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Carmeuse Biodiesel Experience

MSHA/NIOSH Diesel Technology Workshop - January 23, 2019

CARMEUSE

AGENDA

1. Carmeuse Usage
2. The Good…
3. The Bad…
4. The Ugly…
5. Close Out

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Carmeuse Background

Carmeuse Lime and Stone, Inc. (Carmeuse North America) operates five underground limestone mines

- Black River Operation – Butler, KY
- Cisco Operation – Cisco, GA
- Ellijay Operation – Ellijay, GA
- Luttrell Operation – Luttrell, TN
- Maysville Operation – Maysville, KY

Carmeuse--Black River and Carmeuse--Maysville are the largest of the UG operations, with all mining operations carried out completely UG

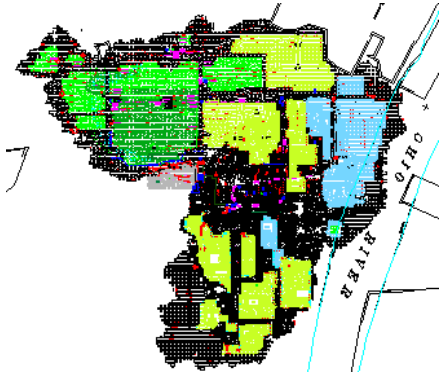
- The other operations utilize truck haulage to surface

All of the mines are solely dependent on diesel mobile equipment to meet the stone production needs of their plants

Maysville and Black River Background

Both mines use a staggered room and pillar mining configuration, with headings and benches mined

- Two to three mining fronts/panels are simultaneously advanced
- Multiple pieces of mining equipment are simultaneously used in the advancing panels, and split between heading or benching operations



Diesel equipment utilized:

- Cat 988 wheel loaders
- Cat 772 haul trucks
- Fletcher diesel face drills
- Cat track-mounted bench drills
- Oldenburg powder rigs
- Cat excavator-type scalers
- Fletcher roof bolters
- Various diesel powered support equipment
  - Water and service trucks, manlifts, personnel carriers

KY (MY and BR) Background

During initial DPM rulemaking, the mines were found to need to make DPM changes like numerous other mines at the time

Carmeuse formed a DPM Compliance team prior to the initial rules enactment date, and compliance options were evaluated:

- Additional ventilation (shafts and fans)
- DPM exhaust filters
- Alternative fuels
- Engine upgrades
- Enclosed cabs

Initial Compliance Background

Low-sulfur diesel (mandatory)

- Relatively easy change over (purchasing and communication)

Additional ventilation (shafts and fans)

- Large capital costs for shafts and fans
- Significant electrical operating costs for additional fan horsepower

DPM exhaust filters

- Large capital cost if used on all pieces of equipment
- Operating and maintenance issues and costs associated with using and regenerating

Engine upgrades

- Cost prohibitive based on cost and equipment ages at the time
- Would be done with new machine purchases

