UNDERSTANDING OF SURFACE HEAT TRACING OF BULK STORAGE TANKS FOR VISCOUS AND HIGH POUR POINT FLUIDS

Preamble:

Surface Heat Tracing for Pipes has been in use for many decades in the industry; and so are the Surface Heat Tracing of Vessels, Storage Tanks and Bulk Storage tanks are in use since 1970's or even earlier. This note summarises several aspirations and questions dealt with technicalities, economics, dealing with possible accidents and overcoming fears over three decades which has established the success and benefits reaped in usage of Surface heat Tracing of large / bulk storage tanks, particularly handling of varieties of Heavy Fuel Oils. The information herein would be of use to the existing installations of surface heat tracing of tanks, as well as to the designers and decision makers of current requirements where the choice of tank heat tracing has to be made between the conventional immersion heating (e.g. steam / thermal fluid coils, electric immersion heaters) and the surface heat tracing (electric heat tracers, electric flexi panels and steam panels).

It is essential to know that heat tracing of difficult fluids is basically an insurance against plant / process stoppages. It is important to understand differences between the science of Heat Tracing and the science of Heating. The need of Heat-up of tank contents is to be weighed against cool-down realities. The economics of thermally insulating the storage tank versus the bare tank surface has to be understood. Most importantly the chemical and physical properties of the fluid being handled should be studied and kept in mind, all the time. These issues would be addressed, for clarity of users and decision makers.

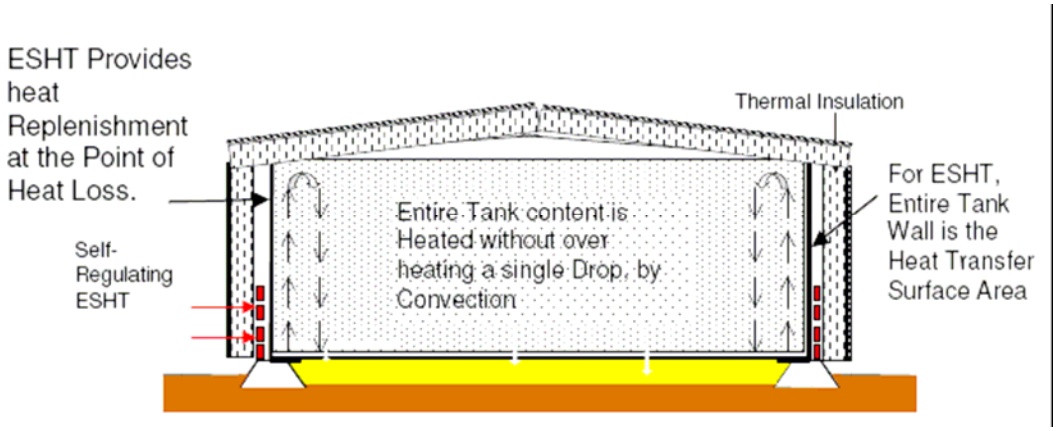
To begin with, accept the fact that Heat Tracing of Storage tank is nothing but heat tracing of a very large sized pipe. Having said that, you would have experienced that in heat tracing of pipes, it is in the small bore pipes which pose solidification problems compared to large bore pipes; and, after all a storage tank is nothing but a very large sized pipe with no possibility of fluid solidification in normal plant operations and shutdowns when thermally insulated. We will now address various aspects of the Heat Tracing of Storage tank by Surface Heat Tracing methodology.

Heat Tracing V/s Heat Up

Heat Tracing is a subject of Replenishing of heat loss taking place from heated fluids through a thermally insulated surface, whether it is from a pipe or a tank. Heat Tracing is generally carried out with the heat transfer surface at a temperature slightly above fluid maintenance temperature and employing **low-watt density** heating.

Heating is a subject of mass rate of rapid heat input to Raise Temperature and thereby change the state of fluid (solid to liquid). Heating is generally carried out with the heat transfer surface at a temperature way above fluid maintenance temperature and employing **high-watt density** heating.
Now, in the case of Heat Tracing, that is maintaining temperature of fluids inside the storage tank, the method employed is to thermally insulate the tank and use low-watt density heat tracers. In the case of Heat up requirement, high-watt density heaters are to be used, and the tank surface may be bare or thermally insulated, though the later is a preferred choice for heavy fuel oils with high pour point properties. By and large a Heating system cannot perform the function of Heat Tracing as efficiently, as economically and as safely as a heat tracing system, and vice versa.

