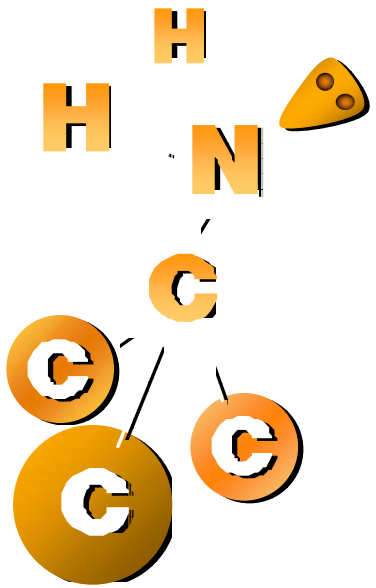
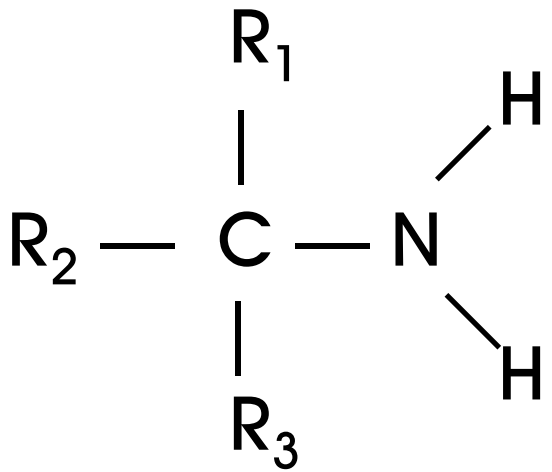
Primene™ amines



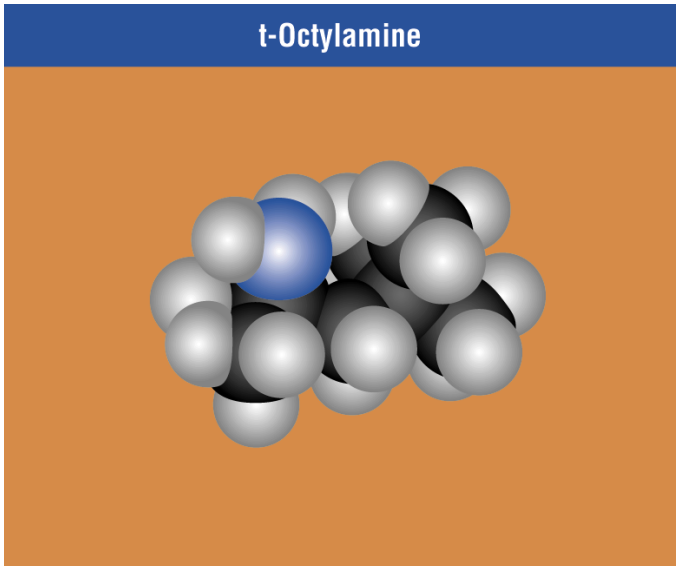
The Amazing Amines

What are Primene™ amines?

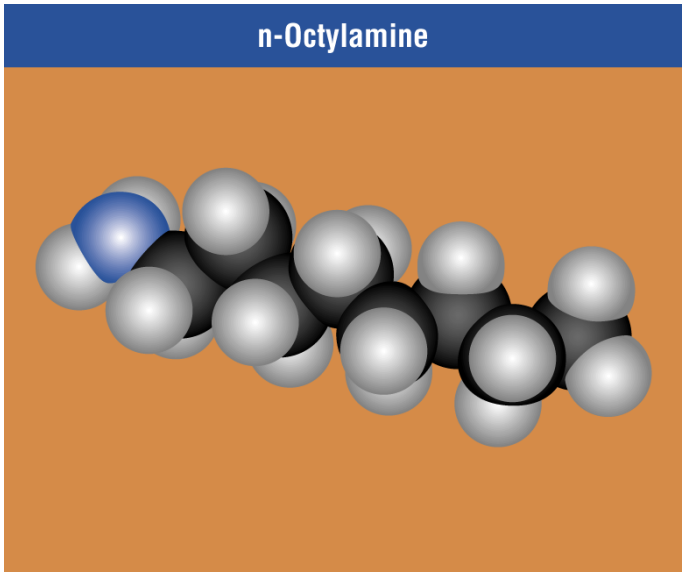


- *Tertiary Alkyl Primary Amine structure*

What makes them unique?



