

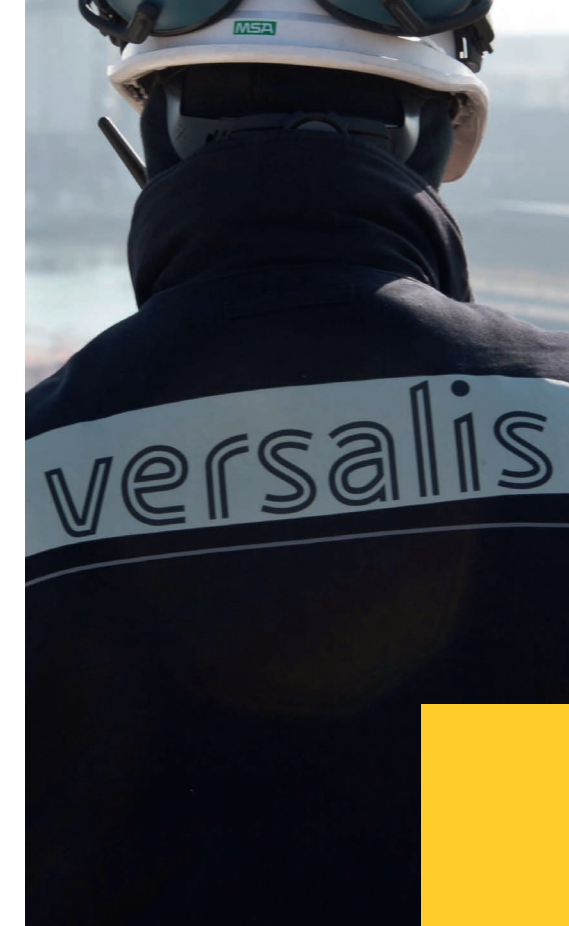
Proprietary process technology

EPS

Expandable Polystyrene

SUSPENSION POLYMERIZATION TECHNOLOGY





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 EPS suspension technology

Versalis has been producing Expandable PolyStyrene by the suspension process since 70s. In the last decade, because of market requirements in terms of products quality and environmental impact issues, Versalis R&D has continued to update its technology and product portfolio, by improving its key proprietary equipment and optimizing the process cycle. The result of this effort makes Extir® EPS, with its wide product portfolio, a benchmark within the European scenario.

The key features of Versalis EPS suspension technology are:

- flexible technology allowing tailor-made solutions for specific needs, in terms of plant capacity and products range;
- use of inorganic suspending agent, which leads to narrow bead size distribution;
- single step technology (the impregnation of the beads with the blowing agent is made during the polymerization step);
- simple process scheme and easy process control;
- very good reactor filling and no need for solvent washing of the reactors;
- easy availability in the world market of the chemicals used in the process;
- special and unique process and mechanical design of key equipment such as the reactor.

