# LAKELAND LABORATORIES LIMITED

Manufacturers of Speciality Surfactants

## 3 Imidazolines

Why? Which? Where?

1 Amphoterics

2 Phosphate Esters

3 Imidazolines

4 Wax Emulsions

CHEMICALS FOR INDUSTRY

Lloyd's Register Quality Company ISO9002

National Accreditation of Certification Bodies

Lloyd's Register Quality Company ISO9002

Erkend door de Raad voor de Certificatie

Certificate No.890395

# Why Imidazolines?

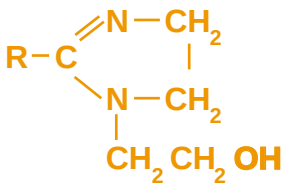
## INTRODUCTION

Lakeland Imidazolines are thermally stable organic nitrogenous bases. The un-neutralised Imidazoline, being lipophilic, is soluble in non-polar solvents and mineral oil but only dispersible in aqueous systems. The ability of imidazolines to form cations means they will be strongly adsorbed onto the negatively charged surface of metals, fibres, plastics, glass and minerals; thereby these hydrophilic surfaces are converted to hydrophobic surfaces. Imidazoline salts are much more hydrophilic than their bases and function as acid stable detergents with good wetting agents. Imidazolines may also be made compatible with aqueous systems using Lakeland AMA as solubiliser. The film forming and corrosion inhibition properties lend themselves to numerous and varied industrial applications.

## Imidazoline Types

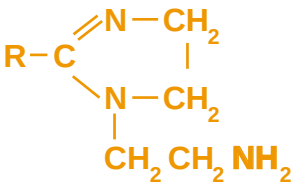
Lakeland manufacture three main types of imidazolines, namely:

**HYDROXYETHYL**



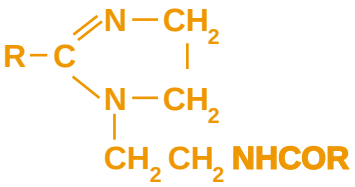

Based on Fatty acid/
Aminoethylethanolamine 1 :1

**AMINOETHYL**




Based on Fatty acid/
Diethylene triamine 1 :1

**AMIDOETHYL**




Based on Fatty acid/
Diethylene triamine 2 :1

**Some of the many properties/advantages imidazolines offer to the formulator are:**

- Strongly cationic.
- Good Emulsifiers.
- Form acid salts to confer water solubility.
- Can be solubilised into aqueous systems using Lakeland Dipropionates.
- Water repellant/water proofing.
- Nominally 100 % Solids.
- Soluble in oil/hydrophobic solvent, as base.
- Good lubricity.
- Strongly hydrophobic.
- Good base for corrosion inhibition formulations.

## Imidazoline Range

| Product | Appearance | Alkyl Chain (derivative) | Equivalent Weight (E2) (typical) | % Free Fatty Acid (typical) | % Cyclisation (typical) |
|---|---|---|---|---|---|
| HYDROXYETHYL IMIDAZOLINES | | | | | |
| **Imidazoline 18 OH** | Clear light brown to dark brown liquid | $C_{17}$ (Tall Oil) | 375 | <0.5 | 75* |
| **Imidazoline 12 OH** | Green/brown paste at 20°C, clear green/brown liquid at 40°C | $C_{12}$ (Coconut) | 250 | <0.3 | 75* |
| **Imidazoline S OH** | Off white to light brown solid at 20°C | $C_{17}$ (Stearic) | 375 | <0.5 | 70* |
| AMINOETHYL IMIDAZOLINES | | | | | |
| **Imidazoline 18 NH** | Clear dark brown liquid | $C_{17}$ (Tall Oil) | 310 | <1.0 | 60* |
| **Imidazoline 18 CA** | Clear dark brown/ green liquid at 35°C | $C_{17}$ (Tall Oil) | 320 | <4.0 | N/A |
| AMIDOETHYL IMIDAZOLINES | | | | | |
| **Imidazoline 18 DA** | Clear dark brown/ green liquid at 20°C | $C_{17}$ (Tall Oil) | 580 | ≤ 1.0 | 50* |

* by Titrimetric method LA C15. The above represent our major products, other variants available on request.

