Meters & Controls, Inc
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May 11, 2018

Tank Heating is more than a fabrication job!!

- Published on December 14, 2017

Mohit Goel

Large stockpiles of cargo are a quite common these days. There are several storage & transportation points in oil companies, FPSOs, refineries, Storage terminals where a very large capacity storage is witnessed. Storage tanks larger than football fields are not so rare.Due to increasing stockpile, efficient terminal operations have also become a far important necessity.Out of various products stored, heavy oils, heavy crude, fuel oil comprises a significant part. Increasing infrastructure projects also increases usage of asphalt & bitumen. These heavy oils & asphalt need to be heated to reduce viscosity for pumping and transportation.

The role played by efficient tank heating provisions has been well underestimated in many instances. Tank heating is not always a most discussed topic related to tank designs. However, industry experts acknowledge the role and importance of efficient and effective tank heating.The petroleum oils change density with temperature. Since the supply stock measurements are taken in volume and then temperature corrections applied to determine actual stock sold, maintaining correct temperature directly affects profitability. Hence product supply at correct temperature is a business necessity.

Due to drastically changing viscosity and pumping ability over changing temperatures, incorrect or non-uniform temperatures make operations difficult. Thus, cargo heating is also important for transportation.Oil blending is equally important to ensure quick

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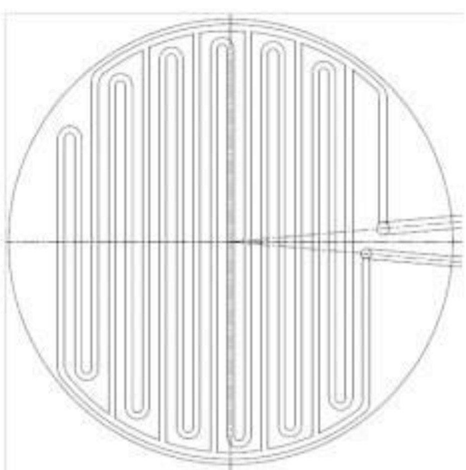
response to customer demands. Efficient blending is possible with better temperature control of the tank. There are many instances where the tank hold needs to be heated. There have also been many methods and philosophies used to design tank heating system.

Traditional concept

The traditional concept of tank heating was to use a serpentine coil manufactured from pipes, laid at the bottom of the tank. The heating fluids such as steam / thermal fluids are passed through these pipes to achieve heating. This traditional method did work fine and satisfactorily when the average tank sizes were relatively smaller. This concept itself was innovative once upon a time and gained popularity due to easy availability of raw material (in this case pipes), easy concept for design and fabrication.



In many instances of tank designs, the tank heating had been a matter of lesser importance due to several reasons such as

- Heating coil design and fabrication is considered as part of tank design.
- Supply & installation of heating coil in the scope of tank fabrication and not routed through thermal or heat transfer designers.
- Thermal Performance subject to interpretation due to Changing temperatures over the day & year (due to changing seasons)

