



Electric Industrial Process Heaters



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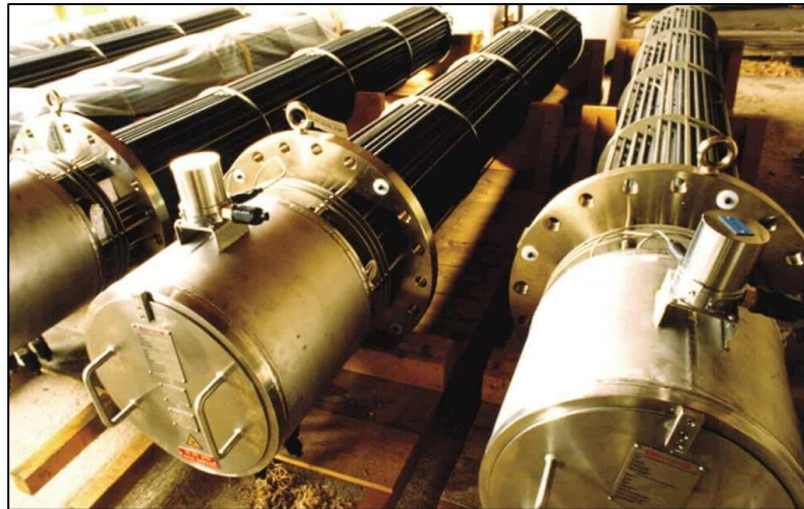
Agenda

- Heating Basics
- Component Heaters
- Process Air Heaters
- Immersion Heaters
- Radiant Infrared Heaters
- Large Capacity Electric Heating Systems
- Hazardous Location Heaters
- Process Heater Controls
- Tank Heating
- Heat Tracing/Offsetting Losses



Advantages of Electric Heat

- Less complicated installation
- Green friendly, no direct carbon emissions
- No moving parts, or mechanical wear
- Low noise (humming)
- Predictable maintenance/element replacement
- Predictable operating costs
- Potential physical footprint savings

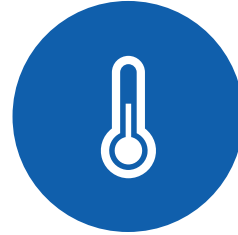


Design Considerations



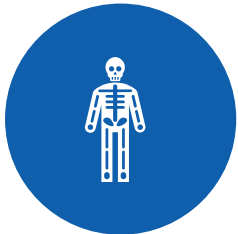
Heat Loss

Compensate accordingly.
Insulation is your friend.



How do you want to control it?

Longer element life vs. lower initial costs.



Physical Footprint

Does it allow for removal or replacement of elements?



Potential Corrosives/pH

Picking out the right element materials.

Heating Basics

■ Conduction

- Transferring heat through direct contact.
 - **Example:** Electric range or cooktop with flat, ceramic surface (direct contact with cookware).

■ Convection

- Transferring heat through air or ambient conditions.
 - **Example:** Air fryer cooking with high heat + air circulation to ensure all surfaces are evenly heated.

■ Radiant Infrared

- Heat energy emitted from an intense source that can both directly heat the object with short, medium, or long wave energy and also heating surrounding surfaces that re-emit convection energy to the ambient air.
 - **Example:** Sunlight & melting snow.

Heating Basics



Gases

Air or gases are typically heated with either circulation heaters or process air heaters.

The process itself determines the type of heater, but gasses are a relatively simple application.



Liquids

Can vary in weight, viscosity, and heat tolerances. Water can take high watt densities like 52w/in.

Boilers, circulation and immersion heaters are typically used with liquids.



Solids

The weight and thermal conductivity of the solid can vary and they can also be affected by different tolerances or melt points.

Component, radiant, heat cable, and process air heaters are typically used.



