HOTFOIL-EHS

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Heat Tracing of Long Pipelines

Pipelines provide a simple means of transporting materials, liquids, powders, and gasses over sometimes relatively long distances, both efficiently and inexpensively. When thermal insulation alone is not sufficient, then the pipeline needs heating.

There are two factors necessitating heating:

a) Heat loss compensation – to maintain the pipe at a specific temperature.
b) Temperature raising – to elevate the temperature of the pipe and contents in a specific time.

Materials are heated for many reasons:

1) To prevent liquids changing state
2) To reduce viscosity
3) To heat materials in preparation for the next process
4) To prevent corrosion

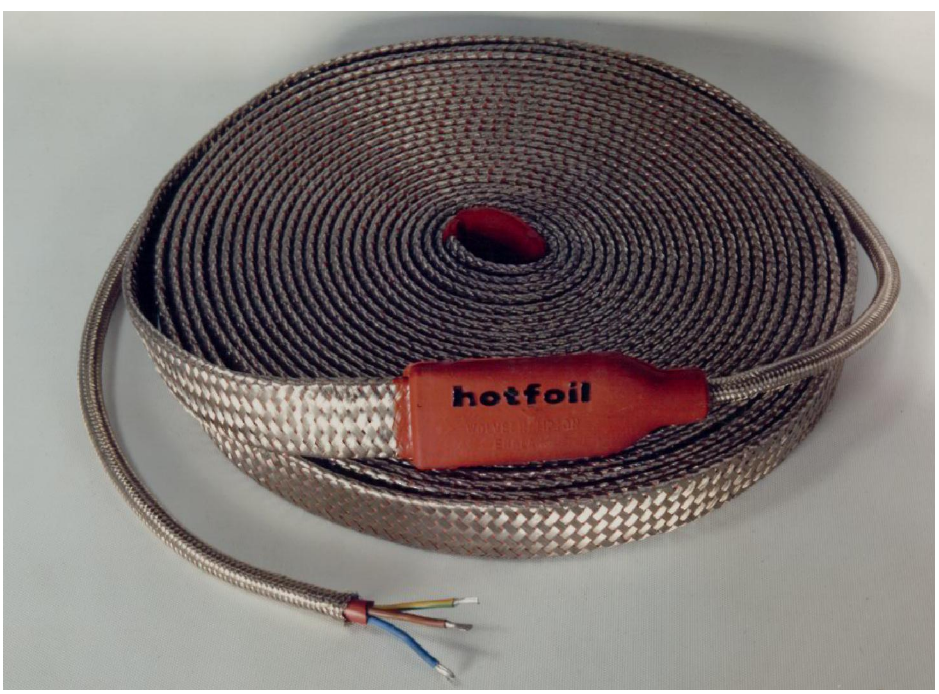
Electricity offers many advantages. It is clean, easy to install (or repair, if necessary), easy temperature controlled and readily available. Operating costs are low, and on a properly designed and installed system, maintenance is virtually non-existent.

Typically, two types of external heat tracing systems are being used:

1) Mineral insulated heating cable
2) Heating tape

Heating cables – Usually of the mineral insulated (mi) type, with a variety of covering. The covering or outer sheath is of metal, i.e. copper, stainless, inconel, cupro nickel, etc. The conductors are usually of low resistance nature. The cables only give point contact, and heat transfer rate and efficiency is low. Vibration is a problem and causes insulant migration. The cables have to operate at higher temperatures to give the needed heat transfer. Heat transfer cement is usually used to assist in heat transfer. M.I. cables are semi-rigid and, once bent into shape or configuration, it is virtually impossible to get the cables straight again. Repeated bending of metal sheathed cable can set up stresses, resulting in stress cracking of the metal sheath.

Heating tapes – these are the most versatile form of heating. They can be designed for practically any voltage, can be made for single or three phase operation, can be covered with a variety of sheaths for compatibility with the environment, etc. Heating tapes are flexible and thus easy to work with. They can be braided with either stainless steel or nickel plated copper, for hazardous environments or non-metallic pipes.