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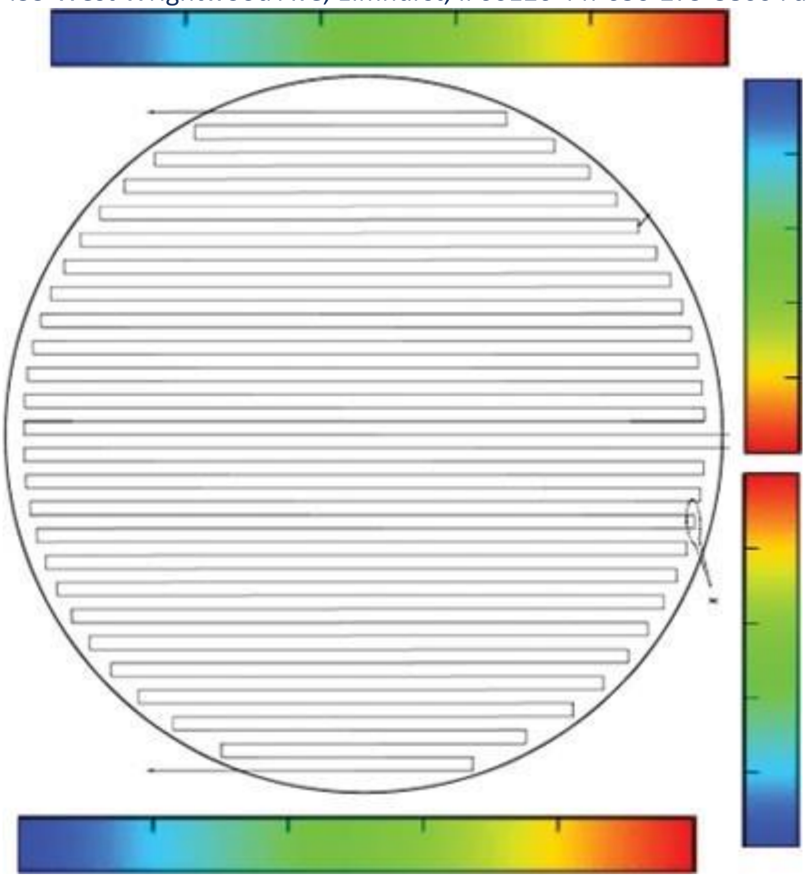
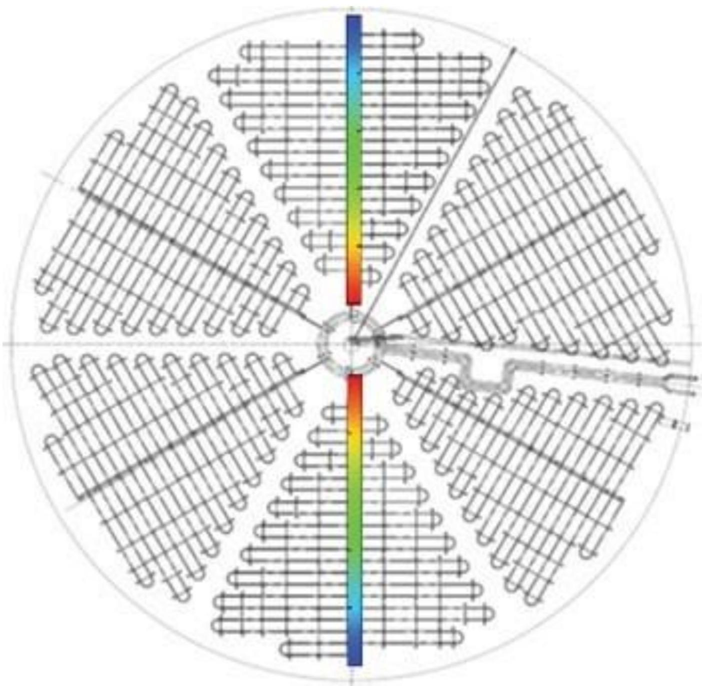
- Absence of uniformly accepted standard / code for measurement of thermal performance
- Traditionally the tank sizes had been relatively small. Due to changing dynamics and cost structure, the average storage tank sizes are increasing nowadays.

The traditional method of heating with pipes worked fine for smaller tanks. Eventually an extension of the same traditional concept was being adopted for many larger tanks. On those projects, heating became more complicated.This traditional method has several constraints when evaluated carefully for the intended use. Heat transfer, which is the prime intention for these heating coil, gets affected the most unfortunately.

As the heating medium continues to loose heat along its path in a serpentine coil, the temperature profile along its length continues to get affected, affecting the Log Mean Temp Difference (LMTD, in heat transfer parlance), thus overall heat transfer. The adjoining figure shows arrangement of a fairly medium size tank and the heating coil had to be split in 2 sectors to have better heat transfer.



As one can see, the steam continues to transfer heat along a very long serpentine pipe. Thus saturated steam at the start of heating coil is either a vet steam / condensate or even a mere hot water at the exit of heating coil.This means that the heat transfer will not be same all along length of the heating coil. In many instances it is observed that in order to compensate for ineffective heat transfer and temperature gradient across the tank, the heating coil layout had to be complicated



As can be seen from the adjoining figure, temperature distribution has improved. The multiple sectors of heating coil ensure that there is fairly consistent temperature in each of the sectors. However, due to very long serpentine pipeline in each of the sectors, there is still a temperature gradient along the length of heating coils in each of these sectors. It means that the temperature gradient has reduced but not eliminated.

