Energy Conservation at the Plant Makes Sense and Saves Dollars

By TJ Young

In the last two years asphalt producers have seen a rapid and unforeseen increase in the price of fossil fuels and the electricity associated with running plants. In an effort to be cost-effective, NAPA members requested a guidance document for evaluating energy efficiency and identifying opportunities for energy conservation at their facilities. The result of this request was Energy Conservation in Hot-Mix Asphalt Production (QIP-126), published in December 2007 (see sidebar).

This document outlines energy-saving opportunities for hot-mix producers, and provides information useful for "score-carding" energy efficiency. Energy consumption in asphalt pavement production is focused in three main areas:

- Drying the aggregate so the liquid asphalt cement can adequately adhere to the stone
- Keeping the virgin asphalt cement stored in a heated liquid state
- Operating the facility

Table 1: Chart showing equivalent prices of different fuels based on Btu content

Type of Energy	Heating Value (Net or LHV)		Billing Units	Cost Comparisons Based on Heating Values									
No. 2 Fuel Oil	Btu/gal.	132,000	Per Gallon	$1.00	$1.10	$1.20	$1.30	$1.40	$1.50	$1.60	$1.70	$1.80	$1.90
				$2.00	$2.10	$2.20	$2.30	$2.40	$2.50	$2.60	$2.70	$2.80	$2.90
				$3.00	$3.10	$3.20	$3.30	$3.40	$3.50	$3.60	$3.70	$3.80	$3.90
				$4.00	$4.10	$4.20	$4.30	$4.40	$4.50	$4.60	$4.70	$4.80	$4.90
No. 5 Fuel Oil	Btu/gal.	143,250	Per Gallon	$1.09	$1.19	$1.30	$1.41	$1.52	$1.63	$1.74	$1.84	$1.95	$2.06
				$2.17	$2.28	$2.39	$2.50	$2.60	$2.71	$2.82	$2.93	$3.04	$3.15
				$3.26	$3.36	$3.47	$3.58	$3.69	$3.80	$3.91	$4.02	$4.12	$4.23
				$4.34	$4.45	$4.56	$4.67	$4.78	$4.88	$4.99	$5.10	$5.21	$5.32
Propane (LPG)	Btu/gal.	84,345	Per Gallon	$0.64	$0.70	$0.77	$0.83	$0.89	$0.96	$1.02	$1.09	$1.15	$1.21
				$1.28	$1.34	$1.41	$1.47	$1.53	$1.60	$1.66	$1.73	$1.79	$1.85
				$1.92	$1.98	$2.04	$2.11	$2.17	$2.24	$2.30	$2.36	$2.43	$2.49
				$2.56	$2.62	$2.68	$2.75	$2.81	$2.88	$2.94	$3.00	$3.07	$3.13
Natural Gas	Btu/CCF	90,500	Per CCF	$0.69	$0.75	$0.82	$0.89	$0.96	$1.03	$1.10	$1.17	$1.23	$1.30
				$1.37	$1.44	$1.51	$1.58	$1.65	$1.71	$1.78	$1.85	$1.92	$1.99
				$2.06	$2.13	$2.19	$2.26	$2.33	$2.40	$2.47	$2.54	$2.61	$2.67
				$2.74	$2.81	$2.88	$2.95	$3.02	$3.09	$3.15	$3.22	$3.29	$3.36
Gas	Btu/Therm	100,000	Per Therm	$0.76	$0.83	$0.91	$0.98	$1.06	$1.14	$1.21	$1.29	$1.36	$1.44
				$1.52	$1.59	$1.67	$1.74	$1.82	$1.89	$1.97	$2.05	$2.12	$2.20
				$2.27	$2.35	$2.42	$2.50	$2.58	$2.65	$2.73	$2.80	$2.88	$2.95
				$3.03	$3.11	$3.18	$3.26	$3.33	$3.41	$3.48	$3.56	$3.64	$3.71
Electricity	Btu/Kwh	3,413	Per Kwh	$0.03	$0.03	$0.03	$0.03	$0.04	$0.04	$0.04	$0.04	$0.05	$0.05
				$0.05	$0.05	$0.06	$0.06	$0.06	$0.06	$0.07	$0.07	$0.07	$0.07
				$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.09	$0.10	$0.10	$0.10
				$0.10	$0.11	$0.11	$0.11	$0.11	$0.12	$0.12	$0.12	$0.12	$0.13
Coal	Btu/pound	12,000	Per Ton	$182	$200	$218	$236	$255	$273	$291	$309	$327	$345
				$364	$382	$400	$418	$436	$455	$473	$491	$509	$527
				$545	$564	$582	$600	$618	$636	$655	$673	$691	$709
				$727	$745	$764	$782	$800	$818	$836	$855	$873	$891

