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Thermal Oxidizers

Clean the Air,
Capture the Energy





on the cover

Natural gas-fired thermal oxidizers, such as this large regenerative system, eliminate VOC emissions, and save energy in the process. In many cases, the energy recovered can go back to support manufacturing or building comfort systems. Photo courtesy Anguil Environmental Systems.



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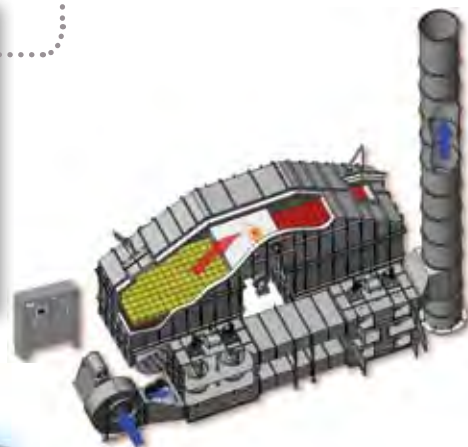
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A3

Thermal Oxidizers

Installing a modern thermal oxidizer will virtually eliminate VOC emissions while conserving energy from the process. Natural gas usually fuels the system. Select exactly the right system for your plant exhaust characteristics.

A6 Convert Your Boiler Plant to Natural Gas

Increasingly, owners of oil-fired boiler systems are taking the step of converting to natural gas. The fuel cost savings are obvious, and consider also the lower emissions, lower greenhouse gas potential, reduced maintenance and stable fuel prices. It might be a no-brainer.

A8 Fuel Cells Becoming Available

The long-awaited commercial status for fuel cells is becoming a reality. A variety of cell cycle types offer advantages, particularly for owners that can also use the thermal output. Growing hours of commercial operation show the future for this advanced technology.

A10 Insulate Pipes and Fittings for Major Energy Savings

Too often heated plant lines and fittings go without adequate insulation. Custom insulation solutions not only dramatically reduce energy losses, but allow rapid access for inspection and service, with easy replacement afterward. Get insulated!

A12 CNG Lift Trucks Are Picking Up the Load

Plant and warehouse operators are discovering the benefits of CNG as a fuel for lift trucks. Cost is lower, emissions are reduced, and refueling is simplified. Especially if you already have other CNG vehicles, lift trucks are an obvious solution.

Remove the Pollutant and Keep the Energy

Modern Oxidizers Can Do Both

MANY INDUSTRIAL PROCESSES HAVE exhaust streams that contain significant levels of vapors and mists classified as volatile organic compounds (VOCs). VOC emissions are regulated because many are health risks directly, or can be absorbed into rainwater or other sources of public drinking water, or into the environment. Although research is incomplete, VOCs from human activities can also contribute to smog and formation of persistent greenhouse gases.

Industries with processes that may have such emissions and that usually require treatment include petrochemicals, paper, pharmaceuticals, plastics, graphic arts, and other manufacturers that use paints and solvents. A widespread method for achieving acceptable emissions is thermal oxidation, where the VOC exhaust gases are directed through a combustion zone to break down these complex hydrocarbon molecules.

First Approach a Simple Flare

The original thermal oxidizers were simply flare systems, sometimes called afterburners, to burn the exhaust gas and thereby reduce emission levels of hydrocarbons. In some cases the exhaust gas is sufficiently consistent and rich in combustibles to support a flame itself. More often a natural gas burner is used to support combustion. While these systems can be reasonably effective, they may not completely break down the VOCs, and whether or not a gas burner is needed to support combustion, all of the thermal energy is lost to the atmosphere.

More Complete Destruction with Oxidizers

Many modern VOC treatment systems use either recuperative or regenerative oxidizers for more complete destruction of exhaust gases, and significant capture of the thermal energy from the process. Done correctly, the oxidation process reduces the VOCs primarily to carbon dioxide and water vapor. Keys to successful treatment are the right temperature, a long enough treatment time, and a good mix of the vapors with oxygen to allow complete combustion.

The most common system today is the regenerative thermal oxidizer. With this solution, VOC containing gases are broken down by high temperature oxidation supported or supplemented by a natural gas burner.

To recover the energy a heat sink is provided in an insulated enclosure, usually filled with a metallic or ceramic media material to capture the heat and at the same time provide a means to maximize turbulence and surface area for further oxidation. Heat from the oxidation step alternately heats two heat sink areas. These support the combustion process

Often multiple oxidizers are used for separate exhaust streams. This permits designs for specific flow volumes and gas content types. Photo courtesy Anguil Environmental Systems.





