Innovative Steam Shower Technology on Pulp, Paper & Board Machines

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ABSTRACT

Production on many paper board machines is limited by the capacity of the drying section. The application of steam/showers to improve sheet dewatering reduces the specific drying requirments and permits a greater product throughput. Steam shower installations provide an attractive economic benefit, generating pre-tax ROI's of 3 - 9 months.

STEAM SHOWER PRINCIPLE

Increased dewatering on the Fourdrinier wire and press section is obtained by lowering the resistance to fluid flow. Steam showers apply steam to the sheet and the latent energy released in the condensing process heats both the water and the fibre. The added heat reduces the viscosity of the water thus lowering the resistance to fluid flow (Figure 1). The net affect is that a hotter and dryer sheet is present to the dryer section thus reducing the dryer demand (Figure 2).

A 2% increase in sheet dryness leaving the press section will result in reduction in drying load per ton (specific Drying)of approximately 8% (see sample calculations).This will be equal to a possible increase in speed on "dryer limited"machines.

The dryer, hotter sheet entering the dryer section

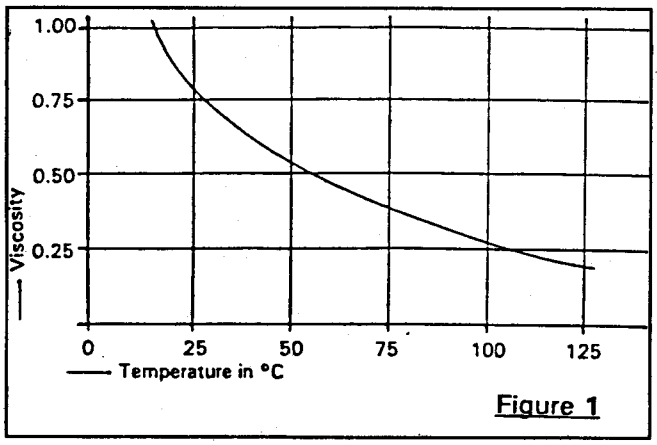

Figure 1

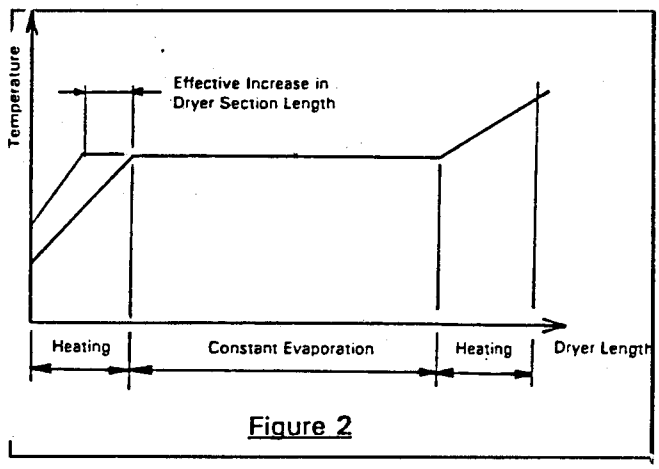

Figure 2

reduces the warm-up stage allowing evaporation to commence earlier. An approximate 1% increase in sheet dryness can be expected for an increase in sheet temperature of 10°C entering the dryers.

Machines which have to maintain the first dryer group at low pressures to avoid sheet "picking" can take advantage of the hotter and dryer sheet, the steam temperatures (pressures) can be increased, in this group, thus providing additional drying capacity.

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C.D. MOISTURE PROFILING

Selective application on steam in the cross machine direction (C.D.) can provide a useful means of controlling variations in C.D. moisture profile. Steam showers are designed with steam discharge screens divided into a number of C.D. compartments. Steam is released to each of the compartments by a valve system which is remotely controlled by the machine operator or machine computer.

Apart from the quality control aspect, which reduces culls, control of the C.D. moisture profile can lead to an increase in machine speeds. As the sheet dries below the 9% moisture level, evaporation becomes more difficult. In this part of the drying process, known as the "bound water zone", a greater amount of dryer surface area is required per unit amount of water removed.

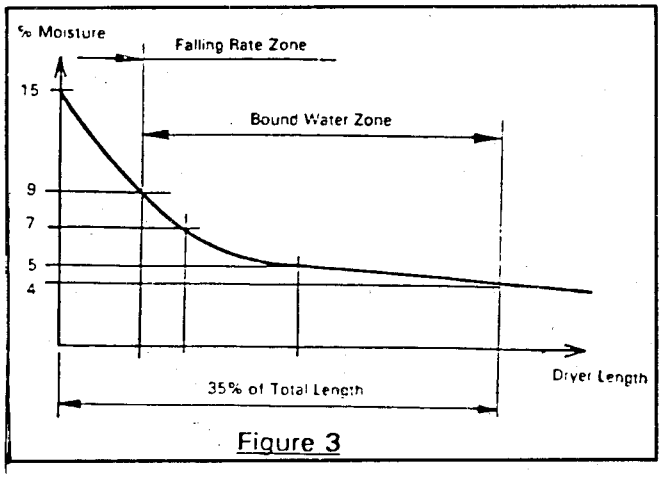


Figure 3

Unfortunately, the machine operators are forced to overdry the sheet in order to produce a uniform moisture profile. Figure 3 illustrates the length of dryer section required to dry the sheet down from 15% to 4% By correcting the C.D. moisture variations, sheet average moistures can be increased thus reducing the sheet dwell time in the "bound water zone". This increases the overall drying rate.