Cost of heating :

There are several direct as well as indirect costs associated with this heating. The direct heating can be measured and optimized easily. The indirect costs are also significant. These need to be monitored and optimized. This heating, which is merely for transportation purpose, must be reduced. This can be done by using correct design philosophy.

Direct heating costs :

The products stored at ambient temperature require to be heated to agreed discharge temperature. This direct heat addition can be measured by simple formula. Irrespective of heating mechanism or philosophy inside the tank, these heating (direct heat addition into the product) costs are generally dependent upon the efficiency of the heater and hence should be same for all heating mechanisms. An efficient heater / boiler can ensure that these costs are kept to as low as possible.

Indirect Heating costs :

Measurement losses

Due to non-uniform heating of the product inside the tank, temperature corrections are applied to the entire stock, although a part of the stock may be at a lower temperature.

Also, due to non-uniform heating, actual heating may be applied for longer time than necessary, thereby increasing the heater / boiler running and in turn, fuel consumption.

Costs due to Non-uniform heating

Provision of good mixers can reduce such losses. These mixers are required to be operated throughout the heating duration. The operating costs of these mixers is added to the cost of heating to ensure uniform product temperature. Operation of mechanical mixers to compensate for inefficient / inadequate heating also adds the running and maintenance costs on mixers to the cost of heating.

Cleaning costs

Non-uniform heating is also one of the causes in non-uniform sludge settlement inside the tank. Heavier sludge settlement makes tank cleaning during the maintenance interventions a major bottleneck. Especially in the instances like bitumen, heavy fuel oil, where the product becomes solid or very viscous at ambient temperatures, complete clean-out is a major nightmare for the maintenance team. Efficient heating can help in reducing sludge settlement, thereby reducing this clean-out cost. Modern heating techniques that help in increasing convection and temperature distribution inside the tanks help in maintaining the hold at uniform temperature, thereby reducing these costs.

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Surface Losses

Due heating up of complete tank holdup even in cases where a very small portion is to be discharged (for instance, tanker loading of bitumen), the heated stock loses heat to the atmosphere from the surface, only to heated up again. These costs can be reduced by providing a discharge / outflow heater, which will be used only when the product is getting discharged. Thus it makes an economic sense to keep the stock at as less temperature as practically feasible and the heat up the stock efficiently prior to discharge or sufficiently in advance of discharge.

Available options

Various methods and philosophies are employed to decide heating mechanism. Factors to be taken into consideration for deciding heating philosophy include Ambient conditions, Storage duration, Product discharge condition (flow rate, continuous or intermittent discharge, Frequency of discharge), Heating medium & Heating cost etc.

Immersion Heating :

There are some efficient heating mechanisms available for ready use. PLATECOIL® heating offered by Tranter can improve heating efficiency, internal circulation and ensure uniform product properties inside the tank. The vertically oriented heating coils at correct location induce proper convection currents inside the fluid and ensure uniform heating. The adjoining picture from a live installation shows such an arrangement.

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This arrangement has several advantages

1. Uniform temperature in tank making operation dependable.
2. Improved convection inside tank leading to lesser settling, lesser maintenance
3. Reduction in hold-up volume inside heating coils means faster start-up
4. Reduction of condensate hammering making operations Safer
5. Reduction in pressure drop means Smaller pump and lesser pumping costs
6. Weld-joins reduced by almost 75% enabling a faster installation
7. Better accessibility leading to a better quality of installation.

This efficient heating is a result of a very interesting internal convection.

A computational fluid dynamic analysis (CFD analysis) of heating in the tank validates this internal convection and internal circulation as a result of this heating method.

The vertically oriented heating coils ensure that heating of the fluid is prolonged until the fluid leaves the heating surface. This sets in very high convection velocities inside the tank. This leads to uniform temperature distribution across the tank over the heating duration.

By maintaining uniform temperature, viscosity of the product is also maintained uniform facilitating the pumping. This can also ensure lower pumping cost. Reduced sludge sedimentation due to proper circulation reduces maintenance costs. There are many satisfied customers in the industry who vouch for satisfactory performance of this methodology.

As experts say, "increasing efficiency is not a mere strategy, it is an imperative".

The industry today strives to increase efficiency in every aspect of its business, its operations. In storage tank parlance, this efficient heating can make operations much better and reduce the operations cost.

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E-mail: sales@tranter.com

Web: www.tranter.com