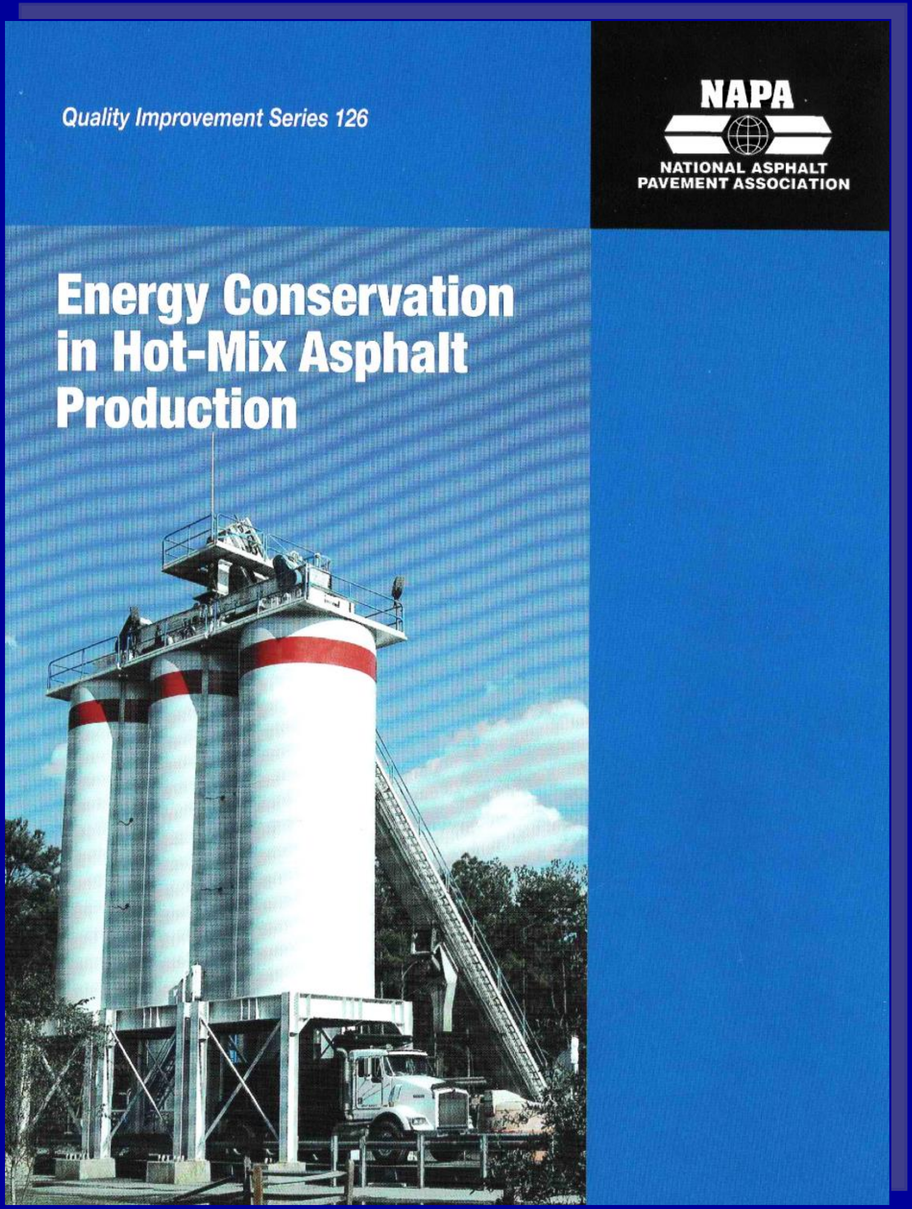


Energy Savings & Energy Management for Your Plant Facility

NAPA's Quality Improvement Series #126 – *2023 Update*

“Nothing New Under the Sun” …

“Nothing New Under the Sun” …

Physics haven’t changed!

“Nothing New Under the Sun” …

What has changed is the cost of our energy …

10% of $.85 - $1.00/ton
is different than

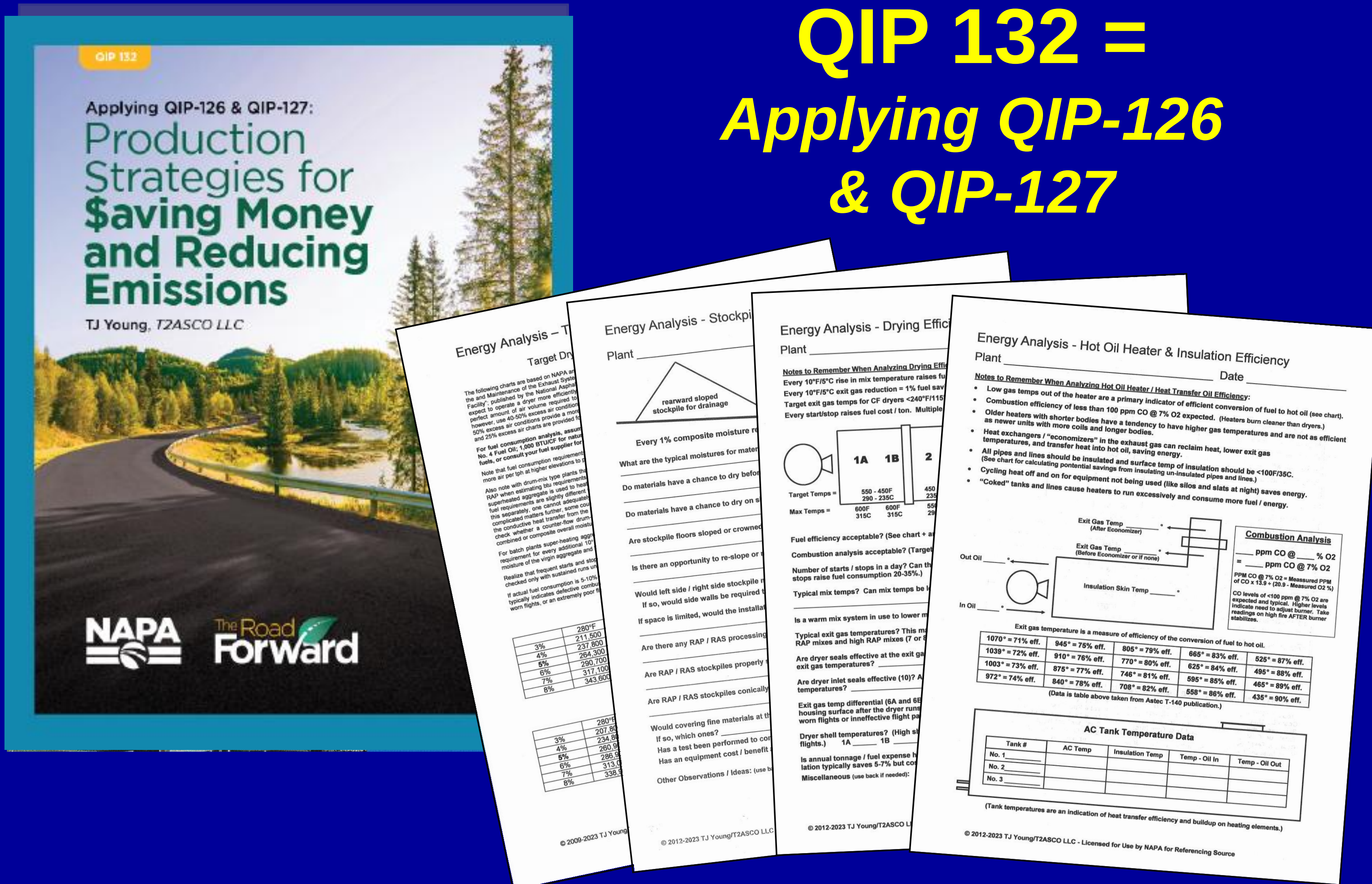
10% of $4.00 - $8.00/ton !

"Nothing New Under the Sun" …

"Big Three" Energy Consumption Areas…

1. Drying and Heating
2. Storing Asphalt Cement & Keeping Plant Hot
3. Electrical Energy Use

QIP 132 =
Applying QIP-126 & QIP-127



Worksheets for identifying ways to reduce energy consumption & EPD values

Areas Addressed This Talk…

1. **Reducing aggregate moisture content** ***(1% = 10%)***
2. **Reducing exit material temperatures** ***(10° = 2%)***
3. **Reducing exit gas temperatures** ***(10° = 1%)***
4. **Insulating dryer shells** ***(save 5-7%)***
5. **Managing starts & stops** ***(save 10-30%)***
6. **Using alternative fuels** ***(saves $ / cleaner burn?)***
7. **Using more efficient hot oil heater designs** ***(save $)***
8. **Employing more effective piping insulation** ***(save $)***
9. **Using VFD's & other operational & electrical power management techniques** ***(save $)***

Drying Cost Reduction

Stockpile Moisture Reduction

- Every 1% moisture reduction reduces fuel consumption 10%!

(10-13% different energy models)

NAPA's IS52 Study

Effect of Aggregate Moisture on Exhaust Fan and Heat Demand Requirements

	BATCH FACILITY 255°F at Exhaust Fan 275°F at Dryer Exit		DRUM MIXER 290°F at Exhaust Fan 310°F at Drum Exit	
Aggregate Moisture (% removed)	Heat Required (1000 BTU/ton)	Fan Volume Required (ACFM/TPH)*	Heat Required (1000 BTU/ton)	Fan Volume Required (ACFM/TPH)**
1	160.0	60.2	154.1	60.6
2	187.9	79.1	181.3	79.7
3	215.8	98.1	208.4	98.8
4	243.7	117.1	235.5	117.9
5	271.6	136.0	262.7	137.0
6	299.5	155.0	289.8	156.1
7	327.4	173.9	317.0	175.2
8	355.3	192.9	344.1	194.2
9	383.3	211.9	371.3	213.3
10	411.2	230.8	398.4	232.4
11	439.1	249.8	425.6	251.5
12	467.0	268.8	452.8	270.6
13	494.9	287.7	479.8	289.7
14	522.8	306.7	507.0	308.8
15	550.7	325.6	534.2	327.9
16	578.6	344.6	561.4	347.0
17	606.5	363.6	588.4	366.1
18	634.4	382.5	615.6	385.2
19	662.3	401.5	642.7	404.3
20	690.2	420.5	669.9	423.3

Table 1-3

*Tons per hour of dry aggregate.
**Tons per hour of mix.
Note: Baghouse cleaning air has not been included in the calculations. These numbers represent the process exhaust volume.

