LEVULINIC ACID IS A RECOGNIZED VERSATILE PLATFORM MOLECULE TO ADDRESS A LARGE MARKET POTENTIAL

Levulinic Acid

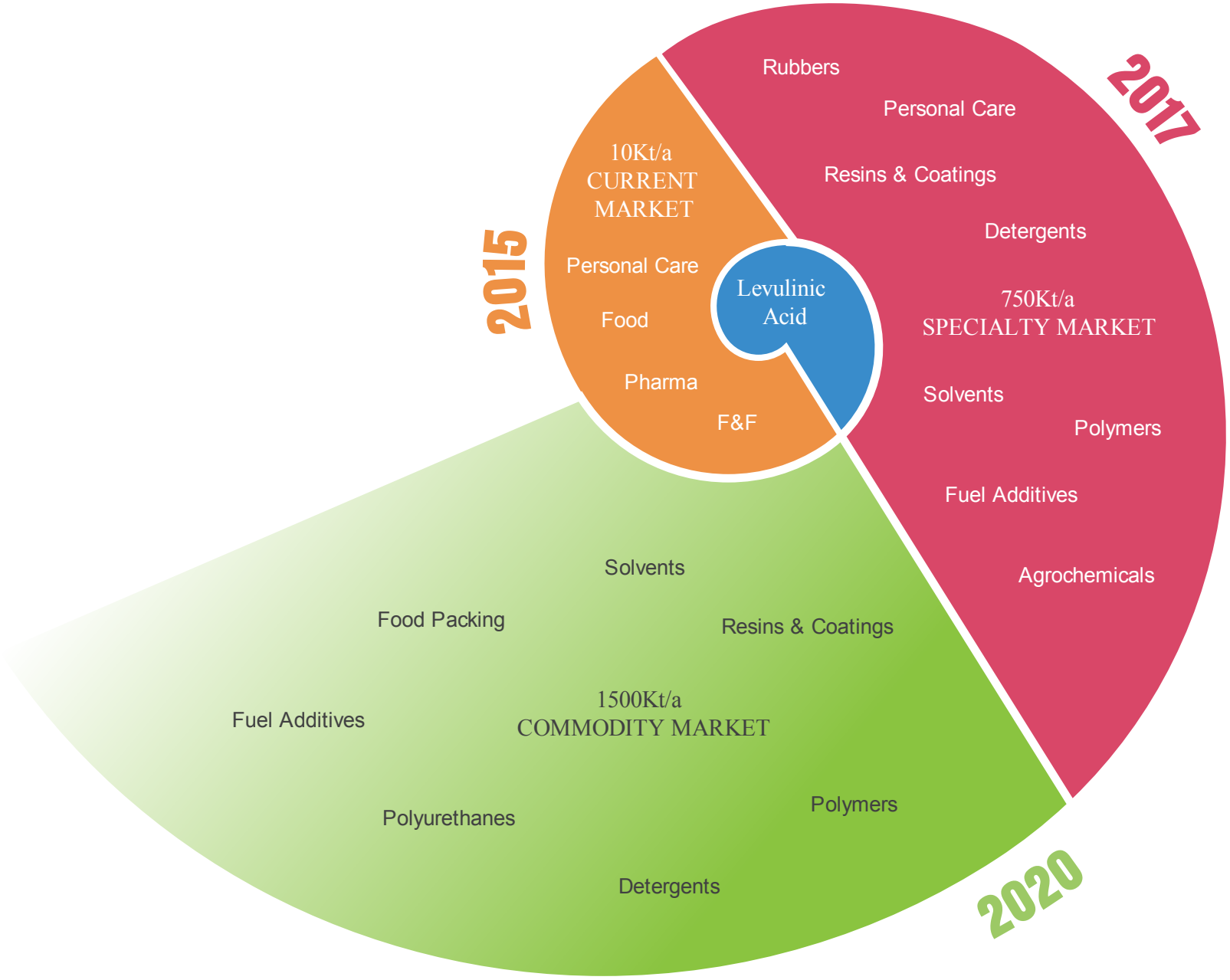
Levulinic Acid was recognized by the US Department of Energy as one of the top biobased building block chemicals of the future. It is a versatile biobased building block with a clear value proposition in chemicals.

