APPLICATION PROFILE #5

HAT VALVES VS. CONVENTIONAL STEAM TRAPS: OPERATING COST COMPARISON

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The **THERM-OMEGA-TECH *HAT*** valves provide substantial savings when compared to the cost of operating conventional steam traps. The ***HAT*** valves sense condensate temperature and open to allow flow only when the condensate temperature is below the setpoint, well below saturated steam temperature. The condensate forms a liquid seal ahead of each valve preventing live steam losses. Also, the sensible heat in the condensate between steam temperature and the ***HAT*** discharge temperature is used for heating.

Most properly functioning conventional steam traps have inherent live steam losses: at least 2 lbs/hr. for inverted bucket traps, and over 5 lbs/hr for disc traps. Actual field studies have shown that live steam losses of disc traps increase considerably with time in service, with losses of 20 lb/hr after less than one year of service being not unusual. Losses from other types of conventional traps also increase with time, but usually less than losses from disc traps.

For this example, we will use 2 lb/hr of live steam loss for conventional traps in good condition and compare this to ***HAT*** valves which have **zero live steam loss**. Further, ***HAT*** valves achieve additional savings by discharging condensate at reduced temperature. These additional savings can be calculated based on the value of the heat content at varying discharge temperatures.

COMPARE OPERATING COSTS FOR TYPICAL SYSTEM:

One hundred 3/8” steam tracers (50 to 75 feet long)
70 psig steam pressure (316°F saturated steam temperature)
Assumed steam cost @ $8.00/1000 lbs or $8.00/1,000,000 BTU
Estimated individual trap load: 20 lb/hr

	3/8 TV/HAT	**CONVENTIONAL TRAPS**
Discharge Temperature	165°F	316°F
Heat of Condensate (From Steam Tables)	133 BTU/lb	286 BTU/lb
Live Steam Loss Per Trap	0 lb/hr	2 lb/hr

Total system load: 100 X 20 lb/hr = 2000 lb/hr

SENSIBLE HEAT SAVINGS:

286 BTU/lb - 133 BTU/lb = 153 BTU/lb Saved by ***HAT***

2000 lb/hr X 153 BTU/lb X 8760 hr/yr X $8/1,000,000 BTU:

<u>Annual Savings Based On Reduced Condensate Temperature: $21,445</u>

ANNUAL COST OF LIVE STEAM LOSS FOR CONVENTIONAL TRAPS:

2 lb/hr per trap X 100 traps X $8/1000 lbs X 8760 hr = $14,016

SUMMARY OF ANNUAL SAVINGS FOR EXAMPLE SYSTEM

	3/8 TV/HAT	**CONVENTIONAL TRAPS**
SAVINGS OF LIVE STEAM LOSS	$ 14,016	$0
SAVINGS FROM SENSIBLE HEAT	$ 21,445	$0
TOTAL SAVINGS:	**$ 35,461**	**$0**
SAVINGS PER TRAP	**$ 354**	**$0**

CONCLUSION: A typical steam tracer system using **THERM-OMEGA-TECH’s *TV/HAT*** valves can <u>save at least $354 per valve each year</u>.

Based on an average cost of $88 each for the **THERM-OMEGA-TECH 3/8 TV/HAT** valve and neglecting installation labor, the savings will provide a simplified return on investment (R.O.I.):

R.O.I. = $354/$88 = 4.02 or 402% or Payback = 3 months

STEAM TRACING BASICS*

Heat tracing is used for liquid-containing pipelines to prevent the liquids from freezing or becoming too viscous. With pipelines containing gases, heat tracing prevents gas components from condensing.
Heat tracing will normally be required when:

- The lowest ambient site temperature will be below the freezing point of the liquid carried in the pipes. An exception must be made for underground water-pipes installed below the ground frost level. *Examples of liquid lines requiring heat tracing are: phosphoric acid, molten sulfur, glacial acetic acid, benzoic acid, cresol, naphthalene, phthalic anhydride, sorbitol, p-xlene, and water.*