NAPA's IS52 Study

+/-1% of Moisture = +/-10% BTU Requirement

3% Moisture	215,800 (-20%)
4% Moisture	243,700 (-10%)
5% Moisture	271,600 BTUs
6% Moisture	299,500 (+10%)
7% Moisture	327,400 (+20%)
8% Moisture	355,300 (+30%)

Stockpile Moisture Reduction

- How can we reduce stockpile moisture?
  - Allow material to dry before feeding to dryer
  - Create a "solar / wind face" & feed from it
  - "Stay up 12" – feed drier material
  - Slope stockpiles away from feeding face
  - Pave under stockpiles, plus slope for drainage
  - Cover stockpiles (fine aggregate & RAP most advantageous / cost beneficial)

Managing Moisture …

- **Every 1% Reduces Drying Costs 10%**
- **Every 1% Raises TPH Capability 13%**
- **Temperature Stability = Step #1 to Density Success**

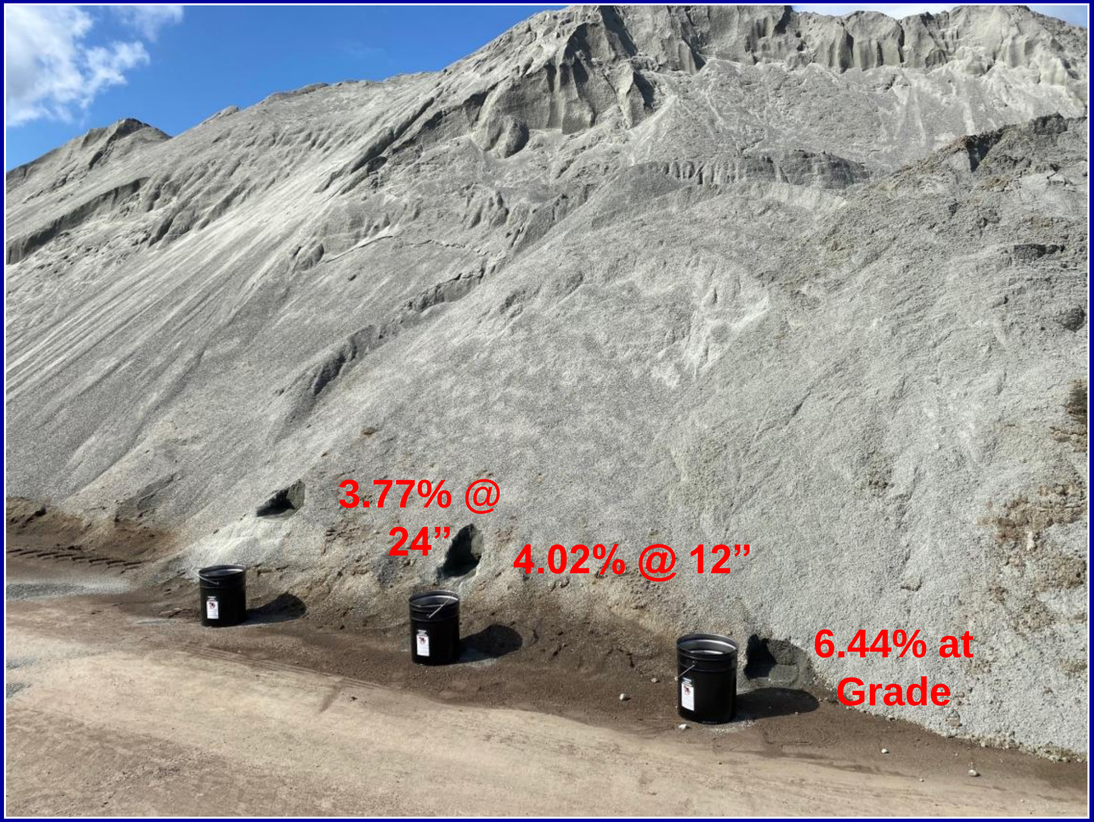
Managing Moisture …

- **"Staying Up 12 Inches" has a HUGE effect …**

Managing Moisture …

Stone Screenings - A

(2.4% less up 12”)



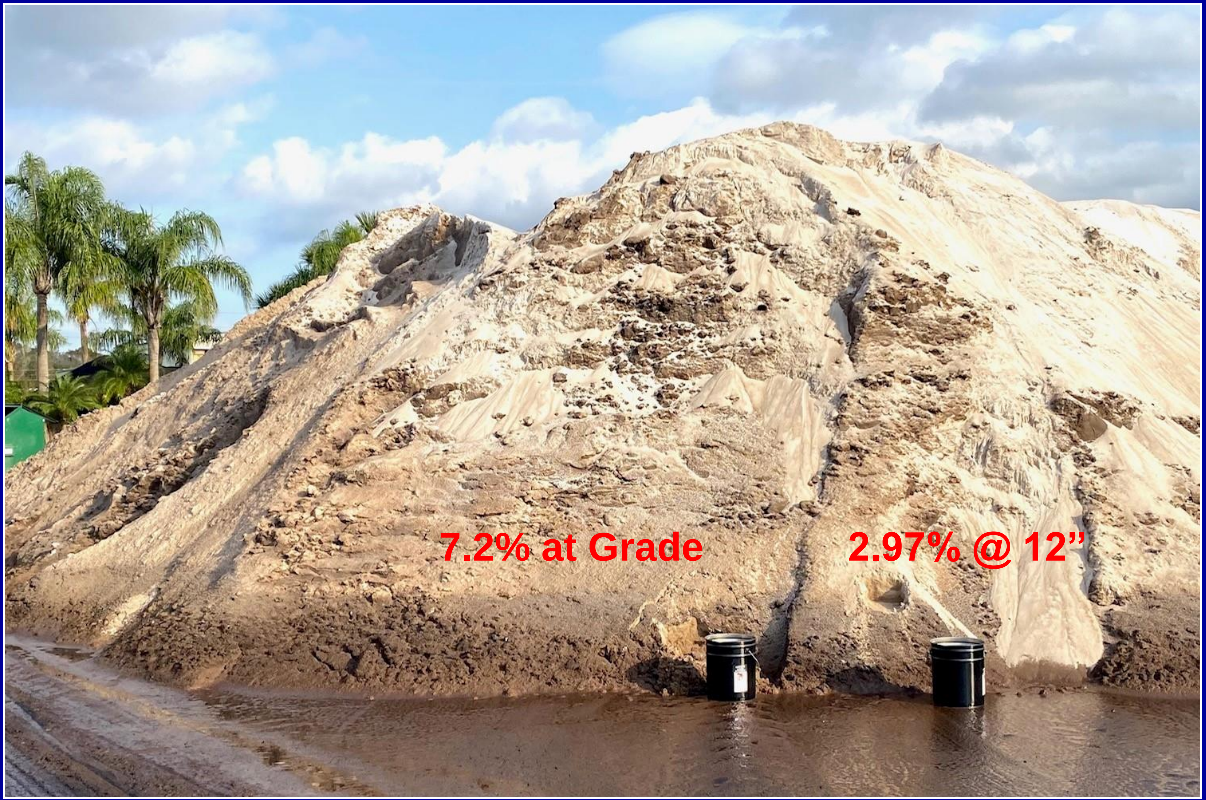
Managing Moisture …

Stone Screenings - B

(2.3% less up 12”)

Managing Moisture …

Natural Sand
(4.2% less up 12”)



Managing Moisture …

3/8" Stone
(1% less up 12")

Managing Moisture …

1/2” Stone
(0% less up 12”)

Managing Moisture …

RAP

(0.3% less up 12")

Managing Moisture
Impact of Change

	Sand	Fines	3/8”	1/2”	RAP	Total Moisture
First 12”	7.2%	6.3%	2.3%	.6%	2.8%	
Second 12”	2.97%	3.9%	1.4%	.6%	2.56%	
Average H_20	5.1%	5.1%	1.85%	.6%	2.68%	
% of Feed	10%	30%	10%	15%	35%	
Total H_2O%	.51%	1.53%	.19%	.09%	.94%	3.26%

	Sand	Fines	3/8”	1/2”	RAP	Total Moisture
Feed Up 12”	2.97%	3.9%	1.4%	.6%	2.56%	
% of Feed	10%	30%	10%	15%	35%	
Total H_2O%	.297%	1.17%	.14%	.09%	.896%	2.59%

3.26% H20 – 2.59% H20 = .67% Moisture Savings

Managing Moisture
Impact of Change

.67% Moisture Savings from Feeding Up 12”