# Which Imidazoline?

The case has been made "WHY" imidazolines are used. The problem for the formulator now becomes - "WHICH IMIDAZOLINE?" A series of comparative tests have been carried out:

- **Solubility**
- **Corrosion Inhibition**
- **Emulsification**

## Solubility

**10% Imidazoline was added to the solvents and the following observations were noted:**

| Product | Water | Mineral Oil | Xylene | Pet ether | Propan-2-ol |
|---|---|---|---|---|---|
| Imidazoline 18 0H | See table below | Soluble | Soluble | Soluble | Soluble |
| Imidazoline 12 0H | | Dispersible | Soluble | Insoluble | Soluble |
| Imidazoline S OH | | Dispersible* | Soluble* | Insoluble | Soluble* |
| Imidazoline 18 NH | | Soluble | Soluble | Soluble | Soluble |
| Imidazoline 18 CA | | Soluble | Soluble | Soluble | Soluble |
| Imidazoline 18 DA | | Soluble | Soluble | Soluble | Soluble |

* Requires heating and may become unstable on standing

## Aqueous Solubility

**5% Imidazoline was added to the aqueous systems and the following observations were noted:**

| Product | HCl | $H_3PO_4$ | Acetic | Lakeland AMA | Lakeland PA100 |
|---|---|---|---|---|---|
| Imidazoline 18 0H | Soluble | Soluble | Soluble | Soluble | Soluble |
| Imidazoline 12 0H | Soluble | Soluble | Soluble | Soluble | Soluble |
| Imidazoline S OH | Insoluble | Insoluble | Insoluble | Insoluble | Insoluble |
| Imidazoline 18 NH | Dispersible | Dispersible | Dispersible | Insoluble | Insoluble |
| Imidazoline 18 CA | Dispersible | Dispersible | Insoluble | Dispersible | Dispersible |
| Imidazoline 18 DA | Dispersible | Dispersible | Dispersible | Dispersible | Dispersible |

## Emulsification

Lakeland imidazolines are used as emulsifiers and co-emulsifiers for both 'oil in water' and 'water in oil' systems. The choice of imidazoline can be optimised based on their comparative solubilities in oil as well as their hydrophobic character. The Hydroxyethyl imidazolines are regarded as the most hydrophilic compounds, with the imidazoline 12 OH ($C_{12}$ coco derived) more hydrophilic than the imidazoline 18 OH ($C_{18}$ oleic derived). The Amidoethyl types (due to the presence of two large alkyl groups) are the most hydrophobic of the series.

# Corrosion Inhibition

**The following figures represent the % weight loss on mild steel coupons when immersed in the respective acid (10% solution) dosed with 0.1% Imidazoline for 48 hours:**

| Product | Phosphoric Acid | | Hydrochloric Acid | | Sulphuric Acid | | Acetic Acid | |
|---|---|---|---|---|---|---|---|---|
| | 20°C | 80°C | 20°C | 40°C | 20°C | 40°C | 20°C | 80°C |
| Blank | 1.0 | 65.0 | 5.0 | 48.0 | 2.0 | 100.0 | 2.0 | 14.0 |
| Imidazoline 18 0H | 0.6 | 23.0 | 0.1 | 1.3 | 0.4 | 0.4 | 0.2 | 1.0 |
| Imidazoline 12 0H | 0.3 | 62.0 | 0.1 | 1.0 | 0.2 | 3.3 | 0.3 | 3.0 |
| Imidazoline S OH | 1.0 | 26.0 | 0.4 | 2.0 | 4.6 | 16.0 | 0.3 | 1.0 |
| Imidazoline 18 NH | 0.8 | 31.0 | 0.1 | 0.8 | 0.8 | 3.8 | 0.2 | 4.8 |
| Imidazoline 18 CA | 1.2 | 42.0 | 0.4 | 3.4 | 0.9 | 17.0 | 0.1 | 2.1 |
| Imidazoline 18 DA | 0.8 | 30.0 | 0.7 | 0.8 | 0.7 | 4.5 | 0.3 | 3.8 |

