
AMERICAN NATIONAL STANDARD

**DETERMINING CONDENSATE LOADS
TO SIZE STEAM TRAPS**

Fluid Controls Institute, Inc.

Sponsor:



Fluid Controls Institute, Inc.
1300 Sumner Ave
Cleveland, Ohio 44115-2851

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Foreword (This foreword is included for information only and is not part of FCI 13-1-2016, *Determining Condensate Loads to Size Steam Traps.*)

This voluntary standard has been developed by the Steam Trap Section of the Fluid Controls Institute, Inc. It is intended to assist users in estimating condensate loads using generally accepted formulas. The result is then used to size a steam trap with sufficient safety factor to cover the flow throughout the range without being grossly oversized.

FCI recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Fluid Controls Institute, Inc., 1300 Sumner Avenue, Cleveland, Ohio 44115-2851. All constructive suggestions for expansion and revision of this standard are welcome.

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AMERICAN NATIONAL STANDARD

Determining Condensate Loads to Size Steam Traps

1. PURPOSE

The purpose of this standard is to help estimate condensate loads using generally accepted formulas. The result is then used to size a steam trap with sufficient safety factor to discharge the necessary flow throughout the positive pressure differential range without being grossly oversized. A properly-sized steam trap can help provide reliable and efficient function.

2. SCOPE

Many steam trap manufacturers design and test steam trap flow capacities to stringent standards. Steam trap hot condensate flow capacities can be measured in accordance with ANSI/ASME PTC 39 or ISO 7842 standards. Steam trap manufacturers should publish capacity tables or graphs according to the aforementioned standards in order for users to select the correct steam trap to discharge the condensate load required by their application.

Calculation of the condensate load requirement that the steam trap needs to discharge is just as important as having an accurate flow capability. Under-sizing of the steam trap due to poor load information can lead to poor process performance or dangerous water hammer. Over-sizing the steam trap also serves little purpose, and in the case of certain types of traps, may cause steam leakage under low flow conditions. Steam traps are often considerably over-sized, which may result in removal of condensate; however, it may also shorten steam trap life in addition to possible unnecessary steam loss as referenced above.

If the equipment manufacturer lists the heat output of the steam equipment that needs to be drained, the estimated condensate rate can be easily calculated. Generally, equipment manufacturers provide the BTU/hr output. In that case, divide the BTU/hr output by the operating steam pressure latent heat (Table 1) to estimate the condensate generation rate from that equipment. (For more exact calculation, the steam quality / wetness has to be considered to adjust for actual lowered latent heat available at the process).

Example: 2,500,000 BTU/hr @ 30 psig steam

$$\frac{2,500,000 \text{ BTU/hr}}{929 \text{ BTU/lb of 30 psig steam}} = 2,691 \text{ lb/hr condensate flow}$$

When selecting the trap type, size, and required discharge capacity, consideration still has to be given to whether the steam pressure is steady state or modulating. The calculation shown in the example above is maximum condensate load at full pressure.

When the heat output rates from the equipment are unknown, estimated calculations for heat load using other sources of data can be utilized.

3. DEFINITIONS

- 3.1 Steam trap – An integral, self actuated valve which automatically vents air in the steam system and drains condensate from a steam containing enclosure while remaining tight to live steam. Most steam traps will also pass non-condensable gases while remaining tight to live steam.
- 3.2 Condensate – The fluid created after steam has given up its latent heat energy and becomes liquid phase.
- 3.3 Capacity – The manufacturer's rated capability of a steam trap to discharge condensate. Capacity is typically stated in the manufacturer's product specifications, illustrated through either charts or tables.
- 3.4 Drip Points – Vertical piping pockets located along the steam main pipe where condensate is collected for the purpose of draining from the system. These points are commonly referred to as collecting legs, drip points/legs/pockets, or drain pockets. In the formulas contained here-in this standard these locations are referred to as drip points.

4. GENERAL FORMULAS FOR DETERMINING CONDENSATE LOADS

4.1 Glossary of Abbreviations and Terms

- A = area of heating surface, sq ft
BTU = British thermal unit
Cp = specific heat, BTU/lb (Table 4)
CFM = air flow, cubic feet/minute
d = density of air, lb/ft³ (Table 3)
D = diameter of dryer, ft
EDR = effective direct radiation, sq ft
ft = length, Feet
G = volume, gallons
GPM = flow, gallons/minute
L = latent heat BTU/lb (Table 2, saturated steam latent heat value, adjust for wetness %)
Ll = latent heat of lower pressure, BTU/lb
Lot = length of tubes, ft
N = number of tubes
P = sq ft of surface area per lineal foot of pipe (See Table 1)
Q = condensate generated, lb/hr
Qi = Incoming condensate flow, lb/hr
R = rate of condensation, (lb/sq ft-hr), (typical 7 lb/sq ft-hr)
s.g. = specific gravity @ 60°F
S = sensible heat, BTU/lb
Sh = sensible heat, higher pressure, BTU/lb
Sl = sensible heat, lower pressure, BTU/lb
t = time, hours
Ta = ambient air temperature, °F

T_f = process material final temperature, °F
 T_i = process material initial temperature, °F
 T_s = steam temperature at pressure, °F
 U = heat transfer coefficient, BTU/hr ft² °F
 W = weight of solid material, lbs
 W_g = liquid weight, lbs/gallon
 W_h = width of dryer, ft.

Note: For any formula requiring latent heat (L) use Table 2

Table 1 Pipe Size Conversion Table

(Divide lineal feet of pipe by factor given for size and type of pipe to get square feet of surface)		
Pipe Size (in)	Iron Pipe	Copper or Brass Pipe
1/2	4.55	7.63
3/4	3.64	5.09
1	2.90	3.82
1-1/4	2.30	3.05
1-1/2	2.01	2.55
2	1.61	1.91
2-1/2	1.33	1.52
3	1.09	1.27
4	.848	.954

4.2 Steam Main:

Steam mains in various applications may operate in saturated or superheat conditions. When the steam main is superheated, the start-up load may be high to bring the pipe to temperature, but then very little or no condensate is generated when operating at full superheat. In low steam velocity conditions, such as very low demand or in a (stagnant flow) collecting leg, flow reduces to the threshold where the heat loss of the main exceeds the BTU's of superheat available. Then, condensate will again be created and must be removed from the system.

In instances where the superheated steam flow is stopped, the main or collecting leg can revert first to saturated steam, and then to wet steam, depending upon the amount of time for the flow cessation. For that reason, a steam trap is required at the drip points along the pipe with either saturated or superheated steam.

Steam mains generally operate more than 90% of the time in the full operational mode. The condensate load produced during normal operation is known as "Running Load", whereas the condensate load generated during the time when the main is brought up to full operation is known as "Start-up Load".

Start-up times of the main should not be so short as to generate large amounts of condensate that could cause water hammer. Another issue with short start-up times is that large steam traps need to be used to handle the over-large start-up load, and then those traps could be grossly oversized in the normal operating mode. It is important that both Start-up Load and Running