A 1% increase in sheet reel or precoater average moisture can provide significant production increases.

APPLICATION

Successful steam shower application depends not only on good design and knowledge of the process, but also on the involvement of the mill production and engineering personnel. It is of the utmost importance to discuss the affect of the steam shower on the process, equipment and the operation of the machine. Installation down time requirements, sheet threading and felt changes must be considered before a final location is decided upon.

Typical paperboard wet ends consist of Fourdrinier, either multiple units or with top wires, or cylinder formers. Figures 4 and 5 show possible steam shower locations for these machines.

Units which are located at the beginning of the press section have the advantage of offering the heated sheet to the maximum number of press nips. Units which are positions toward the final presses have the advantage of using less steam (Figure 6) and presenting a hotter sheet to the dryers.

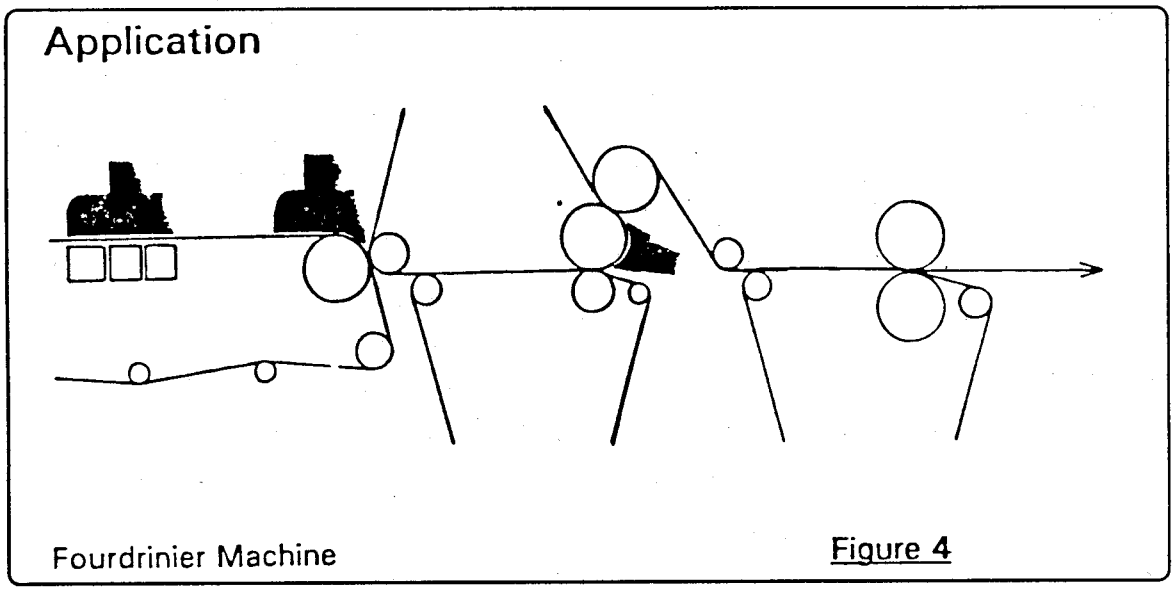
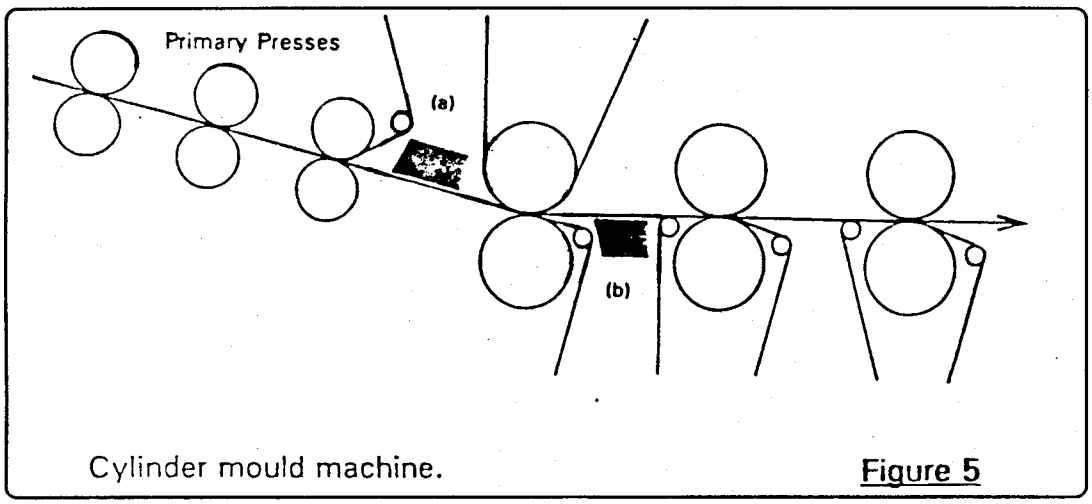


