HEAT TRACING TECHNOLOGIES

GEARING UP FOR ENERGY SAVINGS

Process heating accounts for about 36% of the total energy used in industrial manufacturing applications.[1] Particularly, as energy costs continue to rise, industrial plants need to find effective ways to reduce the energy used for process heating.

This article discusses the evolvement of Heat Tracing technologies (both electrical and steam) and the role that modern heat trace systems and components can play in energy savings.

It is estimated that anywhere up to 85% of the energy supplied to industrial process heating equipment is actually used for heating - the rest being lost due to inefficiencies such as heat losses. Effective heat tracing systems & control methods can assist greatly in minimising heat losses.

WHAT IS THE PURPOSE OF HEAT TRACING, IN THE FIRST PLACE?

Heat tracing is a source of **external heating to pipes, storage tanks, vessels & instrumentation for the purpose of process temperature maintenance and/ or freeze protection.** Simply put - 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.

Maintaining fluids and gasses at elevated temperatures reduces viscosity (makes the product easier to pump), enhances combustion (on fuel lines), and prevents freezing or crystallisation where there is a fluctuation in ambient conditions.

Typically in the oil & gas industry, the upstream sector requires elevated temperatures to move the crude oil and/or raw natural gas to the surface. The downstream sector requires freeze protection to the refining, petrochemical, and distribution of the products.

[1] Save Energy Now in Your Process Heating Systems; Industrial Technologies Program (ITP) Best Practices: Process Heating (Fact sheet) www.eeere.energy.gov. Accessed June 2015.

In power generation, heat tracing needs vary from providing winterization for steam and water lines, to maintaining fly-ash hoppers and “CEMS” sample lines above the flue gas dew point.

HEAT TRACING METHODS - HISTORY

Since the early 1900’s steam tracing has been the primary means of keeping materials such as petroleum residues, tars and waxes flowing through pipelines and equipment in the petroleum and chemical processing industries.

Following the Second World War, the petroleum and chemical industries grew substantially. Many of the raw materials for these new products had to be maintained at lower temperatures and held within a narrow temperature band to protect the quality of the end product. The “bare” steam tracing method of the time was frequently inadequate to meet these requirements. Various methods were tried to reduce the amount of heat supplied by the bare tracer. However, unpredictable heat transfer rates, hot spots, and high installation costs were often encountered.

During this era plant engineers were inclined to use fluid tracing methods (glycols and hot oils) where possible because of the ease of regulating fluid flow to maintain required temperatures although due to inadequate fittings, leaks frequently presented a problem. Electric resistance heating was also developed in the early years of the 20th century and some types were adapted for pipeline heating, but they had minimal use due to burn out failures caused by excessive sheath temperatures at high wattages. Fittings and connections were also weak points in the system. In the 1950’s experimentation began in earnest to develop more durable electric tracing methods that could be adapted to automatic temperature controls. These efforts brought about marked improvements and by the 1960’s, electric tracing began to be accepted as a viable challenger to steam and fluid tracing methods for heating process plant piping and equipment.

WHICH HEAT TRACE TECHNOLOGIES ARE USED TODAY?

Surprising to some, **steam** is still predominantly used for heating energy in approximately 60% of chemical-, petrochemical-, and industrial processing plants.

STEAM TRACING

A typical chemical plant can have around 55 000 meters of steam tracing and a refinery 220 000 meters of steam tracing – therefore there is considerable scope for improvement and energy savings.

In Africa there are many remote locations with inadequate electricity supply. In South Africa specifically, Eskom is facing capacity constraints, forcing industry to reduce electricity consumption, and hence the trend to consider steam tracing.

Industrial steam users contribute to an enormous amount of energy wastage in most countries, with many plants being outdated, and in a poor state. It is estimated that in the U.S. alone, roughly 2,800 trillion Btu of energy could be saved through cost-effective energy efficiency improvements in industrial steam systems.[2]

The wastage can be as a result of worn insulation, leaking pumps and valves, etc. 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.

Today, a wide range of steam tracing methods exists. New pre-insulated steam tracers have been developed by companies like Thermon from the USA that today offer a range of heat transfer rates for low to medium temperature control as well as improved safety. Where low pressure steam is available, these tracers may be used to heat materials such as caustic soda, resins, acids, and water lines which previously could not be heated with bare steam tracing. Insulated tracers may also be used for temperature control where higher steam pressures are available rather than installing pressure reducing valves.

For the high temperature range, steam may be used as the heat transfer medium in a modern "conduction" tracing system where heat transfer compound is installed over the tracer and covered with a steel "Strap-On" Jacket to provide permanent and maximum contact at the surface of the pipeline.

