

The Janus Concept - A Completely New Calendering Technology to Meet Future Market Requirements

Udo Gabbusch

Voith Sulzer Finishing GmbH, D-47803 Krefeld

ABSTRACT

At present, high-quality paper finishes are obtained by the exclusive use of supercalenders and softcalenders. Experience has shown that both calendering processes will not always be able to meet future requirements of increased efficiency combined with improved paper finish.

The answer to these challenges is the development of a new technology, a synergy of supercalender and softcalender called the "Janus Concept".

This paper outlines the rationale behind this new development as well as the technical characteristics providing for the successful online integration irrespective of production speed.

Laboratory results are included to demonstrate that the Janus Concept enables a high-quality SC finish even at PM or CM speeds.

RÉSUMÉ

Actuellement, le satinage du papier de haute qualité est exclusivement réalisé à l'aide de supercalandres et de softcalandres. L'expérience montre que ces deux méthodes de satinage ne pourront pas toujours satisfaire les critères futurs de rentabilité croissante en liaison avec une meilleure qualité du papier.

La réponse à ces défis est apportée par le développement d'une nouvelle technologie, une synergie réunissant la supercalandre et la softcalandre: le "Janus Concept".

Une vue d'ensemble faisant des principaux arguments de cette innovation et de ces caractéristiques techniques garantissent le succès de l'intégration en ligne (on-line) pour toutes les vitesses de production.

Sur la base de résultats de laboratoires, nous montrons que le Janus Concept permet d'obtenir un satinage de haute qualité même à la vitesse des machines à papier ou des coucheuses.

INTRODUCTION

At present, high-quality coated and uncoated printing paper is calendered exclusively by supercalenders and softcalenders. A comparison of the two procedures shows clear differences. While processing on the supercalender is mainly based on mechanical energy in the form of many nips and high compressive stress, the softcalender relies on thermal energy, i.e. very high temperatures, as

the number of nips and the compressive stress are much lower here.

Therefore, the successful use of the softcalender for woodfree coated papers and wood-containing LWC offset papers is mainly due to the fact that the coating formulation is specially adapted on a thermal reaction. However, the currently used surface temperatures of approx. 200 °C require an enormous amount of energy.

In the case of highly compressed papers such as LWC rotogravure papers as well as SC-A grades, comprehensive studies have shown that the high thermal energy required for the softcalender is not sufficient even with 4 nips to achieve printability similar to the supercalender at CM or PM speed (1).

On the other hand, unlike the softcalender, the supercalender cannot be integrated in the paper or coating machine.

The comparison shows that neither the supercalender nor the softcalender are able to meet future requirements of increased quality and maximum efficiency.

1. THE JANUS CONCEPT - TECHNOLOGICAL CHARACTERISTICS

The development of a completely new calendering concept was based on the need for online and offline installation for any conceivable production speed with a finish that would be comparable to or even better than the supercalender.

A completely new calendering concept was the only possible answer to these challenges. The new development is based on a concept that provides an optimum combination of the options and effects of the supercalender and the softcalender.

The new calendering concept was named after the two-faced ancient god Janus. While the first face symbolizes the comprehensive technical knowledge gained in the past, the second one stands for the new calendering era based on the total synergy of supercalender and softcalender.

The following table lists the demands made on the Janus Concept.

Table 1: Janus Concept - requirements

- | |
|---|
| <ul style="list-style-type: none">• Finish of all paper grades at high quality• Online and offline installation possible• High efficiency including less roll changes• Low space requirement without add. personnel• Low amount of energy to be installed• Less energy loss during operation• Minimization of two-sidedness• Wide load and temperature range |
|---|

Numerous analyses have shown to what extent the future requirements will be met from a technological point of view. The key statement of these studies is that the process parameters 'temperature' and 'number of nips' are

reduced to the amount that is absolutely required. That means, in comparison to the softcalender, the surface temperature is not 200 °C, but between 100-150 °C. The question as to whether the 11 nips of the supercalender can be renounced is answered by a study carried out for an LWC rotogravure paper grade, the results of which are shown in figure 1.

