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CONSIDERATIONS IN GOOD CONSISTENCY CONTROL

By: Horace A. Thompson, Jr.
Technical Director and CEO
Thompson Equipment Company, Inc.
New Orleans, LA

Abstract

This paper discusses important installation considerations when setting up a consistency control system.

INTRODUCTION

Why are we concerned with consistency other than on the machine where it is the dominant characteristic of the fluid that makes up the basis weight of the paper? At other locations in the mill such as from the high density tower, washing, screening, bleaching, refining, etc. why shouldn't we just hold the consistency within a reasonable range as the end result of a specified grade of paper or pulp is all that counts? This is not so! Consistency is one of the most important and difficult measurements to obtain. Consistency determines the efficiency of the bleaching operation and hence the amount of expensive chemical wasted. It affects water consumption and more important the amount of energy used in many of the unit operations. The closer the consistency can be held to the desired value the smoother and more efficient each operation can be conducted. Therefore, we are talking about big dollars when we compare the costs of production when the consistency swings 0.1% in one mill and 0.2% in another. The closer the consistency regulator controls, and the less time the mill is operating by "feel" because the regulator has quit or the mill has to shut down to change it, the lower the production costs in $/TON of finished product.

Anyone interested in this subject should read "Pulp Technology and the Treatment of Paper" by James d'A. Clark (1).

METHODS OF MEASUREMENT

The measurement of pulp consistency is elusive, and other than by laboratory analysis is determined by inferential measurement. Ultrasonics, optics, conductivity, pipe friction, microwaves and vibration are a few of the methods that have been tried with varying success. The dominant technique, however, is to measure the forces required to separate the fibers. This force is usually determined by measuring the load on an electric motor driving a paddle, the force on a fixed blade or "scimiter" or the force on a cylindrical bar around which the fibers must separate from one another to move down the pipe. Unfortunately, forces due to flow enter into the picture in all of these methods and must be ignored or factored out. To confuse the measurement more, the flow effect is not linear, being practically zero at 2 ft./sec. and considerable at 7 ft./sec. To remove this effect mechanically usually overcompensates at one rate and undercompensates at another.

FLOW EFFECT

Flow effect is caused by drag across the measuring device used to shear the fibers and affects each shape differently. Blades have dragging surfaces on which force is added as flow increases. Rods have less surface, but the flow effect is still there.

Cylindrical rods, however have an advantage over streamlined bodies due to a reverse flow against the downstream side caused by vortices shed from the bluff bar. Fig 1. shows this phenomena and Fig 2 illustrates how contrary to expectations velocity effects are less on a bluff body than on a streamlined body. The compensating effect of the reverse flow between the vortices is much greater when the probe is angled downstream inasmuch as the reverse flow is at the end of the probe. At this point the leverage is a maximum from the fulcrum which gives the maximum reverse thrust. This is illustrated in Fig 3.

Inasmuch as the flow effect starts at 2 ft./sec. and is linear to 6 or 7 ft./sec. the converter can be equipped with a circuit to accept a flow signal and compensate from 2 to 6 ft./sec. As shown in Fig 4.

PH, SOLIDS, ADDITIVES

Strangely enough, the shear effect on the probe is hardly effected by changes in pH and additives such as rosin therefore these can be practically ignored.

AIR

Air is always an enemy and is basically the reason ultrasonic devices are not used for consistency measurement. Air usually travels along the top of a horizontal line and a big bubble hangs behind any intrusion on the top of the line due to the low pressure caused by vortices. For this reason any regulator that intrudes in the line should be installed in a vertical line or in the side of a horizontal line.

As velocity increases the rate of low pressure vortex formations behind the probe also increase. At flows greater than 7 ft./sec accumulated air in the stock accumulates behind any intrusion in the line even when the intrusion is in the side of the line. Naturally this affects the validity of the consistency measurement, therefore, velocities should be held lower than this in all installations.

ECCENTRIC VS. CONCENTRIC REDUCERS

Expanding the line to reduce velocities is valueless in a horizontal line unless the top of the line is level so that air traveling the top of the line can move downstream rather than accumulate in the upper section of the line and thus increase velocity.

FLOW PATTERN

A good installation will provide at lease 5 diameters of undisturbed flow upstream and 2 diameters downstream. It is surprising how many regulators are installed immediately after an expander, and then the user is surprised when he doesn't get consistent readings.

DILUTION WATER

A rule of thumb has usually been to limit the consistency reduction to not more than 1%. This actually depends on the consistency. A better rule is not to add more than 20% dilution water in the final reduction stage. A reduction from 7% to 3 1/2% in one stage requires an addition of a volume of water equal to the volume of pulp flowing thru the line. This obviously sets up a difficult mixing and control problem, therefore this type of reduction should be done in several stages with the last stage being the smaller reduction.