As the world moves from fossil to alternative feedstocks, Levulinic Acid can serve as an incredibly versatile building block for chemicals and materials derived directly from biomass.

Levulinic Acid can successfully address many performance-related issues attributed to petroleum-based chemicals and materials.

Advantages

- Versatility allows for various down-stream transformations
- Feedstock flexibility, high conversion yields, high productivity and concentrated process streams result in cost-competitive economics
- Cost-competitive economics are key for fast and successful market introduction of Levulinic Acid as well as for substantial market growth in the coming years


2015
10Kt/a
CURRENT
MARKET
Personal Care
Food
Pharma
F&F
Levulinic
Acid
2017
Rubbers
Personal Care
Resins & Coatings
Detergents
750Kt/a
SPECIALTY MARKET
Solvents
Polymers
Fuel Additives
Agrochemicals
2020
Solvents
Food Packing
Resins & Coatings
1500Kt/a
COMMODITY MARKET
Fuel Additives
Polymers
Polyurethanes
Detergents

THE FULL POTENTIAL OF LEVULINIC ACID PROMISES EXCITING DEVELOPMENTS, NEW APPLICATIONS AND MARKETS

Biobased Levulinic Acid from GFBiochemicals offers a more sustainable solution for chemicals and biofuels. It is made directly from biomass for existing processes at prices competitive with petroleum-based products.

Pharmaceuticals

Levulinic Acid is used in anti-inflammatory (e.g. indomethacin), anti-allergy agents, mineral supplements (e.g. calcium levulinate) and transdermal patches. Levulinic Acid derivative delta-amino Levulinic Acid (DALA) has increased consumption in pharma in photodynamic treatment or diagnostics of cancer.

Agro-chemicals

Delta-amino Levulinic Acid (DALA) is naturally occurring in plants with potential for very large uses. It is an environmentally benign herbicide for lawn and certain grain crops use. DALA is suitable replacement for currently used herbicides and pesticides.

Flavors and fragrances

Levulinic Acid has a sweet, creamy, acidic, buttery, guaiacol-like odour and commonly used in compositions to create caramel, butterscotch, brown sugar, maple flavours. Levulinic Acid esters are often used as niche fruity flavour and fragrance ingredients. Ethyl levulinate is a potential replacement for valencene, a flavor currently extracted from oranges and used in most beverages.

In Food applications Levulinic Acid is used for multiple functions such as: flavoring agent derivative levulinate ester, alkaline earth metal salt to inhibit microbial growth in foods, pH regulator for food ingredients and disinfectant of fruit surfaces.

Resins and coatings

Levulinic Acid can be used in polyester coating resins, powder coatings, unsaturated polyester resins and polyester polyols to increase scratch resistance for interior and exterior coatings.

Diphenolic acid (DPA)

DPA is easily made from levulinic aicd. It is a commercial chemical that will be far more attractive at the lower cost allowed by Levulinic Acid production route. DPA is used in some protective and decorative finishes, but in recent years its use has been largely replaced by the less expensive, toxic bisphenol-A (BPA). DPA has the potential to present itself in the future, as a better, economical, eco-friendly and renewable alternative to bisphenol-A.

Personal care

Levulinic Acid and its derivatives are used in organic and natural cosmetic compositions for antimicrobial, perfuming, skin conditioning and pH-regulating purposes. They give inherent fresh odor, prevent wrinkles, stabilise formulations and emulsions.

