ETHOCEL™
Ethyl Cellulose Polymers for Industrial Applications
WHAT ARE ETHOCEL™ ETHYL CELLULOSE POLYMERS?

ETHOCEL™ Ethyl Cellulose (EC) Polymers are cellulose ethers that are derived from natural wood or other cellulosic materials. To obtain ETHOCEL™, wood pulp is treated with sodium hydroxide to form alkali cellulose, which is then treated with ethyl chloride to form ethyl cellulose.

DUPONT IS THE WORLD LEADER IN CELLULOSIC DERIVATIVES

ETHOCEL™ EC Polymers offer specific properties that are unique compared to other cellulose ethers. Most cellulose ethers, such as carboxymethyl cellulose or hydroxypropyl methylcellulose, are water-soluble. ETHOCEL™ EC Polymers are not water-soluble, making them an excellent choice for protecting materials and products against water.

DuPont Nutrition & Health invented ETHOCEL™ EC Polymers and has continued to pioneer them for over 80 years. Like other cellulosic polymers in DuPont’s Nutrition & Health portfolio, ETHOCEL™ can be fine-tuned to create customized solutions. ETHOCEL™ is backed by DuPont’s world-class Research & Development team, regional Technical Application teams and regional laboratories. ETHOCEL™ EC Polymers are manufactured in our Michigan Operations plant in Midland, Michigan, USA.

A RANGE OF FUNCTIONAL PROPERTIES

- Organo solubility
- Binder
- Forms clear and resistant films
- Water barrier
- Thermoplasticity
- Viscosity (4 to 300 mPas in 5% solution)
- Rheology modification
- High purity: combusts without residue
- Low toxicity
- No ionic charge
- Enzymatic resistance
UNIQUE PROPERTIES DEVELOPED FOR YOUR APPLICATION NEEDS

- **Film Former**
  - Forms clear and resistant films. Improves spreadability, suspension and homogeneity in paints, coatings and inks.

- **Low Toxicity**
  - Naturally-derived cellulose ether, making it a good choice for consumer applications, such as food contact packaging.

- **Binding**
  - Exhibits superior binding capabilities and is used in many electronic applications where binding, high purity and film-forming properties are required.

- **Viscosity & Rheology Modification**
  - Extensive product and molecular weight options enable users to customize the required viscosity and rheology according to their applications.

- **Organo Soluble**
  - Soluble in many organic solvents. (Solvent solubility indicated on Page 6)

- **Water Barrier**
  - Useful property in various applications across a wide range of industries, particularly in specialty packaging.

- **Low Ash Content**
  - ETHOCEL™ has a very low ash content, providing high purity and clean burn out for high-end electronic applications.

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ETHOCEL™ is a versatile polymer, soluble in many organic solvents. Though it can be used in a wide variety of applications, below are a few select examples.

ETHOCEL™ is the world-premier binder for multi-layer ceramic capacitors (MLCC) and other high-end electronic ceramic parts. It provides clean burn-out, high purity, high solubility, thixotropy for print and adhesion for lamination.

Used as a seed coating polymer and in crop treatment products with oily actives to stabilize emulsions.

Used in coatings, paints and inks formulations because of ideal binding, rheology modification and stabilization properties. ETHOCEL™ is a good alternative to other polymers made from non-renewable sources.

Widely used in photovoltaics applications because of binding properties in silver or aluminum electrode pastes.

The premier binder for plasma display panels (PDPs).

Coatings, Inks

Displays

Agriculture

Electronics

Photovoltaics
This product table highlights the key grades in our ETHOCEL™ family. Other product options are available depending on your specific application requirements. Please contact a DuPont sales representative to discuss product options.

