Refining Strategies and Options for Lead Phase Out

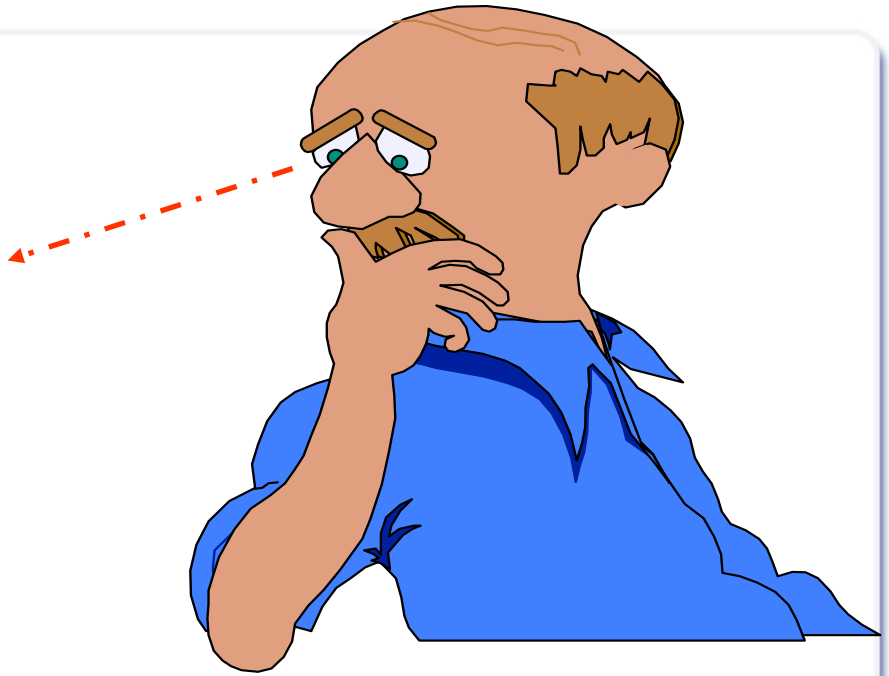
North Africa Lead phase out workshop

Technical session

August 14th, 2008

Options to remove Lead

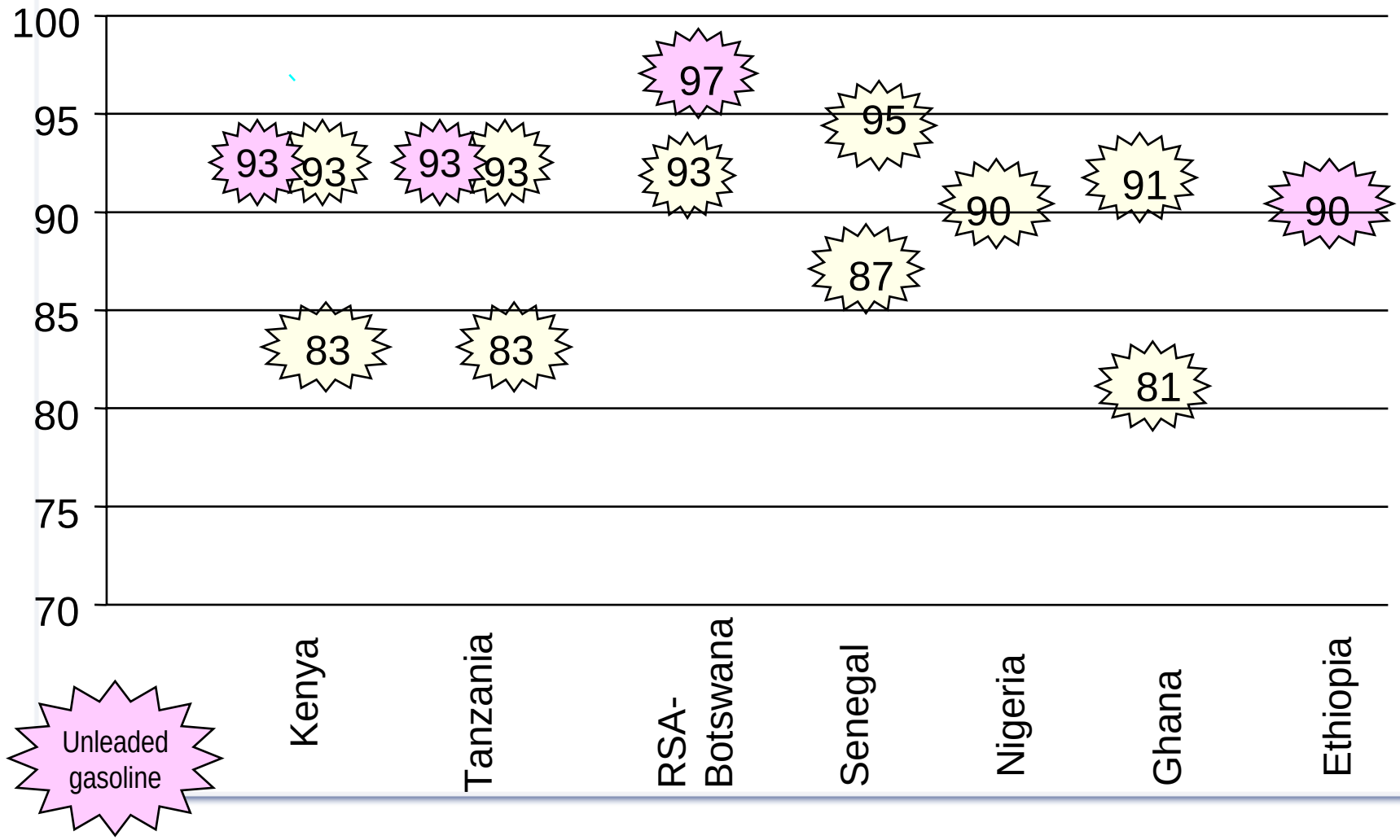
New processes…?
New additives…?



