



# **North American Asphalt; Past, Present & Yet to Come**

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# About ASA

**Asphalt and Sourcing Alliance (ASA)** is a consulting group comprised of established and industry recognized individuals with extensive experience in working with asphalt; assisting asphalt refining, asphalt paving and asphalt roofing clients to solve problems in all facets of their business

- ASA offers “**Virtual**” staff integration
  - Fee-paid resources and capabilities
  - Available for short-term or long-term, No headcount impact
- Technology guidance & analytical resources
- Idea generation & feedback without bias
- Best practices to manage costs
- Confidential transactions & agreements

**ASA** has conducted multiple asphalt market studies for its clients and has presented to multiple North American and International Industry groups

*AS I BEGIN TODAY'S TOPIC, I AM REMINDED OF A  
BOOK I RECENTLY READ:*

# ORIGIN

A NOVEL BY DAN BROWN

**Where do we come from?**

**Where are we going?**

# Where Do We Come From?

**How many of you will agree that the asphalt binder of today doesn't work as well as it did 10 or 20 years ago? How many will agree that it doesn't work the same as it did last month?**

The asphalt we use today is different; now generated from multiple and very different crude oils, perhaps processed differently and often extended or modified by the addition of one or more new chemistries, all with the intent of generating a performing road mix or lasting roofing product.

Today, we will take a quick look at some reasons for the many changes that have occurred and try to grasp some of the changes yet to come. We will also briefly examine some of the additive tools being developed to modify and manage the continuing challenges we face in using this unique black and sticky glue found throughout our nation's highways.

# Where Do We Come From?

*In 1995, we were receiving 100% of our asphalt requirement for a Texas manufacturing plant from a local refinery in West Texas and had been doing so for several years*

*The refiner ran a locally produced West Texas sour crude and the asphalt was always high quality and very consistent*

*In 1996, Texaco was expanding its refinery in Port Arthur, TX and building a product pipeline to transport gasoline and jet fuel from Port Arthur to West Texas and on to Denver*

*By 1998, that single Texaco project had forced the closure of six less-complex refineries along or near the pipeline path because they could no longer compete in their local fuel markets*

# What is Asphalt...

**The heavy black sludge that's remaining after distilling a barrel of crude oil?**

Asphalt is a unique mixture of chemical molecules generated from the specific crude oil(s) that were processed by a refinery

The major asphalt molecular structures are classified as “**maltenes**” (composed of asphaltic resins & oils) and rock-hard “**asphaltenes**” (large polar and non-polar molecular structures)

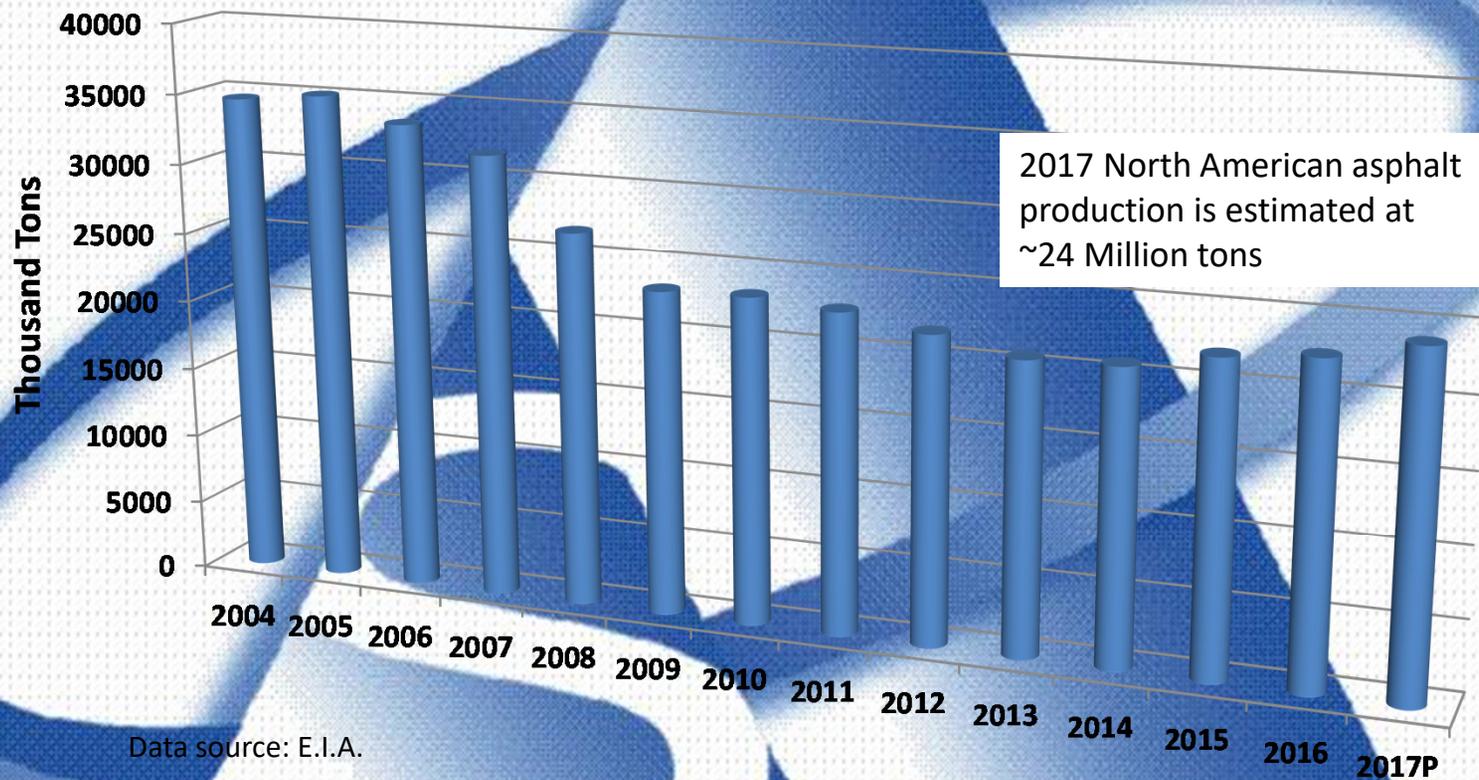
For most applications, the **maltene** fraction, comprised of **saturates** and **aromatics**, is the key functional component, providing strength, flexibility, solvency and polymer compatibility. Solvency and compatibility are further aided by the **aromatics** found in the **maltenes** and **distillate** fractions. The **naphthenic** or **paraffinic** characteristics of these components impact polymer compatibility

