Make sure you buy the right desuperheater

Desuperheating applications range widely, but so do equipment types.
Your job: correctly match equipment to need.
Begin by checking all available designs-advantages and limitations of each.

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Whenever steam is available but temperature is too high, some form of desuperheating will be needed. What we want to do is adjust steam temperature with minimum drop in steam pressure. At first glance, desuperheating would seem to be a waste-why begin by superheating the steam beyond our needs and then have to reverse the process and desuperheat it? But in today's technology, high-pressure high-temperature boilers make economic sense, so there is a built-in incentive to produce steam with more and more superheat. On the other hand, there will always be cases where superheated steam is too hot or too dry for some power-plant and process operations.

In power-generating stations, for example, steam temperatures rise when loads are light. This calls for desuperheating, either between or after superheater stages and possibly in a reheater too. In plants that generate steam for power and process, superheated steam must sometimes be diverted directly to process when power demand drops. Just right for the turbine, this steam is too hot for the process; again we have to desuperheat it. Or the steam may be too hot because: (1) process equipment has structural temperature limitations (2) lubrication equipment can't tolerate high temperatures (3) process material would be damaged by too much heat.

Superheated steam may be too dry for process operations, as well as too hot. Surface heat exchangers, for example, work best when fed with saturated steam. They're usually very inefficient with superheated steam.

Most desuperheaters work on the same principle. They bring cooling water into contact with the superheated steam, evaporate the water to desuperheat the steam and control the flow of cooling water according to desired degree of desuperheating. The basic need is to establish intimate contact between the cooling water and superheated steam, and desuperheaters may be classified on the basis of how they go about this job.

Spray type desuperheaters spray cooling water into the steam, first breaking it up into small drops. To do this, they use mechanical atomizers (sometimes called carburetor types) or steam atomizers. Nozzles inject cooling water directly into the steam pipeline. All of these atomizers need a source of clean water at higher-than-line pressure. Cooling water hitting the pipe walls can create a serious erosion problem. But it's possible to control or even eliminate erosion by inserting a *thermal sleeve* into the pipe at the point of contact. In addition, thermal sleeves can actually increase desuperheating efficiency if they are installed so that superheated steam circulates between sleeve and pipe wall-this promotes more complete evaporation of the cooling water.

Steam atomizers use a constant flow of auxiliary steam to disperse the cooling water. They can operate over a range of cooling-water flows, but the auxiliary steam pressure must be higher than line pressure.

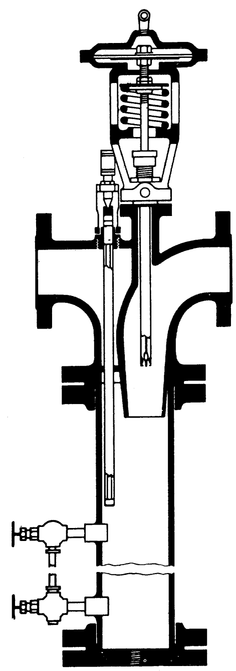
Surface type desuperheaters establish the needed contact between cooling water and steam by mechanically extending the contact surface. In this class, too, come shell and finned-tube heat exchangers, which can double as desuperheaters if there is no convenient supply of clean cooling water.

Turbulent-contact desuperheaters establish intimate contact by creating steam turbulence at the point of water injection. In most cases this is accomplished by a restriction in the steam line. Pressure drops in turbulent-contact desuperheaters are low, and units work well over a flow range of 10:1. Again, they need a source of clean cooling water. Here, however, cooling-water pressure is not directly related to steam pressure but depends upon the specific design.

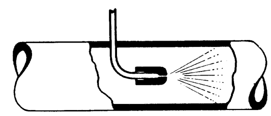
A modification of this basic type recovers unevaporated cooling water and recycles it through the desuperheater. This design is most likely to apply where the approach to saturation is 10 to 50°F at low flows.

Sketches on the next two pages illustrate the basic types, and show some variations to meet specific needs.

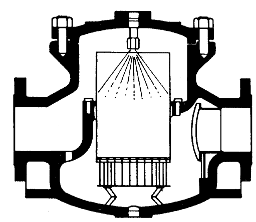
Water is sprayed under pressure directly into the flowing superheated steam
Simplest mechanical spray atomizer is just a *spray nozzle*, **2**, inserted directly into the steam line. It breaks cooling water into a fine spray, promoting intimate contact with the steam. Nozzle angle must be limited to prevent erosion of pipe wall unless a thermal sleeve is used. Multiple nozzles may work better than one large one; nozzles can be turned around upstream. In the *spray-chamber* type, **3**, cooling-water nozzle is inserted in an enlargement in the pipe which also contains a steam separator.