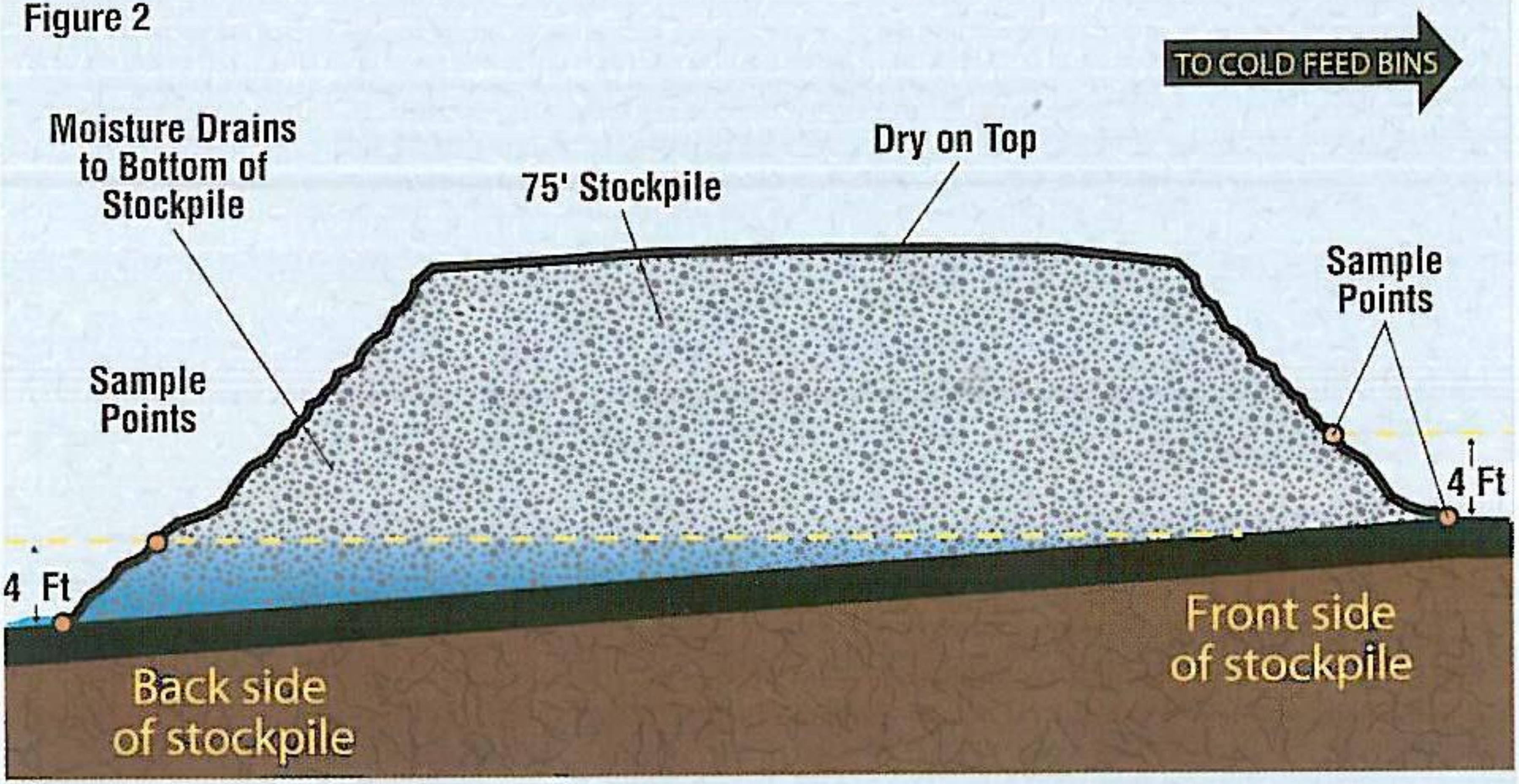
- **6.7% (7%) Reduction in Energy Costs**
  (at 10% for every 1% moisture change)

- **8.7% (8%) Increase in Production Rate Capability**
  (at 13% for every 1% moisture change)

At 250,000 Tons Per Year and $3.00 / Dry Cost

- **$50,250 per year in drying cost savings**
- **6.7% less Green House Gas Emissions**
- **Significant improvement in EPD rating**

Figure 2

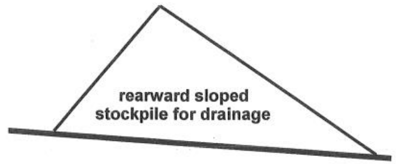


Stockpiles with ideal 6 percent slope.


07.11.2008

Energy Analysis - Stockpile Management

Plant ______________________________ Date ______________



Every 1% composite moisture reduction lowers fuel consumption 10% and raises tph 13%!

What are the typical moistures for materials at this site? (List by material type - moistures vary) __________

____

Do materials have a chance to dry before being transferred to this plant? ______________________

____

Do materials have a chance to dry on site before being fed into the dryer? ______________________

____

Are stockpile floors sloped or crowned to promote drainage? ____________________________

____

Is there an opportunity to re-slope or re-profile the stockpile floor to improve drainage? ______________

____

Would left side / right side stockpile management be useful at this site? ______________________

If so, would side walls be required to increase stockpile capacity? ______________________

If space is limited, would the installation of "French drains" be useful / possible at this site? ___________

____

Are there any RAP / RAS processing techniques that would help reduce moisture during processing? _____

____

Are RAP / RAS stockpiles properly sloped to promote drainage? ____________________________

____

Are RAP / RAS stockpiles conically shaped and/or crowned to reduce moisture from rain/snow events? ____

____

Would covering fine materials at this site significantly reduce moisture added from rain/snow events? _____

If so, which ones? _______________ **What is the estimated moisture reduction?** _____________

Has a test been performed to confirm this? _____ **What percentage of the mix is this material?** ________

Has an equipment cost / benefit analysis been done? _______ **Outcome?** ____________________

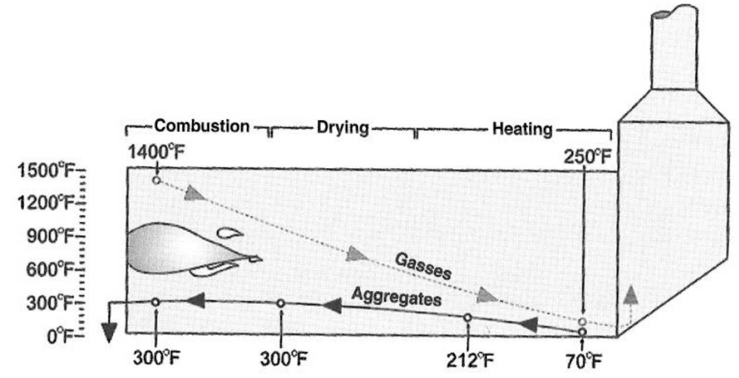
Other Observations / Ideas: **(use back if needed)**

Drying Efficiency…

Managing Material Temps

- Every 10º increase in material temperature results in a 2-3% increase in drying costs:

(Bumping 20º raises drying costs 4-6%!)

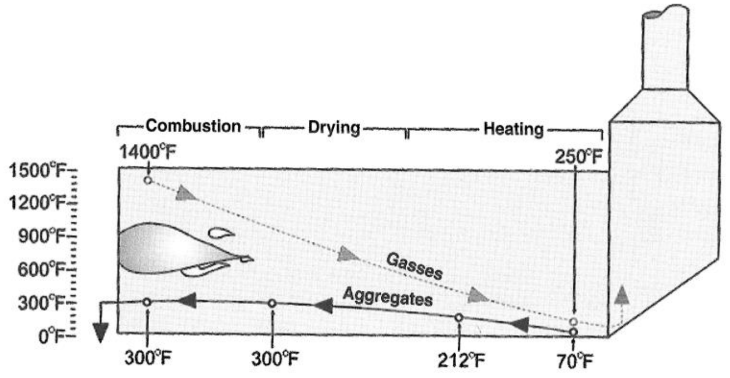


Temperature profile of counter-flow dryer drying virgin aggregates

Managing Material Temps

- Every 10° decrease in material temperature results in a 2-3% decrease in drying costs:

(Dropping 20° drops drying costs 4-6%!)

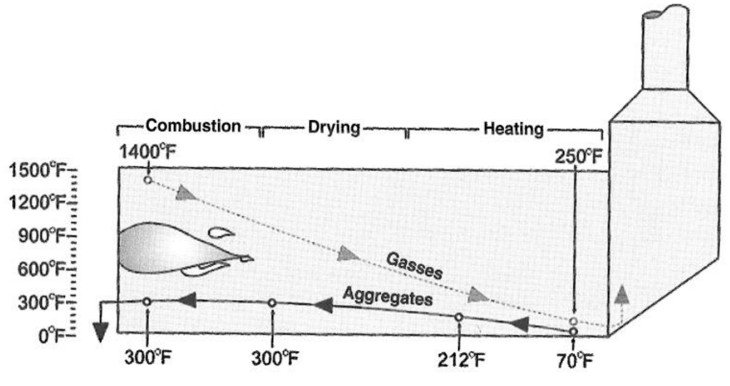


Temperature profile of counter-flow dryer drying virgin aggregates

Warm-Mix Benefit …

- 40º decrease (320º - 280º mix temperature results in 8-12% decrease in drying costs:

(Every 10º drops drying costs 2-3%!)

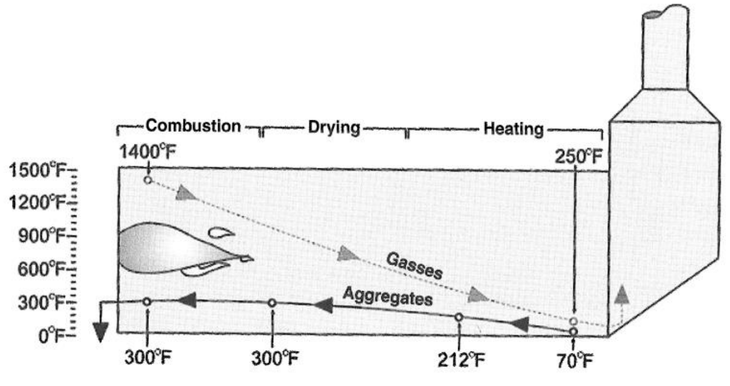


Temperature profile of counter-flow dryer drying virgin aggregates

Warm-Mix Benefit …

- 60^{o} decrease (320^{o} - 260^{o} mix temperature results in12-18% decrease in drying costs:

(Every 10º drops drying costs 2-3%!)