Figure 4



Cylinder mould machine. Figure 5

It is quite common to see multiple steam showers operating on paperboard machines. The first unit is located on the Fourdrinier or couch, (in the case of Fourdrinier machines) or just prior to the first press in the case of the cylinder machine. This first unit will increase the sheet temperature by approximately 20-25°C. The sheet temperature will then fall by 10-15°C as it passes through on or two press nips. At this point, the indroduction of a second shower will raise the temperature by a further 20-25°C.

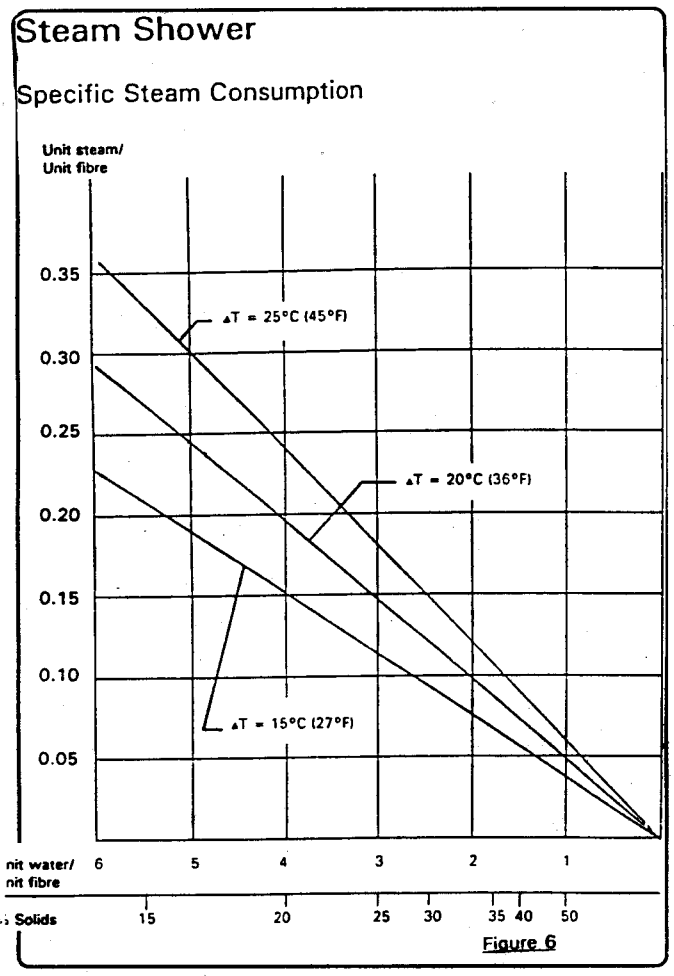


Figure 6

If C.D. moisture is considered, the profiling unit should be located closest to the dryer section. Non -profiling units following profiling units will dampen the C.D. moisture profiling affect.

Most steam shower suppliers require a suction device under their units for effective operation. While these suction devices assist steam penetration, it is not essential for units produced by Deltec Systems Inc.

Where units are located before straight-thought type presses, it is important to add the steam to the the dewatering side of the sheet.On double- felled presses ,the steam shower is placed above or below the sheet whichever is most convenient (Fig 5a).For single,bottom -felted presses,the steam shower must be located under the sheet (Figure 5b).

STEAM SHOWER DESIGN

Steam shower design falls into two categories, non-profiling and profiling. The non-profiling design some times referred to as a pre-heater or booster,have no regulation of steam in the machine cross direction. They rely on internal pressure drops for even steam distribution.

Profiling steam showers come in a number of manufacturers patented designs. All of which use some form of valve system to vary the C.D. distribution of steam to the sheet. A number of these steam

showers have pre-heat sections preceding the profile control zone. These pre-heat sections tend to limit the capability of the profiling range while units which do not employ pre- heat sections and control all the steam being supplied to the sheet through the profiling valves, such as in the Deltec Systems design ,can use the full range of ttemperature gain for profile control.

The individual control valves are operated remotely, either by the machine operator or through a link to the machine process computer.