Enclosed cabs

- Similar implementation reasoning as engine upgrades

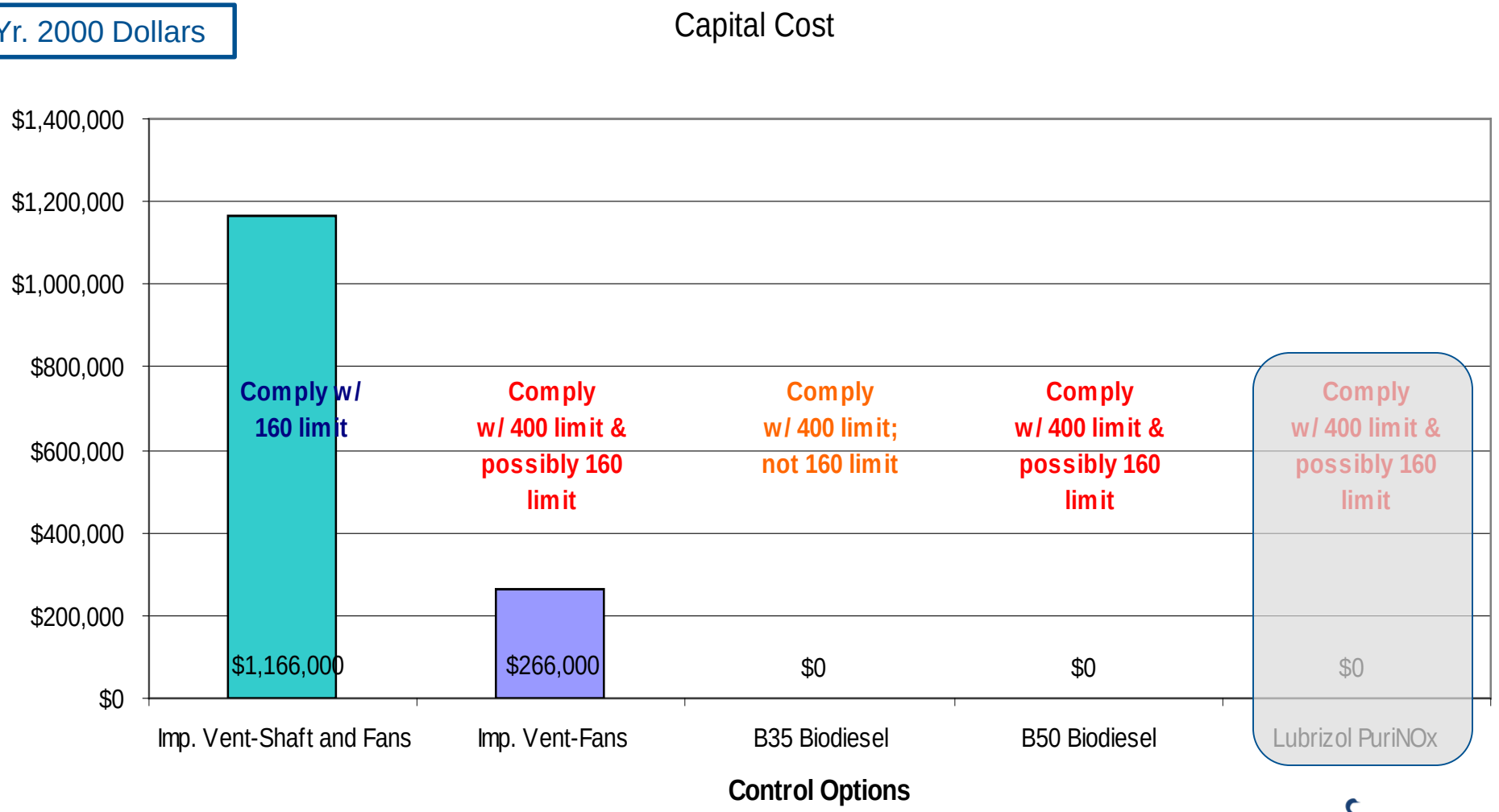
Initial Compliance Background

Alternative fuels

- Relatively easy implementation (purchasing/scheduling/communication)
- Very minimal capital costs (if any)
- Possible performance issues to overcome
- Increase in operating/fuel cost
- Decreases emissions at the source - engine