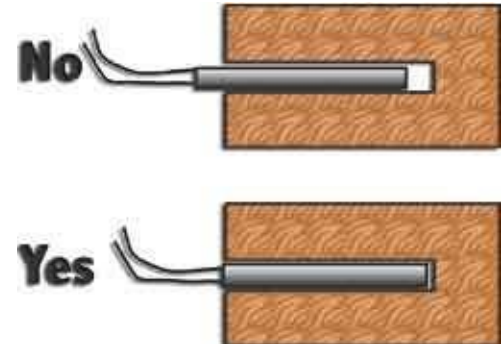
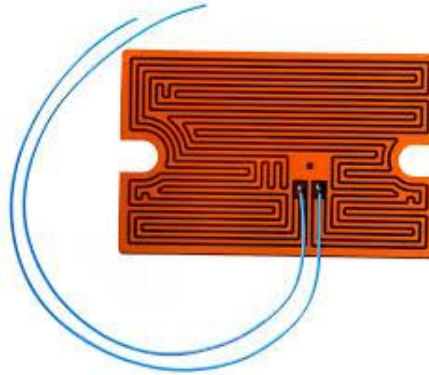
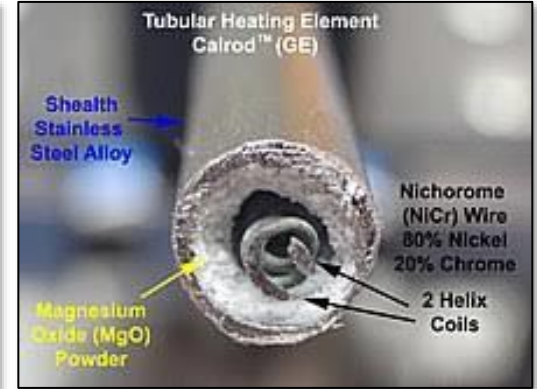
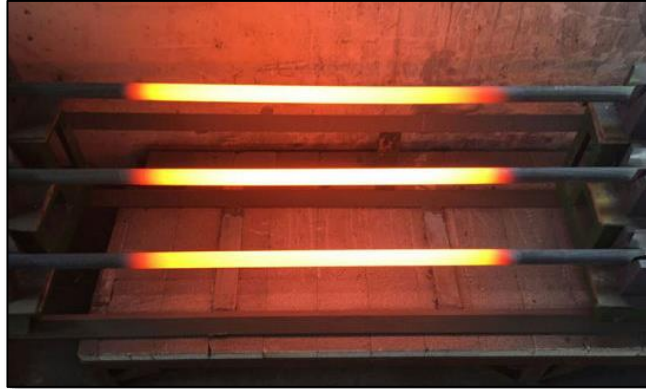
Component Heaters

Component Heaters

- Can be used as a single process solution or integrated into a larger system.
- Size, shape, and desired wattage output will dictate what kind of heater is used.
- The component family is made up of tubular, cartridge, strip/ring/disc, band, flexible, and thin blade heaters.
 - Flexible heaters have a maximum temp output of about 390°F.
 - Thin Blade heaters go up to 1200°F.
 - Tubular, cartridge, strip/ring/disc, and band heaters go up to 1600°F.
- Voltage ranges up to 600V.
- Various sizes, diameters, lengths, sheath materials and terminations.



Component Heaters

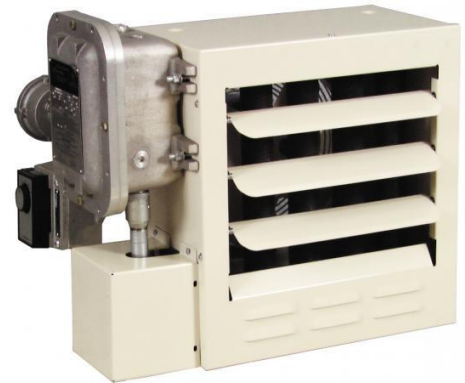


A photograph of a large industrial process air heater. The heater consists of a metal frame with a grid of horizontal and vertical bars. Inside the grid, there are several rows of horizontal tubes. The tubes are connected to a network of pipes and valves. A blue rectangular overlay is positioned in the center of the image, containing the text "Process Air Heaters" in white. On the left side of the image, there is a red label with white text that reads "CAUTION" and "HOT SURFACES".

