Thermal Cracking Technologies for VTAE and Waste oils

Presented by LouisBertrand and Lucie Wheeler

Sweet Gazoil inc.

Agenda

- **Oil distillation and cracking**
- **Cracking and coking in refineries**
- **Cracking as applied to waste oils**
- **Economics of cracking**
- **Questions**

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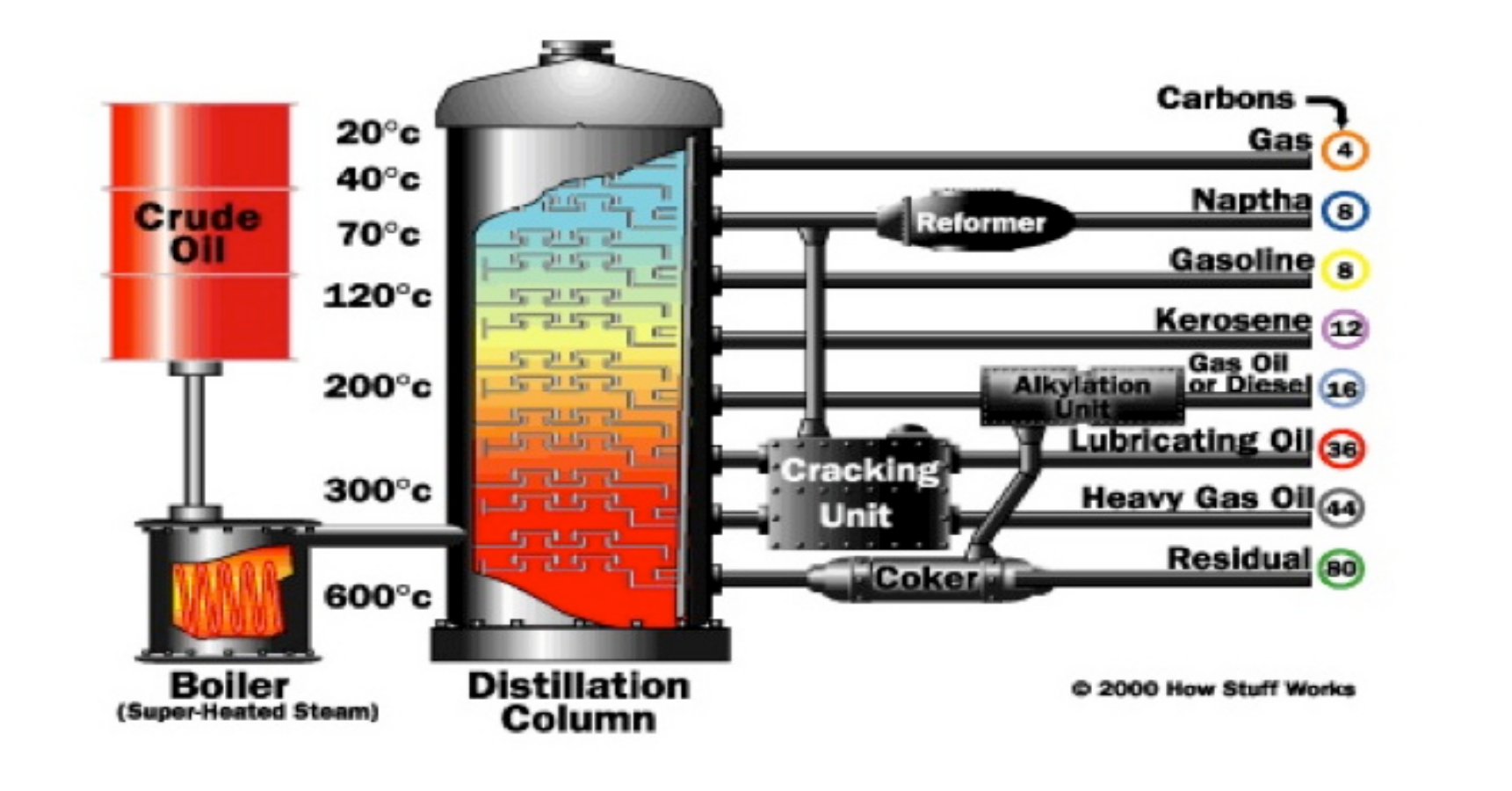
Oil distillation

Distillation is used to separate the components of a liquid mixture according to their boiling point ranges.



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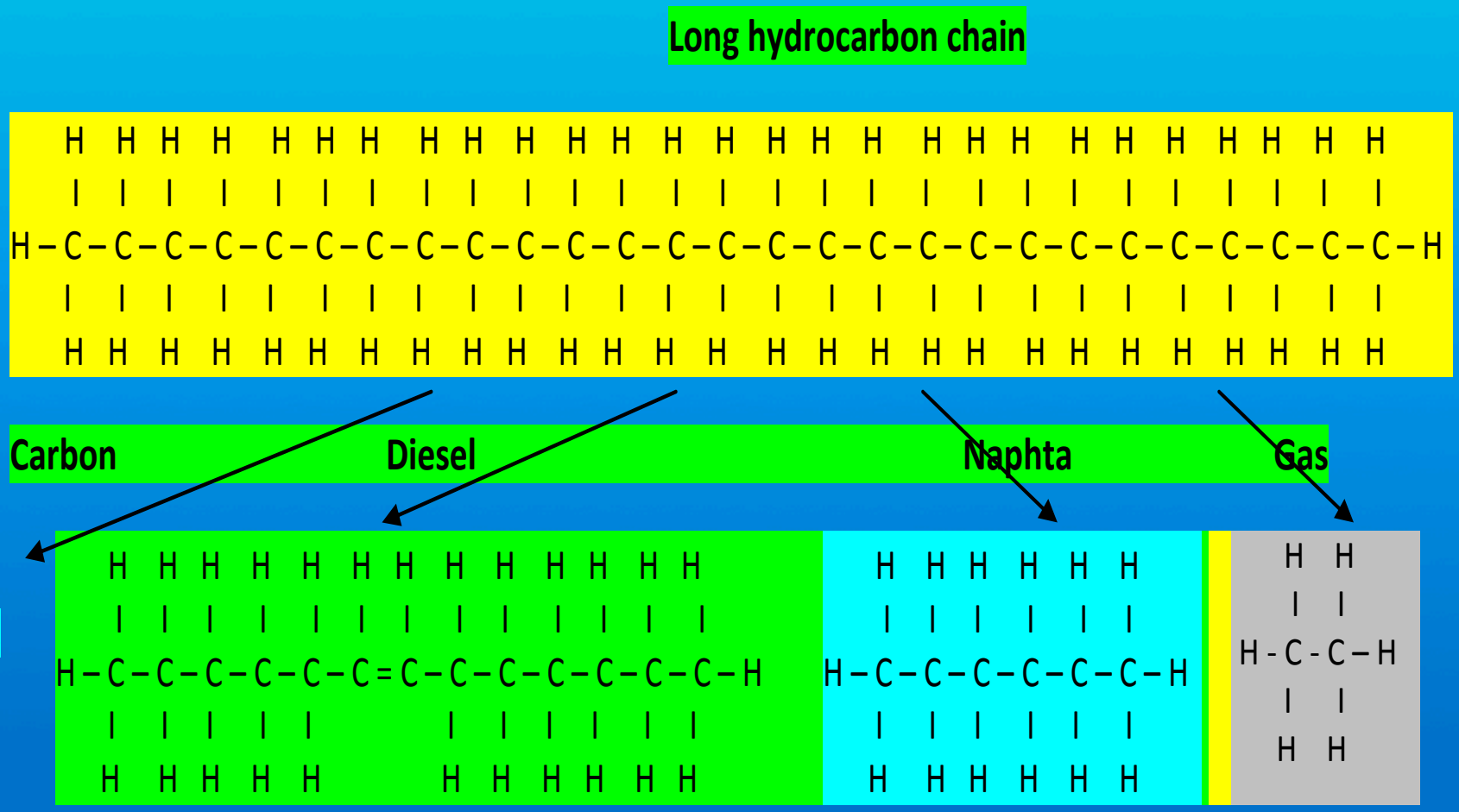
Cracking