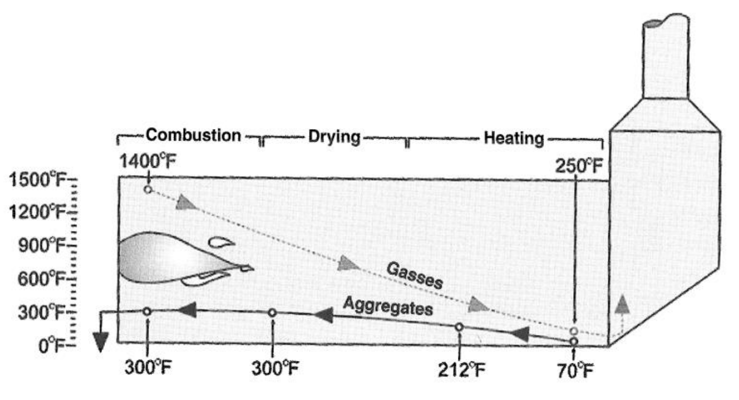


Temperature profile of counter-flow dryer drying virgin aggregates

Managing Exit Gas Temps

Every 40º reduction in exit gas temperature results in 4% fuel reduction:

(1% for every 10º)



Temperature profile of counter-flow dryer drying virgin aggregates

Managing Exit Gas Temps

Every 40º reduction in exit gas temperature results in 4% fuel reduction:

(1% for every 10º)

(260º CF dryer vs. 220º = 4% potential fuel savings)
(280º CF dryer vs. 220º = 6% potential fuel savings)

(340º PF drum vs. 300º = 4% potential fuel savings)
(350º PF drum vs. 300º = 5% potential fuel savings)

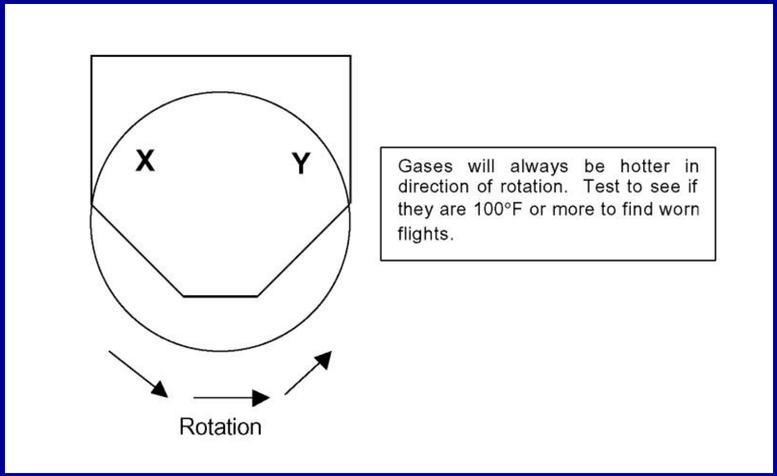
Manage Seals First!

Leaks Mask True
Exit Gas Temperatures!

(Dryer Entries & Dryer Seals)

Managing Exit Gas Temps

Side-to-Side Exit Gas Temperature Differential should be 75° or less (100º pass/fail)



Savings with Insulation

- Dryer insulation can result in as much as 10% fuel savings when the plants are run continuously:

(7% is typical)

(5% is easy)

Managing Starts & Stops

- Starting and stopping the plant frequently, pushes drying costs up 20-30%

(How do we manage this?)

Managing Starts & Stops

- Starting and stopping the plant frequently, pushes drying costs up 20-30%

(How do we manage this?)

(Usually Project Management related)

Equivalent BTUs & Costs

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
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
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
Natural Gas	Btu/CCF (see note)	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
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
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
Coal	Btu/lb	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

Each column of cost comparisons relates the costs of various types of energy to each other based on heating values. For example, the cost of No. 2 fuel oil at $1.00 per gallon is equivalent to a cost of $1.09 for No. 5 fuel oil for the same Btu. Thus, if No. 2 fuel is $1.00 per gallon it doesn't pay to choose No. 5 fuel oil unless it is less than $1.09. Likewise, it wouldn't pay to use electricity unless it is less than $0.03 per Kwh when No. 2 fuel oil is $1.00 per gallon. The actual heating values of various fuels vary somewhat from one region to another. However, the values used here are for fuels commonly used in the US. CCF stands for 100 cubic feet. The net heating value of one cubic foot of natural gas is 905 Btu. However, natural gas is normally billed at its gross heating value, which is approximately 1,000 Btu per cubic foot.

Table 3: Chart showing equivalent prices of different fuel based on BTU content (Courtesy Heatec with revision)

Equivalent BTUs & Costs

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
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
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Natural Gas	Btu/CCF (see note)	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
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
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Coal	Btu/lb	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

Each column of cost comparisons relates the costs of various types of energy to each other based on heating values. For example, the cost of No. 2 fuel oil at $1.00 per gallon is equivalent to a cost of $1.09 for No. 5 fuel oil for the same Btu. Thus, if No. 2 fuel is $1.00 per gallon it doesn't pay to choose No. 5 fuel oil unless it is less than $1.09. Likewise, it wouldn't pay to use electricity unless it is less than $0.03 per Kwh when No. 2 fuel oil is $1.00 per gallon. The actual heating values of various fuels vary somewhat from one region to another. However, the values used here are for fuels commonly used in the US. CCF stands for 100 cubic feet. The net heating value of one cubic foot of natural gas is 905 Btu. However, natural gas is normally billed at its gross heating value, which is approximately 1,000 Btu per cubic foot.

Table 3: Chart showing equivalent prices of different fuel based on BTU content (Courtesy Heatec with revision)

Energy Analysis – Theoretical BTU Expectations

Target Dryer Fuel Consumption Expectations

The following charts are based on NAPA and CIMA/BAEB industry standards outlined in "IS52: The Performance of the Operation of the and Maintenance of the Exhaust System in a Hot Mix Asphalt Facility", and "TAS22: "Performance Expectations for Your Plant Facility"; published by the National Asphalt Pavement Association, in Lanham, MD. These documents conclude that one cannot expect to operate a dryer more efficiently than under 25% excess air conditions (as a percent of stochiometric volume - or the perfect amount of air volume required to combust and convert fuel to useable energy). Most burner and plant manufacturers, however, use 40-50% excess air conditions when sizing and designing plant equipment. Field operating experience also shows that 50% excess air conditions provide a more practical guideline to use when establishing dryer performance expectations. Both 50% and 25% excess air charts are provided for analysis. Actual production performance should fall within these two ranges.

For fuel consumption analysis, assume 138,000 BTU/Gal for No.2 fuel oil; 142,000-145,000 BTU/Gal for Reclaimed and/or No. 4 Fuel Oil; 1,000 BTU/CF for natural gas; 2,500 BTU/CF for vaporized propane, and 92,000 BTU/Gal for liquid propane fuels, or consult your fuel supplier for their declared values.

Note that fuel consumption requirements do not change with elevation, although production expectations do. One needs to move more air per tph at higher elevations to properly burn the fuel, but the fuel (BTU) requirement remains essentially unchanged.

Also note with drum-mix type plants that it is practical to simply look at total composite moistures of both the virgin aggregate and RAP when estimating btu requirements per ton. Technically with counter-flow drum-mixers, the aggregate is superheated, then the superheated aggregate is used to heat the RAP; and conductive heat transfer is not equivalent to convective heat transfer, so the fuel requirements are slightly different than with parallel-flow plants. Without knowing the RAP moisture percentage and analyzing this separately, one cannot adequately estimate the fuel consumption required to heat and dry the RAP in these type plants. To complicated matters further, some counter-flow drum-mixers add RAP to the combustion zone area of the plant, taking advantage of the conductive heat transfer from the flights and shell and the radiant heat transfer from the flame, lowering the required btus. To check whether a counter-flow drum-mixer is operating within expected ranges, therefore, it is practical to simply look at the combined or composite overall moisture and check it against the charts provided.

For batch plants super-heating aggregate to heat RAP, and known virgin aggregate discharge temperatures, add 2% to the btu requirement for every additional 10° additional temperature to that shown on this chart; or one can also calculate the combined moisture of the virgin aggregate and RAP as suggested above to arrive at an estimated btu requirement for efficiency analysis.

Realize that frequent starts and stops raise fuel consumption 20-30% above these values. Therefore, fuel consumption should be checked only with sustained runs under known moisture and temperature conditions.

If actual fuel consumption is 5-10% more than the values shown on these charts, further investigation to the cause is warranted. It typically indicates defective combustion flights (and material dropping through the developing flame), an improperly tuned burner, worn flights, or an extremely poor flight design, in that order – once frequent starts and stops are eliminated from the analysis.

BTU's Required (50% Excess Air Conditions)

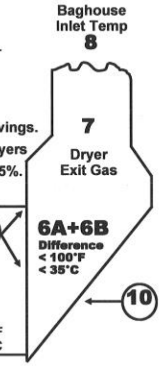
	280°F	290°F	**300°F**	310°F	320°F	330°F
3%	211,500	215,800	220,200	224,600	229,000	233,400
4%	237,800	242,700	247,700	252,700	257,600	262,600
5%	264,300	269,700	**275,200**	280,700	286,200	291,700
6%	290,700	296,600	302,700	308,800	314,800	320,900
7%	317,100	323,600	330,200	336,800	343,400	350,000
8%	343,600	350,600	357,800	365,000	372,100	379,300

BTU's Required (25% Excess Air Conditions)

	280°F	290°F	**300°F**	310°F	320°F	330°F
3%	207,800	212,000	217,300	221,700	226,000	230,300
4%	234,800	239,600	244,400	249,300	254,200	259,100
5%	260,900	266,200	**271,600**	277,000	282,500	287,900
6%	286,900	292,800	298,800	304,800	310,800	316,700
7%	313,000	319,400	325,900	332,400	338,900	345,400
8%	338,900	345,900	353,000	360,000	367,100	374,200

Energy Analysis - Drying Efficiency:

Plant ______________________________ Date ______________



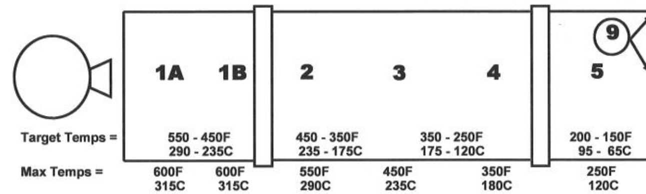
<u>**Notes to Remember When Analyzing Drying Efficiency**</u>**:**

Every 10°F/5°C rise in mix temperature raises fuel consumption 2%.