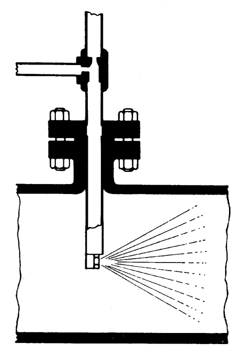
1 Variable-orifice nozzle



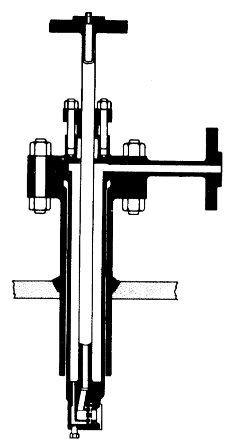
2 Spray nozzle



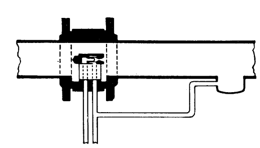
3 Spray chamber



4 Steam assist



5 Two-fluid nozzle



6 Ejector with recycle

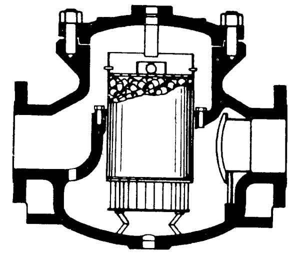
When target type *variable-orifice* nozzles are use, **1**, it's possible to run with reduced flows. But these aren't true atomizing nozzles, so dispersion efficiency drops off somewhat.

Steam-assist desuperheaters give some boost to cooling-water pressure so you can get away with initial lower-than-line water pressure. Auxiliary steam pressure, of course, must be higher than line pressure. Basic *steam-assist* design, **4**, merely draws water into a water-steam mixture, then introduces this mixture. In the *2-fluid nozzle* type, **5**, concentric nozzles handle steam and cooling water separately. High-velocity steam impinges on the cooling water to give superior atomization. But in this design, auxiliary steam must be furnished at about 100 psi higher than line pressure.

An ejector desuperheater uses h-p steam to entrain, preheat and atomize the cooling water. It operates efficiently even at low flow rates (up to 20:1). But at very low flows-up to 50:1-unvaporized water tends to settle out no matter how it's introduced-especially when you're approaching saturation by 10 to 50°F. An *ejector-plus-recycle* arrangement, **6**, catches this unvaporized water, returns it to cooling-water inlet and re-injects it.

Reaction rings up cooling surface

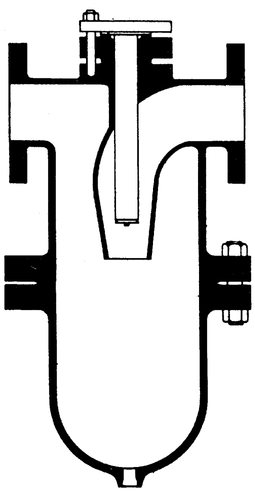
Surface-absorption desuperheaters, **7**, use reaction rings to extend cooling-water surface, create turbulence and prolong contact time. They normally have integral steam separators and can be used without controls to give saturated steam. With controls they handle a flow change up to 10:1. Pressure drop is high. Because chamber size is large, these units are usually limited to 12-in. lines or smaller.


7 Surface absorption

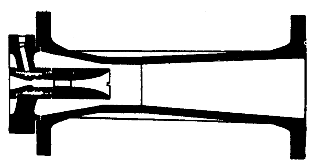
When there is no convenient supply of clean cooling water, a shell-and-tube heat exchanger can double as a desuperheater. But extended-surface tubes on the steam side are a must. First cost is high compared to other types; operating costs can also run high because a portion of the heat is lost to cooling water.

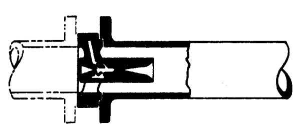
Turbulence helps disperse desuperheating water in steam flow

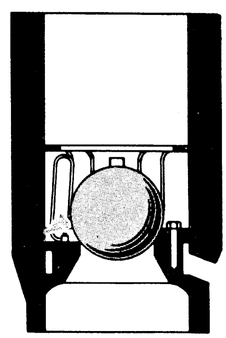
Turbulent-contact desuperheaters get intimate mixing via steam turbulence; they introduce a restriction in the steam flow at the point of water injection. Thus contact time between steam and water is extended, pressure drop is low and performance is good over a flow range of 10:1.


8 Flow nozzle

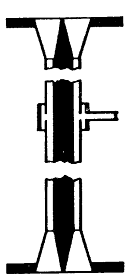
Simple *flow-nozzle* type, **8**, encourages mixing, high velocity and turbulent expansion. More sophisticated *full-venturi,* **9**, and *partial-venturi* types, **10**, create very high velocities and turbulence with lower pressure drops. In some design, superheated steam enters the cooling-water chamber where it's preheated and atomized before discharging into the main mixing chamber. In most cases cooling water must be at line pressure, but double-venturi types can take a lower water pressure.


9 Full venturi


10 Partial venturi


11 Variable orifice

Variable-orifice desuperheaters, **11**, have a ball that floats on upward steam flow. They must go in a vertical line so the ball will always tend to seat. Alternate design resemble throttle valves: they control stem travel to vary flow. In either case cooling water comes in at the seat-point of maximum steam velocity. Both types follow steam-flow needs by varying the orifice: they keep steam velocity constant.


12 Annular venturi

Annular-venturi design, **12**, must also be installed in a vertical pipe run with upward steam flow. Cooling water enters through a nozzle ring. At low flows the water is suspended in steam flow to prolong contact time, assuring more complete evaporation in these operating ranges.