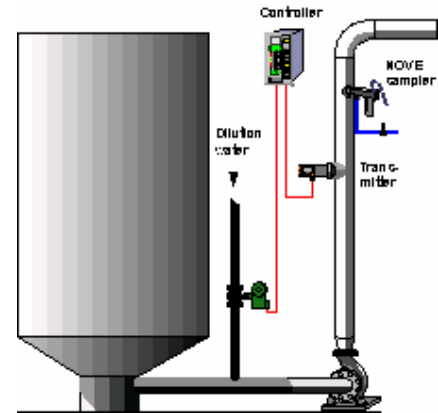


Consistency control loop's design aspects

Besides good measurement, proper sampling and careful consistency analysis in laboratory, we must ensure that the consistency control loop as a whole is properly designed for the intended control tasks. Leaving the detailed discussion of control parameters and control loop calibration to another occasion, the purpose of this show is to examine a few other features which must be in order to ensure successful control results.

Consistency at the bottom of dilution tower should be as uniform as possible, because there will be a delay before a sudden change there is detected at the measuring point. The distance between dilution water inlet and transmitter will then cause fluctuation in the control loop. This uniformity is the result of several factors: consistency variations in the pulp entering the tower, the tower's delay, the mixing result in the tower and even the pulp type, since e.g. CTMP tends to retain pulp concentrations. Such concentrations are formed immediately when the pulp enters the tower. Balancing will occur at the lower part of the tower if agitation there is efficient enough. Higher than 0.5 Cs% variations have been detected in the tower outlet, which indicates a highly irregular control result. The average result may still be O.K., and possible disadvantage depends on the next part of the process.



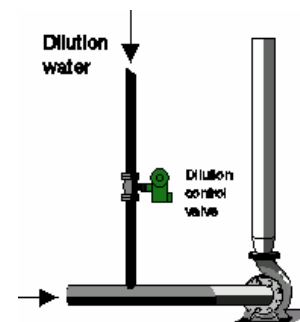
If such fluctuation on either side of the average causes problems, control has to be carried out in two steps by providing an intermediate tank before this tower. However, we should first determine if the tower's outlet consistency can be balanced through, for example, more efficient agitation and/or by measuring the consistency at the bottom of the tower and by making it constant through addition of predilution water to the lower part of the tower. No parts of the tower's agitation elements should ever be above the stock's surface (or even close to the surface), because that would admit air to the stock. Air problems will also occur if the level in the tower drops too low, in which case suction will cause an air eddy at the pipe inlet.

Dilution water

Dilution water pressure should be constant because sudden pressure variations will change the dilution water's flow rate. This will only be corrected by the controller after the control loop's delay, if the pressure change is a non-recurrent event.

Dilution water temperature should be nearly the same as the pulp temperature from tower to pump. This applies especially to mechanical measuring equipment, and to other equipment affected by temperature.

Effects of additives, fillers and coating materials in dilution water should be taken into account especially in optical measuring equipment. Even a small filler content in dilution water may disturb optical measurements especially when the diluted stock is "pure" stock, such as chemical pine pulp.



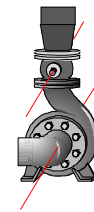
Dilution water feed upstream from pump should be such that mixing in the pump will occur properly.

The dilution water valve should be sized correctly for the best operating range, and the valve should not have excessive free motion or dead time.

The pump

The pump should be able to mix water and inlet pulp effectively. (Note! Variable-speed pumps?? consistency...).

Between pump and transmitter there should be no gate valve or any other partially open valve. A fully open globe valve is possible if it does not cause a restriction in the pipework. The best position for it would be immediately on the pump flange (turbulent flow), after which there would be an expansion in the pipe. However, the valve's axis should be parallel to the pump's axis to avoid whirling flow before the measuring point. Possible limitations specified by the valve manufacturer should be taken into account in this connection.