Typical of any equipment, operator acceptance is of the utmost improtance. Many steam showers spill steam causing dripping, and near sauna conditions in the operating area. This deterioration of working environment has made steam showers unpopular with many machine operators. The series of steam showers marketed by Deltec Systems Inc. are provided with an integral exhaust system which prevents steam spillage into the machine room.

There are a number of other design features which ensure effective, trouble-free steam shower operation. Heated edges at the sheet entering and leaving points, prevent steam from condensing and dripping onto the sheet. Valves or taps at the shower internal low points remove any condensate formed during the warm-up period after machine shut-downs.

Correct design of the steam supply and control system is almost as important as the design of the steam shower itself. Steam sources can be flash steam returned from the dryer section, or live steam taken from one of the many lines in the mill.

The condition of the steam should be close to saturation at the release point to the sheet. As soon as the steam contacts the sheet condensing will commence, transferring the latent energy to the sheet. Steam showers operate below15 psig, normally between 3-10 psig. Any superheat in the steam after reducing to this operating pressure, should be controlled. A temperature slightly above saturation is advisable to compensate for any heat losses in the approach piping and steam shower itself. Automatic steam traps at strategic points in the piping system are necessary to keep the system free of condensate and ensure a supply of dry steam to the shower.

RESULTS

Results are shown in table -1 These are typical and show increases in sheet dryness of above 2% and machine speeds of better than 10%.

SAMPLE CALCULATION:

Assume existing sheet dryness:

Leaving presses - 46%

At reel _ 94%

$$\text{Evaporation rate} = \frac{\%\text{Entering moisture}}{\%\text{ Entering dryness}} - \frac{\%\text{ Leaving moisture}}{\%\text{Leaving dryness}}$$