A 22,000 scfm rotary concentrator with a three-chamber regenerative thermal oxidizer is designed for high destruction efficiency. Photo courtesy Catalytic Combustion Corporation.

by heating the incoming combustion air and exhaust mixture.

Catalytic Systems Offer Lower Temperatures

A variant of the regenerative thermal oxidizer is a catalytic regenerative system. These use a precious-metal catalytic bed within the system to accomplish destruction of the exhaust hydrocarbons at a lower temperature, thereby further reducing energy usage. According to Keith Herbert from Catalytic Combustion Corporation, with these oxidizers it is especially important to get an accurate description of the composition of the vapor.

Herbert says, “The gas composition is a key variable because one needs to evaluate what the temperature rise would be across the catalyst bed. If the temperature rise is too high (gas composition too rich), then a catalytic oxidizer would be ruled out. The gas composition also needs to be screened to make sure there are no catalyst poisons.”

He adds, “If this is a cyclical or batch process, then the extremes of the instantaneous composition (not the aver-

age) need to be determined – again to make sure the catalyst does not over-heat.” Also, if there are components in the vapor composition that create acid exhaust gases such as HCL, HF, or

H₂SO₄, then it may be necessary to add a downstream scrubber.

Recuperative Systems Are an Alternative

An alternative method of heat recovery using thermal oxidation is the recuperative oxidizer. These use a natural gas burner to stabilize and intensify combustion of hydrocarbons, and with a heat exchanger, capture as much of the heat energy as possible after combustion. Recovered energy is then fed back into the process by preheating combustion air to reduce necessary fuel usage and to help assure high oxidation levels..

The heat exchanger preheats the incoming contaminated waste gas stream by recovering heat from the exiting clean waste gas stream. This is done using a shell-and-tube or a plate-type exchanger. In many cases, enough energy is recovered that a secondary heat exchanger can be used to deliver clean, heated air or gases back to another part of the plant.

Energy Reduction Strategies

Jeff Kudronowicz was a recent presenter

This 1,000 scfm packaged gas-fired catalytic regenerative thermal oxidizer is designed for smaller industrial exhaust streams. Photo courtesy Catalytic Combustion Corporation.



at a Technology & Market Assessment Forum sponsored by the Energy Solutions Center. Kudronowicz is an Application Engineering Manager with Anguil Environmental Systems, a major manufacturer of thermal and catalytic oxidizer systems. He provided information on current regenerative thermal oxidizer technology, with an emphasis on energy reduction strategies. He pointed out that regenerative thermal oxidizers are often the most energy-efficient solution, with the lowest total emissions of greenhouse gases to the atmosphere.

Choosing the Right Media

He explained the importance of selecting the right heat exchange media for the oxidation zone in the device. Often the efficiency of a system can be significantly improved by choosing a better media material. The right selection depends on accurate gas characterization and the anticipated flow rate.

According to Kudronowicz, these systems can achieve 95% heat recovery from the process, along with high levels of destruction efficiency of the exhaust gases. They are widely used for chemical, pharmaceutical, wood finishing, metals, painting and printing processes. In his presentation, he pointed out the potential value of also using secondary heat recovery in the regenerative thermal oxidizer. This heat can then be used for a variety of purposes, including makeup air for process ovens, driers, boiler feedwater, or even to preheat air for electric power generation.

Strategies for Optimization

Kudronowicz suggested that for highest VOC destruction efficiency and maximum thermal recovery, attention should be given to choosing the right type of oxidizer for the exhaust stream. For highest destruction efficiency with a regenerative system, Anguil offers a three-chamber oxidizer rather than the standard two-chamber design. This unit operates with a 90-second cycle for the chambers, with butterfly valves to redirect the flow to the next sequence. Because of the complexity and size of this system, it has a higher

capital cost than a conventional two-chamber unit.

Kudronowicz described several strategies for improving the efficiency of thermal oxidizers. For regenerative systems, upstream flow concentrators can improve systems with waste gas flows greater than 5,000 scfm and VOC concentrations less than 500 ppm. By concentrating the VOC level, the oxidizer can be smaller and operating costs can be reduced. In the regenerative oxidizer treatment area itself, high-efficiency ceramic media can be selected to increase treatment efficiency.

