

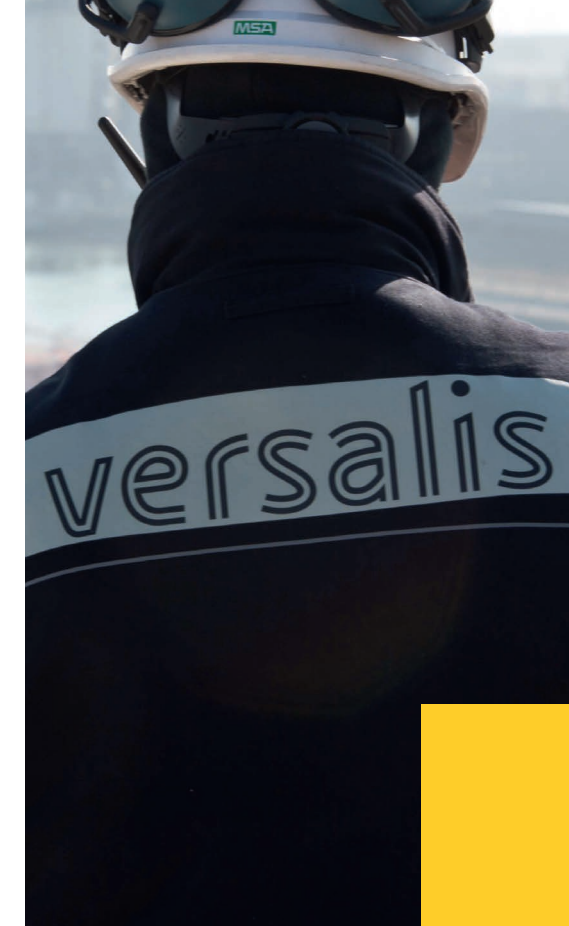
Proprietary process technology

# GPPS

General Purpose Polystyrene



versalis



## Versalis proprietary process technologies available for licensing

### Our company

Versalis - the petrochemical subsidiary of Eni - is a dynamic player in its industry sector facing the multifold market needs through different skills.

With a history as European manufacturer with more than 50 years of operating experience, Versalis stands as a complete, reliable and now global supplier in the basic chemicals, intermediates, plastics and elastomers market with a widespread sales network.

Relying on continuous development in its production plants as well as in its products, strengthening the management of the knowledge gained through its long industrial experience, Versalis has become a worldwide licensor of its proprietary technologies and proprietary catalysts. The strong integration between R&D, Technology and Engineering departments, as well as a deep market expertise, are the key strengths for finding answers to customers requirements.

Our commitment to excellence, in quality of our products and services, makes our company an active partner for the growth of customers involved in petrochemical business.

Through engineering services, technical assistance, marketing support and continuous innovation, our knowledge is the key strength to customize any new project throughout all phases.

Customers can rely on this strong service-oriented outlook and benefit from a product portfolio that strikes a perfect balance of processability and mechanical properties, performance and eco-friendliness.

# Introduction to Versalis GPPS technology

General Purpose PolyStyrene has been produced by the innovative continuous mass process in Versalis since 70s in a 75 KTA plant unit located in Italy. During the next two decades the GPPS technology was considerably improved and in 1989 a new 75 kTA GPPS unit based on the updated technology was started up in Belgium. After that date, further units were licensed first in Hong Kong and then in Brazil, with capacity respectively of 75 and 50 KTA. In the last decades, Versalis R&D has been continuously updating the technology in terms of proprietary equipment and process optimization.

Even though GPPS production technology can be considered to be well consolidated and mature, in the last decades the more demanding parameters required by market in terms of products quality and the greater sensitivity towards environmental issues pushed Versalis R&D to continuously update its technology and product portfolio, by improving its key proprietary equipment and by optimising the process cycle. The results of this effort make Edistir® GPPS, with its wide product portfolio, a benchmark within the European scenario.

The key features of Versalis GPPS technology are:

- special and unique process and mechanical design of key equipment such as the reactor and devolatilizer;
- really simple process scheme and easy process control;
- flexible technology allowing tailor-made solutions for specific needs, in terms of plant capacity and products range;
- minimum amounts and number of foreign materials introduced in the process;
- very low residual monomer and oligomer content;
- very low amounts of chemicals consumption for the same property balance;
- fine-tuned macromolecular structure (molecular weights and its distribution);

- even the most challenging fields of application like the insulation panels (XPS) and the expanded trays by means of direct gassing are covered by the Edistir® GPPS portfolio.

