A Keystone Company

The Importance of Correctly Instrumenting a Desuperheating System

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A correctly sized desuperheater can be incorrectly instrumented causing line flooding. This common problem often has a quick no cost solution.

Steam desuperheaters spray atomized cooling water into the steam line for direct contact mixing with the superheated steam. Superheat energy (enthalpy) goes toward vaporizing the cooling water. Ideally, just enough water is injected to convert all of the superheated steam to a saturated vapor for admission into the heat exchanger.

Process industries use condensing film heat exchangers to transfer a steams' latent heat of vaporization into the product. Superheated steam forms an insulating vapor layer that inhibits heat transfer decreasing heat exchanger efficiency. Saturated vapor steam has the highest heat transfer coefficient and makes for highest heat exchanger throughput.

Determining what is and is not a saturated vapor can be difficult in an industrial setting. One method is a calorimeter enthalpy measurement test but this would be expensive and time consuming, making it unsuitable for real time control.

Temperature measurement and feedback control is the chosen method. Steam superheat temperature is measured (process variable) and compared to the required temperature (set point). The controller then determines the new position of the water control valve (final control element) located upstream.

Temperature measurement is an indirect method of control in that enthalpy is not measured. Temperature measurements can only detect changes in the superheated region. When the saturation temperature is reached the temperature stops changing. Any additional water starts the isothermal phase change of vapor to liquid.

Every steam pressure has a saturated vapor temperature. If the temperature control set point is below this saturation temperature the controller will try to achieve set point by further opening of the water control valve. It is thermodynamically impossible for the steam temperature to decrease. The water control valve will now go full open and flood the steam line.

Initially the control room operator will be satisfied with the resulting nice and smooth (flat lined) temperature chart. Then the inconsistency of maybe a 30% process steam demand and a full open water valve won't sit right. The usual but incorrect conclusion is that at 100% process steam demand insufficient water will be injected. Many times the problem surfaces due to water hammer, piping damage, and/or equipment damage.

The first try at a solution might be to crank set point up to saturation plus one or two degrees. But allowances must be made for:

- Fluctuations in steam pressure due to upstream pressure control valve. Steam pressure fluctuations mean a shifting saturation temperature.
- Typically temperature set points are not automatically reset to match the fluctuating steam pressure.
- Inherent errors in the pressure and temperature measurement and control instrumentation.
- Challenging transients in process steam demand and the resulting timing between a steam pressure control loop and the lagging temperature control loop.

The correct solution is to allow for the above considerations by increasing the temperature set point to a minimum saturation +10°F (≈6°C).

If your desuperheating system continues to flood the steam line, call the desuperheater manufacturer. Their experience can help you define the problem, identify causes, and quickly reach solutions.

EXAMPLE

Given Steam pressure 50 psig (Set Point) with ±10% fluctuations due to process demand transients. This results in a pressure range of 45 psig to 55 psig, or corresponding saturation temperature range of 293°F to 303°F.

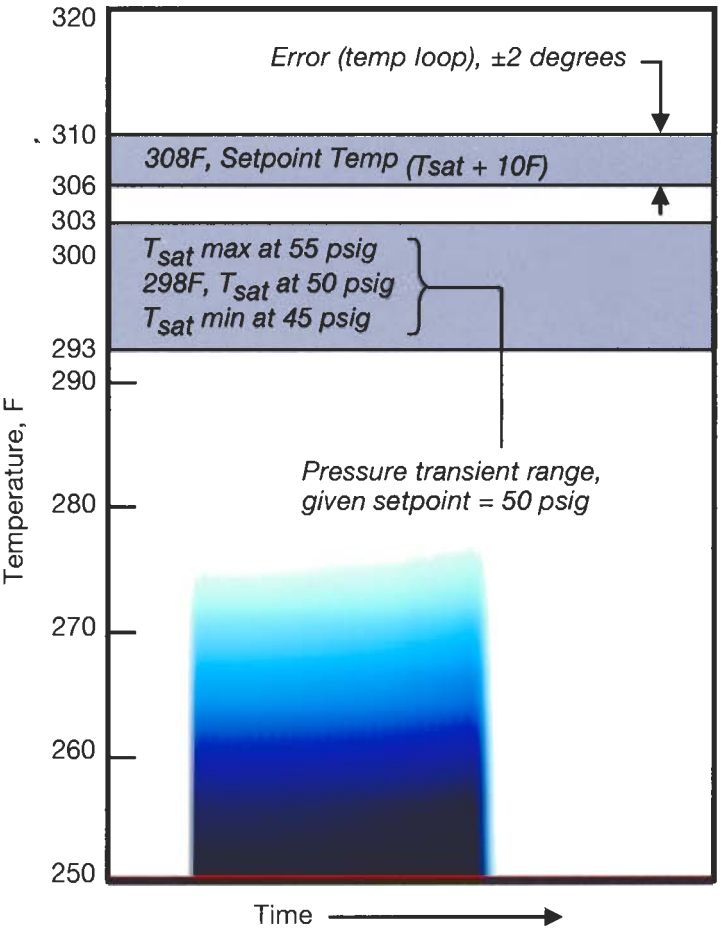
Given Steam outlet temperature 308°F (Set Point) is equal to saturation temperature at 50 psig plus 10°F (298°F +10°F=308°F). Given a typical temperature controller range of 200°F to 400°F and instrument control to within ±1% of the controller range.... then the temperature set point could be from 306°F to 310°F.

The process temperature could vary about the low 306°F set point. The pressure may vary to 55 psig giving a saturation temperature of 303°F. This would leave 3°F superheat region above saturation for the feedback controller to maintain temperature stability (306°F - 303°F = 3°F.)

In general any occasion where the saturation temperature goes higher (from a pressure increase) than the set point temperature, spray water will likely fall out.

Extended events where the saturation temperature stays higher than the set point temperature will cause the temperature controller to drive the desuperheater (Temperature - Control Valve) to the 100% open position thereby flooding the steam line.

Rule of thumb ..... steam desuperheater temperature controller set point should be at least 10°F above the pressure set point's saturation temperature.



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