- The liquid becomes highly viscous at ambient temperatures. *Examples are: certain crude oils,fuel oils, polymeric materials, waxes, bitumen and tar residues, and caustic soda liquor.*

- The gas carried in the line has a dewpoint above the ambient temperature and, condensation of liquid from the gas is undesirable. *Examples are: fuel gas in oil refineries where the liquid causes trouble in the gas burners; natural gas containing moisture that may cause freezeup of control valves or even the whole system; compressor suction lines (liquid is harmful to compressors); and H_2S/water vapor (causes corrosion on condensation.)*

In winterizing practice, water lines are insulated in an effort to avoid tracing. However, there is always a heat loss from insulated lines. If the liquid cooling resulting from this heat loss cannot be tolerated, heat tracing will be necessary.

If there is no heat tracing, the line may have to be disassembled, with associated high costs and long shutdown times.

The length of a traced line is quite variable. It may be a few feet in a process area, a few thousand feet between offices and the process area, or over a hundred miles as in the case of underground lines carrying crude oil or fuel oil.

Still, steam tracing is commonly used because there is a surplus of low-pressure steam available in most plants.

Since steam has a high latent heat, only a small quantity is required for a given heating load. Also, steam has a high film heat-transfer-coefficient, condenses at constant temperature, and flows to the point of use without pumps.

The simplest method of external tracing is to wrap copper tubing around valves, pipe fittings and instruments. This procedure is unsuitable for horizontal runs because steam condensate collects at low points and may freeze during a shutdown. (**THERM-OMEGA-TECH, INC.**, as well as most engineers, recommend that horizontal runs be traced by strapping a single run of copper tubing to the bare underside of the pipeline. There are different means of insulating and increasing the thermal efficiency of the tracer.)

It is essential to ensure that the tracer lines are self-draining.

The length of a single tracer tube (from steam supply valve to steam trap) is limited by the pressure drop in the tracer. The trap should have a condensate drainage capacity to match the heating load. At a steam pressure of 100 psig or higher, the length of a single tracer should not exceed 150 ft. If the steam pressure is lower, a tracer length of 100 ft. is recommended.

* excerpts from an article by I.P. Kohli, M.Sc.

PROPERTIES OF SATURATED STEAM

Gauge Pressure PSIG	Steam Temperature °F	SPECIFIC HEAT			
		Sensible Heat btu/lb	Latent Heat btu/lb	Total Heat of Steam btu/lb	Specific Volume cu ft/lb
0	212	180	970	1150	27.0
1	216	183	968	1151	24.0
2	219	187	965	1152	25.0
3	222	190	964	1154	22.5
4	224	193	962	1155	21.0
5	227	195	961	1156	20.0
6	230	198	959	1157	19.5
7	232	201	957	1158	18.5
8	235	203	956	1159	18.0
9	237	206	954	1160	17.0
10	240	208	952	1160	16.5
15	250	218	945	1163	14.0
20	259	227	940	1167	12.0
25	267	236	934	1170	10.5
30	274	243	929	1172	9.5
35	281	250	924	1174	8.5
40	287	256	920	1176	8.0
45	292	262	915	1177	7.0
50	298	267	912	1179	6.7
55	303	272	908	1180	6.2
60	307	277	905	1182	5.8
65	312	282	901	1183	5.5
70	316	286	898	1184	5.2
75	320	290	895	1185	4.9
80	324	294	892	1186	4.7
85	328	298	889	1187	4.4
90	331	302	886	1188	4.2
95	335	306	883	1189	4.0
100	338	309	881	1190	3.9
110	344	316	876	1192	3.6
120	350	322	871	1193	3.3
125	353	325	868	1193	3.2
130	356	328	866	1194	3.1
140	361	334	861	1195	2.9
150	366	339	857	1196	2.7
160	371	344	853	1197	2.6
170	375	348	849	1197	2.5
180	380	353	845	1198	2.3
190	384	358	841	1199	2.2
200	388	362	837	1199	2.1
250	406	381	820	1201	1.75
300	422	399	805	1204	1.5
350	436	414	790	1204	1.3
400	448	428	776	1204	1.1
450	460	441	764	1205	1.0
500	470	453	751	1204	0.90
600	489	475	728	1203	0.75
750	513	503	697	1200	0.45
1100	558	560	629	1189	0.39
1450	593	607	565	1172	0.29
1800	622	650	501	1151	0.22
2200	650	697	424	1121	0.16
2600	675	746	334	1080	0.12
3000	696	805	211	1016	0.08

GLOSSARY OF TERMS

Air Binding: The process of steam trap closing due to the presence of air rather than steam. This slows down the discharge of condensate and the ability of a steam system to reach its desired temperature.