Initial Capital Estimates

Yr. 2000 Dollars



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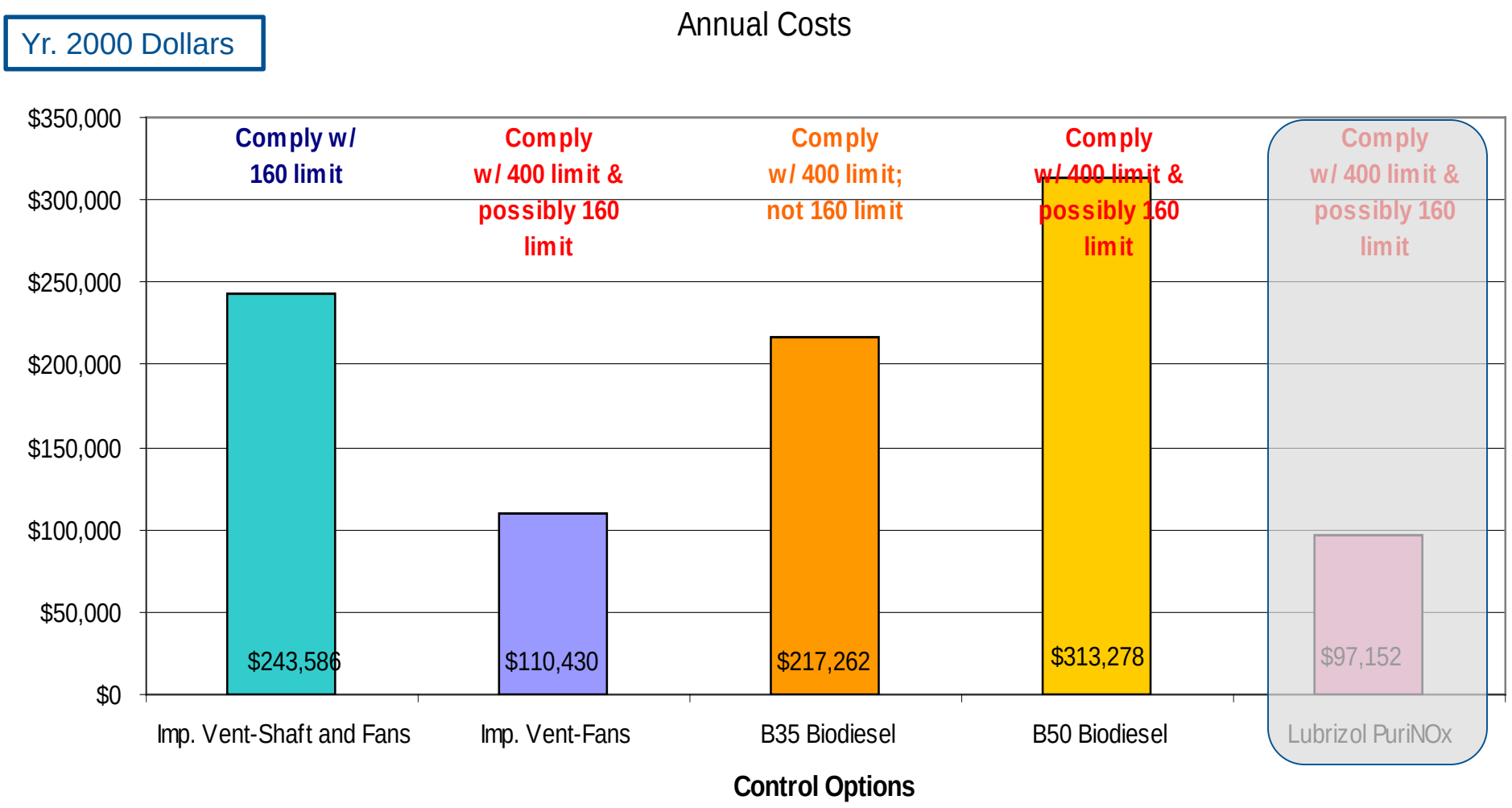
Initial Operating Cost Estimates

Yr. 2000 Dollars



Fuel Selection

Alternative fuels selected as primary DPM control methodology based on cost and implementation

Biodiesel selected fuel choices available

- Recycled yellow-grease derived
- Virgin soybean oil derived
- Animal fats based
- And other sources

Yellow-grease based biodiesel initially selected

- Locally available
- Limited reported power loss issues
- Some comfort with fuel supplier

