Steam Trap Testing
How Do Steam Traps Stack Up?

PART 1

By

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ABSTRACT

During the design and fabrication of Biopharmaceutical systems such as Bioreactors, Fermentors and other hygienic equipment designed for SIP, the minimum heights of these systems are often governed by the elevation of the steam traps.

In order to achieve successful sterilization, RTD's that are installed upstream of these traps must be high enough above the trap to prevent a column of condensate from coming in contact with the RTDs during maintenance of SIP temperatures. If the condensate column contacts the RTD, the temperature will drop and this will disrupt and extend SIP cycles.

As an OEM skid manufacturer, Cotter Brothers encounters a wide variety of client-specified models of sanitary traps as well as a large range of specifications for minimum RTD-trap heights. These heights range from 6" to 18", and in many cases, the designs require some sacrificing of these heights in order to meet other criteria such as available room height.

Obviously in these conditions, traps that can operate with a minimum backup of condensate during maintenance of SIP temperature will be the best performers.

The questions are: how does the performance of different traps compare when tested under similar conditions, and which might be the best selection where piping does not allow much vertical distance between the trap and the RTD? Also, where vertical distance is not available, does horizontal piping upstream of the trap help?

We decided to put this to a test. A number of common traps models, listed in Table 1, were provided to us by vendors for use in this testing.

Table 1. Trap List

MFG	Model	Size	Ends
Sarco	MTS21	3/4"	TC
Sarco	BTM7	3/4"	TC
Sarco	BTD52L	1/2"	TC
Jordan	MK93	1/2"	TC
Jordan	MK93	3/4"	TC
Nicholson	CDS204	3/4"	TC
Nicholson	DS100	3/4"	TC
Sarco	BT6	3/4"	TC
Sarco	BT6HC	1"	TC
Gestra	SMK22	3/4"	TC
TLV	LV6SF	3/4"	TC
Watson McDaniel	FDA600	3/4"	BW

Target condensate loads for our tests were selected based on typical loads found during maintenance of SIP for various size vessels, as shown in Table 2 below.

Table 2. SIP condensate loads

Nominal Tank Volume (Liter)	Peak Condensate Load (lb/h) during vessel heat-up	Steady Condensate Load (lb/h) during SIP Maintenance
40000	2500	27
15000	1250	14
7200	400	7
3000	300	5
1500	200	3
600	100	2
100	30	1
20	15	0.5

(Reprinted with permission "Designing a Shorter Vertical Leg for Sanitary Steam Traps" by George W. Page Jr. and Richard Kral. Published September 2006, Biopharm International.)

TEST APPARATUS (Fig. 1a)

The test rig consisted of a length 3" tubing with an internal cooling coil. A flowmeter and needle valve on the cooling coil allowed a range of condensate loads to be generated.

The loads could also be increased as needed to "challenge" each trap. An 18" polysulfone sight tube was installed on the outlet of the rig, and the trap to be tested was installed downstream of the sight tube, allowing the heights of condensate to be viewed and measured. The sight tube was graduated to measure the height in inches of condensate as measured from the top clamp connection of the trap. A pressure gauge was installed on the inlet of the rig, and a graduated beaker was used to collect and measure the condensate passed by the trap during each test.

