"TURNING INFORMATION INTO ENERGY SOLUTIONS FOR INDUSTRY"

ENERGY MATTERS

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Premium Energy Efficiency Systems

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The forced internal recirculation (FIR) burner—just one of many new efficient natural gas technologies. Learn about others on page 3.

New Gas Technologies Cut Costs and Emissions

Boilers, furnaces, and other process heaters account for about two-thirds of the energy used by U.S. manufacturers. Considering the cost, productivity, and environmental implications of this intensive energy use, it follows that every manufacturing industry could benefit from improved combustion technologies. OIT and the Industrial Center, a natural gas trade organization and an OIT Allied Partner, have teamed up to promote the use of new gas combustion technologies to industrial end users who want to increase productivity and competitiveness.

Since 1991, more than a dozen new gas combustion technologies have been introduced to the manufacturing market. (Read about some of these in the accompanying gas technologies sidebar.) Here, we will provide an overview of three of the newer, cutting-edge natural gas technologies.

Forced Internal Recirculation Burner

The forced internal recirculation (FIR) burner is being developed to dramatically reduce nitrogen oxide (NO_x) and carbon monoxide (CO) emissions from natural-gas-fired steam boilers without sacrificing boiler efficiency. The NO_x emissions goal is less than 9 volumetric parts per million (vppm) and the CO emissions goal is less than 50 vppm.

The FIR burner combines several techniques to reduce emissions:

- Premixed substoichiometric combustion and significant internal recirculation of partial combustion products in the first stage to achieve stable, uniform combustion that minimizes peak flame temperatures and pockets of high oxygen concentration
- Enhanced heat transfer from the first stage to reduce combustion temperatures in the second stage
- Controlled second-stage combustion to further minimize peak flame temperature.

This burner can reduce emissions without using diluents such as steam, water, or external flue gas recirculation. It can increase system efficiency, plus reduce

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Air Liquide/PIX 11020

Oscillating combustion technology can produce significant fuel savings, reduce NO_x emissions, and can be installed as a simple retrofit, requiring no burner or furnace modification.

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developmental, operating, maintenance, and capital costs when compared to currently available low NO_x burner systems. One significant feature is that it can be installed new or retrofitted to a wide range of combustion chamber configurations. These include watertube boilers used in the paper, chemicals, petroleum refining, food, and steel industries.

Currently, the FIR burner is operating on two natural-gas-fired industrial boilers: a 2.5-million Btu/hr firetube boiler at Vandenberg Air Force Base, and a 60-million Btu/hr watertube boiler at a California brewery. It is also being adapted to fire on downfired once-through boilers and for steel industry boilers firing mixtures of natural gas, coke oven gas, and blast furnace gas. The technology is being developed by a partnership composed of OIT; the Gas Technology Institute (an organization that combined the former Gas Research Institute and the Institute of Gas Technology); Southern California Gas Company; Coen Company, Incorporated; Peabody Engineering Corporation; and Johnston Boiler Company.

Oscillating Combustion

When the fuel flow rate to a burner is oscillated with a special valve action, it creates oscillating combustion. The oscillation creates successive, NO_x-formation-retarding, fuel-rich and fuel-lean zones within the flame. Heat transfer from the flame to the load is increased because of more luminous fuel-rich zones and the breakup of the thermal boundary layer. The increased heat transfer shortens heat-up times, thereby increasing thermal efficiency.

One of the major benefits of this technology is that it can be installed as a simple retrofit, requiring no burner or furnace modification. Furthermore, recent testing has shown significant fuel savings and NO_x emissions reductions.

Several field evaluations of oscillating combustion have been completed. One was on a batch-annealing furnace in a steel mill. It showed a 2% to 5% fuel savings and a 32% NO_x reduction. Another was on an oxy-fuel-fired glass melter in a fiberglass plant. In this case, a fuels savings of 3% to 4%, oxygen use savings of 10% to 14%, and a NO_x reduction of 55% were documented.

Peter Lortus, Arthur D. Little, Incorporated/PIX 11014

Test furnaces for high-efficiency, ultra-low-emission, integrated process heater systems.

In another recent evaluation at a forging facility, fuel savings of up to 3% and NO_x reductions of up to 49% were achieved. These evaluations were performed by a partnership composed of OIT; the Gas Technology Institute; Air Liquide America; Bethlehem Steel Corporation; California Air Resources Board; CeramPhysics, Incorporated; Columbia Energy Group; GT Development Corporation; Southern California Gas Company; and Synergistic Partners, Incorporated.

Oscillating combustion can be applied to many types of furnaces used in the steel industry, including box annealing, steel reheating, and ladle drying and preheating. In addition, it is expected to be used widely in glass melters, aluminum melting furnaces, forging furnaces, metal-melting furnaces, cement and lime kilns, and other high-temperature furnaces.

Smart, Integrated Burner/ Fired-Heater Systems

Yet another gas technology is showing great promise, along with some proven results. An advanced process heater is being developed for refinery and chemical plant applications. OIT; Arthur D. Little, Incorporated; ExxonMobil Research and Engineering

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A Sampling of Current Gas Technologies

Excerpted from the Technology Tour pages of the Industrial Center Web site: ***www.industrialcenter.org/techtour/techtour.htm****.*

Air Compressor—*The primary difference between an electric and natural gas-engine-driven air compressor is the prime mover. The natural gas engine is a variable speed driver that is ideally suited to power a rotary screw air compressor because it takes advantage of its positive displacement characteristics. For more information, see* ***www.aircompressor.org****.*

Catalytic Oxidation—*Catalytic oxidation is similar to thermal oxidation in that heat energy is used to convert hydrocarbon fuels to carbon dioxide and water vapor. A catalyst is used to lower the activation energy of the combustion reaction, allowing combustion to occur at temperatures significantly lower than those of thermal systems.*

Central Thermal Fluid Systems—*A thermal fluid system is similar to a hot water heater operating at temperatures below 212°F. The advantage of thermal fluids is the ability to provide operating temperatures of 575° to 800°F at atmospheric pressure. At these temperatures, thermal heat transfer fluids remain chemically and thermally stable, and high-pressure operating systems are avoided.*

The primary components of a gas-fired Central Thermal Fluid System (CTFS) are the heating unit, gas burner, control panel, expansion tank, de-aerator, and main circulating pump. The CTFS is generally skid mounted. A complete system requires piping, insulation, and valving to control temperature and possibly additional pumps to achieve the required temperature control for individual heating loops.