With recuperative oxidizers, thermal efficiency can be improved by replacing existing shell-and-tube heat exchangers with deeper coil designs for more complete heat recovery. Recovered heat can be used for a variety of in-plant uses including makeup air heaters, boiler economizers, and process heating.

Monitor Unit Performance

Kudronowicz emphasized the importance of knowing and tracking thermal per-

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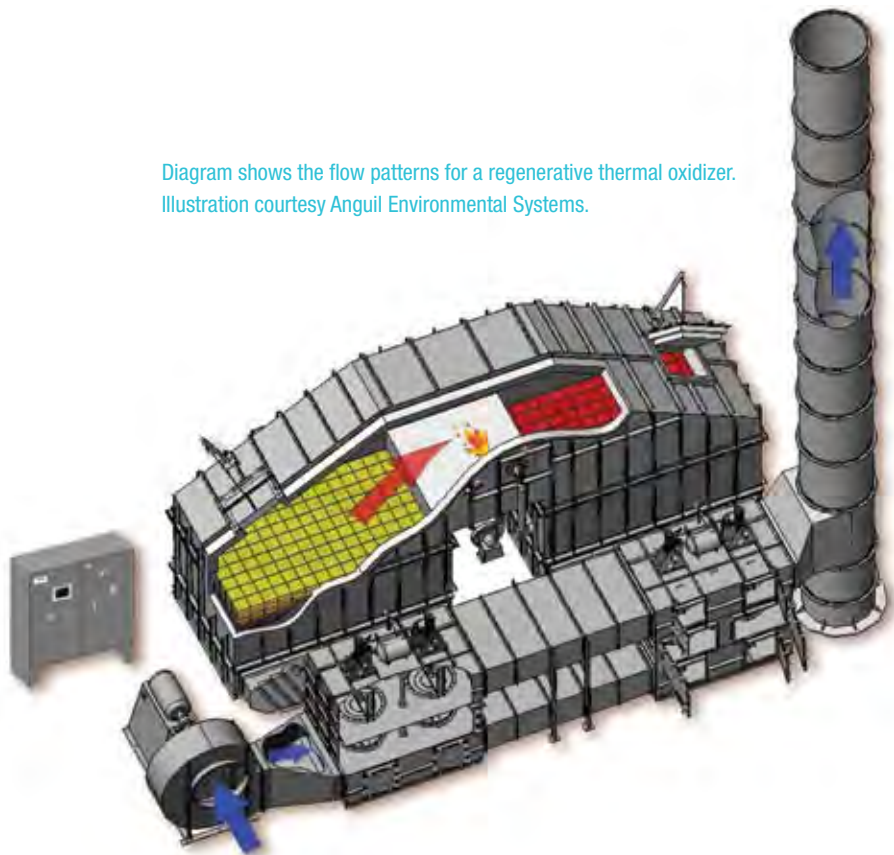
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formance of the oxidizers, and regularly evaluating the analysis of the gases being treated to assure optimum destruction. A thermal or thermal-catalytic oxidizer is a necessary device for many industries. Regular reevaluation of performance is essential to achieving regulatory compliance, maximum energy recovery and overall efficiency. **GT**

Diagram shows the flow patterns for a regenerative thermal oxidizer. Illustration courtesy Anguil Environmental Systems.





Oil-Fired Boiler Users Converting to

Price Advantage is a Driver

INDUSTRIAL AND LARGE COMMERCIAL energy users with oil-fired boilers are changing to natural gas, and the incentives are stronger than ever. Michael Collins is from Yankee Gas Services Company, a Northeast Utilities company. Collins says, "When natural gas is available, people want to make the switch from oil." This is happening throughout the U.S. and Canada, but the movement is most prominent in the U.S. in the Northeast and the Northwest, where oil-fired boilers were widespread.

Another attractive aspect of gas-fired boilers is that natural gas is a North American fuel, and far less sensitive to global political and economic fluctuations. Collins points out, "Commercial and especially industrial accounts are very frustrated with fluctuations in the oil markets. It makes it difficult to plan and budget. They feel they won't have that kind of uncertainty with domestic natural gas."

Shale Gas Coming Into the Market

Collins says, "Here in the Northeast, commercial and industrial customers understand that much of the gas in the future will come from shale gas development in the eastern U.S. They like the fuel supply being closer to home." New England in particular has few fossil fuel resources of its own, so customers are looking for reliable supplies for the future.

