Monitoring Oven Vapor Levels

Infrared Analyzers Help Tape Manufacturer Net Drying Oven Efficiency Improvements of Up to 300% on Three Coating Lines

In New England, where energy costs are high and pollution standards are among the nation's most strict, a major tape manufacturer's air pollution and drying oven control systems are being used to cut operating costs to a fraction of what they once were.

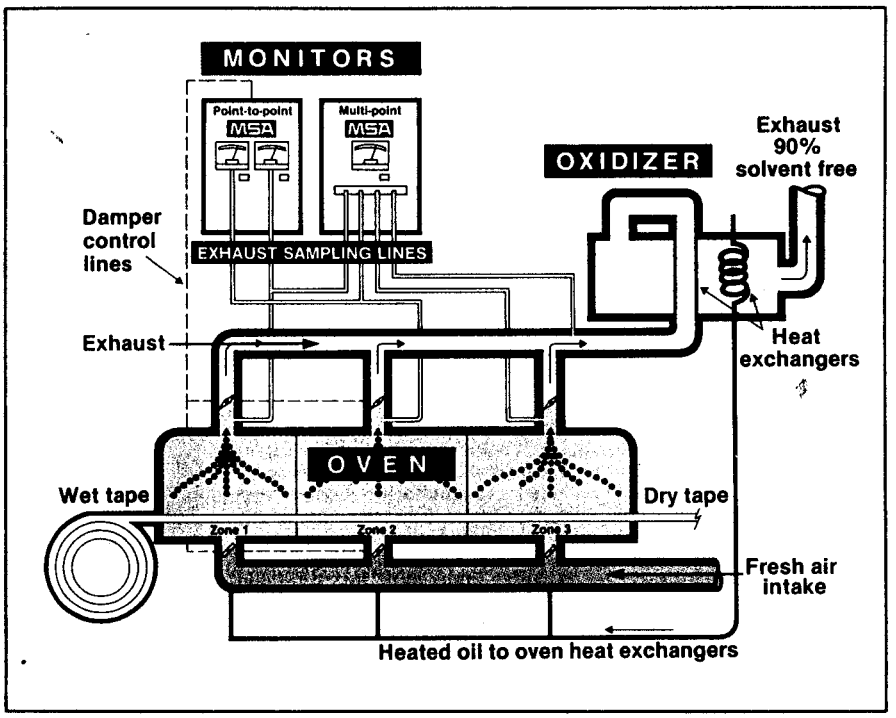
CHR Industries, New Haven, Conn., an Armco Company, achieved dual savings through the installation of drying oven monitoring controls and a heat recovery system on three primary coating lines. Infrared continuous surveillance instruments net drying oven efficiency improvements of up to 300%, while waste heat is recovered from the incineration of solvents for a calculated annual fuel savings of $121,500.

Conservative estimates based on engineering studies prior to installation show a 20-month payback for the monitoring equipment used in the drying oven and heat recovery systems at CHR, according to Michael F. Granacci, maintenance supervisor.

The continuous surveillance instruments from Mine Safety Appliances Company (MSA), Pittsburgh, Pa., use LIRA Infrared Analyzers to monitor and control vapor levels within the drying ovens. The infrared analyzer system controls ventilation to maximize efficiency and to keep concentrations of the highly flammable solvent vapors within safe levels. The infrared sensing method of the analyzers also helped CHR Industries overcome a difficult problem of monitoring vapors in the presence of silicones.

CHR Industries is a supplier of silicone rubber sheet and sponge, coated fabrics, and self-adhering tapes made of nylon, Teflon, glass cloth, and polyester film. An important ingredient of the high performance silicone-based adhesives is solvent, primarily toluene, ethyl acetate, and xylene hydrocarbons.

