Proprietary process technology

HIPS

High Impact 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 HIPS technology

High Impact PolyStyrene has been produced by the innovative continuous mass process in Versalis since 70s in two plants located in Italy and Belgium. During the next two decades the HIPS technology was considerably improved and in 1991 /1992 two new units were started up in Italy and Hungary.
After that date, further units were licensed first in Hong Kong and then in Brazil, with capacity respectively of 75 and 70 KTA. In the last decades, Versalis R&D has been continuously updating the technology in terms of proprietary equipment and process optimization.

Due to the more demanding parameters required by market in terms of products quality and the greater sensibility towards environmental 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 results of this effort make Edistir® HIPS, with its wide products portfolio, a benchmark within the European scenario.

The key features of Versalis HIPS 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 high rubber phase efficiency (reduced rubber consumption), minimum rubber cross-linking and polymer degradation;
- Versalis HIPS technology minimizes the effects of raw materials and chemical impurities on the process and product structural parameters;
- fine-tuned macromolecular structure (rubber particles size and resins molecular weights distribution).

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 very 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 fluodynamic 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 equipment, that guarantee the best results in terms of mechanical reliability and process performances.

The flexibility of Versalis HIPS technology allows to provide with a single line convenient solution for a broad range of 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 HIPS units, based on proprietary technology, are on-stream in Italy (80 kt/y, since 1981; 45 kt/y, since 1992), in Hungary (70 kt/y, since 1991), and in Belgium (75 kt/y, since 1979), making Versalis one of the major European producers of high impact polystyrene. One HIPS unit (75 kt/y) licensed by Versalis is on-stream in Hong Kong since the early 90s. A second one (70 kt/y) was started up in Brazil in 2000.

Main process parameters

	per MT HIPS
Raw Materials	1,005-1,008 kg
Electricity	0.15 MWh
Fuel Gas (10,000 kcal/kg)	15-20 kg

The Edistir® HIPS product portfolio

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

- very low residual monomer and oligomer content;
- very high rubber phase efficiency (reduced rubber consumption);
- minimized rubber cross-linking and polymer degradation.

The flexibility of Versalis HIPS technology allows to manufacture all main HIPS grades, suitable for the most challenging fields of application.

Refrigeration industry

- environmental stress cracking resistant (ESCR) grades for highly chemical-resistant inner liners;
- very high gloss grades to enhance the aesthetic properties of the internal cabinet;
- medium-impact grades combining high flowability and stiffness for injection-molded internal parts.

Telectronic

- a wide range of grades having a very good balance among toughness, stiffness, gloss, and flowability for injection moulding of technical parts, housings, and covers;
- high impact grades with good flowability and high stiffness;
- high impact grades, with good stiffness and high thermal resistance.

Packaging

- high-performance grades for extrusion and thermoforming of disposable tumblers, flatware, cups, lids, and containers or diary products and frozen food.

Other applications

- high-flowability grades for very fast injection moulding of toys and housewares.

Process description

Versalis HIPS technology is based on a continuous mass peroxide-initiated polymerization of styrene in a rubber-styrene solution. Rubber, after being ground in a mill, is dissolved in styrene in a proper section and then added with chemicals and peroxide 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 two/three plug-flow reactors; the reaction thermal profile is controlled by thermal oil circulating inside internal coils. The whole reaction section arrangement is selected case-by-case, in order to meet specific requirements.

At the end of the reaction train, the polymer solution is sent to a devolatilization section, operated in two stages 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, 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 is heated.

Process design advanced features

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

Polymerization section

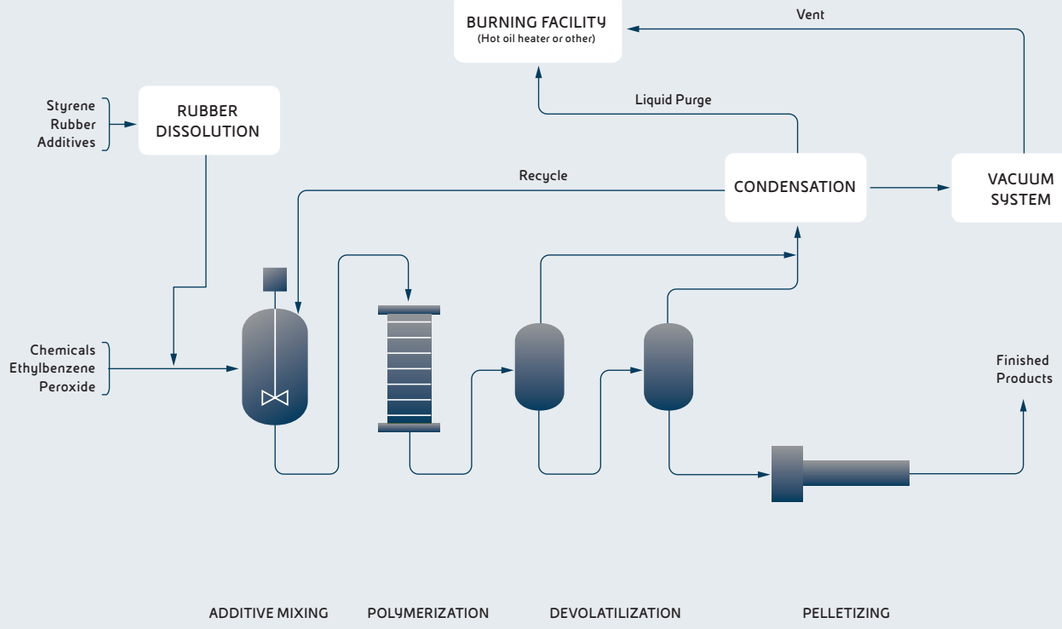
The main items are full plug-flow reactors (PFRs); thanks to agitation and a high specific thermal exchange surface area, they are characterized by very precise control of the thermal reaction profile. Any specific need in terms of product quality/portfolio can be matched by tuning the reaction train arrangement. In this way, it is possible to achieve maximum control of the morphology of the disperse phase (rubber phase), together with good efficiency of the catalytic grafting reaction. This synergy allows to optimise the balance between production rate and polymer quality.

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 temperature (thus minimizing polymer chain degradation) and without the addition of water or other stripping agents.

fig. 1

HIPS 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, Alphamethylstyrene*
High selectivity Cyclohexanone
Acetone hydrogenation to Isopropyl Alcohol*
Isopropyl Alcohol to Cumene**
Ammoximation (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

* Co-licensing in cooperation with Lummus Technology (a McDermott International Company).
** Close to commercialization.

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