Surface Heat Tracing (SHT)
In Surface Heat Tracing the heat input or heat loss replenishment is at the point of heat loss from a thermally insulated surface. The entire tank surface becomes a large heat transfer surface, inputting heat into the fluid inside it. Thus by conduction heating, by means of a low-watt density heating, it ensures that every drop of fluid inside the tank is heated without overheating any portion of it; and thereby the fluid at bottom most portion of a tank remains in a heated state, preventing formation of sludge at the tank bottom area. Temperature sensing one point on the outer tank wall surface will control the temperature of the entire tank content in a Surface Heat Tracing system. As the surface temperature of heated insulated tank is maintained at or a degree above the fluid temperature inside of a tank, the differential temperature between them is virtually zero, thus preventing the heat loss to take place. The Surface Heat Tracing can be easily and quickly installed, even on a tank filled with fluid; and does not require any cutting of tank surface.



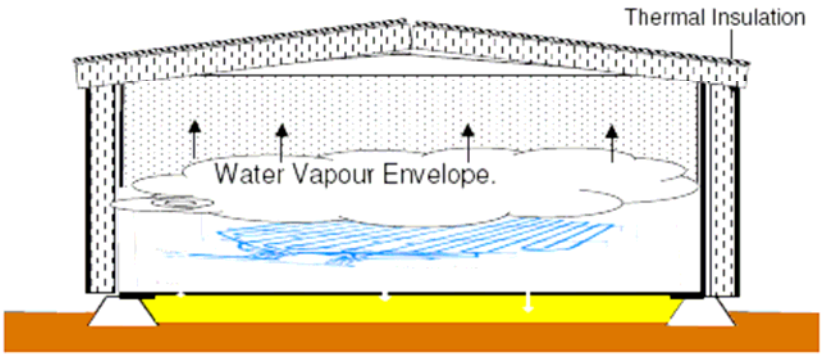
Electric Surface Heat Tracing (ESHT) of Crude Oil / Heavy Fuel Oil Storage Tank

Immersion Heat Tracing

Immersed Steam coils are the widely used method for Immersion Heat Tracing, particularly for heavy fuel oils. It is a practice to have the immersed steam coils closely spread over the entire tank bottom area, with a pitch of 200 mm to 300 mm between each coil. Generally, these steam coils have to be provided with a gradient for the condensed steam to flow by gravity to the discharge end of the coil; therefore these coils are installed at an average height of 300 mm to 600 mm above the tank bottom surface. The heat transfer from the steam coils into the oil tends to rise by convection current and the heat does not flow below these coils. Thus, the heavy fuel oil below the coils cools down and forms into sludge or even solidifies over a period of time. This sludge formed or solidified oil 300 mm to 600 mm below the coils becomes a dead stock and is a very expensive proposition particularly for large storage tanks. Furthermore, entry of water inside of heavy fuel oil storage tank is inevitable, and the water being heavier than oil usually settles at the bottom level of the tank, where the steam coils are located. The water gathered around the steam coils is under pressure and it being in continuous contact with it gets heated, forming into steam vapour envelope. This vapour envelope grows in size pushing the oil contents upwards, and this could eventually blow off the tank roof. Such a phenomenon in the oil industry is termed as a 'Boil Over' accident. Due to high-watt density heating of immersed steam coils, the oil film on the coil surface overheats and chars. Particles from charred oil and from sludge which get carried over into to fuel oil firing system it erodes the precision nozzles of the oil burner and effects the combustion efficiency by a fraction percentage resulting in huge financial losses which goes unnoticed. Another aspect is that as the length of a coil has to be limited, multiple coil sets have to be installed, resulting in multiple connections which are to be provided by cutting the tank wall surface at steam entry points and condensate exit points.

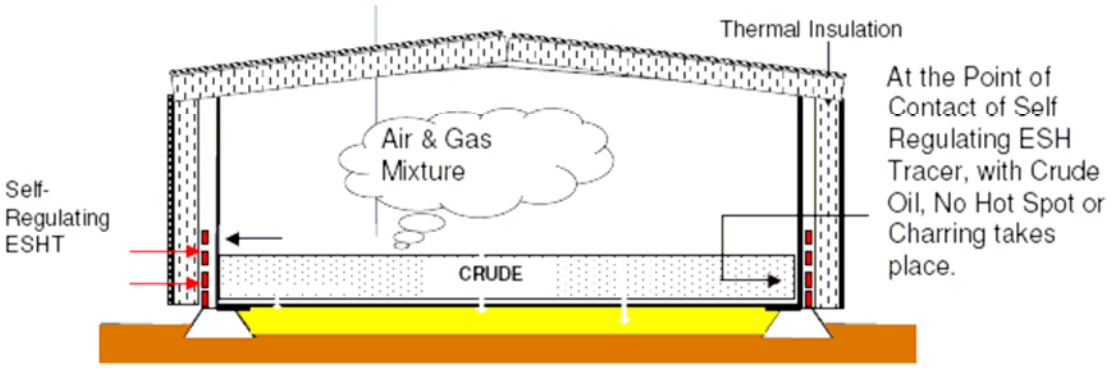
Electric Immersion Heating rods may be considered, but they could selectively be used for small service tanks and are not in use for large storage tanks. They are high-watt density heaters and are not suited for heat tracing applications from the point of view of Safety and effective efficiency.