Chillers—*A gas-engine-driven chiller employs the same refrigeration cycle as a standard electric chiller, but has several advantages. The main difference is that the electric motor is replaced by an industrial duty natural gas engine.*

Co-firing and Reburning—*Natural gas co-firing in stoker boilers is now maturing as an off-the-shelf tool to improve the economics and operation of stoker boiler systems. Co-firing and reburning are the lowest capital cost technologies for reducing stoker emissions. Natural gas co-firing is the simultaneous firing of natural gas and a solid fuel using specialized burners and controls. Co-firing applied to stoker boilers typically involves two burners designed to create a spinning flame that more thoroughly burns particulate.*

Desiccant Dryers—*Desiccant systems can be used in three ways: spot dehumidification, machine shrouding, and full area conditioning. Spot dehumidifiers deliver dry air directly over the surface of a mold when it opens. This method uses a small dehumidifier and requires ductwork to bring the dehumidified air to the mold cavity. Machine shrouding involves construction of a small chamber to encase the molding machine and limit the infiltration of moist air to the machine. In full-area air conditioning, distribution ductwork is eliminated. However, with a larger space to condition, the unit must be sized to compensate for room openings, people and the presence of other types of equipment.*

Gas-Fired Vacuum Furnaces—*One of the greatest benefits of gas-fired vacuum furnaces is their substantially lower energy cost. Natural gas is usually substantially lower in cost than electricity per Btu of heat input. In addition, the processes used in gas vacuum heat treating allow faster cycle times and higher product consistency. These benefits can greatly increase production.*

Infrared Paper Drying—*Gas catalytic infrared paper drying is a quick-cooling, flameless method of removing moisture from paper as it is being manufactured. Benefits of this technology include high overall efficiency, low operating cost, low maintenance cost, and an automatic moisture leveling effect.*

Resin Dryers—*Natural gas can be used in resin dryers to heat the air stream to relatively low temperatures (200° to 300°F) to pre-dry and pre-warm the resin prior to entering a molding machine. In addition, natural gas can be used to regenerate the desiccant bed or moisture-laden air circuits.*

Thermal Oxidation—*Thermal oxidation is a process in which organic-laden emission streams are combusted at high temperatures to form carbon dioxide and water vapor. There are three types of thermal oxidizers—direct flame (afterburner), recuperative, and regenerative—differentiated by the equipment used for heat recovery. Afterburners employ no heat recovery equipment. Recuperative systems use heat exchangers, while regenerative systems rely on ceramic beds for heat recovery.*

New Gas Technologies

continued from page 3

Company; and Callidus Technologies, Incorporated are developing and demonstrating the technology base for a high-efficiency, ultra-low emission (ULE) integrated process heater system. Four advanced technologies are being incorporated:

- ULE smart burners
- A specially designed fired heater with enhanced heat recovery, optimized for use with the ULE burner systems
- An online process tube temperature sensing and burner control system to enhance heat transfer, reduce maintenance costs, and increase run lengths
- An adaptive Predictive Emissions Monitoring System (PEMS) to provide continuous emissions information without costly continuous emissions monitoring (CEMS) equipment.

Designed for both natural and forced-draft operation, the ULE burner internally recirculates furnace flue gases to reduce the rate of NO_x formation without compromising efficiency. Advanced system components (burners, sensors, control systems, and heat exchangers) are being developed for use in both new and retrofit applications.

Results from the process-heater development project indicate that this technology has the potential to save 110 trillion Btu per year in the U.S. refining and chemicals industries (with 100% market penetration). It could decrease CO_2 emissions by 7.2 million tons annually and decrease NO_x emissions by 200,000 tons annually (an 85% reduction in the chemicals and refining industries). It is further estimated that an industrial plant could save $100,000 in capital and labor per installation by using PEMS instead of CEMS technology.

To capture near-term benefits, system components are being designed for use in retrofit applications. Economically attractive technologies will be demonstrated at an ExxonMobil refinery.

A prototype ULE burner has already been scaled up for commercial application. This commercial model has been demonstrated in the field and is now available to the oil and chemical industries, according to Chuck Benson, a Vice President at Arthur D. Little, Incorporated, who manages the firm's Energy and Transportation Technology Sector.

Widespread Industry Potential

The appeal of these three technologies is that they can be used in many common process heating situations throughout industry, according to Henry Mak, a technology development consultant with Southern California Gas Company and an active Industrial Center member. For example, he says, the FIR burner can be used with both boilers and furnaces. Oscillating combustion has broad applicability because of its large potential for retrofitting, and its cost is "extremely reasonable," he says. Furthermore, he states, the smart burner/fired-heater system technology "has a lot of control built into it." The uniformity of heating improves product quality and cuts waste.