Usage of copper conductors, or other low resistance metals, is needed for running long lengths of circuits. The length of circuit is governed by temperature of the pipe, voltage supply, type and thickness of thermal insulation, amount of load given out by the tape or heat needed on the pipe, delta 't', etc. Low resistance metals mean that long circuit lengths can be achieved. Long circuits are what is needed to have the voltage supply at one end only. If possible.

Various methods of heating long pipelines by heating tapes are available. It can take the form of one (1) three phase heating tape or three (3) single phase tapes.

Design Consideration

Each pipeline is different and it is doubtful if two projects will ever be the same. Factors governing the designs are:

1) *Temperature Range*. This is the final designed maintenance temperature of the pipe. Thought must be given in the initial design to the materials that could be in the pipe during its lifetime. For example, an initial approach may be to pump light oil at a higher maintain temperature.

2) *Ambient Temperature*. Designs must take into account the lowest anticipated ambient temperature.

3) *Temperature Raising*. The design may ask for the temperature of the material to be raised during transit through the pipe. Alternatively, designs may request that the heaters have to have sufficient power to "melt out" a system in the event of prolonged shutdown. The specific heat and gravity of the material needs to be known.

4) *Voltage*. The most convenient voltage supply for the system.

5) *Needed Info.* Length, diameter, thickness and material of the pipeline to be heated.

6) *Temperature Control*. How the pipe is to be temperature controlled and by what means.

7) *Corrosion Effect*. Of materials near to the pipe and heater.

8) *Materials in the Pipe*. If they have a flashpoint, freezing and boiling points.

9) *Thermal Insulation*. Type, thickness, K factor, etc.

The thermal insulation on any project must be known, as this dictates the amount of heat losses and is a most important factor to bear in mind. There are various types:

- *Polyurethane*. Usually used for low temperature applications. It is approximately 95% air and is a good insulator. It is either preformed or can be sprayed on.
- *Fiberglass*. In preformed, half round pipe sections is a common means of thermal insulation.
- *Mineral Wool*. This has similar properties as fiberglass.
    - *NOTE: In the majority of cases, heat loss tables from heater manufacturers or suppliers are based on glass fiber or mineral wool.*
- *Calcium Silicate*. Widely used in plants due to its robust, solid qualities. It is not a good insulator and standard heat loss tables have to be raised by 35-40% to accommodate the inefficiency.

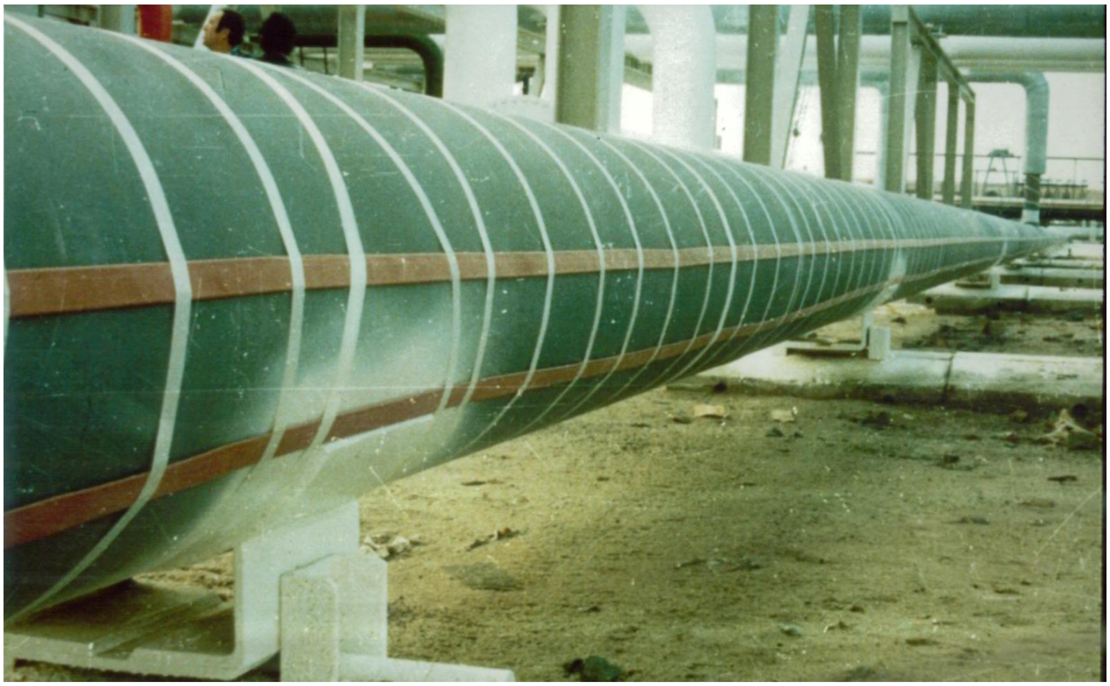
With using polyurethane and/or calcium silicate, care must be taken, as they are "hard" materials and do not readily flex. On steam traced lines, either a groove is cut in the insulation to accommodate the tracer, or oversized insulation is used. With mineral wool or fiberglass, it is usually sufficiently flexible to absorb the tracer if the tracer is of small diameter. This factor also has to be borne in mind with a heating cable system. Heating tapes are usually thin in nature and a grooved or oversize insulation is not needed.

