FEATURE

Electron Beam: One Way to Mitigate Rising Energy Costs

By Rick Sanders

Hurricanes Katrina and Rita caused vast devastation along the Gulf Coast during the summer of 2005. Collateral damage to the oil refineries, drilling rigs and platforms along the coast has been the focus of many newscasts and newspaper articles ever since.

I dare say we have all felt the impact of these storms due to the skyrocketing costs of refined petroleum products. Along with rising gasoline costs, natural gas costs have spiked to more than two times their levels in late 2004. As such, converters who use gas ovens to dry/cure inks and coatings for the packaging marketplace have been hit hard with rising costs.

Usually when costs spike like they have recently, decision makers look for ways to mitigate these ever rising costs. It therefore warrants taking a look at energy efficient curing technologies like EB and UV to see how they can be put to use.

For reference purposes, this article will compare the electrical and gas utility costs of running a 54-inch wide offset press with heat-set solvent-based inks and coatings against the electrical costs of the same press outfitted with an EB system to cure EB inks and coatings.

Process Overview

Heat-Set, Solvent-Based Inks

Inks and coatings used in the heat-set process consist of pigment and resins dispersed in a solvent. Typically solvent-based heat-set inks contain between 60-65% solids. The dryers use elevated temperatures to evaporate the solvent. High airflow aids in the removal of the solvent from the substrate and oven. Often located after the oven are chill rolls used to cool the substrate. In order to ensure complete drying, it is important to balance the dryer operation with press speed, ink formulation and ink coverage. Press operators must monitor and maintain this balance to assure good quality print runs and no residual solvent in the product.

Electron Beam Inks

EB inks are 100% solids, which mean they are not suspended in a diluent like water or solvent. When exposed to high-energy electrons, they become crosslinked or cured almost instantly. Since EB inks do not contain solvents, there are no volatile organic compound (VOC) emissions to manage.

EB curing is a “cool temperature” process. Minimal heat is deposited to the substrate from the EB system. There is, however, a slight temperature rise due to the exotherm caused by the energy released from the ink changing from a liquid to a solid. This temperature shift is usually about 15-20˚F, a modest amount compared to heat-set processes.

EB ink curing requires an inert atmosphere, which is accomplished by replacing air with pure nitrogen. The reason for this is that the presence of oxygen in air inhibits or prevents the EB ink or coating from curing properly. As such, EB systems are typically manufactured with devices to automatically maintain an inert nitrogen atmosphere within the system when in operation.

Utility Cost

While offset and CI flexo presses have subsystems within them that can require added utilities, such as oxidizers and chill drums, this comparison will focus primarily on the electrical and gas cost differences between conventional gas-fired dryers and electrical cost of an EB system.

Utility costs for conventional gas dryers include the use of electricity and natural gas (Table 1). The burning gas is the source of the heat and electricity powers the blowers to move the heated air within the system.

Conventional Dryer Operating Utility Costs

As previously stated, the press/dryer width is 54". The typical print job will have between 35-40% ink coverage on a light 12-point board stock. The oven temperature is set at approximately 300° F to bring the "magie oil," a mineral spirits-based solvent, to the surface of the ink layer. The air turbulence created by the blowers removes the solvent off of the substrate as it passes through the dryer.

The "cost per therm" was determined by the most recent cost in the New England area for December 2005. This "cost per therm" includes the utility expense of the natural gas plus the cost of distribution. We have seen the cost per therm increase significantly within the past few months.

Figure 1 compares the utility expense of natural gas and electricity for the New England area during 2005. You can see clearly how natural gas prices have spiked since the storms hit the gulf coast. Also evident is the relative stability of electric costs for the same period.