# Asphalt Demand

- Total Paving, tons                      80-85%                      ~20,000,000
- Total Roofing, tons                      15-17%                      ~4,000,000
  - Roofing Shingle Flux
  - Modified Bitumen Membranes
  - Built-up Roofing Asphalt
  - Roofing Adhesives; Self-Seal Adhesives, Laminating Adhesives
- Other applications, tons                      1-2%                      ~200,000-400,000
  - Crack-fillers for concrete or asphalt
  - Foundation & Waterproofing Coatings
  - Driveway & Parking Lot Sealers
  - Specialty niche applications

# Asphalt Production

## U.S. Asphalt Production



Asphalt production is gradually increasing with increasing demand

# Fundamentals

- Global crude oil development has changed; shifting from predominately heavy sour crude to producing shale oil; containing little or no asphalt content, then back again as OPEC forced a new global balance of crude oil in 2014
- Transportation of crude oil today involves more flow by pipeline and more comingling of crudes
- Clean Air Act spawned refining technology; consolidating refining operations and shutting down many refineries
- Coker technologies changed the refinery value of asphalt
- Refinery product pipelines and increased refining complexity led to improved refinery profitability

# Fundamentals

- Pre-2000 – Heavy sour crudes dominated new production
- 2003-2004 – PDVSA strike disrupted crude oil and asphalt
- 2003-2008 – Tar Sands emerged as new heavy crude supply
- 2009-2014 – Shale Oil dominated NA crude oil growth
- 2015 – OPEC (Saudi) increased production to drop price
  - as a targeted result, U.S. Shale Oil production plummeted
- 2016 – More Iranian & Iraqi crude oil comes into market
- 2016-2017 – Shale Oil recovers as incremental cost supply
- 2016-2017 – Emergence of integrated crude traders
- 2017 – OPEC cuts crude production to stabilize global price
- 2018-2020+ – MARPOL?

# Fundamentals

- MARPOL 2020: Max. 0.5% sulfur in heavy fuel by 2020
  - Ship-board scrubbers on 19,000+ vessels?
  - Refinery investments?
  - Chemical additives to reduce sulfur emissions?
  - Compliance & Policing
- Will refiners run more **sweet crude** for LS Marine Fuel?
  - Reducing asphalt and coker feed production?
  - May drive expanded discounts on heavy sour crude oils?
- Will MARPOL regulations push asphalt out of heavy fuels?
- Economic impacts on asphalt supply, price or quality?
- Market stability?

