Operational experience with the Hydra Nip press at White Pigeon Paper Company

Hung Ma and William G. Schmidt

Installation of a Hydra Nip press in the last dryer section of a boxboard machine improved sheet smoothness with no loss of bulk.

White Pigeon Paper Co., located in White Pigeon, Mich., is a manufacturer of clay coated recycled boxboard. The mill produces approximately 180 tons/day of boxboard utilizing a seven-cylinder Ultraformer, where the headboxes have been converted to seven Black Clawson Bristol projection slice headboxes.

The mill production is primarily directed to the sheetfed offset market. The mill desired to produce a smoother sheet without sacrificing bulk. To accomplish this, a rod coater was added to the machine. This made the sheet better, but the mill felt the smoothness of the sheet could be improved further.

Hydra Nip press

During the installation of a new dryer section, Black Clawson approached the mill with the idea of installing a Hydra Nip press in the dryer section. The Hydra Nip concept uses a rubber covered press roll which is loaded against a heated dryer shell located in the last dryer section.

The installation would require an extra-strength dryer shell, heavy-duty dryer bearings, and heavy-duty dryer bearing stands. Through limited application of water to the top liner followed by pressing against the reinforced dryer surface, it was expected that a smoother sheet with no bulk change could be produced.

The benefits projected—increased smoothness with no loss of bulk—met the mill objectives. Based on trial results* on the pilot plant Hydra Nip unit at the BC-K Research Centre in Watertown, N.Y., White Pigeon decided to include the Hydra Nip press in the design and layout of the new dryers. A Hydra Nip was installed in June 1987. This paper reviews the operational theory of the Hydra Nip as well as the impact of the unit on the physical properties of the sheet. Future changes to the unit will also be discussed.

Operating principle

The Hydra Nip unit at White Pigeon is located in the last dryer section in order to avoid densification of the sheet. It uses a combination of heated surface, soft nip, and sheet moisture gradient to provide smoothness and other surface improvements with a minimum loss of bulk. When used with the surface rewetting spray, the moisture gradients set up through the sheet prior to the nip makes the Hydra Nip unique. This Hydra Nip will not replace the calender stack, but will act as a prelude to it.

Since only the white top liner is treated, the Hydra Nip consists of a special heavy wall dryer, a pressure roll, and a moisture spray, as shown in **Fig. 1.** The dryer has the same diameter (60 in.) and surface finish as the others in the dryer section. Unlike calender rolls, the pressure roll used is rubber covered (15–20 P & J), providing a relatively soft nip. The pressure roll can be loaded pneumatically up to 150 pli and is water cooled. Since the maximum operating speed on this machine is relatively low (up to 500 ft/min), the pressure roll has no helper drive. In addition, its surface is kept clean by an oscillating doctor during operation.

A moisture gradient is set up through the sheet by spraying hot water in a controlled manner onto the surface of the top liner immediately before it is pressed against the heated dryer surface.

