BENEFITS OF AIROL® VORTEX CYCLONE SEPARATORS AND SCRUBBERS FOR GEOTHERMAL FLASH APPLICATIONS

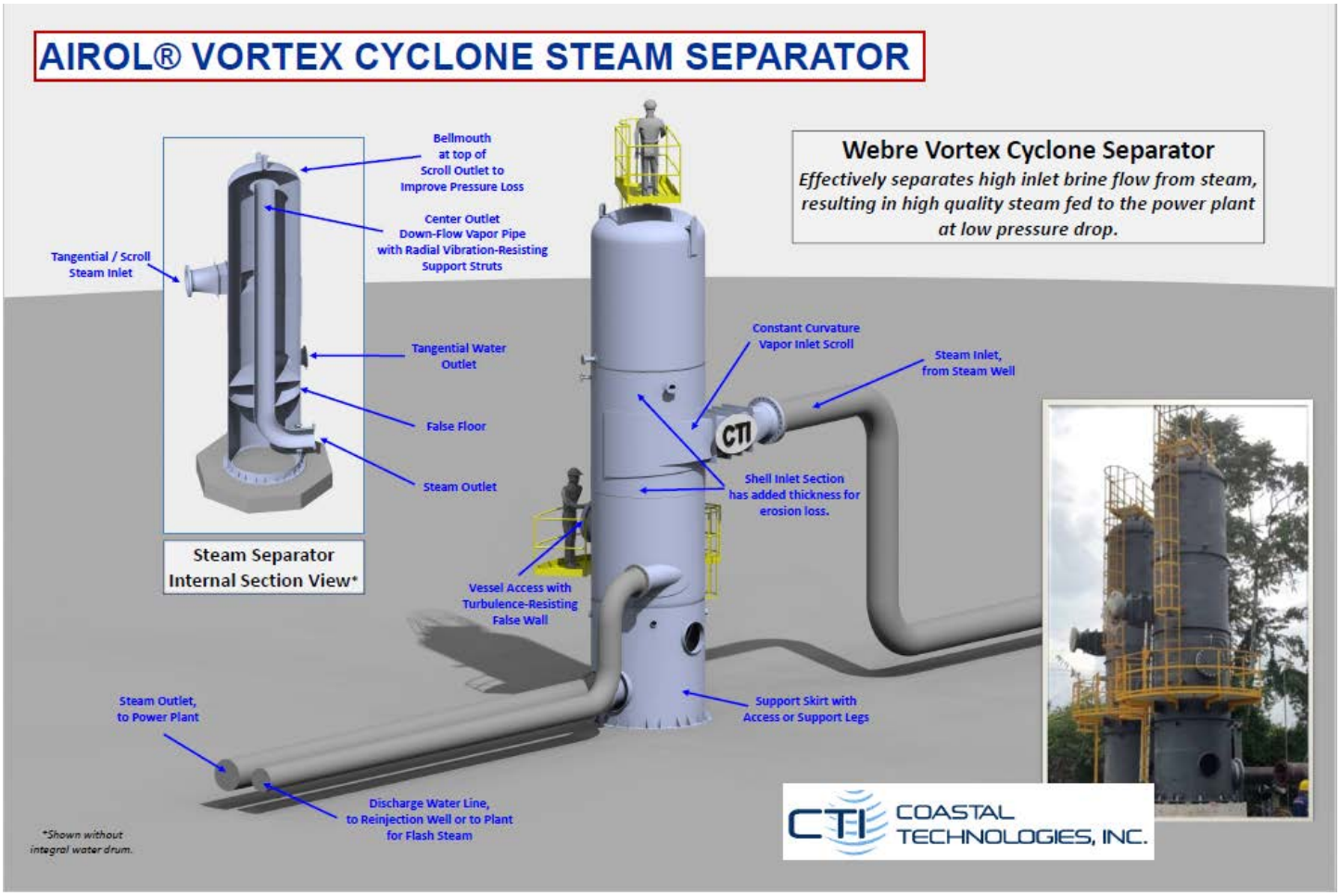
Geothermal conditions are highly variable and change over time. Steam from production wells rises to the surface as a result of flashing brine from the reservoir as pressure decreases. The result is a significant quantity of liquid brine, along with the flashed steam, at the surface. A range of 35-60% of the mass at the surface is liquid. Almost all the brine must be removed to safeguard the downstream steam turbine, which is driving the electric generator. The chemistry of the brine and steam coming from the wells, and the liquid ultimately flowing to the turbines is unique. The type of contaminates, quantity of contaminates, and chemical composition of contaminates are in flux, and vary at each geothermal site, and can vary even at the same well. Wells can be susceptible to 'slugs' and surges in the flow. The design of separators and scrubbers needs to handle these varied and potentially changing conditions. In geothermal power applications robust equipment is required.

Flash separation of the brine occurs at the well-head in a separator designed for high pressure and high temperature conditions in the pipeline. Coastal Technologies offers its well-head *AIROL® Vortex Cyclone Steam Separator* for high removal efficiency at a low pressure drop. In addition, CO_2 removal may be required at the well-head in some binary geothermal systems where the hot brine is used to vaporize a separate hydrocarbon liquid. Smaller vortex separators can be used here as well.