# Fundamentals

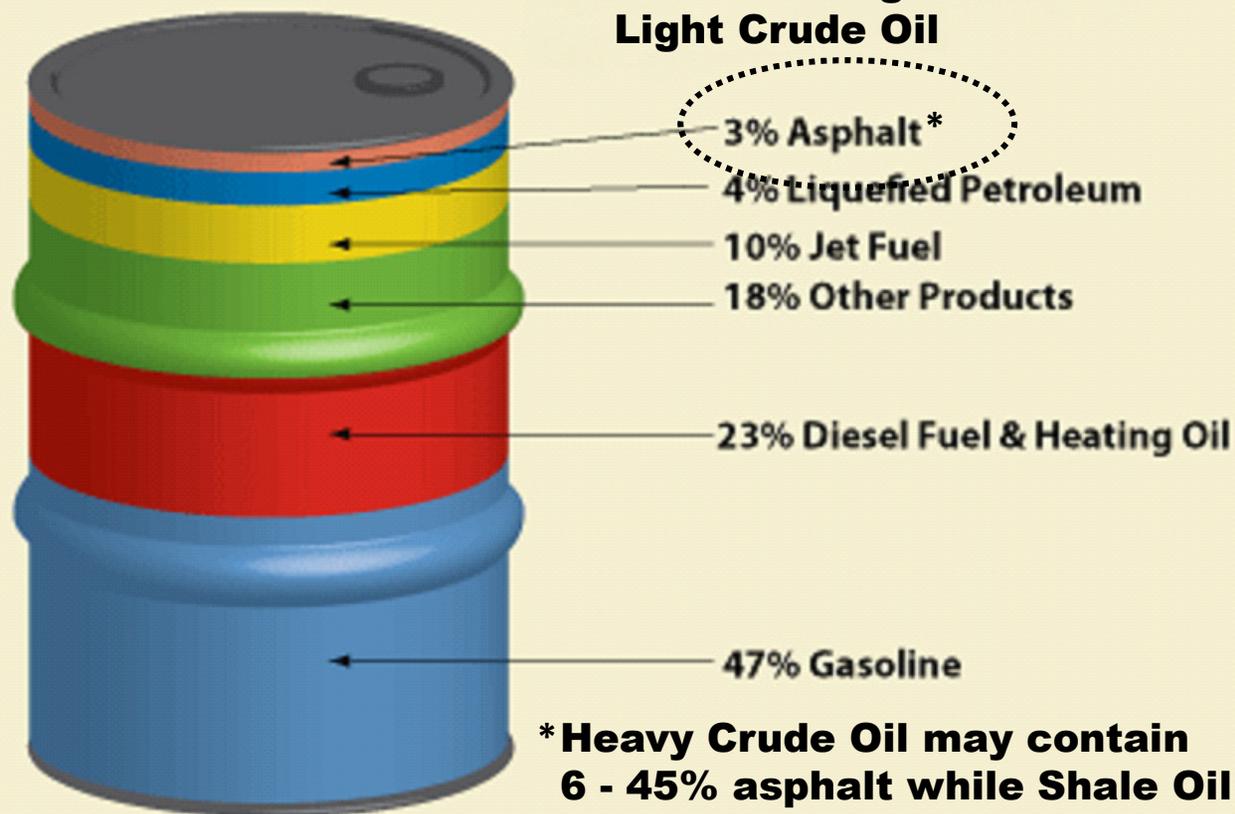
- Conventional U.S. Heavy – **6-8% asphalt**
  - Cost of new wells - ~\$80-\$110 per BBL
- U.S. Shale Oil – **0-2% asphalt**
  - **New well economics - ~\$50-\$60 per BBL**
  - Cost of adding laterals on existing wells - **~\$27-\$50** per BBL
- Conventional Canadian Heavy – **30-40% asphalt**
  - Cost of new wells - ~\$80-\$110 per BBL
- Canadian Tar Sands – **70% asphalt\*** (mostly asphaltenes)
  - Cost of new capacity - ~\$85-\$95 per BBL
- Brent/North Sea – **5-10% Asphalt** - ~\$50-\$60 per BBL
- Middle East – **10-15% Asphalt** - ~\$20-\$40 per BBL
- Venezuelan – **40-45% Asphalt** - ~\$40-\$60 per BBL

# Fundamentals

- Today, there are ~130 refineries operating in North America and ~70 of those produce asphalt
- Majority of North American asphalt is generated from Conventional Heavy Sour (sulfur containing) Crudes
- Synthetic Crude oil qualifies as a heavy crude oil but the asphalt generated is of poor quality for both roofing and paving applications
  - Poor quality limits slates to a small percentage of synthetic crude or as a block-run of synthetic crude oil for coker feed
  - Synthetic crude oil is typically low in sulfur content which may offer refiners a different option in addressing MARPOL 2020
- Shale oil generates a small amount of waxy asphalt but not enough to support asphalt demand or coker demand

