



GREEN ASPHALT  
TECHNOLOGIES, LLC.

# HYDROGREEN

## Bridging The Gap Between

### RAS and HMA

PREM NAIDOO

&

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# Asphalt Shingle Components



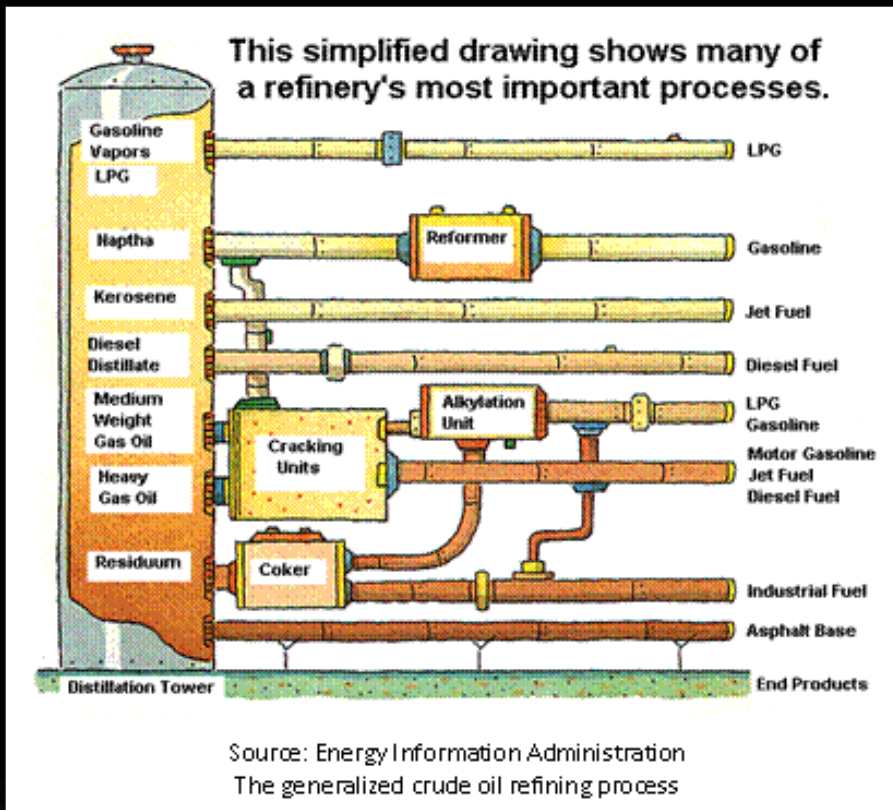
- Granules / Fine Aggregates
- Fiber Glass Mat / Organic Felt
- Mineral Filler Backing
- Asphalt Binder  
Typically 15-35% of Shingle

- This presentation will focus on the Asphalt Binder Component



# What is Asphalt?

■ Asphalt/Binder/Bitumen... "The Bottom of the Barrel" ...



- Start → Unrefined Crude Oil
- Process → Combination of high temperature (600°C+) and applying vacuum to create vapors. Cooled vapors condense and create liquid. Different vapors cool and condense at various heights of "The Barrel" – Fractional Distillation.
- Asphalt last in this process



# What is Asphalt Binder?

- Asphaltenes – Solid. Have the highest polarity. Act as thickeners – direct effect on binder viscosity.
- Resins – Semi-solid. Highly adhesive component. Act as a dispersing medium for the asphaltenes.
- Aromatics – Liquid. Serve as primary dispersion medium for the asphaltenes.
- Saturates – Liquid. Viscous-oily component. Highly absorptive with direct impact on binder fluidity.

“Not all asphalt binder is the same” = Not all asphalt compositions are the same



# Manufactured vs. Post Consumer

## ■ Manufactured Scrap Shingles –

(a) Asphalt binder oxidized (aged) to meet roofing grades

### **Shingle Binder**

(b) Approximately 15-20% asphalt binder per ton of shingle

(c) Are there alternatives to oxidizing? Revisit at end of presentation

## ■ Post Consumer / Tear-Off Shingles –

(a) Asphalt binder oxidized to meet shingle grades + asphalt binder further oxidized during life usage of the shingle