Cracking is the process of breaking a long-chain of hydrocarbons into shorter ones to make lighter products.



Cracking Facts

- **Over 60 % of the fuels produced comes from cracking**
- **Cracking was first discovered in Russia in 1908 and in the US in 1912**
- **In 1930 steam cracking was introduced**
- **In second world war Catalytic cracking is introduced**
- **Hydrocracking is introduced in North America in the 1960s**

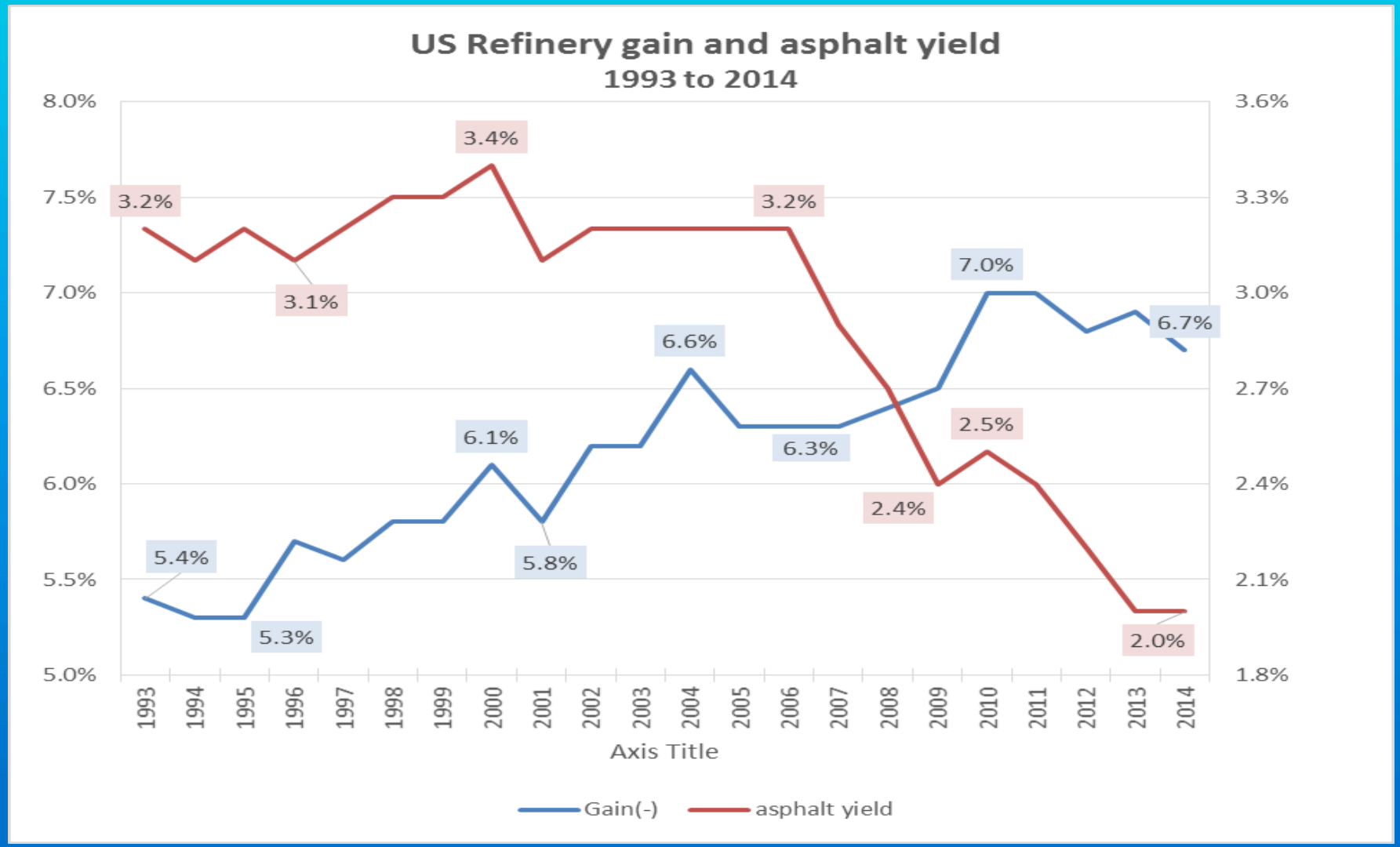
Coking Facts

- **Oil Coking as used presently is a form of cracking**
- **Petroleum coke was first made in 1860**
- **1913 Burton invents a process at the origin of the first delayed coker in 1929. He became president of Standard oil of Indiana.**
- **In the late 1930s Shell oil developed hydraulic decoking which permitted delayed coking to become a semi-continuous process.**
- **In 2002- 130 refineries produced 172,000 tons a day of coke**
- **In 2002- 59 coking units in the US produced 114,000 tons a day of coke or about 2000 tons a day per unit.**