Versalis can always provide appropriate solutions to different client's needs thanks to its capabilities and experience in the following fields:

## Research & development

The presence of a strong R&D team, established in Mantova since the early 70s, qualifies Versalis as an outstanding owner of know-how in the field of styrenics. Reliable and updated facilities (pilot plants, synthesis and analytical labs, equipment for polymer processing), allow Versalis to continuously improve the technology in order to support the styrenics business in a competitive and demanding market scenario. Additional services are then available for potential Licensees, such as technical assistance, training, development of analytical methods, site assistance for start-up and follow up, development of tailor made products on demand.

## Process design & operational experience

Process design is flexible and able to face different conditions and constraints. Any project is individually evaluated to offer the best solution, tailored to specific customers needs. Thermal and fluidynamic analysis (CFD) can be applied to the design of key equipment, such as reactors and agitators. The design takes also advantage of the Versalis long-term manufacturing experience. New technological solutions are first tested in production plants and the acquired experience transferred to the licensed technology, in order to reach not only the best process performances, but also a safe and reliable plant arrangement.



## Mechanical design

Versalis Engineering Dept. has been working in close coordination with the Process Dept. since a long time. This fact has allowed to develop unique and well sound engineering solutions for critical equipments, that guarantee the best results in terms of mechanical reliability and process performances.

The flexibility of Versalis GPPS technology allows to provide with a single line convenient solution for a broad range of economically feasible capacities: up to 200 kt/y. The plant arrangement can be tuned to fit required targets, such as special grades and/or peculiar products range.

## Wastes and emissions

The main liquid organic wastes and vents can be sent to the process hot oil heater to lower plant emissions and save energy by recovering relevant heat of combustion.

## Industrial applications

Versalis GPPS units, based on proprietary technology, are on-stream in Italy (75 kt/y, since 1971), and in Belgium (75 kt/y, since 1989), making Versalis one of the major European producer of general purpose polystyrene. One GPPS unit (75 kt/y) licensed by Versalis is on-stream in Hong Kong since the early 1990s. A second one (50 kt/y) was started up in Brazil in 2000. Another unit (80 kt/y) is on stream in Italy (since 2011).

## Main process parameters

	per MT GPPS
Raw Materials	1,005 - 1,008 kg
Electricity	0.1 MWh
Fuel Gas (10,000 kcal/kg)	20 kg
Steam	100 kg



## The Edistir® GPPS product portfolio

Versalis GPPS products are characterized by a very good balance between key properties such as:

- very low residual monomer and oligomer content;
- low amounts of chemical consumption for the same property balance;
- fine-tuned macromolecular structure (molecular weight and its distribution).

This set of characteristics allows the Edistir® products portfolio to cover even the most challenging fields of application.

### Packaging

- thermoformed and injection-moulded cups and food containers;

- injection-moulded disposable items and cutlery.

### Direct gassing

- insulation panels (XPS);
- expanded trays.

### Others

- injection moulding of CD boxes, house wares, medical articles and toys;
- injection moulding of refrigerator clear internal components;
- extrusion of clear panels and shower boxes;
- oriented and bi-axially oriented extruded films.

## Process description

Versalis GPPS technology is based on a continuous mass peroxide-initiated polymerization of styrene. The monomer is added with chemicals in a mixing section. The mass reaction occurs in the presence of solvent. This mixture is thus fed to the polymerization section, generally composed by a sequence of 2 continuously stirred tank reactors (CSTRs), where the heat of the reaction is removed by evaporating the volatile matter. Different reaction section arrangements are also available, in order to meet specific customer requirements.

At the end of the reaction train, the polymer solution is sent to a devolatilization section, consisting of two stages operating in series under vacuum conditions.

The monomer and low-boiling compounds are removed from the polymer, which is finally sent to the pelletizing unit.

The heat is provided by a thermal oil system. The vapour mixture, recovered by the devolatilization section after, is condensed and then continuously recycled to the mixing section.

Non condensed vapours/inert gases from the vacuum system and liquid organic purge from the condensation section are recovered as fuel in a furnace, where thermal oil for the process needs is heated.