$$= \frac{54}{46} - \frac{6}{94}$$

$$= 1.1101 \text{ units water/units fibre}$$

Operating a steam shower increase sheet dryness by 2%

Therefore new evaporation rate

$$= \frac{52}{48} - \frac{6}{94}$$

$$= 1.0195 \text{ units water/units fibre}$$

Reduction in evaporation rate

$$= \frac{1.1101 - 1.0195}{1.1101} \times 100\%$$

$$= 8.16\%$$

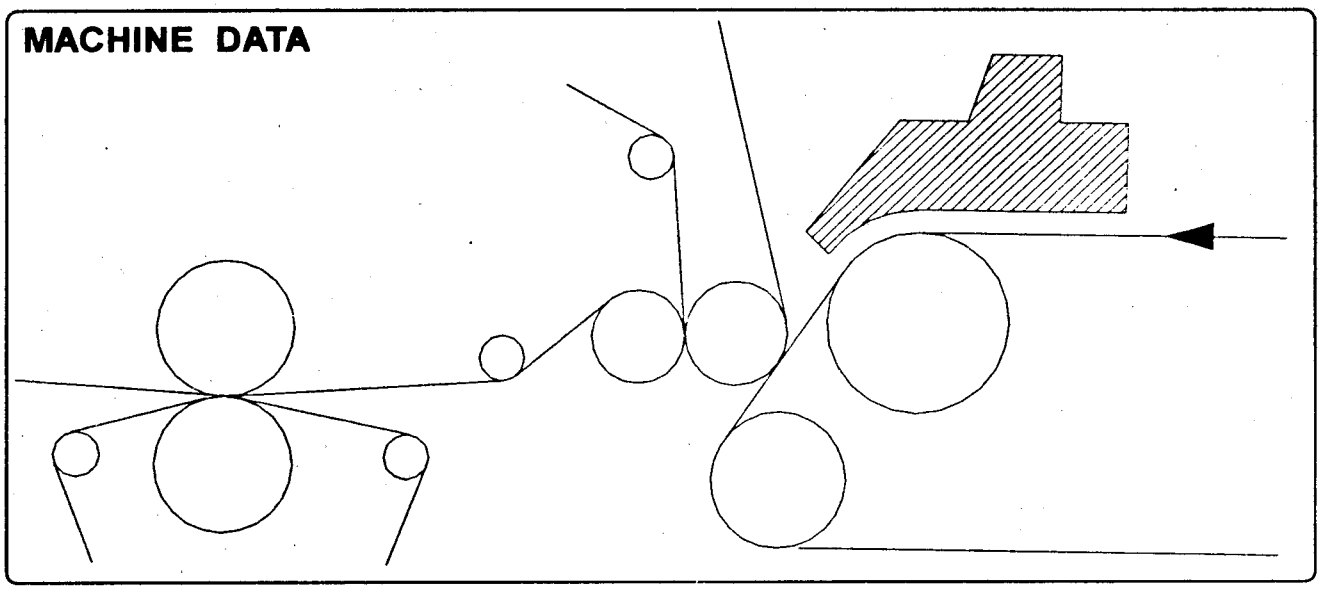
TABLE 1

SAMPLE OF RESULTS

PRODUCT	BASIS WEIGHT		MACHINE SPEED		FURNISH	STEAM SHOWER LOCATION	PROFILING		RESULTS		
	g/m^2	Lb/ 1000 ft^2	m/min	ft/min			Yes	No	Speed Increase	Dryness Increase	Streak Reduction
a) Test Liner # (1)	120-200	25-41	400	1310	100% Recycle	Couch	X			2.11%	3.10%
b) Fluting # (2)	112-180	23-37	360	1180	60% Chem. 40% Recycle	Fourdrinier	X			1.90%	
c) Tubestock # (6)	100-700	20-143	245	804	100% Recycle	Fourdrinier	X		19%		2.50%
d) Coated Board # (9)	240-600	49-122	233	764	100% Recycle	2nd Press	X		12%		6.10%
e) Board # (12)	400-1000	80-200	30	98	100% Recycle	1st Press		X	12%		
f) Coated Board # (15)		50-120	122	400	100 Recycle	1st Press		X	11%	2.50%	

INSTALLATION RESULTS No. 1

MACHINE DATA

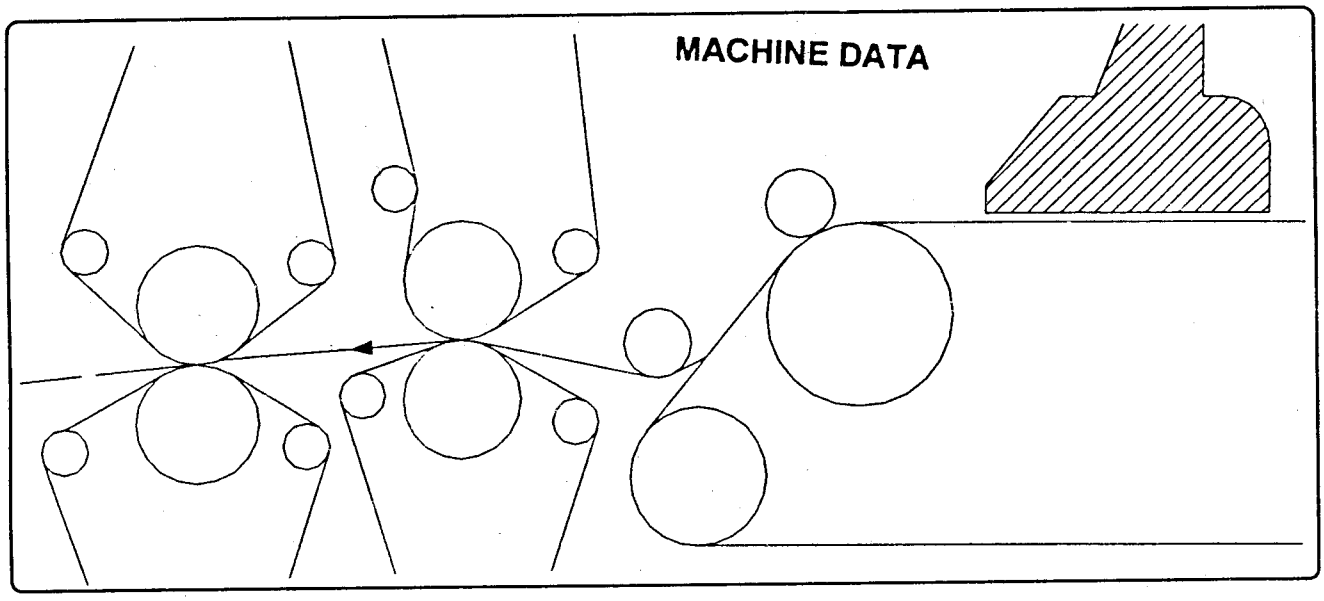


	Grade:	Test liner 120-200 g/m^2	
	Furnish:	100% Recycle	
	Machine Speed:	400 m/min	
BI-FLO DATA	Model:	C-18P	
	Profiling Sections:	18 @ 153 mm	
RESULTS	Steam Usage:	215 kg/tonne paper	
	Sheet Dryness:	Bi-Flo off -	44.16%
		Bi-Flo on -	46.27%
		Change -	2.11%
	Moisture Streak:	Bi-Flo off -	7.80%
		Bi-Flo on -	4.70%
		Change -	3.10%
COMPARISON		**actual**	**guaranteed**
	Sheet Dryness:	2.11%	1.5%
	Moisture Streak:	3.11%	1.0%