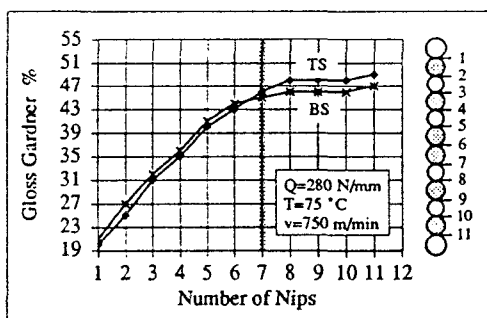


FIG. 1: LWC-rotogravure 48 g/m², development of gloss

It is quite obvious that, in principle, the gloss is already achieved after 6-7 nips. In production, the remaining nips merely level out the markings in the paper produced by damaged filled rolls.

Figure 2 shows the same trend as the previous illustration: With regard to densification, too, only minor changes occur after 6-7 nips.

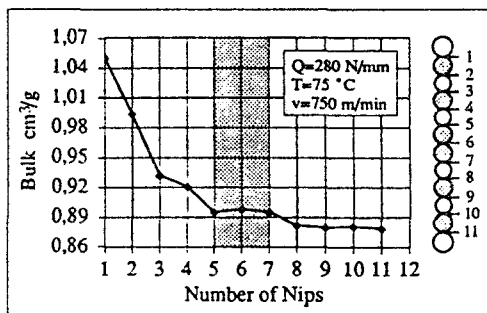


FIG. 2: LWC-rotogravure 48 g/m², development of bulk

This example, which also applies to other paper grades examined, shows why the Janus Concept uses only as many nips as necessary or a maximum of 8 nips, respectively, for calendering a certain paper grade. The lacking mechanical transformation energy resulting from the reduced number of nips is replaced by higher thermal energy supply and increased compressive stress in the remaining nips.

2. TECHNICAL CHARACTERISTICS

The example of a Janus Concept configuration consisting of a stack of 8 rolls for calendaring SC-A papers shown in figure 3 demonstrates the technical characteristics.

It also shows how the added performance of the Janus Concept in comparison to the supercalender is achieved.

In contrast to the supercalender process with an average roll surface temperature of 70 °C, the Janus Concept uses a higher thermal energy portion.

For this purpose, new, directly steam-heated intermediate rolls with a maximum surface temperature of 150 °C are used, with each roll having a separate heating circuit in order to minimize two-sidedness. The result is a clear reduction of operating costs, in particular if steam from existing networks of the paper mills can be used.

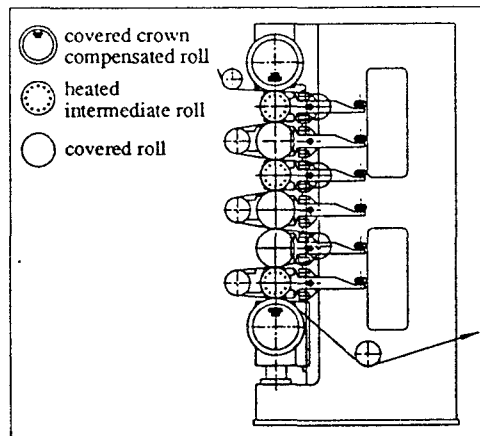


FIG. 3: JANUS CONCEPT - calender with 1x8 rolls

Thus, the temperatures required for the Janus Concept are higher than those required for the supercalender, however, they are much lower than those of the softcalender.

In comparison to a corresponding 4-nip softcalender, the energy required for the Janus Concept is up to 50 % lower. On the one hand, this is due to the substantially reduced roll diameters in comparison to the softcalender, thus reducing the heat lost to the environment, and on the other, it is due to the use of the thermal energy produced by one heating roll for two nips (2).

In addition, the special web guidance of the Janus Concept provides for energy dissipated by the roll to be absorbed by the paper web so that it is not lost.

Moreover, all heating rolls feature a newly developed SGD coating which is much smoother and harder than a chromium coating, so that in comparison to chromium coating, doctor operation is no problem at all, thus providing for a long life time and excellent surface quality.

In addition to the increase in thermal energy, the portion of mechanical transformation energy had to be adapted to the new concept, too.

In contrast to the softcalender, the Janus Concept works with smaller rolls, thus producing the high compressive stress required for calendering.