Water Vapour Envelope formed, pushes the oil upwards, causing 'Boil Over' / 'Roof Top Blow off' accident, when water contents are in contact with base steam heated coils.



Steam Immersed Base Coil Heating of Crude Oil Storage Tank

At the point of contact of Self Regulating ESH Tracer with mixture of Air & Gas, Tyco tracers provide total Safety against Burnout and auto ignition with its built-in Unconditional T Rating, Certified by FM



Electric Surface Heat Tracing (ESHT) of Crude Oil Storage Tank

Heat up of Heavy Fuel in Storage Tank

When Heat Tracing of Storage Tanks for heavy fuel oils is planned, most often the question of heating up of tank contents is addressed for fear that should the entire tank content solidifies, and then what backup is provided for heat up. In normal operation if the heating operations halt for twenty-four to even around for a week, there won't be a substantial drop of heavy fuel oil temperature so as to significantly effect the operation. Here again, greater the contents in a large tank, lesser will be the rate of temperature drop. For large sized thermally insulated storage tanks, the rate of temperature drop could be One-degree centigrade or even less in 24-hours.

There are other conditions where the tank with Heavy Fuel Oil contents is to be heated. The temperature of heated heavy fuel oil at delivery point of tank filling operation could be lower than the maintenance temperature requirement. It is not a good safe practice to heat up the delivery oil inside the storage. The heat up rate of fuel oil inside the tank should be at a very slow rate of less than one-degree centigrade per hour. The better option is to install an in-line heat exchanger to raise the temperature of flowing heavy fuel oil. This is a rapid, economical and safe heat-up alternative. Another method of raising the temperature of oil inside of the storage tank is to cycle the oil through a heat exchanger which could be outside of the tank or an outflow type of heat exchanger fitted on to the tank. It would be a more fruitful exercise to have **cool-down time** calculations carried out for storage tank content than to have Heat up requirement.

There is often a question raised as to why store the Heavy Fuel Oils at elevated temperatures at all times, instead of storing them at ambient temperatures and to later heat up at the time of transfer. This is an accepted practice for fuel oils with relatively not so high a viscosity (RedwoodNo.1) and having 'low pour point', and by the use of an outflow heater the fuel oil at ambient temperature surrounding the outflow hearer could be heated up as it sucked and pumped out through an outflow heater. Such fuel oil storage tanks anyway would not require thermal insulation or any heat tracing. But Heavy Fuel Oils having high viscosity, high pour point and paraffin content waxy fuel oils have to be

maintained at around 10 deg-C above its pour point temperature level. By storing these heavy fuel oils at the prescribed elevated temperatures, will prevent sludge formation; and, in the case of waxy paraffin oil it will prevent formation of waxy globules, which once formed have to be heated at a very high temperature way above its maintenance temperature. Besides this, the studies show that the cost of thermally insulating and heat tracing on continuous basis pays back compared to storage tank which is kept bare and is heated 3 to 4 times and more in a year.

Cool-down

Cool-down time determination will enable to understand that provision for mass heat up of tank is not that necessary. This can be determined by spread sheet computation.

The cool-down of storage tanks generally takes place from tank wall, and whilst the temperature is cooling from the sides and waxy fuels tend to form solidified layer on the inner tank wall, the central content portion of oil remains hot. This waxy layer as it forms acts as an insulation and further retards the rate of heat loss from the tank. Often people are concerned about as to how the heat from surface heating would reach the centre of the tank, least realising that **in surface heat tracing the heat is being replenished at the point of heat loss**. Matter of fact with the limited heat transfer surface area of immersed steam coils one has to worry as to how the heat from these immersed stem coils would reach the entire tank wall side surface. In waxy heavy fuel oil storage tanks having immersed steam coil heating arrangement, it is reported that the wax layer builds up on the tank wall on windward side, and by the sheer weight of the waxy oil build up the tank wall has buckled in.

Conclusion

Surface Heat Tracing of Heavy Fuel Oil Storage Tank is a much Safer, Cleaner, and Economical option compared to any immersed heating system. Electric Surface Heat Tracer or Electric Flexi-panels will be highly efficient and cost effective compared to Steam Heat Sheets. One has to address all possible questions of the user at the beginning so that they use the Surface Heat Tracing of Heavy Fuel Oil Storage Tanks with full confidence, and are ale to satisfy panic button strikers whenever they surface.