Bob Gallo from New Jersey Natural Gas indicates that his utility has a similar, proactive program to inform customers about the benefits of replacing oil as a boiler fuel with natural gas. "We are predominately providers to small to medium sized office, warehouse and food service customers. Annually, we switch about 200 commercial customers from oil to natural gas as a boiler fuel. Included are about 10-15 large commercial/industrial locations."

Oil Cost Continues to Increase

Gallo notes, "Currently we are emphasizing the price advantage, with our gas being equivalent to #2 fuel oil at \$1.53 per gallon." He adds that New Jersey emission standards are tightening for certain oil-fired boiler equipment. "This will add to the incremental cost of continuing to operate an oil-fired boiler."

Owners are generally aware of the market price advantage of natural gas, but may not fully understand some of the other incremental costs of continuing to use fuel oil. Recently, Collins from Yankee Gas and Eric Burgis from the Energy Solutions Center presented a webinar to help large energy users understand the options, steps and benefits in going from oil to gas. In the presentation, they note that prices for #2 and #6 oil do fluctuate, but have been trending upward in recent years, and futures prices suggest this will continue.

Compare on a Btu Basis

Comparisons of other fuels to the price of natural gas is best made on a dollars per million Btu basis (\$/MMBtu). Using these terms,



Often replacing an oil-fired boiler is an opportunity to go to a modular gas-fired boiler system. Here six 1,800 MMBTU gas fired ClearFire-C boilers replace an older oil-fired unit in an educational building. Photo courtesy Cleaver-Brooks.

Price Spread Widening

In most of the U.S. and Canada, oil-fired boilers typically use either #6 or #2 oil. As the price spreads between these two fuels and natural gas continue to widen, the economic incentive to change becomes more powerful. Collins notes that it is not just the price difference that is driving the trend, though that argument is powerful. "Owners are also impressed at the opportunity to significantly reduce emissions including sulfur oxides, particulate and mercury." He explains that the potential to dramatically reduce greenhouse gas emissions is also a motivator.

Natural Gas

typical New England winter prices for oil for large users recently was about \$18/MMBtu for #6 oil and \$23/MMBtu for #2 oil. The presenters noted that these prices compare with natural gas retail prices for large users typically between \$8 and \$10/MMBtu, sometimes even lower. Expressed another way, current natural gas prices are approximately equivalent to #2 oil at \$1.14/gal., or #6 oil at \$1.24/gal.

In the presentation, Collins and Burgis emphasized numerous other cost advantages to the use of natural gas as a boiler fuel. Air emission permits may be more difficult to obtain for oil-firing, and additional emission control equipment may need to be installed, maintained and operated. Often the use of oil necessitates underground fuel storage tanks, which may require immediate or future replacement, along with leak monitoring and additional insurance. The presentation also notes, "With oil-firing, there is also a significant cost associated with the degradation of efficiency as soot builds up in the boiler between cleanings." The loss in boiler efficiency because of soot buildup between cleanings may be as much as 15%.

Small Penalties Add Up

In addition to these cost penalties, additional costs are incurred with oil from pumping costs, atomization energy, and with #6 oil, energy for preheating, storage heating and oil conditioning additives. Further, with both #2 and #6 oil, there are inventory costs associated with purchasing fuel before the time of use. Although many of these penalties are individually small, together they can add to an additional 2.8% for #2 oil and 6.8% for #6.

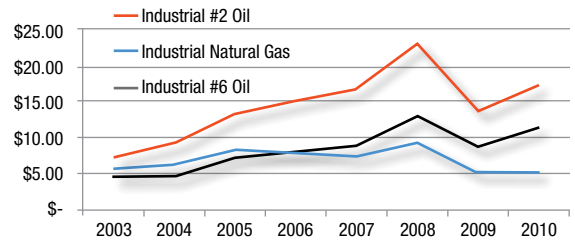
Taken together, all of the price, regulatory, and operating cost penalties with oil can make a conversion to natural gas yield overall savings of as much as 67% at current energy prices. In addition to the financial costs of continuing to use fuel oil, there are environmental drawbacks. Oil tanks, whether underground or above grade, are a continual environmental risk for spills and leaks. In the webinar presentation, it was demonstrated that a facility that burns 50,000 gallons of oil annually will emit 557 tons of CO₂, versus 392 tons with natural gas, a reduction of 165 tons. From a greenhouse gas perspective, natural gas is obviously preferable.

Convert or Replace?

