

# Online Soft-Nip Calendering on Off Machine Coater

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## ABSTRACT

Online Soft-nip Calendering (SNC) was studied on plant scale using one side coated paper (CIS) and compared with normal off machine supercalendered coated paper. An extensive study was carried out on optical and surface properties employing different calender roll temperatures during coating operation.

Gloss and smoothness were easily developed on on-line coater. In general, the gloss and smoothness of the on-line hot soft-nip calendered sheets were comparable to that of supercalendered sheets with an added advantage of better brightness and bulk. Results show that Soft-nip calendering is an alternative to traditional supercalendering finishing.

## INTRODUCTION

Soft-nip calendering (SNC) in '60s and 70s' was known as gloss-calendering and sometimes as thermo planishing. It is a method of finishing coated paper or paper board in line with the coating and drying processes. In sequence, the web is coated, dried to optimum moisture content and finished by hot thermal calendering in one or two -nip thermo finisher. Various degree of gloss may be achieved by employing the technique without compromising in bulk. Ink hold out ink set time may be controlled by adjusting both the coating formulation and the thermal finishing intensity. Soft-nip calendering has a number of advantages over both machine and supercalendering. The more important advantages are :

1. Installation can occur both on and off the paper machine.
2. Less capital investment.
3. Less operational cost than a supercalender.
4. Fewer operating problems
5. Less bulk reduction
6. Performs on both coated and uncoated papers.
7. Higher strength retention, brightness and opacity
8. Equal gloss and smoothness (PPS) and
9. Better subsequent web converting characteristics.

Soft-nip calender in its simplest form consists of a smooth highly, polished, hot roll or molding drum and a resilient pressure roll which form a nip loaded by a suitable system. The hot roll may be chromo plated or juts ground to a very smooth surface finish and is heated by steam, oil or other controllable means to temperature

ranging from 90 to 300°C. The pressure roll may be either a plastic - or rubber covered internally cooled roll or a conventional filled roll. The web is processed in such a way that it is pulled out of the finishing nip directly away from the hot roll surface so that there is less opportunity for the coating to adhere on the molding surface.

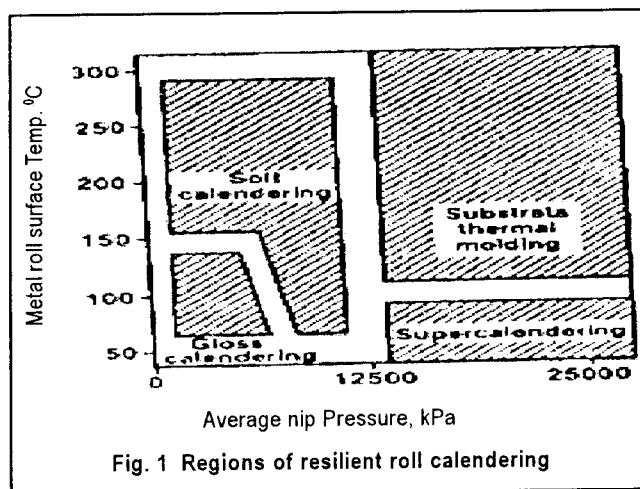


Fig. 1 Regions of resilient roll calendering

For comparison, the zone of operation defined for soft nip calendering is shown in Fig 1 together with the more traditional areas occupied by gloss calendering, super calendering and susbrata thermal molding.

In calendering operation, each of the rolls is stressed and are deformed as illustrated by Fig. 2. The work done generates heat inside the resilient cover at a point about 3-4 mm below the outer surface. Hence, supercalender filled rolls degrade and SNC pressure roll covering compounds are differentiated. This heat must be removed to prevent degradation of the cover. The chemical