Adhesives are applied wet to the 36- to 50-in wide tape webs and must immediately be dried and cured. Drying and curing occurs in three-chambered drying ovens where the solvents evaporate and are vented for incineration in compliance with state pollution standards. The Connecticut Department of Environmental Protection mandates a minimum 90% destruction, which requires heating the exhaust to 1300°F.



Schematic of adhesive drying process at CHR Industries shows vapors evaporating from tape in a three-zone oven. Three infrared analyzers draw samples from four points. Intake and exhaust dampers are controlled by the system to maximize oven efficiency. Exhausted solvent vapors are destroyed in the oxidizer, where heat is recovered through an air-to-oil exchange and then is recycled to the drying ovens.

Originally CHR's adhesive drying and curing was done in electrically-heated ovens, a costly process in which fumes from all the plant's ovens were continuously vented to an incinerator with only partial heat recovery to heat the incoming exhaust.

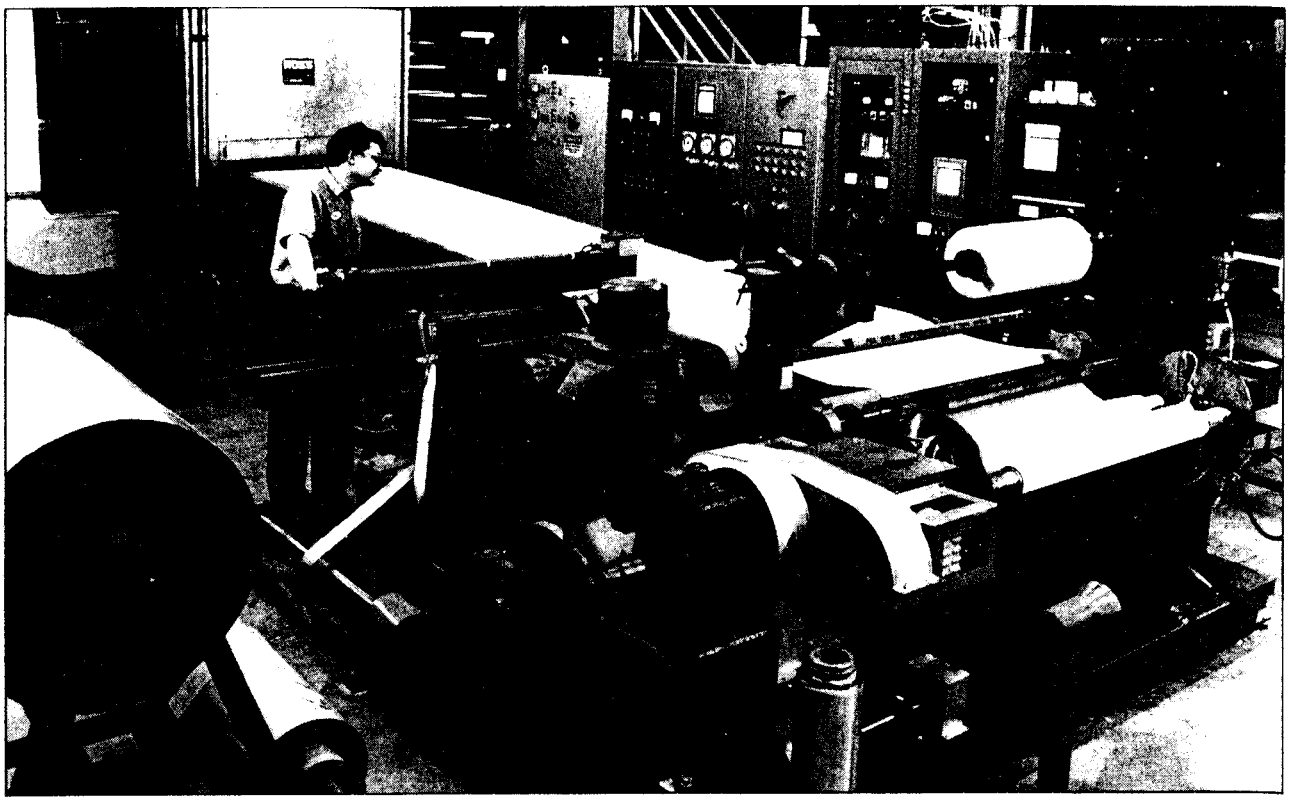
In 1977, the tape coating process was targeted as an area where drastic productivity improvements would be necessary.