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

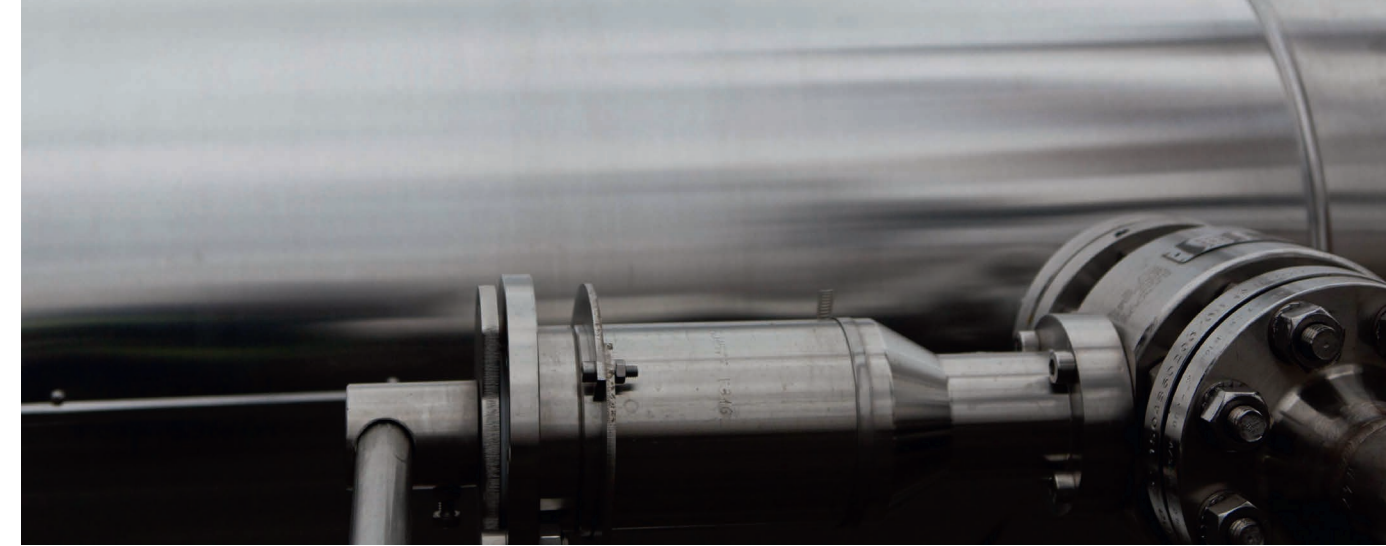
Research & development

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 polystyrene 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) are extensively 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; then the acquired experience is transferred to the licensed technology, in order to ensure not only the best process performances, but also a safe and reliable plant arrangement.



Mechanical design

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

The flexibility of versalis EPS suspension technology allows to provide with a single line convenient solution for a broad range of economically feasible capacities: up to 60 kt/y. The plant arrangement can be tuned to fit required targets, such as special grades and/or peculiar product range.

Wastes and emissions

All the waste water can be treated by a common biological plant. Process vents are sent to an abatement unit (flare or oxidizer).

Industrial applications

Three versalis EPS units are on-stream in Italy (35 kt/y, since 1974), Belgium (35 kt/y since 1983) and Hungary (50 kt/y, since 1991), making versalis one of the major European producers of expandable polystyrene.

A 50 kt/y EPS unit was licensed in 2004 in the Russian Federation.

Main process parameters

	per MT EPS
Raw Materials	990 - 1,010 kg
Electricity	0.21 MWh
Demineralised water	3.5 m ³
Steam	0.5 MT

The Extir® EPS product portfolio

Versalis EPS products are characterized by a unique balance between key properties such as:

- very good expandability;
- short cycle times and very good fusion;
- fine-tuned design for specific applications.

Within Extir® product portfolio it is possible to find a suitable grade for all the current processing technologies (moulding, transfer, vacuum or blocks), which can cover the following main applications.

Normal grades

- boxes and containers for marble and food;
- packaging;
- lightened concrete;
- light and heavy blocks.

Flame resistant grades

- industrial packaging;
- sheet and blocks for insulation in the building industry;
- wall padding sheets;
- floor bodies;
- disposable forms;
- lightened mortars and bricks.



Process description

The Versalis EPS technology is based on a batch suspension polymerization of styrene, with an inorganic suspending agent. The internal chemicals are dissolved in styrene. This preheated solution is afterwards transferred into a reactor, pre-filled with demi water and suspending agent, under agitation.

The blowing agent is added during the polymerization cycle.

The reaction goes ahead until the residual styrene reaches the target value, according to a proper temperature cycle and recipe. Final bead size is chemically controlled during the polymerization up to the desired diameter.

The small amount of blowing agent escaping from the polymerization section is sent to an abatement unit (flare or other). After polymerization, the EPS beads slurry is transferred to an agitated tank where cooling occurs. The slurry is then transferred into a bigger slurry storage tank, designed to contain several batches, in order to get a good homogeneity and to continuously feed the centrifugation section.

Wet beads are then still continuously fed to a drier and to the screening section to be classified in the desired products. Single fractions are temporarily stored in silos and then lubricated with a proper coating recipe.



Process design advanced features

Even if the process scheme basically calls in mind the most common current technologies, Versalis EPS technology is peculiar being provided with the following proprietary advanced design features:

Polymerization section

Proprietary Reactor Design able to:

- give narrow bead size distributions;
- high reactor filling;
- no need for chemical washing.

Proprietary Suspension System based on an inorganic agent, able to:

- get an optimal control on bead size distribution and bead internal cellular structure;
- stabilize the small styrene droplets, avoiding the risk of agglomeration during the polymerization cycle.

Single Step Technology:

- the impregnation of the beads with the blowing pre-foaming agent is carried out during the polymerization step, thus avoiding a further and expensive steeping phase.

Wide Bead Size Range from 0.2 to 3 mm; a typical narrow size distribution (s/x) of 0.18 can be obtained for any bead size. Easy availability in the world market of the chemical used in the process.