Installation of heat tracing

Heating tapes can be either "straight" traced or "spiraled". Obviously, the easier method is straight traced.

Although heat tape can be supplied in unit lengths of several hundred feet, it is not advisable to have them this long. Long heaters are heavy and hard to handle and, if dropped or mishandled, fall into an uncoiled pile on the ground. To simplify installation and maintenance, medium lengths of heaters should be chosen, i.e. 150-300'-0". Then, series junction boxes can be used to connect up the lengths of heaters to achieve the total pipe run. (Sketch 1)

On straight traced applications, the heaters must be secured at approximately 1'0" intervals to prevent sagging of the heater away from the pipe. Contact between heater and pipe is paramount. For heating tapes, securing fiberglass tape or similar should be used.



Junction boxes

Normally on pipelines, there are three (3) types used:

1) *Voltage Supply Box*. This is where the client's supply is brought in and feeds the heating system.

2) *Series Boxes*. This is where "n" number are used to series connect the various lengths of heating means.

3) The back end box to connect the heaters in a star or "Y" fashion for three (3) phase applications.

The boxes should be weatherproof for outdoor locations and suitable for any environmental attack from chemicals, gasses, dusts, etc.

Control of temperature can be achieved by a simple thermostat and contactor method, all the way up to sophisticated control panels. Each system of control must be investigated as to the requirements of the client/engineer for control, monitoring alarm levels, etc.

Repairs – fault finding

Fault finding on long, continuous circuits is very difficult. On uninterrupted runs of 1000’ or more with no series joints, unless there is mechanical damage, a break cannot be easily located. Where there are section lengths of 150-300’, it is easier to find the fault in such a section with standard electrical measuring instruments.

Above/below ground locations

The majority of heated pipelines are usually above ground. Some heated lines are below ground and, where such installations exist, records must be kept of the geographical routing, junction boxes, joints, etc. On underground lines, the thermal insulation must be totally waterproof as water tables do exist. Care must be taken on the installation due to the possible dissolved chemicals in the soil, which could attack the total installation.

Records must be kept of all systems, locations, items used, reference numbers of components, etc.

Hotfoil-EHS Design

On all long pipelines, the object is to reduce, to a minimum, the number of voltage supply points. By keeping these to a minimum, the cost of the total project of the heating system is attractive and competitive because it minimizes the electrical conduit and wiring.

Long pipeline systems usually need a three (3) phase voltage supply. Such a supply also offers a balanced three (3) phase load.

There are two (2) ways of achieving the requirements:

1) A single, three phase heating tape (three foils in one sheath)
2) Three, single phase heating tapes (each tape with one foil)

Although various sheaths can be used on the heating tapes, we have been using rubber. Silicone rubber offers many advantages, such as temperature range and chemical attack resistance.

Systems do not end with just the heating tapes. The junction boxes (series, supply and “Y”), must be provided. Also, the system has to be temperature controlled. For hazardous areas, the heating tape will invariably have to be braided.

Being a project engineering company, Hotfoil can supply all the accessories needed on any system and do all engineering designs, drawings, wiring diagrams, system layout, field supervision, startup services, etc.

