

G. Kaspari, C. Höltervenhoff*

'Silent Drive'!

In 1989 the technical paper "silent dryer drive concept for paper machines" was published in the USA by Joseph G. Miller, Product Manager Drives of the Beloit Corporation. According to the American definition the term is split into two different processes: 'silent felt roll drive' and 'silent dryer drive'. If someone uses the term 'silent drive' today he usually means the 'silent felt roll drive' resp. the guide roller drive (Fig. 1).



Fig. 1: Practical example for a 'silent felt roll drive'

Within the last few years the 'silent felt roll drive' approach has fallen out of favour completely in Germany. Nevertheless these systems are still heavily utilized e. g. in Southern Europe. This is due to the fact that local manufactures only have a good command of 'silent felt roll drive' systems, as at first glance it seems to be less expensive or the maintenance engineers can shift their problems to the production. In the past AS depended on the power ratings for projects. Due to that reason an engine builder was consulted about empirical 'specific earned values'. The existing power ratings could hardly have been checked according to their actuality (Fig. 2).

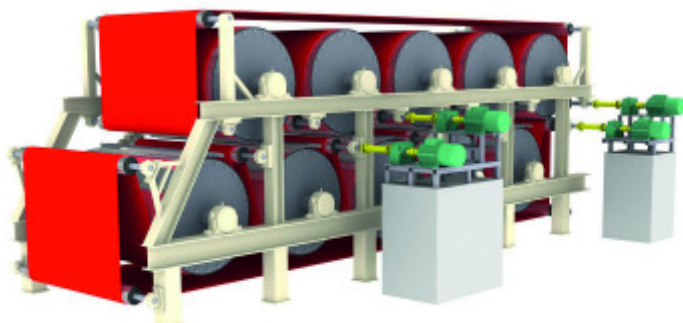


Fig. 2: Simplified exposition of one dryer group with silent felt roll drive, without exposition felt spanner

*Dipl.-Ing. Gerd Kaspari (g.kaspari@as-group.eu), Dipl.-Ing. Christian Höltervenhoff; Specialized lecture of AS Drives & Services GmbH, an enterprise of the AS Group, Industriestr. 17, 48734 Reken, Germany

As AS is always open to new technologies, they recognized complementary solutions for requirements in which 'silent dryer drive' concepts with gearboxes and/or motors would not be the first choice. AS wanted to know the truth: they developed a simulation model for multi-body systems!

The main objective of this model was to design a precise power transmission for the 'silent felt roll drive' as well as for the 'silent dryer drive' made by AS.

Different tensions of the felt and their effects on the drive system

In the first step the two 'silent drive' concepts had been compared head on. The basic idea was to collect kinematical processes. A calculation model was developed which can determine the necessary power of a dryer group independently of the power input.

The number of dryer cylinders and guide rollers does not play a decisive role in the flexible calculation model of AS. The model can be adjusted individually according to every dryer group.

It does not matter if it is a 'silent felt roll drive' or a 'silent dryer drive': the drive always depends on the felt tension, the enlacement of the felt, the surface friction between the felt and the cylinder as well as the surface friction between the felt and the roller and the cylinder itself resp. the diameter of the guide roller. The necessary tension of the felt as modifiable size and the resulting torque which is submitted to the machine in the form of input power are brought into focus. The remaining influencing factors are integrated in the calculation. In the calculation model they are constant and can be adjusted according to the customers' requirements.

To achieve comparable results, the delivery of torque in Nm was calculated in dependence of the felt pretension at the starting of the machine. The transmissible torque for each drive guide roller resp. each drive cylinder had been considered (see Diagram 1).