# Fundamentals

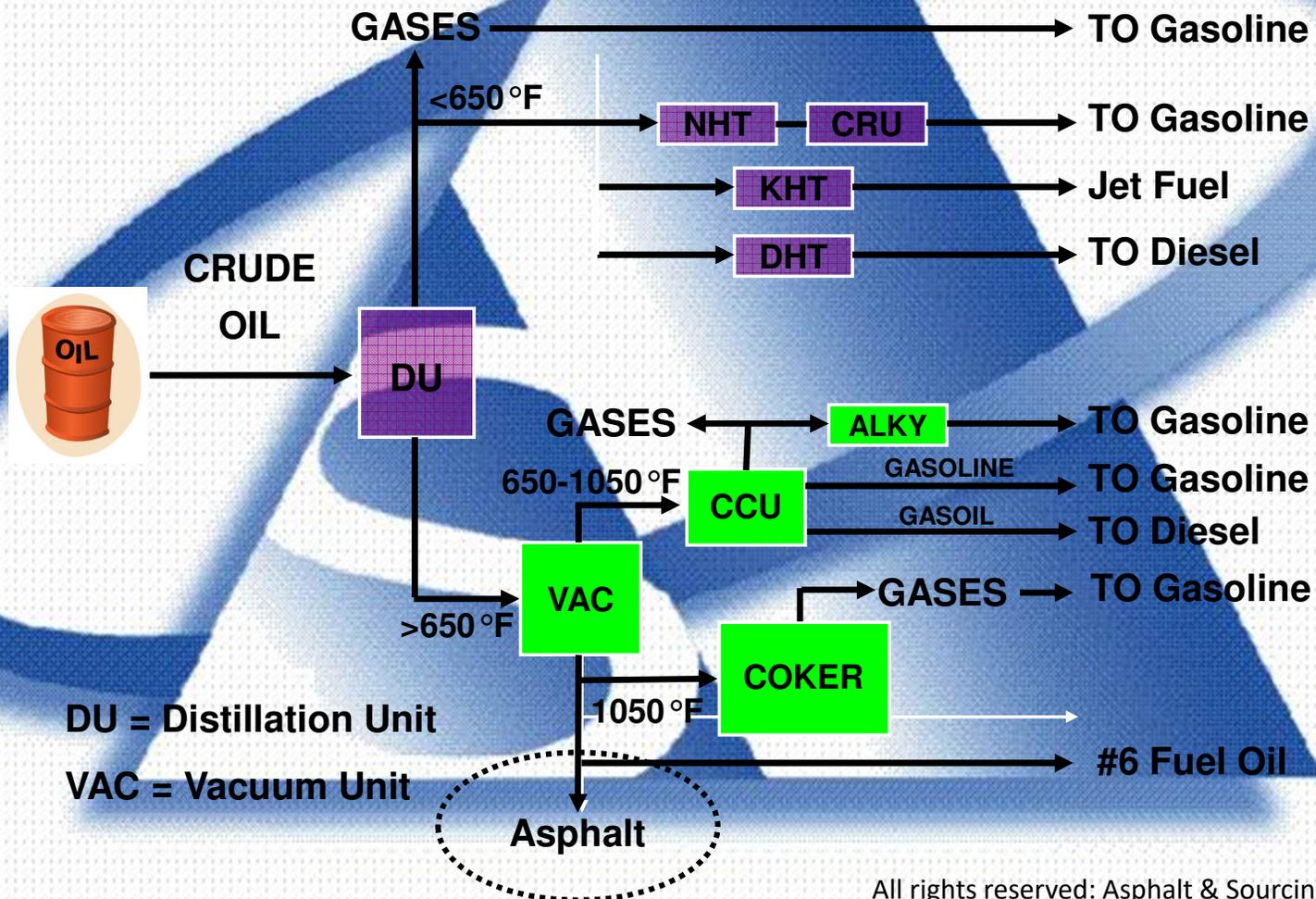
## Typical Products Made from Refining a Barrel of Light Crude Oil