Process Air Heaters

Process Air Heaters

- Used for several applications including:
 - Curing, drying, heat treating, baking, sterilization, bonding.
 - Pre-heating combustion air for boilers or other equipment.
- Can raise air temps or gases up to 1200°F.
- Have several element sheath materials, terminations.
- Can be designed and engineered to specific gas applications like nitrogen and argon.
- Comply with Class1 Div.1 applications.



Process Air Heaters

- Finned tube and Ni-Chrome wire elements.
- Finned tube is more durable physically, and handle moisture/humidity better.
- Always use an Air Flow Proving Switch in conjunction with the heater's contactor.
- This prevents it from operating and prematurely burning up if air flow isn't present to remove the heat.



Process Air Heaters



A close-up photograph of industrial immersion heaters. The image shows several parallel metal tubes (heaters) mounted within a larger metal housing. The tubes are secured with nuts and washers. A semi-transparent blue rectangular overlay is positioned in the lower half of the image, containing the text "Immersion Heaters" in white.

Immersion Heaters

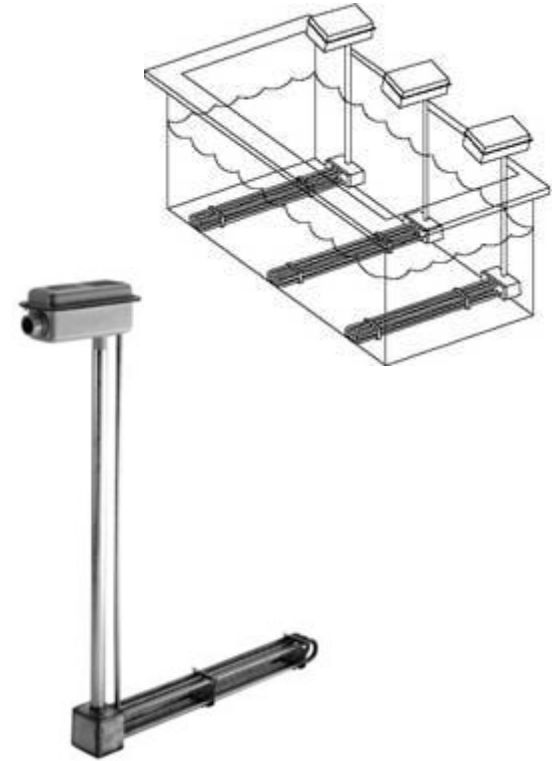
Screw Plug Immersion Heaters

- Screw plug immersion heaters are tubular elements fitted to threaded connectors and are immersed directly into the fluid or gas.
- Sheath materials include copper, steel, stainless, Monel, and Inconel.
- Sizes range from 1/2 to 2 1/2 " - 120V-480V single and 3-phase.
- Up to 18kW or MTO heat output.
- Terminal enclosures can be general purpose, moisture resistant, or explosion resistant.



Over The Side Immersion Heaters

- Primarily designed for open top tanks.
- Heater elements are fully immersed in direct contact with fluid.
- Riser and cold lead lengths can also be made to order.
- Many sheath materials available including copper, quartz, fluoropolymer, titanium, steel, stainless and Inconel.
- 1-18 kW ranges.
- Terminal enclosures can be general purpose, moisture resistant, or explosion resistant.



Flanged Immersion Heaters

- Same functionality as a screw plug heater but utilize flanged fittings for direct immersion into fluid or gases.
- Flanged immersion heaters can be constructed to much larger ranges than screw plugs and can sustain far greater pressure demands.
- Sheath materials include copper, steel, stainless, and Inconel.
- Up to 240" element lengths 120V-600V single and 3-phase.
- Up to 2000 kW.
- Terminal enclosures can be general purpose, moisture resistant, or explosion resistant.



Circulation Heaters

- Separate from the tank, they are comprised of a flanged immersion heater inside a vessel with an inlet and outlet.
- Typically used to heat water, oil, or gases, and the vessel can be either standard or ASME pressure rated, standard steel, or stainless.
- Standard circulation heaters are typically controlled by a mechanical bulb and capillary stat welded within the element bundle.
- High temp RTDs can also be welded to the element bundle.
- Contactor or SCR control.
- Terminal enclosures can be general purpose, moisture resistant, or explosion resistant.

