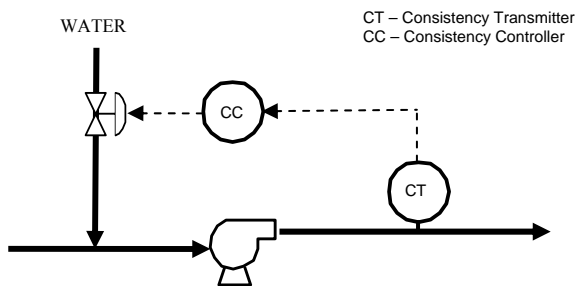


# Application Summary

## Making Effective Consistency Control Easy

Good control of pulp consistency throughout several stages of the papermaking process is essential in the production of a consistent, high quality product. Consistency control operates on a feedback control principle, shown below. The consistency controller reads the consistency from the consistency transmitter and sets the position of an upstream dilution valve to bring the consistency to a desired value. There should be some form of mixing such as a pump between the dilution point and the measurement.



**Basic Consistency Control Loop**

This strategy is the reality in the majority of consistency control loops in industry. Improved control, however, can often be realized by employing straightforward, advanced control techniques. This improvement in consistency control can result in large increases in product quality & consistency, as well as a reduction in shutdowns that would be caused by significant consistency deviations and variability.

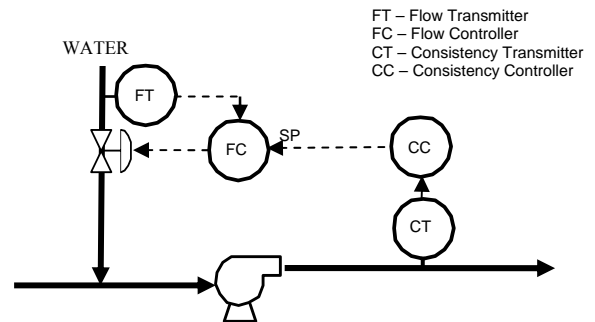
### Header Pressure Disturbance and Cascade Control

Dilution water header pressure variability is often a major variability in the consistency loop. Flow is proportional to the square root of pressure. Thus, with no movement of the control valve, the dilution water flow will vary with varying header pressure. Variations in upstream pressure can also cause variations in valve plug position further disturbing dilution water flow. In the basic consistency control loop, the controller has no way of

knowing about and correcting for this variation in dilution water header pressure until the resulting flow disturbance shows up at the consistency transmitter.

If there were a sudden drop in header pressure, for example, the result would be a drop in dilution water flow. A corresponding increase in consistency would result, but this increase will not be noticed until it is seen at the consistency transmitter. It will then take some time for the controller to correct for this disturbance. The result is that the consistency will be off set point for some time. The problem is greatly compounded if the header pressure varies faster than the consistency control loop can respond. Generally, the consistency control loop is a relatively slow loop in comparison to flow and pressure variation.

It is difficult for most mills to eliminate header pressure fluctuations. The impact of these fluctuations on dilution flow rate, however, can be greatly reduced by adding a flow control loop to the basic strategy. In this cascaded control approach, the dilution water flow is measured and controlled directly. Flow is the slave or secondary loop, and consistency is the master or primary loop. Instead of the output of the consistency controller going directly to the dilution valve, it goes to the set point of the flow controller. The flow loop now regulates the flow as demanded by the consistency controller.



**Cascade Control**

Because the flow loop is a fast-acting loop, variations in dilution flow caused by header pressure disturbances can be corrected before they cause a significant variation in the important consistency measurement. Now when the consistency controller demands a

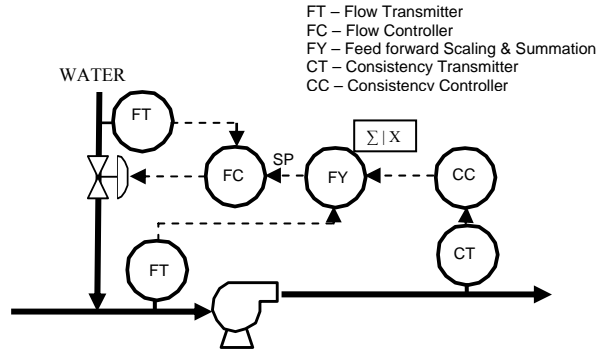
particular flow, the flow controller insures that flow is provided despite disturbances in the upstream pressure.