But don’t forget to ask the question: what do the vehicles ACTUALLY need? A fleet survey is ESSENTIAL before considering refinery investment

Gasoline Grades: SSA 2003

RON (Research Octane Number)



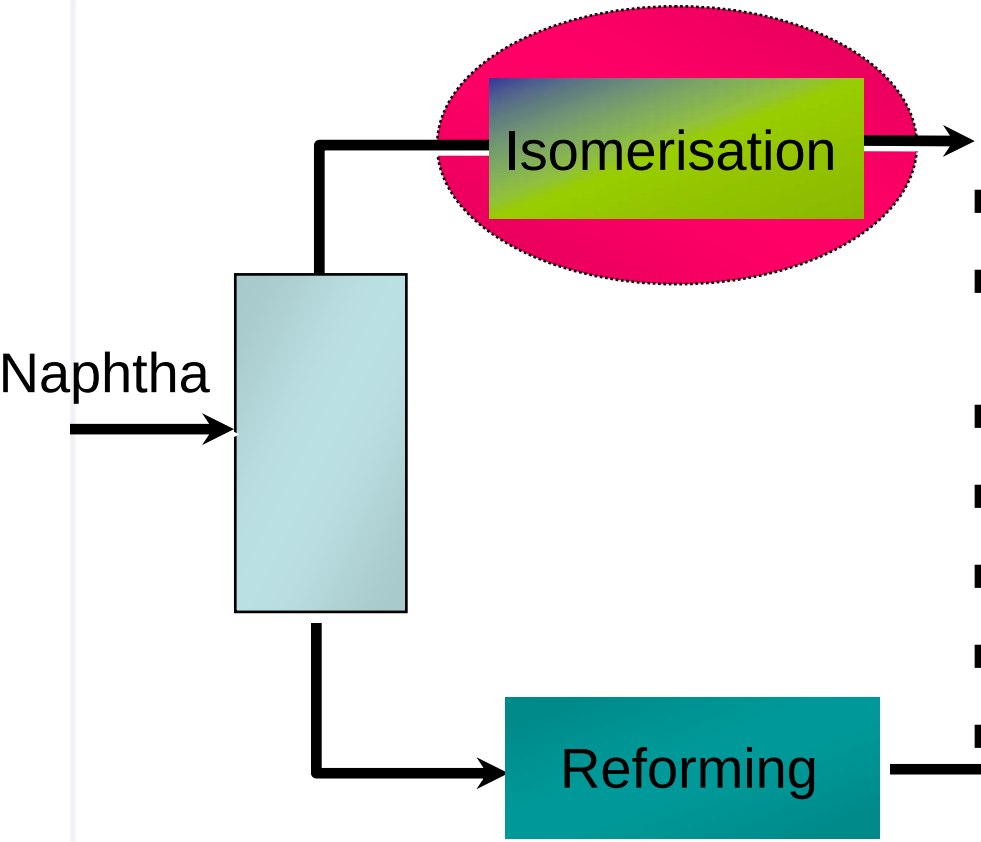
Refining upgrades

- To produce a higher octane gasoline, the refinery will probably consider one or more of the following options:
  - Reforming
  - Isomerisation
  - Catalaytic Cracking
  - Alkylation
  - Others (eg additives)

Additives & blendstocks

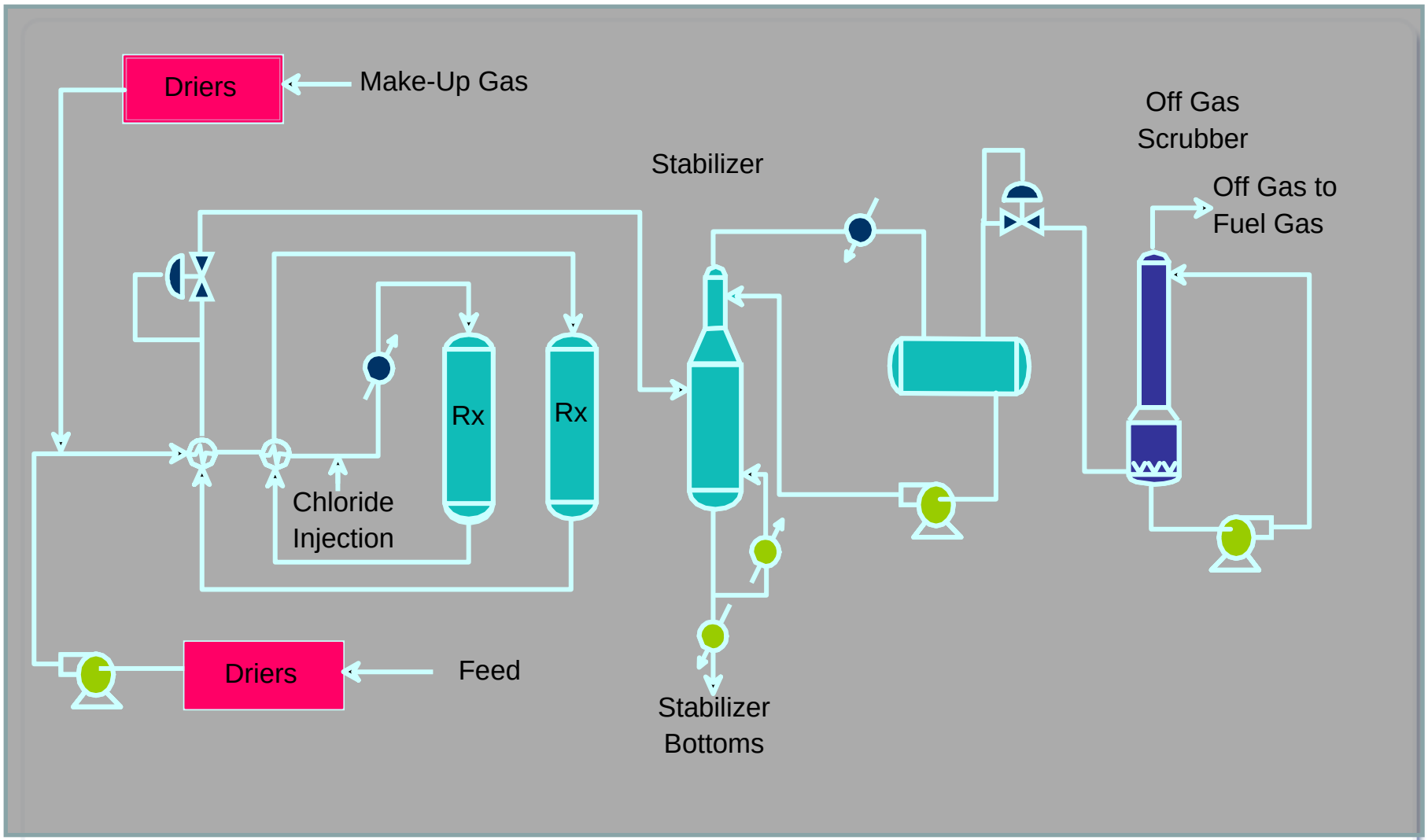
- Additives and blending components can be added to the available gasoline pool so as to increase octane:
  - Imported high octane gasoline or naphtha for blending
  - Alcohols
  - MTBE
  - MMT
  - Others