Method (a) – One 3 Phase Heating Tape
Hotfoil Type HTF – 3P

This system uses a single heating tape with three resistance foils as the heating means. (Sketch 2)

The foils can be of any material depending on the job requirement. As we are concerned with long lines, the foils are usually copper. Copper possesses a low resistivity, 10.3 ohms/c mil-ft. and thus long lengths can be achieved with this low resistance metal conductor.

Calculations are done to determine from loading needed (watts) with a given supply (voltage), the actual resistance of the circuit. This is then translated into the length and cross sectional area of the copper foil.

With the three (3) copper foils suitably spaced apart, they are fed through an extruder and receive a sheathing of silicone rubber. The thickness is dependent on the insulation factor of the project.

The back end of the tape system is taken through the leads to a junction box. On a 3 phase star/"Y" system, the three (3) leads are connected together to form a star point.

The front end of the system is connected to the voltage supply. This has to be a 3 phase supply. Since all three (3) foils are of the same cross sectional area and the same length, the load is balanced evenly over the 3 phases.

Typical systems done so far are:

a) One run of pipe/tape 5,300'-0" long, one supply point of 600 volts, 3 phase, giving a load of 5 watts per foot of tape/pipe.

b) One run of pipe/tape 1,400'-0" long, one supply point of 208 volts, 3 phase, giving a load of 5 watts per foot of tape/pipe.

c) One run of pipe/tape 7,920'-0" long, one supply point of 480 volts, 3 phase, giving a load of 7 watts per foot of tape/pipe.

d) One run of pipe/tape 7,920'-0" long, one supply point of 480 volts, 3 phase, giving a load of 9 watts per foot of tape/pipe.

These systems were for freeze protection of steam condensate return lines. The tapes use copper foils with silicone rubber sheaths. These were ideal as the rubber can withstand a 400° F continuous exposure, which the condensate could attain.

Also,

a) One run of pipe/tape 1,780'-0" long, one supply point of 480 volts, 3 phase, giving a load of 7 watts per foot of tape/pipe.

b) One run of pipe/tape 850'-0" long, one supply point of 480 volts, 3 phase, giving a load of 7 watts per foot of tape/pipe.

These systems are freeze protection of water lines running alongside coal conveyors in Utah.

Method (b) – Three Single Phase Heating Tape
Hotfoil Type HTF – 1P

This system is basically the same as (a) but each tape is a single phase.

When systems call for high electrical loadings, both on the heating tapes and the pipes, or the pipe/circuit is exceptionally long, the foils must be of a larger cross sectional area. Due to this fact, individual foils are extruded with silicone rubber. (Sketch 3)

Extruded lengths of tape are kept to 100’-150’ due to the weight of the tape and the obtaining of foil in workable lengths.

Junction boxes are used for the series connections, star/“Y” connection and the incoming supply. The heating tapes are straight traced on the pipeline and secured with fiberglass or equal securing tape, every 1’-0”. Note: metal, plastic, nylon or pvc must not be used for securing due to mechanical damage or chemical non-compatibility.

Section lengths of tapes have cold leads, firmly butt spliced to the foils, and with a silicone rubber molding over.

The three (3) tapes are connected in a star/”Y” formation at the back end to achieve a balanced, 3 phase load.

A fourth redundant tape can be installed as a spare. Should any damage occur to one of the three working tapes, the fourth can be connected into the system at the series boxes quickly, and the heat is back on line. This means that the system is 100% operational without removing the thermal insulation or disrupting the system. When the pipeline is off line or shut down for other reasons, the repair of the damaged tape can be effected. This method of four tapes has been more than welcomed on many jobs.

Some projects done are:

a) 6,562’-0” run of pipe, 12” diameter to raise and maintain at 150°F. Most of the pipe was buried.

b) 187,000’-0” of tape for pipes up to 36” diameter to raise temperatures and maintain up to 160°F.

c) One run of pipeline, 6,853’-0” of 10” diameter, one 3 phase system, 67 KW, to maintain temperatures between 86° and 186° F, hazardous location.

d) 118,000’-0” of tape on 10” pipe with a total loading of 157 KW to maintain temperatures up to 104°F in a hazardous location.