What is Clean Steam

By Carey Merritt

Fulton recently published an ad in the ASHRAE journal for "Clean Steam." There appears to be some confusion about what constitutes clean steam and how Fulton can recommend boiler operation without the use of chemicals. For all those who wonder please read on…….

"Clean Steam" is a term that refers to steam that has very little amounts of water content, dissolved and suspended solids. To get clean steam, the pressure vessel used to generate the steam must be maintained relatively free of corrosion products and scale (sources of suspended solids). Furthermore, the water media used as the source of steam must have a Total Dissolved Solid (TDS) concentration low enough to mitigate carry over in the boiling steam. Lastly, the boiler design relative to steam and water separation (dryness) is very important. A boiler, well designed and operated, will allow only dry (<2%moisture) steam to leave the boiler.

Clean steam is used in many applications. Hospitals required clean steam for autoclaves and sterlizers. Food processes that use steam as a contact heating source can not tolerate any impurities in the steam. Humidification and some industrial processes, especially electronics manufacturing are large users of clean steam.

Traditionally, clean steam boilers have featured small direct fired stainless steel pressure vessels or larger indirect fired stainless steel pressure vessels. Unfortunately, ASME regulations only allow for small direct-fired units (ie. up to about 16hp) when using a stainless steel pressure vessel. Indirect fired clean steam generators can be made to virtually any size, however, many times the cost of the steam to water heat exchanger is prohibitive. In most of these applications ultrapure water (ie. DI/RO) is used to produce steam. Ultrapure water can be costly to produce and itself is mildly corrosive (due to low ph) to carbon and stainless steel. Therefore, the use of ultrapure water usually requires a chemical treatment process to increase the boiler water ph to an acceptable level. With all this said, one can see why clean steam generation has always been a challenge.

The concept of operating a boiler without the use of a chemical treatment program is frightening to most boiler manufactures. This, I believe, is due to some boilers being manufactured that are very unforgiving to corrosion and scaling, and a culture that relies on chemical companies to tell us how to operate our boilers. The fact that Fulton boilers are built like "Sherman Tanks" provides a sound pressure vessel design for generation of clean steam. We have found that normal water (ie. city or well water), if pre treated, can be used in a boiler without the use of chemicals to provide clean steam.

The basis of our claim is a boiler design that incorporates enhancements that allow an operator to maintain a water chemistry favorable for PV longevity. We provide means to remove impurities that cause scaling (softening), corrosion (dearation) and carry over (automatic blowdown and steam dryer). These enhancements coupled with improved boiler monitoring relative to stack temperature and conductivity can provide a simple cost effective method of clean steam generation.

Guidance for Clean Steam/ Humidification Boiler Design and Operation

Assumptions: The boiler will operate with no chemical treatment program, thus providing a very high steam quality.

Theory of Operation: Since no chemicals will be used to control corrosion and scale build up, then the design and operation of the boiler system must be comprehensive and compensatory. Here is a list of the standard features of this boiler package.

1. Water conditioning program that will de-chlorinate and soften the make-up water. The softening system is a dual tank system that has electronic controls for automatic operation. A carbon filter is used to remove organics and the chlorine. If DI/RO water is used then conditioning is not required
2. A conductivity based surface blowdown system is used to control dissolved solids in the boiler. The system has an automatic control with a manual bypass. This enables operators to keep the cycles of concentration at a very controlled level with minimal interfacing.
3. Extremely low NPSHR feed water pumps are used which enable the boiler operator to preheat the make up water to 200F and drive off most of the dissolved oxygen.
4. A preheat system that will de-oxygenate the feed water to an acceptable level.
5. A stack temperature sensor and alarm is used to monitor boiler efficiency. This will give operators an early detection system if the boiler starts to scale or foul.
6. An optional sample cooler is offered to provide an easy access point to monitor boiler water. Side stream monitoring can be done at this location if desired.
7. A steam dryer is offered as an option if super dry steam is required.

Recommended Chemistry Limits for Clean Steam Boilers:

	Make up Water	*Feed Water*	*Boilerwater*	*Method of Control/ Removal*
Free Chlorine	< 0.02ppm		ND	Carbon Filtration
Dissolved Oxygen		<0.05ppm	ND	De-aeration/preheat
Hardness	< 0.05ppm		< 1 ppm	Water Softener
Suspended Solids	< 1 ppm		< 15 ppm	Back wash/ blow down
ph			8.5- 10	Neutralizer pre-teatment
Total Dissolved Solids (TDS)			< 1500 ppm	Blow down
Total Organic Carbon	< 1ppm		ND	Carbon Filtration