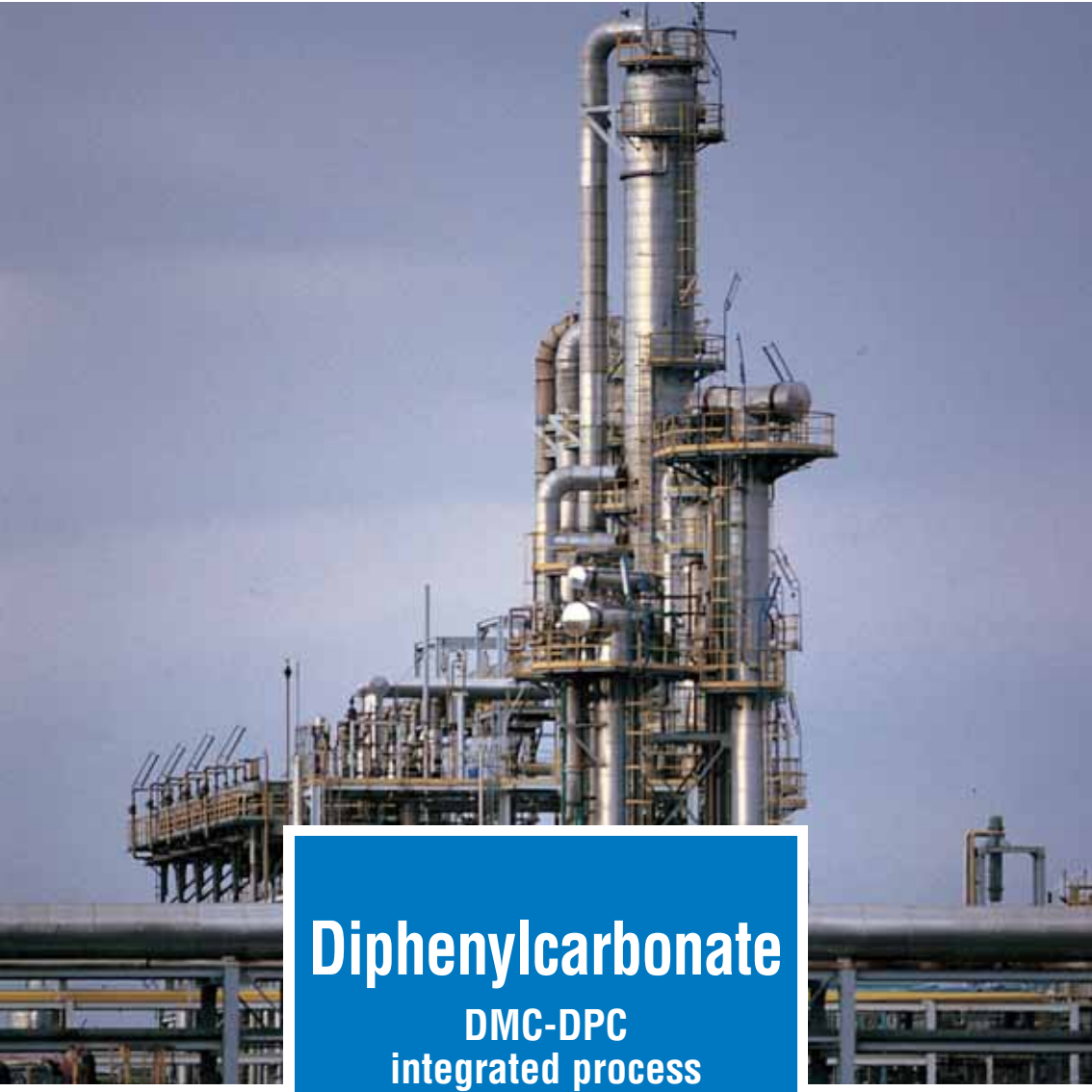


Diphenylcarbonate

DMC-DPC integrated process

Proprietary process technology

eni

polimeri europa

POLIMERI EUROPA PRODUCTION TECHNOLOGIES FOR LICENSING

Licensing

Proprietary process technologies

Phenol and derivatives
PBE-1 Zeolite catalyst based Cumene *
Phenol, Acetone, Alphamethylstyrene *
Isopropyl Alcohol Acetone hydrogenation *
Isopropyl Alcohol to Cumene *
PBE-1 Zeolite catalyst
TS-1 Titanium silicalite catalyst based Ammoximation

DMC and derivatives
Dimethylcarbonate
via Carbon Monoxide and Methanol *
Dimethylcarbonate / Diphenylcarbonate *

Polyethylene
LDPE
HDPE
EVA

Styrenics
PBE-1 and PBE-2 Zeolite catalyst based Ethylbenzene
Styrene monomer
GPPS
HIPS
EPS
ABS continuous mass polymerization
SAN

Elastomers
e-SBR
s-SBR
SBS / SB / LCBR
Polybutadiene

Proprietary catalyst technologies

Titanium silicalite
PBE-1 Zeolite
PBE-2 Zeolite

* Co-licensing in cooperation with Lummus Technology

Polimeri Europa

Polimeri Europa – the petrochemical company of Eni – manages the production and marketing of Basic Chemicals, Polyethylene, Elastomers and Styrenics.