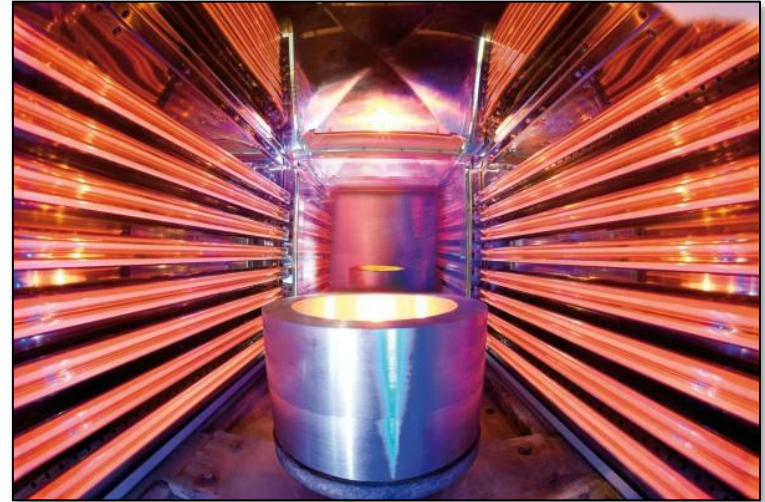




Radiant & Infrared Heating

Radiant & Infrared Heating

- Radiant heating means an extreme heat source is 'radiating' heat energy from it to adjacent objects absorbing that energy. Infrared refers to the type of energy wave used to carry that heat energy.
- There are 3 categories of infrared heat: long wave, medium wave, and short wave.
- Long wave is a less intense wave and travels the furthest distance from the emitting heat source.
- Medium wave is a bit more intense but comfortable to humans and travels medium distances.
- Short wave infrared is intense, and most process applications probably fall into this category.



Radiant & Infrared Heating

- One of the biggest advantages of radiant infrared heating is it heats the object, not the air (indirectly through convection). Paint curing booths, fiberglass curing, melting, food, or any non-hazardous heating applications and you don't want to move air. It is also a very consistent and stable intensity of heat on the object the heater is facing.
- Heating effectiveness is determined by the type of infrared emitter, wattage output, distance from object & coverage, density/absorption level of object to be heated.



A photograph of a complex industrial system featuring large white pipes, valves with handwheels, and various fittings. The system is set in a factory or warehouse environment with other equipment visible in the background. A semi-transparent blue rectangle is overlaid on the lower half of the image, containing the title text.

Large Capacity Electric Heating Systems

Large & High Temperature Systems

- Electric Boilers/Vaporizers
- Steam Superheaters
- Fluid Transfer Systems/Skid Systems
- Circulation and Immersion Heaters
- Air/Annealing Systems
- Power Control Systems
- Custom solutions based on your application
- Ratings: ASME, ATEX, UL, cUL, N, GOST, INMETRO, IEC, PED, KOSHA
- Fluid & Oil temps up to 750°F
- Steam PSI up to 450, max. output 22,025 lbs./hr.
- Air temps up to 1200°F



CAUTION

HAZARDOUS AREA
AUTHORIZED

Hazardous Location Heaters

Hazardous Location Heating

- The ability to quench an electrical arc that could ignite flammable materials or gases.
- Thick, heavy-duty cast wiring boxes, higher temp/flame resistant/non-ferrous spark resistant materials.
- Comfort heaters, duct heaters, and convectors are typical for occupancy areas.
- Includes tank & immersion heaters, heat trace cable, process heaters, and controls.
- C1D1 and D2 all classes, and group codes (application dependent).



Hazardous Location Controls

- Hazardous location controls are typically rated for use in Class 1, Division 2 application, however there are some single-circuit controllers for Class 1, Division 1, or highest threat of explosion/flammability.
- We typically try to design the controls on the outside of the hazardous location to avoid more limited selection of controllers.