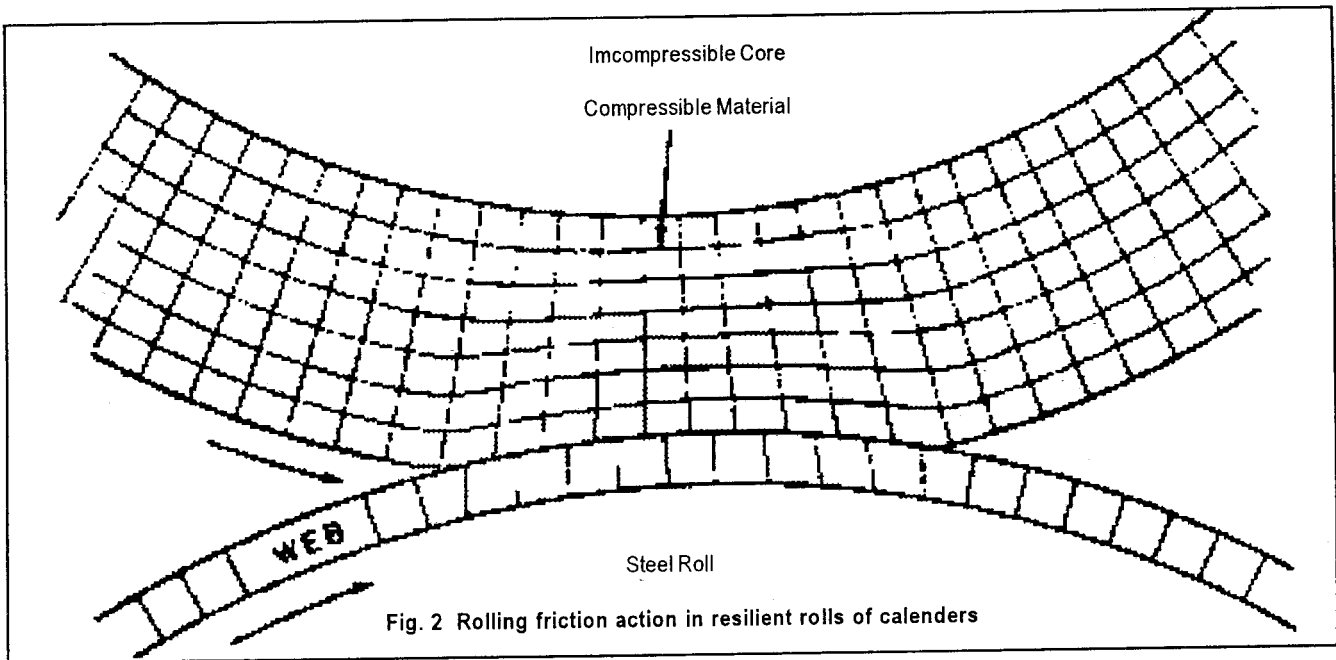


Fig. 2 Rolling friction action in resilient rolls of calenders

(Polymer) composition of the resilient roll is consequently very important and one of the most proprietary components of SNC technology.

#### Blade coater

The mill is having an off-machine blade coater with two coating stations, drying through gas infrared, air dryers and cylinder dryers, on-line QCS system for coat weight and moisture control and unique two nip soft-nip calendar. Soft-nip calendar, having top and bottom rubber covered (Type KR-2) swimming rolls, is fully auto temperature control and equipped with safety devices to avoid overheating of the rolls. The technical and operating parameters are included in Table 1.

Table 1 Technical Parameters for Soft-nip Calendar

No. of rolls	Three 1 Chilled iron roll, 2 Rubber covered roll
Finished dia of roll	420 mm
Core dia for covering	397 mm
Thickness of covering	11.5 mm
Face length	2650 mm
Covering material	KR-2
Hardness	90±, Shore 'D'
Max nip load	350 KN/M
Operating temp	120°C