Cracking Processes

Table 1 - Comparison of Refinery Cracking Processes				
	Thermal Cracking	**Catalytic Cracking**	**Steam Cracking**	**Hydro Cracking**
Used to crack	Long Chains	Long Chains	Smaller Chains	Long Chains
Products	Gasoline, Kerosene	Gasoline, Diesel, Jet Fuel	Petrochemical feedstocks	Jet Fuel & Diesel
Temperature	425 C - 950 C 800 F – 1740 F	660 C - 760 C 1220 F – 1400 F	850 C 1560 F	400 C - 820 C 750 F – 1510 F
Pressures	1 atm. - 7 atm.	1 atm. - 3 atm.	2 atm. - 10 atm.	65 atm. – 130 atm.
Catalyst	None	Silica-Alimina, Zeolite	None	Silica-Alimina, Platinum, Palladium, Tungsten, Nickel

Impact of increased cracking and coking in the US



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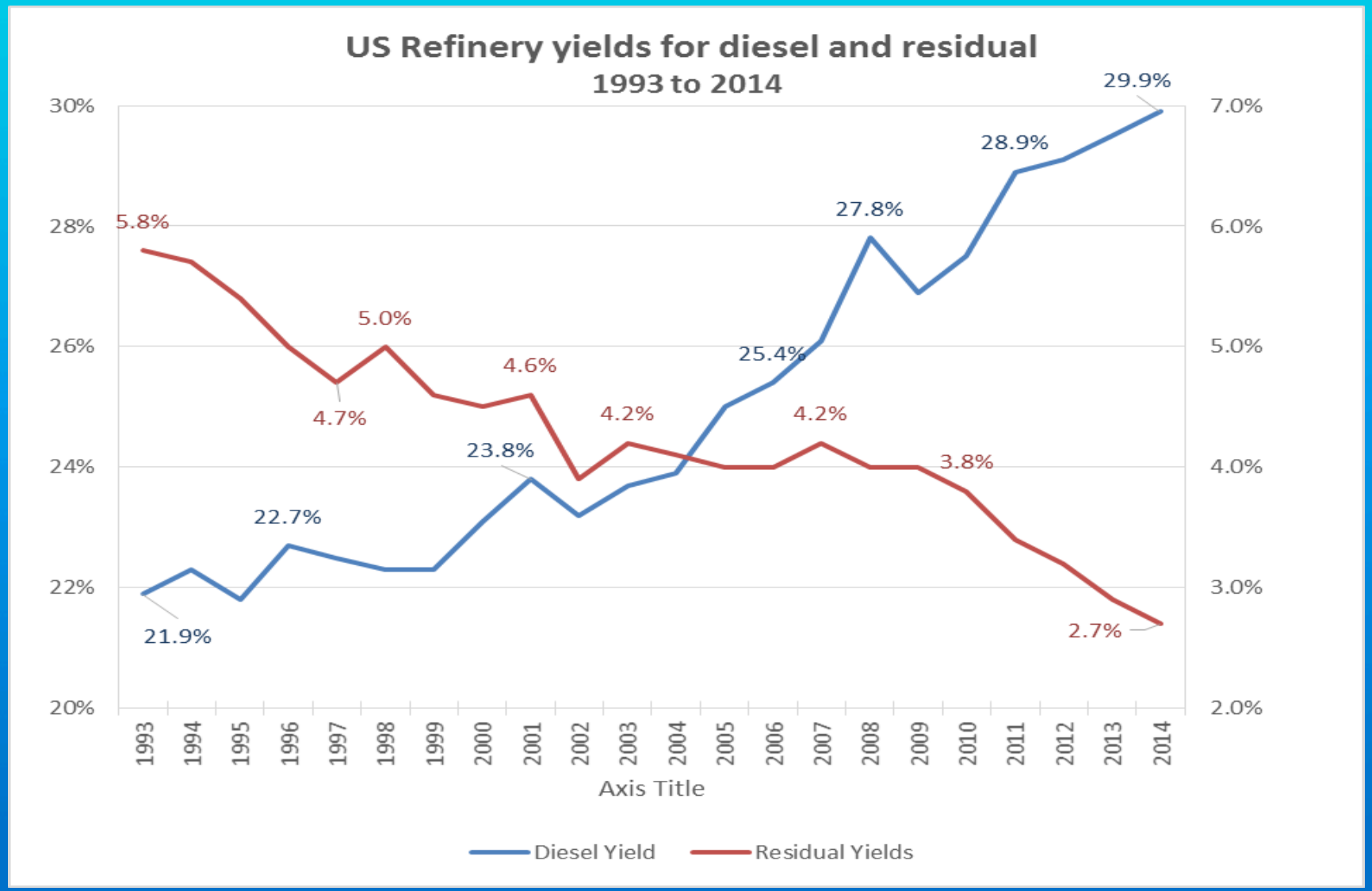

