Introduction to Re-Refined Vacuum Tower Asphalt Extenders (VTAEs)

Presented to OHMPA 2015 Fall Asphalt Seminar

December 02, 2015
Purpose of Presentation

• Provide a basic understanding of the characteristics of VTAEs
• Where do VTAEs come from
• How are they (or how “should they” be) used
Agenda

• Oil refining basics
• Crude refinery vs used oil re-refinery
• Statistics
• Discuss future of VTAEs
VTAEs

• Also known as…
  – REOB – Re-refined engine oil bottoms
  – RHVTB – Re-refined heavy vacuum tower bottoms
  – RMO – Re-refined motor oil
  – WEO – waste engine oil
  – Others as well…some not so flattering

• NORA has established VTAE as the standard for our industry
The Crude Oil Refinery
Simply Put: Asphalt Is A Vacuum Tower Bottom
Simplified Schematic – Crude Refinery

Atmospheric Distillation

Crude Oil → Atmospheric Pressure

- LPG
- LSR/Naphtha
- Jet Fuel
- Diesel
- Heating Oil

Vacuum Distillation

- LVGO
- VGO
- HVGO

Long Residue
Generally >350°C
~660°F

Short Residue
Or VTBs
Generally >425°C
~800°F
Asphalt and Lube Oil Production
What Determines Asphalt Grade?

• Crude oil feedstock
  – Heavy Crude: More Asphalt
  – Light Crude: Less Asphalt

• Type of refinery
  – Not all produce the same product slate

• How a given refinery is run
  – Based solely on economics
  – Spread in light vs heavy fraction profitability
  – Asphalt used as Coker feed?

• Lots of blending happens to make asphalt of a given grade
Distillation Process

Lubricating Oil Production

De-Waxing

Wax-Free Oils

Hydrotreating and Fractionating

Greases

Low Viscosity Lubes

Medium Viscosity Lubes

High Viscosity Lubes

Wax Free Oils Can Be Further Refined
Wax Free Oils

• Additives are used to enhance oil properties
  – Anti-wear additives
  – Friction reducers
  – Antioxidants

• Why do you change your oil?
  – Additives wear out
  – Wear metals from the engine
  – The base oils (wax-free oils) remain mostly unchanged

• We recycle the recovered oils to refine out the “base oils”
Oil Collection Process

• Oil collectors are required under used oil regulations strictly enforced by EPA to check the oil for contaminants that should not be in the crankcase oil
  – PCB’s from old transformers
  – Water
  – Glycols from coolants
  – Chlorinated compounds such as solvents

• The EPA has determined that oil collected in this way is non-hazardous
VGO Production – Group I VTAEs

- Used Oil Feedstock
- Guard Tanks for Quality Testing
- Vacuum Distillation
- Vacuum Distillation Bottoms
- VGO for Marine Fuel
- Industrial Fuels
- Fuel Stripping
- Dehydration

Recovered Oils

Typically, this process results in more lighter oil in the VTAE

Flash = 450°F+
Recovered Oils

Typically, this process results in less lighter oil in the VTAE

Flash = 550F+

Kleen®
PERFORMANCE PRODUCTS
The Oil Re-Refinery

This is the “Real Deal” …a true refinery!
Re-Refined Oils Breakdown

- ~13% Other Light Fractions (Including Losses) Water, Glycol, Fuels, Light Hydrocarbons
- ~75% Base Oils For Lubricant Production VGOs
- ~12% Asphalt Extenders (VTAEs) HVGOs
VTAEs – What is this stuff?

• Definition
  
  – The non-distilled fraction from the vacuum tower of re-refined lubricating oils

“Loosely” Equal To AC-1 Viscosity
Makeup of VTAEs

- Heavy Vacuum Gas Oils (HVG0s)
  - Higher viscosity lubricants
  - From industrial lubricants
    - Locomotives, Heavy Trucks, Generators etc.
    - Higher boiling point than base oils for standard motor oils
- Wear metals from engines, gears etc.
- Additives from motor oils
  - Polymers (synthetic oils)
  - Anti-friction additives (molybdenum)
  - Anti-wear (zinc)
  - Viscosity modifiers
Why Is VTAE Used In Paving Grade Asphalt?

- Used to modify viscosity
  - Crude refiners don’t always produce soft asphalt
  - Low viscosity binder reduces cracking potential
- More RAP/RAS requires softer base asphalt
  - Softer binders need to be engineered
  - Hard base asphalt needs to be blended with a cutter
The Bottom Line

• VTAEs have been used in paving applications for over 30 years in NA as a soft asphalt component to enhance low temperature and aging properties of binders

• Approximately 160KT of VTAEs are produced in NA: that is ~0.5% of total asphalt and less than ~0.4% of the paving asphalt
  – Generally it is used between 2% and 6% by weight of binder making up less than 0.2% by weight of total mix
  – Mix in NA may contain 10-20 times more recycled binder than VTAEs!
  – More recycled asphalt requires softer virgin binder for blending

Total AC in Mix = 5.0%
30% Recycle replacement = 1.5%
Virgin Binder = 3.5%
4% VTAE by weight of Virgin = 0.14%
1.5 / .14 = ~11 times more recycled asphalt
Myth: Used Engine Oil Is Added Into Asphalt

• Used Engine Oil (UMO) is dehydrated and screened (like crude oil)
• If it is not used as feed for a re-refinery it goes into the marine fuel oil market where it commands significantly higher price than wholesale asphalt
• Since it contains fuel (diesel and gasoline) it is combustible and cannot be used in hot mix plants
• Putting UMO into asphalt would be like pouring a heavy crude oil into asphalt
• Used Engine Oil is NEVER added to asphalt
• Little information until ~2009
• This has become a “high interest” issue in recent years
• Much ongoing research now
  – Agencies, Universities, Material Suppliers
• Asphalt Institute formed a task group as part of TAC - 2014
Asphalt Institute REOB Task Force

• Literature Review Results – 16 total papers published (from FHWA ETG Meeting 09/15 – Buncher)
  – 2 papers looked at waste engine oil (not re-refined)
  – 7 papers suggest the use of REOB is not detrimental and may enhance pavement performance
    • Research by a variety of sources
  – 7 papers suggest the use of REOB is detrimental to pavement performance
    • All 7 traceable to Hesp et al
Use In Paving Binders

• **Benefits** *(Dosage Dependent and when used properly)*
  - Improve Cold Temperature Properties
    • PG (PAV Properties)
  - Reduce Viscosity
  - Improves Resistance to Aging
  - Extends Conventional Asphalt
  - Reduces Carbon Footprint
  - Compatible with Nearly All Asphalts
  - Long History of Use
This Process defines VTAEs
This Process defines VTAEs

This is VTAE!
This Process defines VTAEs

**THIS IS NOT VTAE!**

**THIS IS VTAE!**
THANK YOU!