Steam Tracing Design Considerations

When designing a modern steam tracing system, the plant needs to consider a number of design and installation factors to ensure an efficient and reliable operation.

1. **Process Temperature**
   If the process fluid temperatures are to remain constant in the process lines, then the amount of heat energy that has to be added must be equal to the amount of heat energy that is being lost from the process fluid. The lost energy can be from worn insulation, leaking pumps and valves, etc. The energy measurement is usually measured in watts per meter (W/m) or Btus per hour per foot of pipe (Btu/hr.-ft.). Correctly matching the steam tracer type with a heat output which closely matches the heat loss from the process will improve the system’s efficiency.

2. **Process Evaluation Items**
   The plant must review and evaluate many different items to select the proper tracing system. These items include:
   - Start-up time
   - Process temperatures (maximum and minimum)
   - Steam pressures available (maximum and minimum)
   - Condensate recovery system (pressurized or not pressurized)

   **a. Start-up Time**
   The highest energy demand occurs at start-up, and the time allowed for start-up will affect the steam flow requirements. The shorter the warm-up time allowed, the higher the steam flow requirements. Additionally, more heat transfer surface area or higher steam pressures could be required.

   It is important to work with the production area to evaluate the start-up requirements to ensure you provide the proper steam flow requirements and the proper heat transfer surface area.
b. What are the process temperature requirements?
The process temperature will dictate selection of the materials and components. The process temperatures will also dictate the steam pressures the plant will have to use for the heating of the media in the process line.

Use conduction-type tracers when process temperatures exceed 175°F. Bare convection tracers are used at lower temperatures, including freeze protection applications.

c. How long is the process line?
Tracers are generally limited to 150 feet. For longer lengths, engineering is required. The plant should consider the steam header size, pressure drop from fittings, valves, bends, increases in elevation, and return system pressures when determining a process line length.

3. Supply and Condensate System Trees
Design and selection of the steam supply tree and the steam trap station tree are critical components for a successful operation. When considering tree arrangements versus non-tree arrangements, keep in mind that engineering studies have shown tree arrangements provide a more reliable steam and condensate operation than non-tree arrangements. Tree arrangements are less likely to experience leakage problems, and their steam trap station reliability is greater. Tree arrangements provide the maintenance and operation personnel the ability to quickly determine if any problems are occurring in the system due to ease of accessibility.
4. Selecting a Steam Trap Station
Don’t just select a steam trap. A steam trap is only one component of the system.

Steam Station Components:
   a. Steam isolation valve
      - Class IV or higher shutoff standard
      - Class VI is recommended
   b. Numbered tags for all components
   c. Universal connector for the steam trap
   d. Universal connector strainer
   e. Blowdown valve for the strainer
      - 20 or 40 mesh strainer recommended
   f. Steam trap
   g. Test valve
      - Isolation for the discharge side of the steam trap station
      - Visual steam trap testing
      - Class IV or higher shutoff standard
      - Class VI is recommended

5. Required Steam Pressures
If the plant’s steam pressures are too high for the tracing application, then the plant will need to add a way to reduce the pressure in the steam system. The steam pressure should be selected to meet the tracing application, but not excessive due to the added thermal stresses a higher steam pressure will cause on the tracing components.

6. Piping or Tubing Material Selection
Selecting the right material is a key factor in the ability to transfer steam energy to the process system. Stainless steel is the preferred material for tracing applications, but stainless steel has a lower thermal conductivity rating. Industrial plants used copper tubing in previous years, but it will deteriorate over time, causing problems with fouling or plugging in the system and with returning the condensate to the boiler plant.

7. Insulation Type and the K Factor
The type of insulation and the K factor are very important. The highest energy losses are from the insulation. The K factor of the insulation will determine the degree of loss for the insulation.

8. Pressurized Condensate Return System
The steam tracing system typically doesn’t modulate the steam pressure to the steam tracer system; therefore, the plant can use a pressurized condensate system to recover the condensate. The pressurized condensate system will have very high thermal steam cycle efficiency. Pressurized condensate systems operate continuously at a pressure above 15 psig, and the condensate return system isn’t vented to the atmosphere. The pressure in the condensate system is sustained by the dynamics of the system or a systematic control process loop.
Typical condensate systems operate with some backpressure due to condensate line undersizing and neglect of steam traps blowing steam into the condensate line. These items alone can cause pressure in the condensate system. A pressurized condensate system differs in that the condensate return pressure is systematically controlled to a predetermined set point, which is matched to the peak performance level of the process to achieve the highest steam thermal cycle efficiency.