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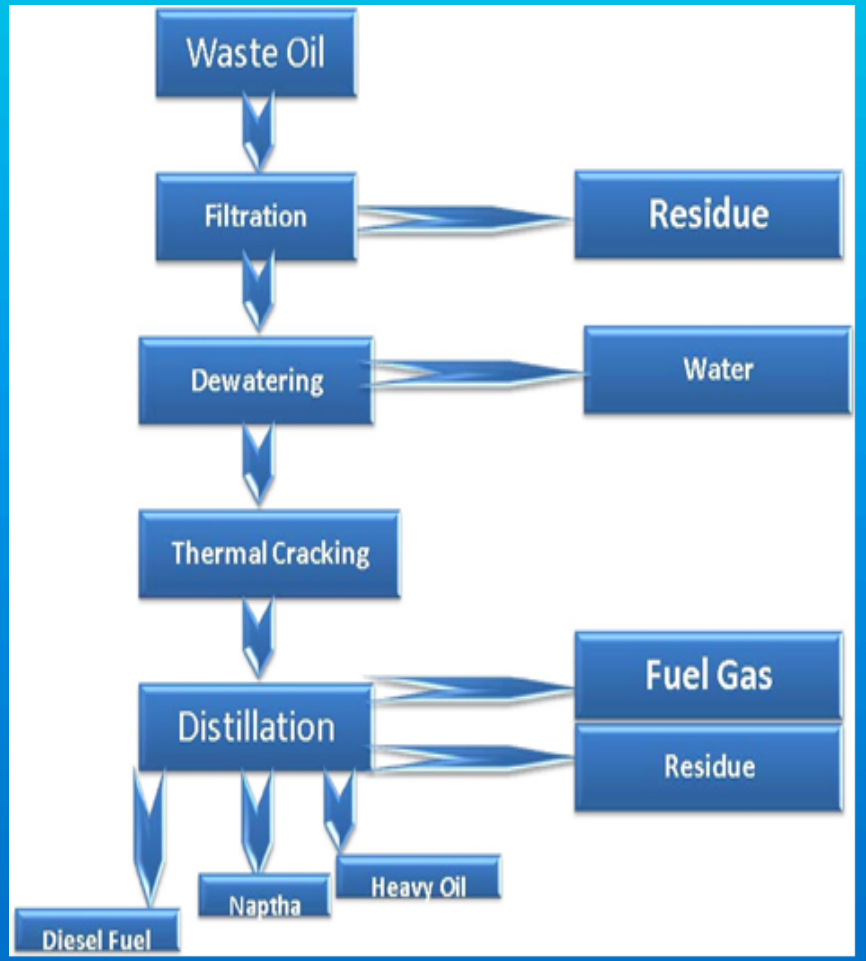
Used oil cracking

- **Problems associated with processing used oils**
  - **Transport costs and logistics**
  - **Small volumes**
  - **Equipment fouling**
  - **Additives containing metals, sulphur and halides**
  - **Acidic feedstock**
  - **Water content**
- **Cracking processes for used oils**
  - **Shurtleff and SOC1**
  - **GNP or visbreaking**
  - **SOC2 and Sweet Gazoil reactors**
  - **Hybrid Process**
  - **Cracking VTAE**

Shurtleff and SOC1 cracking

Used oil is filtered, dewatered and thermally cracked in heated kettles. The products are separated in by successive condensations and the gasoil fraction is either sold as fuel or stabilized and stored to be sold later.



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Shurtleff and SOC1 cracking

Advantages

- Low capital costs
- Simple – Do not need sophisticated operators
- Can be profitable in small plants

Drawbacks

- Fuels: Lower margin products
- Labor Intensive
- Batch process with long residence time
- Produce fuels: Reuse as lubricating oil is preferred by environmentalists to recycle as fuels

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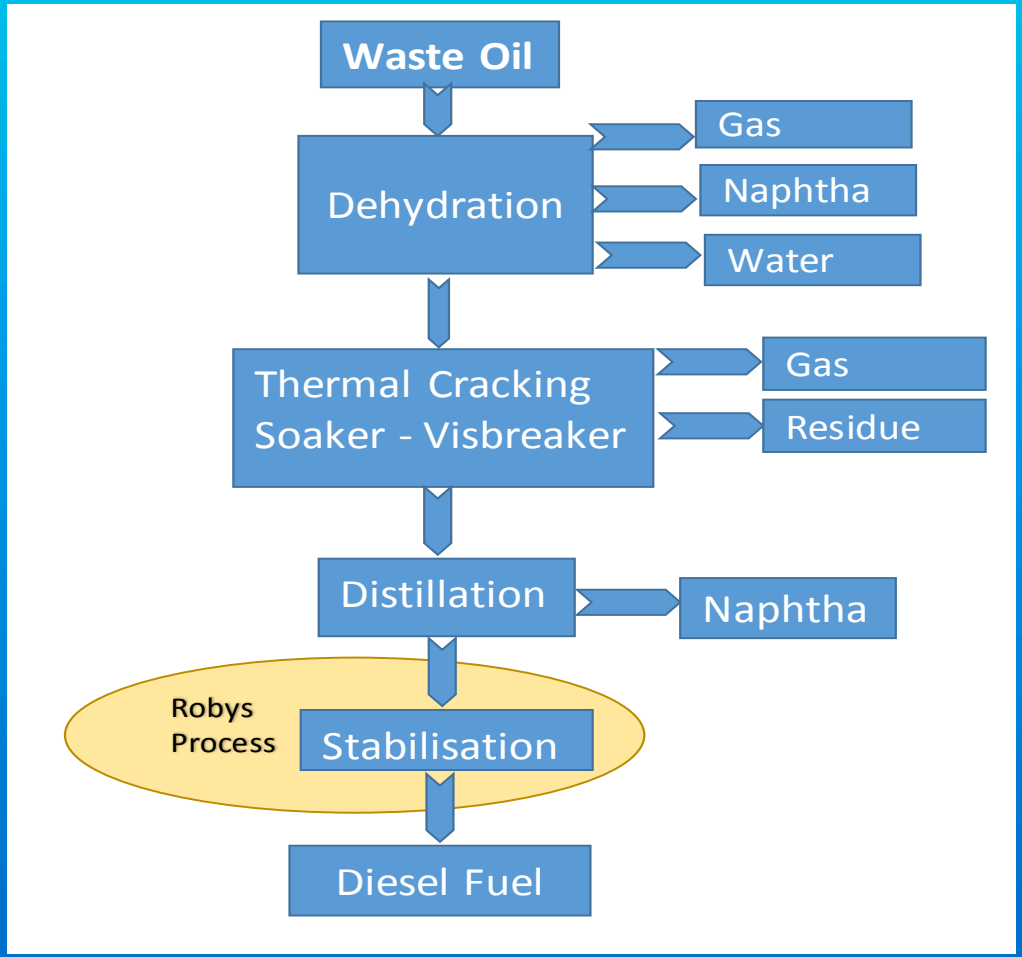
GNP or Soaker Visbreaker

Used oil is filtered, dewatered and thermally cracked in a coil heater and soaker drum. The residue is withdrawn from the soaker and the products are separated by distillation. The diesel cut is stabilised by the Robys process (methanol extraction) and stored to be sold later.