**\* Heavy Crude Oil may contain 6 - 45% asphalt while Shale Oil contains 0-1% asphalt**

# Fundamentals

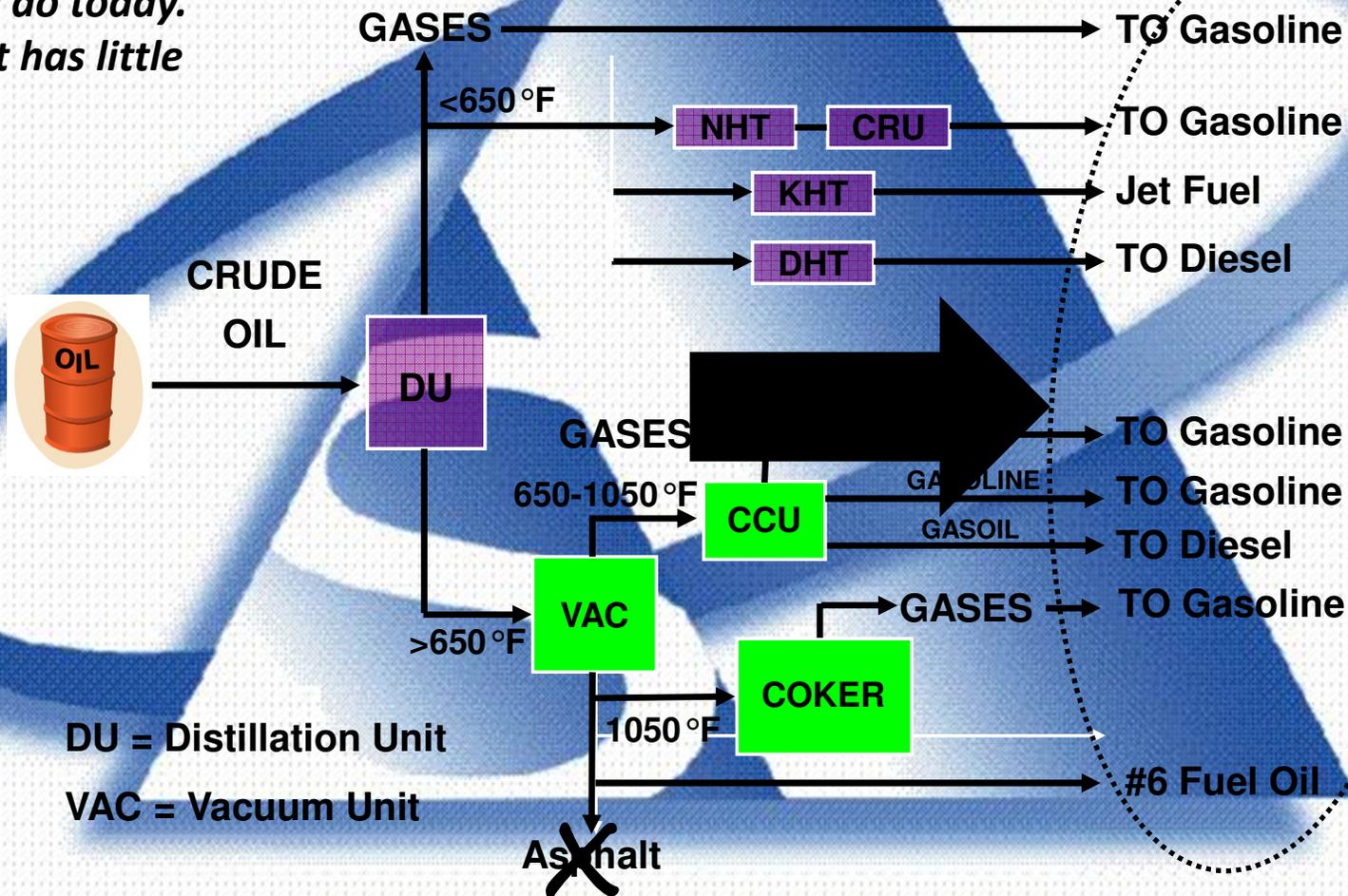
## CCU - “Complex” Refinery



*Motor fuels are why most refineries exist and why they make many of the decisions as they do today. Asphalt has little impact*