Customers who wish to take advantage of the benefits of natural gas as a boiler fuel must evaluate whether to replace existing boiler

Industrial Pricing – Today

Industrial Natural Gas and Oil Prices (Average Retail Pricing per EIA in \$/MMBTU)



Gas prices stabilizing while oil increases

A recent presentation from Yankee Gas and The Energy Solutions Center demonstrated the low and stable price of natural gas versus alternative oil fuels.

ers with new equipment designed for natural gas or to convert existing oil-fired boilers to gas. Bob Gallo from New Jersey Natural Gas indicates that in their area, large customers generally retain existing boilers and install conversion burners and gas train equipment. Also in this area, the smaller commercial and institutional users tend to purchase new boilers at the time of conversion.

Current new packaged natural gas boilers have efficiencies ranging from 82% to as high as 90%, depending on the desired heating condition and operating environment. Replacement of an older boiler is also an ideal time to reevaluate your current and planned future steam or hot water requirements, and to buy a unit that most closely matches your needs.

Modular Approach

Because of dramatic efficiency improvements in smaller package boilers, it is often desirable to install multiple smaller units to operate in modular fashion. This reduces standby energy losses and low part-load operation times. This type of modular boiler installation also improves availability through unit redundancy, and allows periodic boiler maintenance without service interruptions.

Time is Ripe

The payback for conversion or replacement of boilers is today often very short, a matter of a few months or at most a couple years for a full replacement. The benefits also include lower emissions, fewer environmental risks, and overall better system reliability. Even if you've considered changing to natural gas in the past and not taken the step, now is the time to give it serious consideration.

GT



Fuel Cells - An

Onsite Power Generation Option

IN RECENT YEARS the pace of fuel cell commercialization has picked up and more choices are available to customers. Manufacturers have developed an array of products, mostly fueled by natural gas, that are accumulating hundreds of thousands of hours of successful operation in a wide range of applications. The technology is beginning to blossom.

Fuel cells convert energy from fuel and an oxidizing agent reaction directly into DC electric power without a mechanical conversion, using one of several electrolyte agents. Most fuel cells use hydrogen as a fuel gas and air as the oxidant. Most often, natural gas is the economical source of the hydrogen stream. The DC power is easily converted to AC for factory or commercial use.

Natural Gas - The Source for Hydrogen

The process for producing hydrogen from natural gas is called 'reforming' and this has been one of the key building blocks to viable commercial operation in a fuel cell package. Today reformer technology has greatly improved and natural gas is an economical and widely available fuel. In addition, certain technologies such as the molten carbonate system eliminate the need for an external reformer as they can reform natural gas directly in the cells.

Individual cells in a fuel cell array produce relatively low voltages and amperages, but by stacking cells and operating parallel stacks, unit packages are now available in hundreds of kilowatt capacity. The DC power output is converted to AC for application in standard power circuits.

All fuel cells also have the ability to produce byproduct heat, and in some types this can be very high quality steam. Whether in the form of hot water or steam the recovered energy can often be utilized

One of two 400 kW fuel cells serving a Coca Cola manufacturing facility in Elmsford NY.



At Left: A UTC Power PureCell® Model 400 fuel cell being unloaded to serve St. Helena Hospital in California's Napa Valley. The unit now provides 60 percent of the hospital's electricity needs and 50 percent of its space heating and domestic hot water requirements.

All Photos courtesy UTC Power.

in manufacturing processes, for boiler feedwater heat, for space heating or for absorption cooling. Effective utilization of the heat is one of the keys to an economically successful fuel cell installation.

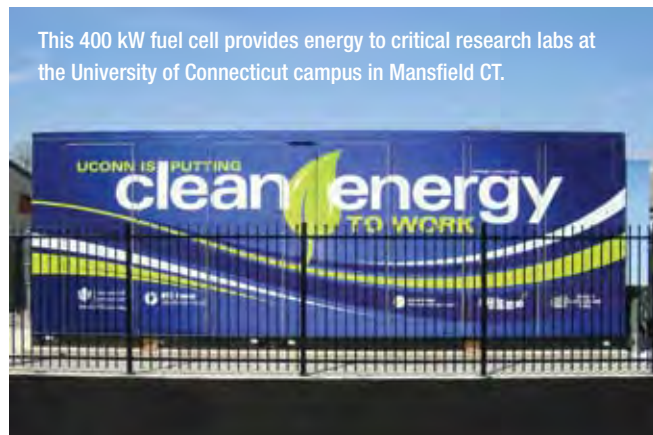
Various Technologies

The U.S. Department of Energy (DOE) has been participating with the private sector in a large scale molten carbonate fuel cell development program beginning in the 1970s. Today one of those private companies, FuelCell Energy, has demonstration and commercial units operating at over 50 installations worldwide. Most of the units are about 250 kW, but in some cases multiple units have been combined for even larger operations.