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>Viscosity (mPa•s)</th>
<th>Ethoxyl Content (Weight %)</th>
<th>Industrial Applications</th>
</tr>
</thead>
</table>
| ETHOCEL™ Standard 4 | 3.0 – 5.5        | 48.0 – 49.5%               | Conductive pastes
|                 |                   |                            | Printing inks
|                 |                   |                            | Specialty coatings                                   |
| ETHOCEL™ Standard 7 | 6.0 – 8.0        | 48.0 – 49.5%               | Conductive pastes
|                 |                   |                            | Printing inks
|                 |                   |                            | Specialty coatings                                   |
| ETHOCEL™ Standard 10 | 9.0 – 11.0       | 48.0 – 49.5%               | Ceramics
|                 |                   |                            | Conductive pastes                                   |
|                 |                   |                            | Printing inks                                       |
|                 |                   |                            | Specialty coatings                                   |
| ETHOCEL™ Standard 20 | 18.0 – 22.0      | 48.0 – 49.5%               | Specialty coatings                                   |
|                 |                   |                            | Printing inks                                       |
| ETHOCEL™ Standard 45 | 41.0 – 49.0      | 48.0 – 49.5%               | Ceramics
|                 |                   |                            | Conductive pastes                                   |
|                 |                   |                            | Printing inks                                       |
|                 |                   |                            | Specialty coatings                                   |
| ETHOCEL™ Standard 100 | 90 – 110         | 48.0 – 49.5%               | Ceramics
|                 |                   |                            | Conductive pastes                                   |
|                 |                   |                            | Low solid coatings                                   |
|                 |                   |                            | Specialty coatings                                   |
| ETHOCEL™ Standard 200 | 180 – 220        | 48.0 – 49.5%               | Conductive pastes                                   |
|                 |                   |                            | Low solid coatings                                   |
| ETHOCEL™ Standard 300 | 270 – 330        | 48.0 – 49.5%               | Conductive pastes                                   |
|                 |                   |                            | Low solid coatings                                   |
| ETHOCEL™ Medium 70 | 63.0 – 77.0       | 45.0 – 47.0%               | Conductive pastes                                   |
|                 |                   |                            | Optical films                                       |

* All viscosity test solutions are prepared with 5% ETHOCEL® and measured in an Ubbelohde viscometer at 25°C:
  - for Standard products, solvent is a 80% toluene and 20% ethanol combination
  - for Medium products, solvent is a 60% toluene and 40% ethanol combination
ETHOCEL™ SOLUBILITY

The table below does not list concentrations or viscosities and is only intended as a general guide for the solubility of ETHOCEL™ Standard grades. In general, ETHOCEL™ polymers are most soluble in blends of aromatic hydrocarbons and aliphatic alcohols.

<table>
<thead>
<tr>
<th>Completely Soluble</th>
<th>Moderately Soluble</th>
<th>Insoluble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear Solutions</td>
<td>Hazy Solutions / Swollen Gels</td>
<td>No Interaction</td>
</tr>
<tr>
<td>Aromatic Hydrocarbons</td>
<td>Acetates</td>
<td>Aliphatic Hydrocarbons</td>
</tr>
<tr>
<td>Chlorinated Hydrocarbons</td>
<td>Ethers</td>
<td>Mineral Spirits</td>
</tr>
<tr>
<td>Monohydric Alcohols</td>
<td>Alkyl Ethers</td>
<td>Glycols</td>
</tr>
<tr>
<td>Glycol Ethers</td>
<td>Naphtha</td>
<td>Glycerol</td>
</tr>
<tr>
<td>Ketones</td>
<td>Turpentine</td>
<td>Water</td>
</tr>
</tbody>
</table>
WHAT WE DO

ETHOCEL™ EC Polymers for industrial applications, are available only from DuPont Global Specialty Solutions and its distributors. Global Specialty Solutions, a business unit of DuPont Nutrition & Health (N&H), manufactures cellulosic polymers alongside other N&H portfolio products. The dedicated Global Specialty Solutions team commercializes DuPont products into various global markets.

GLOBAL SPECIALTY SOLUTIONS MANUFACTURING & RESEARCH SITES

5 production sites, 3 R&D/Technical Support and Development (TS&D) centers

- Michigan Midland, USA
- Louisiana Plaquemine, USA
- Germany Stade, Bomlitz
- China Shanghai

OUR CORE VALUES

More than just goals, our core values reflect the way we work every day with our customers and partners in communities around the globe:

- Safety & Health
- Environmental Stewardship
- Respect for People
- Highest Ethical Behavior

WHO WE ARE

We are innovative problem solvers, drawing on deep application understanding and market insight to help our customers turn challenges into high-value business opportunities.

Learn more at dupontspecialtysolutions.com

DUPONT GLOBAL SPECIALTY SOLUTIONS
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