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GNP or Soaker Visbreaker

Advantages

- Low capital costs
- Flexible: an accept wider variety of feedstocks
- Simple – Do not need sophisticated operators
- Can be profitable in small plants

Drawbacks

- Coke stays in the products resulting in lower product quality
- Is subject to fouling
- Produces fuels, resulting in lower margin products
- Produces fuels: Reuse as lubricating oil is preferred to recycle as fuels by environmentalists

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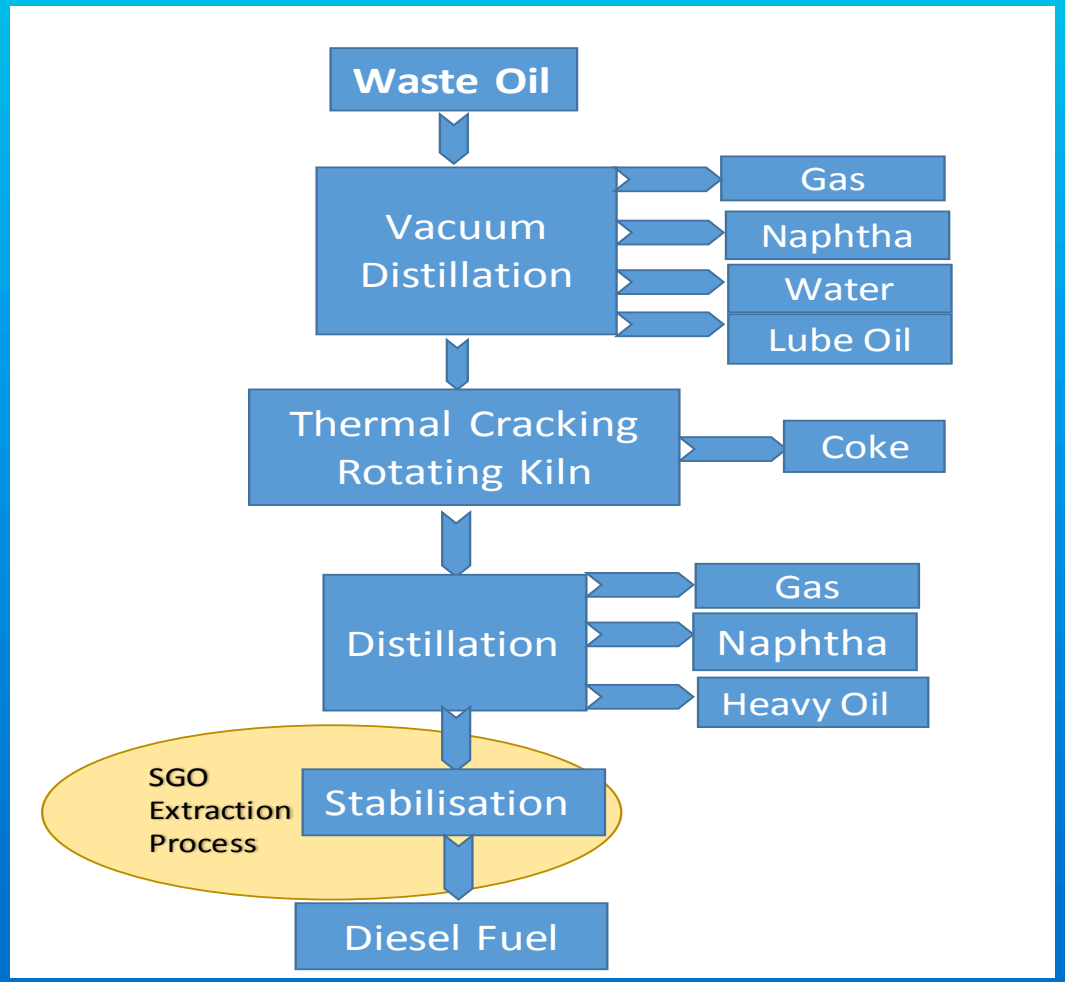
Sweet Gazoil Hybrid Process

The used oil is heated and flashes in a drum. The vapours are scrubbed and distilled in a vacuum column where gas, naphtha, light lube oil and water are produced. The heavier oil is thermally cracked in a rotating kiln. At the exit of the kiln, the coke is withdrawn. The vapours are distilled into products. The diesel cut can be stabilised, de-sulphurised and stored.



Sweet Gazoil Hybrid Process

Advantages

- Relatively low capital costs
- Flexible: can accept wider variety of feedstocks
- Produces oil basestock preferred by environmentalists
- Operation can be adapted to get a more profitable product slate
- No need to pre-treat
- Lower equipment fouling
- Does not need sophisticated operators
- Can be profitable in small plants

Drawbacks

- New
- Produces fuels, resulting in lower margin products
- Uses a rotating kiln, not equipment known to refineries

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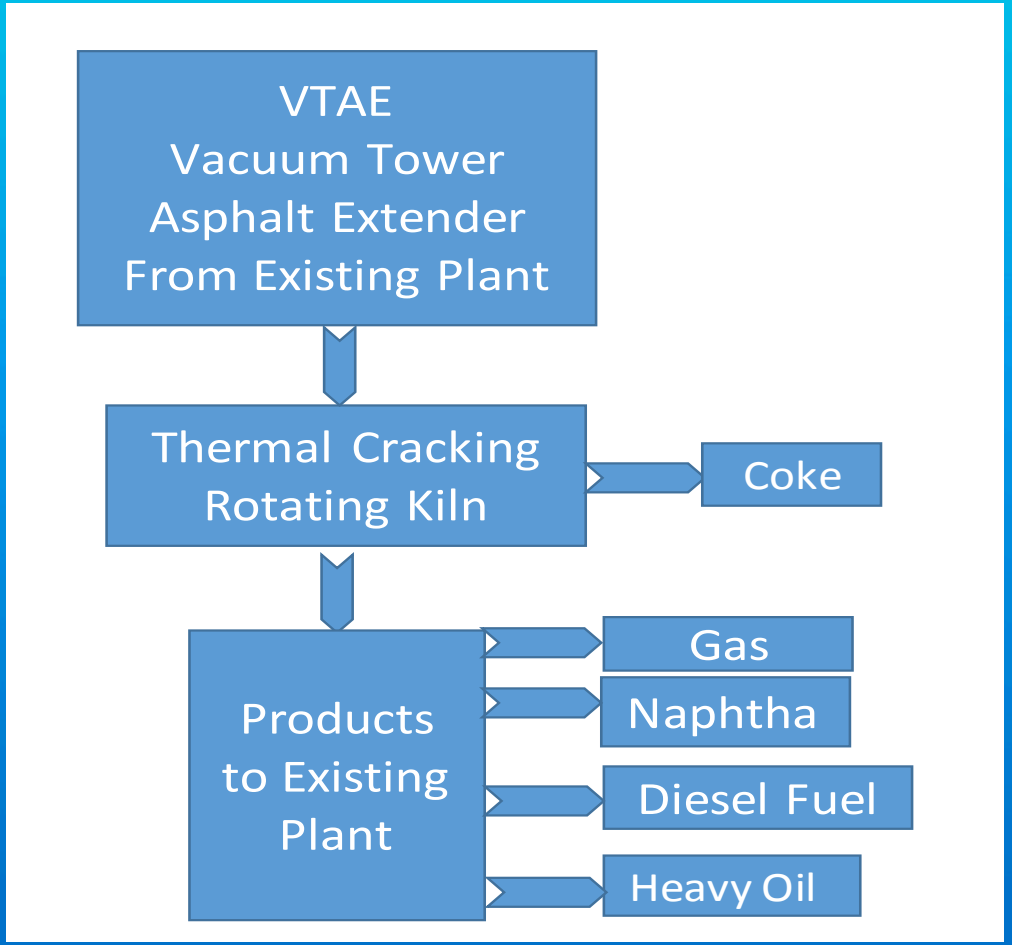
CRACKING VTAE