# Imidazoline Range

| Product | Chemical Name | S.G (20°C) (Typical) | Viscosity (cPs/20°C) (Typical) | CAS No | EINECS | Standard Pack Size (Kgs) | Data Sheet No |
|---|---|---|---|---|---|---|---|
| HYDROXYETHYL IMIDAZOLINES | | | | | | | |
| Imidazoline 18 0H | 1H-imidazole-1-ethanol,4,5-dihydro,-2-$C_{15-17}$ unsaturated alkyl derivatives | 0.95 | 450 | 68937-01-9 | 273-051-1 | 190 | 900 |
| Imidazoline 12 0H | 1H-imidazole-1-ethanol,4,5-dihydro,-2-nor coco alkyl derivatives | 0.94 | 360 | 61791-38-6 | 263-170-7 | 190 | 650 |
| Imidazoline S 0H | 1H-imidazole-1-ethanol,2-Heptadecyl-4,5-Dihydro | 0.95 | N/A | 95-19-2 | 273-051-1 | 100 | 560 |
| AMINOETHYL IMIDAZOLINES | | | | | | | |
| Imidazoline 18 NH | Fatty acids,tall oil compounds with diethylene triamine tall oil fatty acid reaction products | 0.93 | 200 | 68526-44-3 | 271-205-2 | 190 | 700 |
| Imidazoline 18 CA | Fatty acids,tall oil reaction products with diethylene triamine | 0.96 | 1500 | 61790-69-0 | 263-160-2 | 190 | 555 |
| AMIDOETHYL IMIDAZOLINES | | | | | | | |
| Imidazoline 18 DA | 9-Octadecenamide N-[2-[2-[(8-Heptadecenyl) 4,5-Dihydro-1H-Imidazole-1Y]Ethyl]- | 0.93 | 660 | 63441-26-9 | 271-205-2 | 190 | 600 |

# Where to use Imidazolines?

We now have the answers to WHY and WHICH imidazoline. The following examples of WHERE Imidazolines are often applied should give the formulator a complete picture of the flexibility of these types of surfactants.

## Major Areas of Application

### Corrosion/Rust Inhibitors

The adsorbtion of imidazoline salts onto metal surfaces will displace any water and form a monomolecular hydrophobic layer on the surface. The most effective system for this type of application would be a solution of Imidazoline 18 DA in oil, as the oil is also carried to the surface. The protective coating is resistant to aqueous and acid corrosion.

Lakeland Imidazoline 18 OH may be incorporated into lubricants for metal working, where it will function as an emulsifier and corrosion inhibitor. Best results would be obtained using a blend of Imidazoline 18 OH as emulsifier and 18 DA as corrosion inhibitor.

Imidazolines may be used in acid pickling baths to improve the wetting by acid, rapidly coating the cleaned metal surface and limiting the rate of acid attack. Lakeland Imidazoline 12 OH is recommended for this purpose.

### Car Washing

Automatic car washes often include a final rinse which renders the car bodywork water repellent.Traditional oil/solvent based rinse aid concentrates can be prepared as follows:

| | |
|---|---|
| Imidazoline 18 OH | 28.2% |
| Acetic Acid | 9.5% |
| Methylcyclohexanol | 15.9% |
| Mineral Seal Oil | 18.9% |
| Alcohol Ethoxylate ($C_{10}$ + 5EO) | 7.6% |
| Butyl Oxitol | 19.9% |

The above product is a concentrate which can be diluted in water (10%-30%) to desired concentration and used through brush wash system at 200-400 times dilution.

An alternative aqueous based concentrate can be prepared as follows:

| | |
|---|---|
| Imidazoline 18 OH | 1.5% |
| Imidazoline 18 DA | 13.5% |
| Lakeland PA 100 | 5.0% |
| Lakeland AMA LF 40 | 5.0% |
| Water | 75.0% |

The above concentrate should be formulated with biodegradable solvents such as D'Limonene and hydrophobes such as Lipinol O (oleyl 2 ethyl hexanoate) to give more environmentally friendly vehicle wax/rinse systems.

### Water Repellents

Lakeland Imidazoline 18 OH applied either as the free base in non-polar solvent or aqueous dispersion of the acid salt or solubilised with Lakeland AMA will impart water resistance to surfaces such as wood, concrete, plaster and metal.

### Acid Cleaners

Lakeland Imidazoline 18 OH, phosphoric acid, and kerosene are the basis for a good metal cleaning formulation. This type of product will clean the metal and deposit a corrosion resistant film to inhibit further attack.Other applications are in the formulation of acidic lavatory cleanser and dairy cleaners.