*** Note: 1.5% reduction at 10% streak.**

INSTALLATION RESULTS

No. 2



	Grade:	Fluting 112-180 g/m²	
	Furnish:	60% Chemical - 40% Recycle	
	Machine Speed:	200-360 m/min	
BI-FLO DATA	Model:	F-18P	
	Profiling Sections:	16 @ 160 mm + 2 @ 180 mm	
RESULTS	Steam Usage:	230 kg/tonne paper	
	Sheet Dryness:	Bi-Flo off	- 43.5%
		Bi-Flo on	- 44.4%
		Change	- 1.9%
	Sheet Temperature:	Before Bi-Flo	- 37°C
		After Bi-Flo	- 61°C
		Entering Dryer	- 55°C

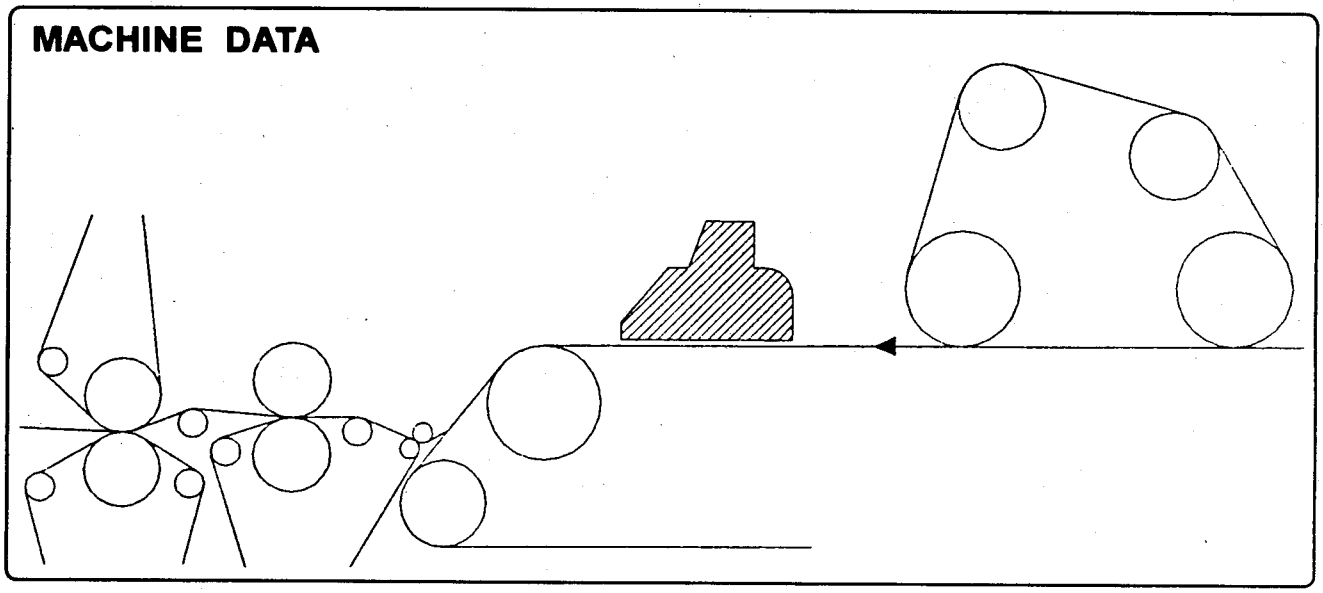
COMPARISON		**actual**	**guaranteed**
	Sheet Dryness:	19%	1.5%
	Sheet Temperature:	24°C	15°C*

*** Note: 10°C temperature increase = 1% dryness increase in presses.**

INSTALLATION RESULTS

No. 6

MACHINE DATA



	Grade:	Board 100-700 g/m²		
	Furnish:	100% Recycle		
	Machine Speed:	245 m/min (at 100 g/m²)		
BI-FLO DATA	Model:	F-21P		
	Profiling Sections:	21 @ 150 mm		
RESULTS	Steam Usage:	234 kg/tonne paper		
	Machine Speed:	Bi-Flo off	-	98 m/min
		Bi-Flo on	-	117 m/min
		Change	-	19 m/min
	Moisture Streak:	Bi-Flo off	-	7.5%
		Bi-Flo on	-	5.0%
		Change	-	2.5%