# Fundamentals

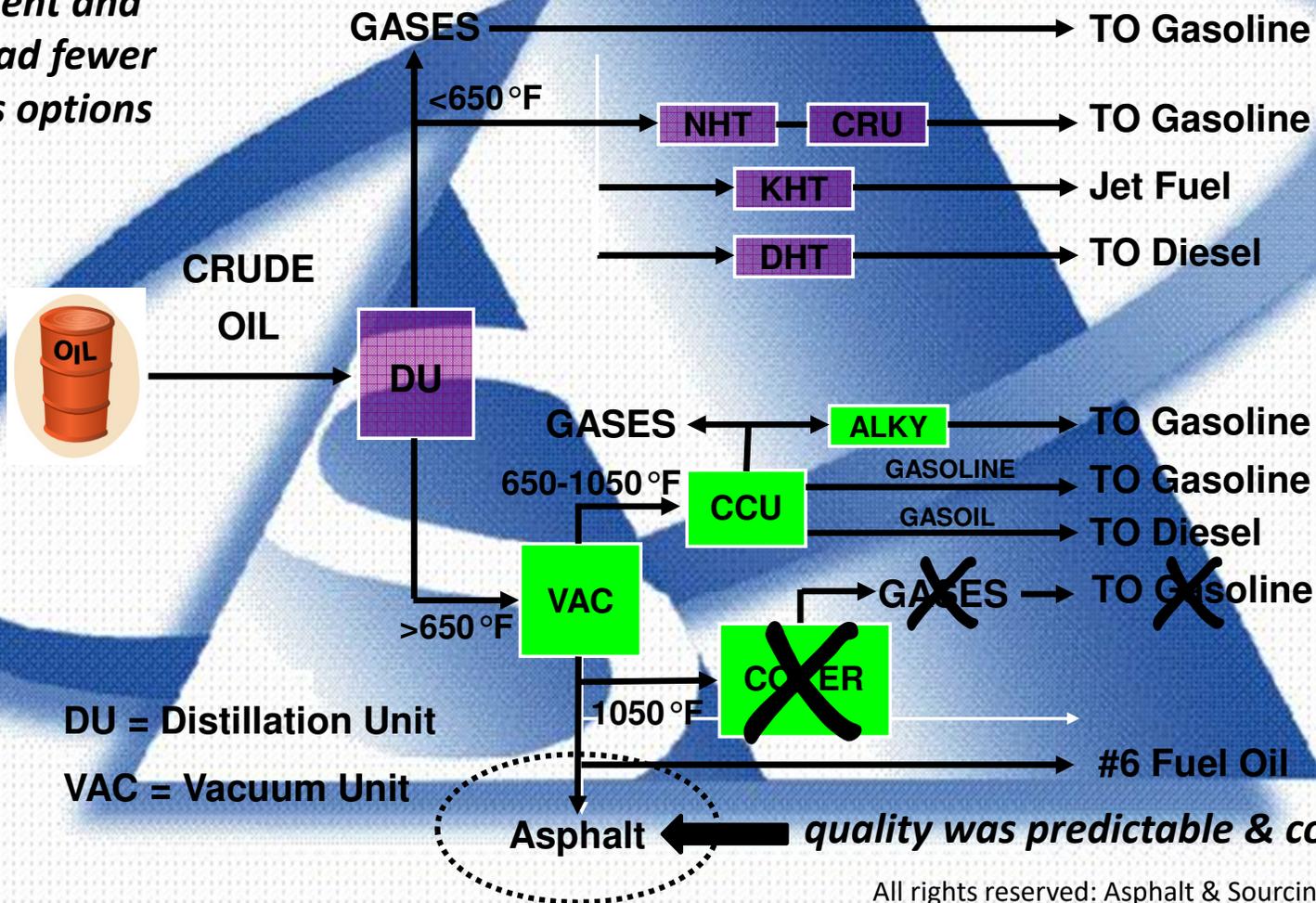
## CCU - "Complex" Refinery



25 years ago,  
refiners running  
single or 1-3  
crude oils were  
common.  
Changes were  
infrequent and  
most had fewer  
process options

# Fundamentals

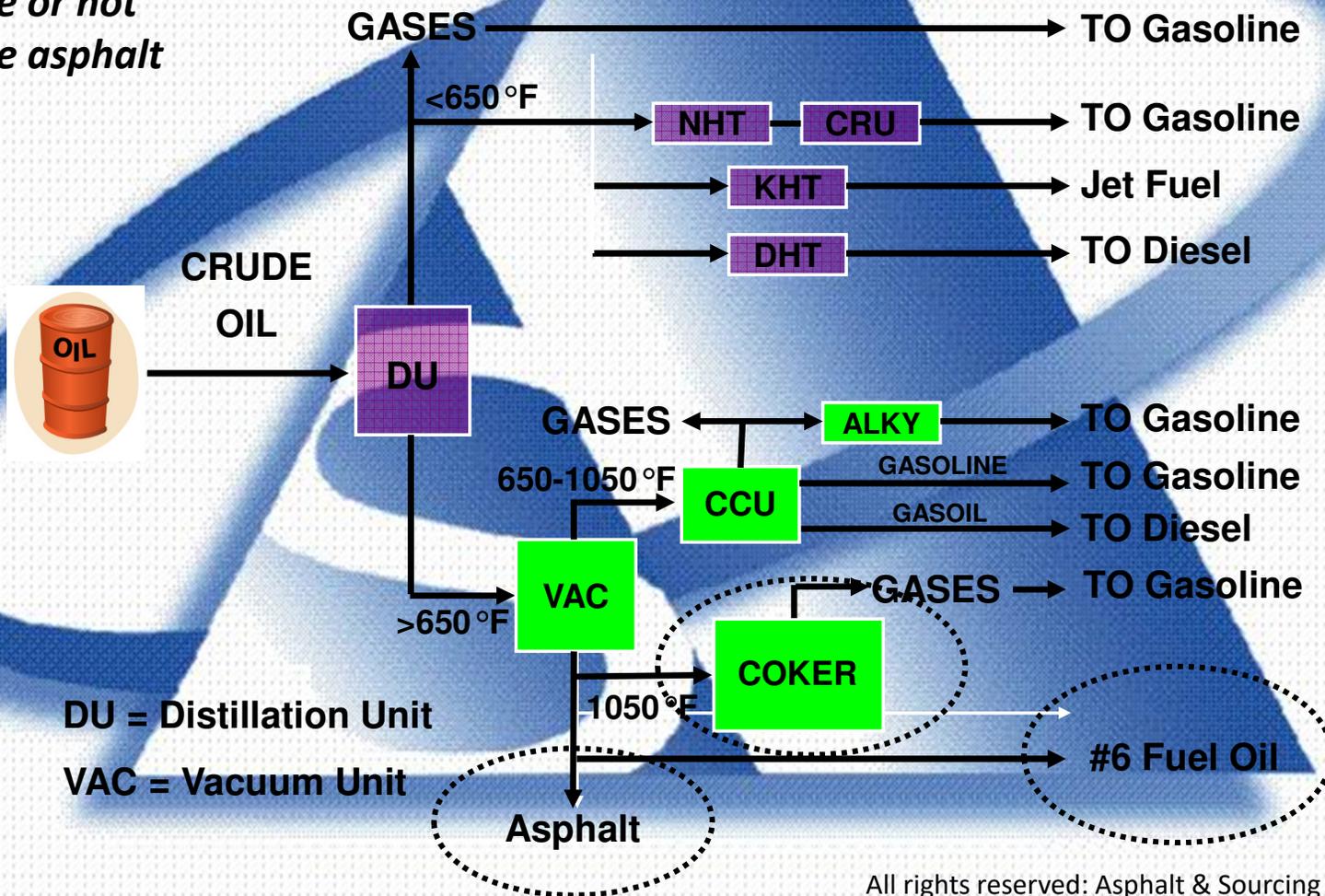
## CCU - "Complex" Refinery



Today, with the advent of cokers, most asphalt-capable refineries can choose to produce or not produce asphalt