Every 10°F/5°C exit gas reduction = 1% fuel savings. 40°F/20°C gas savings = 4% fuel savings.

Target exit gas temps for CF dryers <240°F/115°C and 10°F/5°C above mix temp for PF dryers

Every start/stop raises fuel cost / ton. Multiple starts/stops raises fuel consumption 20-35%.



Fuel efficiency acceptable? (See chart + analysis below) ____________________

Combustion analysis acceptable? (Target 350 ppm CO @ 7% O2) ______________

Number of starts / stops in a day? Can they be reduced? Qty? (Multiple starts / stops raise fuel consumption 20-35%.) ______________________

Typical mix temps? Can mix temps be lowered to better manage fuel costs? ____
____

Is a warm mix system in use to lower mix temps? ____________________

Typical exit gas temperatures? This may vary with tph or between virgin / low RAP mixes and high RAP mixes (7 or 8). ____________________

Are dryer seals effective at the exit gas end (9)? Are they artificially pulling down exit gas temperatures? ____________________

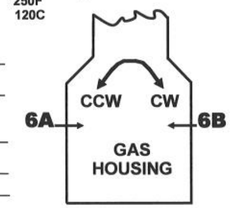
Are dryer inlet seals effective (10)? Are they artificially pulling down the exit gas temperatures? ____________________

Exit gas temp differential (6A and 6B)? Differential can be measured off the gas housing surface after the dryer runs at least one hour. 100°F/35°C or more shows worn flights or inneffective flight pattern. ____________________

Dryer shell temperatures? (High shell temperatures indicates worn or ineffective flights.) 1A ______ 1B ______ 2 ______ 3 ______ 4 ______ 5 ______

Is annual tonnage / fuel expense high enough to consider shell insulation? Insulation typically saves 5-7% but costs $15-30,000 to install. ____________________

Miscellaneous (use back if needed):



<u>**Combustion Analysis**</u>

____ ppm CO @ ____ % O2

= ____ ppm CO @ 7% O2

PPM CO @ 7% O2 = Meassured PPM of CO x 13.9 ÷ (20.9 - Measured O2 %)

<u>**Fuel Efficiency Analysis**</u>

Typ BTU/Ton = ________

Req BTU/Ton = ________

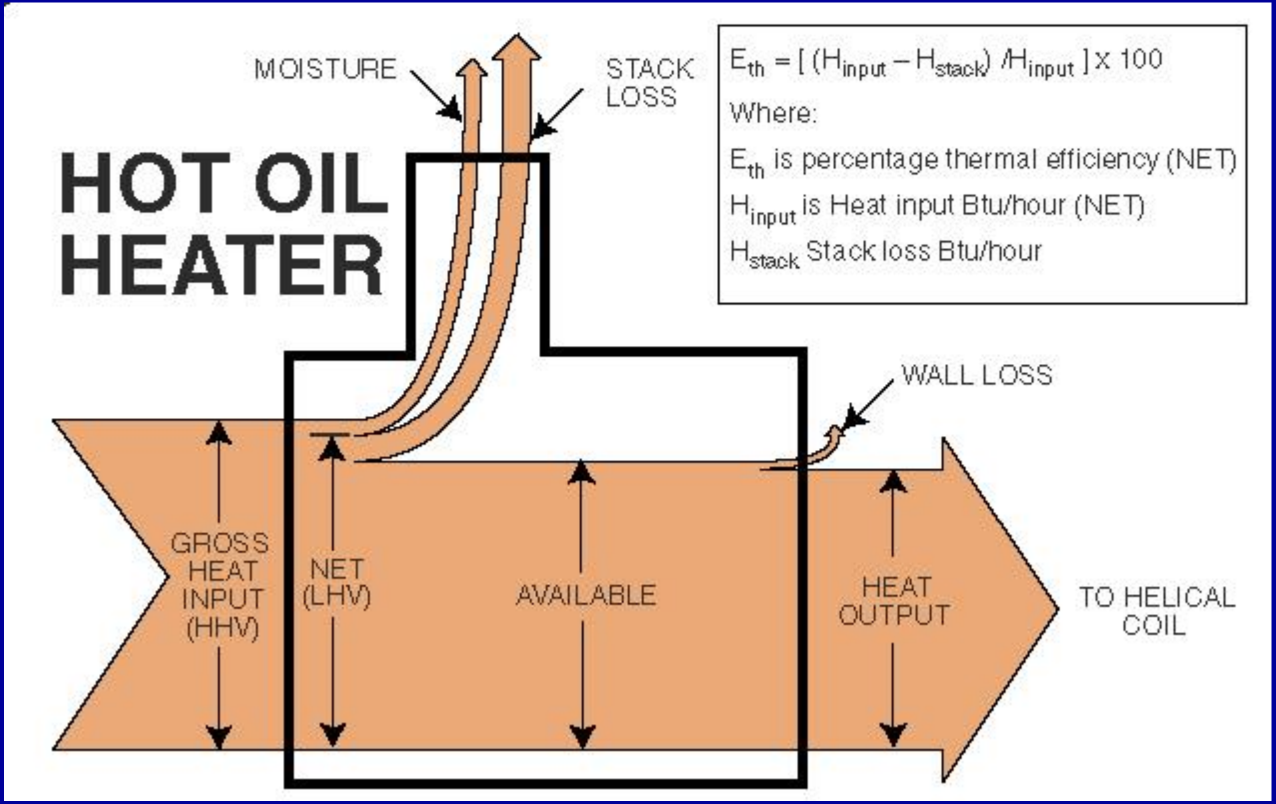
(See chart vs. average moisture of RAP and VAM at final mix temp)

Fuel Efficiency Ratio = ____

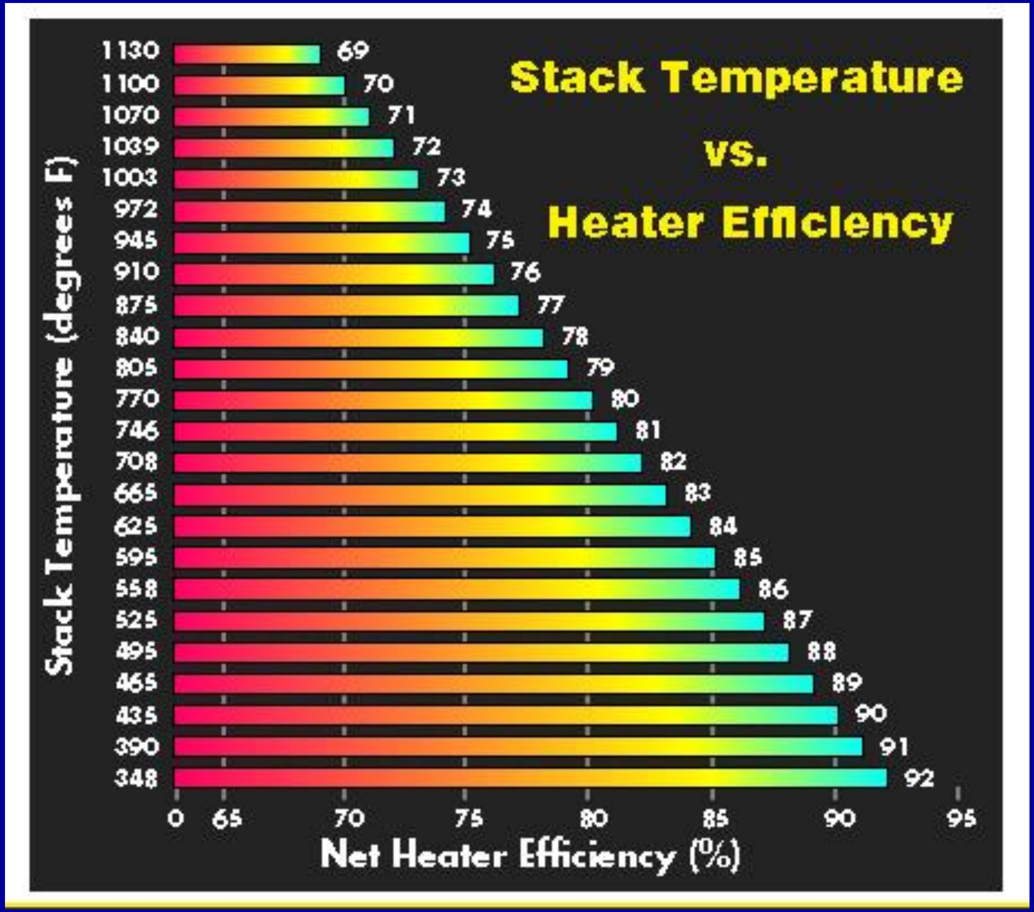
(Actual BTU/Ton ÷ Required BTU/Ton is Fuel Efficiency Ratio)