Choosing the Right Technology

As you can see, there are many new cost-saving, energy-efficient gas combustion technologies. If you would like to learn more about choosing the appropriate technology for your plant, log on to the Industrial Center Web site at **www.industrialcenter.org**; contact Richard Biljetina, Director of Industrial Technology at the Industrial Center at biljet@att.net; or call the Industrial Center at 202-824-7150. You can also get valuable information from the OIT Combustion home page at **www.oit.doe.gov/combustion/** or contact Bob Gemmer, DOE Combustion Program Manager, at bob.gemmer@ee.doe.gov. ●

INDUSTRIAL CENTER AND OIT JOIN IN PARTNERSHIP

In October 2001, OIT's Combustion Program Manager Bob Gemmer joined the Industrial Center, Incorporated Board of Directors and Industrial Center consortium members at the Industrial Center's annual meeting in Phoenix to celebrate the OIT/Industrial Center Allied Partnership Agreement. The Industrial Center's mission is to accelerate the acceptance of new gas-fueled technologies that enhance the productivity and competitiveness of the industrial sector.

Allied Partnerships provide opportunities for industrial partners to build awareness of OIT's Industries of the Future program; broaden, strengthen, and support partnership networks; leverage program development and deployment through cooperative activities; and promote applications of OIT-sponsored technologies and energy management best practices. Specific activities to be undertaken as part of the Industrial Center/OIT Allied Partnership include:

- *Participation in the development and dissemination of information, tools, and resources*
- *Promotion of OIT solicitations*
- *Assistance in the commercialization of emerging technologies, and*
- *Partnerships in workshops, seminars, and similar events.*

Since 1997, OIT and its Allied Partners have worked successfully to assist thousands of industrial end users nationwide achieve increased energy efficiency and productivity improvements. Currently, OIT is seeking to expand the Allied Partner initiative to include companies and organizations in a wide range of industrial process and utility systems. Allied Partners not only have access to valuable information and materials that will assist their customers, they also are able to promote information on their own successful projects. Sharing techniques of successful projects will assist other industrial manufacturers to improve their operations and will demonstrate a company's interest in improving its customers' bottom line.

Becoming an Allied Partner is easy and there is no charge to participate. If you would like to learn more, contact the OIT Clearinghouse at 800-862-2086, or e-mail Clearinghouse@ee.doe.gov. You may also access more information on the Allied Partner Web page at OIT's BestPractices Web site, ***www.oit.doe.gov/bestpractices/ap_howto.shtml****.*

IAC Benchmarking Study Identifies Steam Efficiency Opportunities

By Dr. Anthony Wright, Oak Ridge National Laboratory

A recently completed project by the Oak Ridge National Laboratory (ORNL) to develop a benchmark measure of OIT's Steam System Scoping Tool software resulted in a list of 89 money-saving steam process improvement opportunities.

The Steam System Scoping Tool software was developed by the OIT BestPractices program in 2000 to help industrial energy users improve their operations' efficiency. The software's intended audience is steam system energy managers and operations personnel for large industrial plants.

Dave Parsons, NREL/PIX 06909

If you fill such a role, the tool is designed to help you become aware of opportunities to improve your steam system, evaluate your steam system operations against identified best practices, and compare your steam system operations to those from other facilities.

The Industrial Assessment Center (IAC) team, which executed the Steam Tool Benchmarking Support project, compiled data from recent steam assessments and identified potential improvement opportunities. A review of energy efficiency assessments at 18 plants that use steam systems identified 89 potential improvement opportunities. Each improvement had an average annual potential energy savings of $31,500, and an average payback period of about 7 months. Energy savings for the 18 steam assessments averaged 12.5%.

The accompanying table highlights a handful of the improvements identified by the benchmarking study.

Manufacturing and process plant types involved in the 18 assessments included cheese and whey products, chemicals, corrugated containers, fabric drying, frozen food, hardwood moldings, industrial cleaning compounds and sanitizers, inorganic chemical intermediates, pulp and paper, redwood lumber, rubber tires, shopping carts, Styrofoam™ cups, textiles, and vinyl flooring.

The IACs obtained annual fuel cost data for most of the plants. Fuel bills ranged from $79,000 to $14.8 million a year, and averaged $1.6 million a year.

The benchmarking support project was funded by DOE. Dr. Anthony Wright, of ORNL, directed the study. Participating IACs included the University of Massachusetts, Amherst; North Carolina State University; Oklahoma State University; San Francisco State University; South Dakota State University; and University of Tennessee, Knoxville.

To obtain your own copy of the Steam System Scoping Tool, call the OIT Clearinghouse at 800-862-2086 or e-mail: Clearinghouse@ee.doe.gov. To learn more about IACs and how their no-cost assistance might benefit your company, log on to Energy Matters Extra at **www.oit.doe.gov/bestpractices/energymatters/emextra/**. ●

A SAMPLING OF STEAM PROCESS IMPROVEMENT OPPORTUNITIES*

Improvement	Yearly Cost Savings ($/yr)	Implement Cost ($)	Payback Period
Insulate Boiler Valve Bodies and Fittings	$ 1,274	$ 198	0.2 years
Insulate Steam Lines	$ 2,693	$ 1,780	0.7 years
Retune Boiler and Purchase Combustion Analyzer	$ 7,010	$ 4,080	0.6 years
Repair Steam Traps	$13,868	$ 2,580	0.2 years
Shut Steam Valves Feeding Unused Presses	$54,060	$15,000	0.3 years
Use Economizer to Preheat Boiler Feedwater	$84,500	$ 1,500	.08 years
Install Automatic Boiler Air/Fuel Ratio Controls	$33,580	$25,000	0.7 years
Cover Heated Tanks	$ 780	$ 390	0.5 years
Insulate Steam Distribution and Condensate Return Lines	$ 2,600	$ 5,200	2.0 years
Insulate Hot Exterior Surface of Heat Exchangers	$ 2,240	$ 1,510	0.7 years

*Actual savings, implementation costs, and payback periods may vary depending on scope of project, type of plant and other variables.
Source: Industrial Assessment Center Steam Tool Benchmarking Support Project, Final Summary Report, 12/20/01, ORNL.

