It is possible to use any make, or type, or even size of steam trap on any given application, and the trap will usually work. The equipment being drained will also "work", but very often it will be working at much less than 100% effectiveness!

Maximizing equipment efficiency and output, energy conservation, and other facets which add up to the proper use of the equipment are not only of correctly sized steam traps, but also of types having characteristics which closely match the needs of each individual application. The first of these application requirements is the necessity of choosing a trap to remove the maximum amounts of air and other noncondensible gases which will collect in the system. The second consideration is to lock us into choosing one type of trap by keeping in mind when choosing the best trap for the job. The equipment being drained must be held back in the system until it has cooled to a condition where saturation temperature may be acceptable when draining condensate continuously, as soon as it forms. In all cases, undersized traps simply cannot drain condensate from the steam equipment at the required rate, while oversized traps which cost more will usually wear faster and begin leaking expensive steam.

This emphasizes the need for carefully selecting trap sizes that are properly engineered for maximum performance capabilities that satisfy specific application needs, and then to choose a size which handles the condensate loads with the necessary excess capacity. The Selection Guide, Table 1, is not comprehensive but helps in many applications where no unusual operating conditions or severe corrosion problems exist. Choosing the correct trap size then simplifies calculating the steam consumption rates, which of course equals the condensate load. Sometimes the load has already been measured, or the rated output of the steam equipment is known or can be obtained from the original manufacturer. In other cases, an estimate must be made and a Table of Load Factors will help although, too, cannot be comprehensive.

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ABSTRACT
For maximum effectiveness in steam systems, steam traps should have operating characteristics which closely match the requirements of the applications for which they are used. A trap which holds back condensate until it is subcooled and some of the sensible heat has been utilized is unsuitable where the need is to get maximum output from an exchanger by discharging condensate as soon as it forms. Equally, a trap discharging condensate at steam temperature can exacerbate flash steam problems in cases where surplus heat exchange area exists and condensate loss might be acceptable.

In all cases, undersized traps simply cannot drain condensate from the steam equipment at the required rate. Worked-on traps which heat up will usually wear faster and begin leaking expensive steam.

This emphasizes the need for carefully selecting trap sizes that are properly engineered for maximum system efficiency. And, of course, the ability of a trap to cope with varying loads and to discharge noncondensible gases is often important. The recommended procedure for selecting a trap type which has performance capabilities that satisfy specific application needs, and then to choose a size which handles the condensate loads with the necessary excess capacity. The Selection Guide, Table 1, is not comprehensive but helps in many applications where no unusual operating conditions or severe corrosion problems exist. Choosing the correct trap size then simplifies calculating the steam consumption rates, which of course equals the condensate load. Sometimes the load has already been measured, or the rated output of the steam equipment is known or can be obtained from the original manufacturer. In other cases, an estimate must be made and a Table of Load Factors will help although, too, cannot be comprehensive. After making the best possible estimate of the load, a safety factor is applied. This allows for any inaccuracies in the estimating, for increased condensation rates at start-up, and for lower than anticipated pressure differentials across the trap.

What is the truth regarding leakage? Conclusive, independent tests have shown that all steam traps, regardless of type, will lose a small amount of steam when tested on extremely light loads. This loss amounts to less than the steam condensed in an exposed section of 2" pipe about one foot long. Further, this extremely light load condition is unusual, and as normal condensate loads are generated, steam leakage becomes negligible. These tests provide the strongest justification for selecting quality steam traps that satisfy particular application needs without the under-grounded fear of suffering excessive steam leakage. As a general rule, the Selection Guide shown in Table 1 indicates traps which are suitable for many applications where no unusual operating conditions or severe corrosion problems exist. An examination of how the different steam trap types operate will clarify the reasoning behind these choices.

The Floatthermostatic trap is designed to discharge condensate continuously, as soon as it forms, and at steam temperature, as well as to discharge air reaching the trap. Therefore, it will help achieve full output on first steam, and air heating coils, hot water heaters and shell and tube heat exchangers where immediate condensate removal and air venting are required. However, where water hammer exists, and until it is eradicated, the use of the Float and thermostatic trap is to be avoided because the ball float can be damaged by water hammer.

Inverted bucket traps can also discharge condensate continuously, as soon as it forms, and will not permanently air bind. Although they continuously discharge air at the temperature of the air/steam mixture, this discharge is at a very slow rate due to the limitations of the bucket's vent hole. This orifice, usually about 1/16 inch diameter and located in the bottom of the bucket, allows the air to be pushed through it by the difference in water level between the inside and outside of the bucket. Even in the largest traps this is only a matter of about 2 inches or so. Because of its limited air handling capacity, an inverted bucket trap that deals happily with the small amount of air and condensate in 2-feet of 1/2-inch diameter pipe will itself be able to clear a larger volume of air from 160-feet