The New System

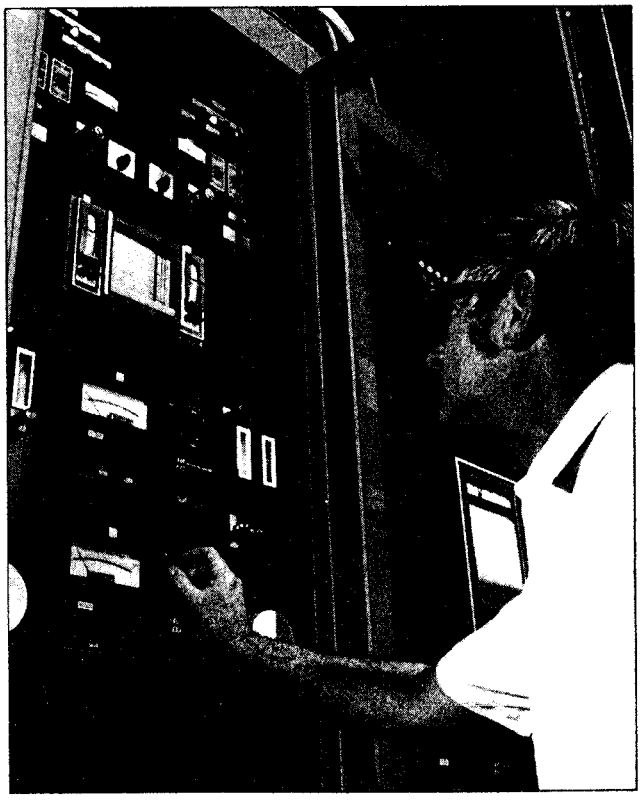
With the new system, the incinerator, called an oxidizer, heats the exhaust to 1,300°F to destroy the hydrocarbons. Heat from the oxidizer is then recovered and used to warm the drying ovens.

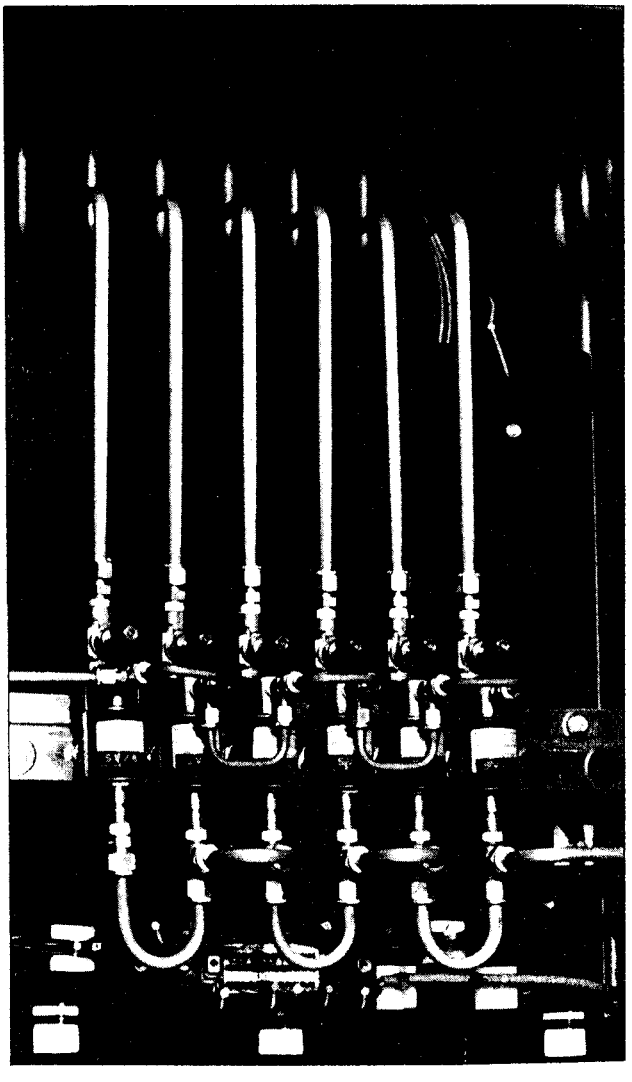
Figure 1 illustrates the drying and heat recovery process. As shown, there are two heat exchangers within the oxidizer. One, an air-to-air heat exchanger, preheats oven exhaust for improved combustion efficiency within the oxidizer itself. The other uses the 1,200°F exhaust fumes to heat an oil-like heat-transfer fluid, which is subsequently used to heat the oven drying chambers. Oil-to-air heat exchangers within the ovens maintain oven zone operating temperatures in the 100°F to 450°F range. (In cooler weather, the heated oil also helps with plant climate control.)