These elastic rolls represent a new generation of plastic covers which were developed over the past year almost simultaneously by several manufacturers.

The covers are characterized by high mechanical and thermal resistance even at nip frequencies of up to 25 Hz

The Janus Concept - A Completely New Calendering Technology to Meet Future Market Requirements

as well as low sensitivity to marking, providing for long life time.

A further distinctive feature of the Janus Concept is the consisted use of the functional units represented by the new generation of lever type calenders with compensation of overhanging loads which considerably improves the distribution of line load in the individual nips (3).

At a comparable line load in the bottom nip, clearly increased line loads can be achieved in those on top. The resulting steeper characteristic line of the line load provides for a clearly reduced line load difference between the top and the bottom nip so as to minimize two-sidedness. In addition, the calendering capacity is increased.

As online installation requires paper web feeding at full PM and CM speed, all rolls of the calender need to be driven continuously.

Extensive tests carried out for several years on a pilot plant exclusively designed for this purpose have shown that web feed can be realized successfully by combining aerodynamic elements with ropes and belts.

Another element of the modular Janus Concept is the crown compensated plastic roll in the top and bottom positions.

Figure 4 shows a variant of the Janus Concept: A calender with 2 independent stacks and 5 rolls.

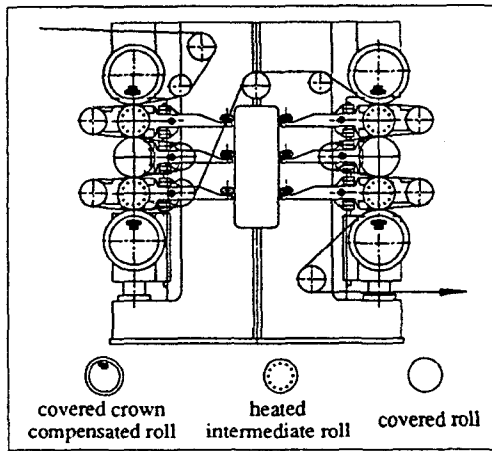


FIG. 4: JANUS CONCEPT - calender with 2x5 rolls

The benefit of this solution is e.g. the targeted influence on two-sidedness exerted by two individual stacks.

This version, too, has the same elements as the 8-roll variant. The selection of the optimum Janus variant depends on the calendering specified for the product. The following table sums up the characteristics of the Janus Concept.

In conclusion, it can be said that the Janus Concept is suitable for calendering almost all kinds of paper at PM or CM speed due to the high compressive stress available, the temperature range of up to 150 °C and the steep char-

acteristic line of the line load when 7 and 2x4 nips, respectively, or any other conceivable layout are used.

Table 2: Janus Concept - features

- High-speed open-nip threading system
- All rolls driven
- New generation of plastic covered rolls
- Midrange-heated intermediate rolls with new type of surface treatment
- Soft top and bottom roll
- Individual temperature control of all thermo-rolls
- Lever-type calender with overh. load compensation

3. CALENDERING OF LWC ROTOGRAVURE PAPER

The following is a presentation of the results for a European LWC roto gravure grade.

Figures 5 and 6 show that gloss as well as roughness of supercalendered standard paper is obtained using the Janus Concept at 1400 m/min and 140 °C surface temperature at a line load of 300 N/mm.

