Some Important Considerations in Making a Good Quality Paper on a Medium Speed Fourdrinier Wire

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The significant properties of pulp from a paper making point of view are (1) the fibre morphology, (2) the amount and distribution of the chemical constituents of the pulp fibres, (3) the shape, size, distribution and physical condition of the pulp fibres. The first two properties depend upon the raw materials of pulping and the pulping method. The third property, although depends upon these factors, is further determined by the fibre preparation or fibre treatment process. So beating or refining is the paramount important process in paper making.

The principal effects of beating are physical and among the most important are the following : (i) fracture and partial removal of the primary wall of the fibre, (ii) increase in the wetnesss or tenacity with which the fibres hold water, (iii) increase in fibre flexibility, (iv) fibre cutting, (v) increase in the ratio of fibre length to fibre diameter which is a more important factor in paper making than fibre length, since it determines the felting characteristics of the fibre. (vi) fibrillation, (vii) increase in the external specific surface of the fibre.

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The rate and nature of beating or refining is an important consideration in making different grades of paper. In general, increased beating within the commercial range increases bursting strength, tensile strength, smoothness and amount of fibre bonding but on the other hand tends to decrease the opacity and lower the bulk and dimensional stability of paper. So in the manufacturing of different grades of paper it is sometimes necessary to reduce the amount of beating and sacrifice some qualities in order to obtain the desired properties of paper to be manufactured; such as pulp used for absorbent papers are beaten with a sharp tackle at a fairly low consistency to promote cutting of the fibres with a minimum of wetness. For making paper of thin substance a well fibrillated wet stock is needed but to make good sheet of printing paper of thick substance a fine and free stock is needed. To make a very ideal stock for a particular paper machine, making different grades of paper with varying substances becomes difficult and which comes on the way of making a good and well formed sheet on the Fourdrinier wire. The greatest difficulty of obtaining a satisfactorily formed sheet with a slow stock particularly in making thick substance is to extract enough water to make the sheet ; as the consistency at which the stock is entering into the headbox has a pronounced effect on the uniformity of dispersion of the fibres. The higher the consistency, the greater the ten-

dency of the fibres to flocculate and produce wild paper. Above the critical consistency the fibre entanglement occurs and aggregates are formed—a phenomenon known as flocculation of fibres. Although the flocs can be broken down by stirring the suspension but they continually reform, particularly as the rate of agitation decreases. The condition of flocculation is often therefore a dynamic one in which individual fibre passes from one floc to another. The tendency of the fibres to form flocs increases rapidly with increasing fibre consistency and increasing fibre length. Although there are many devices to break the flocs for having better —dispersion of the fibre suspension such as good approach flow system, headbox design, use of distributor roll, etc., yet the consistency of stock is the most important factor for having a high degree of uniformity of fibre dispersion.

By the following formula we can approximately find a relation between the opening of slice and consistency in different substance of paper.

S X O X W X Consistency $\times$ 1440 = W x substance $\times$ 5 $\times$ 1440

Where O = Opening of the slice.
W = Width of the slice.
S = Speed of the machine.
1440 = Minutes of a day.

$\therefore$ Opening of the slice = Substance/consistency.

Say the Substance = 50 GSM
and Consistency = 0.5%

$\therefore$ Opening of the slice (o) = 10 mm.

But a good paper making with a better fibre dispersion at a consistency higher than 1.0% is very difficult. Very long fibred stocks usually require lower consistency to produce a good formation. The basic functions to be performed for laying the sheet on the wire properly by a paper machine tender can be summarised as follows :—

1. To dilute the stock going to headbox to a consistency as low as possible so as to permit easy relative motion of fibres when a high degree of uniformity of fibre dispersion can be achieved.

2. To distribute the fibre suspension uniformly and stably on the wire.

Substance	Consistency in 10 mm slice opening	Consistency in 11 mm slice opening	Consistency in 12 mm slice opening
30 GSM	0.3%	0.27%	0.25%
40 ,,	0.4%	0.37%	0.34%
50 ,,	0.5%	0.45%	0.42%
60 ,,	0.6%	0.55%	0.50%
70 ,,	0.7%	0.64%	0.58%
80 ,,	0.8%	0.73%	0.67%
90 ,,	0.9%	0.82%	0.75%
100 ,,	1.0%	0.91%	0.83%
110 ,,	1.1%	1.0%	0.92%
120 ,,	1.2%	1.1%	1.0%
130 ,,	1.3%	1.2%	1.1%
140 ,,	1.4%	1.27%	1.17%
150 ,,	1.5%	1.36%	1.25%
160 ,,	1.6%	1.45%	1.34%

3. To adjust the stock speed and the wire shake according to the wire speed and to see whether the individual fibres uniformly coming on the forming wire deposit as the suspending water drains away through the wire. If the above things are properly adjusted while the fibre mat is in a plastic condition a close fibre to fibre contact can be obtained for having better fibre bonding. Now to maintain a consistency low enough in different substances of paper particularly with a slow stock on a short wire length becomes a problem. Although the drainage on wire can be increased by many factors such as heating the stock; slightly reducing the wire shake (if possible without affecting the formation), etc., but the most effective thing is to concentrate on the setting of the bottom lip of a projection type slice so that the breast roll drainage can be controlled according to the drainage condition on the wire; and for that there should be some arrangement for adjusting the bottom lip for having more or less breast roll discharge particularly on a machine where a wide range of different substances of paper are manufactured, because the maximum percentage of total drainage on wire can be performed in the breast roll, if necessary (maximum breast roll drainage may be 16 to 18% of total drainage on wire).

The total importance of stock speed and exact angle of impingement of jet on the wire should be considered very carefully. For best operation the stock speed should be 95% of the wire speed. If the stock speed is much higher than the wire speed the stock will rush on to the wire and it will run in a turbulent state some way up the wire and pass the maximum influence of the shake before settling down sufficiently for the shake to form the sheet. Thus the effect of shake will be largely lost and the sheet will be cloudy instead of close. If the stock speed is too less than the wire speed, small scale shifting will occur on the wire due to the lack of carrying medium and closeness of the sheet will suffer. So according to the drainage capacity of the machine, the consistency and the slice opening should be adjusted in such a manner so that the stock enters the wire with about 95% of the wire speed for having good results. The bottom lip of the slice should always be set as close to the wire as practical as this always results in a better formation for a given set of condition.

For having better formation a forming board is used under the wire between the breast roll and the 1st table roll where it supports the wire and retards the early drainage which helps to get more time for the stock for having good formation and uniform dewatering over the entire forming length. The forming board is generally set with its leading edge about 1|8 inch below the line formed by a straight edge from the top dead centre of the breast roll to the top dead centre of the 1st table roll. There should be a true breast roll discharge on a machine having a forming board so that the water discharged through the wire should not be doctored off by the forming board. It is better to use a lattice construction in the forming board which can allow some drainage, if found necessary.