An interesting FuelCell Energy molten carbonate fuel cell operation is in Renton, Washington, where a 1 MW power plant using wastewater digester gas is operating at the wastewater treatment plant. Other units have successfully operated on coal mine methane gas and are supplying electricity for the mining operation.

UTC Power

Another leader in commercialization of fuel cells is UTC Power. Its PureCell® system uses a phosphoric acid fuel cell (PAFC) product for distributed generation and combined heat and power applications.



This 400 kW fuel cell provides energy to critical research labs at the University of Connecticut campus in Mansfield CT.

According to Jennifer Sager from UTC Power, the PAFC offers an attractive blend of system performance, durability and value for stationary power applications. She says, "The PureCell system produces 400 kW of continuous, reliable electric power while generating 1.5 million Btu/hour of useable heat byproduct."

She notes that the system is well-suited for applications requiring anywhere from 400kW to 5 MW of baseload power. "Typical market sectors fitting this profile include supermarkets, hospitals, hotels, data centers, bottling plants, pharmaceutical plants, prisons and many other load types." According to Sager, the largest multi-unit to date consists of 12 PureCell systems in South Korea that produce 4.8 MW of power. This installation provides more than 12% of the town's power supply. The New York Power Authority also selected UTC Power to provide 12 systems for the new World Trade Center, "The Freedom Tower."

Attractive Project Paybacks

Each PureCell system that produces 400 kW of electric power also produces enough "high-grade" heat to drive a 50-ton single-effect absorption chiller. Sager indicates that a facility that is a strong fit for the electric and thermal output from a PureCell system can often achieve a financial payback of 3-4 years with current federal tax credits and state incentives. "Because our system is designed to operate for ten years on its initial fuel cell stack, the customer is able to reap significant savings over the life of the system."

In April 2012, the University of Connecticut commissioned a 400 kW PureCell system on its Depot Campus in Mansfield, CT. The unit provides energy to critical UConn research labs and offices, including those working on advancing fuel cell and microgrid technology at UConn's Center for Clean Energy Engineering. By generating and using power

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www1.eere.energy.gov/hydrogenandfuelcells/fuelcells/fc_types.html

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on-site with a PureCell system, UConn will prevent the release of more than 831 metric tons of carbon dioxide annually – the equivalent of planting more than 192 acres of trees.

Mobile Fuel Cell Power

Another interesting approach to integration of fuel cell technology into industrial and warehouse operations is Plug Power's GenDrive® hydrogen fuel cells with on-board hydrogen storage to power lift trucks and pallet jacks. The units typically operate an entire shift on a hydrogen charge. The fuel cell unit fits into the existing battery space of standard electric lift truck equipment.

According to Plug Power, units can be refueled in approximately two minutes. Use of fuel cells eliminates the need for large battery-charging areas, and the fuel cells operate at temperatures down to -22°F in freezer spaces, eliminating the problem of "battery fade" at low temperatures. Hydrogen for refueling is supplied by outdoor liquid hydrogen storage facilities. The fuel cells use the PEM (proton exchange membrane) system, one of the most widely used fuel cell technologies.

Plug Power equipped lift trucks can refuel in less than two minutes, a clear advantage over electric battery units. Using this technology, a lift truck can support continuous service on three shifts.

Taking the Step

If your need is for an alternative, clean source of electric power and thermal energy, or for a niche application such as replacing lift truck electric batteries with a modern hydrogen solution, fuel cells can be your answer. **GT**

Often irregularly shaped vessels are poorly insulated. This can be corrected with customized removable insulation systems. All photos courtesy Coverflex Manufacturing.



Pipe and Fitting Insulation

Saving Energy and Improving the Factory Environment

A WIDE RANGE OF FACTORIES have extensive networks of piping systems carrying hot fluids. Piping configurations may have hundreds of exposed fittings, such as tees, unions, valves, flanges, gauge stations and larger elements such as turbines, tanks and heat exchangers. These industries may include plastics, food processing, petrochemicals, commercial laundries, paper and pulp, metal treatment and many others. Hot pipes and associated fittings may carry steam, condensate, hot water, process fluids or hot manufactured liquid products.

