Coefficient of Friction Comparision of Papers from Recycled Vs Virgin Fibres in the Light of Stock Preparation

Shrirang Deshmukh

Navneet Publications (I) Ltd, Navneet House, Gurukul, Memnagar, Road, Ahmedabad 380052,

Email: shrirangdeshmukh@navneet.com

Keywords : Friction, Recycled fibre, Virgin fibre, Stock preparation, Clay, Roughness, Fatty acid, Surface property.

Both surface chemistry and mechanical parameters are decisive. A high surface energy surface i.e. a hydrophilic paper surface with all the oleophyllic material removed has a high paper to paper and paper to metal friction. The static coefficient of friction for all filler free papers tested were near 0.70 independent of pulp type. In clay filled papers the friction coefficient was around 0.55 Long Aliphatic Chains, such as those from fatty acids in the paper surface yield a low energy surface and a low metal to paper friction. Paper roughness has little if any effect on paper friction but the metal to paper friction is expected to increase with metal surface roughness due to ploughing effect of its harder, rough surface particles into softer paper material.

INTRODUCTION

The last five years have seen a quantum jump in the quantity of quality recycled paper coming from various new projects set up across the country. These mills have defied the logic that recycled fiber based papers cannot run on high speed machines in terms of strength properties.

Despite the huge advancements in the strength parameters, the core issue of runnability should be a matter of concern.

The need for this study arose when the printer repeatedly observed the sudden appearance and the disappearance of crease during printing. The mills were called in to attend the complaints at times and there were, no doubt some improvements but the problem persisted, still in damaging proportions.

DEFINITIONS

Friction forces or friction resistances are energy consuming forces which appear when one attempts to slide one solid body over another or when it moves in a liquid or in a gas. In case of paper as a two dimensional flat body, only the static friction and the sliding friction are of significance, the rolling friction can be disregarded. The cause of the frictional resistance lies in the roughness of the contacting surfaces and in the attractive forces between the molecules.

Coefficient of friction is that force used to initiate the movement. It is divided in two parts

a) Kinetic Friction: It is the force required to start and maintain the motion of an object across a horizontal surface.

b) Static Friction : It is the tangent of the angle at which the motion is initiated when the object is kept on a inclining surface

EXPERIMENTATION

The method used to determine the COF was sliding angle method in which the angle at which the sliding is initiated was noted.

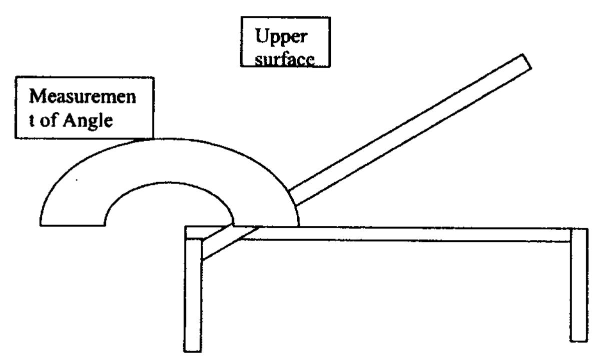

Figure1: The schematic diagram of the apparatus is shown below

The upper surface is covered by a piece of rubber blanket, similar one used in a printing machine.

The sliding was noted in two ways:

1. Metal to paper A sheet of paper was clamped on the surface and a metal block, same as the metal of which the reel stand rollers was made to slide by lifting the upper surface slowly.

2. Paper to rubber The paper was tied to the metal block in such a way that the surface of the paper touching the metal block was free of wrinkles.

Measurements on four papers, two from deinked fiber and two from virgin fiber were measure and compared. All the papers selected were non surface sized for the sake of uniformity of observation.

Table : 1

Deinked Paper			Virgin Fiber		
PAPER	Smoothness	Ash%	PAPER	Smoothness	Ash%
(Gurley) sec/50 ml			(Gurley) sec/50 ml		
MILL 1	45.3	22	MILL 1	38.2	5.07
MILL 2	57.5	20	MILL 2	41.3	12.6

Table 2 : The Results of the Coeficient of Friction are Tabulated

Deinked Paper				Virgin Fiber			
Metal to Paper				Metal to Paper			
PAPER	Slide Angle Degrees	Slide Angle Radian	Coeff of Friction (TAN A)	Paper	Slide Angle Degrees	Slide Angle Radian	Coeff of Friction (TAN A)
MILL 1	15	0.26	0.27	MILL 1	17	0.30	0.31
MILL 2	15	0.26	0.27	MILL 2	17	0.30	0.31