In an existing ULO distilled fuels or base stock plant, VTAE is routed from the bottom of the vacuum tower to the rotating kiln. The coke is withdrawn from the vapours as they exit the reactor. The vapours are processed as additional products in the plant.



Cracking VTAE

Advantages

- Low capital costs
- Flexible: Operations can be tailored to suit a variety of feedstocks
- Does not need additional operators
- All products environmentally friendly
- Coke is removed from the products
- Lower sulphur and metals content in products
- More stable products

Drawbacks

- Produces fuels, resulting in lower margin products
- Produces fuels: Reuse as lubricating oil is preferred to recycle as fuels by environmentalists

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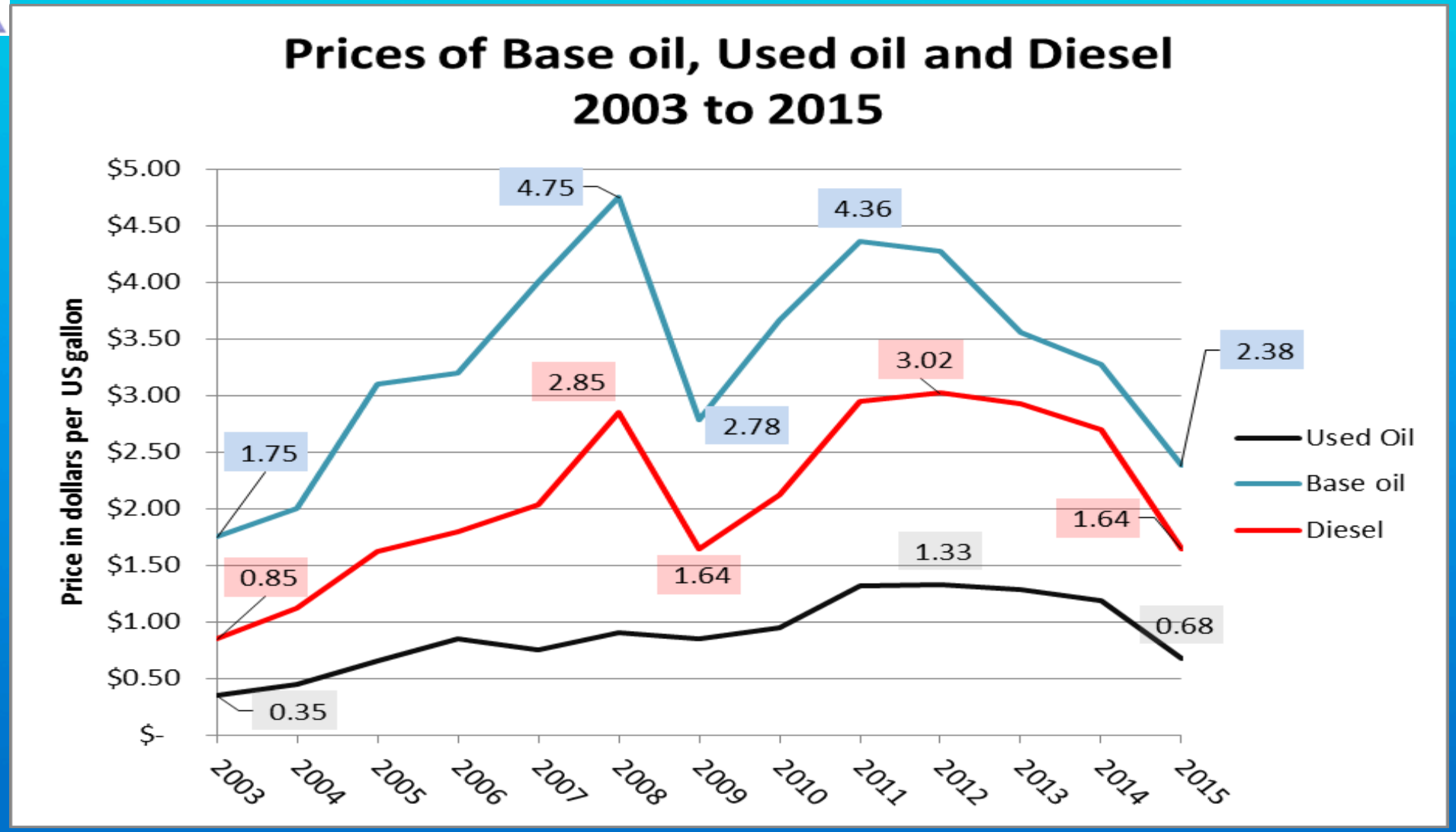
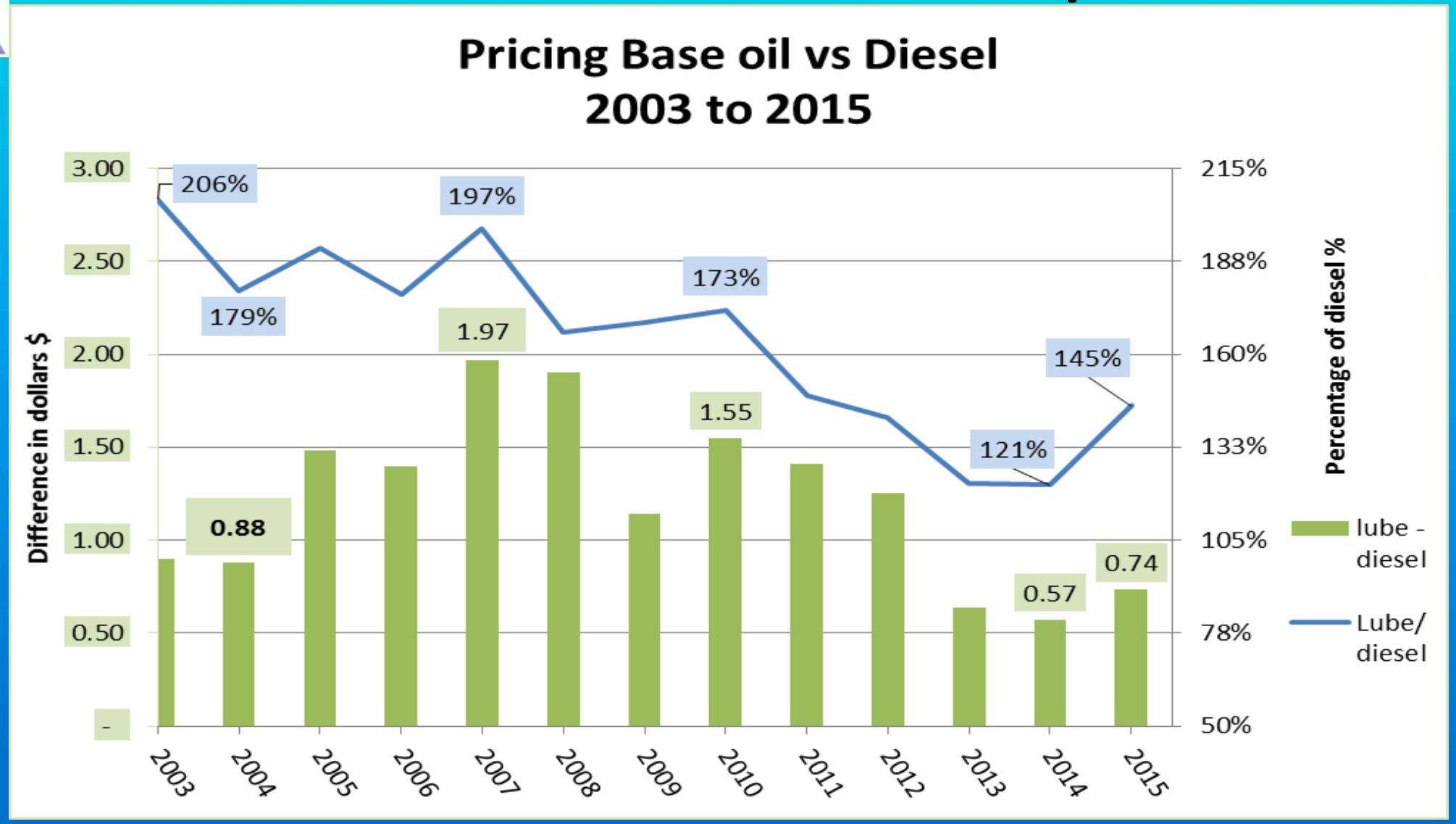
Prices of Base oil, Used oil and diesel over 12 years