Primene™ TOA



Straight Chain Counterpart

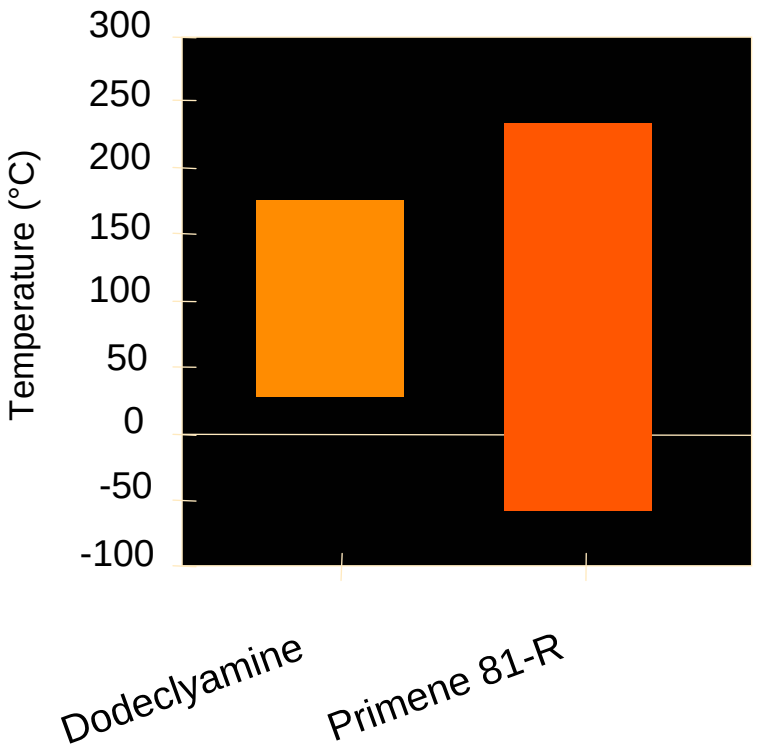
- Highly Branched
  - Providing steric hindrance to Amino group

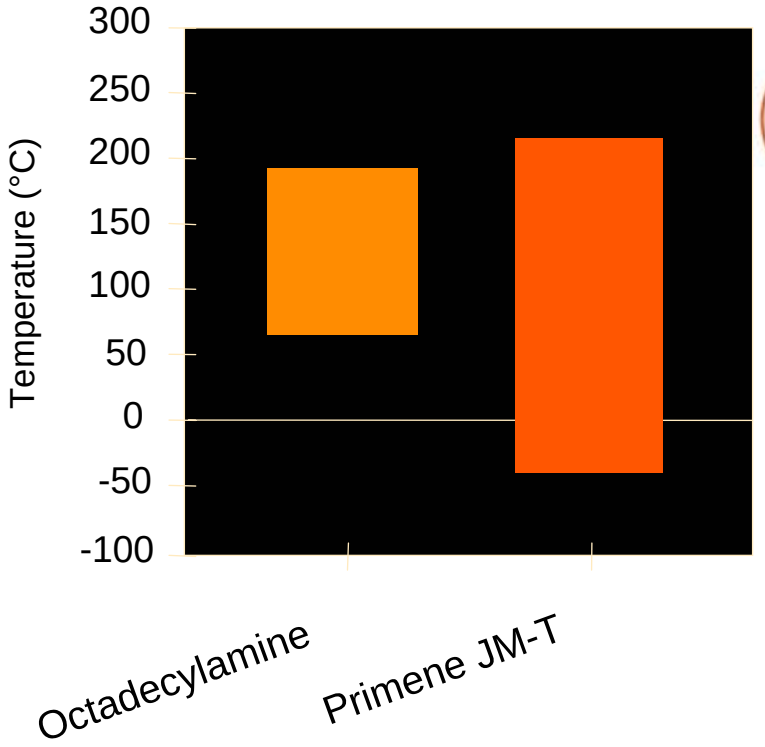
Distinctive key features of Primene™ amines