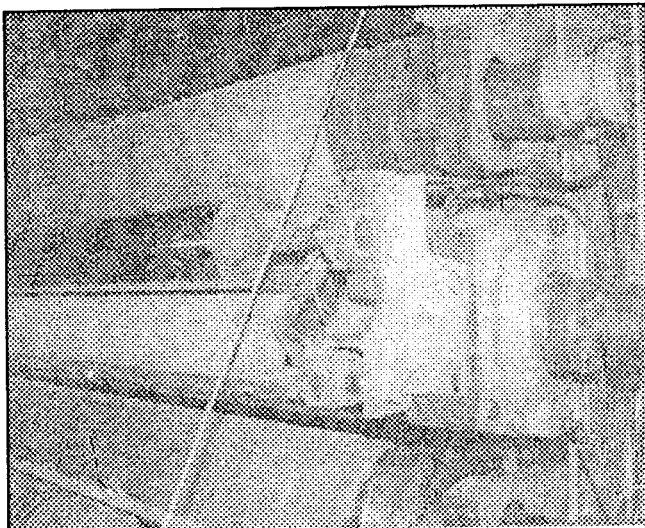


Fig. 3 Online Soft-nip calendar

#### Supercalender

Supercalender is having eleven nips with bottom swimming roll. It is having a stack of alternating chilled iron rolls and roll with resilient covers (cotton and wool) with hot water circulation arrangement for temperature control during supercalendering. Accessories devices such as quick separation, web sensors, tension control through load cells, web carrying and spreader roll have been provided for efficient and productive operation. To avoid one sided finishing action, a reverse nip, having two filled roll in contact, has been provided for contacting the other side of sheet to smooth chilled iron roll. The technical and operating parameters are included in Table 2.

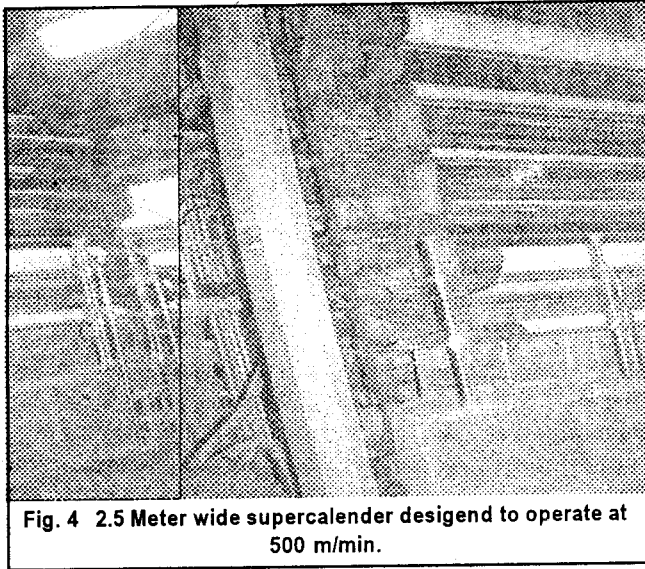


Fig. 4 2.5 Meter wide supercalender desigend to operate at 500 m/min.

## EXPERIMENTAL

The unique design of soft-nip calender and its salient features have given us the opportunity to study and establish online calendering of coated paper at various temperatures. The aim of this study was to examine the response of the trial paper on glos and smoothnes development through soft-nip calendering with an objective to bypass the conventional supercalendering operation. To study response of double coated CIS paper in respect to gloss, brightness, bulk and smoothness (PPS), following three trials have been planned.

### Trial-I

Calendering by on line two nips soft -nip calender at three different temperatures but at constant nip load.

Table 2 Technical Parameters for SuperCalender

No. of rolls	Twelve 6 Filled rolls, 6 Chilled iron rolls
Filled roll dia (Cotton + Wool)	460 mm
Swimming roll dia	406 mm
Chilled iron roll dia	350 mm
Hardness	85° Shore 'D'
Max Nip load	300 KN/M
Deckle	2.50 Meter
Maxm. Speed	500 m/min.
Operating Temp	80°C

### Trial-II

Calendering by offline nip supercalender at 220 KN/M nip load and temperature of 70°C.

### Trial-III

Calendering first by soft-nip calender followed by conventional supercalender at 200 KN/M nip load

The base paper for coating was used from our own paper machine having on-line QCs system for moisture, basis weight and ash control and equipped with Custer calender to impart uniform caliper in paper and superior surface properties. The paper was coated on off-machine coater.

Soft-nip calendering was carried out at three different temperatures i.e. 80,90 and 100°C keeping a constant nip load of 150 KN/M. Bulk, smoothness, brightness and gloss of coated paper (CIS, 90 gsm) under three different roll temperatures were determined. The coated paper (without