A large, horizontal industrial process heater is shown in a factory setting. The heater is a long, cylindrical vessel supported by several vertical legs. It has various pipes, valves, and a large circular access door at one end. The background shows a typical industrial environment with high ceilings, structural beams, and other equipment.

Process Heater Controls

Interlock Controls

- **Limit Switches**

- Interlock pumps to heater contactors, airflow/differential pressure for air heaters.

- **Level Control Interlock**

- At no point should the heater elements be exposed without liquid to transfer heat away from the elements.

- **High Limit Interlock**

- High temp cutouts are necessary to ensure no damage occurs to the process or the element.



Single Point controls

- Single point or single circuit controllers are used for almost any application.
- Mechanical or digital - these can utilize either line voltage (120-480), or low voltage signal.
- Mechanical stats are the least expensive but are less accurate +/- 5F range. Reliable and extremely versatile, NEMA 4, 4X, and C1D1, D2.



Process Temp Controllers/High Limit

- From single loop with one output, to multi-loop with 9 outputs and microprocessor-based PID control, Chromalox offers the complete range. Advanced models feature:
- Heat/cool modes
- LCD text displays
- Multiple alarms
- Data logging & graphic trend recording
- Remote access Modbus RS-485 or TCP



Controls - Contactor Relay Panels

- One of the most common and essential means of heater control.
- They are very easily customized for any application and can have any number of contactors/circuits to control.
- CR panels can be paired with digital temp controllers, PLCs, line, or low voltage controller signals, and communications protocols.
- Contactor relay panels are most common and least expensive means of controlling higher than 22A loads.



Controls – SCR Panels

- SCR (Silicon Control Rectifier) panels control the power output efficiently and accurately to resistive loads.
- Turn on/off incredibly fast (30 milliseconds <zero cross>/or 5milliseconds <phase angle> and affect the sine wave of resistive loads to pinpoint accuracy and control.
- Whereas a mechanical stat has a +/- 5°F, SCRs are accurate to within tenths of 1-degree Fahrenheit.



Controls – SCR Panels (Continued)

- SCRs and SSR (solid state relay) controls also limit in-rush current, so they essentially “soft start” heaters.
- Limiting that in-rush greatly improves the life expectancy of the electrical connections/contactors and resistance wire within the heater.
- Element life expectancy is easily 2-3 times longer utilizing an SCR/SSR based control.





Tank Heating

Tank Heating Applications And Basics

- Tank heating is typically broken down into 2 main applications:
 - Process
 - Freeze Protection/Temperature Maintenance
- One of the first steps is to consider the tank dimensions and do a wattage loss calculation to determine how much heat the vessel itself is losing and add that to the amount of heat needed for process.

Area of tank surface X Insulation factor X Delta T = kW of losses coming off tank

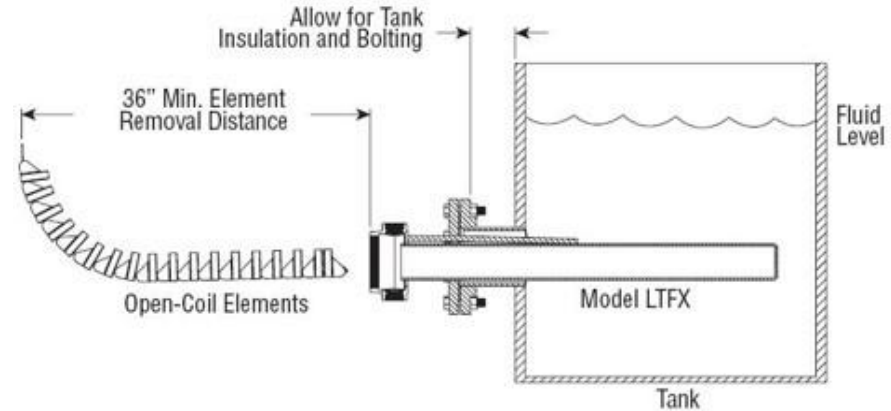
- Process tank heating takes an incoming fluid and raises the temperature to a desired setpoint. Calculate to determine how much heat is needed to increase the volume of fluid or gas to the desired set point in each amount of time.