Hot Oil Heating Cost Reduction

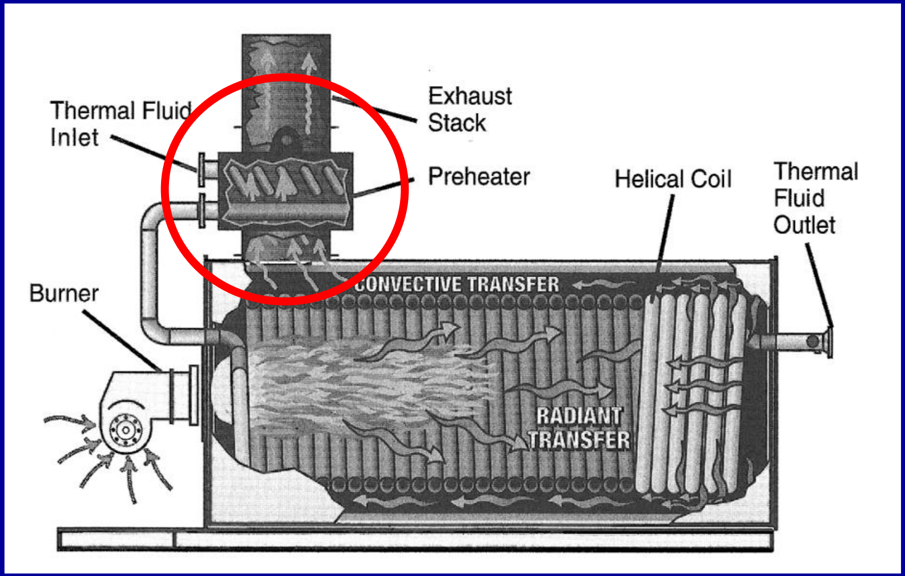
Hot Oil Heater Efficiency Savings

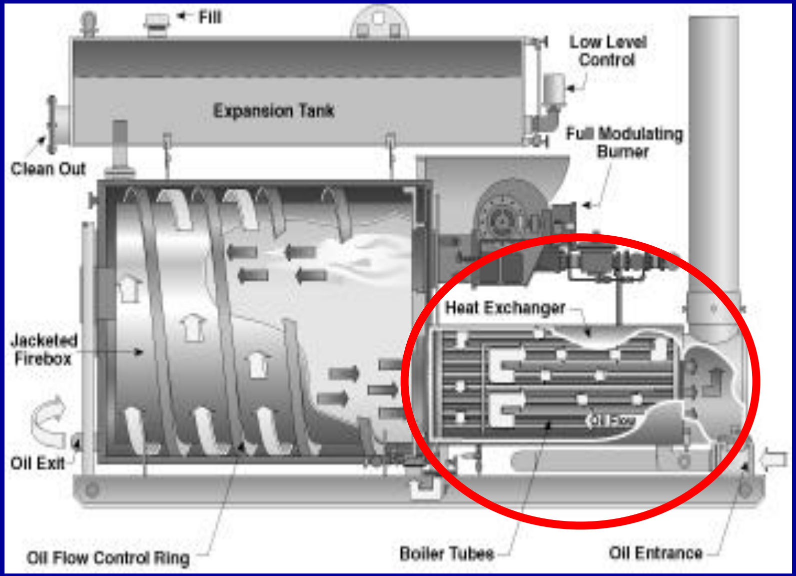


Hot Oil Heater Efficiency Savings



Hot Oil Heater – Heat Exchangers
(hot oil pre-heaters)





Hot Oil Heater Efficiency Savings

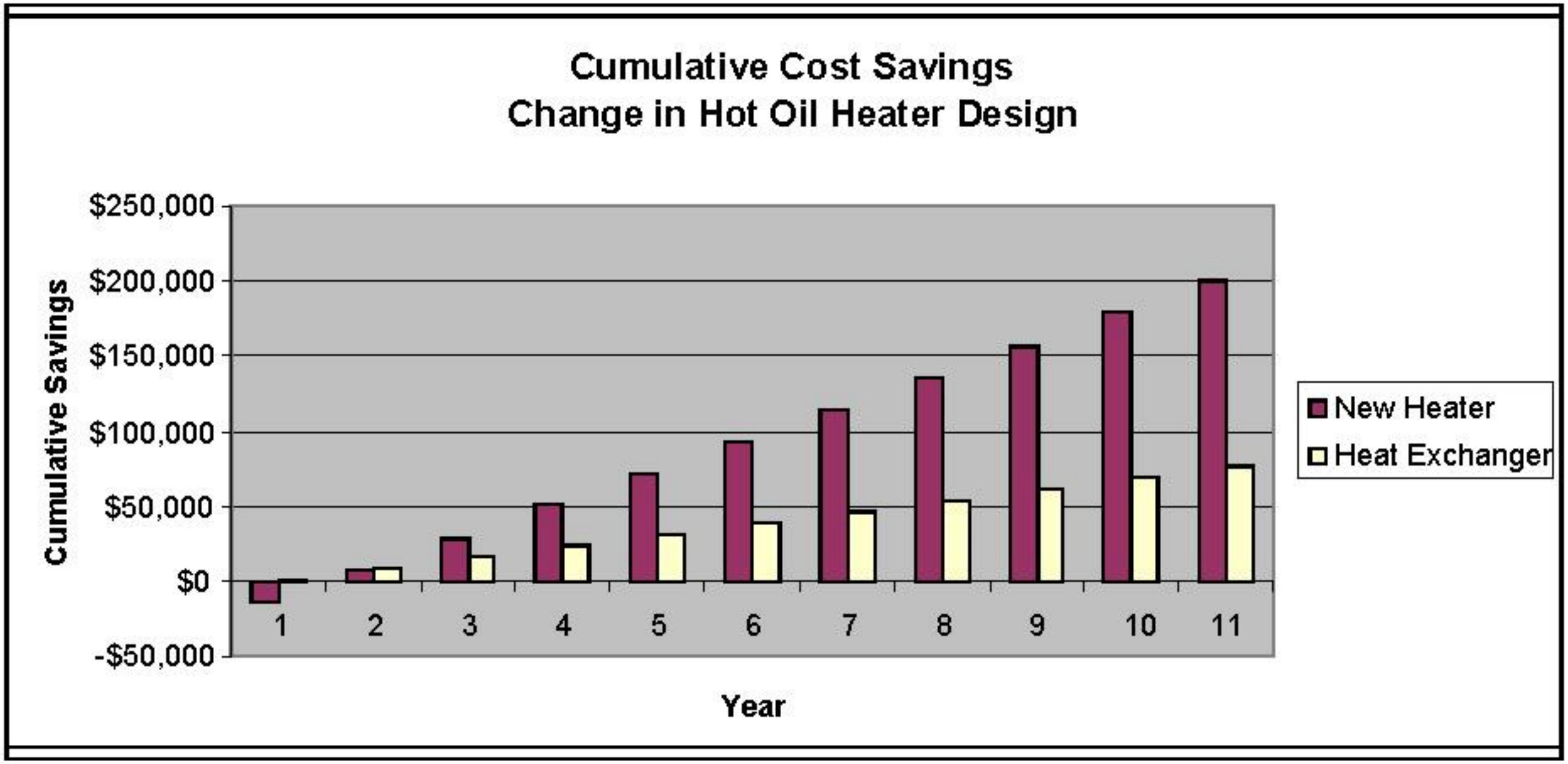
Read from chart that difference in thermal efficiency between 70% and 85% is 17.65 % as follows:

- Thermal efficiency for sustained 1 million BTU / hour at 70% requires 10.82 gallon per hour.

- Thermal efficiency for sustained 1 million BTU / hour at 85% requires 8.91 gallon per hour.

- Thermal efficiency gain is (10.82 – 8.91) / 10.82 x 100 = 17.65%

Hot Oil Heater - Conceptual Net Payback

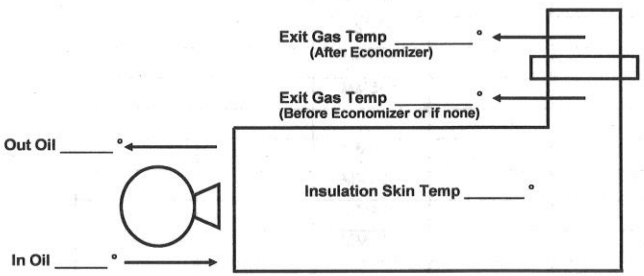


Energy Analysis - Hot Oil Heater & Insulation Efficiency

Plant ______________________________ Date ______________

Notes to Remember When Analyzing Hot Oil Heater / Heat Transfer Oil Efficiency:

- **Low gas temps out of the heater are a primary indicator of efficient conversion of fuel to hot oil** (see chart).
- **Combustion efficiency of less than 100 ppm CO @ 7% O2 expected.** (Heaters burn cleaner than dryers.)
- **Older heaters with shorter bodies have a tendency to have higher gas temperatures and are not as efficient as newer units with more coils and longer bodies.**
- **Heat exchangers / "economizers" in the exhaust gas can reclaim heat, lower exit gas temperatures, and transfer heat into hot oil, saving energy.**
- **All pipes and lines should be insulated and surface temp of insulation should be <100F/35C.**
  (See chart for calculating pontential savings from insulating un-insulated pipes and lines.)
- **Cycling heat off and on for equipment not being used (like silos and slats at night) saves energy.**
- **"Coked" tanks and lines cause heaters to run excessively and consume more fuel / energy.**



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(Data is table above taken from Astec T-140 publication.)

AC Tank Temperature Data

Tank #	AC Temp	Insulation Temp	Temp - Oil In	Temp - Oil Out
No. 1__________				
No. 2__________				
No. 3 __________				

(Tank temperatures are an indication of heat transfer efficiency and buildup on heating elements.)

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Total Savings Potential →				

* Multiply MM BTU / Month x $29.00. $29.00 per MM BTU is based on $4.00 diesel fuel and 138,000 BTU's/Gallon. MM = Million. The values in this chart are determined from data from Turner & Malloy and Astec's T140 publication.

Heating and Storage Cost Calculation (Calculate When Plant Not Producing):

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Cost per Test Hour: __________ ÷ Total Gallons Stored = Store Cost per Gallon _______
Store Cost per Gallon x 30,000 = Cost to Store 30,000 Gallon This Facility ____________

Miscellaneous Notes This Facility:

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Savings from Insulating Pipe

- Every 100’ of un-insulated heat-jacketed asphalt line results in **$10,000+** annual energy loss if diesel fuel is $2.00 per gallon.
- This increases to **$15,000+** annual energy loss if diesel fuel is $3.00 per gallon!
- Now it is **$20,000+** annual energy loss with diesel fuel at $4.00 per gallon!

Savings from Insulating Pipe

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 35).

Revised 11-24-03

Savings from Insulating Pipe

Assume 100' of un-insulated 3" pipe, (4) un-insulated flanges, (6) un-insulated 1 ½" hot oil jumper lines

(100 x 1598 BTUs) + (4 x 1890) + (6 x 676) = 171,146 BTUs / hour

171,146 BTUs / 132,000 BTUs per gallon for No. 2 Diesel fuel = 1.3 gallon / hour

1.3 gallon / hour x 24 hours = 31.2 gallon / day

31.2 gallon / day x 270 = 8,424 gallon / production year

If No. 2 Diesel fuel cost $1.50 per gallon,
this **cost totals $12,636 per production year.**

Savings from Insulating Pipe

Assume we insulate the 3" pipe, flanges, and jumper lines ….