With its 17 production sites throughout Europe and a widespread sales network, Polimeri Europa can present itself to the intermediates, thermoplastic resins and elastomers market as a sound and comprehensive supplier whose key strength is its integration. From raw materials to production plants, from research laboratories to technology, through to the interface with the market which can turn to a single source with the certainty of finding solutions to its requirements not only in terms of products, but also in terms of assistance and service. Thanks to the definition of the e-commerce and the logistic portal express, Polimeri Europa can offer to its customers the opportunity to use their tailored made e-shopping and logistics.
Saving time and money.

On the basis of its first hand experience, Polimeri Europa can also license its proprietary production technologies aiming to satisfy the even more specific customers needs.

Polimeri Europa's commitment to quality, improvement and innovation continues, as does its pledge to promote sustainable growth with regard to the community and the environment.

NOW AVAILABLE

Introduction to Polimeri Europa Diphenylcarbonate process

Diphenylcarbonate (DPC) is an important intermediate in polycarbonates production.
Polycarbonates can be prepared according to direct or transesterification route.
In direct route (interfacial polymerization), phosgene reacts with bisphenol A (BPA) to yield polycarbonate.
The system requires a two phases solvent (water/NaOH and methylene chloride).
This route has environmental and corrosion problems; moreover recovery of chlorine from NaCl is critical.
In transesterification route (melt polymerization) BPA reacts with DPC with formation of polycarbonate and phenol.

Compared with the direct route, the transesterification one allows higher productivities, easier polymer processing, and does not need any solvent recovery section.

DPC can be industrially produced according to the following technologies:

- Phosgene route
  Phosgene reacts with phenol in presence of NaOH yielding DPC and NaCl. This technology has to manage environmental and coproduction problems of the direct route that can limit plant capacity.
- DMC route
  DMC reacts with phenol yielding DPC and methanol. No chlorine is involved in the synthesis and no environmental and corrosion problems have to be faced.
  Polimeri Europa, owning a high competitive DMC technology, licenses this route.
  The methanol recycle and the possibility of energy integration form DPC to DMC unit create a synergic single one technology.

Main features of Polimeri Europa DMC/DPC technology are:

- environmentally safe process;
- high production capacity;
- high product purity;
- polycarbonate quality improved, critical for optical media applications.

TECHNICAL DATA

Product purity and material balance

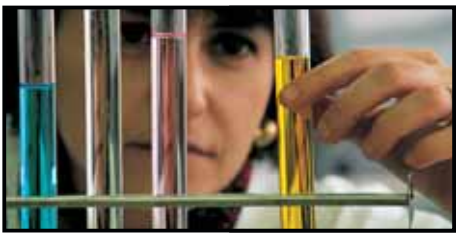
Diphenylcarbonate quality
Purity
Colour APHA
Ti
Fe

DMC/DPC plant material balance
Raw materials
Methanol
Carbon monoxide [1]
Oxygen [1]
Hydrochloric acid [2]
Phenol
Ti tetraphenoxide [3]
Product
Diphenylcarbonate
By products
Process water
Inerts purge [4]
Organics purge
Carbon dioxide to CO unit
Anisole
Catalyst purge

[1] As 100% vol. Pressure 30 bar g
[3] DPC catalyst. Prepared from commercial Ti isopropylate.

Process economics

DMC/DPC plant utilities consumption
Steam 40 bar g
Steam 8 bar g
Electricity
Cooling water
Brine 10 °C
Temperated water 45 °C



99.6% wt min	
20 max	
0.1 ppm wt max	
0.1 ppm wt max	
MT per MT DPC	
0.030	
0.223	
0.127	
0.010	
0.885	
0.002	
1.000	
0.108	
–	
0.025	
0.134	
0.005	
0.005	

(2) As 30% wt soln.
(4) Function of inerts contained in CO feed.

per MT DPC
11,800 kg
5,000 kg
270 kWh
1,140 m^3
25 m^3
34 m^3

Investments estimation

A 85 kt/y ISBL DPC plant (DMC unit included) has an estimated investment cost of 82 million Euro (NWE basis).