Table 3 A comparison of Soft-Nip Calendering and Supercalendering

Calender	No. of nips	Standard roll Temp (°C)	Gloss (75° Hunter) %	Smoothness (PPS) Microns	Bulk CC/GM	Brightness ISO, %
<b>CIS Art Paper, 90 gsm</b> Soft-nip Calender	2	80	66	1.14	0.99	88.8
	2	90	68	1.08	0.98	88.5
	2	100	70	1.06	0.96	88.4
Super Calender, Load 220 KN/M	11	70	75	0.78	0.91	87.8
<b>CIS Art Paper, 145 gsm</b> Soft-nip, Load-150 KN/M	2	80	65	1.18	1.13	88.5
	2	90	67	1.14	1.11	88.3
	2	100	68	1.12	1.10	88.1
Supercalender, Load 220 KN/M	11	70	74	0.90	0.98	87.3

**Table 3 A comparison of Soft-Nip Calendering and Supercalendering**

Calender	No. of nips	Standard roll Temp (°C)	Gloss (75° Hunter) %	Smoothness (PPS) Microns	Bulk CC/GM	Brightness ISO, %
<b>CIS Art Paper, 90 gsm</b>						
Soft-nip Calender 150 KN/M	2	100	68	1.09	0.99	88.6
Super Calender, Load 200 KN/M	11	70	85	0.65	0.91	86.7

soft nip calendering) was also calendered on 11 nip supercalender for comparison in regards to above properties. The study was also extended to CIS art paper, 145 gsm under similar operating conditions. The results obtained under different conditions are indicated in Table 3.

In another set of experiment, the soft-nip calendered paper was subjected to supercalendering at a loading of 200 KN/M temperature of 70°C. The coated CIS paper, 90 gsm was evaluated for bulk, smoothnes, brightnes and gloss before and after supercalendering. The results are included in Table 4. The moisture content in the paper was maintained in the range of 5-5.5% at final stage in all the trials.

## RESULTS AND DISCUSSION

### Trial-I

The gloss and smoothness (PPS) of soft-nip calendered paper (CIs, 90 gsm ) were 66%, 68%, 70% and 1.14, 1.08, 1.06 microns at roll temperature of 80,90 and 100°C respectively. The bulk and brightness were 0.99, 0.98, 0.96 cc/gm and 88.8%, 88.5%, 88.4% respectively. Similarly, the gloss and smoothness (PPS) of CIS art paper, 145 gsm were 65%, 67%, 68% and 1.18, 1.14, 1.12 microns respectively. With increase in temperature of the soft-nip calender roll, there was improvement in gloss and smoothness (PPS), however, there was marginal reduction in bulk and brightness of CIS art paper. CIS art paper of higher grammage possessed marginally lower gloss and smoothnes (PPS) as compared to lower grammage paper when processed under identical conditions.

### Trial-II

The gloss and smoothness (PPS) in supercalendered paper were 75% and 0.78 microns in CIS art paper 90 gsm and 74% and 0.90 microns in CIS art paper 145 gsm respectively. Supercalendered CIS art paper possessed marginally superior gloss and smoothness (PPS) when compared to soft-nip calendered CIS art paper. However, there is reduction in bulk and brightness.

### Trial-III

The bulk, smoothness (PPS), brightness and gloss of soft nip calendered paper were 0.99 cc/gm, 1.09 microns, 88.6% and 68% respectively. After supercalendering, these values were 0.91 cc/gm, 0.65 microns, 86.7% and 85% respectively. Soft-nip calendered paper when subjected to suercalendering improved the smoothness (PPS ) and gloss considerably. There was drop in brightness by approx. 2 points. There was also drop in bulk, it reduced to 0.91 from 0.99 cc/gm

## CONCLUSION

The blade coater is running successfully. Hot soft-nip calendering can produce comparable gloss and smoothness with higher bulk commonly associated with conventional supercalendered coated paper; Gloss and smoothness improve on increase in soft-nip calender roll temperture, however, there is marginal drop in bulk and brightness. A combination of soft-nip calendering and supercalendering may be utilized for high gloss paper segment with improved smoothness and bulk of the coated paper.

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## REFERENCES

1. Michael JK. Kocurek - Pulp and Paper manufacture Vol 7- Paper Machine Operation.
2. Jack A. Perry - Coating processes - Soft-nip calendering of coated paper and paper board.
3. Jon D Peel - supercalendering and Soft -nip calendering comparison, TAPPI, p. 179-186 (1991).
4. Barbara J Schultz - On line soft-nip calendering and supercalendering: Efect of coating formulation and operating variables, TAPPI p. 215-225 Feb. (1996)