Isomerisation as a solution

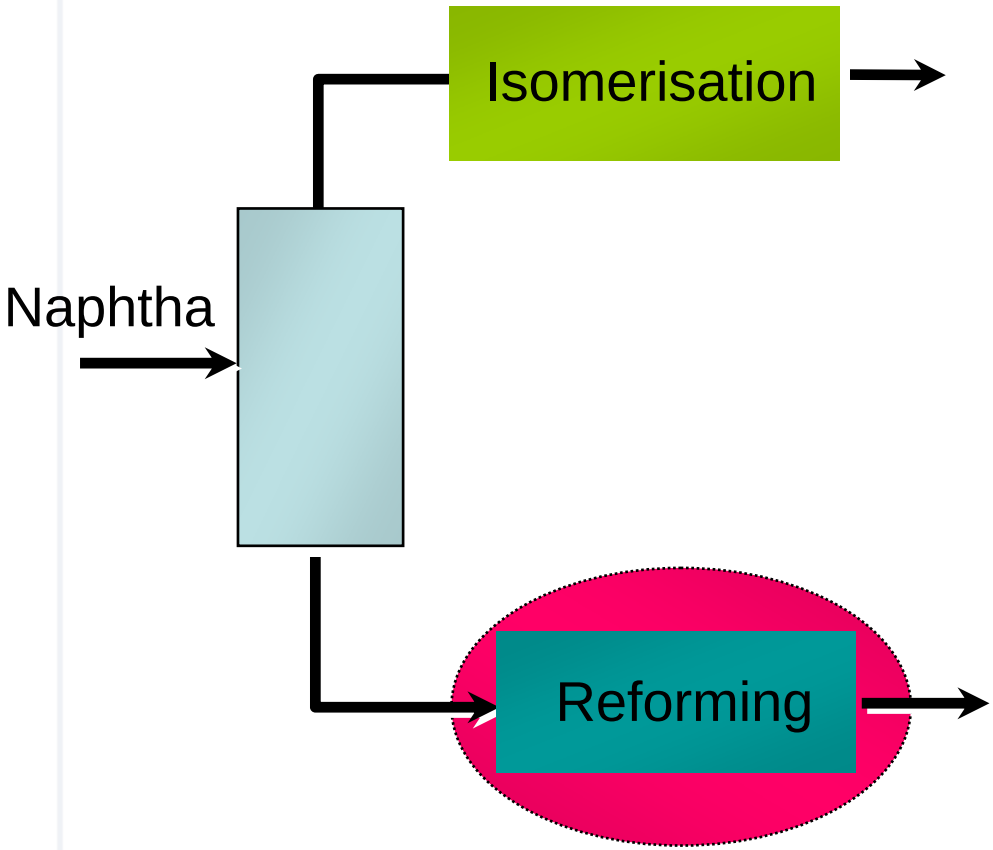


- No sulfur or olefins
- High octane non-aromatic gasoline blendstock
- Yields approach 100%
- Low H_2 consumption
- Can eliminate benzene
- Low capital and operating costs
- Highly suitable for revamps

ISOM: Penex Process (UOP)