Coating section

Highly developed Coating Deposition Technology able to tailor EPS grades to the desired customer needs. Easy availability in the world market of the chemicals used in the process.

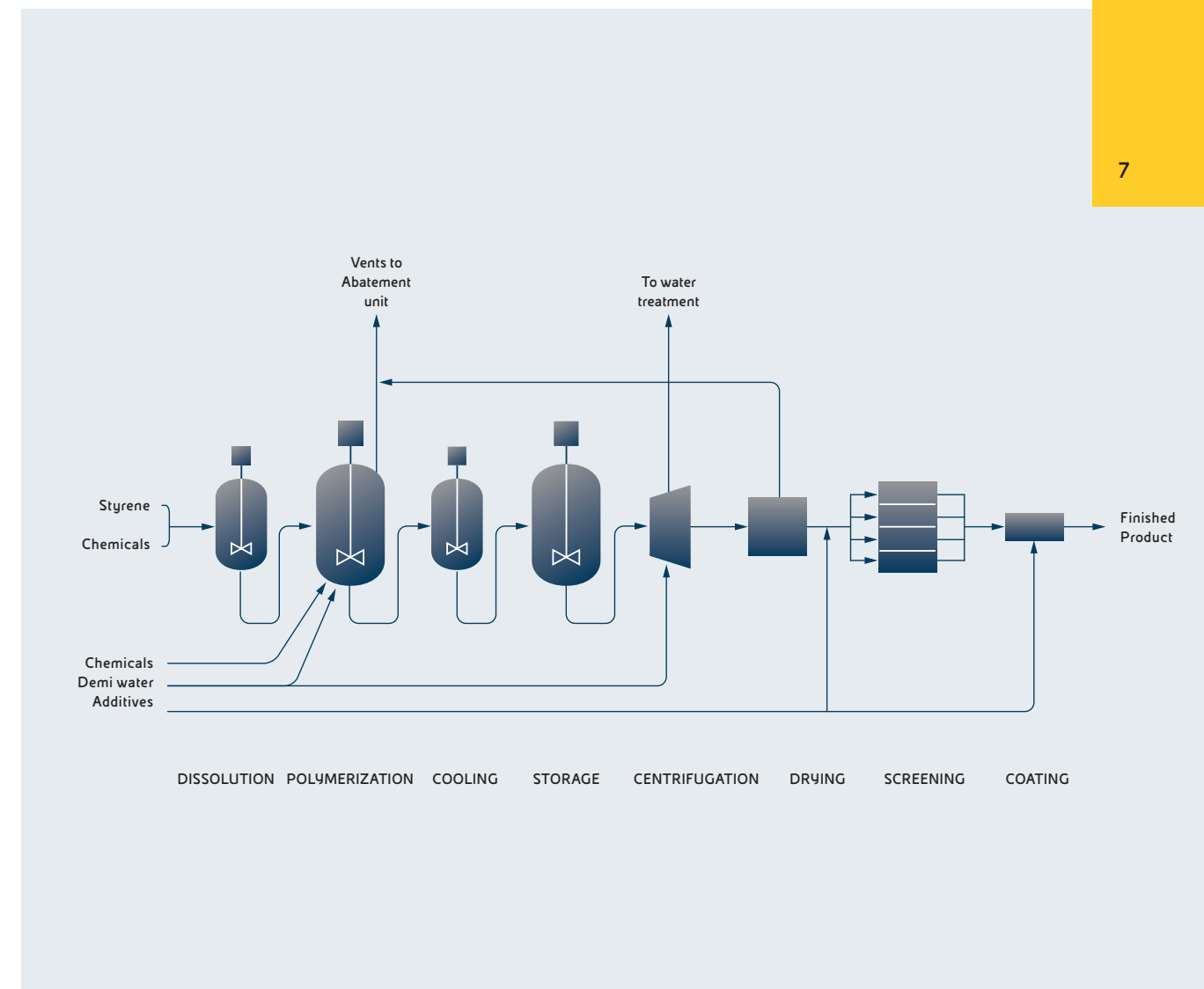
Flexibility

As a consequence of its optimised plant design Versalis technology can match any possible requirement in term of product portfolio, keeping the polymer quality to the top level.



Fig.1

EPS suspension • 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 Latexes

Solution-SBR

TPR

LCBR

HCBR

NBR

Carboxylated latexes

EP(D)M



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