IMPROVING PROFITS THROUGH ALTERNATIVE FUELS
WHAT IS THE BEST FUEL CHOICE?
FUEL SELECTION FACTORS

• FUEL COST PER HEAT UNIT
• MAINTENANCE COST IMPACT
• OPERATING COST IMPACT
• CAPITAL EQUIPMENT COST
• AVAILABILITY
TRADITIONAL MAINSTAY FUELS OF THE HMA INDUSTRY

• NO. 2 DIESEL
• NATURAL GAS
• PROPANE
BY ALL MEANS, BURN NATURAL GAS, IF IT IS AFFORDABLE.
ALTERNATIVE FUELS

• RECYCLED PETROLEUM OILS
• BIODIESEL
• VEGETABLE OIL
• COAL
RECYCLED PETROLEUM OIL

USED IN THE HMA INDUSTRY TO THE EXTENT THAT IT IS HARDLY EVEN THOUGHT OF AS AN “ALTERNATIVE” FUEL.
RECYCLED OIL IS GENERALLY LESS EXPENSIVE THAN NO. 2 OIL BUT IS BECOMING INCREASINGLY SCARCE WHILE QUALITY STEADILY DIMINISHES.

MAKE SURE YOU CONSIDER THE HIDDEN COSTS.

EXPEND THE EXTRA EFFORT TO DO IT RIGHT.
SUBTRACT THE WATER

5% WATER IN THE FUEL AMOUNTS TO A DECREASE IN HEATING VALUE OF ABOUT ABOUT 7,500 BTU PER GALLON.

FUEL OIL HHV 142,000 BTU/GAL
WATER LOSS 7,500 BTU/GAL
USABLE HEAT 134,500 BTU/GAL
ON THE BASIS OF HEAT PROVIDED PER DOLLAR, THESE ARE ALL EQUAL VALUES:

1. WASTE OIL AT $1.00/GAL *
2. NO. 2 OIL AT $0.98/GAL
3. NATURAL GAS AT $0.74/THERM

* WASTE OIL CONTAINING 5% WATER.
YOU CAN BURN RECYCLED OIL RELATIVELY CLEANLY AND EFFICIENTLY.
KEYS TO BURNING RECYCLED OIL

• KEEP OIL CLEAN COMING IN
• KEEP BURNER CLEAN AND IN GOOD CONDITION
  – Air passages collect dust
  – Oil passages collect filter fibers
  – Solids in the oil cause atomizer wear
• VISCOSITY
  – 80 SSU or less
    • Must be preheated for good atomization.
    • Preheating is easier if oil is “pushed” through the preheater.
    • Vaporizing in the nozzle is minimized by using an air atomized nozzle.
• OIL PROPERTIES
  – Make sure the oil is free of destructive contaminants.
ATOMIZATION IS CRITICAL
MANY WASTE OIL BURNING PROBLEMS ARE RELATED TO POOR ATOMIZATION.
LARGE OIL DROPLETS WILL BE BLOWN INTO THE VEIL BEFORE THEY CAN BURN COMPLETELY.
POOR ATOMIZATION CAN LEAD TO A DISASTER.
POOR ATOMIZATION DESTROYS COMBUSTION ZONE FLIGHTS.
IMPROPERLY ATOMIZED OIL CAN FOUL THE WHOLE BURNERFRONT.
PROPERLY ATOMIZED FUEL HELPS PRODUCE A FLAME THAT IS SHORT AND SMALL IN DIAMETER LIKE THIS.
VISCOSITY AT THE BURNER IS WHAT MATTERS.

• CONTROL VISCOSITY, NOT OIL TEMPERATURE.
• AVOID LONG UNINSULATED FUEL LINES.
• KEEP FUEL HOSES UP OFF OF THE GROUND AND OUT OF THE MUD.
• RECIRCULATE BEFORE LIGHTING.
• HEAT IN-LINE (OK TO HEAT TANK TOO BUT NOT INSTEAD OF IN-LINE.)
RECYCLED OIL CANNOT BE BURNED EFFECTIVELY WITHOUT PROPER PREHEATING.
THIS WASTE OIL SYSTEM WORKS WELL EVEN WITH LONG PIPING RUNS BECAUSE THE PIPING IS WELL INSULATED.
WORN ATOMIZERS WASTE FUEL AND MONEY.
USE SOCK FILTER AT UNLOADING POINT.
KEEP BURNER AIR AND OIL PASSAGES CLEAN.
KEEP EXCESS AIR LOW.
CHECK EXHAUST GASES
WITH AN ANALYZER.

