**INGEO LACTIDES**

Monomors & Chemical Intermediates

**DESCRIPTION**

Ingeo™ lactides are high-purity di-lactones useful for the synthesis of polymers, copolymers, and grafted substrates. They are also useful as reactive chemical intermediates for other synthesis and manufacturing purposes.

**Formula:** \( \text{C}_6\text{H}_8\text{O}_4 \)

**Chemical Name:** 3,6-dimethyl-1,4-dioxane-2,5-dione

**Molecular Weight:** 144 g/mol

**CAS Registry Number:** 95-96-5

**COMPOSITION & PHYSICAL PROPERTIES**

<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>TYPICAL VALUE(^{(1)})</th>
<th>METHOD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L-LACTIDES</td>
<td></td>
</tr>
<tr>
<td></td>
<td>L50</td>
<td>L1000</td>
</tr>
<tr>
<td>Grade</td>
<td>Polymer</td>
<td>Polymer</td>
</tr>
<tr>
<td>Stereochemistry (D-lactic equivalent)</td>
<td>≤ 0.5%</td>
<td>&lt; 3%</td>
</tr>
<tr>
<td>Color</td>
<td>White</td>
<td>White to light yellow</td>
</tr>
<tr>
<td>Overall Lactide Purity</td>
<td>≥ 99.9%</td>
<td>≥ 99%</td>
</tr>
<tr>
<td>Melting Range (Peak) (°C)</td>
<td>95–98</td>
<td>54–56</td>
</tr>
<tr>
<td>Specific Gravity: Solid at 25°C</td>
<td>1.36</td>
<td>1.33</td>
</tr>
<tr>
<td>Specific Gravity: Liquid at 130°C</td>
<td>1.16</td>
<td>-</td>
</tr>
<tr>
<td>Specific Heat Capacity: Solid at 25°C (J g(^{-1}) K(^{-1}))</td>
<td>1.3</td>
<td>-</td>
</tr>
<tr>
<td>Specific Heat Capacity: Liquid at 130°C (J g(^{-1}) K(^{-1}))</td>
<td>2.2</td>
<td>-</td>
</tr>
<tr>
<td>Heat of Vaporization (kJ mol(^{-1}))</td>
<td>~63</td>
<td>~56</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Typical composition and properties are not to be construed as specifications.
SAMPLES
Ingeo lactides can be supplied in 1-litre and 5-litre containers for laboratory-scale evaluations, and in 5-gal (19-litre) and 55-gal (225-litre) stainless steel drums for pilot-scale evaluations. They can also be supplied at a commercial scale in bulk tank-trucks and jacketed iso-containers.

BULK STORAGE RECOMMENDATIONS
The resin silos recommended and used by NatureWorks are designed to maintain dry air in the silo and to be isolated from the outside air. This design would be in contrast to an open, vented to atmosphere system that we understand to be a typical polystyrene resin silo. Key features that are added to a typical (example: polystyrene) resin silo to achieve this objective include a cyclone and rotary valve loading system and some pressure vessel relief valves. The dry air put to the system is sized to the resin flow rate out of the silo. Not too much dry air would be needed and there may be excess instrument air (-30°F dew point) available in the plant to meet the needs for dry air. Our estimate is 10 scfm for a 20,000 lb/hr rate resin usage. Typically, resin manufacturers specify aluminum or stainless steel silos for their own use and avoid epoxy-lined steel.

SAFETY AND HANDLING CONSIDERATIONS
Safety Data Sheets (SDS) for Ingeo biopolymers are available from NatureWorks. SDS’s are provided to help customers satisfy their own handling, safety, and disposal needs, and those that may be required by locally applicable health and safety regulations. SDS’s are updated regularly; therefore, please request and review the most current SDS’s before handling or using any product. The following comments apply only to Ingeo biopolymers; additives and processing aids used in fabrication and other materials used in finishing steps have their own safe-use profile and must be investigated separately.

HAZARDS AND HANDLING PRECAUTIONS
Ingeo biopolymers have a very low degree of toxicity and, under normal conditions of use, should pose no unusual problems from incidental ingestion or eye and skin contact. However, caution is advised when handling, storing, using, or disposing of these resins, and good housekeeping and controlling of dusts are necessary for safe handling of product. Pellets or beads may present a slipping hazard. No other precautions other than clean, body-covering clothing should be needed for handling Ingeo biopolymers. Use gloves with insulation for thermal protection when exposure to the melt is localized. Workers should be protected from the possibility of contact with molten resin during fabrication. Handling and fabrication of resins can result in the generation of vapors and dusts that may cause irritation to eyes and the upper respiratory tract. In dusty atmospheres, use an approved dust respirator. Good general ventilation of the polymer processing area is recommended. At temperatures exceeding the polymer melt temperature (typically 175 ºC), polymer can release fumes, which may contain fragments of the polymer, creating a potential to irritate eyes and mucous membranes. Good general ventilation should be sufficient for most conditions. Local exhaust ventilation is recommended for melt operations. Use safety glasses (or goggles) to prevent exposure to particles, which could cause mechanical injury to the eye. If vapor exposure causes eye discomfort, improve localized fume exhausting methods or use a full face respirator. The primary thermal decomposition product of PLA is acetaldehyde, a material also produced during the thermal degradation of PET. Thermal decomposition products also include carbon monoxide and hexanal, all of which exist as gases at normal room conditions. These species are highly flammable, easily ignited by spark or flame, and can also auto ignite. For polyesters such as PLA, thermal decomposition producing flammable vapors containing acetaldehyde and carbon monoxide can occur in almost any process equipment maintaining PLA at high temperature over longer residence times than typically experienced in extruders, fiber spinning lines,
injection molding machines, accumulators, pipe lines and adapters. As a rough guideline based upon some practical experience, significant decomposition of PLA will occur if polymer residues are held at temperatures above the melting point for prolonged periods, e.g., in excess of 24 hours at 175°C, although this will vary significantly with temperature.