### Dispersing Aids

When imidazolines are mixed with positively charged products a dispersing effect is observed, e.g. imidazolines can be used to disperse carbon black.

### Textile Applications

Imidazolines are known to have many and varied applications in the textile industry. The following is a brief list of potential applications:

- Acid resistant detergents
- Improved adhesion of anionic resin emulsions to fibres
- Improved light fastness of dyes
- Fabric softeners and lubricants

Lakeland Imidazoline 18 OH is also an ideal emulsifier/ wetting agent for the acid degreasing of pelts in the leather industry.

Most textile fibres carry a negative charge, hence imidazoline salts can be applied to them from aqueous solution. The acetate salt or the dialkyl sulphate quat are recommended.

### Dewatering

Lakeland Imidazoline 18 DA and 18 OH in low concentrations in hydrocarbon or chlorinated solvents, will remove traces of water from steel or brass surfaces and deposit a protective coating which inhibits corrosion.

### Lubricant Emulsions

Imidazolines have various applications in the preparation of lubricant emulsions where they are known to act as emulsion stabilisers, corrosion inhibitors and improve the lubricity of oils. Imidazolines are recommended as oil and wax emulsifiers for application in paper, textile and metal working industries. Imidazolines, or their chloride or acetate salts, are capable of acting as both emulsifiers and corrosion inhibitors. The oleic acid salt of Imidazoline 18 OH is known to have applications in tube and wire drawing. Metal surfaces which have been treated with Imidazoline 18 DA will be much more resistant to corrosion during processing.

# Further Application Areas

### Bituminous Coupling Agents and Emulsifiers

Lakeland Imidazoline 18 OH added to bitumen at 0.1 - 0.2% concentration will increase adhesion to substrate even if the substrate to be treated is wet. Bitumen emulsions may be prepared using Imidazoline 18 OH to provide extremely good adhesion to metal surfaces.

### Antistatic Agents

Imidazolines are known to have antistatic properties in both their salt and quaternised forms for both the textile and plastic industries. Lakeland Imidazoline 18 OH diethyl sulphate "quat" would be most suitable for textile applications. For the plastics industry Lakeland Imidazoline 12 OH and 18 OH in the form of their acetate salts are recommended.

### Flocculants

The positive charge of imidazoline salts will neutralise the negative charge of certain colloidal silicates. An aqueous suspension of colloidal silica can be precipitated by the addition of imidazoline salts. Anionic detergents may also be eliminated from effluent streams using Lakeland imidazolines.

### Oil and Grease Thickeners

Imidazolines are known to form complexes with bentonites and thus may be used as thickening/gelling agents for paraffin wax and paint systems.

### Biocidal Enhancement

Imidazolines can be used to make salts of pentachlorophenol which allows application to ropes etc to prevent mildew.

### Agricultural Spray

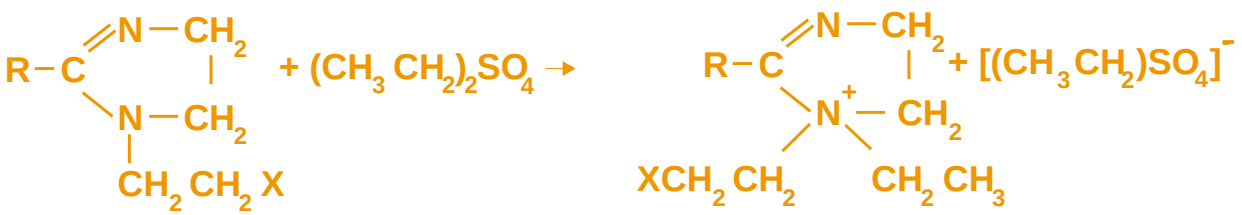
Insecticides and other products for application by spray to the land may be emulsified into water by Imidazoline 18 OH. Quick breaking sprays can be made using less than 1% imidazoline.

### Paint Applications

The incorporation of Lakeland Imidazoline 18 OH or 12 OH into paint is known to improve adhesion of paint even to wet surfaces. Waterproofing properties are also improved.