Base oil versus Diesel prices

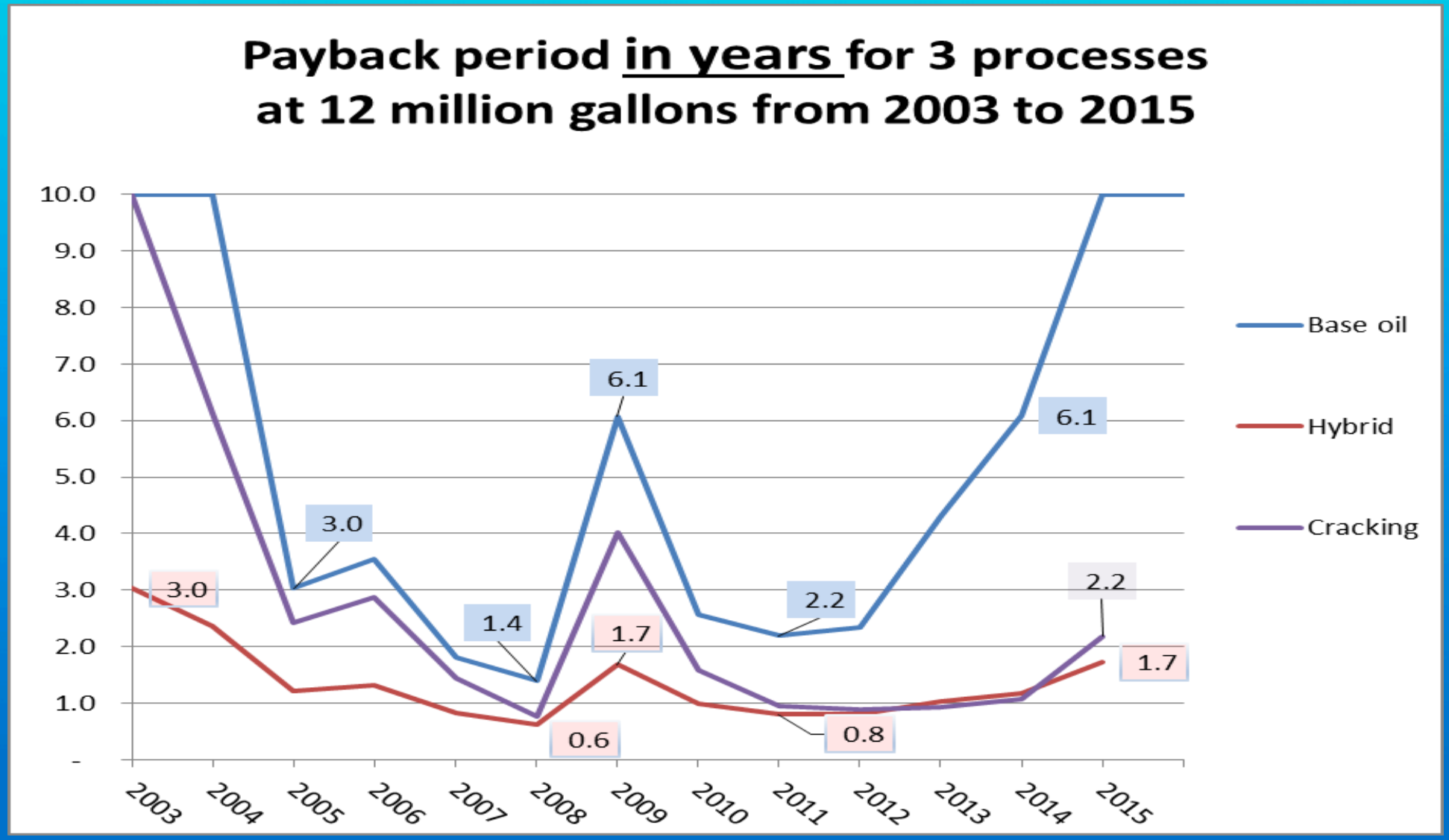


Economic success for refineries

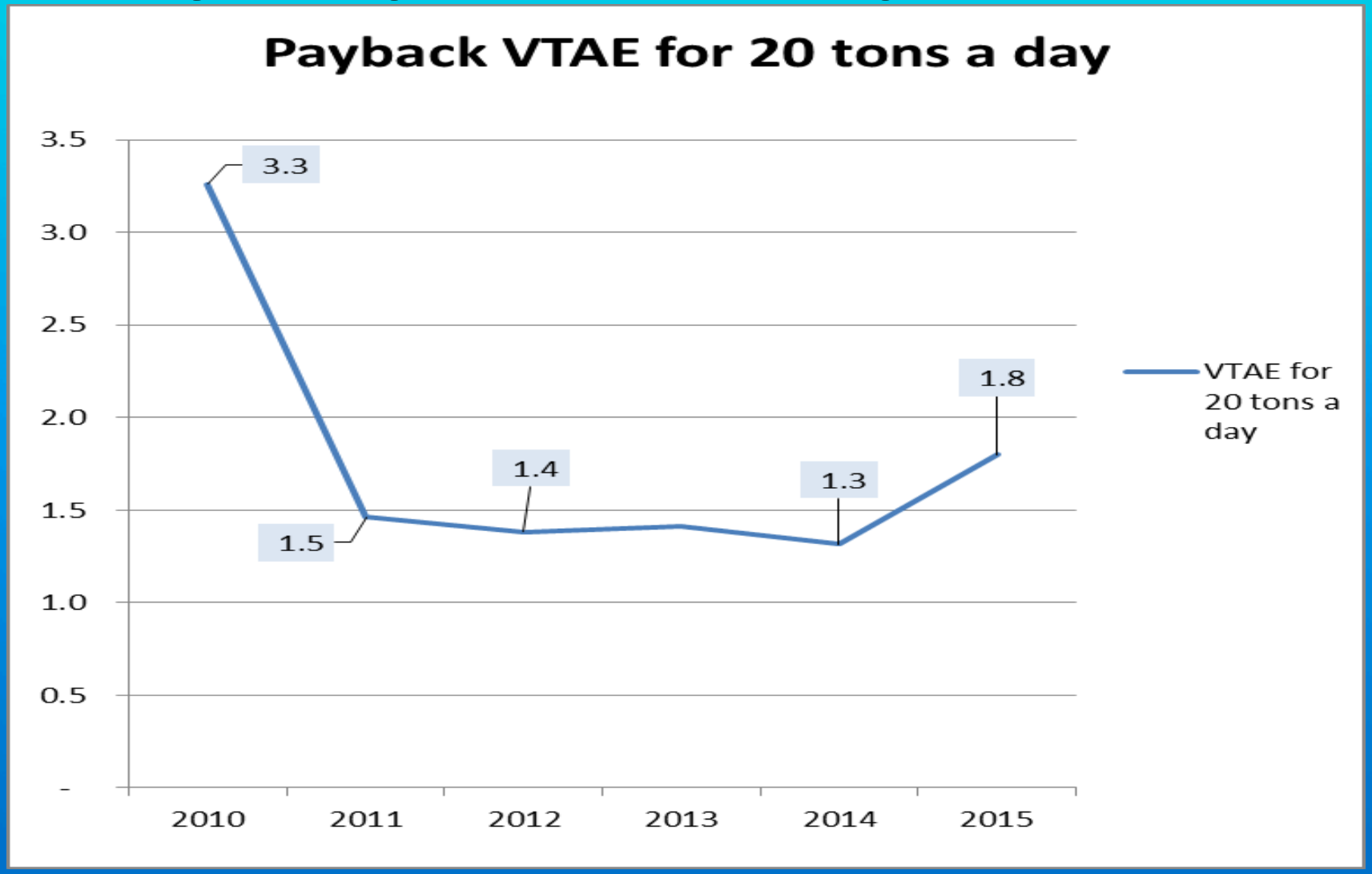
Complexity = flexibility= profit long term

- **Choice of feedstock ex: Bakken vs Bitumen**
- **Choice of product made ex: Diesel versus residual (Bottomless crude)**
- **Base oil from residual by hydrotreating versus extraction from specialty crude**
- **Increase in size of refineries**

Impact of prices on profitability



Payback period for new process for VTAE



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Changes in economics for re-refining and other used oil treatment

- **Base oil comodization**
  - **Huge addition of base oil refining capacity added nearly all group 2 and 3. Oversupply??**
  - **Great reduction in production costs of base oil (Tech.)**
  - **Higher specifications for base oil**
  - **Premium pricing of group 2 versus 1 has disappeared**
- **Available Used oil volumes have stabilized**
  - **Synthetic oils last longer**
- **Re-refineries costs versus base oil refineries**
  - **Average re-refinery is 6 times smaller**
  - **Base oil refineries now use “low cost” residuals**
  - **Transport costs and logistics is becoming a bigger part of the costs of re-refiners**

Cracking opening up new possibilities

- **Can take a wider variety of feedstock**
  - **Lower costs of feedstock including VTAE**
  - **Smaller collection area = reduced transport and logistics.**
- **Lower costs of treatment**
  - **Lower capital expenditures**
  - **Lower operating costs**
  - **Simpler to operate**
- **Can be added to existing Base oil and VGO operations to increase profitability and flexibility**
- **Profitable in smaller plant (Reduce logistic and transport)**
- **No need for pre-treatment = reduce costs better fuels**

Conclusion

- **We have to be flexible to respond to changes in the used oil markets, on both the feedstock and product sides.**
- **We need to be able to adapt to technological advances, not only in used oils but also in competing industries.**
- **Big refineries have done it, we can do it too.**