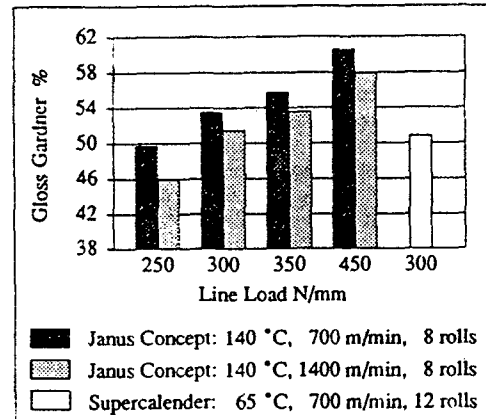


FIG. 5: LWC-ROTO 48 g/m², gloss vs. line load

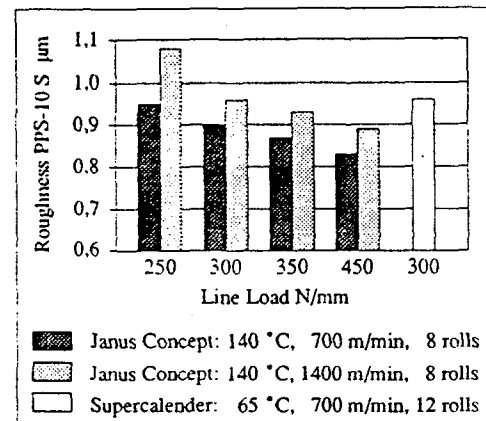


FIG. 6: LWC-ROTO 48 g/m², roughness vs. line load

Special attention should be paid to the bulk results obtained as shown in figure 7.

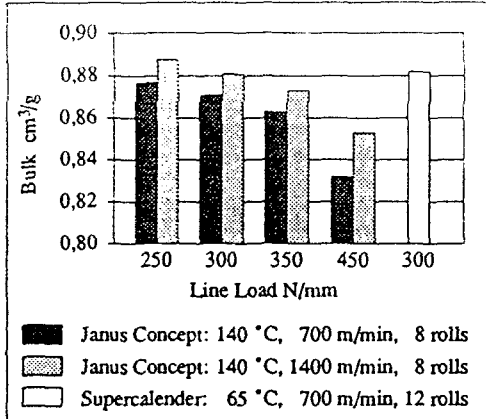


FIG. 7: LWC-rot 48 g/m², bulk vs. line load

Based on the speed of 1400 m/min, we see that the calendering conditions of the Janus Concept for the gloss and smoothness values of the supercalender also provide for a bulk value corresponding to the supercalender.

With regard to this issue, previous studies have shown that if comparable gloss and smoothness values are achieved at a comparable densification, printability is comparable, too. The rotogravure printing tests carried out in this regard confirm this finding. Neither the visual assessment nor the number of missing dots showed a difference to the supercalendered paper.

Figure 8 shows that the test sheet calendered according to the Janus Concept at 1400 m/min and a line load of 300 N/mm has a higher printgloss than the supercalendered paper.

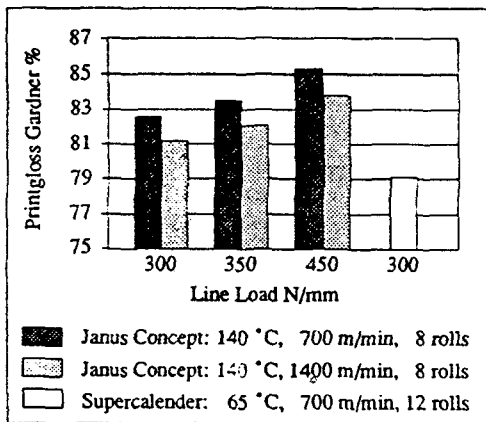


FIG. 8: LWC-rot 48 g/m², printgloss vs. line load

To sum it up, this test has shown: With only 7 nips, the Janus Concept provides for a printing result that is abso-

lutely comparable to the one of the supercalender even at double production speed.

4. CALENDERING OF WOODFREE COATED PAPER

The following is a presentation of the results for woodfree coated paper.

Figures 9 and 10 show that even at 1200 m/min with a line load of 300 N/mm and surface temperatures of 125 °C, an improved gloss and roughness level compared to the supercalender is obtained.