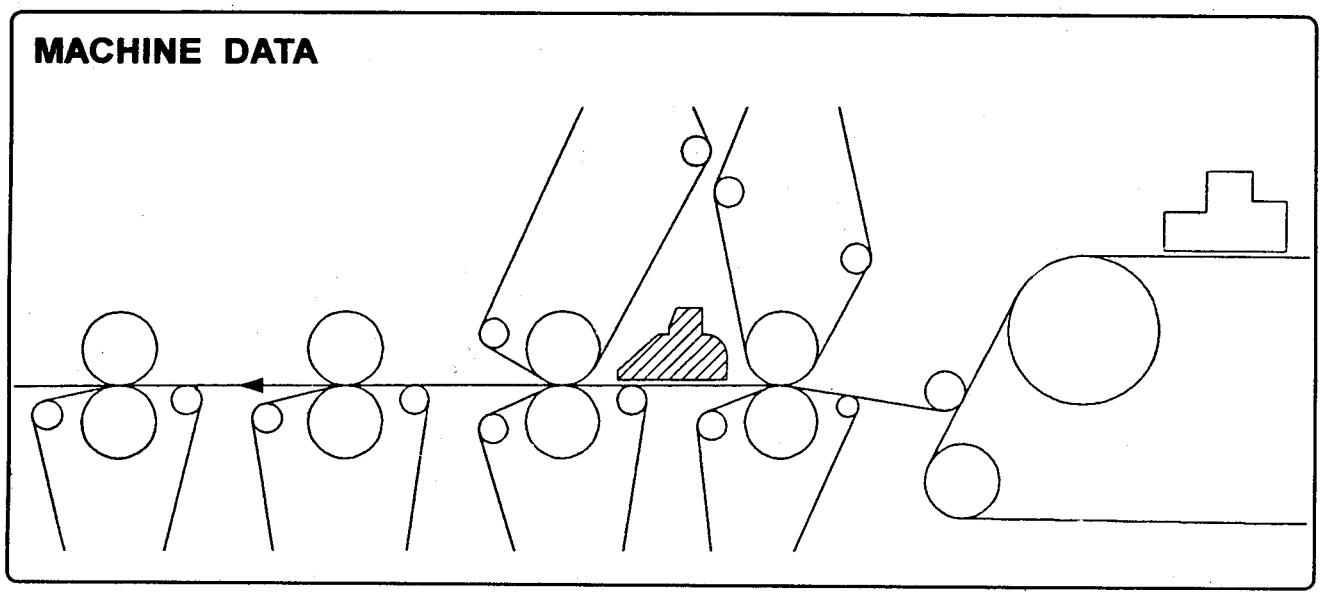
COMPARISON		**actual**	**guaranteed**
	Machine Speed:	19%	5%
	Moisture Streak:	2.5%	0.8%*

*** Note: 1.5% reduction at 10% streak.**

INSTALLATION RESULTS

No. 9

MACHINE DATA



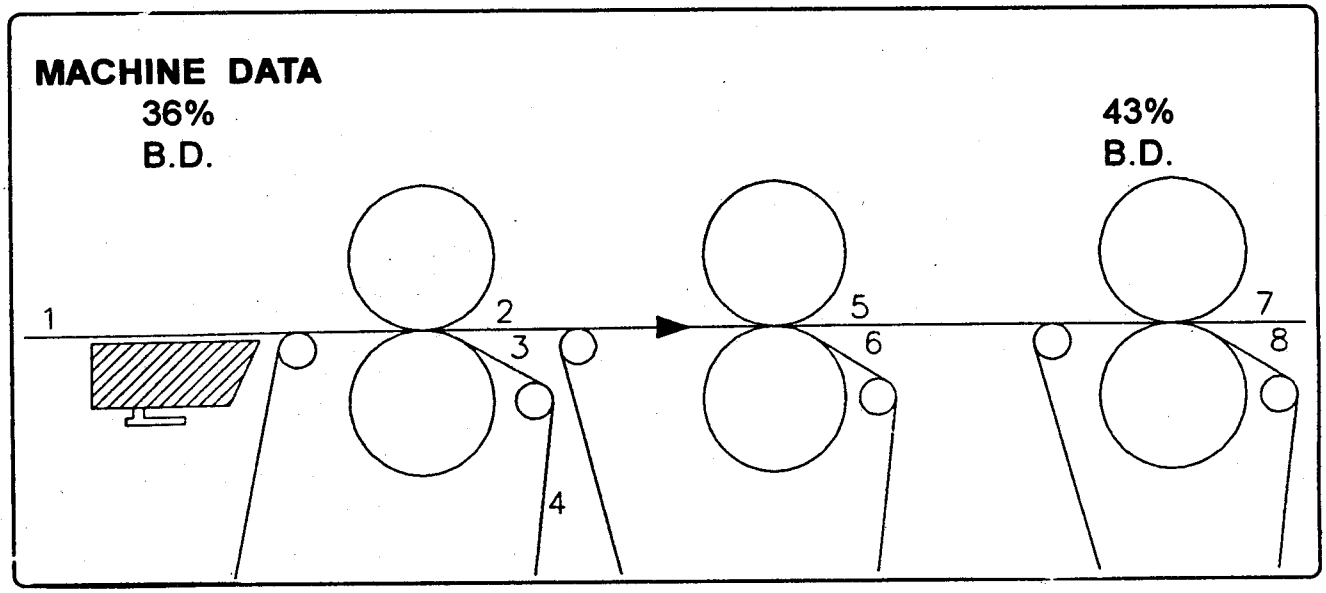
	Grade:	Coated Board 240-600 g/m^2		
	Furnish:	100% Recycle		
	Machine Speed:	85-233 m/min		
BI-FLO DATA	Model:	P-16P		
	Profiling Sections:	16 @ 294 mm		
RESULTS	Steam Usage:	146 kg/tonne paper		
	Moisture Streak:	Bi-Flo off	-	13.1%
		Bi-Flo on	-	7.0%
		Change	-	6.1%
	Sheet Temperature:	Before Bi-Flo	-	30°C
		After Bi-Flo	-	50°C
		Entering Dryer	-	37°C
	Machine Speed:	Bi-Flo off	-	178 m/min
		Bi-Flo on	-	200 m/min
		Change	-	22 m/min