Gallon of fluid X Heat Factor of material (weight) X Delta T / 3412 = kW needed to raise temp in 1hr.

- Freeze protection is calculated the same way as process heating, but with a temp range of 40°F down to -20°F.

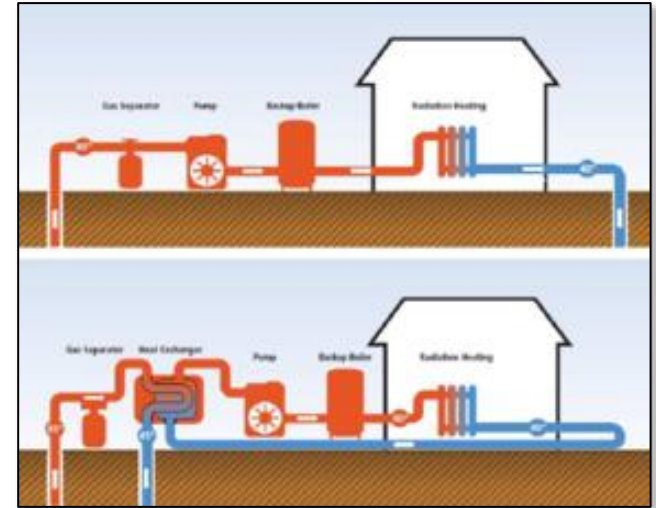
Sheathed Immersion

- Sheathed immersion heaters utilize a dry well pipe welded to the tank, and a slide in heating element.
- The main advantage to a sheathed immersion heater is the elements can be serviced without having to drain the tank.
- Ceramic heating elements also have a bend radius to allow for insertion in tighter places.
- Do not allow for air gapping between the elements and the sheath, or the heater will overheat and prematurely fail.



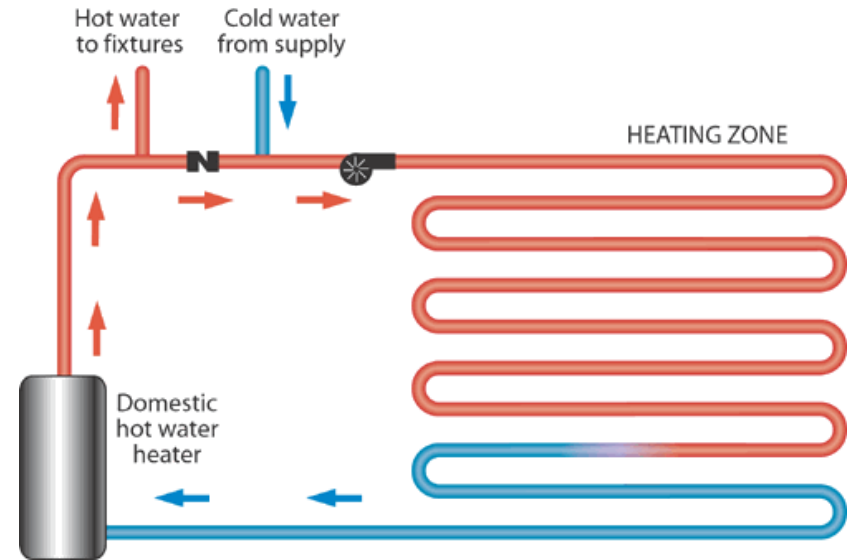
Open and Closed Loop

- Because process heating usually has higher temp thresholds than freeze protection, typically more heat is required to do the job and usually in a much shorter window of time desired. Applications dictate how precise the level of control is needed.
- Process heating is direct immersion into the fluid or gas and can be either an OPEN LOOP or CLOSED LOOP system.
- **Closed Loop** systems are when the fluid or gas is heated and continually circulates through the system, transferring heat continually with none of the heated material leaving or heat transfer loop.
- **Open Loop** systems heat fluids and gases in a single pass across the heating element, and then goes to the process.