- Fluid and low viscosity over a wide temperature range
- Thermally and oxidatively stable at high temperatures
- Excellent petroleum hydrocarbon solubility
- High basicity
- Controlled reactivity and selectivity

Liquid Phase Temperature Range

of Alkyl Primary Amines





Thermal and Oxidative Stability

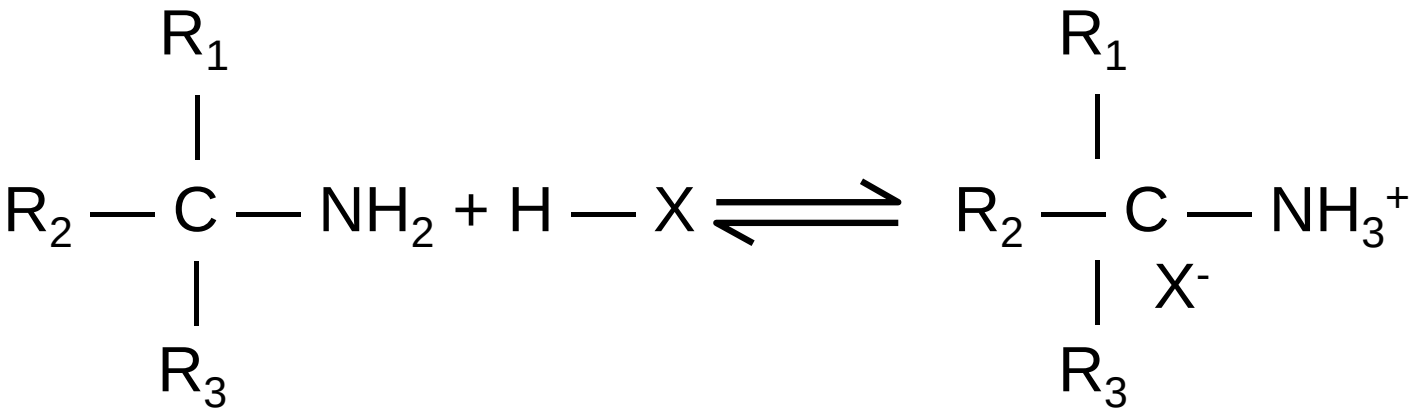
of Alkyl Primary Amines

Alkyl Primary Amine	VCS Color [a]	Product Decomposition (°C) [b]
n-Dodecylamine	11	>300
Primene 81-R	9	>500
n-Octadecylamine	14	>300
Primene JM-T	11	>500