Augusta Newsprint Showcase

Rolf Butters, OIT Photo

More than 200 pulp and paper industry professionals took part in OIT's Augusta Newsprint Showcase, March 6-7 in Augusta, Georgia. Here, three mill tour participants discuss energy efficiency gains with an Augusta Newsprint expert. The discussion took place near the mill's compressed air consolidation project, one of nine showcase projects. The compressed air project consolidated two compressed air systems, eliminated a spare compressor, and repaired leaks. The upgrades cost $75,000, reduced energy consumption by 1 million kWh/year, and resulted in an annual savings of $59,000.

Copper Motor Rotors Tackle a Life or Die Question

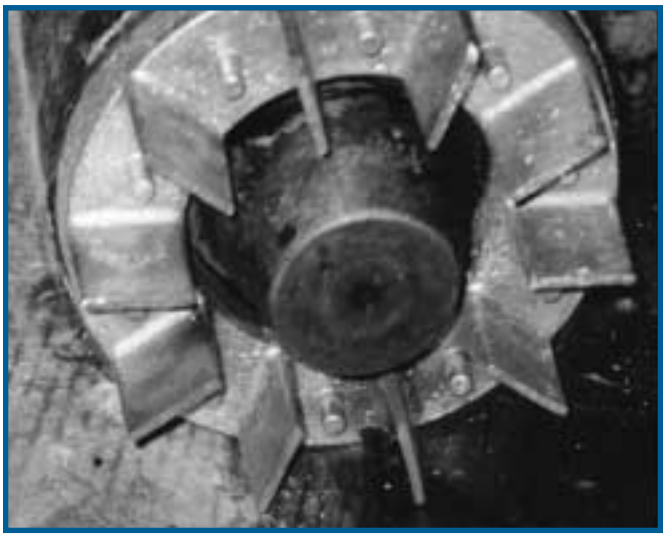
The problem sounds like a contradiction in terms: how to extend die life. For the copper industry, however, solving that problem breathes life into efforts to make copper motor rotors commercially viable.

The copper industry has contended that replacing conventional casting technologies with copper in motor rotor manufacture may allow companies to build and sell motors that are even more energy efficient. Those motors could, in turn, help reduce operating costs for industries that use electric motors, and cut the overall cost of manufacturing premium efficiency motors.

The copper motor rotor program is of interest to OIT's Metal Casting Industries of the Future Program for its potential to foster new processing technologies that can contribute to the industry's productivity, energy efficiency, and environmental goals, said Harvey Wong, OIT's Metal Casting Team Leader.

According to the Copper Development Association (CDA), analyses by several manufacturers show an additional 15% to 20% reduction in motor losses (input/output method) achievable with copper rotor, compared to the same motor design using conventional technologies.

CDA said its tests also show that motors with copper rotors yield overall energy loss reductions of 15% to 20%, compared with standard technology. In the United States alone, a 1% increase in motor efficiency may save roughly 20 billion kWh of electricity a year. That equals roughly $1.4 billion at an electric rate of 7¢/kWh.



Copper Development Association, Inc./PIX 11013

After casting, the copper motor rotor looks like this.

In 1999, OIT released a comprehensive assessment of opportunities to increase electric motor system efficiency and reduce energy costs in U.S. industry. The report, *U.S. Industrial Electric Motor Systems Market Opportunities Assessment,* followed 3 years of research. It reported that potential industrial motor system energy savings using mature, proven, cost-effective technologies could range from 11% to 18% of current annual usage, or 75 billion to 122 billion kWh per year, equal to $3.6 billion to $5.8 billion in savings.

The assessment also collected information on the prevalence of actions identified by industry experts as "good practice" in facilities, because achievement of significant increases in motor system efficiency depends to a large extent on the adoption of good design, purchase, and management practices.

For a copy of the *U.S. Industrial Electric Motor Systems Market Opportunities Assessment,* call Best Practices Motor Challenge staff at 800-862-2086.

For the copper industry to realize any of the potential benefits from further developing copper motor rotors, it had to overcome a technical problem. Copper melts at a higher temperature than other metals commonly used in motor rotor manufacture. In its molten state, liquid copper stresses die molds so much that cracks and other failures shorten their life span. Hence, the worries over how to extend die life.

Backed in part by a $425,000 grant (won through a competitive bidding process from DOE's National Industrial Competitiveness through Energy, Environ-

(continued on page 7) ▶

Copper Development Association, Inc./PIX 11012

A craftsman at the Formcast Incorporated facility in Denver pours molten copper into a die form for casting.

Copper Motor Rotors

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ment, and Economics (NICE³) program), the copper industry in 1997 began to look for ways to extend die longevity and improve the prospects for copper rotors' commercial viability.

The NICE³ grant program provides funding to state and industry partnerships (large and small business) for projects that develop and demonstrate advances in energy efficiency and clean production technologies. State and industry partnerships are eligible to receive a one-time grant of up to $525,000. The industrial partner may receive a maximum of $500,000 in federal funding. Nonfederal cost share must be at least 50% of the total cost of the project.

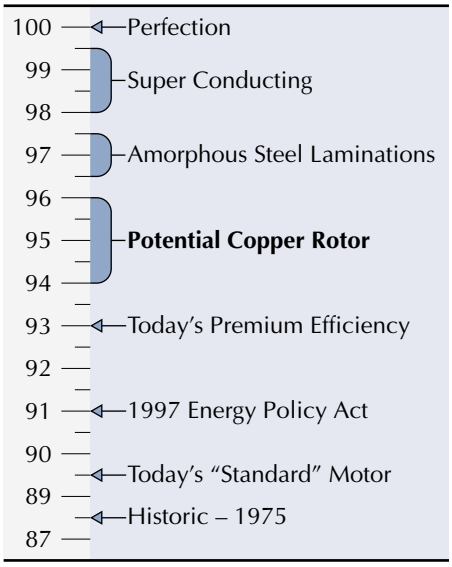
Copper motor rotors could be the next step in a steady line of motor efficiency improvements.