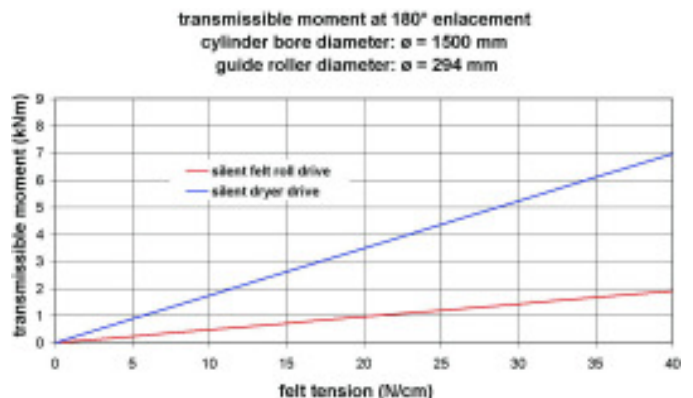


Diagram 1: Comparison of the 'silent drives'

The diagram shows the results of the comparison of 'silent felt roll drive' and 'silent dryer drive'.

As partial result it can be seen that there is a considerable difference in the incline of both straight lines. Out of this two important conclusions are clear: If you expect a pretension of the felt of 25 N/cm it becomes

apparent that the transmissible torque of the 'silent dryer drive' is multiple times higher than the 'silent felt roll drive'.

A decisive factor for the operator of the machine is not a predetermined pretension of the felt. He is interested in making sure that the necessary torque will be applied to his machine. If you want to achieve a certain torque with a guide roller, as with the 'silent dryer drive', you have to increase the pretension of the felt or the number of the guide rollers which are driven. Both possibilities have disadvantages. Due to a higher tension of the felt, the surface pressure from the paper web to the dryer cylinder will be increased as well. This can lead to jamming or combustion of the paper/board web as well as increased wear of the felt. Furthermore a higher tension of the felt at the 'silent felt roll drive' often leads to a deflection of the guide drive rollers. The effects of a sagging drive roller should not be overlooked. During the rotation of the roller the enlaced felt wears more to the outer border than to the middle. If the force of the felt arrives at the dryer cylinder which is carried along in consequence, the difference in force will be transferred in the same way to the paper web which is in between (*Diagram 2*).

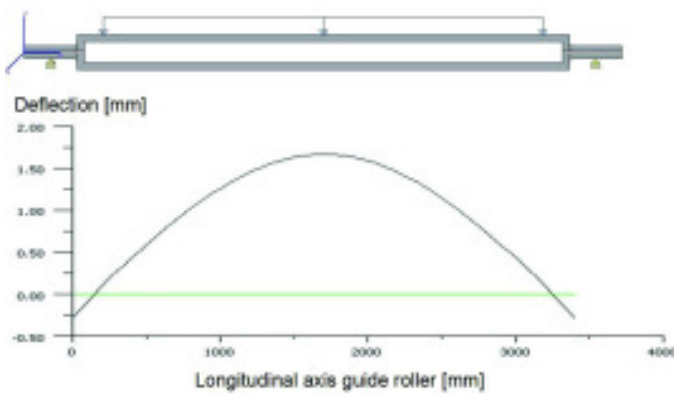


Diagram 2: Deflection from a guide roller

The paper web tends to stretch in the border area more than in the middle. This unintended effect reduces the paper quality and leads to different thicknesses of the width of the paper web. Due to the deflection, the loading of the guide roller bearings increases as well. Especially for bearing types which react even if there is a slight inclination, damages can result even after a short time frame (creation of pitting). In the worst case the guide roller bearings including the whole guide roller have to be replaced.

On the other hand the contact pressure which tends to be low in the 'silent dryer drive' concept has a positive effect on the wear of the felt and therefore on the repair and maintenance expenses. Normally a modification of the pretension of the felt is a limited possibility. To stay in the optimal technical and operating parameters it is necessary to divide the torque between additional drives.

Determination of the perfect drive

In addition to the previous outlined data the model has been extended. The question was: How to find the best position for the drive within a dryer group?