PuriNOx side note

- Water-Diesel fuel emulsion blend
- Deionized water, Lubrizol chemicals, and diesel fuel
  - Water molecules are encapsulated in diesel fuel
  - 10% water – winter blend
  - 20% water – summer blend
- Manufacturing phased out at end of 2006
- Ran the problematic fuel at various levels from 2004 thru 2006

Fuel Utilization

As required, switched to Low-Sulfur Diesel fuel (<0.05% sulfur)

Tested number of alternative fuel blends

- B20 Bio, B50 Bio, B50 Soy, PuriNOx

Used B35 Biodiesel for 7 mos. – middle to end of ‘03

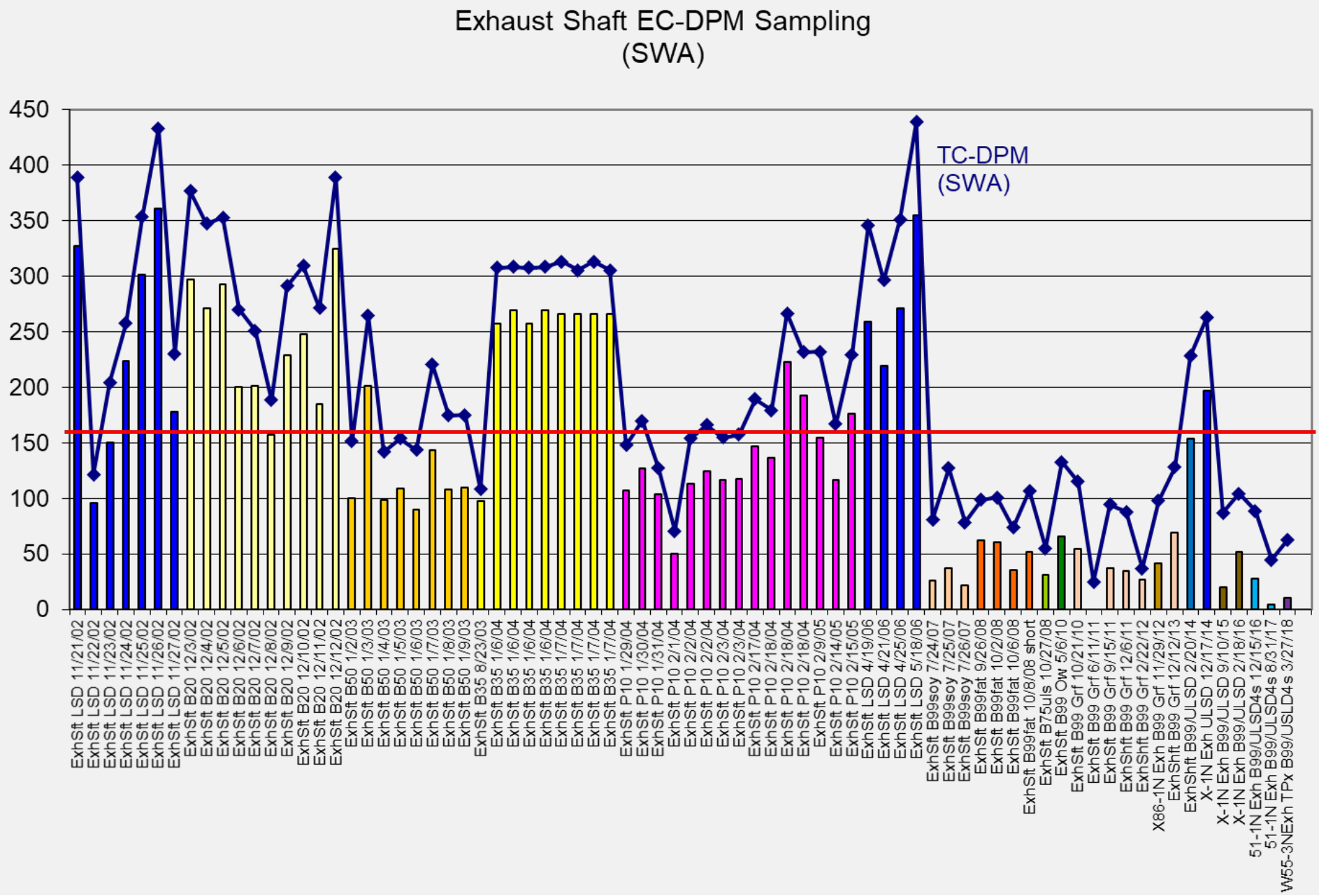
Tested and used PuriNOx

- 10% and 20% emulsion blends
- Majority of equipment operating on it from Jan ’04 to late ’05
- Select pieces still on it in mid-’06, but product phased out Dec’06

Switched back to biodiesel

- Selected B99 to meet PuriNOx performance levels
- Tried a few suppliers and feed stocks
- Migrated to distillation only processing of soy or yellow grease feed stocks

Fuels Performance



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The Good

- Biodiesel brought the Carmeuse UG limestone mines into DPM compliance in the early days of the DPM regulations
  - Alternatives and recommendations had been considered, but biodiesel was selected as the best lead option
- Biodiesel was instrumental in keeping the KY Mines in compliance during the DPM limit changes
  - Other DPM controls were utilized as well, but Bio remained the lead (eliminate the generation of emissions)
- Biodiesel was a part of keeping the mines in compliance
  - Tier 4 engine technology usage increased, with Biodiesel remaining utilized in the non-Tier 4 units
  - Without additional DPM controls development and implementation, unable to remain consistently within compliance limits without Biodiesel
- Very limited issues with power and performance
- Significant emissions reductions
- Another site utilized biodiesel to quickly achieve compliance

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The Bad

- Biodiesel has its disadvantages and limitations