Polymers and plasticizers

Plasticizers are organic esters used to render polyvinyl chloride, or PVC, more flexible. PVC is used in multiple end-markets because it is low cost, durable and versatile. Levulinic Acid ketal ester drivatives can replace major phthalate-based plasticisers which account for the majority of world's plasticiser market. Demand is increasing for renewable, phthalate-free plasticizers, in applications for children's toys and articles as well as for products with human contact exposure.

Fuel additives

Fuel Additives based on Levulinic Acid can replace current cetane improvers and cold-flow performers for diesel. They may also replace the lubricity improvers.

Renewable bio-diesel is produced by hydrogenating Levulinic Acid oligomer derivatives. Hydrogenation is used today for production of bio-diesel, using vegetable oils and animal waste fat that have limited availability and high price. Levulinic Acid oligomers can be produced at large scale from biomass feedstock and at lower price to be hydrogenated in existing installations. The hydrogenated material formed can be further processed with existing technology to 'drop-in' renewable bio-diesel and renewable jet-fuel.

Methyltetrahydrofuran (MTHF), a Levulinic Acid derivative, can be blended up to 50% with gasoline to increase vehicle performance and reduce air emissions.

At large-scale production, MTHF is competitive with common fuel oxygenates, like ethanol. MTHF has low vapor pressure, so blending with gasoline is effective in reducing volatile organic compound (VOC) emissions.

Solvents

Gammavalerolactone (GVL)

GVL can be economically comparable with ethyl acetate, but has value advantage with higher solvating power and lower vapor pressure for applications in paint stripping, softening polymers, or solubilizing intermediates in industrial processes. Economical GVL can be a monomer for polyester-polymer and starting material for pyrrolidinone isomers. Levulinic Acid based-isomers have reduced toxicity, making them widely applicable.

Methyltetrahydrofuran (MTHF)

MTHF is currently produced from furfural which is produced from corn cobs. MTHF can substitute THF due to its environmental advantages and its non-carcinogenity. Because of its lower water solubility it is easier to recover from waste streams than THF and generates fewer VOC emissions.

1,4-Pentanediol (PDO)

PDO can be obtained from Levulinic Acid similarly as GVL and MTHF, but with different catalyst. A chemical similar to 1,4-Pentianediol has existing demand for polyurethanes, but is relatively expensive. PDO has environmental and safety advantages due to its reduced potential leaching out other chemicals.

Alpha-methylene-gammavalerolactone (alfa-mGVL)

alfa-mGVL is a top-performing glass temperature booster to increase functionality and performance of low-cost plastics. It is considered for Plexiglass to improve its hardness for scratch resistance for use to replace glass. Its potential use is in consumer electronics, like touch-screens.

DERIVATIVES

Levulinic Acid offers one of the largest families of value-added derivatives.

These include:

Gammavalerolactone (GVL)

With GFBiochemicals lower price range, GVL becomes economic as a solvent comparable to ethyl acetate. GVL has value advantages over commonly used ester solvents with higher solvating power and lower vapor pressure. It is more functional for paint stripping, polymer softening or solubilizing intermediates in industrial processes.

GVL can be a monomer for polyester-polymers and starting materials for pyrrolidinone-isomers. In the medium future GVL will become the key intermediate for the production of Nylon-monomers and speciality acrylates.

Conversion of Levulinic Acid into GVL is proven with existing catalysts, resulting in high yields at reasonable operating conditions. Catalysts

widely applied include ruthenium and platinum on carbon support.

Methyltetrahydrofuran (MeTHF)

MeTHF is primarily used as a solvent for chemical reactions. It can substitute tetrahydrofuran (THF) due to its environmental advantages. Because of its lower water solubility, it is easier to recover from waste streams than THF. It generates fewer VOC emissions due to its lower vapor pressure.

The melting and boiling point of -136°C and 83°C respectively offer one of the largest ranges of liquid matter state in common solvents. This makes MeTHF perfect for low temperature reactions where other solvents like diethylether or THF fail. MeTHF's suitability as a fuel additive has led to its recognition and approval in fuel blends by the US Department of Energy (DOE).