Fifteen years ago, a typical 15-kW motor was about 87% efficient. Standard motors today are 89% to 90% efficient. The Energy Policy Act set an efficiency standard of 91% and premium efficiency motors currently on the market have efficiencies of about 93%.

Motors with copper rotors may be able to achieve efficiencies of 94% to 96%.

15 kW MOTOR – PAST, PRESENT AND FUTURE

Nameplate Efficiency (in percent)



Source: Darryl Van Son, Motor Test Results presented at Die Cast Copper Motor Rotor Workshop and Technology Demonstration Meeting, January 29, 2002, Denver, CO.

ALUMINUM AND COPPER MOTOR TEST RESULTS

HP	kW	Poles	Efficiency		Difference	Loss Reduction
			Aluminum	Copper		
4	3	4	83.2	86.4	3.2	19.0%
7.5	5.5	4	74.0	79.0	5.0	19.2%
10	7.5	4	85.0	86.5	1.5	10.0%
15	11	4	89.5	90.7	1.2	11.4%
25	19	4	90.9	92.5	1.6	17.6%
40	30	4	88.8	90.1	1.3	11.6%
120	90	2	91.4	92.8	1.4	16.3%
270	200	4	92.0	93.0	1.0	12.5%
Average						**14.7%**

Source: Darryl Van Son, Motor Test Results presented at Die Cast Copper Motor Rotor Workshop and Technology Demonstration Meeting, January 29, 2002, Denver, CO.

Motors with copper rotors may cost more than conventional rotors, said Darryl Van Son, a consultant to the copper industry, who spoke at a CDA-sponsored, copper motor rotor conference in Denver, Colorado, in late January. But the extra cost may prove to be nominal. A copper rotor in a 15-hp motor could result in a 1.2% efficiency gain and a difference in retail list price of $10 to $12 per motor. For a $900 to $1,500 motor, the payback may be measured in months.

Van Son also said that test results showed copper motor rotors improved energy efficiency in motors as small as 3 kW and as large as 200 kW. And he said that motors using copper rotors may last longer because high efficiency motors run cooler.

Reaching the next level of efficiency cost-effectively offered a challenge for the copper industry. A report by CDA, *Technology Transfer Report—The Die-Cast Copper Motor Rotor,* said that for copper rotors to win acceptance by motor manufacturers, they need to be produced with the same equipment that is currently in place. To meet that requirement, the copper industry had to find a way to deal with the thermal difference between molten copper and conventional technology and its effect on die life.

Following tests at a motor manufacturing plant in Denver, and other research, the CDA found that several high-temperature die materials might work well, depending on specific thermal stresses and load requirements. The association also found that preheating molds is key to reducing thermal stresses and helping to ensure long die life.

Solving the die-life problem won't make copper motor rotors commercially practical overnight. The technology still faces a chicken-and-egg dilemma. For manufacturers to build copper motor rotors, the market must demand them. But for market demand to exist, a supply of copper motors must exist.

CDA, with help from NICE³, continues to seek answers to this dilemma because building a market for copper motor rotors may be the next step in efforts to make electric motors even more energy efficient. ●

In total, NICE³ has sponsored more than 100 projects, with more than half going to small businesses. NICE³ has leveraged $26.3 million in federal funds, with $81.8 million in state and industry funds since 1991.

If you are interested in learning more about the NICE³ grant program, visit the Web site at ***www.oit.doe.gov/nice3/nice3.shtml*** *or call DOE's Golden Field Office at 303-275-4728. To learn more about the Metal Casting Industries of the Future (IOF) initiative, visit the Web site at* ***www.oit.doe.gov/metalcast****.*

CDA is a long-time participant in the IOF Allied Partner program, and sponsored the copper motor rotor conference mentioned previously. This conference attracted 75 attendees from the United States and abroad. To learn more about CDA, visit its Web site at ***www.copper.org.***

New NEMA Premium™ Efficiency Motor Standard Helps U.S. Industry Compete

By Rob Boteler, Emerson Motors Technologies, St. Louis, MO, Chairman of NEMA's Energy Management Taskforce

In May 2001, the Motor Generator section of the National Electrical Manufacturers Association (NEMA) announced a new motor efficiency standard. Consequently, motor manufacturers have had roughly a full year to reconfigure their product lines to meet this new standard to meet customer demand.

One of NEMA's first steps in creating this new standard was to reach an agreement with other national organizations involved in the promotion and support of energy-saving motor products. NEMA appointed an Energy Management Taskforce to achieve this goal. Through a series of meetings and phone conversations, motor efficiency levels and definitions were developed and finalized over a 6-month period.

Using DOE data, NEMA estimated last year that its efficiency motor program could save more than 5,800 gigawatts of electricity and prevent the release of nearly 80 million metric tons of carbon into the atmosphere over the next 10 years. That would be the equivalent of keeping 16 million cars off the road.

Particular attention was paid to the new motor standards to ensure "user friendly" replacement. NEMA manufacturers were careful to follow designs that retain the critical elements of motor performance necessary to function within starting current, break down torque, temperature considerations, and other pertinent motor performance requirements. By maintaining these standards, replacement motors do not risk incompatibility with existing motor starters and facility wiring systems critical to safe user replacement and cost containment.

The new NEMA Premium™ standard has been added to NEMA MG1, the NEMA standard that covers motors. Data from this standard can be found in the accompanying table, which addresses enclosed, three-phase motors from 1 to 500 hp in low (230/460) voltages. (To see an expanded version of this table, plus other tables covering both open and enclosed motors in low and medium (2100/4160) voltages, log on to Energy Matters Extra at **www.oit.doe.gov/bestpractices/energymatters/emextra/**.)