Insulation Deficiencies

In most cases the piping is at least partially insulated, though sometimes even that in-

isulation is inadequate or has become damaged. Commonly though, many fittings are not insulated or were given only an initial wrap or spray insulation treatment. Often that initial insulation was removed when the device first needed service and was not replaced. This may be because qualified personnel from local commercial insulators are not readily available or are perceived to be too costly for small repair jobs. Or it may simply be the perception that frequent access will be needed and insulation will get in the way.

Inadequate insulation on fittings, tanks and other equipment can result in very high energy losses and may cost the plant tens or even hundreds of thousands of dollars annually. Further, exposed hot surfac-

es can represent a safety hazard to workers and may create excessively noisy or uncomfortable working conditions. With the right insulation, these problems are eliminated. Today, industrial insulation specialists offer custom products that can be fitted to nearly every device and fitting. Custom blanket insulation can be quickly removed for access to the fitting, and can be just as quickly replaced.

Large Field for Improvement

Mellanie Askew represents Coverflex Mfg. Inc., a major industrial insulation manufacturer. According to Askew, removable insulation products are made of various types of fiberglass materials, and can be installed on nearly all fittings and many

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other problem areas. She comments, "It seems like there is a lot of under-insulated equipment and piping. We estimate that 10-30% of all installed mechanical insulation is either damaged or missing." This does not include devices that were never insulated in the first place.

She points out that it is often important for insulation blankets to be removable for inspection or service. "Our Coverflex blankets have fastening systems using stainless steel buckles, D-rings and straps, Velcro fasteners or stainless tie wire. All can easily be removed and reinstalled with no special tools."

Short Payback for Insulation Investment

Askew notes that insulation additions or repair projects often have paybacks of less than a year. She cites an example of a six-inch steam valve that operates at 350°F and is uninsulated. It has a fuel cost for lost steam energy as high as \$880 per year. That same valve if insulated with two inches of high-temperature insulation would reduce the energy lost by 95%, a savings of as much as \$800 annually, and a ten-year savings of \$8,000.

She adds that in addition to the energy cost savings, adding insulation provides personnel protection, prevents moisture condensation, maintains product temperatures, reduces combustion emissions and adds fire protection. "All of this is in addition to an excellent return on investment."

The advantages of removable and replaceable insulation are many. Arnold Mazurkiewicz from Shannon Enterprises was a recent presenter at a Technology & Market Assessment Forum sponsored by the Energy Solutions Center. His firm specializes in the installation of Insultech® blanket insulation products.

Access Needed to Fittings

He points out the disadvantages of conventional wrap or spray insulation on industrial pipe fittings. "These are complex surfaces

and quick access is needed. Each time conventional insulation is removed, a contractor has to be brought in to replace it." Further, he explains that conventional insulation may not hold up to field conditions of moisture, temperature or steam leaks. "The end result is a neglected surface condition."

The solution is custom, removable blanket insulation designed to withstand high temperatures. According to Mazurkiewicz, the typical industrial facility that uses steam has 250 exposed fittings, with an energy loss of \$75,000 per year. "The average opportunity for annual savings here is \$68,000." He notes that the typical return on investment ranges from 4 to 14 months. "Remove and reinstall the insulation just once and you are ahead."

Custom Designed for Each Device

Custom blanket insulation is designed for each specific device, with correct match-up around the valve bonnet, and correct overlap with adjacent pipe or fitting insulation. For installations where there might be condensation or liquid leaks, the insulation usually has a drip grommet so liquid does not accumulate inside the blanket and any leaks can be quickly spotted. Exterior blanket surfaces are often Teflon-coated fabric for easy cleaning and resistance to high temperatures.

Mazurkiewicz and Askew both emphasize the importance of a complete insulation energy appraisal of the industrial facility to determine areas needing attention. The appraisal puts actual dollar savings to Btu losses as well as calculating potential reductions in emissions of greenhouse gases. The appraisal is based on data supplied by the plant or energy manager and gathered during a facility walk-through. This data is fed to a computer program that calculates energy savings on an annual basis.

Infrared Technology Used to Identify Targets

According to Mazurkiewicz, an infrared



A single uninsulated six-inch steam valve operating at 350° could be using over \$800 in energy annually. By installing removable insulation, as shown here, the cost is reduced by 95%.

gun or camera is normally used to obtain surface temperatures and each fitting examined is also tagged for identification. The blanket insulation supplier can then design removable wraps for each fitting. Usually a follow-up infrared survey is done to verify the results of the insulation project.