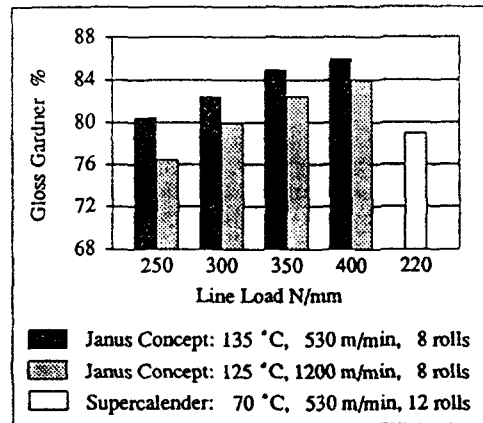


FIG. 9: Woodfree coated paper 135 g/m², gloss vs. line load

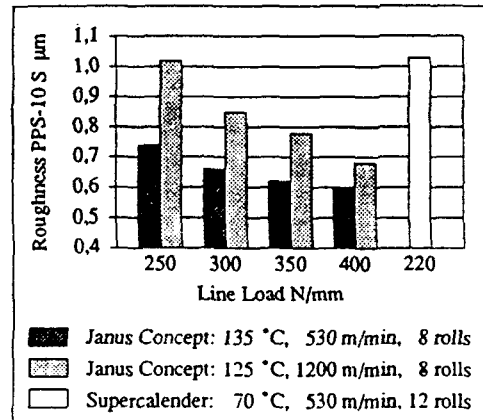


FIG. 10: Woodfree coated paper 135 g/m², roughness vs. line load

Brightness is of course another important feature for assessing the paper quality.

Figure 11 demonstrates that compared to the supercalender, the Janus Concept at 1200 m/min does not only provide improved gloss and roughness values, but that brightness is also increased by approx. 0.5 %.

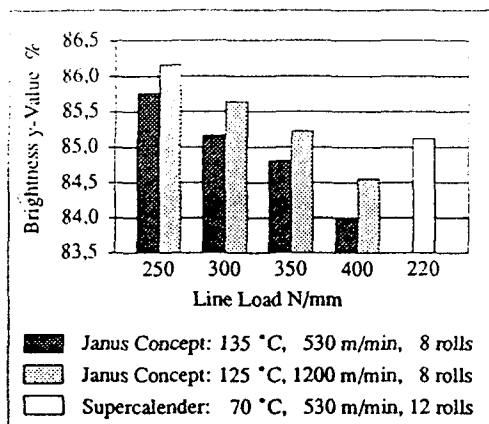


FIG. 11: W'free coated paper 135 g/m², gloss vs. line load

To sum it up, these results show: Calendering according to the Janus Concept at nearly twice the production speed does not only produce gloss results comparable to the supercalender, but is also beneficial to smoothness and brightness.

5. INFLUENCE OF THE JANUS CONCEPT ON BLACKENING

An important criterion especially with regard to SC-A papers is the so-called blackening produced by high densification.

With the aid of a newly developed image analysis system, it was possible to measure blackening and establish an index in which the larger number shows the percentage of increased blackening, as demonstrated in figure 12.

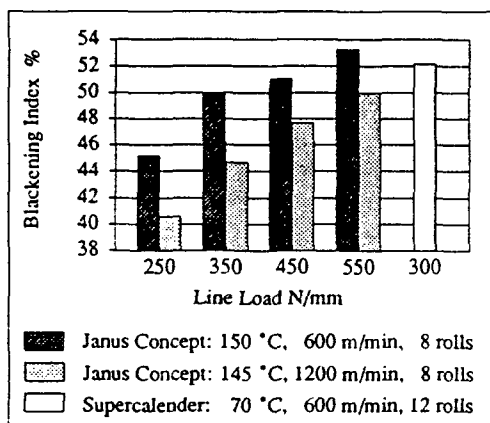


FIG. 12: SC-A grade 56 g/m², blackening index vs. line load

Based on a comparable printability achieved by the Janus Concept at a line load of 450 N/mm and a surface temperature of 145 °C, the test sheets showed less blackening than the supercalendered ones.

CONCLUSION

The studies discussed here impressively illustrate the enormous potential of the Janus Concept. They show clearly that the goal of "supercalender quality" at CM and PM speed can be met fully, in a highly efficient way and at reduced energy consumption.

The concept modules presented here are a prerequisite for the reduction of the production parameters 'temperature', 'line load', and 'number of nips' to the amount that is absolutely required.

REFERENCES

- (1) Rothfuss, U.
Inline- und Offline-Satinage von holzhaltigen, tiefdruckfähigen Naturpapieren. Wochenblatt für Papierfabrikation 121 (1993), Nr. 11/12, 457-466
- (2) Gabbusch, U., Rothfuss, U.
Alternative Calendering Technologies—Effect of Geometry and Number of Nips on Calendering Results. ECOPAPERTECH Conference, Helsinki 1995
- (3) Bresser, H., Kayser, F.
SNC—Der Supercalender der 90er Jahre. Das Papier 43 (1989), Heft 10 A, 169-182