In response to the new standard, manufacturers have released standardized products in the new design in both open drip format (an open motor that allows air to circulate) and totally enclosed format (in which the fan is entirely enclosed), and built up inventory to support customer demand. In addition, several NEMA motor manufacturers now offer additional products, at lead-time, such as vertical pump motors, close-coupled pumps, and a variety of definite- and special-purpose configurations. These new designs provide users with additional energy savings opportunities not previously available.

Motors continue to move up the cost savings ladder every day. In our ever-increasingly competitive global market, other countries may have lower labor rates or other natural resources, but the United States has an opportunity now to help level the "cost playing field" by adopting the new NEMA Premium standard plant wide.

Through motor management and the use of NEMA Premium motors, companies of all sizes are realizing significant energy cost savings. Even greater savings may be experienced when companies replace all their less efficient motors with NEMA Premium models, an entire plant at a time. A national campaign, of which several NEMA members are sponsors, offers the tools and information needed to help companies get started on a motor management plan. The campaign, Motor Decisions Matter, supports the use of NEMA Premium motors to achieve maximum energy saving results.

For more information about the NEMA Premium standard campaign, visit **www.motorsmatter.org**. To learn more about OIT's BestPractices motors efforts, visit **www.oit.doe.gov/bestpractices/motors**. ●

FULL-LOAD EFFICIENCIES FOR NEMA PREMIUM™ EFFICIENCY ELECTRIC MOTORS RATED 600 VOLTS OR LESS (RANDOM WOUND)

	Enclosed Motors					
	2 Pole		4 Pole		6 Pole	
HP	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency	Nominal Efficiency	Minimum Efficiency
1	77	74	85.5	82.5	82.5	80
5	88.5	86.5	89.5	87.5	89.5	87.5
10	90.2	88.5	91.7	90.2	91	89.5
15	91	89.5	92.4	91	91.7	90.2
20	91	89.5	93	91.7	91.7	90.2
25	91.7	90.2	93.6	92.4	93	91.7
50	93	91.7	94.5	93.6	94.1	93
100	94.1	93	95.4	94.5	95	94.1
150	95	94.1	95.8	95	95.8	95
200	95.4	94.5	96.2	95.4	95.8	95
300	95.8	95	96.2	95.4	95.8	95
400	95.8	95	96.2	95.4	95.8	95
500	95.8	95	96.2	95.4	95.8	95

Source: NEMA. To view an expanded version of this table and to view other tables covering both open and enclosed motors rated 600 volts or less and 5000 volts or less, log on to Energy Matters Extra at **www.oit.doe.gov/bestpractices/energymatters/emextra/**

TAPPI Signs Allied Partner Agreement

The Technical Association for the Pulp and Paper Industry (TAPPI), the leading technical organization for the worldwide pulp, paper, and converting industry, has become the latest member of OIT's Allied Partner program.

Grace Ordaz, OIT Photo

Denise Swink, (l) Deputy Assistant Secretary for Industrial Technologies, and Michael Wallace, (r) TAPPI president, sign an Allied Partner agreement in Atlanta on March 6.

Denise Swink, Deputy Assistant Secretary for Industrial Technologies, and Michael Wallace, TAPPI president, signed the Allied Partner agreement during TAPPI's Energy Results Showcase conference in Atlanta on March 6.

Allied Partners are manufacturers, trade associations, industrial service and equipment providers, utilities, and other organizations that agree to help promote increased energy efficiency and productivity for those industries that participate in OIT's Industries of the Future strategy.

"We couldn't find a better partner than TAPPI," said Swink at a press conference that accompanied the signing. She noted that TAPPI, with 23,000 members, is well positioned to help disseminate energy efficiency BestPractices techniques throughout the pulp, paper, and converting industry.

Wallace said that one of TAPPI's strengths is its ability to capture, evaluate, and disseminate information. "The thing that joins TAPPI members together is we love to solve problems," he said at the signing.

Under the agreement, TAPPI and DOE will coordinate programs to help the pulp and paper industry capture a part of the large energy savings opportunities that exist within mills throughout the United States, and to help focus the industry on issues such as energy and environmental concerns and thereby foster cooperation and involvement in OIT Industries of the Future activities.

Becoming an Allied Partner is easy and there is no charge to participate. For information on how your organization can get involved, contact the OIT Clearinghouse at 1-800-862-2086 to have an information package sent to you. Or, log on to the BestPractices Allied Partner Web site at **www.oit.doe.gov/bestpractices/ap_whatis.shtml**. ●

California Energy Events

How did California get itself into an energy crisis? That was the question posed by California State Assemblyman Fred Keeley on January 16, 2002, at the San Jose, CA, energy event—Energy Solutions for California Industry. And, helping California industry remain profitable during the energy crisis is the purpose of the Energy Solutions series.

The San Jose energy event was the second in the series, informally known as "energy fairs." OIT and the California Energy Commission (CEC), which co-sponsors the series, held the first fair in Sacramento on August 14, 2001. The events concentrate on energy improvements in pumping and compressed air systems, motors, and drives.

"The events bring together public- and private-sector organizations, including financial institutions, technical services firms, and utility companies, and provide attendees with information and tools to achieve cost and energy savings," said David Garman, DOE's Assistant Secretary for Energy Efficiency and Renewable Energy.

OIT's Chris Cockrill, an organizer of the Energy Solutions events, explains that they began when the CEC approached OIT last year about working together to help California industry weather the energy crisis. At about the same time, Gunnar Hovstadius from Allied Partner ITT Fluid Technologies was talking to OIT about pulling together an Allied Partner event in California. The efforts came together, and in April 2001 OIT and CEC agreed to schedule three energy events in California.