## Process design advanced features

Even if the process is similar to the most common current technologies available in the market, the Versalis GPPS technology is unique, due to the following proprietary advanced design features:

### Polymerization section

Generally, continuously stirred tank reactors (CSTR), with optimised design of the stirrers can be applied. In such a way the better compromise between thermal control and polymer production rate can be accomplished. By ensuring a good fluidynamic and thermal homogeneity, the Versalis CSTR reactor provides maximum control of molecular weight growth and distribution. Other arrangements, involving a combination of CSTR and plug flow reactor (PFR) is also possible in order to meet any other client's requirement.

### Devolatilization section

This section involves a two-stage operation, with high heat and mass transfer rates and very low residence times. This combination of factors leads to a very efficient monomer and organic matter removal even at relatively low operating temperature (thus minimizing polymer chain degradation) and without the addition of water or other stripping agents.

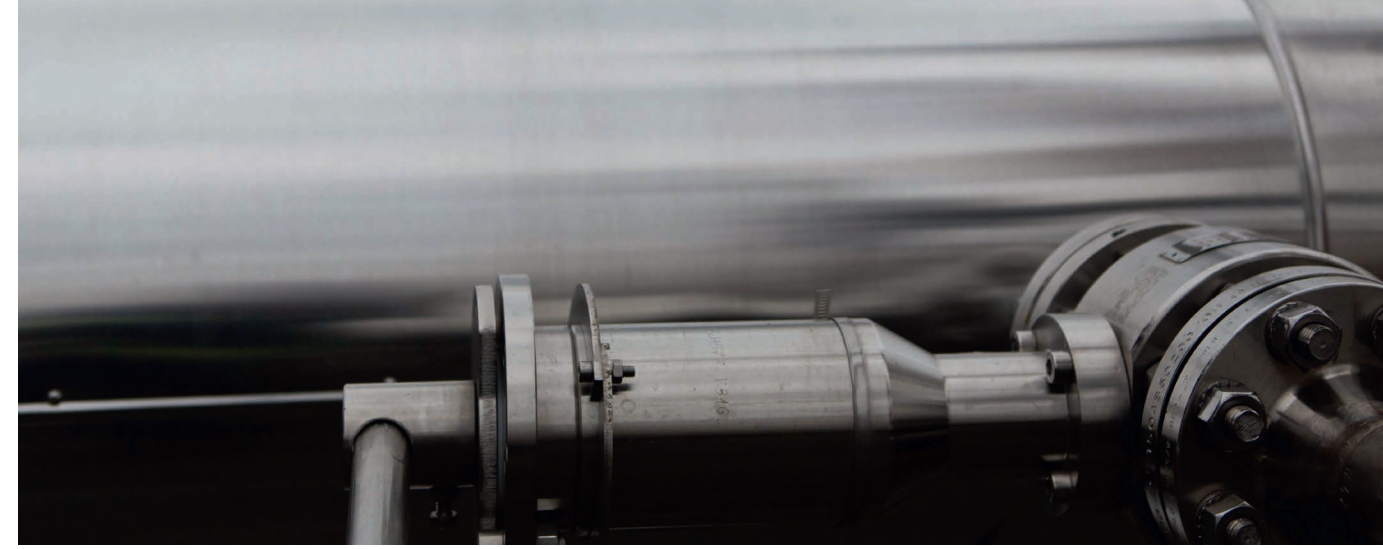
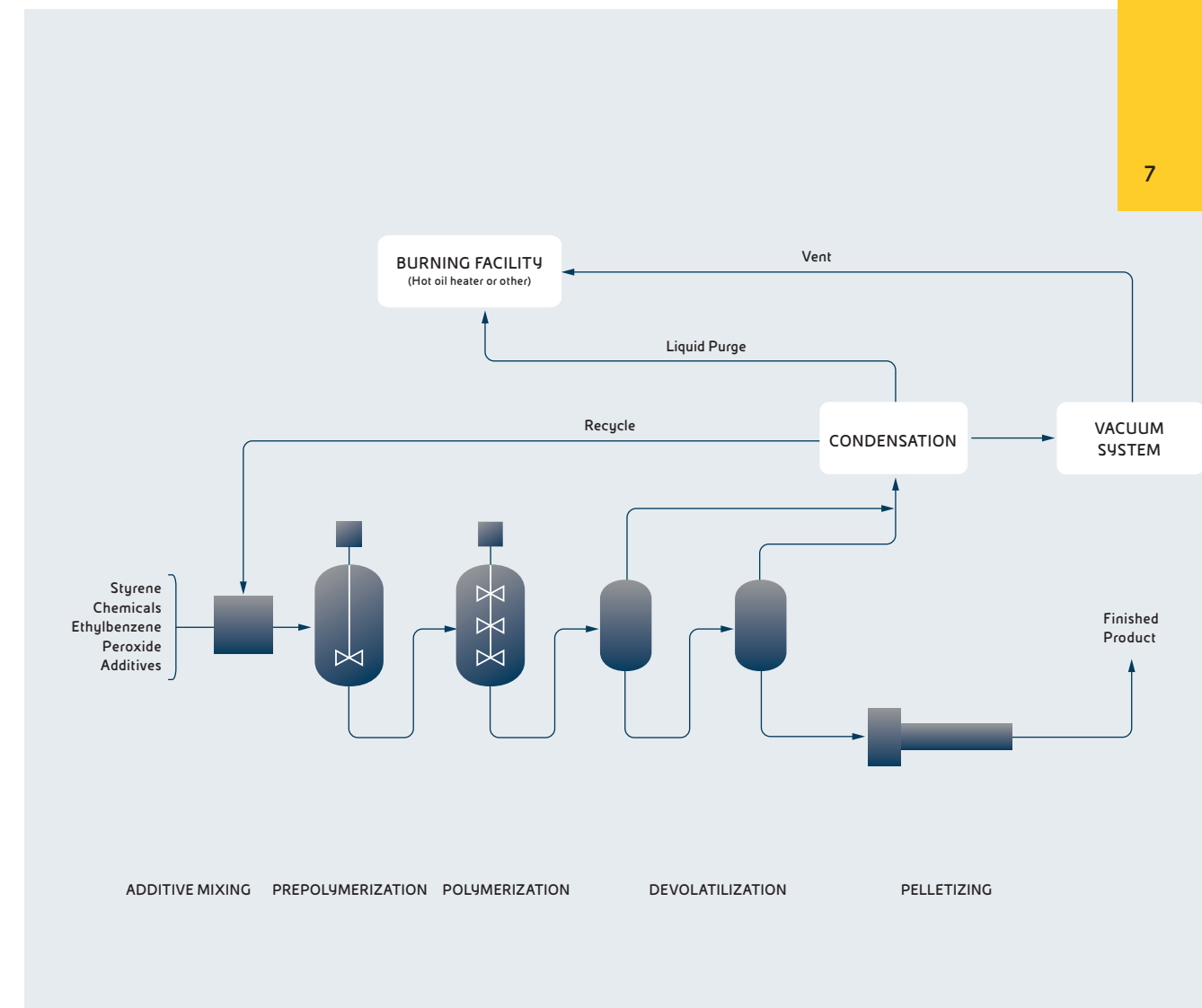