# Fundamentals

## CCU - “Complex” Refinery



# Fundamentals

U.S. Coker Capacity



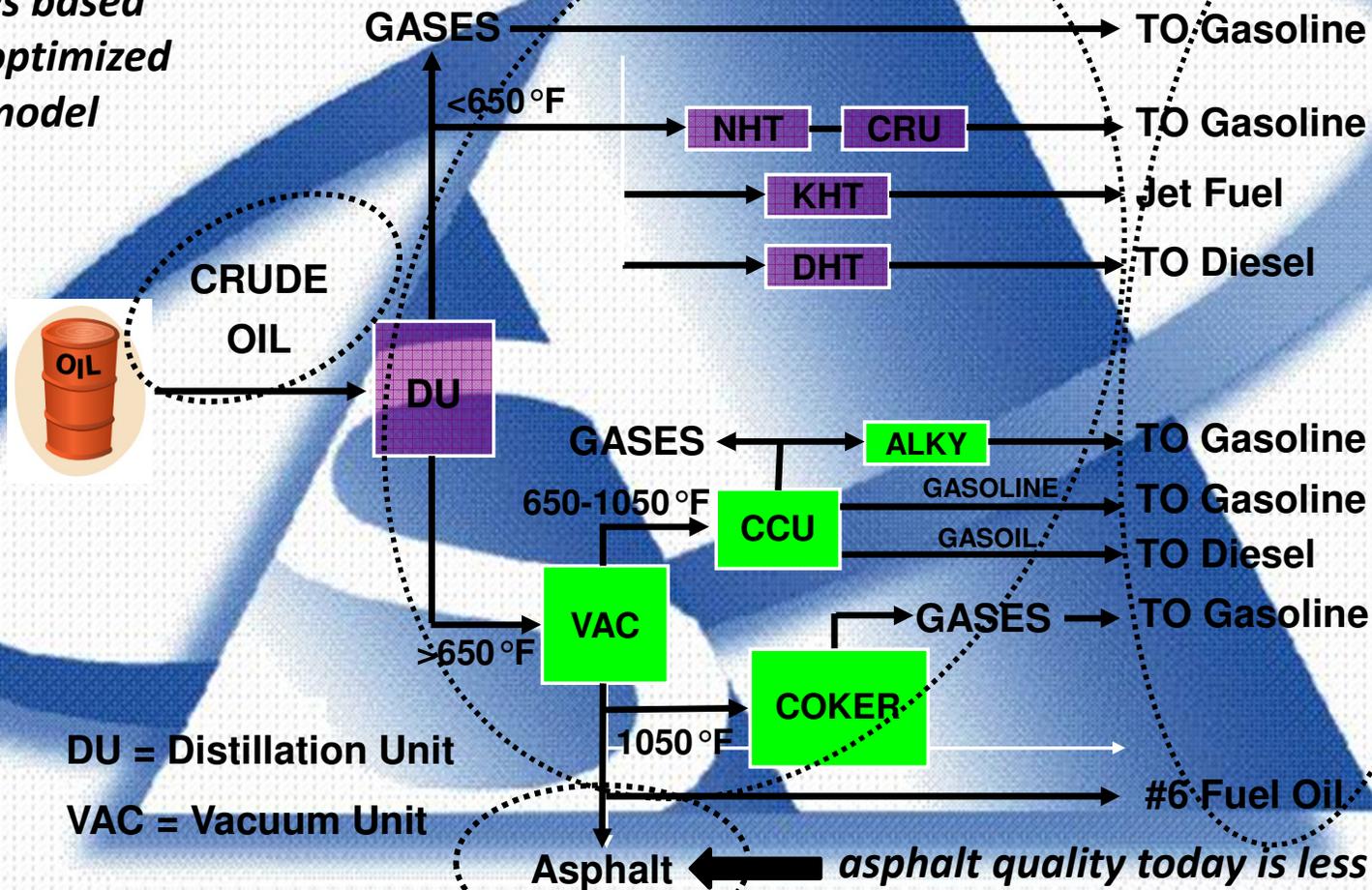
Data source: E.I.A.

Coker technology does not distinguish feedstock value based on crude oil basis

Today, most refiners will run 5-9+ crude oils simultaneously, with crude slate and product changes based on an optimized value model

# Fundamentals

## CCU - "Complex" Refinery



# How Does This Impact Asphalt?

- 2003-2008 – Synthetic crude generates poor quality asphalt
- 2008-2014 – Asphalt price increases with crude price
- 2009-2014 – Shale Oil generates little asphalt
- 2010-2017 – Chemical extenders and bio-alternatives flood the asphalt marketplace: **good/bad or ?**
- 2014-2015 – Asphalt price falls 50% following OPEC actions
- 2014-2017 – Blending with non-petroleum products may change functional characteristics of asphalt: **good/bad or ?**
- 2015-2017 – Integrated asphalt & crude traders arrive, further obscuring the crude oil lineage of the asphalt we use
- Will MARPOL increase or reduce asphalt supply?