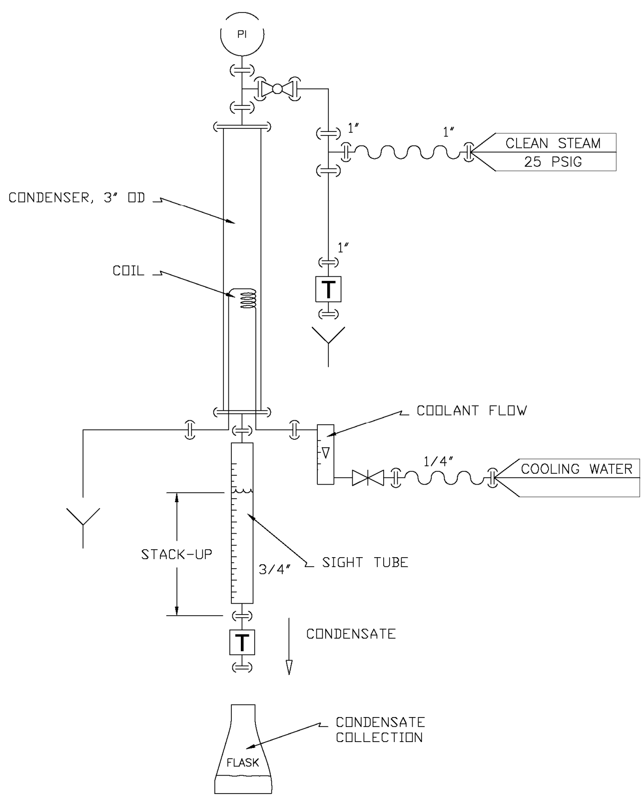


Fig. 1A: TEST RIG

PROCEDURE

After a 5 minute warm-up, each trap was subjected to four (4) 15 minute tests using approximately 25 psig clean steam. For each of the four tests, a different target condensate load was set to measure performance at four loads from about 4 to 10 lbs/hr. During the test, if any condensate column was observed, the height and frequency of any observed condensate build up was logged. At the end of each test, the total volume of condensate passed by the trap was recorded. If a trap would not build up any condensate at a load between 4 and 10 lbs/hr, the load was increased until some measurable stackup could be observed and recorded.

The four tests were then repeated with the horizontal spool installed between the sight tube and the trap, taking into account the added vertical distance for the elbows.

FINDINGS

The traps behaved differently during the test. Some models would maintain some steady level of condensate above the trap for long periods of time, cycle very slowly and evacuate infrequently. Some models would build up and evacuate condensate quickly a great number of times, but never exceed a certain height of condensate. Some traps remained empty for the majority of tests, and suddenly filled to a few inches once or twice. We decided to compare the traps based on their average condensate stackup in inches for each given condensate load. The results are plotted in Table 3a.

We also looked at the maximum height vs. condensate load, shown in Table 3b.