[a] Thermal Stability at 200 °C

[b] Oxidative Stability up to 500 °C

Salt Formation with Primene™ amines



Oil-Soluble Primene Amine

Oil-Insoluble Acid

Amorphous Oil-Soluble Salt

Solubility of Acids and their Primene™ Salts

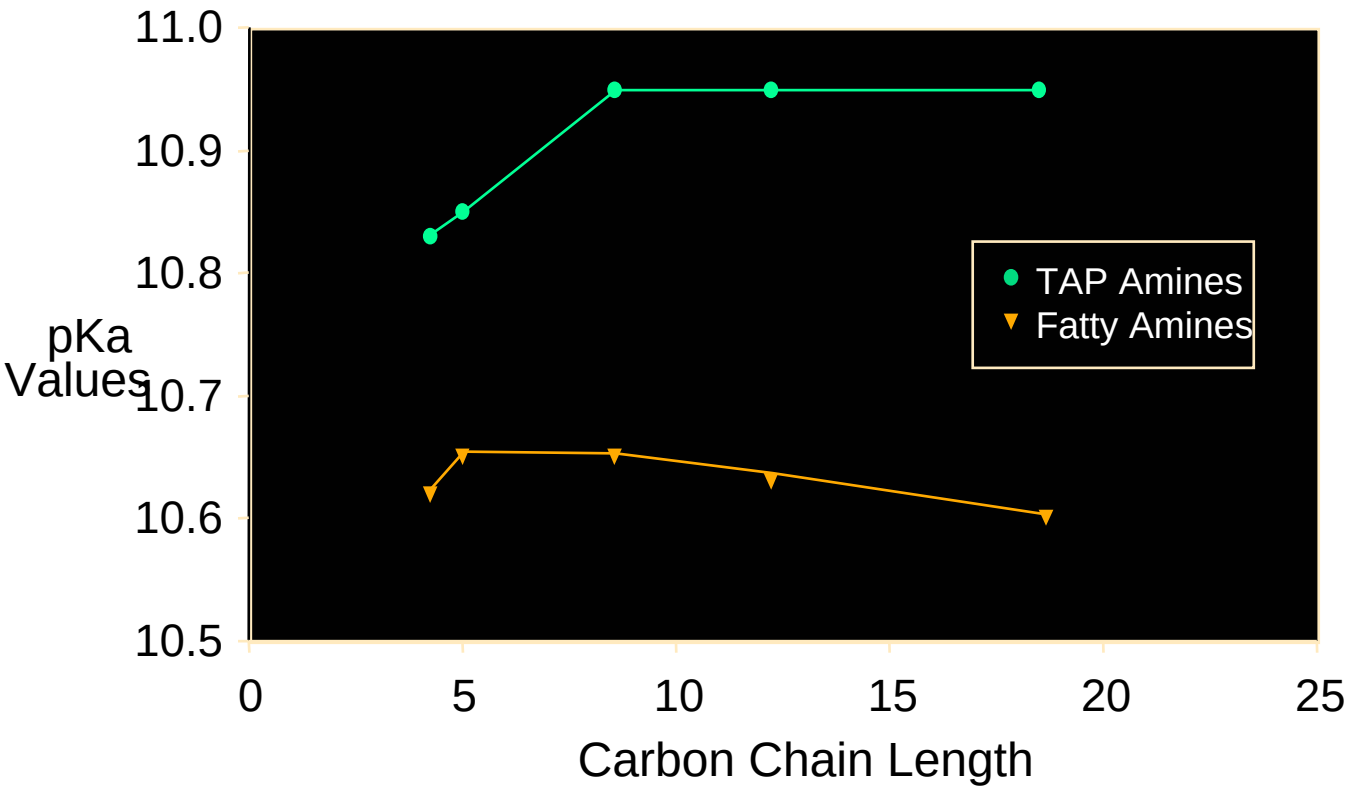
in common Petroleum Hydrocarbons

Acid	Primene Amine	Solvent	Weight % Solids Free Acid, 21°C	Salt, 21 °C
Molybdic	81-R	A	0.00	>50
		B	0.00	>5
		C	0.00	19.3
	JM-T	A		>50
		B		>50
		C		>50
Hydrochloric	81-R	A	<0.001	>60
		B	<0.02	>5
		C	<0.01	>10
	JM-T	A		>15
		B		>10
		C		1.0