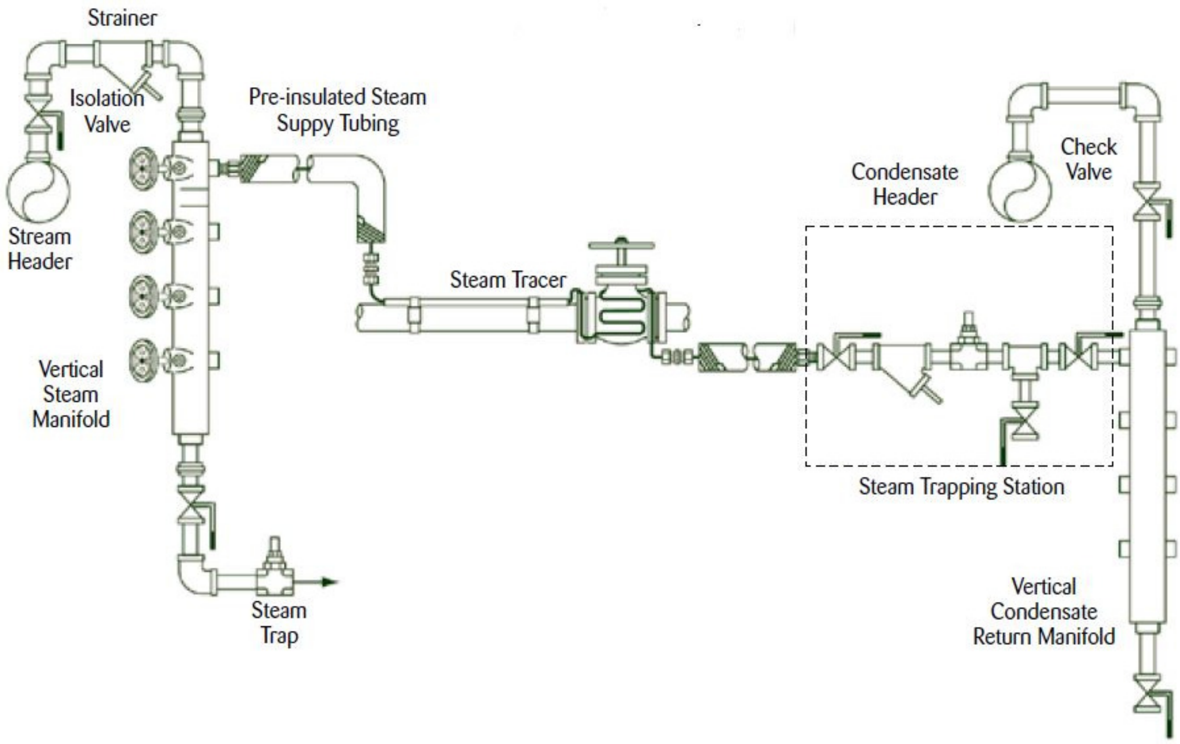
Heat transfer compounds (also known as "heat transfer cement") provides efficient thermal connection between tracer and process equipment. By eliminating the air cavities, heat is transferred into the pipe or tank wall through conduction as opposed to convection. A single tracer using the cement has the comparable performance of three to five bare tracers.

Additional benefits of using such compounds include a possible reduction in the number of tracers needed compared to bare tracers, and the ability to replace jacketed pipe without the high cost and fear of cross contamination.

Figure 1 portrays a typical steam tracing system. Most steam tracing is used in "run free" systems where no control methods are applied other than steam pressure reducing valves. However, several control methods are available which are discussed later in this article.

[2] Ted Jones, "Gathering Steam," Insulation Outlook, March 1998.

Figure 1: Typical steam tracing system



What is meant by the term "free steam?"

Steam tracing circuits can frequently use flash steam from hot condensate, steam produced by waste heat boilers, or steam from exothermic processes. Energy from these sources is often referred to as "free steam." However, flash vessels, waste heat recovery equipment and various accessories are required to control and transport this steam. The equipment and the accompanying maintenance services are not free. But, additional fuel is not being consumed to produce this steam, therefore it is a low cost energy source and is often referred to as "free steam."

Figure 2: “Safe Trace” installation

Designing steam tracing systems with today’s technology can:

- Significantly reduce energy losses by selecting the best tracer option and insulation
- Lower the generation of hydrocarbon pollutants
- Improve touch safety and reduce OSHA recordable burns
- Lower capital and maintenance costs by optimising circuit lengths and associated equipment
- Minimize thermal expansion in the piping network

The key to both good temperature control and energy conservation is designing and installing tracing systems that control the condensate rate, and thereby reduce energy consumption.

ELECTRICAL HEAT TRACING

Electrical heat tracing has its place too.