Table 2 : Energy Savings from Reduced Aggregate Moisture

% Moisture Before Change	% Moisture After Change																		
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
1.0	0%																		
1.5	8%	0%																	
2.0	15%	7%	0%																
2.5	21%	14%	7%	0%															
3.0	26%	19%	13%	6%	0%														
3.5	30%	24%	18%	12%	6%	0%													
4.0	34%	29%	23%	17%	11%	6%	0%												
4.5	38%	33%	27%	22%	16%	11%	5%	0%											
5.0	41%	36%	31%	26%	21%	15%	10%	5%	0%										
5.5	44%	39%	34%	29%	24%	20%	15%	10%	5%	0%									
6.0	47%	42%	37%	33%	28%	23%	19%	14%	9%	5%	0%								
6.5	49%	45%	40%	36%	31%	27%	22%	18%	13%	9%	4%	0%							
7.0	51%	47%	43%	38%	34%	30%	26%	21%	17%	13%	9%	4%	0%						
7.5	53%	49%	45%	41%	37%	33%	29%	25%	20%	16%	12%	8%	4%	0%					
8.0	55%	51%	47%	43%	39%	35%	31%	28%	24%	20%	16%	12%	8%	4%	0%				
8.5	57%	53%	49%	45%	42%	38%	34%	30%	27%	23%	19%	15%	11%	8%	4%	0%			
9.0	58%	55%	51%	47%	44%	40%	36%	33%	29%	26%	22%	18%	15%	11%	7%	4%	0%		
9.5	60%	56%	53%	49%	46%	42%	39%	35%	32%	28%	25%	21%	18%	14%	11%	7%	4%	0%	
10.0	61%	58%	54%	51%	48%	44%	41%	37%	34%	31%	27%	24%	20%	17%	14%	10%	7%	3%	0%

Table 1, which is an extension of values from Table 3 in QIP-126, enables an asphalt producer to compare the cost saving potential of using alternative fuels.

A NAPA member used this information this year to make an energy decision which resulted in considerable savings. This producer in New Jersey was firing his aggregate dryers on natural gas due to strict emission regulations in the air quality district. In the past, the hot-oil heaters used to keep the liquid asphalt stored at 280° F were fired with No. 2 diesel fuel as it is not a significant contributor in total emissions from the site, and No. 2 diesel fuel has historically been cheaper than natural gas for this producer. This year, the price of No. 2 diesel rose to over $4 per gallon. The company was paying the equivalent of $2.13 per gallon for the same number of BTUs in natural gas. The manufacturer makes a combination oil/gas burner that allows the burner to be fired on either natural gas or No. 2 fuel oil. This burner cost $8,000. Even after paying about $10,000 including labor and tune-up to install the new heaters, this producer can recover the cost of this conversion in less than six months. He is in the process of installing the new burners.

The asphalt industry has historically been a large user of recycled fuel oils, or RFO. Asphalt pavement production facilities are ideally suited for burning this type of fuel. Unofficial reports have indicated that asphalt pavement producers consume as much as 80 percent of the available RFO in the United States. RFO is becoming difficult to obtain in some markets and has risen to over $2 per gallon as demand has outstripped supply. With the aid of this quick reference tool, many NAPA members have discovered they can reduce drying costs this year by switching back to natural gas, and in some locales back to propane. RFO typically has a BTU equivalent close to No. 5 or "heavy" fuel oil. The chart indicates that if natural gas cost less than $1.44 per therm, or $1.30 per CCF, or if liquid propane cost less than $1.21 per gallon, these fuels will be cheaper to use than RFO (No. 5 oil) when RFO rises above $2.06 per gallon.

One lesson the industry has learned from the volatile fuel markets of 2007 and 2008 is that fuel alternatives need to be closely monitored as prices fluctuate. Most dryers and hot-oil heaters can burn either gaseous or liquid fuels. Switching back and forth between fuels is very easy and will probably remain commonplace in the near future as long as prices of the different forms of fuels continue to move independently of one another. Table 1 can help a producer use his lowest-priced fuel alternative.

Purchasing BTUs in the most cost-effective manner is important, but avoiding the use of those BTUs can be equally important. The Table 2 from QIP-126 shows the energy savings potential available by reducing the moisture in the material to be dried.

Figure 1 shows a picture of a fabric building installed this year by a producer in the Southeast to keep his manufactured sand and natural sand products dry. Actual field testing showed these materials were accumulating moisture from rain while the material sat in his yard, even though the aggregate suppliers were doing an excellent job shipping relatively dry material to the plant.

Figure 1

By installing these buildings, and providing adequate drainage away from the buildings, stockpile material moistures for these fine aggregates were reduced from an average of 7 percent to an average of 4 percent. With these products representing 40-55 percent of the materials in his mix formulas, the overall energy saving in drying his aggregate was reduced by 10.4 to 14.3 percent. At the current price of fuel, his estimate for payback on these buildings is around 200,000 tons of production, based on drying cost reduction alone. The added benefit is an increase in tons-per-hour capability of 15 to 21 percent through the dryer, which further reduces overall manufacturing costs.