The existing felt forces at different places in the dryer group had to be analysed. The observation of the different felt runs showed that the 'silent dryer drive' is possible nearly everywhere. The 'silent felt roll drive' cannot be installed in dryer groups with a common slalom felt

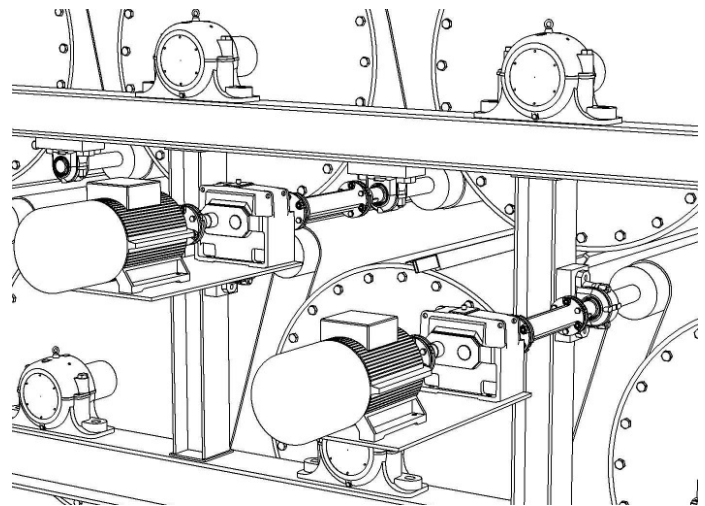


Fig. 3: Dryer group with 'silent felt roll drive'

run as there are insufficient guide rollers. Reason: The small amount of possible guide rollers offers an insufficient contribution of torque (*Fig. 3*).

For the simulation a dryer group with 10 cylinders in the upper and lower felt run, in which either a 'silent dryer drive' or a 'silent felt roll drive' could be installed, was utilized. The model was accelerated within 25 sec to 100 m/min. The different forces were examined. Different divisions of the drive led partially to a critical increase of the forces in the felt. Increased paper web tensions resulted. The driving power of the 'silent dryer drive' in the felt is less when starting the machine. The reason is that the massive dryer cylinders which are driven directly do not have to be carried along via the felt. The effective mass which is driven via the felt is 40 % less than in the 'guide roller drive'.

The problem which is known by in the industry as "to be flooded" can be handled in a better way with 'silent dryer drive'. In this situation, which occurs normally after a longer standstill, the dryer cylinder contains increased condensate in the sump. In spite of the increased additional mass the heavy cylinder can be turned easier. In the 'silent felt roll drive' concept the guide rollers may slide as the cylinder drive is completely carried along (*Figs. 4 and 5*).

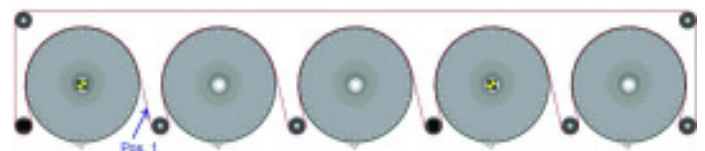


Fig. 4: Upper felt of the model dryer group with 'silent dryer drive'

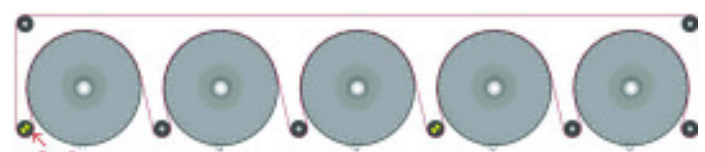


Fig. 5: Lower felt of the model dryer group with 'silent felt roll drive' (att. both schemes without exposition the felt spanner)

The following drawing (*Diagram 3*) shows the arising forces (Y-axis) of the felt. The X-axis describes the time response. When starting the machine the higher forces via the guide rollers (Pos. 2) can be seen.

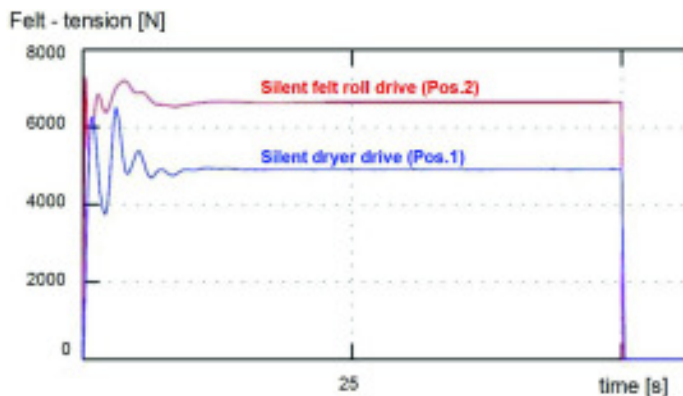


Diagram 3 shows the negative effect: The felt tension is much higher with silent felt roll drive compared to silent dryer drive