A=Xylene B=Kerosene C=Mineral Oil

Comparative Basicity

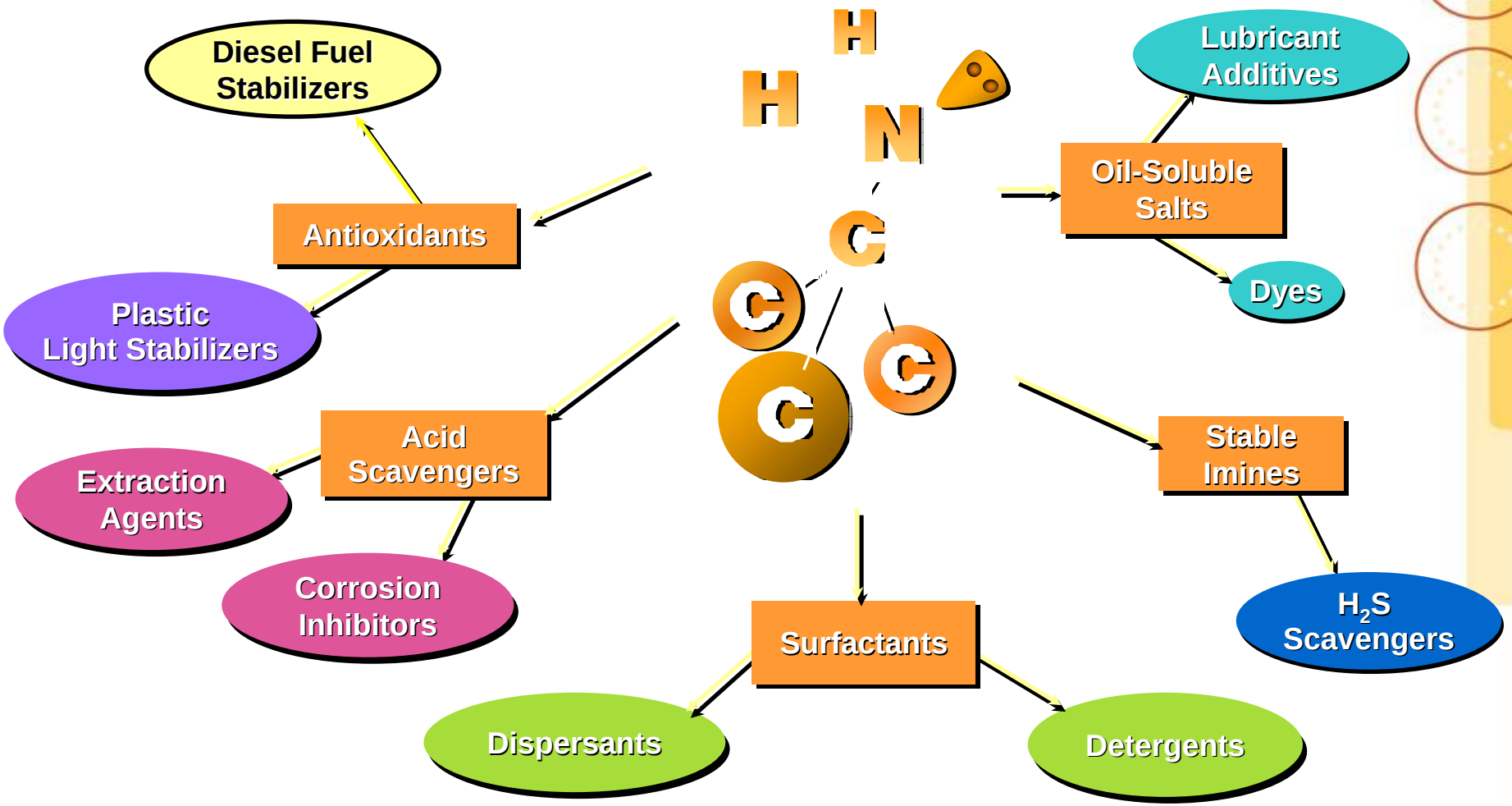
Linear vs. Tertiary Alkyl Primary Amines (C_4 - C_{18})