GAS ANALYSIS OF A WELL-ADJUSTED
AND WELL-MAINTAINED SYSTEM

- OXYGEN 10.5%
- CARBON MONOXIDE 250 - 300 PPM
- NOX (OIL) 100 - 150 PPM
RECYCLED OIL
CONTAMINANTS CAN
CAUSE MAJOR PROBLEMS.
ASH ACCUMULATION ON BAGS
NORMAL RECYCLED OIL APPEARANCE
SEPARATED WASTE OIL COMPONENT MAKING ASH
BEWARE OF CORROSIVE CONTAMINANTS

THIS DAMAGE WAS CAUSED BY SULFURIC ACID RESIDUAL FROM A WASTE OIL TREATMENT PROCESS.
CORROSIVES IN SOME RECYCLED FUEL OILS CAN ATTACK THE DRUM.
BIODIESEL

BIODIESEL IS AN ALTERNATIVE FUEL PRODUCED TO COMPLY WITH ASTM SPECIFICATION D 6751. IT IS MADE PRIMARILY FROM SOY BEANS BUT MAY ALSO INCLUDE OTHER VEGETABLE OIL AND ANIMAL FATS.
BIODIESEL

BIODIESEL IS SOLD AS A BLEND OF PURE VEGETABLE / ANIMAL OILS AND NO. 2 DIESEL. ITS PROPERTIES VARY ACCORDING TO THE PROPORTIONS OF THE BLEND.
B20, A BLEND OF 20% BIODIESEL AND 80% NO. 2 DIESEL CAN BE BURNED IN PLANT APPLICATIONS AND EVEN IN MOST DIESEL ENGINES.

<table>
<thead>
<tr>
<th>Region</th>
<th>Biodiesel (B20) Information Reported by Clean Cities ($ per gal)</th>
<th>Diesel Information Reported by Clean Cities ($ per gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average Price / Standard Deviation of Price</td>
<td>Approximate Number of Stations</td>
</tr>
<tr>
<td>New England</td>
<td>$2.96 / 0.00</td>
<td>2</td>
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<tr>
<td>Central Atlantic</td>
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<tr>
<td>Lower Atlantic</td>
<td>$2.82 / 0.06</td>
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<tr>
<td>Midwest</td>
<td>$2.86 / 0.10</td>
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<tr>
<td>Gulf Coast</td>
<td>$2.94 / 0.20</td>
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</tr>
<tr>
<td>Rocky Mountain</td>
<td>$2.91 / -.--</td>
<td>1</td>
</tr>
<tr>
<td>West Coast</td>
<td>$3.26 / 0.34</td>
<td>5</td>
</tr>
<tr>
<td>NATIONAL AVERAGE</td>
<td>$2.92 / 0.22</td>
<td>29</td>
</tr>
</tbody>
</table>
B99-B100 is very viscous (thick) and must be preheated like recycled motor oil or heavy virgin oil to be made thin enough to atomize sufficiently for burner firing.

Table 11. Biodiesel (B99-B100) Average Prices by Region from Clean Cities Sources

<table>
<thead>
<tr>
<th>Region</th>
<th>Biodiesel (B99-B100) Information Reported by Clean Cities ($ per gal)</th>
<th>Diesel Information Reported by Clean Cities ($ per gal)</th>
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<tbody>
<tr>
<td></td>
<td>Average Price / Standard Deviation of Price</td>
<td>Number of Data Points</td>
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<tr>
<td>New England</td>
<td>$3.89 / 0.51</td>
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<td>Central Atlantic</td>
<td>$3.00 / -.--</td>
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<tr>
<td>Lower Atlantic</td>
<td>$3.98 / -.--</td>
<td>1</td>
</tr>
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<td>Midwest</td>
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</tr>
<tr>
<td>Gulf Coast</td>
<td>$2.75 / -.--</td>
<td>1</td>
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<tr>
<td>Rocky Mountain</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>West Coast</td>
<td>$4.02 / 1.30</td>
<td>4</td>
</tr>
<tr>
<td>NATIONAL AVERAGE</td>
<td>$3.76 / 0.89</td>
<td>11</td>
</tr>
</tbody>
</table>
Heat of Combustion