(100 x 86 BTUs) + (4 x 120) + (6 x 97) = 9,662 BTUs / hour

9,662 BTUs / 132,000 BTUs per gallon for No. 2 Diesel fuel = .073 gallon / hour

.073 gallon / hour x 24 hours = 1.752 gallon per day

1.752 gallon / day x 270 = 473 gallon per production year

If No. 2 Diesel fuel cost $1.50 per gallon, **this cost totals $709 per year.**

Savings from Insulating Pipe

Savings are \$12,636 - \$709 or **\$11,000+ per year!**

(Payback = Immediate / Rapid)

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Miscellaneous Notes This Facility:

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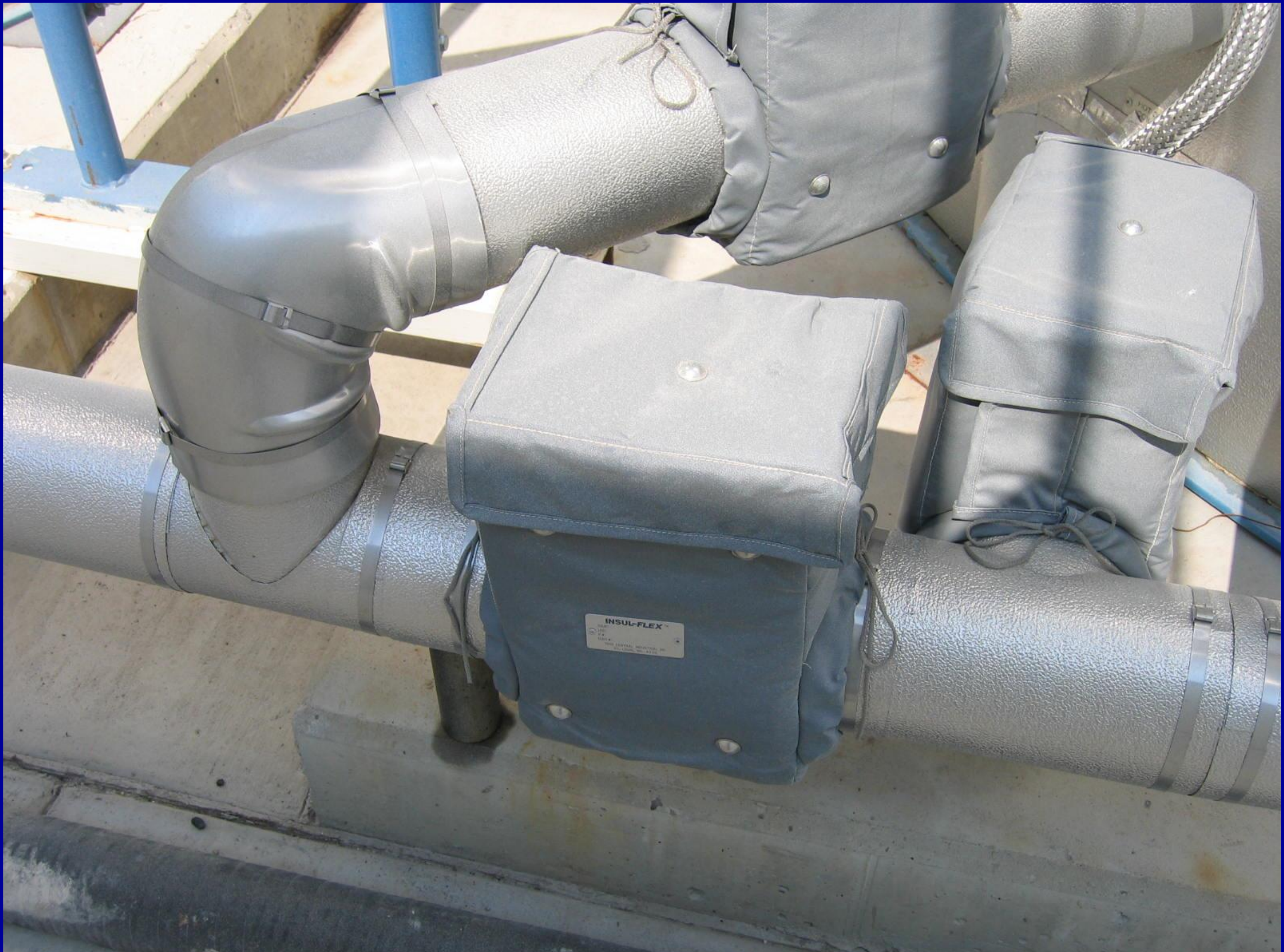
MEEKER


INSUL-FLEX

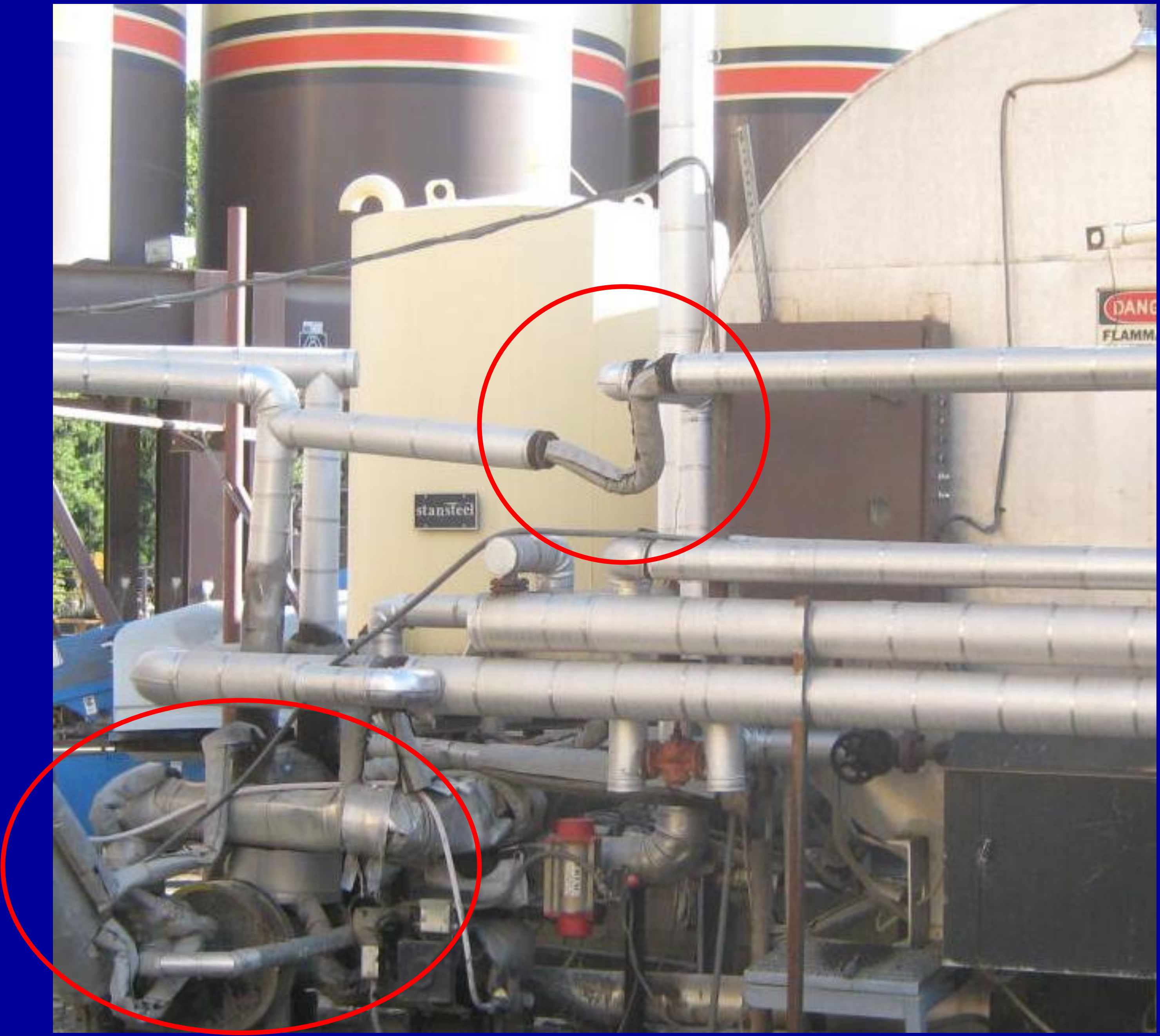

INSUL-FLEX


3257
IMPORTANT!


IMPORTANT!


HELI-TANK
TANK 14
18000 GALLONS
DANGER
HOT
HEAT


DANGER
FLAMMABLE
TANK #1
LIQUID


stansteel
DANG
FLAMM

Energy Analysis - Hot Oil Heater & Insulation Efficiency

Plant ______________________________ Date ______________

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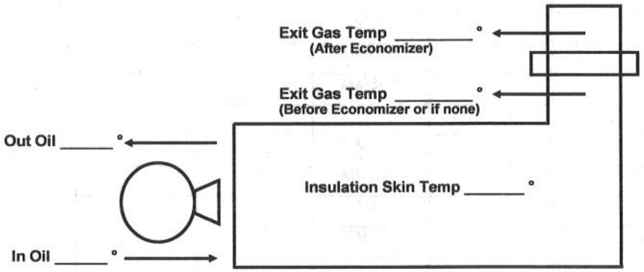

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Saving Electrical Energy

Falls Into Two Categories

- **Reduce your "Peak Demand" = "Demand Charge"**
- **Reduce your KW Consumption During Operation**

(Utility subsidies are still available some markets)

Ways to Reduce "Demand Charges"

- Do not start big motors immediately after one another
- Avoid hot starts / hot stops / "midstream" starts
- Bring motors back on line with delays after hot starts / hot stops / "midstream" starts
- Talk to your control manufacturer about automating delayed starts on hot starts / "midstream" starts
- Apply more VFD's as they have "power factor reducing" characteristics when properly applied

Power Factor Reducing Capacitors

(Saving Energy - KW $) (OLD School)