**Shafts of
the valve
and pump
parallel**

The sizing and design of the pipework should meet the requirements of the transmitter type. There should be no leaks on the pump's inlet side because that would admit air to the stock, thereby disturbing the consistency measurement. Transmitter and also sampling valve should be installed at a point where the flow is fully developed in the pipe. The pulp will then be as uniform as possible, also in terms of consistency.

The Transmitter

The transmitter should be installed as close to the pump as possible to make the distance between transmitter and dilution water feed point short (an additional metre will increase dead time by 0.3-4 s). However, we should not forget the required minimum distance which depends on the transmitter's type and the process conditions (flow rate, consistency...).

The transmitter should be installed as instructed at the correct location and position in relation to the pump and pipework.

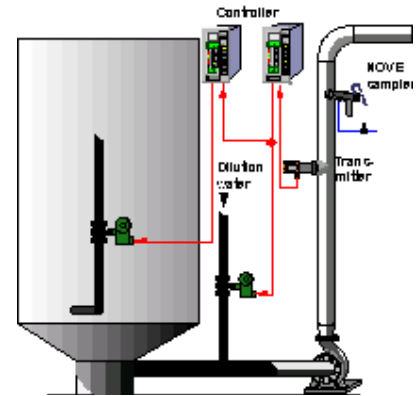
We should know the selected or already running transmitter's behaviour at the selected point in the process. The transmitter's output is affected by a number of different factors, some of which may make the transmitter completely "crazy".

The Controller

Control step should not be too great. Maximum drop in a single step is 50%, preferably 30%, of the initial consistency. If the step is greater, the consistency should be regulated in several steps.

Controller parameters should be set correctly.

Possible rapid flow variations in the main flow should be taken into account in the control loop's design, so that a fast step change (change in production rate) in the main flow will cause an immediate response in the dilution water valve.

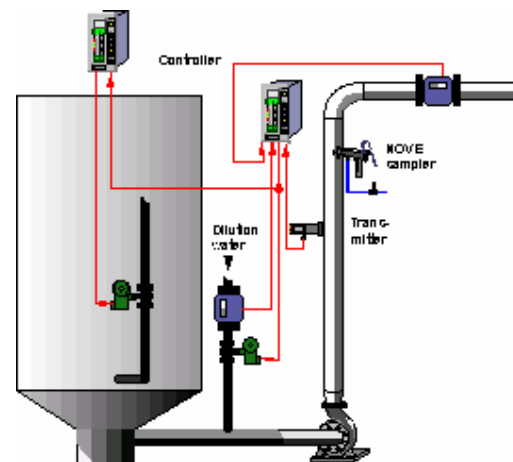


In cases where the tank's infeed consistency or pulp outlet volume from the tank varies substantially (a machine that makes several grades) the dilution water valve must have a wide range. It may happen that the dilution valve gets nearly closed when the tank consistency is low and outlet volume is small. Or, in the opposite case, the valve may get almost fully open. Such cases involve the danger that the valve may be driven off its proper range in either extreme position.

This can be rectified by adjusting the valve's operating range correctly through the injection of dilution water to the bottom of the tank by means of another valve.

Possible rapid flow variations in the main flow should be taken into account in the control loop's design, so that a fast step change (change in production rate) in the main flow will cause an immediate response in the dilution water valve.

The illustrated dilution water control loop also prevents effectively disturbances in the control result caused by pressure variations in the dilution water.



The Sampling

Sampling for on-line transmitters should be arranged properly. It makes a difference where and in what position you install the end of the sampling tube. As a rule, the flow should be fully developed before the sampling point.

Sample taking for laboratory should be performed at the correct point (fully developed flow) and with correct equipment, and it should be done with special care. The features mentioned in sections 1 and 2 will sometimes cause a big difference between the consistency transmitter's signal and laboratory result. For this reason it is important to take a sufficient number of samples from a sufficient time interval (e.g. 5-10 samples at 2-3 s intervals while the transmitter's output is constant), and to compare the average of the samples and of the transmitter.

Laboratory

Work at laboratory should be efficient especially in the calibration of the consistency transmitter.