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much closer to the steam saturation curve, and follow
coils, very great care is needed with their position-
cations. On shell and tube exchangers or heater
temperature, and also waterhammer.
traps include steam radiators, many types of steam
ceptible to damage by corrosion or waterhammer, but
the steam curve, withstand corrosive gonditions and
the introduction of stainless steel elements has
generation, stainless steel capsules closely follow
fecting output. In other cases where traps are used that
have of subcooling, condensate backup is fine provided that
steam for the thermodynamic effect to operate, and
steam traps have been optimistic rather than realistic,
and a suitable size chosen and fitted, there remains
reduced, down to or even below atmospheric pressure.
interest is usually to apply a
and require for start-up conditions when pressures may be
lawed but condensing rates are highest, and also for
any inaccuracies in the assumptions made in the initial
imates. This table also lists some safety factors
commonly used.
additional, we need to know the differential pressure
which will be available to push this conden-
through the trap, and the maximum pressure at
which it will be required to operate. Remember that
where temperature controls modulate the supply of
steam to heat exchangers, the steam pressure in the
steam to heat exchangers, the steam pressure in the
system work more effectively.
steam will substantially lower the
steam's temperature, these traps cannot air bind,
their free air venting characteristics mean that they
serve double duty by being a first choice air vent for
steam systems. This air venting requirement is one
that is all too often overlooked, and the lowered heat
transfer rates, and pressure problems that subsequently
result are then wrongly accepted as inevitable concom-
ients of steam service.

Once the best type of trap to be used on a given
application has been chosen, the appropriate size must
be selected. This process is an estimate that must be
made of the condensate load to be handled, and Table II
may be helpful in this context. It is usual to apply a
safety factor to the calculated condensate load, to
allow for start-up conditions when pressures may be
lowered but condensing rates are highest, and also for
any inaccuracies in the assumptions made in the initial
timates. This table also lists some safety factors
commonly used.

Even where supply pressures are maintained, back
pressures caused by lifts in condensate lines reduce
differentials across traps. Equally, pressurized
return lines mean that differentials are lowered, so
the effects of total back pressure resulting from
lifts, friction, and existing pressures must be con-
sidefully. When using the estimated loads and differential
pressures to size traps in the manufacturers capacity
tables or charts, make sure that the capacities are
quoted for hot condensate rather than for cold water,
which is sometimes used so that inflated figures can
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A special chamber (Table III) is built into the condensate line at the inlet side of the steam trap. The chamber contains a baffle plate under which condensate can pass, and a conductivity electrode. A small hole in the baffle equalizes the pressures at each side, when the trap is working normally. If the trap, which can be of any manufacturer or type, begins to leak steam, this leaking steam will begin to pass beneath the baffle with the help of a pressure differential between the upstream and downstream sides. When this differential reaches 1 or 2 inches water gauge, it depresses the water level on the upstream side of the baffle enough to expose the conductivity electrode to steam instead of water.

Checking the trap is then simply a matter of plugging onto the electrode a portable meter, and switching on. A green light shows if the electrode detects water, a normal condition; but if a red light shows, then the electrode is surrounded by steam indicating leakage. In cases where the trap and sensor chamber are located at an inaccessible position, perhaps behind a ceiling panel, the sensor can be permanently wired to either a single or a 12-way remote checking point. Alternatively, up to 12 sensors can be wired to an H2E electronic continuous monitor. Of course, any number of these can then be connected in a cascade system to a master indicator or to a building management system, so that faulty steam traps can be serviced or replaced before the cost of steam losses becomes a problem.

In summary, overall benefits will be maximized when properly sized traps are selected with performance capabilities that match application needs; and when these traps are part of an overall energy management program that quickly identifies and corrects maintenance problems as they occur, thereby eliminating excessive energy losses.
| TABLE 1
STEAM TRAP SELECTION GUIDE |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>APPLICATION</td>
</tr>
<tr>
<td>Air Heating Coils</td>
</tr>
<tr>
<td>Low and Medium Pressure</td>
</tr>
<tr>
<td>High Pressure</td>
</tr>
<tr>
<td>Hot Water Heaters (Instantaneous)</td>
</tr>
<tr>
<td>Low and Medium Pressure</td>
</tr>
<tr>
<td>High Pressure</td>
</tr>
<tr>
<td>Hot Water Heaters (Storage)</td>
</tr>
<tr>
<td>Shell-and-Tube Exchangers</td>
</tr>
<tr>
<td>Small—High Pressure</td>
</tr>
<tr>
<td>Large—Low and Medium Pressure</td>
</tr>
<tr>
<td>Reboilers</td>
</tr>
<tr>
<td>Steam Humidifiers</td>
</tr>
<tr>
<td>Steam-Jacketed Vessels</td>
</tr>
<tr>
<td>High Pressure</td>
</tr>
<tr>
<td>Steam Line Trap Traps</td>
</tr>
<tr>
<td>0-15 PSI G</td>
</tr>
<tr>
<td>16-125 PSI G</td>
</tr>
<tr>
<td>126-600 PSI G</td>
</tr>
<tr>
<td>High Pressure—Superheat</td>
</tr>
<tr>
<td>Steam Pipe Coils (Air Heating)</td>
</tr>
<tr>
<td>Steam Radiators</td>
</tr>
<tr>
<td>Steam Separators</td>
</tr>
<tr>
<td>0-15 PSI G</td>
</tr>
<tr>
<td>16-125 PSI G</td>
</tr>
<tr>
<td>126-600 PSI G</td>
</tr>
<tr>
<td>Steam Tracer Lines</td>
</tr>
<tr>
<td>Storage Tank Coils</td>
</tr>
<tr>
<td>Submerged Heating Coils</td>
</tr>
<tr>
<td>Low and Medium Pressure</td>
</tr>
<tr>
<td>High Pressure</td>
</tr>
<tr>
<td>Unit Heaters</td>
</tr>
<tr>
<td>Shell/Sheath</td>
</tr>
<tr>
<td>Aerobic</td>
</tr>
<tr>
<td>Driers</td>
</tr>
<tr>
<td>Plate Heat Exchangers</td>
</tr>
</tbody>
</table>