ASTM D3338

Low sulfur diesel was purchased locally from MFA Oil Company to prepare these blends.
Viscosity
ASTM D445

Fig. 30

Low sulfur diesel was purchased locally from MFA Oil Company to prepare these blends.
VEGETABLE OIL

VEGETABLE OIL IN THIS INDUSTRY MEANS PRIMARILY WASTE VEGETABLE OIL (WVO). THIS IS MAINLY USED COOKING OIL.

WVO IS GENERALLY LOW COST BUT CAN BE TROUBLESome.
WASTE VEGETABLE OIL

- PRICE IS USUALLY LOW.
- WVO HAS GOOD HEATING VALUE SIMILAR TO RECYCLED MOTOR OIL.
- WATER CONTENT, SOLIDS, AND CORROSIVES CAN BE PROBLEMS
  - CORROSIVES – WVO USUALLY CONTAINS CLEANING AGENTS, WHICH TEND TO INCLUDE NaOH (CAUSTIC) AND NaCl (SALT)
QUESTIONS ABOUT BURNING COAL

1. HOW MUCH MONEY WILL COAL SAVE?
2. HOW AVAILABLE IS COAL?
3. WHAT KIND OF COAL?
4. ABILITY TO GET AIR POLLUTION PERMIT DUE TO HIGHER EMISSIONS LEVELS?
5. HOW IS THE COAL PREPARED TO BURN?
6. OPERATING AND MAINTENANCE COST AS COMPARED TO GAS OR AND WASTE OIL?
7. COMPLEXITY AND OPERATIONAL DIFFICULTY?
8. FLEXIBILITY TO BURN OTHER FUELS AND COMBINATIONS OF FUELS?
9. ELECTRIC POWER CONSUMPTION?
ON THE BASIS OF HEAT PER DOLLAR, 12,500 BTU/LB COAL AT $60/TON IS AN EQUIVALENT VALUE TO OIL AT $0.33/GAL. OR NATURAL GAS AT $0.24/THERM.
THE U.S. HAS MORE ENERGY AVAILABLE AS COAL THAN IS AVAILABLE FROM THE ENTIRE WORLD’S PROVEN OIL RESERVES.
TYPES OF COAL

- LIGNITE
- SUBBITUMINOUS
- BITUMINOUS
- ANTHRACITE

ONLY ANTHRACITE COALS ARE UNSUITABLE AS FUELS FOR HMA PRODUCTION.
IMPORTANT COAL PROPERTIES

• HEATING VALUE
• GRINDABILITY
• % VOLATILE MATTER
• SULFUR CONTENT
COAL SPECIFICATION

BECAUSE THESE IMPORTANT PROPERTIES OF COAL VARY CONSIDERABLY, IT IS NECESSARY TO HAVE A COAL SPECIFICATION WHEN YOU PURCHASE YOUR FUEL.
COAL ANALYSES, TOGETHER WITH THE HEATING VALUE AND GRINDABILITY, PROVIDE A PRETTY GOOD EVALUATION OF A PARTICULAR COAL.

**PROXIMATE ANALYSIS**

- % MOISTURE
- % VOLATILE MATTER
- % FIXED CARBON
- % ASH

**ULTIMATE ANALYSIS**

- % CARBON
- % HYDROGEN
- % OXYGEN
- % NITROGEN
- % SULFUR
RECOMMENDED COAL SPECIFICATIONS

• WASHED GRADATION 1” X ¼”
• HARDGROVE INDEX > 50
• VOLATILE MATTER > 34%
• MOISTURE < 5% surface (inherent n/a)
• SULFUR <1% (recommended)
• HEATING VALUE > 10,500 BTU’s/POUND HHV
HOT MIX ASPHALT PLANTS ARE GREAT CANDIDATES FOR COAL, BECAUSE ...........
THEY HAVE "BUILT-IN" SOLUTIONS TO THE TWO MOST SIGNIFICANT DETERRENTS TO BURNING COAL.
SULFUR