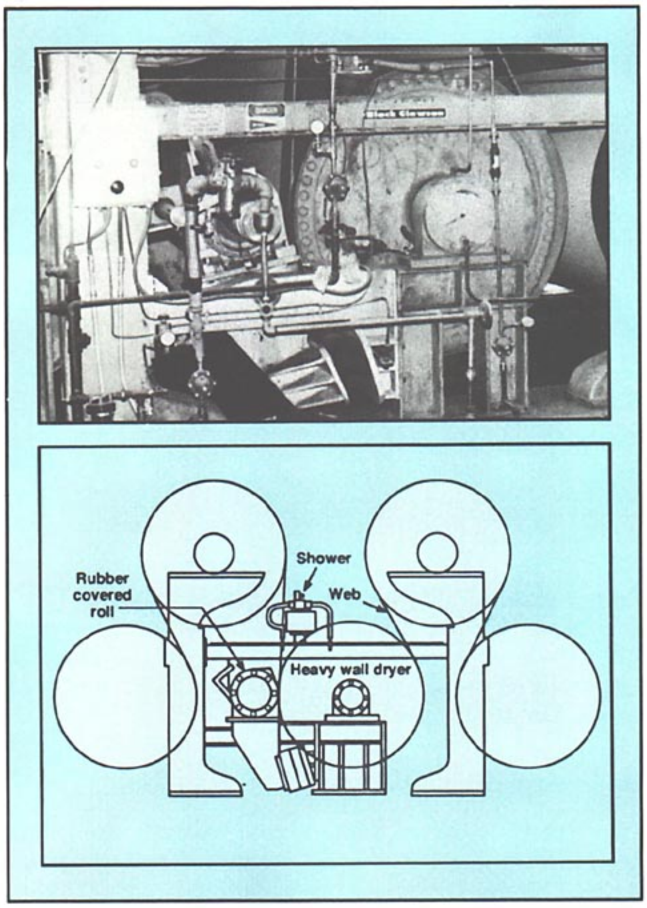
Results

In order to determine the impact of the Hydra Nip press on the bulk/smoothness relationship of the coated finished sheet, different water spray flow rates and nip pressure loadings were carried out during a 19-point production run at the mill. The water spray was found to have the

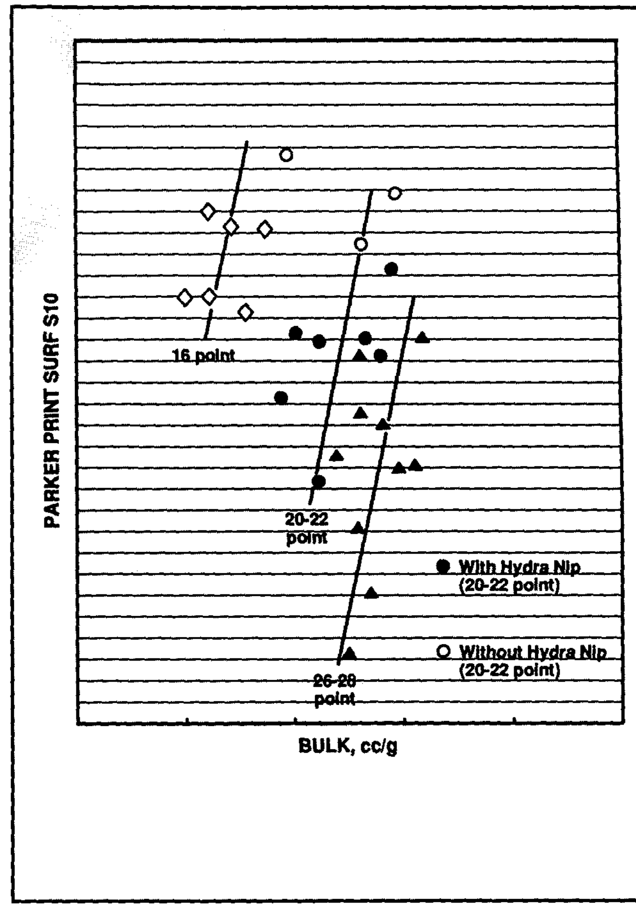
*Foulger, M., Tappi J. 71(09): 73(1988).

Ma is manager of technical services with Black Clawson-Kennedy Ltd., 3300 Cavendish Blvd., Suite 400, Montreal, Que., Canada H4B 2N1. Schmidt is vice president of White Pigeon Paper Co., P. O. Box 277, White Pigeon, Mich. 49099.

1. Hydra Nip press installed at White Pigeon (top) and diagram of operation (bottom)



2. Bulk/smoothness relationship for different boxboard grades



biggest impact on sheet smoothness, whereas nip loading had minimal effect on the sheet properties.

Effect of nip loading with the shower turned off

With the water spray turned off, the Hydra Nip press was loaded at different nip pressures varying from 0 pli to 95 pli. This operating mode was found to have a minimum effect on both sheet smoothness improvement and bulk loss. The optimum upper limit of the nip loading pressure appeared to be around 75 pli, as indicated in **Table I.**

A nip pressure range between 60-75 pli has been used in subsequent operation of the Hydra Nip press.