Furthermore, efficiency is maximized within the ovens by controlling ventila-



At CHR Industries, three coating lines, such as the one above, incorporate heat recovery and solvent monitoring for fuel savings, improved productivity, and plant safety. Vapor concentrations are measured and controlled by LIRA Infrared Analyzers housed in cabinets to the right of the coater. A rear view of a cabinet (right) that houses a Model 3000 analyzer from Mine Safety Appliances Co. shows the set-up for sequential gas monitoring. Gas samples from six points — four of which are critical to safety — are drawn into the analyzer for 30-sec monitoring in a 3-min cycle. A close-up view of the analyzers is shown below. The equipment maintains solvent concentrations below explosive limits in drying ovens and provides continuous readouts for CHR Industries.





on. This function is handled by the IRA systems, which assure vapor concentrations do not build to dangerous levels.

In total, these processes work together to conserve approximately 137 TUs per day, the equivalent of burning 446 gal of #2 fuel oil, Granucci explained. At a cost savings of $1.09/gal-on, based on 250 working days, annual fuel savings total $121,535 (446 gal oil x 250 days x $1.09/gal), Granucci said. The oxidizer may be fired by either oil or gas, and normally only consumes fuel oil at a rate of 10 gal/hr, he added.

Critical to oven efficiency is the use of the LIRA Analyzers for solvent monitoring. Three analyzers are assigned to each of the three main coating lines. The primary two adhesive coating lines which were set up new in 1980, use Model 303 Analyzers. Model 3000 Analyzers, a new-generation version of the Model 303, were installed in 1982 on the third coating line.

The new coating lines and MSA continuous surveillance instruments mean CHR's tape production capacity is three times greater than before. The key to maintaining this level of productivity is minimizing exhaust from the drying chambers, thereby allowing solvent vapor concentrations to rise within. At higher vapor concentrations the drying ovens operate more efficiently because less fuel is required to heat intake air for solvent evaporation.

These higher levels, however, can only be maintained safely if the monitoring equipment is accurate, reliable, and sensitive to fast upsurges. This is so because higher vapor concentrations mean increased risk of explosion. The solvent vapor level of primary concern is the LEL (lower explosive limit). LEL is the point at which a gas concentration is high enough to support combustion.

Generally, maintaining dryer solvent levels at or below 50% LEL is considered acceptable, but at CHR Industries, the MSA monitoring systems have been programmed to maintain solvents at 40% LEL for added safety. This still enables CHR to recover enough heat for their high energy savings while simultaneously speeding production.

Says Granucci: "It's a level we are comfortable with and it still gives us plenty of heat to accomplish drying."