- Reduces demand charges / power factor charges by using stored energy in the capacitor to start motors first
- Also discharge during operation continuously to help reduce KW consumption
- Are typically applied to large motors only
- Many electrical bills show “power factor” usage
- You are hoping for a high ratio or number not a low one
  (high ratio / number indicates you are using what you “reserve”)
- Payback varies based on your local demand charge

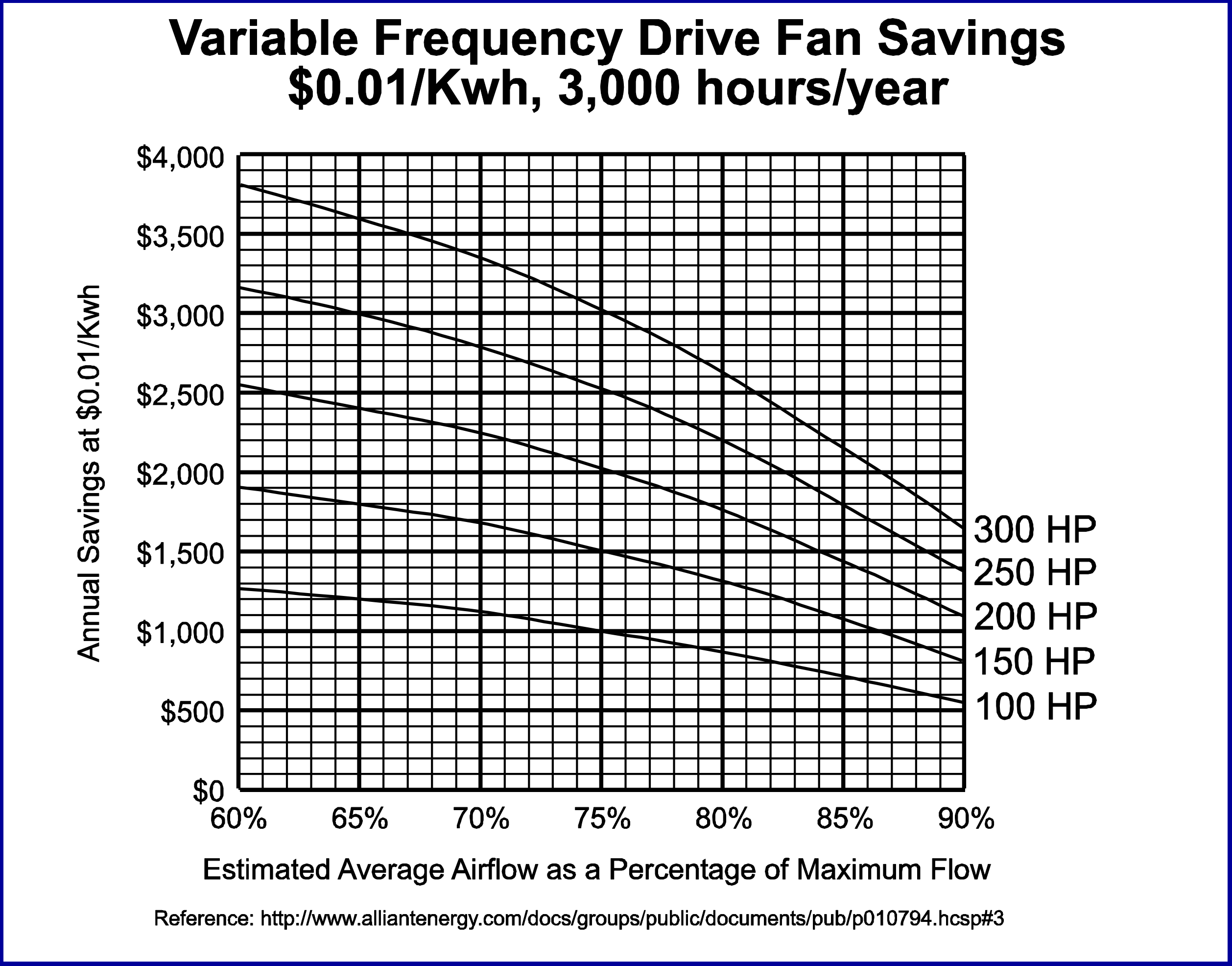
Savings with VFD’s

VFD Applications

(Saving Energy - KW $) (NEW School)

- **VFD's vary the "frequency" of the current to the motor**
- **This slows + speeds motor** (fan like a damper to reduce flow)
- **VFD's use less energy to reduce flow than a damper** (on fans)
- **VFD's <u>have become less expensive last few years</u>**
- **VFD's also <u>have power factor reducing characteristics</u>!**
- **VFD's have become a cost-effective way of reducing air flow vs damper on fans** (reducing KW use + demand charges)
- **On fans VFD's only provide "payback" if the fan is typically operating below 80%** (must analyze your situation)

Exhaust Fan VFD Application
(Saving Energy – KW Usage)



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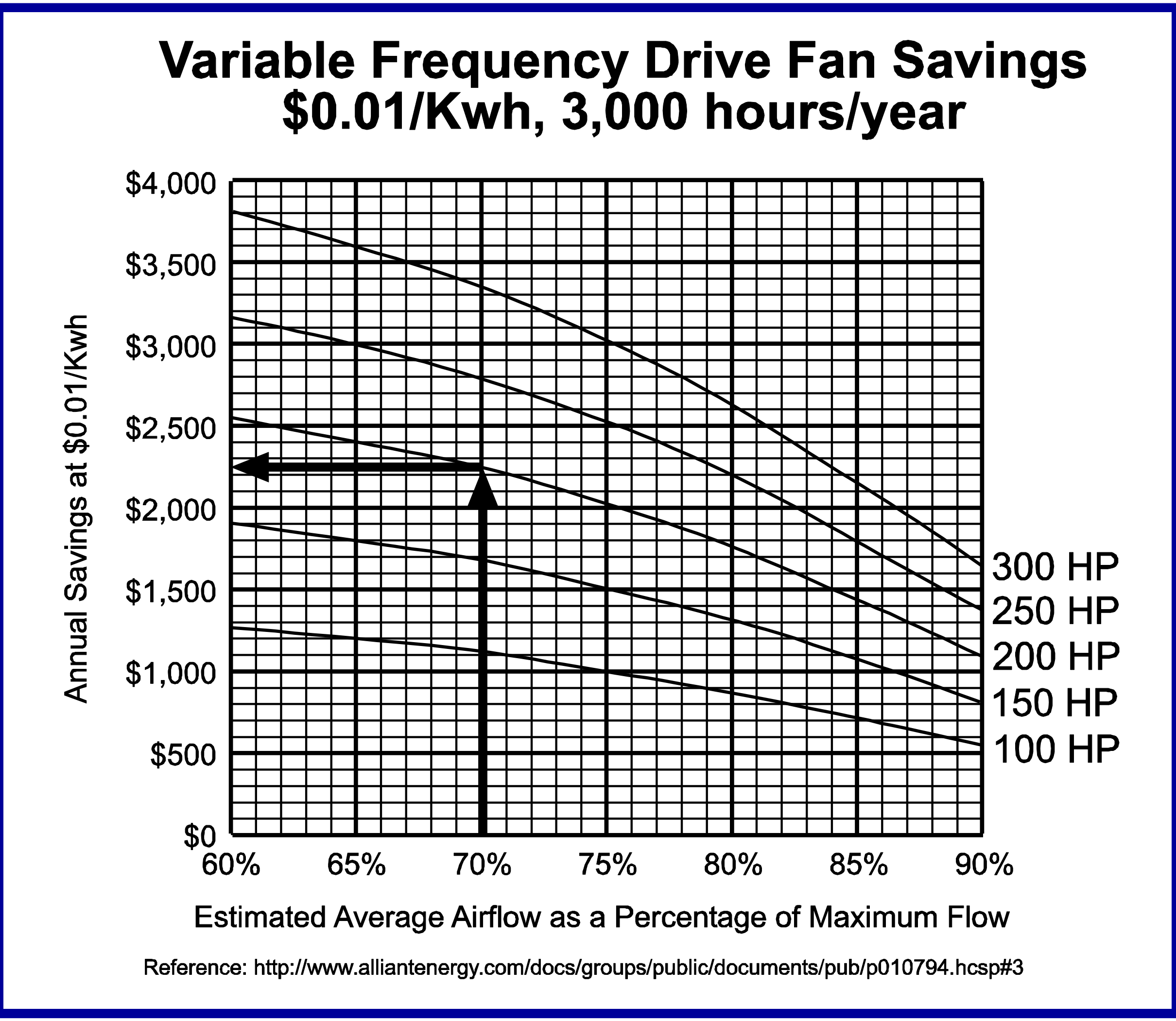

VFD on Slat Conveyors?
(Saving Energy - KW Usage)

- Saves money two ways!
- VFD’s save energy and perhaps more significantly, reduce maintenance and wear costs!
- Slat conveyor wear is mostly “articulation” related
- Slowing slats allows them to last longer
- Fixed speed gearboxes, however, so this creates startup torque related issues – slat can stall if too low rpm
- Most producers experimenting with this set VFD’s so slat cannot be reduced below 50% speed

VFD on Dryers?

- Allows you to “over-flight” the dryer
  - Higher RAP capability by better superheating
  - Lower fuel consumption with less exit gas temps
- Allows you to raise gas temperature on virgin mixes
  - Slowing drum reduces veil and raises gas temp
- Allows you, therefore, to manage exit gas temp to reduce fuel consumption while still achieving high RAP capabilities when needed / maximize effeciency

Other Ways to Reduce KW Usage

- Run only motors needed / going to be used
- LED lighting throughout (75-80% less KW)
- Cycle (electric) heat off when not needed
- Solar yard lights / solar light plants
- Light switches with motion sensors / auto off, etc.
- Moisture management / dryer management / hot oil management also saves KW …

Energy Management

- How do you plan on implementing these ideas?
- Using Field Worksheets ...
- Distributing the new QIP-132 pub …

QIP 132 =

Applying QIP-126 & QIP-127