



## Diglycerol General Overview

Polyglycerols have been known since the beginning of the 20th century, and polyglycerol fatty acid esters have been used in Europe and America since the 1940s. In the 1960s, they were approved for food use in the USA.

Solvay, with more than 20 years of experience in the production of synthetic glycerol, has extended its knowledge to the development of high purity diglycerol. Continuous research carried out by the company has led to a new generation of diglycerol with consistently high purity and unique properties.

Introduced by Solvay to the European and Japanese markets in the early 1990s, high purity diglycerol was immediately successful, especially in food and cosmetic applications. This led Solvay to expand its plant in order to expedite growth in these markets. In early 2000, Solvay Interlox, Inc. introduced Solvay Diglycerol in North America.

Diglycerol's structure is a polyol consisting of two molecules of glycerol bonded by an ether linkage. It is a clear liquid, less volatile and more viscous than glycerol, and is soluble in water and aqueous systems.

Solvay Diglycerol can be used for many applications, either by incorporation in a variety of formulations or by first converting it to derivatives. Diglycerol is a humectant used in personal care products. It can also be used in industrial applications such as the manufacture of polyurethanes.

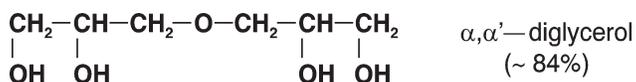
Alkoxylated diglycerol products were developed for their thickening properties. However, the most popular derivatives are esters used as emulsifiers in food, cosmetics and some technical applications. Diglycerol esters are good antifogging agents in polyolefin films.

### Manufacturing process

Solvay Diglycerol is obtained by the reaction of glycerol (synthetic or vegetable origin) and epichlorohydrin, followed by hydrolysis, neutralization and purification.



This process is designed to produce a high purity material, reduce batch-to-batch variability, and minimize the generation of cyclic components. The acyclic isomers are well defined with a high level of  $\alpha, \alpha'$ -diglycerol:



### Advantages of Solvay Diglycerol

Solvay Diglycerol is free of material from animal sources. Its Kosher certificate is renewed annually. The product is also free from GMO as glycerol is not obtained from a genetically modified plant.

The structure of diglycerol gives it the following properties:

- Solubility in water and aqueous systems.
- Compatibility with electrolytes.
- Biocompatibility, as it is easily recognizable by the skin and its arsenal of enzymes.
- High hydrogen bonding propensity imparting humectant properties to the product.
- Due to its hydroxyl groups, diglycerol acts as a cross-linking agent for a variety of applications, including the formation of gels.
- No reactivity towards active components of a formulation.
- Environmental compatibility, as the product is easily biodegradable.

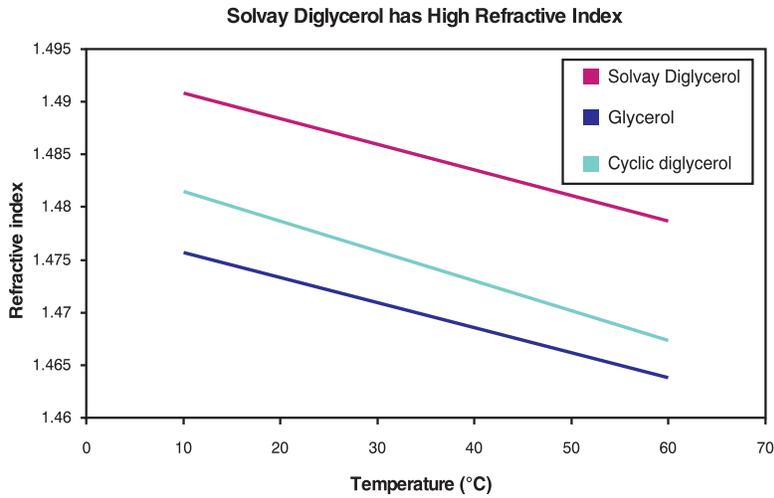
High purity Solvay Diglycerol is a clear product, practically colorless and odorless, making it especially desirable for incorporation in fragrance-free, colorless cosmetic formulations. It also does not impart any color or odor to its derivatives such as esters used as emulsifiers.

Low batch-to-batch variability is important in any application but is most valuable in the manufacture of derivatives. In the production of esters, it is essential to control the degree of esterification. A raw material with variable oligomer levels compounds the problems encountered in the control of these reactions.

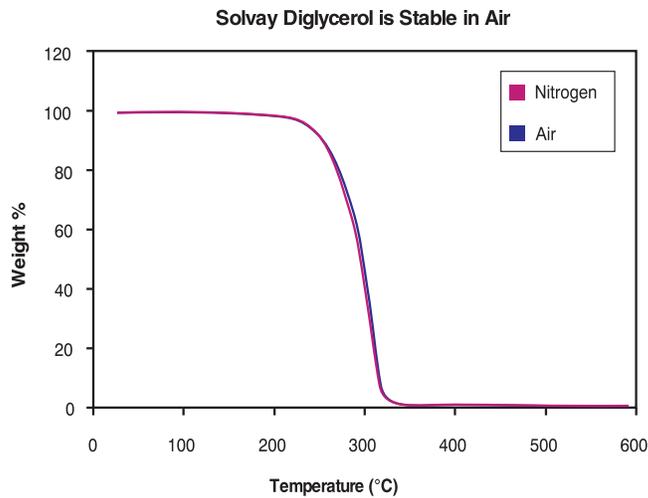
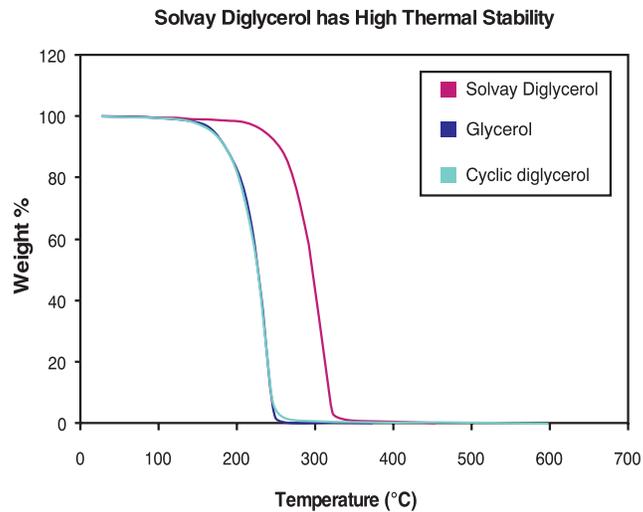
Its minimal content of glycerol allows Solvay Diglycerol to exhibit the full benefits associated with this higher molecular weight product. These include:

- Higher refractive index, which is valuable in the formulation of clear personal care products. Transparent emulsions are obtained when the aqueous and oily phases have a similar refractive index. The use of higher refractive index ingredients such as Solvay Diglycerol in

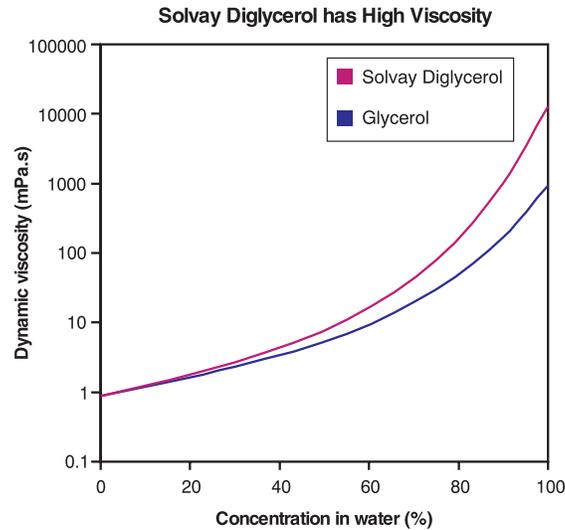
the aqueous phase facilitates formulation, and reduces the need for addition of other components that increase the refractive index.



- Better thermal stability, which is advantageous during the manufacture of esters, as high temperatures are usually utilized during the reaction, especially if no catalyst is included. Polyglycerol esters, in general, are also known to be more thermally stable than the glycerol derivatives.

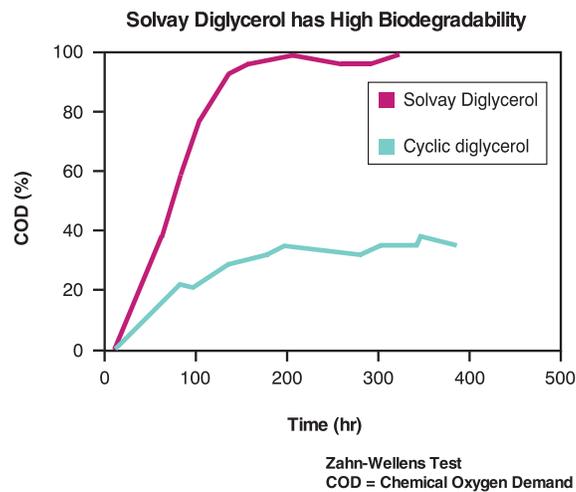


- Higher viscosity, which provides greater body to personal care formulations. This could lead to a reduction in the amount of thickening agent needed in the formulation.



The low content of cyclic components in Solvay Diglycerol gives the product many advantages. These include:

- A higher functionality (hydroxyl value is 1,380), which leads to better hydrogen bonding capability, and increased yields on conversion to esters or other derivatives.
- Higher thermal stability at high temperatures, as the cyclic components were found to degrade faster than the linear product.
- Higher refractive index, which is important in the formulation of clear cosmetic formulations.
- Higher biodegradability, which is important in our environmentally conscious economy. Cyclic diglycerol was found to degrade at a much slower rate than the acyclic product.



**Regulatory status**

Solvay Diglycerol complies with the following:

- Kosher Certificate
  - Free from GMO
  - United States
  - European Union
  - Japan
  - Korea
  - China
- Free from animal sources
- Free from genetically modified materials\*
- Listed in the International Cosmetic Ingredient Dictionary and Handbook
- TSCA registered
- May be used in the production of polyglycerol esters of fatty acid emulsifiers from the sources identified in 21 CFR § 172.854. Esters can be incorporated as antifogging agents with applicable FDA Threshold of Regulation exemptions.
- Complies with EU polyglycerol specifications for manufacture of food esters (EU Directive 98/86/EC).
- Esters are approved for addition to food-contact materials under EU Directive 95/3/EC.
- EINECS 261-605-5
- Complies with the 2000 edition of the Japanese Standards of Cosmetic Ingredients (JSCI)
- Esters registered as food emulsifiers in the list of Food Hygiene Act under Registration No. 80.
- ENCS 2-418
- ECL KE-10573
- Registered

\* At the moment, the glycerol used to make Solvay Diglycerol is either synthetic or biodiesel glycerol. The latter is a coproduct of biodiesel production obtained by transesterification of rapeseed oil certified from countries where crops of genetically modified rape are currently forbidden.

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Solvay Interlox, Inc.  
3333 Richmond Avenue  
Houston, Texas 77098  
Telephone: 713/525-6500  
Or 1-800-INTERLOX  
Fax: 713/524-9032

Website: [www.solvayinterlox.com](http://www.solvayinterlox.com)  
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