Closed Loop Systems

- Closed loop heating systems can directly heat a liquid or gas or indirectly using glycol through a heat exchanger.
- For short duration warm up time, higher kW output is needed.
- Double the kW to cut the warmup time in half.
- Big advantages to electric heaters are:
 - No emissions or moving parts.
 - Easy to change element bundles.
 - No noise or odors, 100% efficient.
 - Low upfront equipment and install costs.



Open Loop Systems

- Open loop heating systems are generally a higher kW heater because a fluid or gas only has a single pass to transfer heat.
- In many of these applications, a circulation heater is in line with the process, and the fluid picks up heat on a single pass through.

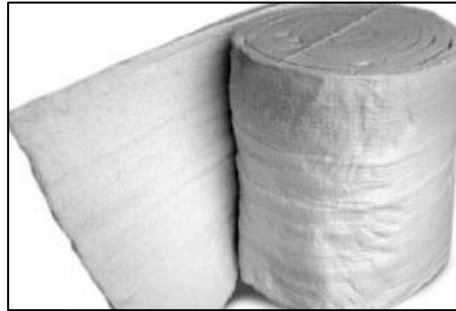
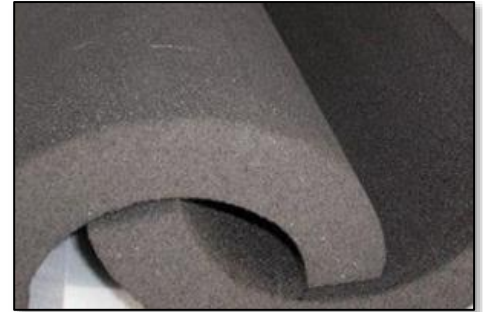


A worker wearing a white hard hat and a white t-shirt with a red logo is bent over, working on a large industrial valve. The valve is covered in orange heat tracing tape. The background is a concrete wall with some electrical equipment.

Heat Tracing/Offsetting Losses

Insulation Types

- Insulation types differ in material, heat loss factor, price, etc.
- Materials include:
 - Fiberglass
 - Foamglass
 - Rubber
 - Calcium Silicate
 - Ceramic Blanket
 - Mineral Wool
 - Spray Foam



Heat Cable

- Skin losses off the tank can be handled by either immersion heaters, or heat cable.
 - Choices are dictated by the level of losses, material of the tank, tapings available, or power.
- Heat cable coupled with insulation is the primary means of maintaining temperature on pipes, valves, couplings, etc.
- Heat cable is useless without insulation.
 - Insulation also needs heat cable to withstand extended periods of time under low temperature conditions.



Heat Cable

- SR cable wattage designation (3, 5, 8, 10, etc.) is what it outputs at 50°F.
- SR cable can be cut, spliced, repaired.
- Self Regulating heat cable is the most popular choice for heat tracing and temp maintenance for several reasons.
 - Low temp SR cable doesn't exceed 150°F output. Safe on PVC based pipes.
 - Can touch itself and not burn through.
 - Most energy efficient choice.



Heat Cable

- Linear runs vs. spiral wrapping.
- Position cable at 5 or 7 o'clock.
- Use extra cable slack for valves, couplings, etc.
- Use aluminum tape to help dissipate heat on the surface, ideal for PVC based pipes, or over 4" diameter.
- Use more than 1 linear run for pipe diameters over 4".
- Position sensing RTD opposite the heat cable run.
- Resistance check cables and record.
MEGGAR, MEGGAR, MEGGAR!



Summary

- Electric is a very versatile and consistent means of applying heat to a very wide range of process applications.
 - With SSR controls, they allow for precise temperature management.
 - Can affect the cost of operation and increases the longevity of the heating elements.
 - Typically, electric is a simpler and faster installation.
 - A smaller equipment footprint and requires less proactive maintenance/costs of ownership.
- The timing is right, and in an era of change, electric process heaters remove the need for combustible fuel supply, don't emit harmful emissions, or create more noise.
 - A practical disadvantage to electric is how much supply power is available or how much BTU load it can support.
 - Renewable energy sources can mitigate power shortages and offer on-site direct energy sources.

Thank You

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