THE HOT MIX MAKING PROCESS IS A NATURAL SULFUR "SCRUBBER" WITH REMOVAL EFFICIENCY UP TO 90%.
ASH

ESSENTIALLY 100% OF THE COAL ASH IS CAPTURED AND INCORPORATED INTO THE HOT MIX.
THIS MEANS STACK EMISSIONS ARE LOW
(ACTUAL EMISSION AT COLORADO PLANT)

- PARTICULATE: ZERO OPACITY
- CARBON MONOXIDE: 260 PPMV
- NOX: 120 PPMV
- SO2: 53 PPMV *

NOTE: GASEOUS EMISSIONS ARE BASED ON 7% O2 REFERENCE.

* NOT CORRECTED
BECAUSE EMISSIONS ARE RELATIVELY LOW, HOT MIX PLANTS CAN BE PERMITTED TO BURN COAL ALMOST ANYWHERE IN THE UNITED STATES.
COAL BURNING IS A TWO PART PROCESS.

1. COAL MUST FIRST BE METERED, PULVERIZED (80% passing 200), AND DRIED.

2. SECONDLY, PULVERIZED COAL DUST IS BLOWN TO THE BURNER AND BURNED.
ASTEC PHOENIX COAL

(THIS BURNER WAS FIRING ON COAL AT THE MOMENT PHOTO WAS TAKEN.)
COAL PREPARATION SYSTEM
COAL CAN BE BURNED IN COMBINATION WITH OTHER FUELS
THE ASTEC COAL BURNER USES A BASE FLAME OF APPROX. 10% OIL OR NATURAL GAS. IT WILL FIRE UP TO APPROX. 90% COAL. THIS BURNER CAN ALSO FIRE 100% OIL OR GAS AT 110% OF RATED CAPACITY.
QUICK BURNING, SHORT, AERODYNAMICALLY STABILIZED FLAME AVOIDS BURNER AND DRUM DAMAGE WITHOUT REFRACTORY.
SOFT PLC BURNER CONTROLS ENABLE PRECISE FUEL / AIR RATIO CONTROL WITH THE EASE OF OPERATION OF OIL OR GAS.
THE ASTEC PHOENIXCOAL BURNER USES A VARIABLE FREQUENCY DRIVE (VFD) TO MODULATE COMBUSTION AIR.

- REDUCES OPERATING COST
- REDUCES NOISE
- IMPROVES PRECISION OF CONTROL
PULVERIZER HAMMER WEAR

• LARGEST MAINTENANCE ITEM FOR A COAL PREP. SYSTEM.
• WORN HAMMERS REDUCE PULVERIZING CAPACITY
• WORN HAMMERS INCREASE POWER CONSUMPTION.
• TURN ‘EM AROUND.
## COAL SYSTEM
### RETURN ON INVESTMENT

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal Heating Value</td>
<td>12,500 BTU/ton</td>
</tr>
<tr>
<td>Mix produced annually</td>
<td>200,000 tons</td>
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<tr>
<td>Aggregate moisture content</td>
<td>5.0%</td>
</tr>
<tr>
<td>Oil purchase price</td>
<td>$1.30/gal</td>
</tr>
<tr>
<td>Annual fuel cost using oil only</td>
<td>$442,000</td>
</tr>
<tr>
<td>Coal purchase price</td>
<td>$55.00/ton</td>
</tr>
<tr>
<td>Approx. cost of coal burner system</td>
<td>$500,000</td>
</tr>
<tr>
<td>Annual fuel savings (90% coal, 10% oil)</td>
<td>$305,556</td>
</tr>
<tr>
<td>Electric power cost (600KW @ $0.07/kwh)</td>
<td>$23,333</td>
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<tr>
<td>Annual coal system maintenance</td>
<td>$14,000</td>
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<tr>
<td>Net annual savings</td>
<td>$268,222</td>
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<tr>
<td>Return on investment (ROI)</td>
<td>1.86 years</td>
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</tbody>
</table>
EXCEPT FOR COAL, FUEL COSTS AND AVAILABILITY WILL CONTINUE TO BE UNSTABLE AND GENERALLY RISING. BE PREPARED TO CHANGE QUICKLY.