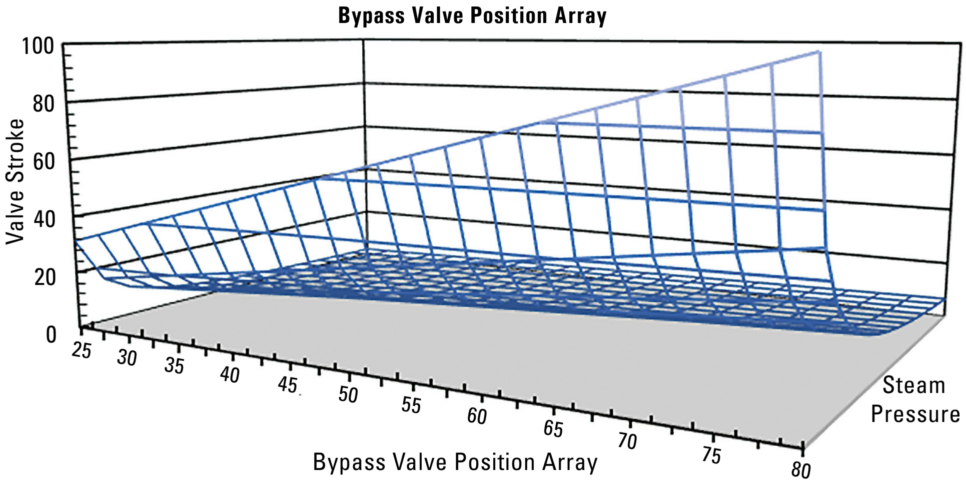
Making Control Loops Smarter

For some applications in power plants, it is not a good option to wait until control loops reach the setpoint based solely on the reaction to the control deviation over time, as this may cause activation of warning signals or, in the worst case, may even trigger protection commands due to a delay in reaching the required setpoint. Some control loops are additionally susceptible to undesired oscillations. Hence, these affected control loops should be made smarter, so they behave more stably and react faster.

How this can be easily achieved is explained here with various examples.

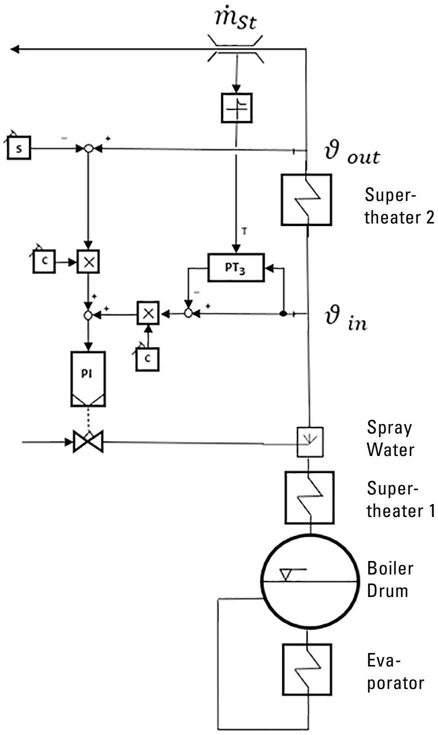
STEAM BYPASS STATION

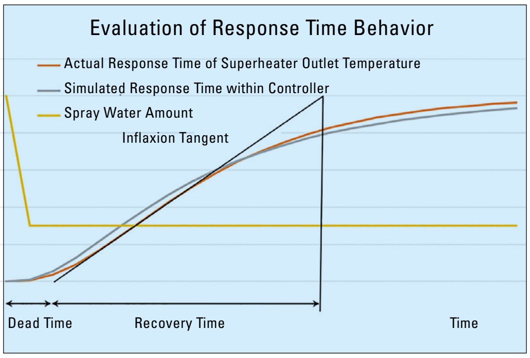
Steam pressure fluctuations lead to temporary changes in steam production in the evaporator. As the evaporation readjusts to the altered thermodynamical equilibrium, the water level within the boiler drum reacts sensitively, especially if transient compressions or decompressions of the steam system are rapid. It is therefore important to smoothly control pressure changes in steam systems. Especially during steam turbine trips, rapid pressure disturbances might occur, which must be avoided to prevent steam generator trips caused by an unallowable water level in the boiler drums. How can this be accomplished? During steady steam bypass operation, the opening position of the pressure regulating valve of the bypass station, the corresponding steam mass flow, and the steam pressure are recorded. Using these values, a specific array can be created which is implemented in the control logic of the bypass station. As soon as a trip of the steam turbine is initiated, the current values of steam pressure and mass flow are transferred to the controller of the corresponding bypass station, and the required position of its control valve is calculated. The controller in turn sends a fast actuation command to the bypass station control valve to position it accordingly. Afterwards the circuit is released to pressure control mode.



STEAM ATTEMPERATOR

A similar approach applies for the spray water of the bypass station to reduce undesired overheating downstream. If the spray water valve were opened solely based on its control deviation, unacceptable delay times might lead to exceedingly high temperatures at the exhaust of the steam bypass regulating valve. The required spray water valve positions to reach the target temperature are determined during steady steam bypass operation at different loads and the corresponding position values are implemented in the control logic. The spray water valve is opened as soon as the bypass station leaves its closed position by transmission of the pre-set position, which it must attain quickly. After the valve position is reached, the circuit is released to temperature control mode.





ATTEMPERATORS

Another good example of smart control is the intermediate spray water control circuit of the superheaters. Due to the thermal inertia caused by the metal mass installed in the heat exchangers, superheaters have a prolonged response time to changes in outlet temperature. Hence, standard control logics have proven to be insufficient to allow a steady, non-oscillating temperature control. A so-called "dual-circuit controller" is applied which uses the in- and outlet temperatures of the second (final) superheater. The steam mass flow is processed in the logic to adjust the correct time constant to simulate the physical time response of the second superheater within the controller. By the way, the response time of the superheater and the steam mass flow behave inversely to each other. The actual time response of the superheater is determined by abrupt manual changes in the spray water amount at different steam mass flows, with the reaction of the outlet temperature being recorded over time. The control deviation is then created by comparison of the actual superheater outlet temperature to its required setpoint, and the changes in the inlet temperature are used to anticipate the reaction of the second superheater outlet temperature to dynamically manipulate the aforementioned control deviation within the logic accordingly, thus resulting in a fast, stable, and non-oscillating control behaviour.

Creative operators can of course transfer the above-described approach to other control tasks in power plant automation. Just be inventive!

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