VALVE SIZING AND WATER PRESSURE

A varying water pressure varies the amount of dilution water and presents a control problem. An undersized or oversized control valve makes good control more difficult therefore, selection of the correct valve size for the application cannot be overemphasized.

LOOP TUNING

A consistency measuring device does what it says it does, measures the consistency in the line at that place and time; it does not control. Control is a function of the controller which receives the consistency measurement and takes action to increase or decrease dilution water to obtain the desired results. No matter how accurate a consistency probe is it cannot achieve the ultimate aim of holding a consistency constant without a properly tuned control loop. There are excellent devices on the market to analyze and fine tune the control loop. The use of computer loop tuning cannot be overemphasized and is worth the investment. If the job is worth doing, it is worth doing right and the extra dollars spent are rapidly recovered in a well tuned consistency loop.

MAINTENANCE

It is a fact of life that if something can go wrong, it will go wrong. It may not happen for years but if a regulator breaks or you have reason to question its calibration, it is an invaluable investment to have a device that can be replaced or recalibrated without shutting down the stock line. A shut down costs money and that's what a paper mill is all about, to make as much money as possible and not to waste any production time or money that can be avoided. One unnecessary shut down can cost more in production than the entire cost of the regulator. Buying on price alone is being penny wise and pound foolish.

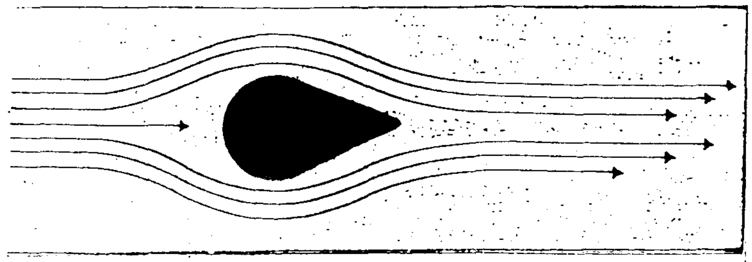
APPLICATIONS

The applications of consistency regulators are well known and it is unnecessary to dwell on them here. It should be noted however that economics is dictating the processing of heavier and heavier consistencies as equipment becomes available to handle higher consistencies. Consistency regulators are available for stocks up to 14%-15% and are now used in such applications as controlling the consistency to the high density chest.

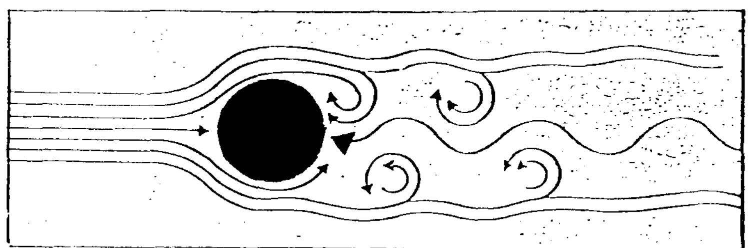
As pulp stocks are thickened costs of bleaching chemicals and power are lowered, however the accurate control of consistency of the heavier stock becomes even more important.

CONCLUSION

When controlling consistency look over the entire installation and do it properly. Don't just take the cheapest bid and waste valuable production time trying to overcome installation deficiencies.