Effect of shower flow rates on the bulk/smoothness relationship

With the shower on, and with a roll loading of about 60 pli, a water flow rate of 4.7 gal/min (water 40 psi, air 50 psi) produced a bulk reduction of about 2.8%. A flow rate of 3.8 gal/min (water 30 psi, air 40 psi) resulted in a bulk reduction of about 1.8%. **Table II** summarizes these findings.

The gain in smoothness more than compensated for the loss of bulk. For example, up to 17.5% improvement in Parker Print Surf S10 (PPS) smoothness (4.03μm vs. 3.33μm) was obtained for a bulk loss of 2.8% at a water flow rate of 4.7 gal/min (water 40 psi, air 50 psi), as shown in Table II. **Figure 2** shows the impact of the Hydra Nip on the bulk/smoothness relationship for different grades of boxboard made at White Pigeon. The application of water spray to the top side of the sheet produced a very marked reduction in Parker Print Surf S10 smoothness, while bulk was largely preserved. In addition, the higher the spray application rate, the more effective was the smoothness improvement. The slope of this relationship also indicated that a reduction of 10% in PPS roughness corresponded to a reduction of about 1.5% in bulk. In other words, the Hydra Nip press can alter the bulk/smoothness relationship and therefore can be an effective sheet smoothing device.

This smoothness improvement differential with and without the Hydra Nip was also maintained across the machine, as shown in **Fig. 3.**

Comparison of smoothness monthly averages before and after Hydra Nip

Monthly averages of Parker Print Surf smoothness on various grades ranging from 17 point to 34 point before and after the installation of the Hydra Nip are summarized in **Table III** and graphically illustrated in **Fig. 4.** With the Hydra Nip, PPS smoothness of the finished coated sheet improved an average of 11% (3.15 "before" vs. 2.80 "after").

However, the smoothness improvement was not consistent, being only marginal on 18, 26, and 28 point. Further analysis of the results suggested that the sheet was already too dry when it entered the Hydra Nip. Subsequent sheet

I. Impact of Hydra Nip press loadings on smoothness bulk relationship (Grade: WCC newsbag, 77 lb, 19 points, Sept. 7, 1989)

Set #	Conditions	Roll pressure, psi/pli	Shower	Parker Print Surf S10	Smoothness improvement[a]	Bulk, cc/g	Bulk reduction
1	Nip Open	0	Off	2.96 ± 0.33	Base	1.281	Base
2	Nip Closed	40/56	Off	3.03 ± 0.30	-2.36%	1.284	+0.20%
3	Nip Closed	50/74	Off	2.91 ± 0.34	+1.72%	1.276	-0.38%
4	Nip Closed	60/94	Off	2.96 ± 0.28	0.0%	1.287	+0.47%

[a] + indicates a positive action
- indicates a negative action

II. Impact of Hydra Nip shower flow rates on the smoothness/bulk relationship (Grade: WCC newsbag, 77 lb, 19 points, Sept. 7, 1989)

Set #	Conditions	Water, psi	Air, psi	Water, gal/min	gal/1000 ft²	Parker Print Surf S10	Smoothness improvement	Bulk, cc/g	Bulk reduction
1	Nip open	Off	Off	0	0	4.03 ± 0.33	Base	1.308	Base
2	Nip closed	Off	Off	0	0	3.60 ± 0.29	+10.7%	1.277	-2.41%
3	Nip closed	55	42	5.0	1.13	3.75 ± 0.41	+ 7.0%	1.274	-2.60%
4	Nip closed	50	40	4.67	1.05	3.33 ± 0.29	-17.4%	1.269	-3.0%
5	Nip closed	40	30	3.80	0.86	3.60 ± 0.39	+10.7%	1.284	-1.83%
6	Nip closed	30	20	2.90	0.65	3.67 ± 0.21	+ 8.9%	1.301	-0.56%

