frictional loss in the flow of fibre suspensions in pipes.

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In this paper the flow pattern of Fibre suspensions is presented. A new equation for the estimation of frictional loss in the flow of fibre suspensions in pipes has been given and the results obtained according to the equation have been discussed.

Introduction :

When liquids flow in pipe, resistance is offered to the flow by the inner surface of the pipe which is termed as friction. A lot of work has been done on the estimation of frictional loss in the flow of fibre suspensions in pipes and this paper describes the recent developments. At such the contents of this paper is likely to be of little importance to the day to day problems of the processmen and Maintenance Engineers ; but is likely to be of help to planning design and development engineers in the pulp and paper industry. Newton and Bingham have postulated definite theories for the flow of liquids. However fibre suspensions do not follow these theories and need separate considerations. Hence, here some recent developments regarding flow of fibre suspensions in pipes have also been discussed.

Flow Pattern :

Loss due to friction in the flow of fibre suspensions in pipes can be explained according to Figure 1. This diagram is on double log paper and shows $\triangle$ H (loss due to friction) m/100 m as a function of velocity.

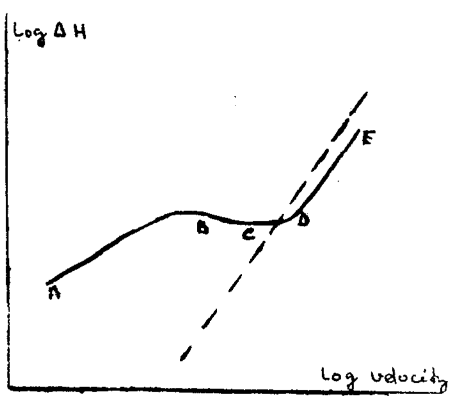

FIGURE 1

In the region of low velocities A-B the loss H is due internal friction. (Compares well with Bingham's medias)... In the region of higher velocities B-C the fibres are oriented in the direction of flow which decreases the internal friction so much that the total loss is decreased. In the region of still higher velocities C-D-E due to turbulance the loss profile is similar to that of water. In the region of D-E-the loss is smaller than that of water which is due to the stabilising effect of fibres.

API's Equation :

Based on the previous published works, (1) to (5) Aktienbolaget Pumpindustri (IPI), Gothenburg, Sweden has developed an equation for the Calculation of frictional loss in the flow of fibre suspensions in pipes (6). API's summation of factors effecting the amount of loss are—

K = Concentration of A.D. Pulp
D = Diameter of pipes in meter.
V = Volume flow/area in M/S.

And the equation is—

$\triangle H = f_1 (K). f_2 (D). f_3 (V)$ ....(1)
The functions f_1, f_2 and f_3 resembles exponential functions and can be put as—

$\triangle H = \text{Constant } K^{\alpha} D^{\beta} V^{\gamma}$ ....(2)
Calculation of exponents :

— To determine the concentration co-efficient experimental results of $\triangle$ H = Constant K^{α} were plotted in a double log paper and L was found to be independant of velocity and diameter and was 2.2 which holds good with the results of previous investigators.

β - Likewise the diameter co-efficient experimental results with different grades of pulps, at different consistencies and at a velocity of 0.5 m/min. and diameter

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range of 12.6 — 316 mm. were plotted in a double log paper and the co-efficient was found to be — 1.

Y — While calculating *Y* co-efficient it was found that with the increase in diameter, the value increases. To plot Y for different diameters in a linear diagram it follows :—

$$Y = 0.15 + \frac{D}{0.5 + D} \qquad \text{..................(3)}$$

With all the calculated co-efficients, the constant was found to be 0.12.

Putting the above mentioned values in Equation 2, it becomes

$$\triangle H = 0{\cdot}12 \, \frac{K^{2\cdot2} \times (V/_{0\cdot5})^{0\cdot15 \, \frac{D}{0\cdot5 + D}}}{D} \qquad \text{..................(4)}$$

where,

K = Percent A.D. Pulp
V = Velocity M/s
D = Diameter in m.

Results :

The effect of different grades of pulps, pipe materials, temperature and fibre dimensions on frictional loss were studied and was found that the effect of temperature and beating degree and fibre dimensions have negligible effect ; and the finishing of the inner surface of pipe and the grade of pulp have a greater effect. However, the extent of the effects of different pulp grades on frictional loss could not be explained. With pipes of raw finish the loss was found to be 20% more than that the equation gives.

The results obtained according to equation 4 in the range of A-B is similar to that in Figure 1. In the range B-D the flow profile depends upon the grades of pulps and also on fibre dimensions. For chemical pulps the frictional loss profile was found to increase in velocity and for groundwood the loss profile was constant. At higher velocities the loss for all kinds of Pulps was similar to that of water.

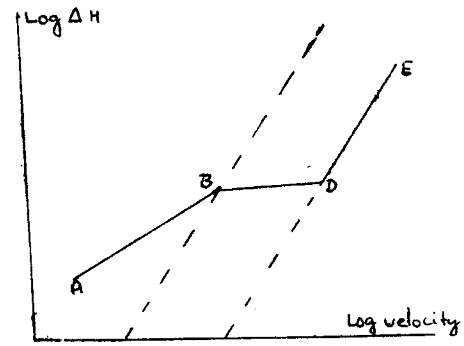

FIGURE 2

The results of Brecht and Heller (2) have shown that the point B in Figure 1 for increasing consistencies follows a line parallel to that of water. So, summing up the results the curve becomes like that shown in Figure 2. 84% of experimental results calculated according to consistency co-efficient 2.2 were within a limit ± 30% of the values calculated according to equation 4.

References :

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