent.

Furthermore, noise has been minimized due to the direct drive. The noises were like a "hammering" in the past and are now characterized by a smooth run. If smaller difficulties occurred after the initial start-up of the new drive system, AS was on site within only a few hours and resolved them. This was really good performance.

For the future, we can imagine equipping further dryer groups with the new AS drive technology to continuously improve our production and keep it at a high level. For example, we have smaller problems with sagging paper webs between the second and the third dryer group, which lead fluttering of the paper web. The good controllability of the motor would certainly resolve this problem."

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