STREAMLINED BODY



BLUFF BODY

FIG 1

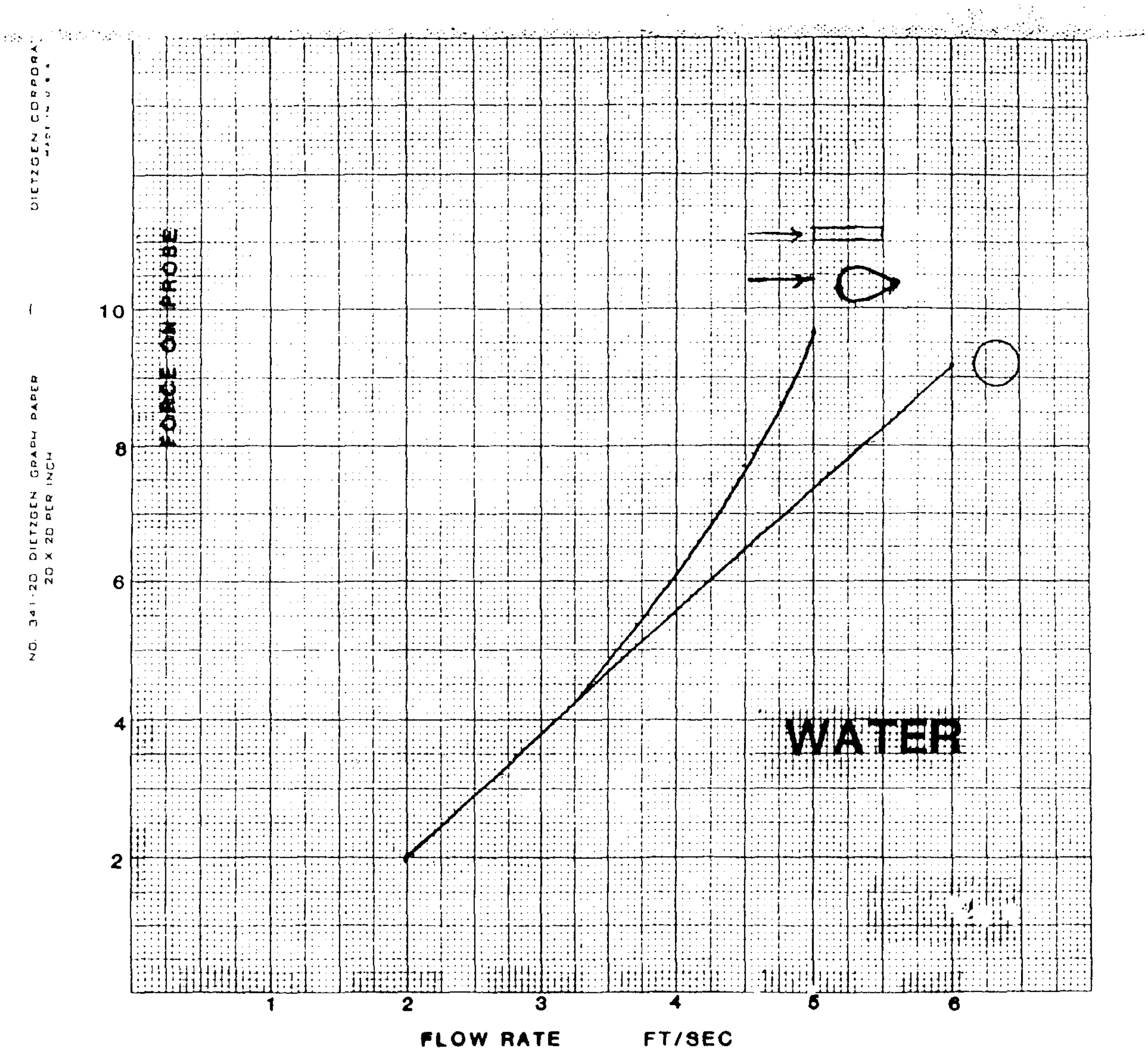

FORCE ON PROBE
10
8
6
4
2
1
2
3
4
5
6
FLOW RATE FT/SEC
WATER
NO. 341-20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH
DIETZGEN CORPORATION