"They are very serious forums that allow industry leaders to talk face to face with solution providers from the ranks of our Allied Partners," explains Cockrill. "It's not a trade show. Exhibitors are handpicked from our Allied Partners. We focus on solutions, not products." The events typically feature 25 to 35 exhibitors and 200 to 300 attendees. Simultaneous breakout sessions are presented throughout the day with plenary speakers at the opening, lunch, and closing. "We knit together speaker topics that might help industry learn more about system efficiency opportunities," says Cockrill.

Among the speaker topics in San Jose, for example, were sessions on managing motor system assets, improving pumping and compressed air systems, evaluating energy service contracts, financing energy improvements, and developing energy management programs in manufacturing facilities.

At the opening plenary, Terry Surles, Director of the Technology Systems Division of the CEC, spoke highly of the collaboration with OIT. "This event is a great example of an effective partnership between DOE and the California Energy Commission," he said. "We at the CEC see a need to emulate what OIT has done at DOE." Surles explained that the CEC is working to get two IOF-type programs off the ground for key California industries—local agriculture and computer manufacturing.

The next energy event is scheduled for May 15, 2002, in Buena Park, CA, at the Sequoia Conference Center. In the future, organizers hope to expand the series beyond California. For more information on the energy events, please see the California Energy Events Web site: **www.projectperformance.net/caenergyevents/**. ●

PHAST Offers a Phriendly Way to Evaluate Process Heating Efficiency

A new user-friendly interactive software program or tool will soon help process heating equipment users assess how much energy their furnaces, ovens, and heaters use, and model different ways to improve individual unit performance and manage bottom-line costs.

The Industrial Heating Equipment Association (IHEA), through its partnership with OIT, is working with Oak Ridge National Laboratory and representatives from industry and equipment suppliers to develop the software program, the Process Heating Assessment and Survey Tool (PHAST). The software is in beta-testing and will be become available through OIT later this year.

Dave Parsons, NREL/PIX 03934

Support for the tool software development is provided by OIT through its Best-Practices program, which works with industry to identify plant-wide opportunities for energy savings and process efficiency.

PHAST and Phriendly

PHAST offers a way to help plant managers and process heating engineers survey their plant's process heating equipment, identify equipment that uses the most energy, and specify improvements that may enhance productivity, reduce waste, and increase energy efficiency.

The PHAST software was developed to be useful in almost all of the nine Industries of the Future, supported by OIT's Best-Practices program. The software is effective for almost any size furnace.

PHAST's first release may prove most useful for process heating applications that rely on oil or natural gas to fire furnaces, ovens, heaters, kilns or melters. The software may also be used for applications using electricity as a heating source, although it currently doesn't offer the same level of detail. A later version is expected to include applications to better evaluate electricity as well as other fossil fuels.

The software tool serves three major purposes:

- PHAST introduces users to process heating energy conversion tools and includes easy-to-use calculators. These calculators assess the effects of a variety of combustion and heat recovery parameters.
- PHAST allows users to compare furnace performance across a range of operating conditions.
- PHAST calculates potential energy savings that may be achievable under different operating conditions.

User-Friendly Energy Calculators

The introductory section of the PHAST software includes three simple "calculators" and a link to sources of information that can be useful to the plant operators and users of the tool. The three calculators include:

- Energy Equivalency: Calculates heat requirements when the heat source is changed from fuel firing (Btu/hr) to electricity (kWh), or from electricity to fossil fuel-firing.
- Efficiency Improvement: Calculates available heat for fuel-fired furnaces and expected energy savings when the burner operating conditions (exhaust fuel gas temperature, excess air, and preheated air) are changed for the burners.
- O_2 Enrichment: Calculates available heat for fuel-fired furnaces and expected energy savings when oxygen in combustion "air" is changed from standard (21%) to a higher value.

The link provided under "Fact Sheets" provides information on the parameters that affect the furnace efficiency and will be expanded to provide links to additional sources of information including direct links to websites where such information is available.

The plant information section of the PHAST tool assists the user to survey a plant's process heating equipment to identify which equipment consumes the most energy. It does this by producing a report summarizing expected energy use for the surveyed equipment. The report also identifies which pieces of equipment consume the most process heating energy in the plant.

A plant equipment survey prompts users to supply a variety of information to create a comparative table of energy consumed by the furnaces and their cost of operation. These features create a list that helps users decide where to focus their efforts to better manage energy costs or improve performance.

The Furnace Analysis and Heat Balance section helps users analyze an energy balance for selected high-energy-use equipment to identify energy usage and losses. This PHAST feature helps users identify locations within the furnace where energy is wasted or used less productively.

In this section, users can have an even more detailed assessment of individual pieces of equipment. In this way, PHAST allows users to work almost like a medical specialist equipped with a variety of parameters and tests to develop a diagnosis and recommend a course of action.

The reports section provides a summary of results for the plant survey in the form of a table and pie chart. The table gives energy use and projected annual cost based on the energy cost data provided in the plant survey section. This allows the user to identify large energy consuming equipment and perform an analysis to see the effects of changing operating conditions or retiring one or more furnaces.

A second part of the report section shows details of energy use in the selected furnace based on the data provided and calculates the effects of selected changes under modified operating or design conditions of the furnace. The information is displayed in pie charts to illustrate different areas of energy use. A bar chart shows comparisons between current and modified operating conditions.

What-If Support

For each step of this detailed analysis, PHAST offers an interactive guide to help users know which measurements to use and where to find appropriate data. Once all the relevant information is entered, the tool builds a summary table that shows how much energy is used in different parts of the furnace. It also shows how changes in one or more parameters may affect energy use.

PHAST also offers a "what-if" decision support tool that lets you easily compare existing conditions with modified conditions. This feature allows users to analyze how decisions affecting one part of a process heating operation will affect operations in another.

If you would like more information on PHAST, contact Bob Gemmer, OIT Combustion Program Manager, at bob.gemmer@ee.doe.gov. ●

Ask the Clearinghouse

Compressed Air End Uses

This column highlights key questions from industrial customers to the OIT Clearinghouse—your source for the full portfolio of OIT resources and technical advice about motor, steam, compressed air, combined heat and power, and process heating systems.