Blow-Down Valve: A valve used when blowing pipeline dirt or scale from a strainer screen or boiler drum.

British Thermal Unit (Btu): The quantity of heat required to raise one pound of water one degree Fahrenheit.

Capacity: The maximum amount of condensate that can be discharged by a steam trap at specific conditions of temperature and pressure differential (between its inlet and outlet). Capacity is measured in pounds per hour.

Condensate: Water that is the result of steam changing from vapor to a liquid.

Cycle: The opening and closing action of a steam trap that allows it to pass condensate and then stop the passage of steam.

Dirt Pocket: A length of pipe in the discharge line of steam heated equipment that allows the collection (by gravity) of pipeline scale and dirt.

Discharge Temperature: The temperature of condensate (measured at a steam trap's inlet) while it is being discharged. Sometimes referred to as the temperature at which a steam trap starts to open.

Enthalpy: The total energy content of a fluid, including both heat and mechanical energy.

Flash Steam: Steam that results when saturated water or condensate is discharged to a lower pressure. It is steam that could not exist at a higher pressure.

Flash Tank: A vessel or tank where flash steam is accumulated for subsequent use.

Latent Heat of Vaporization: Heat that produces a change of state without a change in temperature such as, changing water into steam, sometimes referred to as simply as "latent heat".

Modulate: The partial opening and closing of a steam trap thereby regulating the discharge flow of condensate. Modulation is in contrast to a full open/full closed mode of operation.

PSIA: Pounds per square inch absolute - a measure of pressure including atmospheric pressure.

PSIG: Pounds per square inch gauge - a measure of pressure above atmospheric pressure.

Safety Load Factor: A factor by which the calculated condensate load is multiplied to determine the capacity a trap should possess to properly serve its selected application. The safety load factor is used to accommodate system variables and uncertainties affecting the condensate flow rate.

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Sizing: The process of matching the condensate drainage requirements of an application to a steam trap having a suitable capacity.

Saturated Condensate: Condensate that has a temperature equal to that of the steam with which it is in contact.

Saturated Steam: Steam that has a temperature equal to that of the condensate with which it is in contact.

Saturation Curve: Graphic representation of the boiling point of water at various pressures (the pressure and temperature at which saturated steam and condensate exist).

Saturation Temperature: The temperature at which saturated steam and condensate exist.

Sensible Heat: Heat that produces a temperature rise in a body (such as water).

Steam, Dry: Steam having no water droplets suspended in it.

Steam, Live: "Live steam" is an expression commonly used to describe steam that is still able to do useful work, in contrast to flash steam at atmospheric pressure.

Steam, Total Heat Of: The sum of BTU's per pound of both the sensible heat (of condensate) and the latent heat (of vaporization).

Steam, Wet: Steam having fine water droplets suspended in it, and as a result, having a lower heat content than dry steam.

Steam Binding: The process of steam keeping a steam trap closed and thereby preventing the discharge of condensate that has formed upstream of the trap. This condition results when the condensate discharge line to a steam trap is subjected to sufficient heating that the condensate in it is changed back into steam thereby blocking the flow of condensate to the trap.

Steam Separator: A device that removes entrained water droplets from steam flow.

Steam Tables: Tables that list the properties of steam and condensate at various pressures and temperatures.

Steam Tracing: The use of steam to:

1. Heat or maintain the temperature of a process liquid in a pipeline.

2. Prevent water lines and related equipment from winter freeze-ups.

3. Provide uniform temperature in and around instruments so as to help maintain their calibration.

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