9. Determining the Number of Required Tracers
The number of tracers will depend on the amount of heat required and the size of the process pipe. If possible, the plant should try to limit the number of steam tracer lines to one for each process pipe. The tracer line should be located at the bottom of the pipe, as heat energy will rise. Adding more tracers will require additional connections to the supply and return header and the associated valve and fittings required for the connections.

10. Small Process Lines
If the process line is a smaller size (under 1") then the use of preassembled tubing bundles can take most of the guesswork out of the design and engineering. The plant should consider the temperature requirements, steam pressures, ambient conditions, and level of temperature control.

In Figure 7, you can see examples of preassembled tubing. The tubing on the left side is for “light” steam tracing, or when lower temperatures are used. You can see that there is more insulation between the tracer and the process tube or tubes. The right half shows tubes that are considered “heavy” steam traced, and these are for use in higher temperatures. Note the proximity of the tracer and the process tube.

11. Safety Considerations
The plant must also consider safety when employing steam tracers. All steam tracer lines above the pressure of 15 psig fall within the ASME B31.1 code; thus, all components used should meet the code requirements. All supply and discharge lines feeding the tracer system should be insulated for energy reasons and personnel protection.
12. Standardizing Materials and Designs

Materials and designs should be standardized where possible. Some of the items that will need to be specified include:

- Valves: spec Class IV shutoff at a minimum
- Fittings
- Tubing size and material
- Insulation
- Gauges
- Steam traps

Steam Tracing Installation Considerations

An efficient and reliable steam tracer system relies on the following design considerations:

1. The steam supply for the tracer system should be connected at the top of the main steam header to ensure there is no condensate entrained in the steam supply. See Figure 8.

2. Each tracer line should have its own steam supply isolation valve and steam trap station. See Figure 9.

3. Condensate is drained from the steam tracer system through gravity; therefore, the plant should review the following items:
   a. Ensure there are no low spots in the tracer run.
   b. Don’t wrap the tracer around the process pipe. Figure 10 shows this common error. Condensate can and will build up in the low spots until it fills the tube, which will result in poor heating and possibly water hammer.
   c. Steam tracer installation should flow from the highest elevation to the lowest.
   d. If possible, slope the tracer to the steam trap station.

4. Tracers should be installed on the bottom of the process pipe. Heat rises, and by installing the tracer on the bottom of the pipe, the plant will achieve greater efficiency.
5. The correct support will prevent sagging on the steam tracer line and ensure the tracer line is in contact with the process pipe. Figure 12 depicts small sags, which induce air gaps that will greatly reduce the heat transfer capability. Figure 13 indicates the proper support for the tracing system.

6. The tracer line will expand and contract; therefore, the forces of expansion and contraction must be designed into the system. Using the common horizontal pipe loop will give the line the ability to accommodate the expansion.

7. The tubing material and fitting material should be the same.

8. Don’t install tracing connections under the insulation. Install the connections at points that will allow the process equipment to be easily removed or repaired.

9. Tracer steam supply valves and steam trap stations should be marked for easy to identification. This will provide faster maintenance on the tracer lines because they will be easy to isolate.

10. Use preassembled steam and condensate return headers. These systems will typically have fewer connection points and will be designed to handle the steam loads.

11. Generally, don’t use tracing with non-metal, lined piping or vessels.

12. Minimize the number of connections to reduce the potential for leaks.

Maximizing Steam Tracer Efficiency

Basic awareness of the steam tracer system will greatly influence the system’s overall efficiency. Don’t break the system into components. If the plant considers overall design in conjunction with the rest of the steam system, it can make informed decisions on the proper design and installation of the tracer system.

One of the best ways to maximize steam tracer efficiency is to use steam that would otherwise be wasted: in other words, flash steam. The return on the investment the plant makes in the equipment required to recover this flash steam is quickly paid back, typically within a year.

Another key point is to perform regular testing and maintenance on the tracing system. The plant maintenance manager/operator should regularly check valves and steam trap stations to ensure they are operating correctly.