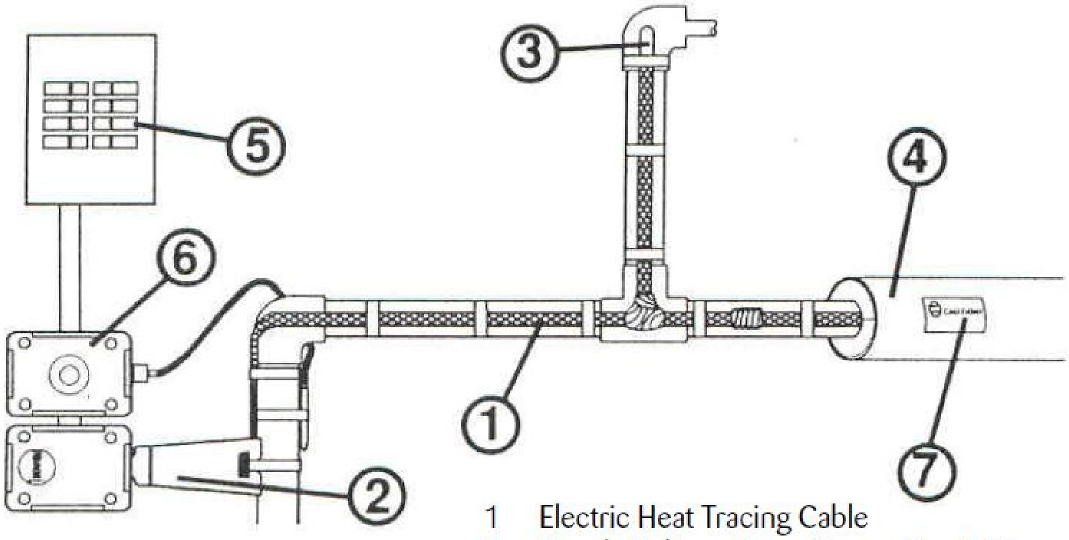
With technology advancement over the recent years, **electric heat trace cables** can reach even higher temperature ranges. Electrical heat tracing generally requires little or no maintenance and so is an attractive solution to plant maintenance personnel. In addition, far better control methods are available having a positive spin-off on energy usage.

New high temperature polymers and processing methods have led to the development of improved flexible self-regulating and power limiting heating cables. These flexible heaters can be used to hold pipeline temperatures in the range of approximately 149℃.

The development of high temperature metal alloys has provided a means to increase the temperature maintenance rating of today's semi flexible mineral insulated electric heating cables up to as much as 500℃ with exposure temperatures up to 593℃.

See Figure 3 for typical electric heat tracing system.

Figure 3: Electrical heat trace system



1 Electric Heat Tracing Cable
2 Supply Voltage Power Connection Fitting
3 End of Circuit Termination
4 Themal Insulation and Weather Barrier
5 Branch Circuit Protection Device
6 Control Device
7 Safety Caution Label

Self-regulating heat trace is typically an energy efficient cable. The resistance of the tracer varies as a function of its temperature. As temperature increases, the resistance of the polymer increases causing a decrease in the power output. The energy output therefore always matches the system's requirements.

HEAT TRACE CONTROL

Control is *really* where the energy savings becomes meaningful.

The different ways of keeping the pipe from freezing or at its required maintenance temperature is accomplished by different (physical) devices or different control methods.

Four different types of control are mainly used in the market today: 1) control by an ambient sensing thermostat, 2) pipe /line sensing controlled by a mechanical thermostat, 3) pipe /line sensing controlled by an electronic controller, and 4) controlled by a CPU based control and monitoring system; with Ambient Proportional Control (APC).

The energy savings is found in the control aspect during the varying process flow conditions. The required heat tracing output is normally designed for the ‘worst-case’ scenario which is at non-flowing condition and adverse ambient conditions. Conventional ambient sensing thermostats apply full power at a given minimum ambient temperature and switch OFF the power at a higher set point (ambient) temperature, with no regard to the actual energy required on the pipe or heat losses through the insulation. The modern **electronic controller, Figure 4,** with a Pt100 temperature sensor directly monitors the temperature changes on the pipe surface (the heat losses). If required, it will automatically switch and provide the required energy to match the heat losses.

Figure 4: ECM controller for pipe sensing

Pipe sensing rather than ambient air sensing is particularly suited to reduce the power consumption and applies the power to always deliver precisely the amount of heat to prevent the pipe temperature from dropping below the set point.

Each process condition might be different but energy savings using a controller with accurate switching in combination with line sensing has consistently been recorded in tests. It can fully optimise the system’s heating requirements, resulting in significant energy savings (20% compared to ambient control)[3], considerably reduced operating costs and accumulated power requirements.

[3] Energy Efficiency Case Study, Form TEP0144U-0214 © Thermon Manufacturing Co, 2015

CONCLUSION

Heat tracing systems are not often listed when energy reduction initiatives are being considered. However, when viewed from the perspective of how many meters of heat tracing exists in a typical refinery or chemical complex, the potential for reducing energy consumption and hydrocarbon pollutants can be significant.

This Case Study is a feature article in the 2015 Energy Efficiency handbook by Crown Publications, South Africa.

About Thermon South Africa

Thermon SA uniquely offers both electrical & steam tracing solutions. It has been Thermon's mission to enhance our customers' process operations by providing innovative and reliable heat tracing solutions at the lowest total cost of ownership.

For more information, visit www.thermon.co.za

Heat Tracing Technologies: Gearing up for energy savings

unitemp®

Tel: +27 11 966 9800 (JHB)
+27 21 762 8995 (CT)
sales@thermon.co.za
www.unitemp.com/contact