Gary Orlove is an Application Engineer and Curriculum Manager at the Infrared Training Center of FLIR Systems Inc., a major manufacturer of infrared sensing equipment. He notes that there is widespread acceptance and growing use of infrared systems for determining and measuring the need for insulation in industrial facilities. He points out that interpretation of infrared sensing results must be done by a qualified person. He explains, "If the industrial owner has taken training in use and interpretation of IR images, then he can do this himself, otherwise it is best to use an outside specialist."

Time to Get Started

With a comprehensive facility review and a program of insulating all pipes and fittings with modern insulating products, major savings in plant energy use are achievable. Further, the facility will be quieter, dryer and safer. If your plant has not done such a systematic insulation review, now is the time. Let the savings begin. **GT**

CNG Lift Trucks

Can Carry the Load

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LIFT TRUCKS ARE ESSENTIAL in many industries and nearly all warehouse operations. Many fuels are used, including diesel, LP and electric batteries. The newest, and possibly the ideal fuel candidate is starting to make its place known. It's compressed natural gas (CNG). Today CNG is an attractive energy source because of its economy, cleanliness, safety and rapid refueling characteristics.

Emission Regulation

Until about 2004, there was a fairly widespread market for conversion engine packages for lift trucks designed specifically for CNG. At that time, the U.S. Environmental Protection Agency (EPA) indicated it planned to begin regulation of lift truck engines manufactured after 2004 as potential emissions sources. Because of the anticipated burden of regulatory testing and compliance documentation, most of the smaller conversion companies discontinued offering packages.

Some lift truck manufacturers which had planned entry into this CNG market also chose to hold off taking this step. A relatively large number of lift trucks converted before 2004 continue in use, and some debate continues as to whether lift trucks manufactured before 2004 can still be converted today. This is a gray area.

Certified conversion options may develop as the market and the availability of CNG refueling stations increases. However, you can purchase a new CNG lift truck today.

Toyota Offers Line of Equipment

Toyota USA had already entered the market and had engines certified to meet EPA and California Air Resource Board (CARB) standards. Toyota continues to offer new lift trucks designed for CNG, with cushion-tire units in sizes from 4,000 to 6,500 lbs and pneumatic-tire units in sizes from 3,000 to 6,500 lbs. According to Mark Faiman, product manager for this area for Toyota U.S.A., this size range covers about 70% of the current lift truck weight-class market.

Faiman feels this market has significant potential for growth, particularly for companies that are putting in fast-fill CNG stations for other fleet operations. "What we're seeing is that CNG lift trucks are especially attractive if the firm already has an installed fast-fill station that can be used for lift trucks on-site." He notes that CNG use for road-tractors, delivery trucks and other commercial and industrial vehicles is on the increase, and with it comes opportunities for CNG warehouse lift trucks.

Rapid Refueling an Advantage

The high-pressure fuel tank for the Toyota lift truck is approximately the same size and weight as a standard LP tank, however it is refilled in place rather than being exchanged for a full tank,

as is the practice with LP. Faiman observes, "With a quick-fill CNG station, the lift truck can be refueled in place without the need to handle a tank."

This refueling can be completed in a few minutes, rather than the 10-20 minute cycle common for LP. Lifting and handling both the full and empty LP tanks in the exchange process has always been a potential source of worker injury.

Lower Cost Fuel, Ideal for Indoor Use

According to Faiman, CNG is currently 30-50% lower in cost than LP or diesel fuel. It is also attractive because of its low combustion odor and emission characteristics, and because refueling is usually a very quick operation. "Especially for indoor operations, it is more attractive than LP or diesel."

He explains that with normal warehouse continuous usage, the CNG lift truck will need one refueling during an 8-hour shift. This is similar to the requirement for LP units. In applications where lift truck usage is relatively light and it is not an around-the-clock operation, an overnight slow-fill refueling station is less expensive and is a practical alternative..

As more refueling stations are established, CNG lift trucks become an increasingly attractive option. If your operation is considering going to CNG for other operations, remember to consider converting to CNG lift trucks as well. Each situation is different, but CNG works out well for many of them. **GT**

CNG lift trucks such as this Toyota model reduce fuel cost, minimize emissions and offer rapid refueling for warehouse and manufacturing operations. Photo courtesy Toyota USA.