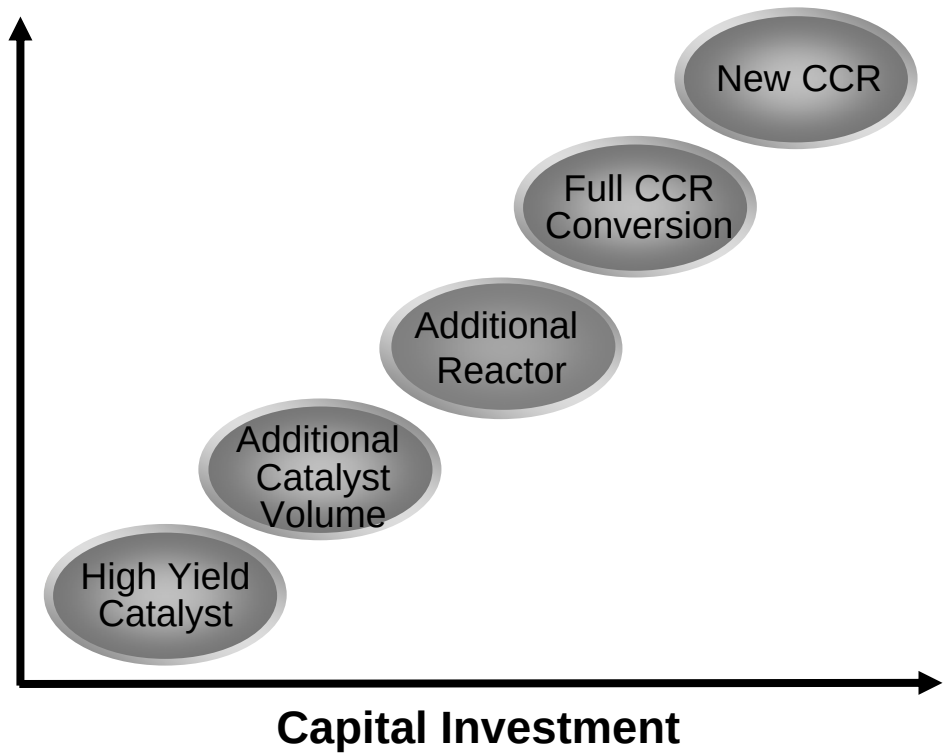


Reforming as a solution

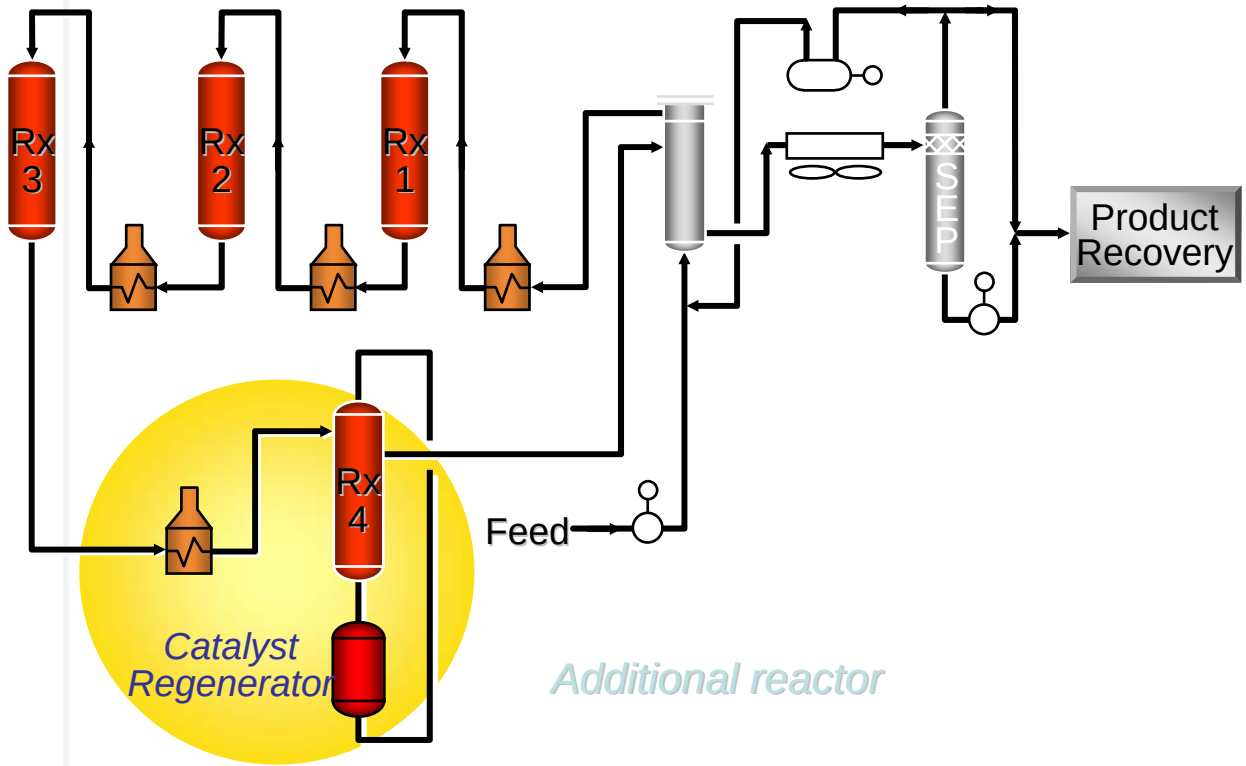


- High octane gasoline blendstock
- No sulfur
- Can increase Benzene
- Most cost effective H_2 source
- Highly suitable for revamps

Reformer upgrading



Simple reformer upgrade



Key Features

- Minimizes changes to existing equipment
- Minimizes plot space
- Easily integrates into operating unit

Which approach?

- Octane sources to replace TEL have a different cost and a different impact on the technical specifications of resulting gasoline.

  SRG = 60-73 RON

  C4 = 93 RON

  Isomerate = 82-92 RON

  FCC naphtha = 90-93 RON

  Reformate = 90-103 RON

  Alkylate = 90-97 RON

  MTBE = 116 RON

Improving fuel quality

- Refiners' decisions will depend on several factors:
  - available raw material (low octane naphtha, mid-distillate, resid/heavy oil …).
  - technical specifications of the gasoline and of the diesel (Aromatics, RVP, Sulphur content, Cetane index…note the AFRI specifications…
  - size and configuration of the refinery
  - expected margins/prices in a given market
  - Last but not least → the economic viability of the investment projects vis a vis imports

Gasoline lead phaseout: international lessons

- Lead phase out should not be carried out in isolation, but consider total gasoline composition, and emissions, air quality and health implications of changing gasoline formulation