Table 2 allows you to calculate the savings potential from insulating pipes and flanges at the plant. The photograph in Figure 2 shows an installation of a new hot-oil heater with blankets around every valve and flange on the hot-oil heat transfer lines. NAPA members have reported payback periods of a few weeks or months after installing insulation similar to that which you see in Figure 2, now that fossil fuel prices have risen to historic levels. Table 2 allows you to inventory

Table 2

JACKETED ASPHALT PIPING

Asphalt Pipe Nominal Size	Hot Oil Jacket Nominal Size	Loss Per Linear Foot Btu Per Hour		Loss Per Flange Btu Per Hour	
		Uninsulated Jacket	Insulated Jacket	Uninsulated	Insulated
3 inches	4 inches	1598	86	1890	120
4 inches	6 inches	2349	122	2600	134
5 inches	8 inches	3057	148	3240	178

HOT OIL PIPING

Pipe Diameter	Loss Per Linear Foot Btu Per Hour		Loss Per Flange Btu Per Hour	
	Uninsulated	Insulated	Uninsulated	Insulated
1-1/2 inches	676	47	1205	97
2 inches	846	54	1660	115
2-1/2 inches	1024	55	2155	125
3 inches	1243	72	2485	130

Asphalt temperature = 300 degrees F. Hot oil temperature = 350 degrees F.
Pipe insulation = 1-1/2 inches (Figure 3.5)

Piping Heat Losses

Figure 2

your existing exposed pipes, flanges, and valves and calculate potential savings once you calculate your costs per BTU and hot-oil heater efficiency level. QIP-126 takes you through the step-by-step process.

One of the new resource tables in QIP126 is Figure 3, which allows you to calculate the electrical energy savings potential from using a VFD (variable frequency drive) on the exhaust fan instead of using a fan damper.

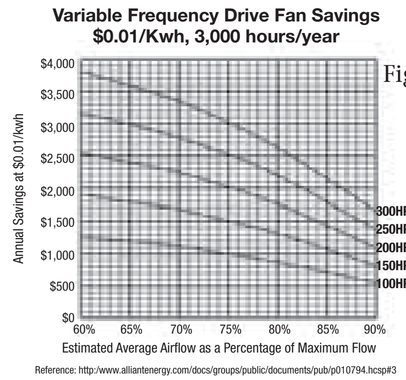


Figure 3

VFDs turn constant-speed electric motors into variable-speed motors by varying the frequency of the power to the motor. Hot-mix plants often use VFDs to control the speed of motors on cold feed bins, but the price of VFDs have decreased drastically the last few years making them practical for larger motors. Using a VFD to reduce air flow reduces the amperage on the fan motor even more than using a damper to restrict air flow, making the VFD an energy-saving device. How much money can be saved depends on the amount of air flow required from the fan and the cost of the electrical energy at the site. Whether the VFD is a good investment depends on the installed cost of the VFD, the price per kilowatt hour being paid, and whether the plant is operating in the 40-70 percent damper range that makes a VFD practical. Figure 17 from QIP126, shown here as Figure 3, provides a simple way of making that calculation.

Repeating the example in QIP-126, if a producer is paying $.05 per kilowatt, and is operating a 200-hp fan motor at 70 percent damper most of the time, the saving will

continued on page 39

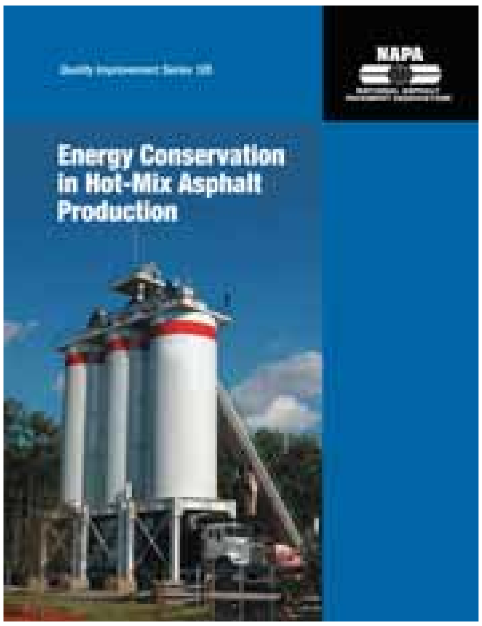
continued from page 34

be $7,500 for a 2000-hour operating year.

Many producers are applying VFDs and saving not only from reduced kilowatt expense, but from reduced demand charges as well. Demand charges are the fixed-rate fees regardless of kilowatt consumption that utility companies charge to be connected to their grid based on maximum use or maximum theoretical use of electricity by the site. VFDs help reduce kilowatt consumption and therefore help reduce demand charge fees in addition to reducing ongoing kilowatt consumption.

Some producers are now exploring the idea of applying VFDs to slat conveyors and compressors, since these motors also do not typically operate at full requirement. An added benefit is reduction in wear and maintenance costs. HMAT

TJ Young is the author of QIP-126, and is the president and principal of T2ASCO LLC. Young is a frequent contributor to the industry through speaking, training, publications, and field performance evaluations, including energy audits. TJ Young and T2ASCO's Web site is www.hotmixproduction.com



Energy Conservation in Hot-Mix Asphalt Production (QIP-126)

This 32-page publication presents opportunities for energy conservation in the asphalt production process, and provides a method to calculate return on equipment investments that might reduce energy-related costs.

NAPA Member price: $12.
State association, government, education price: $18.
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