COMBUSTIBILITY
Ingeo biopolymers will burn. Clear to white smoke is produced when product burns. Toxic fumes are released under conditions of incomplete combustion. Do not permit dust to accumulate. Dust layers can be ignited by spontaneous combustion or other ignition sources. When suspended in air, dust can pose an explosion hazard. Firefighters should wear positive-pressure, self-contained breathing apparatuses and full protective equipment. Water or water fog is the preferred extinguishing medium. Foam, alcohol-resistant foam, carbon dioxide or dry chemicals may also be used. Soak thoroughly with water to cool and prevent re-ignition.

DISPOSAL
DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. For unused or uncontaminated material, the preferred option is to recycle into the process otherwise, send to an incinerator or other thermal destruction device. For used or contaminated material, the disposal options remain the same, although additional evaluation is required. Disposal must be in compliance with Federal, State/Provincial, and local laws and regulations.

ENVIRONMENTAL CONCERNS
Generally speaking, lost pellets, while undesirable, are benign in terms of their physical environmental impact, but if ingested by wildlife, they may mechanically cause adverse effects. Spills should be minimized, and they should be cleaned up when they happen. Plastics should not be discarded into the environment.

PRODUCT STEWARDSHIP
NatureWorks has a fundamental duty to all those that use our products, and for the environment in which we live. This duty is the basis for our Product Stewardship philosophy, by which we assess the health and environmental information on our products and their intended use, and then take appropriate steps to protect the environment and the health of our employees and the public.

CUSTOMER NOTICE
NatureWorks encourages its customers and potential users of its products to review their applications from the standpoint of human health and environmental quality. To help ensure our products are not used in ways for which they were not intended or tested, our personnel will assist customers in dealing with ecological and product safety considerations. Your sales representative can arrange the proper contacts. NatureWorks literature should be consulted prior to the use of the company’s products.

NOTICE:
No freedom from infringement of any patent owned by NatureWorks LLC or others is to be inferred. No information in this publication can be considered a suggestion to infringe patents.

The technical information, recommendations and other statements contained in this document are based upon
tests or experience that NatureWorks believes are reliable, but the accuracy or completeness of such information is not guaranteed. Many factors beyond NatureWorks control can affect the use and performance of a NatureWorks product in a particular application, including the conditions under which the product is used and the time and environmental conditions in which the product is expected to perform. Since these factors are uniquely within the user’s knowledge or control, it is essential that the user evaluate the NatureWorks product to determine whether it is fit for a particular purpose and suitable for the user’s method of application. In addition, because use conditions are outside of NatureWorks control and applicable laws may differ from one location to another and may change with time, Customer is solely responsible for determining whether products and the information in this document are appropriate for Customer’s use and for ensuring that Customer’s workplace, use and disposal practices are in compliance with applicable laws and regulations. NatureWorks LLC assumes no obligation or liability for the information in this document.

NATUREWORKS MAKES NO WARRANTY, EXPRESS OR IMPLIED, REGARDING THE INFORMATION CONTAINED HEREIN OR ITS PRODUCTS, INCLUDING BUT NOT LIMITED TO ANY WARRANTY AS TO ACCURACY OR COMPLETENESS OF INFORMATION, OR ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

NOTICE REGARDING PROHIBITED USE RESTRICTIONS: Unless specifically agreed to in writing by NatureWorks, NatureWorks LLC will not knowingly sell or sample any product into any of the following commercial or developmental applications (i) components of or packaging for tobacco products, (ii) components of products intended for human or animal consumption, (iii) any application that is intended for any internal contact with human body fluids or body tissues, (iv) as a critical component in any medical device that supports or sustains human life, (v) in any product that is designed specifically for ingestion or internal use by pregnant women, (vi) in any application designed specifically to promote or interfere with human reproduction, (vii) in microbeads, including those used in personal care/cosmetic applications, or (vii) to manufacture bottles or bottle pre-forms in North America.

For additional information please contact NatureWorks via our website or reach out to us from our Contact Us Page

NatureWorks, Ingeo and the Ingeo logo are trademarks or registered trademarks in the USA and other countries.