Primene™ amines

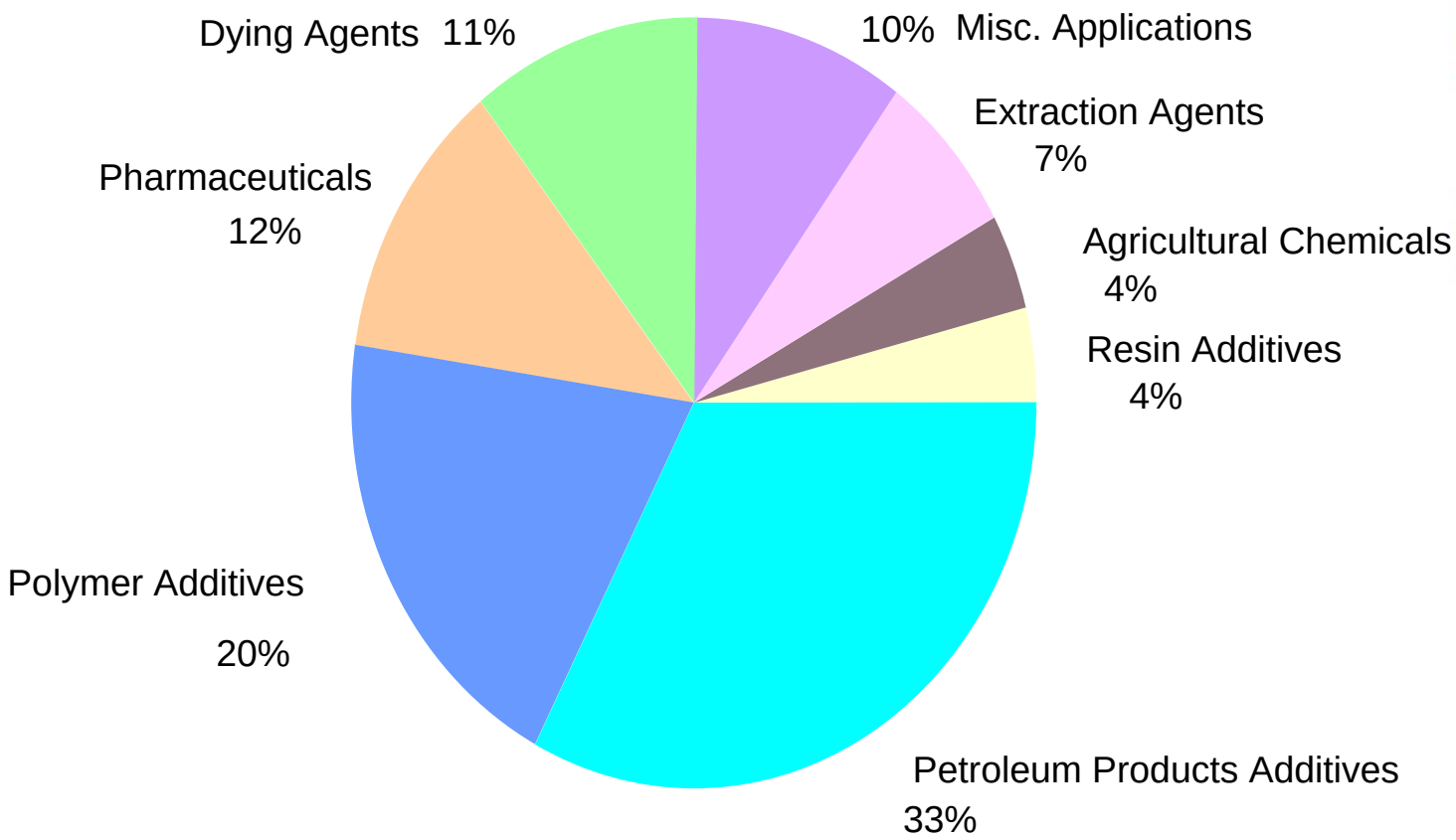
Features	*Benefits*
Flow easily at very low temperatures; very stable at high temperatures	Convenient handling and storage
Excellent solubilizing agent	Primene amines and their salts are soluble in hydrocarbons and insoluble in water
Very strong base	Neutralize corrosive acids Scavenge weak acids Form stable and amorphous salts
Unique chemical structure	Allows full control over complex chemical reactions
Versatile chemistry	Cited in more than 600 patents and publications; useful in a wide range of applications in a large variety of industries

Examples where Primene™ amines are used



Primene™ amines enable innovation

over 600 patents issued across the following segments



Commercially available Primene™ amines

The following products are generally used as building blocks to manufacture additives

- Primene TOA – C8 Chain Length
- Primene 81-R – C12-C14 Chain Length
- Primene JM-T – C18-C24 Chain Length

The following product is generally used as-is or as a component of an additive package….

- Primene RB-3 – Isomeric mixture

Primene™ amines

Multi Functional Additives for Refinery Process Chemicals

- Acid Scavengers
- Antifoulants
- Corrosion Inhibitors
- Middle Distillate Treatment
- Other Fuel Applications

Primene™ amines for use in the Refinery

Acid Scavengers

Primene amines and their derivatives are ideal acid-scavengers…

- Unlike other chemistries like morpholine, MOPA, ethanolamines, ammonia and caustic, the HCl salts of Primene amines are….
  - Highly soluble in the oil and aqueous phases
    - No surface fouling
  - Thermally stable
    - >275°C
  - Not corrosive themselves
  - and non-emulsifying and non-foaming
- H_2S can be significantly reduced in the headspace by the imines and diimines of Primene 81-R and JM-T

Primene™ amines for use in the Refinery

Anti-foulants

Primene amines and their derivatives significantly reduce coke-like or soft sludge deposit formation on heated material surfaces

An example….