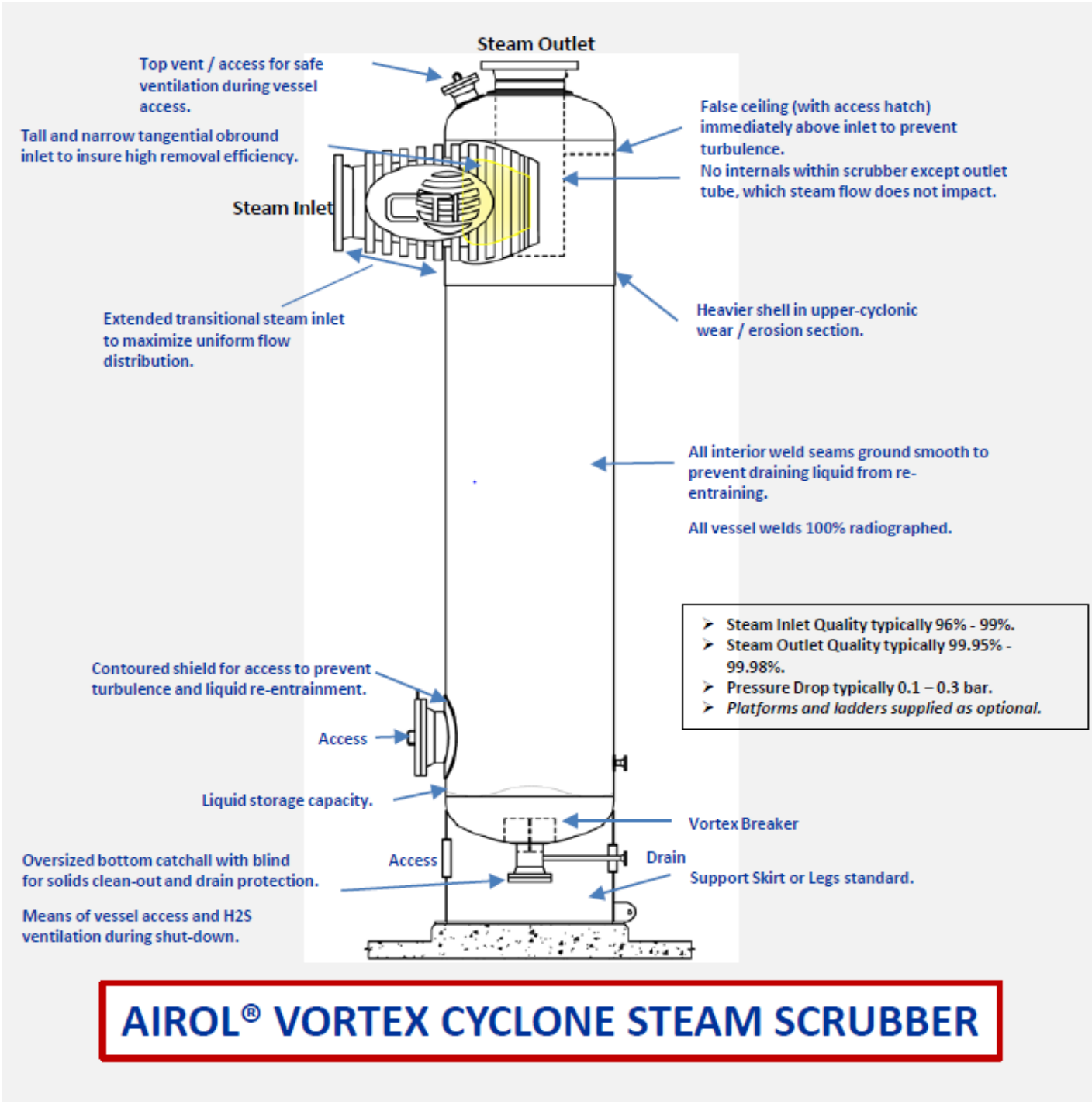
The distance the steam travels to the turbine affects the temperature of the steam. The further the distance, the more the temperature decreases, and the more the steam condenses, becoming wetter. The condensate actually scrubs out residual brine. Just before the steam turbine, a steam scrubber is used to remove the steam that condensed between the upstream separator and the scrubber. Typical scrubber inlet liquid loading is anywhere from 96% to 99% and typical outlet steam quality is 99.95-99.98%. The scrubber, generally, is the last piece of major equipment immediately before the steam turbine, and needs to be highly dependable. Turbine scrubbers basically fall into two types – either a vessel with chevron vanes (vertical or horizontal 2-stage design using an inlet coalescer followed by a chevron mist eliminator), or a vessel using cyclonic separation principles. CTI offers both designs as part of our AIROL® product portfolio.

THE CTI DESIGN

The CTI *AIROL® Vortex Cyclone Steam Separators and AIROL® Vortex Cyclone Scrubbers* are engineered without internal components that might accidentally break off inside the vessel, subsequently finding their way to the turbine and causing major damage. CTI has used mathematical and scientific modeling in its designs to determine the necessary angles and velocities to achieve the vortex action necessary for effective moisture removal, eliminating reliance on feedback loops or spin vanes to generate this vortex action. The absence of internals increases efficiency and reduces maintenance. Vessels for both well-head separators and steam scrubbers are designed and built to ASME Code requirements.



Water and steam is forced into circular cyclonic motion as a result of the mid-level tangential constant curvature inlet. Water spirals downward toward the tangential water outlet at the base. Steam spirals upward with centrifugal force moving remaining droplets to the side walls, where it drains down to the base. Steam continues to cyclonically spin to the top where it reverses flow and moves down the steam outlet pipe.



AIROL® VORTEX CYCLONE STEAM SCRUBBER

Steam with water droplets is forced into circular cyclonic motion by the top tangential inlet. Steam spirals downward toward the base of the unit as centrifugal force moves the droplets, and any solids, to the side walls. The water falls out and steam reverses up through the outlet tube.

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