Clearinghouse engineers and technical staff expertly answer industrial efficiency questions, 11 hours a day, Monday through Friday. The Clearinghouse also has access to industry experts around the country. Call the OIT Clearinghouse at 800-862-2086, or go to **www.oit.doe.gov/clearinghouse/**.

Q: Our plywood plant uses a hogger to convert wood waste into boiler fuel. Conveyors transport sawdust and processed fuel to a storage silo. We use compressed air with a 5/16th inch diameter copper tube to blow wood chips off the conveyor return belt. Is there a more energy efficient way to clean the belts?

A: A 5/16th inch diameter copper tube blowoff consumes about 70 standard cubic feet per minute (scfm) of compressed air, given a 100-psig plant air supply. The compressed air consumption can be reduced to 12 to 16 scfm by replacing the open tube with an air jet or an engineered nozzle. Generally, a 10-micron filter separator is recommended on the air supply side of the air jet.

Your facility uses a lubricant-injected rotary screw compressor equipped with load/unload controls to supply plant air. Rotary screw compressors typically have a power requirement of 18 to 19 kW/100 cfm. Assuming continuous operation, your energy savings due to replacing the copper tube with an air jet are approximately:

Savings = 8,760 hrs/year x (70 - 16 scfm) x 19 kW/100 scfm = 89,877 kWh/year

These savings are valued at more than $4,000 per year, given an electricity price of $0.045/kWh.

When selecting air jets and nozzles, always select the lowest flow nozzle that will achieve the desired result. This maximizes air consumption savings, while minimizing noise. Some air jets and nozzles have an adjustable airflow feature. Ball joints may be provided with air control nozzles to provide for simple adjustment of the nozzle orientation. Consider installing a pressure regulator upstream of the air nozzles, and increasing savings by regulating pressure down to the absolute minimum necessary to achieve the desired result. In some cases, a dedicated low-pressure blower can be specified to meet application requirements. ●

Solicitations for Plant-Wide Assessments Planned to Be Announced in April

With its goal of accelerating the development and use of advanced energy-efficient, technologies and practices to benefit industry and U.S. energy security, OIT uses plant-wide energy assessments as one tool to accomplish this goal. These assessments are performed in U.S. industrial plants through OIT's BestPractices program, and rely on a competitive solicitation process to select proposals for funding.

Such a solicitation is planned for April 2002. DOE anticipates making up to nine cooperative agreement awards with total estimated DOE funding of up to $900,000. Individual awards will be limited to not more than $100,000, and project timeframes should extend for no more than 1 year.

OIT requires a minimum of 50% non-federal cost-share for these plant-wide assessment projects. This ensures industrial involvement in each proposal. Ideally, applicants will reflect a broad range of IOF industries and assessment methods and will not duplicate assessments conducted under prior solicitations.

Only proposals from the nine Industries of the Future (IOF) are considered. Those industries are agriculture, aluminum, chemicals, forest products, glass, metal casting, mining, petroleum, and steel.

Help your company reap the benefits of a plant-wide assessment. Stay apprised of these solicitations by checking the BestPractices Web site, **www.oit.doe.gov/bestpractices/**. ●

Letters to the Editor

Energy Matters welcomes your typewritten letters and e-mails. Please include your full name, address, organization, and phone number, and limit comments to 200 words. Address correspondence to:

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We publish letters of interest to readers on related topics, comments, or criticisms/corrections of a technical nature. Preference is given to articles that appeared in the previous two issues. Letters may be edited for length, clarity, and style. ●

Energy Matters Extra

In the Spring issue of Energy Matters Extra, *Energy Matters'* online complement, we offer more information about Industrial Assessment Center (IAC) activities and how this effort might benefit your company. Plus, we've posted more tables showing full-load efficiencies for NEMA Premium™ Efficiency Electric Motors. Additionally, learn about new solicitations for Plant-Wide Energy Efficiency Opportunity Assessments. And, link to publications such as Steam Tip Sheets and Case Studies from the recent Augusta Showcase. Log on to Energy Matters Extra at **www.oit.doe.gov/bestpractices/energymatters/emextra**. ●

Coming Events

Energy Solutions for California

- May 15, 2002, Buena Park, CA

For more information, e-mail caenergyevents@ppc.com.

Energy 2002

- June 2–5, 2002, Palm Springs, CA

For more information, call JoAnn Stirling at 800-395-8574, or visit the Energy 2002 Web site at **www.energy2002.ee.doe.gov**.

Steam Awareness Workshop

- June 6-7, 2002, Los Angeles, CA

For more information, call Fred Hart at 202-586-1496

5th Industrial Energy Efficiency Symposium and Exposition

- February 11–13, 2003, Washington, DC

For more information, call the OIT Clearinghouse at 800-862-2086

To keep up-to-date on OIT training and other events, check the calendar regularly on Energy Matters Extra at **www.oit.doe.gov/bestpractices/energymatters/emextra**.

BestPractices

The Office of Industrial Technologies (OIT) BestPractices initiative and its *Energy Matters* newsletter introduce industrial end users to emerging technologies and well-proven, cost-saving opportunities in motor, steam, compressed air, and other plant-wide systems. For overview information and to keep current on what is happening office wide, check out the newsletter—The OIT Times—at **www.oit.doe.gov/oit-times**.

Information Clearinghouse

Do you have questions about using energy-efficient process and utility systems in your industrial facility? Call the OIT Information Clearinghouse for answers, Monday through Friday 9:00 a.m. to 8:00 p.m. (EST).

HOTLINE: 800-862-2086

Fax: 360-586-8303, or access our homepage at www.oit.doe.gov/clearinghouse.

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