“Perfect Storm” Changes the Way Industry Regards the Traditional Way to Heat Fluids and Gases

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Water bath heaters have been a common way to heat pipelines carrying fluids and gases, and to prevent freeze damage to critical metering and regulating equipment, since the mid 20th century. Now, a “perfect storm” that includes maintenance requirements, the risks of using hazardous chemicals unnecessarily, and corporate environmental policies, is changing this.

Other factors in the mix include pressures regarding odor and noise, security concerns regarding open flames, and the use of chemicals that are known carcinogens.

The alternative to water baths, (or “glycol heaters,” as they’re often called) is based on a technology that’s also been around for 50 years or so. Only since 2005, however, has it been applied to large scale pipeline heating. Once the first few systems were proven, however, its popularity spread. There are, as of this writing, hundreds of large-scale systems used for the protection of distribution and transmission lines, compressor stations, and gas storage fields.

This “new” alternative is a flameless catalytic process patented and commercialized by Bruest Catalytic Heaters, Independence, KS. The catalytic process is an oxidation reduction reaction which converts natural gas into three components: infrared energy, CO_2 and water. There is no open flame, and no ethylene glycol or other chemical charge. Perhaps most notably, catalytic infrared is a direct, rather than indirect, heating method, which translates into high heat transfer efficiency, and substantially lower operating costs.

The key to the catalytic heater's high heat transfer efficiency is the way in which it uses infrared energy. By surrounding the heat exchanger with catalytic infrared energy that is absorbed directly, system operation requires just two heat transfers: infrared to heat exchanger, and heat exchanger to gas. By contrast, water bath devices involve four separate heat transfers**:** from flame to the fire tube inside the solution, from the fire tube to the ethylene glycol, from the ethylene glycol to the tube bundle, and from the tubes to the gas.

Other factors typically used to compare the two systems include several installation-related items, ongoing operational expense, maintenance, safety, and environmental issues.

Installation

The installation checklist begins with siting. The catalytic heater manufactured by Bruest, the HotCat, has a small footprint, and uses less space than a water bath of equal capacity. There is also permitting to consider. The HotCat catalytic heating system can be installed in Class 1, Division 2, Group D areas**;** water baths must, for safety reasons, be installed outside the classified area "halo."

This fact also drives up operational costs, particularly in cold weather, when heated gas must move 15 ft. or more, continuously losing heat energy in the process.

The foundations required for installation vary as well. A 1200 gallon water bath, filled with fluid, weighs approximately 30,000 lbs. The total weight for a comparably sized catalytic heater will be under 10,000 lbs.

Stacks, each generally 15-20' tall, are required for the water bath**;** there are no stacks for a catalytic system, and the system itself is under 11 ft. tall. This is particularly important when installation is in a residential area. A containment ring is required for a water bath in virtually all instances; none is needed for a catalytic system. Finally, the water bath will require an initial 1200-gallon chemical charge of ethylene glycol mix, which costs, (at recent prices) just over $12,000.

Concerns over the toxicity of ethylene glycol have persuaded some users to shift to propylene glycol. Toxicity is lower, and heat transfer is more efficient. However, propylene glycol is less effective at freeze point depression. Its greater viscosity also increases head loss in the system and accelerates pump wear. In addition, the cost of propylene glycol is even higher than ethylene glycol. And if a changeover is made, the EG must be dumped, because the two can't be combined. There is no chemical charge to contend with in a catalytic heating system.

Operation

Differences in operating cost primarily stem from the minimum fuel consumption rate for each system, expressed in cu. ft./ hr. – (The *maximum* fuel use, in cu.ft./ hr. is similar.)

Water baths require the constant burning of fuel to maintain those 1200 gallons of fluid at threshold temperature, which is between 100^{o} and 120^{o}F at all times, and 190^{o}F during system operation.

The systems' respective turn-down ratios are also in stark contrast. It is 2:1 or 4:1 for the water bath, and 8:1 or 32:1 for the catalytic system

The high turndown ratio for the catalytic technology is a function of its zoned design. Catalytic system automation allows the 4-16 zones within a system to be activated only as needed to maintain the natural gas at a set temperature. Once the desired temperature is established, the PLC adds heat when required, and turns it off otherwise. This is done automatically, without operator intervention.

Maintenance

The maintenance involved with water bath operation primarily involves four considerations: corrosion management, burner maintenance, tube maintenance, and chemical replenishment.

Corrosion is a continuous challenge for all components in systems that use a water-based ethylene glycol, or propylene glycol, mix. Oxygen, heat, metallic impurities, sulfates and chlorides all promote corrosion, causing shut-downs and shortening the life of the system. Also, as glycols degrade from their exposure to heat, they produce organic acids that lower the pH of the fluid. The result is corrosion that's more aggressive than water. In addition, high pressure gas weakens the tubes, and tube bundles that are immersed in ethylene glycol are highly vulnerable to corrosion, which worsens with the application of heat.

Catalytic pipeline heaters do not have corrosion issues. There are no flame burners or tube bundles to maintain. Catalytic systems also have a design advantage in that, unlike water baths, they do not have corrosion-prone components, or problems with related leakage. And there are no chemicals to replenish to compensate for boil-off.

Safety

Worker safety is an issue where water bath devices and catalytic heaters contrast sharply. As discussed, water bath heaters use ethylene glycol, a poisonous alcohol which is designated a hazardous substance under Section 3(b) of the Federal Hazardous Substances Act.

Ethylene glycol has been found in at least 34 of the 1,416 National Priorities List sites identified by the Environmental Protection Agency, according to the US Agency for Toxic Substances and Disease Registry, Division of Toxicology.

Environmental

The environmental issues of most concern when companies are acquiring new process equipment generally include whether or not hazardous chemicals are used, and the potential consequences of accidental spills, (particularly if there is a chance of incidental contact with drinking water).

Other items of concern include whether permitting is required, and whether the process generates VOCs and/ or NOx. Peripheral to these "hard issues" are others that are important, because they make headlines – and headaches - for business. An example of these is noise pollution.

To address these individually, there is always environmental risk where large quantities of ethylene glycol are used, perhaps more so in unmanned facilities, where both inadvertent and malicious chemical release is an ongoing threat. Ethylene glycol use requires permitting, and water baths release both VOCs and NOx. As for noise, there are now noise ordinances covering thousands of incorporated and unincorporated areas.

In contrast, catalytic heating has virtually no environmental risk, does not require complex permitting, and generates virtually no VOCs or NOx. The only by-products of the catalytic heating process are carbon dioxide and water. In addition, operation is silent.

It's rare when an old technology can be replaced with one that has a track record nearly as well-established. The move toward cleaner, safer, less costly infrared heating as a way to provide predictable pipeline heating is one of those instances.

Among the major companies who have chosen catalytic pipeline heating technology are El Paso Corporation, one of North America's largest independent natural gas producers, and owner of North America's largest natural gas pipeline *system; Kinder Morgan, one of the largest pipeline transportation and energy storage companies in North America, Dominion Transmission, TransCanada Pipeline, New Jersey Natural Gas, and Williams Pipeline.*

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