MeTHF can be produced from Levulinic Acid using hydrogenation technology known in the industry. The Pacific Northwest National Laboratory (PNNL) has patented a commercial process from Levulinic Acid. This single-step, single-vessel catalytic hydrogenation process will produce MeTHF by employing a palladium-rhenium catalyst.

1,4-Pentanediol (PDO)

PeDO has potential as monomer for polyurethanes. Levulinic Acid offers cost-competitive PeDO with additional environmental and safety advantages due to reduced potential leaching. Applications for PeDO include the production of a controlled drug release agent. Like GVL and MeTHF, PeDO can be obtained from Levulinic Acid via hydrogenation reactions, though with different catalyst and process conditions.

Alpha-methylene-gammavalerolactone (alpha-mGVL)

Alpha-mGVL is a top-performing product as glass transition temperature booster to increase functionality and performance of low-cost plastics. In Plexiglass, it improves hardness and scratch resistance. It has great potential in consumer electronics, like touchscreens.

Delta-amino Levulinic Acid (DALA)

Delta-amino Levulinic Acid is a naturally occurring chemical with a large variety of functions. It is an environmentally benign herbicide for lawn and certain grain crops use. DALA is suitable replacement for currently used herbicides and pesticides. Increasingly strict environmental protection regulations indicate traditional volumes of pesticide chemicals use will be cut down significantly. Bio-friendly replacements are needed. Delta-amino Levulinic Acid (DALA) therefore has increased consumption in pharma and agro chemicals markets, in photodynamic treatment or diagnosis of cancer for examples

Levulinic Acid esters (LA-esters)

Levulinic Acid esters are sold today as niche fruity flavor/fragrance ingredients. Ethyl levulinate is a potential replacement for valencene, a flavor currently extracted from oranges and used in most beverages. The increasing demand in green solvents put the esters of Levulinic

Acid on the agenda of many chemical companies. As they are not known to be harmful for humans and the environment such as other ester solvents (e.g. ethyl acetate) they will be a valiant alternative at competitive price. Amongst others ethyl-levulinate has been tested as additive for transportation fuels to improve NOX emissions in high compression Diesel engines. Esters of Levulinic Acids are produced via the acid catalysed esterification of Levulinic Acid with the respective alcohol

Diphenolic acid (DPA)

DPA is used in protective and decorative finishes. In recent years, its use has been largely replaced by bisphenol-A (BPA) which is cheaper but harmful.

DPA shows potential as a more functional, sustainable and renewable alternative to bisphenol-A. DPA is easily made from Levulinic Acid and will be far more attractive at the price range allowed by GFBiochemicals' production route.

BY-PRODUCTS

Levulinic Acid production creates useful value-added secondary chemicals.

Formic acid (FA)

Formic acid is a well-known industrial chemical with an annual production capacity of around 800kt. Its main used is as a preservative in life stock feed including silage. The leather industry also consumes considerable amounts of formic acid for tanning and finishing purposes. It is additionally used in cleaning products where acidity is necessary in various applications. Formic acid is a co-product of the Levulinic Acid production. For every molecule Levulinic Acid produced in our process one molecule of formic acid is formed as well.

BIOFUELS

In biofuels, Levulinic Acid derivatives can be used to produce drop-in renewable diesel and jet fuel. Levulinic Acid derivatives can also be used to produce fuel additives as well as gasoline components.

GFBiochemicals' Levulinic Acid offers a more sustainable solution for biofuels as it is made directly from biomass at prices competitive with petroleum-based products. Levulinic Acid is used as a building block in order to produce Ethyl Levulinate and Gamma-Valerolactone (GVL). Both are used in the production of biofuel and biofuel additives.

BIOLUBRICANTS

ADDITIVES

BIOGASOLINE, BIODIESEL

JET FUEL

HOME

SAMPLES

CONTACTS

CAREERS

MEDIA

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