### Stock Flow Disturbance and Feed Forward Control

Another disturbance that can cause variability in consistency is variations in stock line flow. The consistency control strategy works by regulating the ratio of dilution water to solids in the stock line. As stock flow changes, dilution water must change appropriately.

If the stock flow increases, for example, more fibers are moving through the stock line. The dilution water flow must increase correspondingly with the increase in stock flow to prevent an increase in consistency. In the basic strategy, however, the consistency controller will not be able to compensate for this disturbance until it is seen at the consistency transmitter. It will also take some time for the consistency controller to bring the consistency back to the set point. The result is that the consistency will spend some time away from set point.

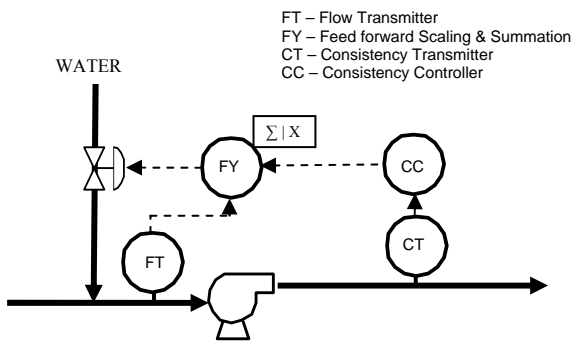
Fluctuations in stock line flow can be compensated for before they cause problems in consistency by using feed forward control. The stock flow is measured and fed forward by scaling and adding it to the output of the consistency controller. With feed forward control, changes in stock flow immediately cause a corresponding change in dilution water flow. Now if the stock flow increases, the dilution water will increase with it so the consistency is not affected.



**Cascade plus Feed forward Control**

### TECO' Solution

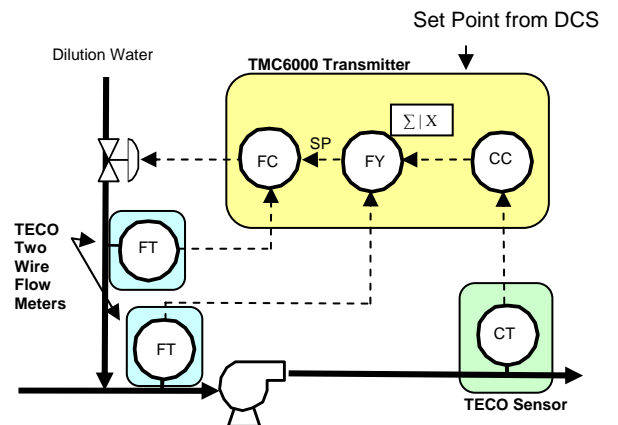
TECO solves the entire consistency measurement and control problem with a unique and economic product line offering, including a broad array of consistency sensors, the industry's only two-wire flow meter and the TMC6000 consistency transmitter. TECO's StockRite™ line of mechanical & microwave consistency sensors measure consistency over a wide range of production flow rates and furnish types. TECO's two-wire flow rate meters can be directly powered by the TMC6000 transmitter. TECO's TMC6000 transmitter combines the various control functions discussed above into a convenient package. Unlike other consistency transmitters, the TMC6000 incorporates both a cascaded dilution water flow control loop and a production flow rate feed forward control loop with the basic consistency control and transmitter function. The TMC6000 can stand alone as a consistency control platform, or can accept consistency set points from a customer's DCS.



**Feedforward Control**

### Cascade with Feed forward Control

Cascade and feed forward control strategies can be combined in consistency control. This strategy compensates for both header pressure disturbances and stock line flow disturbances greatly reducing their effect on the consistency.



**TECO's Consistency Control Solution**

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