# How Does This Impact Asphalt?

**It still looks the same....it's still black and sticky....**

Asphalt is the unique mixture of chemical molecules generated from the specific crude oil(s) that were processed by the refinery

Compatibility & functionality with polymers and additive chemistries is heavily influenced by this unique mixture

- Different crude oils yield different chemical mixtures in the refined asphalt
- Comingling different crude oils may change the functional characteristics of the refined asphalt
- Comingling different asphalts can also change the functional characteristics

# Where Are We Going?

**Quality issues spurred development of asphalt additives**

- Aromatic Extracts & Blends
- REOB or VTAE (Re-refined Engine Oil Bottoms)
- Naphthenic & Paraffinic Oils
- Amine and non-amine antistrips, poly-Phosphoric Acid (PPA)
- **Micro-waxes & wax-based modifiers/extenders**<sup>\*New</sup>
- **Surfactants and surfactant-based modifiers/extenders**<sup>\*New</sup>
- **Multiple Bio-Binders & Bio-Oil Blends**<sup>\*New</sup>
- **Natural Oils**<sup>\*New</sup> such as Corn, Soy, Canola, Flaxseed, Tall Oil
- **Re-purposed Vegetable Oils**<sup>\*New</sup> & **Hybrid oil blends**<sup>\*New</sup>
- **Waste Engine Oils**<sup>\*Sorta New</sup>

# Where Are We Going?

- Modifiers are widely used today by refiners & terminals but not always specified as such
- Most modifiers will offer some degree of improvement
- Modifiers that may have worked last year....may not work next year due to changes in the base asphalt
- Risk of phase separation may exist with certain modifiers
- More modifiers from renewable resources are surfacing
- Not all modifiers will age or weather acceptably
- Be wary of “asphalt specific” or “crude oil specific” labels
- Overuse, misuse and misinformation issues do exist

# Where Are We Going?

- New roads are failing in several states & provinces
- Paving industry is reluctant to accept risk of mix failure
- Mix approvals stalled, i.e. *“Who killed high RAP?”* \*
- Agencies are considering highway-protective strategies while seeking more credible performance test protocols
  - Improved analytical methods for detecting use of additives
  - Ban/limit suspicious additives and non-petroleum additives?
  - Increased use of PMA?
  - Highway pavement warranties?
  - Encourage use of less RAP & RAS?

\* from California Asphalt Pavement magazine

# Where Are We Going?

**Asphalt compatibility & performance has become less predictable**

- Asphalt made from Tar Sands or from Shale is poor quality
- Blending crude(s) changes the asphalt & mix effectiveness
- Poor asphalt quality attracts new performance modifiers
- Tightening asphalt supply drives cost & invites extenders
- Price arbitrage attracts new importers with blended asphalt
- Existing PG criteria may not apply to High RAP or additives
- No unified performance protocols for asphalt additives

**Asphalt mix performance (pavement life) has become less assured**

# Where Are We Going?

- Quality of the asphalt binder we use to build our highways is changing, driven largely by prevailing market conditions
  - Further quality changes are possible with MARPOL impacts
- Improved performance test methods are evolving but there's no reason to wait; only reason to move cautiously
- Expanding technology is bringing us proven solutions such as new functional chemistry and new methodologies
  - Your best solution(s) will rely on new chemistry
- Real & lasting solutions are already here but success depends on patient & disciplined efforts by all stake-holders
- Ask questions, test and evaluate carefully. Challenge and understand application protocols for any chosen modifier

# Where Are We Going?

- As the refining industry evolved in the 1990's with its coker technologies and increased refining complexity, the asphalt industry must evolve in its knowledge and use of asphalt
- We are all stakeholders in our respective highway programs; differing only in the active roles we play
- Get involved in the asphalt marketplace to anticipate, recognize, and manage change rather than be tormented by the failures you didn't see coming
- As the quality of the available asphalt changes, we can learn to adapt to those changes
- Foster new and evolving chemical technologies that offer the potential to improve mix performance

# Where Are We Going?

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*By 1998, that Texaco project had forced the closure of six less-complex refineries along or near the pipeline path because they could no longer compete in their local fuel markets*

**By 1997, we had adapted; finding better quality & lower cost**



**THANK YOU FOR LISTENING.  
QUESTIONS?**

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# 2018 Argus Asphalt Summit

March 12-14, 2018 - Miami

**Asphalt Additives and the Occurrence of Failures:** Many things are changing with the base asphalt and there are many pathways opening up to address those changes including the increasing use of additives for modification.

Not all these tools are properly used and not all additives work as effectively as others. As a result, we face an increasing number of highway failures that are not well understood and everyone casts blame.

Join this interactive panel of experts as we:

- Discuss how to better manage these issues at an industry/agency level
- Evaluate ways to promote the proper processes to be followed
- Analyze strategies for the usage of additive materials in a responsible manner

**Allen Smith**, Managing Partner, **Asphalt & Sourcing Alliance**

**Bill Lee**, PhD, Terminal Manager, **Century Asphalt**, an Eagle Brothers Company

**Al Palmer**, Technical Director, **Kleen Performance Products**

**Austin Miller**, CEO, **Lunday-Thagard Refining**

**Jim Musselman**, Asphalt Performance Mgr., **Oldcastle Materials** & former **FDOT**