Fig.1

GPPS continuous mass • process scheme



# Proprietary process technologies portfolio

## Biotech

PROESA® 2G Ethanol and Cellulosic Sugars

## Phenol and derivatives

Cumene (with PBE-1 zeolite based proprietary catalyst)\*  
 Phenol, Acetone, Alkylphenols\*  
 High selectivity Cyclohexanone  
 Acetone hydrogenation to Isopropyl Alcohol\*  
 Isopropyl Alcohol to Cumene\*\*  
 Ammoxidation (with Titanium silicalite based proprietary catalyst TS-1)

## DMC and derivatives

Dimethylcarbonate (via Carbon Monoxide and Methanol)\*  
 Diphenylcarbonate\*

## Proprietary catalysts

Titanium silicalite  
 PBE-1 Zeolite  
 PBE-2 Zeolite

## Styrenics

Ethylbenzene (with PBE-1 and PBE-2 zeolite based proprietary catalyst)  
 Styrene  
 GPPS  
 HIPS  
 EPS suspension polymerization  
 ABS continuous mass polymerization  
 SAN

## Polyethylene

LDPE  
 EVA

## Elastomers

Emulsion-SBR  
 HSL Latices  
 Solution-SBR  
 TPR  
 LCBR  
 HCBR  
 NBR  
 Carboxylated latices  
 EP(D)M



Versalis spa  
Piazza Boldrini, 1  
20097 San Donato Milanese (MI) - Italy  
Ph. 0039 02 520.1

[info@versalis.eni.com](mailto:info@versalis.eni.com)  
[versalis.eni.com](http://versalis.eni.com)



**Licensing:**

Piazza Boldrini, 1  
20097 San Donato Milanese (MI) - Italy  
Ph. 0039 02 520.42931 - fax 0039 02 520.42286

[info.licensing@versalis.eni.com](mailto:info.licensing@versalis.eni.com)



11 - 2018