The optimal drive solution

The result of the analysis shows that the 'silent dryer drive' is usually the better drive. But this does not take into account that there are paper machines in which the drive via guide rollers can make sense. Nevertheless the following points of the 'silent felt roll drive' should be considered:

- Higher investment costs for electric motors, drive control and drive regulation
- Very high contamination of the guide rollers in the case of recovered paper
 - Slip at the guide roller
- In case of double-felted dryer groups no force-fit connection between the upper and the lower dryer cylinders
 - Danger of speed differences and tears
- A higher tension of the felt often requires new dryer guide rollers
- The pivot often does not exist or is too short
 - Rebuild or change of the guide rollers is necessary
- Problems due to an accumulation of heavy paper or board
 - Turning back can be difficult or impossible!

In the sector of 'silent dryer drive' AS can offer two systems:

1. The FlexoGearSystem®

AS Group successfully completed many projects in the category 'silent dryer drive' by mounting the special gearbox FlexoGear® in different combinations such as single, duo, triple or quattro version for the drive of the cylinders. The guide rollers and the cylinders which are not driven are carried along by the felt.

Fig. 6 shows a FlexoGearSystem® in the duo version.

The special gearbox FlexoGear® is simply attached on the pivot of the cylinder and is fixed with the help of a shrink disc. Driven via a motor, the FlexoGear® transfers the necessary torque to the machine. Furthermore FlexoGear® can be installed on the following dryer cylinders so that the tension of the felt can stay low. More cylinders are driven to increase the friction. If four gearboxes are connected via torque support, you will only need one motor and one frequency converter for each dryer group.

The connection of the two gearboxes in Fig. 6 via torque support can easily be seen (blue plate). An advantage of this system is that the force will not be transferred to the framing. In this example the drive will be flanged to the lower gearbox. The power will be transferred via a shaft to the upper FlexoGear®. There will be less stress on the guide rollers as there is less tension of the felt.

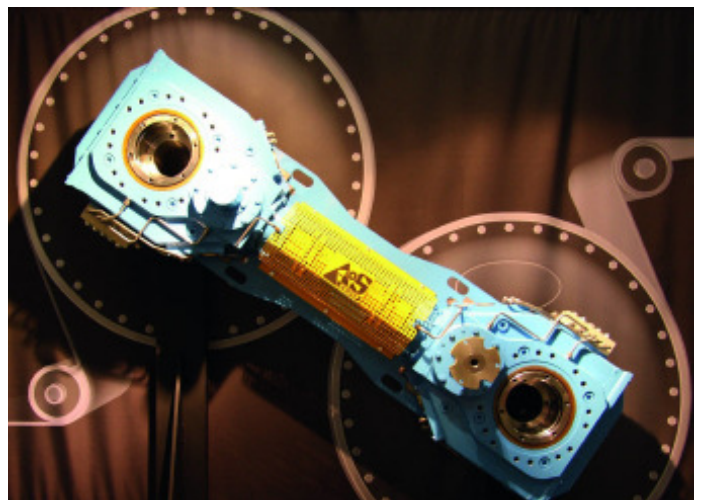


Fig. 6: FlexoGearSystem® in the duo version

2. The FlexoDrive® System

Fig. 7 illustrates the FlexoDrive®.

The FlexoDrive® is a completely new hollow shaft direct motor which can be installed either on the driving or on the operating side.



Fig. 7: Illustration of the FlexoDrive®

In the FlexoDrive®System two FlexoDrive® support each other. Increased torque will not be transferred to the framing and therefore vibrations or tensions from the framing will not have a negative impact on the motors.

Compared to others, AS does not rely only on the guide roller drive concept.

Furthermore AS is not in need of buying technologies in the sector of drive technology or lubrication technology, because AS develops and manufactures all of these products independently. There is no information gap in the supplier chain. Everything comes from one hand – AS.

With AS the customer receives the optimal engineered solution he needs for his machine, not just the basic technology which others might offer.