III. Parker Print Surf S10 monthly averages (Jan.-Sept. 1989)

Caliper	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Avg. (no Hydra Nip)	Test period Sept. 1989 (with Hydra Nip)
18	3.2	3.3	3.4	3.0	3.1	2.9	3.5	2.8	3.15	3.0
20	3.1	3.5	3.5	3.1	3.0	3.2	3.3	3.2	3.24	2.85
22	2.8	3.6	3.2	3.0	3.4	2.8	3.2	3.0	3.12	2.80
24	3.0	3.2	3.3	2.8	3.0	2.8	3.0	3.1	3.04	2.60
26	3.3	3.0	3.4	3.0	3.0	3.0	3.2	3.2	3.14	2.90
28	3.0	...	3.5	3.0	3.4	2.7	3.1	2.9	3.08	2.90
30	3.2	3.5	3.2	3.1	3.1	...	3.6	2.9	3.20	2.80
34		4.0							4.0	2.50
							Avg.		3.15	2.80

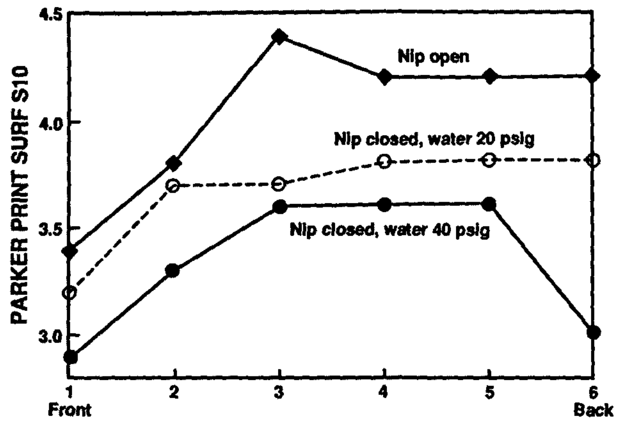
sampling on a 26-point grade at the Hydra Nip location showed that the sheet moisture was only 3%, too little for the spray shower to rewet the sheet surface layer to an adequate moisture and make it resilient again.

Optimum ingoing sheet moisture contact to Hydra Nip press

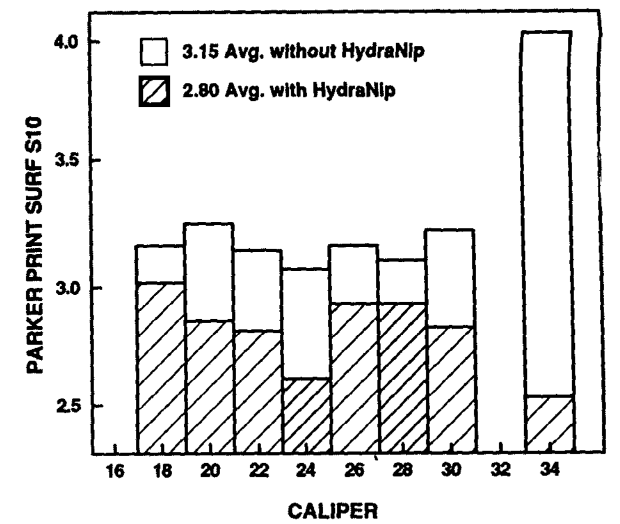
Based on these results, a trial was developed for the pilot plant Hydra Nip to determine the optimum moisture range for sheets entering the Hydra Nip.