N-Alkyl amidophosphoric acid/esters derived from Primene amines

Additive	Dosage (ppm)	Tube Rating	% Fouling Reduction
None		58	0%
81-R Derivative	50	19	67%
81-R Derivative	100	14	76%
Imidazole Derivative	500	20	52%

Diesel distillate fuel evaluated in unit

(700 psi; feed rate: 800 ml/h; Temp: 650 °F)

Primene™ amines for use in the Refinery

Anti-foulants

Primene amines and their derivatives significantly reduce fouling of catalyst beds

Reference: Amoco; U.S. Patent 4,921,592: 1990

Application: Amine/surfactant mixture for controlling fouling of catalyst beds

Key Claim: Contains data showing that the addition of a amine/surfactant mixture shows synergistic benefits

- The Mixture
  - 13% Primene 81-R
  - 16% Dodecylbenzene Sulfonic Acid
  - 71% Kerosene

Primene™ amines for use in the Refinery

Anti-foulants

Lab Results

Additive	Treatment Levels (ppm by volume)	Filter Time (minutes)
None	--	12.14
Surfactant	100	13.16
Primene 81-R	100	3.39
Mixture	100	3.50
Surfactant [a]	25	13.13
Primene 81-R [b]	25	7.55
Mixture [c]	25	4.29

[a] Dodecylbenzene Sulfonic Acid in Kerosene
[b] Primene 91-R in Kerosene
[c] Comprised of 13% Primene 81-R, 16% Dodecylbenzene Sulfonic Acid, and 71% Kerosene

Primene™ amines for use in the Refinery

Corrosion Inhibitors

- Primene™ amines/carboxylic acid derivatives
  - are effective oil-based CI's designed for application in petroleum pipelines and water sumps.
    - Have the additional benefit of being non-emulsifying in nature

- Primene™ amines/nitric acid salts
  - are used as emulsion based rust inhibitors.

Primene™ amines for use in the Refinery

Multifunctional additive for middle distillates

Primene™ RB-3 has been introduced to enhance the quality of middle distillates

- It provides for…..
  - improved thermal and storage stability
    - as determined by long term field studies
      - ASTM D4625 (3 months)
    - and accelerated studies like ASTM D2274 and ASTM D6468
    - particularly effective on diesels requiring high amounts of cetane improver (2-EHN)
  - improved detergency / dispersancy
    - see next slide

Primene™ amines for use in the Refinery

Multifunctional additive for middle distillates

Primene™ RB-3 offers detergency performance as demonstrated by results from the Peugeot XUD-9 Test

Injectors After XUD-9 Test

Blank | **Reference** | **With RB-3** | **With Commercial Additive**

Primene™ amines for use in the Refinery

Multifunctional additive for middle distillates

Primene™ RB-3 enhances the performance or reduces the amount needed of other additive components such as…

- Cetane Improvers
- Corrosion Inhibitors
- Demulsifier, Dehazer

Primene™ amines for use in the Refinery

Multifunctional additive for middle distillates

Primene RB-3 works via the following mechanisms…

- Acid scavenging/Metal deactivation
- Peroxide scavenging
- Solubilization of gums/coke
- Dispersancy of sediments

Primene™ amines for use in the Refinery

Other Fuel Applications

Primene amines and their derivatives are well recognized for their ability to **inhibit thermal degradation of Jet Fuel** per the CFR Fuel Coker Tests

Small amounts of the salts or amide derivatives of Primene amines have been used in **Gasolines** for a variety of reasons including….

- the prevention of stalling and icing during engine warm-up
- stabilization and prevention of emulsification with water
- rust-inhibition of storage vessels and pipelines holding the gasolines