Diaphragm pumps send gas samples from the various sensing points to the analyzer where it flows through a sample cell. Twin beams of infrared radiation are projected through the sample cell and a reference cell. The emergent radiation is directed into a single detector cell that responds to the difference between the beams. The response is converted to an electrical signal proportional to the difference. This signal is amplified and fed to a readout meter, an external recorder, an alarm-warning system and most importantly, the control loops, which operate air intake and exhaust dampers on the drying oven.

Throughout the tape-making process, the infrared analyzers provide printed recordings of solvent vapor levels. The control function begins when 40% LEL is approached. The analyzers then signal intake and exhaust dampers to open to reduce the vapor within the oven

Point-to-Point

On each coating line, two analyzers are set up on a "point-to-point" basis, meaning each provides continuous monitoring from only one sensing point. The point-to-point analyzers are used in Zone 1 and Zone 2 of each oven where solvent concentrations are highest, and therefore, are more critical from a safety standpoint.

The third analyzer takes 30-second sequential readings from four critical points on the adhesive line. Redundant readings are taken from Zones 1 and 2 for added safety. Readings are also taken from Zone 3 and in the exhaust flue between the drying oven and the oxidizer where fumes from all three zones merge.

Throughout the tape-making process, the analyzers provide printed recordings of solvent vapor levels. The control function comes into play when 40% LEL is approached. At this point, the analyzers signal intake and exhaust dampers to simultaneously open to reduce the vapor concentrations within the oven. The dampers modulate open until vapor concentrations level off at 40% LEL at which time a stable damper position is maintained.

If for some reason LEL rises to 45%, a horn sounds and a warning light flashes to alert workers to slow down oven tape input. At 50% LEL, tape feeding into an oven is automatically stopped and exhaust dampers are set in the full-open position.

The presence of silicones, such as those used in CHR Industries' adhesives, poses a particular problem for monitoring in drying ovens. Silicone tends to wet catalytic surfaces of conventional filament-type sensors, which ultimately throws readings off.

CHR Industries experienced difficulty maintaining the stability of flame ionization and ultraviolet oven monitoring systems which were used prior to the installation of the LIRA analyzers. The ultraviolet systems required "constant calibration," and it took two mandays a week (at a cost of $300 for labor, not including cost of parts or losses due to shutting down coating lines for maintenance) to keep three flame ionization units operable, Granucci said. In contrast, the LIRA Model 303 and Model 3000 analyzers are unaffected by sample stream components, including silicone, and have provided continuously consistent readings for CHR.

Granucci estimates the infrared system costs 20% more than UV, and up to 50% more than a flame ionization system. "We have found the infrared system to be very reliable," Granucci said. "The initial investment is higher, but the maintenance involved is minimal."

"We're in the business to put out a product and this is the kind of dependability we need. For every hour of production that we have to shut down for maintenance, we're losing a tremendous amount of money. And when maintenance is needed, 95% of the problems can be solved in-house by our own people," Granucci said. Several of his maintenance workers received training on infrared systems during two-day programs at MSA's Pittsburgh operations.

"The training programs taught the workers techniques of operation, calibration and trouble shooting, and enabled them to talk the same language as the engineers who designed the system," he continued.

"Not only did they gain knowledge of trouble shooting, but they got a real insight into what makes the analyzers tick. This training has been invaluable to us, and has paid us back many times over in not having to call the factory."

Looking Toward Expansion

For CHR Industries, pollution control is paying off in a big way. It provides a system that is energy efficient and boosts productivity — two factors that have a positive impact on the company's profits.

Furthermore, CHR Industries is assured of safety and low maintenance because of the reliable infrared analyzer and control system which automatically governs the level of potentially hazardous gases in its drying ovens.

Because of these performance strides, CHR anticipates installation of a similar system on a fourth coating line at its New Haven facility, and has already installed a LIRA Model 3000 Infrared Analyzer at a sister plant in Chicago.