The mill staff collected two sets of 18- and 26-point samples at a moisture of around 23–26% in the dryer section and sent the samples to the pilot plant for trial. The samples were conditioned to different moisture contents and then fed one by one into the Hydra Nip unit, which was set as close as possible to the operating speeds and conditions used at White Pigeon. In addition, certain samples at about 15% moisture content were fed a second

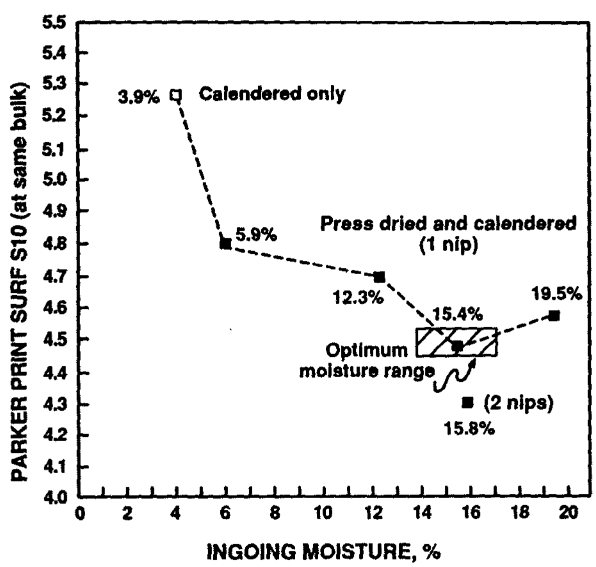
3. Cross direction smoothness profile for 19-point newsbag grade with and without Hydra Nip



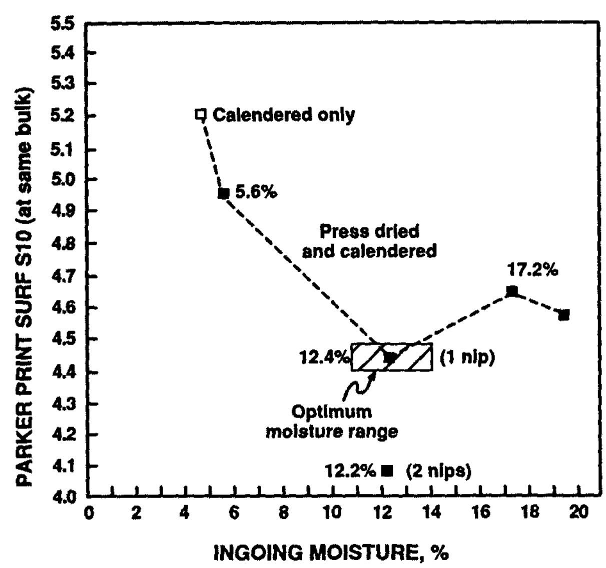
4. Bar diagram of Parker Print Surf roughness with and without Hydra Nip (by grades)



5. Optimum ingoing sheet moisture range into Hydra Nip (for 26 point)



6. Optimum ingoing sheet moisture range for 18 point



time through the Hydra Nip. After the samples had been air-dried under ambient temperature, they were calendered to different calipers and tested for Parker Print Surf smoothness.

Figures 5 and 6 show the PPS smoothness (for the same bulk) at different ingoing sheet moisture contents. The best ingoing moisture range for the 26-point grade for optimum smoothness development with no loss of bulk appeared to be between 13% and 17%, whereas for the 18-point grade, it seemed to be between 11% and 15%. Therefore, there is a moisture window of between 13% and 15% which will be optimum for both 18- and 26-point grades. It is interesting to note that trying to run at a higher moisture content (higher than 17–20%) did not provide better results.

In addition, running two nips appeared to be better than only one, especially if nip dwell time is the determining factor (relatively high machine speed).

Those results confirmed that the Hydra Nip at White Pigeon was not presently at the optimum location for smoothness development because the ingoing sheet moisture was found to be only at 3%. Therefore it was decided to move the Hydra Nip upstream.

Conclusion

The results showed that the Hydra Nip can be an effective smoothing device with a minimum loss of bulk for the boxboard grades such as the ones made at White Pigeon, providing it is at the right location in the dryer section. If operated correctly, an improvement in smoothness as high as 15–23% with no loss of bulk could be obtained with the Hydra Nip as compared to calendering alone.□

Received for review June 25, 1990.
Accepted July 5, 1990.