Innovative Steam Technologies

# The Inherent Safety of Once-Through Steam Generators

As Manufactured by **Innovative Steam Technologies**

## Overview

The Stainless Steel, Once-Through Steam Generator (OTSG) as designed and manufactured by Innovative Steam Technologies is inherently safe. The unique design of the OTSG significantly reduces the magnitude of the hazard potential as well as the probability that the hazard could occur. The unprecedented safety is made possible by a number of design features and manufacturing processes, many of which are briefly described below.

## Alloy Tube Material

Alloy 800 and 825 are high strength, high temperature, highly corrosion and erosion resistant materials that are generally unaffected by the severe water side and gas side environments that can be encountered, even when the OTSG is operating in a “dry”, non-steaming mode. This material is insensitive to oxygen content and pH. The tube wall thicknesses typically used provide significant extra margins beyond the unit pressure and temperature rating.

## Drumless Design

The use of the once-through, water-side flow path eliminates the need for steam drums which significantly reduces the total amount of water at saturated conditions to a range of 1/10 to 1/20 of the total that would be present in a comparable drum-type HRSG (depending upon the circulation ratio of the HRSG used in the comparison). Because the water content in the OTSG is distributed in multiple, independent circuits arranged in parallel, the hazard potential is further reduced. Therefore, an OTSG with 40 parallel circuits would be 400 to 800 times safer than the comparable drum-type HRSG.

In addition to reducing the hazard potential, the very low saturated water content results in a very low thermal inertia allowing the OTSG to respond rapidly to thermal transients. This makes the OTSSG exceptionally forgiving of operator or control system error and highly tolerant of plant upset conditions that would normally trip an HRSG.

Elimination of the steam drums also eliminates drum level controls and dozens of related components that are a constant source of unplanned shutdowns requiring operator attendance.

## Demineralized and Polished Feedwater

Elimination of steam drums in the OTSG basic design requires that total dissolved solids (TDS) in the feedwater be reduced to approximately 50 parts per billion (ppb) prior to being introduced to the OTSG. This eliminates solids deposition and/or carry over, the formation of scale that could plug tubes leading to tube or other failures, and the need for active chemical treatment. It also reduces chlorine levels to well below problem levels to eliminate concern with stress corrosion, crevice corrosion, and pitting.

## Dry Operating Capability

The use of alloy tube material together with polished feedwater permits the OTSG to operate safely in a dry, non-steaming mode, and to be started hot. This simplifies startup procedures by allowing the host gas turbine to be started and place on-line, then starting the OTSG as opposed to the complex practice of "walking" both units together. The dry operating capability also allows the unit to be safely stopped in an emergency by simply closing the feedwater flow control valve.

## Microprocessor Control

The control strategy for the OTSG is very simple. The control system is designed to maintain a constant set point steam temperature under any and all operating conditions by simply varying the feewater flow rate. The predictive, feed-forward control loop provides the final "trim" to the valve position. With the recommended triple redundencly of critical control instrumentation, it becomes clear that the great degree of "fail-safe" operating capability is far superior to any other available technology.

## Manufacturing Processes

The presence of weld cracks in carbon steel tubes is likely to lead to tube failures including fatigues due to stress concentrations at the cracks, crevice corrosion and erosion caused by steam or feedwater leaking from cracks that fully penetrate the tube wall and cause erosion and/or corrosion to adjacent tubes. In the case of the drum-type HRSG, multiple-pass, manual welding techniques are used with the thicker wall carbon steel tubes which can lead to variations in weld quality, and increase the potential for tube failure.

The welding of alloy on the other hand, uses weld procedures very different from and more sophisticated that the welding of carbon steel. Innovative Steam Technologies uses a single-pass, automated Tungsten Inert Gas (TIG) machine welding process to produce a full-penetration, parent metal butt weld wherein no filler material is used. As a result, the consistency in the type and quality of welds is assured, and there are no crevices to precipitate corrosion.

IST's manufacturing processes require the use of minimum tube wall thicknesses that frequently exceed the wall thickness required per ASME Code calculations. As a result, the OTSG thus produced will frequently have a pressure-temperature capability beyond the design point providing extra safety margins.

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## Summary

It is Innovative Steam Technologies' intent to provide exceptional safety margins in it's OTSG design to further enhance the user's value received. Operating safety and simplicity is and always has ranked very high on IST's list of design priorities.