NOTE: Unusual operating conditions, or water erosion may influence the choice of a steam trap for a particular application.
### Table II
CALCULATING CONDENSATE LOADS

When the normal condensate load is not known the load can be approximately determined by calculations using the following formulas:

#### General Usage Formulas

- **Heating water with steam**
  \[
  \text{lb Condensate/hr} = \frac{\text{CFM} \times \text{Temperature Rise } ^\circ\text{F}}{900} \times \text{Temperature Rise } ^\circ\text{F}
  \]

- **Heating fuel oil with steam**
  \[
  \text{lb Condensate/hr} = \frac{\text{CFM} \times \text{Temperature Rise } ^\circ\text{F}}{4} \times \text{Temperature Rise } ^\circ\text{F}
  \]

#### Specialized Applications

- **STERILIZERS, AUTOCLAVES, RETORTS HEATING SOLID MATERIAL**
  \[
  \text{lb Condensate/hr} = \frac{\text{W} \times \text{Cp} \times \Delta T}{\text{L} \times t}
  \]
  - W = Weight of material - lbs.
  - Cp = Specific heat of the material (see page III-33)
  - \( \Delta T \) = Temperature rise of material \(^\circ\text{F}\).
  - L = Latent heat of steam BTU/lb
  - t = Time in hours

Note: The condensate load to heat the equipment must be added to the condensate load for heating the material. Use same formula.

- **HEATING LIQUIDS IN STEAM JACKETED KETTLES**
  \[
  \text{lb Condensate/hr} = \frac{\text{G} \times \text{s.g} \times \text{Cp} \times \Delta T \times 8.3}{\text{L} \times t}
  \]
  - G = Gallons of liquid to be heated
  - s.g = Specific gravity of the liquid
  - Cp = Specific heat of the liquid (see page III-36)
  - \( \Delta T \) = Temperature rise of the liquid \(^\circ\text{F}\)
  - L = Latent heat of the steam BTU/lb
  - t = Time in hours

- **HEATING AIR WITH STEAM; PIPE COILS AND RADIATION**
  \[
  \text{lb Condensate/hr} = \frac{(\text{W} - \text{W}_f) + (\text{W} \times \Delta T)}{1000}
  \]
  - W = Initial weight of the material - pounds per hour
  - Wf = Final weight of the material - pounds per hour
  - \( \Delta T \) = Temperature rise of the material \(^\circ\text{F}\)
  - L = Latent heat of the steam BTU/lb

- **HEATING SOLID MATERIAL**
  \[
  \text{lb Condensate/hr} = \frac{\text{L} \times \text{W} \times \text{Cp} \times \Delta T}{\text{U}}
  \]
  - A = Area of the heating surface in square feet
  - U = Heat transfer coefficient

- **Steam Traps**
  \[
  \text{lb Condensate/hr} = \frac{\text{CFM}}{4} \times \text{Temperature Rise } ^\circ\text{F}
  \]

- **Steam Radiators**
  \[
  \text{lb Condensate/hr} = \frac{\text{Sq. Ft. E.D.R.}}{4}
  \]

#### Recommended Safety Factor for Steam Traps

<table>
<thead>
<tr>
<th>Type of Trap</th>
<th>Safety Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermatrap</td>
<td>2 to 4</td>
</tr>
<tr>
<td>Liquid Expansion Traps</td>
<td>3 to 4</td>
</tr>
<tr>
<td>Float and Thermatrap</td>
<td>1.5 to 2.5</td>
</tr>
<tr>
<td>Thermodynamic Traps</td>
<td>1.5 to 2.5</td>
</tr>
<tr>
<td>Reheat Traps</td>
<td>3 to 5</td>
</tr>
<tr>
<td>Thermo-Matic</td>
<td>1.5 to 2.5</td>
</tr>
</tbody>
</table>

Note: The actual safety factor to use for any particular application will depend upon accuracy of:
- Estimated load
- Estimated pressure at trap
- Estimated back pressure
- Any unusual or abnormal conditions must be taken into consideration.