  - Nothing is free; all of the DPM controls have costs associated with them

Biodiesel

- Increased fuel costs
  - Price
  - Consumption
  - Storage/handling
- Increased maintenance costs
  - Filters
  - Injectors
  - Hoses
- Increased production costs
  - Unplanned downtime (lost production)

Non-Bio DPM Controls (Tier 4)

- Increased new equipment cost (new engine technology)
- Increased fuel related costs (DEF Fluid)
- Increased maintenance costs
  - Regen system issues
  - DEF systems
  - DPM filters
- Increased production costs
  - DEF fluid procuring/handling
  - Regen's
  - Unplanned downtime

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The Ugly

- Downed equipment
  - Plugged fuel filters
  - Injector replacements
  - Deteriorated hoses and o-rings
  - Paint removal
- Varying quality fuel supplies/suppliers
  - Distilled biodiesel production proven to be best
    - Works for Yellow Grease or Soy based bio's
  - Filtration based bio production still leads to filter plugging
    - On-site filtration system additions unsuccessful
    - Blend levels above B20 more susceptible
    - Yellow Grease more susceptible than Soy
- Increased fuel cost, and lower BTU performance (ton/gal)
- Limited fuel supplies, and commodity price fluctuations
- Gelled surface fuel delivery lines
- Gelling in equip near winter air intake areas

Biodiesel Close Out

Carmeuse Experiences

Within Carmeuse, Maysville is the only UG site still utilizing Biodiesel for DPM compliance

With Tier 4 engines (new engine technology) coming in the new equipment replacements, phasing out Bio was one of our recent KY plans

- Although sticking with less problematic, Tier 3 technology was considered at times as well ☺
- Black River has reached that point
  - Fuel additive (TPx HD) is in use at BR to enhance fuel burning and emissions
- Maysville is 23% B99 and 77% ULS Diesel
  - BR had been 15% B99 and 85% ULS Diesel

No Biodiesel blends have been utilized in the Tier 4 engines

- B20 is the known manufacturer limit; B5 can be common level
- Internally decided no Bio would be used in Tier 4's due to the unknowns