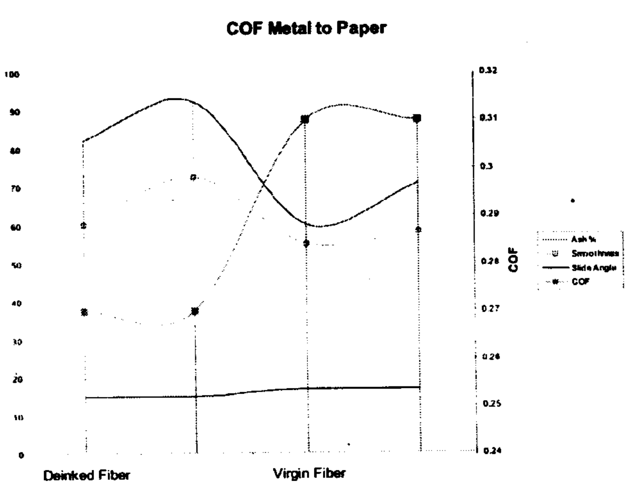

Figure 2

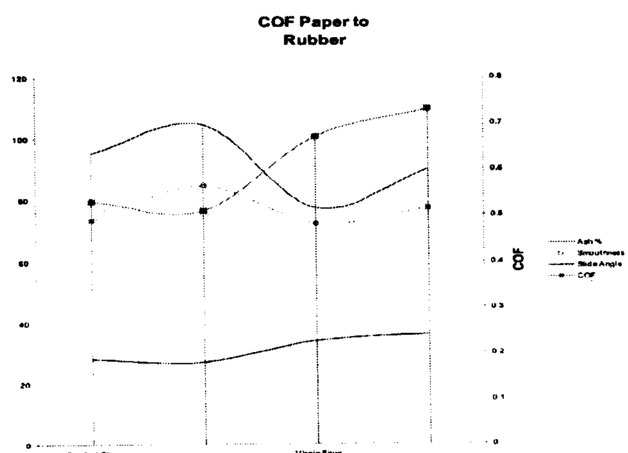

Figure 3

Table 3

	Deinked Paper				Virgin Fiber		
	Paper to Rubber				Paper to Rubber		
PAPER	Slide Angle Degrees	Slide Angle Radian	Coeff of Friction (TAN A)	Paper	Slide Angle Degree	Slide Angle Radian	Coeff of Friction (TAN A)
MILL 1	28	0.49	0.53	MILL 1	34	0.59	0.67
MILL 2	27	0.47	0.51	MILL 2	36	0.63	0.73

The smoothness was measured on Gurley Instrument and Ash content by conventional muffle furnace (difference in weights before and after burning) these results are as follows

RESULTS AND DISCUSSION

The lesser metal to paper coefficients in deinked fiber are definite indicators of the sudden creasing or creeping of the deinked fiber when the reels unwind in the web.

Also the big difference in the coefficients on paper to rubber indicates the quantum of crease when the paper comes in contact with the rubber blankets.

The virgin fiber papers which were taken to compare with the deinked paper had lesser ash content, so the slipperiness at the surface due lesser binders is seen to be less than that of the deinked fiber.

Long aliphatic chains such as those from fatty acids, on the paper surface due to addition of additives, pigments, fillers and binders create a sort of a hydrophobic surface in patches and yield a lower coefficient of friction in those patches.

Both surface chemistry and mechanical parameters are decisive. The static coefficient of friction for all filler free papers tested were near 0.70 independent of pulp type. In clay filled papers the friction coefficient was around 0.55

Paper roughness has little if any effect on paper to paper friction, but the metal to paper friction is expected to increase with metal surface roughness due to ploughing effect of its harder rough surface particles into the softer paper material.

Aliphatic molecules such as fatty acids form low energy friction surfaces on other solid materials and also on paper. Such molecules occur naturally in paper, originating from wood extractives.

Various pigments are commonly used as fillers to improve paper properties or to enhance runnability. Fillers such as hydrous and calcined kaolin, and synthetically produced precipitates increase paper opacity or brightness when used in low percentages. In addition to enhancing paper optical properties many of these have dramatic effect on coefficient of friction.

Common fillers such as hydrous kaolin and talc when added to the furnish can actually aggravate the problem by reducing the paper COF.

Various factors can affect paper friction properties. Woods with higher sap contents such as pine tend to produce sheet with lower COF.

One might expect the effectiveness in developing friction to be a function of filler size or shape. The flat platy pigments seem to be less effective in developing friction then pigments having other morphologies. However there is no evidence to establish a relationship defining filler abrasivity to correspond with a tendency to develop friction.The synthetic pigments add no abrasivity yet they substantially enhance the friction properties. Calcined kaolin and talc both are more abrasive, are much less effective in increasing paper friction properties.

Filler	Coefficient A	Correlation Coefficient
Talc	1.0208	0.9998
Hydrous Kaolin	1.0840	0.9995
Calcined Kaolin	0.9777	0.9855
PSS Silicate	0.9337	0.9975

(Source The effect of filler on paper friction properties, Michael Withiam, Tappi Journal 1991)

With increasing moisture content or with increasing equilibrium relative humidity has been shown to increase the paper to paper friction has been shown to increase by 50%.

CONCLUSION

It is now understood that the coefficient of friction is a major player in deciding the runnability of the deinked papers. Also the usage of deinked fiber is growing year after year, the problem has to be tackled at the press room itself while asking the mills to be more careful on the moisture profile and caliper control.

To over come this problem at our end, we have decided to discharge the paper in the web itself for any static charges. And also introduce a camber roll for gentle spreading of the sheet just before it enters the printing unit.

The static discharge would help us in removing unwanted static charges which are present due to slipperiness and the camber roll would even out the sheet.

REFERENCES

1. Paper to paper and paper to metal friction by Ernst Black 1991 International Paper Physics Conference. Page numbers 49,56,57,58
2. The effects of fillers on paper friction properties, Michael Withiam, April 1991 TAPPI Journal.
3. Deinking Chemistry Part I, Loreen D. Fergusson, July 1992 TAPPI Journal
4. Deinking Chemistry Part II, Loreen D. Fergusson, August 1992 TAPPI Journal