COMPARISON	**actual**	**guaranteed**
Moisture Streak:	6.1%	1.5%
Sheet Temperature:	20°C	15°C*
Machine Speed:	12.36%	5%

*** Note: 10°C temperature increase = 1% dryness increase in presses.**

INSTALLATION RESULTS

No. 12



Product:	Board, 100% Recycle
Basis Weight:	785 g/m²
Basis Weight Range:	400 g/m² - 1000 g/m²
End Moisture:	8.6%
Machine Speed:	27.5 m/min
Production:	90 T/day
Bi-Flo:	P-5M under sheet, before 1st press
Steam Flow:	700 kg/h=0.21 kg steam/kg fibre
Steam Pressure:	0.2 bar
Steam Temperature:	118°C

SHEET TEMPERATURES

Bi-Flo Steam	1	2	3	4	5	6	7	8
Off	29	28	28	28	28	28	28	27
0.2 bar	29	42	51	49	45	45	43	43
0.3 bar	30	44	52	50	47	47	45	45

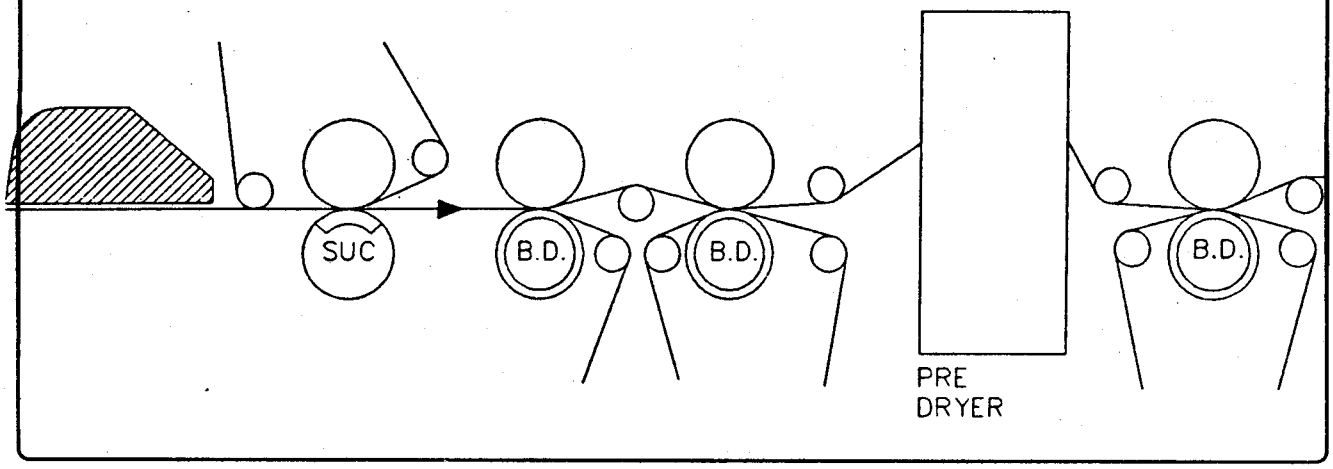
PRODUCTION INCREASE

Operating figures provided by the mill give a 12% increase on sheets of lower basis weights and 5% on heavier sheets. The heavy sheets are limited by a flooded 1st press nip, which causes crushing. The press loading has to be reduced from 15 kg/cm² to 8 kg/cm².

INSTALLATION RESULTS

No. 15

MACHINE DATA



	Grade:	Coated Board 50-120 lbs/1000 ft²
	Furnish:	100% Recycle
	Machine Speed:	400 ft/min (50 lb sheet)
STEAM SHOWER DATA		
	Model:	Thermal Booster - TB
	Heating Zone CD:	128 ins
	MD:	36 ins
RESULTS	Grade:	22 point, 84 lbs/1000 ft²
	Sheet Dryness:	Steam shower off - 44.5%
		Steam shower on - 47.0%
		Increase in dryness - 2.5%
	Machine Speed:	Steam shower off - 370 ft/min
		Steam shower on - 410 ft/min
		Increase in dryness - 10.8%

COMPARISON	**actual**	**guaranteed**
Sheet dryness increase	2.5%	1.5%
Machine speed increase	10.8%	6.0%