## Formation of Cationic Salts


## Quaternisation of Imidazolines



## SYNTHESIS CAPABILITIES

The following represent the synthesis capabilities of Lakeland plant resources;

- Amidation
- Cyclisation
- Esterification
- Quaternisation
- Oxidation
- Condensation
- Dehydration
- Organophosphates
- Saponification
- Others Considered

## TOLL MANUFACTURE AND CUSTOM SYNTHESIS

Toll manufacture has always been an important part of Lakeland's business. The strategic location and our proven track record leads to long lasting working relationships. With on-site engineering facilities our existing plant can be easily modified to customer requirements.All custom and Toll manufacture is carried out under a mutually agreeable secrecy contract.

## TECHNICAL SERVICES

Research and development of in-house products extends our expertise into new markets. Toll and custom synthesis is backed-up by lab-scale work and customer liaison. To support the above and to develop and improve new products the laboratory facilities include;

- FTIR
- Ultraviolet/Visible Spectroscopy
- Automated Wet Analysis Methods:- Karl Fisher, Chloride Determination, Titroprocessor
- Classical Wet Analysis
- Autoclave Facilities
- Process Development
- Formulation
- HPLC

Small scale custom laboratory synthesis will be considered. Applications and formulation help is given where possible.

## QUALITY

At Lakeland we are fully aware of the necessity for complete customer service in terms of both technical backup and quality/flexibility of supply.

We are a BS EN ISO 9002 registered company which, in itself, shows our dedication to quality manufacture and customer satisfaction.

## AMPHOTERICS

| Types | Properties | Industrial Applications |
|---|---|---|
| Dipropionates | Solubilisation<br>Hydrotrope<br>Highly Alkali Stable<br>Acid Stable | Detergents<br>Maintenance Chemicals<br>Metal Finishing<br>Lubricants-Bottling/Conveyer |
| Monopropionate | Salt Free<br>Corrosion Protection<br>Low Foam/High Foam<br>Biostatic | Vehicle Cleaning<br>Toiletries<br>Textiles<br>Oil Fields |
| Amino Betaines | Wetting<br>Emulsification<br>Hydrophobe (In Acid)<br>Free Rinsing | Micro Emulsions<br>Agriculture<br>Institutional<br>Water Treatment |
| Amido Betaines | Non Toxic<br>Hard Water Stable<br>Skin Friendly<br>Lubrication | |

## PHOSPHATE ESTERS

| Types | Properties | Industrial Applications |
|---|---|---|
| Phosphated Alcohols | Wetting<br>Solubilisation<br>Hydrotropes<br>Highly Alkali Stable | Metal Work/Finishing<br>Detergents<br>Maintenance Chemicals<br>Textiles |
| Phosphated Alcohol Ethoxylates | Corrosion Inhibition<br>Low Foam/High Foam<br>Emulsification<br>Load Carrying<br>Free Rinsing<br>Hard Water Stable | Agriculture<br>Oil Fields<br>Institutional<br>Water Treatment<br>Vehicle Cleaning |
| Phosphated Phenol Ethoxylates | | Lubricants<br>Emulsion Polymerisation |

## IMIDAZOLINES

| Types | Properties | Industrial Applications |
|---|---|---|
| Aminoethyl | Corrosion Inhibition<br>Dispersants<br>Dewatering<br>Emulsification | Oil Fields<br>Metal Working<br>Textiles<br>Paper |
| Hydroxy Ethyl | Rheology Modifiers<br>Oil Soluble<br>Water Soluble (Salts)<br>Adhesion Promoters | Lubricants<br>Road Making<br>Paints<br>Inks |
| Amido Ethyl | Acid Stable<br>Flocculation<br>Textiles Softeners | Agriculture<br>Maintenance Chemicals<br>Lapping Compounds |
| Amide Blends | Bitumen Emulsification | Pigment Dispersion |

## WAX EMULSIONS

| Types | Properties | Industrial Applications |
|---|---|---|
| Polyethylene | Completely Aqueous<br>Nonionic | Floor Polish<br>Printing Ink (Flexographic) |
| Oxidised Polyethylene | Cationic<br>Small Particle Size<br>Highly Stable | Temporary Protective Coatings<br>Metal Working<br>Wood Finishes |
| Polyethylene/ Acrylic Copolymers | Hard Waxes<br>Soft Waxes<br>18-35% Solids | Facade Protection<br>Textile Finishing<br>Packaging Films |
| Montan Ester | | Paints (Water Based)<br>Fruit Coating<br>Anti Blocking<br>Mould Release |

# AGENCIES AND DISTRIBUTION

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