### **Shingle Binder → RAS Binder**

(b) Approximately 20-35% asphalt binder per ton of shingle



# Post Consumer Additional Factors

Oxidation = Aging ; Asphalt Oxidation = Asphalt Aging

- During service life shingles are exposed to oxidative conditions:
  - (a) UV exposure from sunlight
  - (b) Moisture due to rain / Thawing snow
  - (c) Temperature changes (Summer → Fall → Winter → Spring)
- = “One Word”
- = Glassy State / Brittleness
- = Increased Stiffness
- = Increased Viscosity
- = Increased Surface Energy
- = Decreased Elasticity
- = Loss in Aggregate Coating
- = Increased Asphaltenes



# Roofing-to-Pavement Comparison

## Roofing:

- Utilizes oxidized asphalt
- Fine Aggregates, Filler
- Water Resistance is Key
- 15 - 25% Binder

## Pavements:

- Utilizes virgin asphalt
- Coarse & Fine Aggregates, Filler
- Handle Traffic Loads is Key
- 4 - 7% Binder

## ■ So....

- Why not use RAS asphalt to replace virgin asphalt?
- What is the difference between RAS asphalt & virgin asphalt?

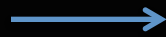




# Asphalt Performance Grade (PG)

- Developed to characterize and differentiate asphalt binders.
- Two part grading – High Temperature – Low Temperature

This asphalt is capable of withstanding a temperature up to 64°C without rutting/softening



64 - 22



This asphalt is capable of withstanding a temperature of -22°C without cracking

- Common typical asphalt grades include:
- PG 64-22, PG 70-22, PG 76-22, PG 58-28, PG 52-34







# Shingle Binder PG

<b>RAS</b>	<b>PG Grade (°C)</b>	<b>Typical Pavement Grades (°C)</b>
Post Consumer 1	184 - +24	64 - 22
Post Consumer 2	178 - +18	70 - 22
Post Consumer 3	169.2 - +18	76 - 22
Manufactured Scrap 1	134.4 - +6.5	58 - 28
Manufactured Scrap 2	140.2 - 1.0	52 - 34

- Determined through extraction and PG characterization.
- "PG +24" – Asphalt will crack if temperature drops below +24°C/+75°F
- Shingle binders highly rut resistant, but highly crack susceptible
- Manufactured Scrap RAS is hard; Post Consumer RAS is even harder



# Effect of RAS on Virgin Asphalt

- How much does RAS change the virgin asphalt?

	<b>PG Grade (°C)</b>	<b>High Temperature Differential (°C)</b>	<b>Low Temperature Differential (°C)</b>
Virgin 64-22	66.3 – 23.3	-	-
40% RAP Mix Design	84.4 – 16.5	+ 18.1	+ 6.8
40% RAP + 5% RAS Mix Design	101.5 – 9.8	+ 17.1	+ 6.7

- Effect of 40% RAP = Effect of 5% RAS on the virgin binder
- Increased Rut Resistance ; Decreased Crack Resistance



# Issues Related to Using RAS in HMA

- RAS has a significant hardening effect on the binder
- Significantly decreases crack resistance
- Stiffer asphalt binder = Viscous asphalt binder
- Viscous asphalt binder = Less mix workability

## Limitations:

- ⌘ Manufactured Scrap, though limited, preferred over Post Consumer Tear-off
- ⌘ Virgin asphalt start grade cannot be maintained – Crack Susceptible
- ⌘ Addition of RAS significantly hurts binder/mix workability
- ⌘ Quantity of RAS allowed in mix design must be restricted

Can these limitations be overcome?



# Hydrogreen Introduction

- Liquid product added to the asphalt binder to re-disperse asphaltenes and counter the stiffness of the RAP/RAS binders. Successfully converts the high RAP/RAS asphaltene proportion back to virgin binder qualities.
- Extends binder properties window to accept more RAP and RAS
- Restoration of long-term pavement life
- Blending of Virgin Binder with RAP/RAS Binder - Comingling
- Low volatility – Less than 1% = RTFOT compliant
- Effective with both RAP and RAS
- Oxidizes at a LOWER rate than virgin asphalt.
- Rejuvenating NOT Softening Agent – Restores youth to pavement



# Hydrogreen Chemistry Evaluation

- ⌘ Manufactured Scrap, tough limited, preferred over Post Consumer Tear-Off
- Hydrogreen addition rate on the weight of the RAS itself

<b>RAS</b>	<b>PG Grade (°C)</b>	<b>Hydrogreen Addition Rate - % on RAS</b>	<b>PG Grade (°C)</b>
Post Consumer 1	184 - +24	11%	70.3 – 41.5
Post Consumer 2	178 – +18	8.5%	88.0 – 26.0
Post Consumer 3	169.2 – +18	7%	85.3 – 21.8
Manufactured Scrap 1	134.4 – +6.5	5%	82.3 – 22.3

- ✓ Effective on both Manufactured Scrap and Post Consumer



# Recap - Effect of RAS on Virgin Asphalt

- ⌘ Virgin asphalt start grade cannot be maintained – Crack Susceptibility
- Can Hydrogreen bridge the gap between RAS and Virgin asphalt?