FIG 2

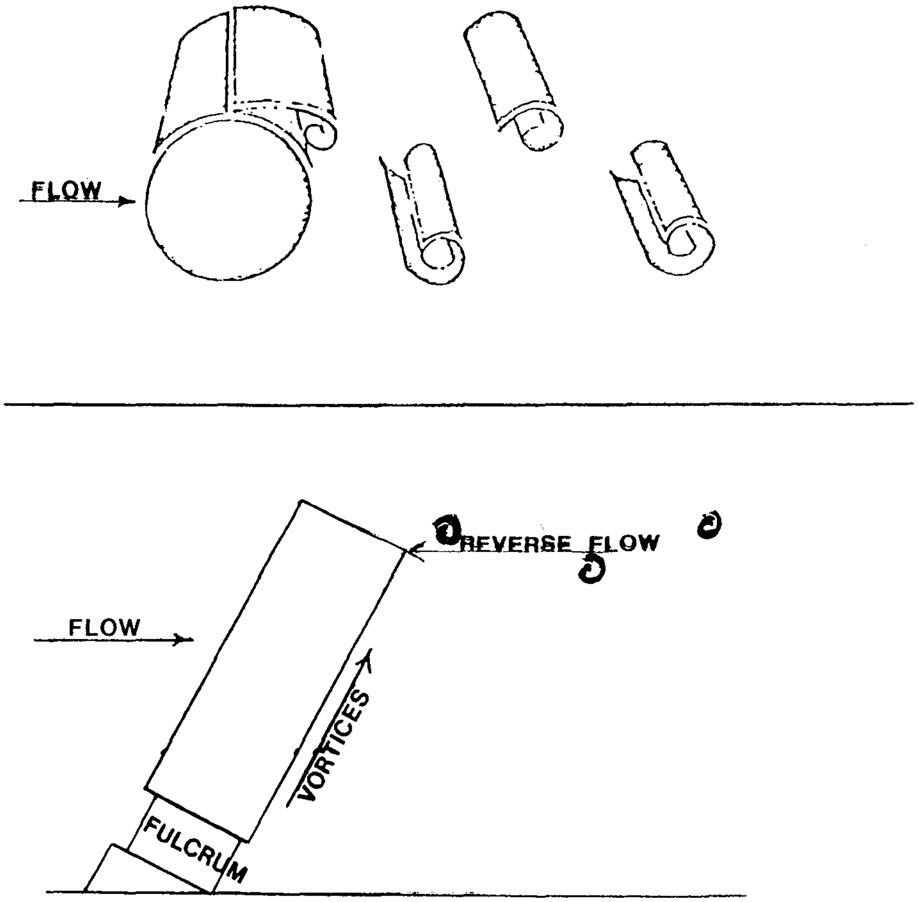


FIG 3

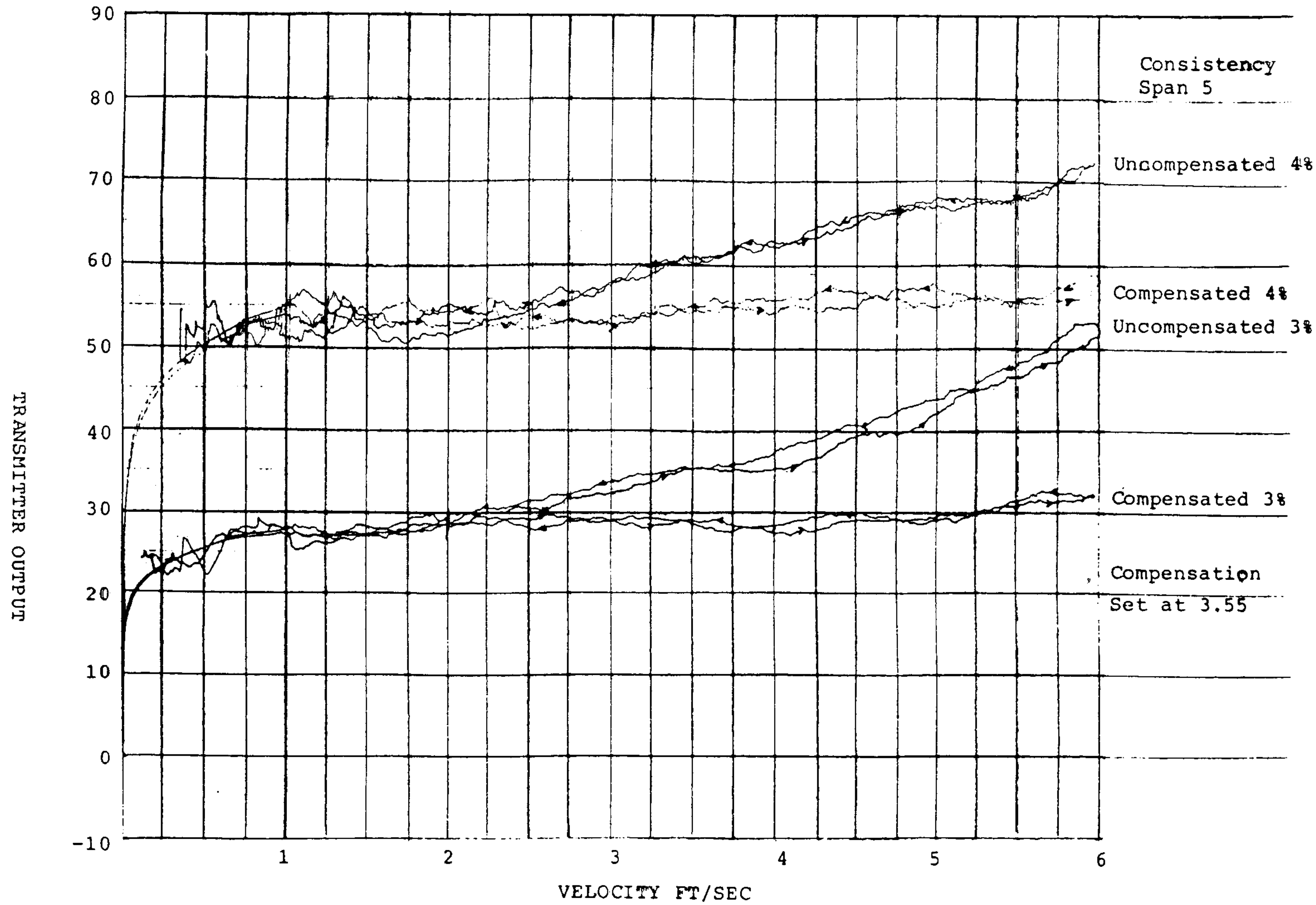

90
80
70
60
50
40
30
20
10
0
-10
TRANSMITTER OUTPUT
1
2
3
4
5
6
VELOCITY FT/SEC
Consistency
Span 5
Uncompensated 4%
Compensated 4%
Uncompensated 3%
Compensated 3%
Compensation
Set at 3.55

FIG 4