Wastes and emissions

In addition to DMC unit wastes and emission, DPC unit has a small CO_2 emission caused by anisole formation. This stream can be added to the one, more relevant, coming from DMC unit that is recycled to CO generation plant.
Spent catalyst/heavies purge is characterized by a content of titanium of about 4.6% wt. This stream has to be sent to a suitable incinerator. Normally, this equipment is not the same used in DMC unit to incinerate the chlorinated organic waste in order to avoid possibility of dioxine formation.

Industrial applications

Licence to General Electric Japan for a DMC/DPC unit at Chiba. DPC unit was 17.2 kt/y capacity and started up in 1993.

Licence to General Electric España for a DMC/DPC unit at Cartagena. DPC unit was 112 kt/y capacity and started up in 1998. In 2004 the total capacity has been increased to 224 kt/y with the start up of a second unit.

Process description

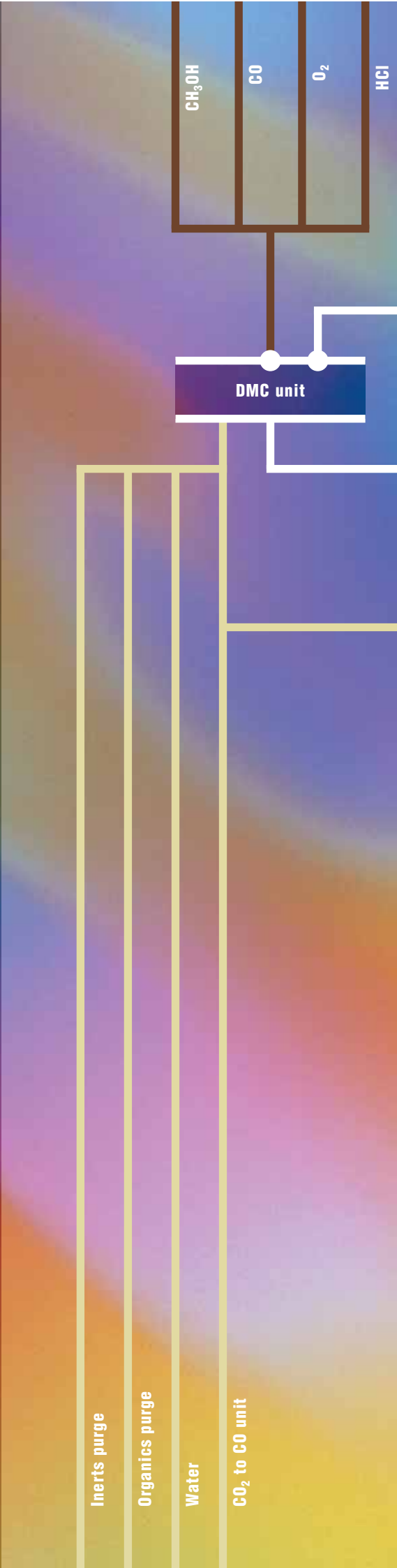
DMC and DPC units are integrated both from material and energy point of view.

DPC is produced in two steps: phenylmethylcarbonate (PMC) synthesis from phenol and DMC followed by PMC disproportion to DPC.
Phenol, DMC and catalyst are fed to PMC reaction section where a small amount af anisole and CO_2 is also produced. CO_2 is joined together with the stream coming from DMC unit and recycled to CO generation plant.

A first stream (light products), mainly methanol, DMC and anisole is fed to the azeotropic distillation section.
Here a methanol and DMC azeotrope is recycled to DMC unit, while part of remaining DMC is fed back to PMC section.
An anisole/DMC mixture is then sent to the anisole recovery section; also in this case DMC returns to PMC section.

A second stream (heavy products), mainly PMC and phenol is fed to DPC reaction section, where disproportion takes place and some heavier byproducts are formed.
From here, unreacted phenol is recycled to PMC section, while DPC, heavies and catalyst are fed to the catalyst recovery section.
Recovered catalyst is recycled to PMC section and partially purged out of the plant together heavies (a continuous make up of fresh catalyst is foreseen).

DPC is subsequently purified from residual heavies that are recycled with some DPC to the catalyst recovery section. As for reagent quality is concerned, in addition to DMC unit requirements (see relative Polimeri Europa technology brochure), phenol BPA grade is needed. Catalyst is prepared in situ starting from commercial titanium isopropilate.




Catalyst
Phenol
Raw materials
Process sections
Products
By products
PMC reaction
Azeotropic distillation
Anisole recovery
DPC reaction
Catalyst recovery
DPC purification
Catalyst / Phenol recycle
Anisole
Diphenylcarbonate
Spent catalyst / Heavies

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Responsible Care

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