	<b>PG Grade (°C)</b>	<b>High Temperature Differential (°C)</b>	<b>Low Temperature Differential (°C)</b>
Virgin 64-22	66.3 – 23.3	-	-
40% RAP Mix Design	84.4 – 16.5	+ 18.1	+ 6.8
40% RAP + 5% RAS Mix <b>40% RAP + 5% RAS + 0.50% HYD (Weight of Mix)</b>	101.5 – 9.8 <b>85.9 – 22.4</b>	+ 17.1 <b>+ 1.5</b>	+ 6.7 <b>- 5.9</b>

- ✓ Hydrogreen restores virgin low temperature properties while maintaining desired rut resistance provided by the RAS



# Hydrogreen Effect on Binder Viscosity

- ⌘ Addition of RAS significantly hurts binder/mix workability
- Binder Viscosity directly effects the workability of the mix. A binder with viscosity less than 3000 cps @ 135°C is deemed sufficiently workable.

Mix Design Extracted	Viscosity @ 135°C
40% RAP + 5% RAS Mix <b>40% RAP + 5% RAS + 0.5% HYD Mix</b>	12,650 cps <b>2,925 cps</b>
30% RAP + 5% RAS Mix <b>30% RAP + 5% RAS + 0.3% HYD Mix</b>	9,750 cps <b>2,713 cps</b>

- ✓ Even with combination High RAP + RAS mix designs the workability of the binder is maintained to specification levels
- ✓ Hydrogreen demonstrating slip properties = Workability



# Pushing the RAS Envelope

- ⌘ Quantity of RAS allowed in mix design must be restricted
- Majority of States consider 5% RAS the upper limit for HMA mix design.

Mix Design	Mix AC Content (%)	Virgin AC – RAP/RAS AC	PG Grade (°C)	Rotational Viscosity @ 135°C (cps)
20% RAP + 10% RAS	5.0	39.0 – 61.0	105.8 – 4.4	20,450
<b>20% RAP + 10% RAS + 0.60% HYD Mix</b>	<b>5.0</b>	<b>39.0 – 61.0</b>	<b>85.1 – 22.4</b>	<b>2,813</b>

- ✓ The quantity of RAS in the mix is no longer a binder quality restricted issue





# Issues Related to Using RAS in HMA

## Limitations:

- ~~⌘ Manufactured Scrap, though limited, preferred over Recycled Tear-Off~~
- ~~⌘ Virgin asphalt start grade cannot be maintained – Crack Susceptibility~~
- ~~⌘ Addition of RAS significantly hurts binder/mix workability~~
- ~~⌘ Quantity of RAS allowed in mix design must be restricted~~
- ✓ Manufactured Scrap and Post Consumer Tear-Off on equal ground
- ✓ Virgin asphalt grade can be maintained while maintaining positive RAS rut resistance properties
- ✓ Even in high RAP/RAS designs Hydrogreen can maintain workability window
- ✓ Opens the door to higher RAS usage while maintaining binder properties



# Paving Experiences To-Date

- Missouri, Kansas, New York, Florida, Michigan, Nebraska
- Contractor with Experience Incorporating RAS/RAP/Hydrogreen Over 1.5 Million Tons Paved- Superior Bowen Asphalt Co. and R2R



# Side Note: New BUR Grade Additive

- Manufactured Scrap Shingles –

Asphalt binder typically **oxidized** to meet roofing grades

- New Alternative developed:

- No need for Oxidizing to meet Roofing Grades

- Additive simply added to the base asphalt and agitated

- Base Asphalt: Softening Point = 125.3°F, Pen = 56

- +1% Additive: Softening Point = 135.6°F, Pen = 45 – BUR Type 1

- +2% Additive: Softening Point = 165.5°F, Pen = 37 – BUR Type 2

- +4% Additive: Softening Point = 202.0°F, Pen = 30 – BUR Type 3

- +6% Additive: Softening Point = 212.5°F, Pen = 25 – BUR Type 4

# For More Information

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