Table 3a, Average Stackup

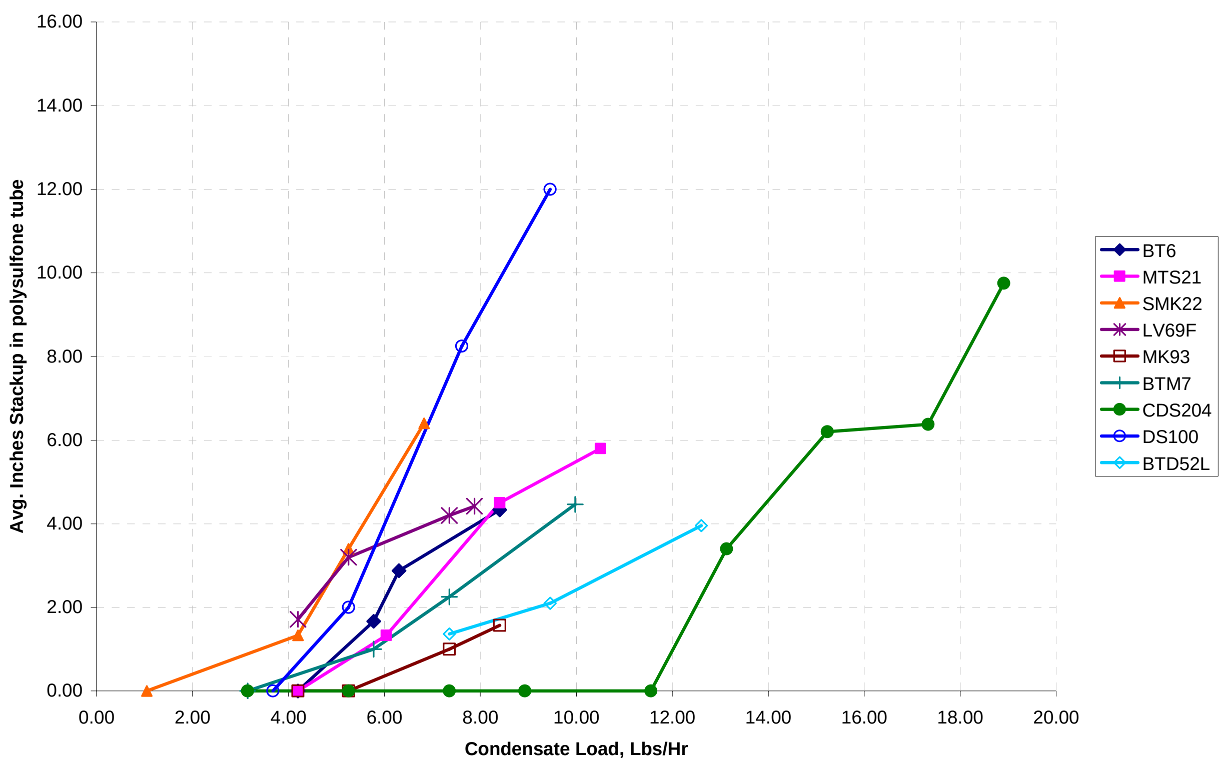
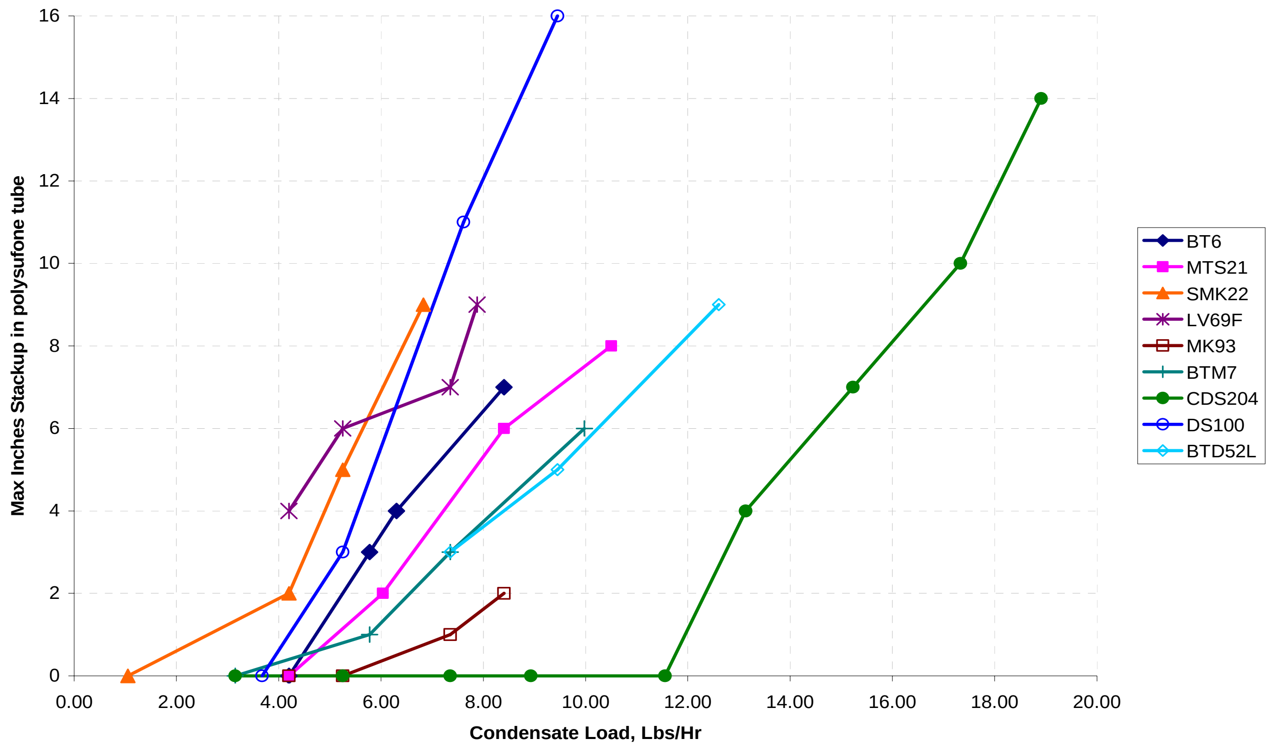


Table 3b, Max Stackup



Testing was also repeated with a 12" horizontal spool with elbows installed between the end of the sight tube and the trap, to see if total stackup height could be reduced by using horizontal piping to increase both the cooling and volume of condensate.
In all cases, the use of horizontal piping greatly decreased the total stack up of condensate.

CONCLUSIONS

Obviously trap performance is dependent on numerous factors that may differ with specific installations, and certain customers have preferences for standardizing on a particular model of trap. Also, our test rig may or may not closely duplicate real-world installations with SS piping and instances of insulated lines, and the traps tested here may perform quite differently in other circumstances. However, when system design is "vertically challenged", our tests indicate that by using a high performance trap, and by increasing the length of horizontal piping upstream of the trap, the total vertical distance between the RTD and trap on small and medium systems can be as low as a few inches, increasing the chances for successful SIP.