- If significant refinery revamps are needed, you may want to examine other fuel streams and consider optimizing the entire refinery complex
- Look carefully at the gasoline – distillate balance: it is changing in many markets worldwide

Gasoline reformulation issues

- Eliminate lead
- Limit benzene (carcinogen)
- Total aromatics may be an issue
- Limit olefins: photochemically reactive, increase NO_x emissions at high level
- Limit volatility (evaporative emissions)

Impact of gasoline formulation

	RON	Comments
n-C4/i-C4	94/100	Very cheap, but high volatility
Isomerate	80-92	No adverse health effects but volatility an issue
FCC naphtha	90-93	Source of S, olefins, PNAs
Reformate	90-103	Benzene, total aromatics, PNAs
Alkylate	90-97	“Jewel” of RFG
MTBE	116	Care with leaking storage tanks
Ethanol	108	High volatility, handling/water issues, aldehydes in non catalysed fleets, long-term future of biofuels uncertain

A final word

- We have already noted the need to look internally and carry out a fleet survey to establish demand, and to investigate broader refinery upgrade solutions
- We strongly advise you to also take account of international trends in order to “future-proof” your proposed solution
  - Example: International regulation will see a dramatic reduction in the use of HFO bunkers in favour of distillate over the next few years.
  - We are likely looking to a distillate constrained world
- There is, and will continue to be, a shortage of process design and construction capability: 5 year lags will become the norm!