Figure 1 is used to illustrate the trend for the unit expense of natural gas and electricity. The reader should note that the actual cost will vary from location to location around the country, but the overall trend is strongly upward for natural gas and propane. What's important here is the significant

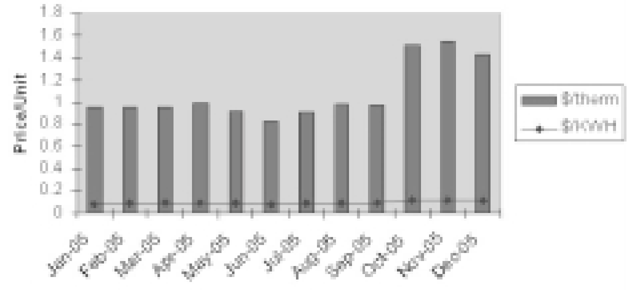
Table 1

Utility costs for a conventional gas dryer

Conventional Gas Dryer	Input	Units	Results
Line Speed	1,000	FPM	
Length of Dryer	22.7	Feet	
Printing width	54	inches	
Working Hours per year (75% available hrs., 3 shifts)	4,680	Hours	
Gas Consumption	9,460,000	BTU/Hr	
Gas therm/hr (1 therm = 100,000 btu)	95		
Cost per therm	$1.66		
Running-Cost per hour (Gas)	$1.66 x 95		$157.70
Electrical Consumption	22.8	KW/Hr	
Cost per KWH	$0.065		
Running-Cost per hour (Electric)	$0.065 x 22.8		$1.48
Nitrogen Consumption	0	Scfh	
Cost per 100 scf Nitrogen	0		
Running-Cost per hour (Nitrogen)			$0.00
Combined Utility Expenses			
Running-Cost per hour (Gas & Electric)			$159.18
Running-Cost per hour (Nitrogen & Electric)			N/A
Annualized Utility Expenses			
Running-Cost per hour (Gas & Electric)	$159.18 x 4,680		$744,962
Running-Cost per hour (Electric & Nitrogen)			N/A

Figure 1

2005 unit cost: natural gas vs. electricity



difference in utility costs associated with these technologies.

Electron Beam System Operating Costs

As illustrated in Figure 1, the cost per kilowatt hour (KWH) for electricity has shown relative stability with only marginal changes month to month. As such, the utility expense to run an EB system is outlined in Table 2.

When we evaluate the running utility expense per hour of the two systems, it becomes evident that EB technology can be considerably more cost efficient.

There is an important element that needs to be pointed out in this example.

- This comparison only focuses on the utility expenses of electricity and gas between these two technologies. In order to make a thorough decision on which technology is most efficient, this line item alone isn't enough and many other factors need to be evaluated as well.

I would suggest that these other factors should be taken into consideration to get a complete picture of which technology is best.

Conclusion

In an increasingly competitive marketplace, it becomes important to manage and reduce daily operating costs to stay competitive. As the comparisons above show, EB technology can be just the advantage that printers need to remain profitable and competitive.

Acknowledgements

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TABLE 2

Utility costs for an EB system

Energy Sciences' EB System	Input	Units	Results
Line Speed	1,000	FPM	
Length of Dryer	6	Feet	
Printing width	54	inches	
Working Hours per year (75% available hrs., 3 shifts)	4,680	Hours	
Gas Consumption	0	BTU/Hr	
Gas therm/hr (1 therm = 100,000 btu)	0		
Cost per therm	$0.00		
Running-Cost per hour (Gas)	0		$0.00
Electrical Consumption	59	KW/Hr	
Cost per KWH	$0.065		
Running-Cost per hour (Electric)	$0.065 x 59		$3.84
Nitrogen Consumption	5,940	Scfh	
Cost per 100 scf Nitrogen	$0.28		
Running-Cost per hour (Nitrogen)	$0.28 x 59.4		$16.63
Combined Utility Expenses			
Running-Cost per hour (Gas & Electric)			N/A
Running-Cost per hour (Nitrogen & Electric)			$20.47
Annualized Utility Expenses			
Running-Cost per hour (Gas & Electric)			N/A
Running-Cost per hour (Electric & Nitrogen)	$20.47 x 4,680		$95,800

Annual Cost Heatset	$744,962.00
Annual Cost EB	$95,800.00

The result of the annualized cost of each technology into a cost per running hour is as follows:

Total gas oven running hourly utility expense:	$159.18
Total EB running hourly utility expense:	$20.47
Net Difference:	$138.71 per hr.