

INEOS Technologies

**Innovene S
Polyethylene**



FactFile 2011



Innovene S has quickly established a reputation as a low cost process that produces high quality polyethylene (PE) products. INEOS Technologies began licensing Innovene S in 2005 and its business model is based on:

- A core licensing team providing expertise throughout the technology transfer process. INEOS Technologies competencies include strong technical and analytical skills, sound project management capability and worldwide commissioning experience.
- Delivery of high quality Process Design Packages (PDP's). INEOS Technologies has a number of approved international contractors who can provide the licensee with EPC services needed to transform this PDP into a fully built plant ready for operation.
- A dedicated process technology team that ensures licensor milestones are met during project execution. Reference plants are two INEOS PE lines at Lillo, Belgium (current capacities 200 and 300 kta) where HDPE has been produced since 1992.
- Access to the INEOS fundamental research and product applications centre at NOH (Belgium) and pilot plants at Rosignano (Italy).
- Use of Operator Training Simulators which provide realistic and practical training that helps to ensure trouble-free plant commissioning.
- Advanced Process Control technology ensuring efficient and consistent operating practices.
- After-sales support helping licensees grow their business and maintain their market position. Flexible long term technical service agreements are available to access INEOS' process design, product, operational, manufacturing, technology development and resin sales and marketing resources.
- INcat Polyolefin catalysts delivering optimum performance at low cost. The INcat catalyst range includes INcat MT Ziegler-Natta catalysts, and INcrease Chromium catalysts. Normal Chromium catalysts are available through specified vendors.



The benefits of Innovene S technology include:

Process Advantages

- Proven dual reactor bi-modal technology
- High on-stream times with no reactor fouling or cleaning
- Best in class economics, low investment and operating costs
- Quick and easy transitions: commercially demonstrated straightforward changes between catalysts, and between mono- and bi-modal products
- No wax treatment required - greatly simplifying solvent separation and recovery designs
- Unique Ziegler and Chromium catalyst flexibility
- C6 and C4 co-monomer flexibility
- Low sensitivity to poisons
- Safe and environmentally clean operation

Market Advantages

- Wide HDPE and MDPE product range based on a suite of tailored catalysts
- Lowest costs of production
- High campaign-to-campaign consistency with minimal wide specification material
- Superior bi-modal products, including PE100 pipe and black compounding.
- Superior blow moulding products

INEOS and predecessor companies are the inventor of HDPE PE100 pipe grade using the Innovene S bi-modal technology. It remains the market leading resin for this application and is widely accepted. Millions of tonnes of INEOS pressure pipe are in service around the world.



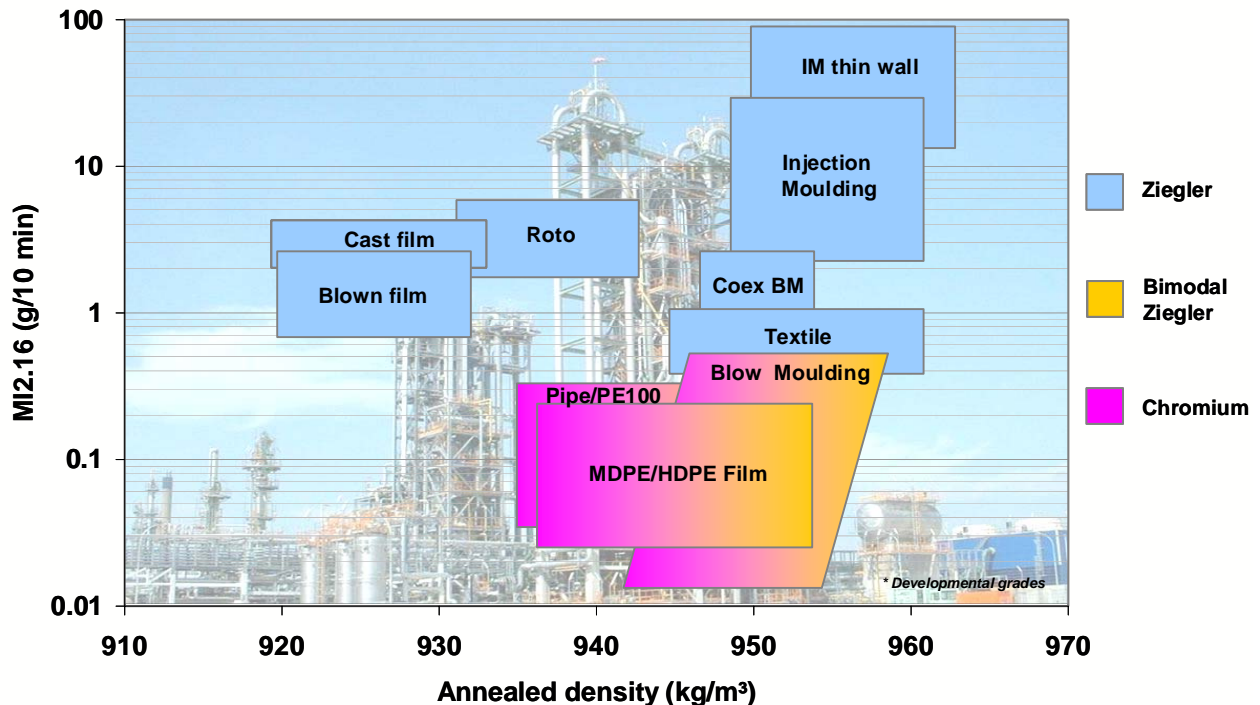
Innovene S technology is a low-cost and flexible process which produces a broad range of MDPE and HDPE resins covering the following applications: Film, Injection Moulding, Blow Moulding, Pressure and Non-Pressure Pipe, Wire & Cable, Tape and Monofilament, Sheets and Rotomoulding.

Innovene S products are known in the market under the INEOS Eltex® brand name, and in some speciality markets are considered as the benchmark. PE100 pressure pipe grades rank among the best products available with outstanding Environmental Stress Cracking Resistance properties. In the black pipe market the INEOS grades are the reference product. Bi-modal grades developed for other applications, such as high strength film and performance blow moulding have outperformed competing products. Considerable development effort is applied to maintain a leading position in bi-modal products.

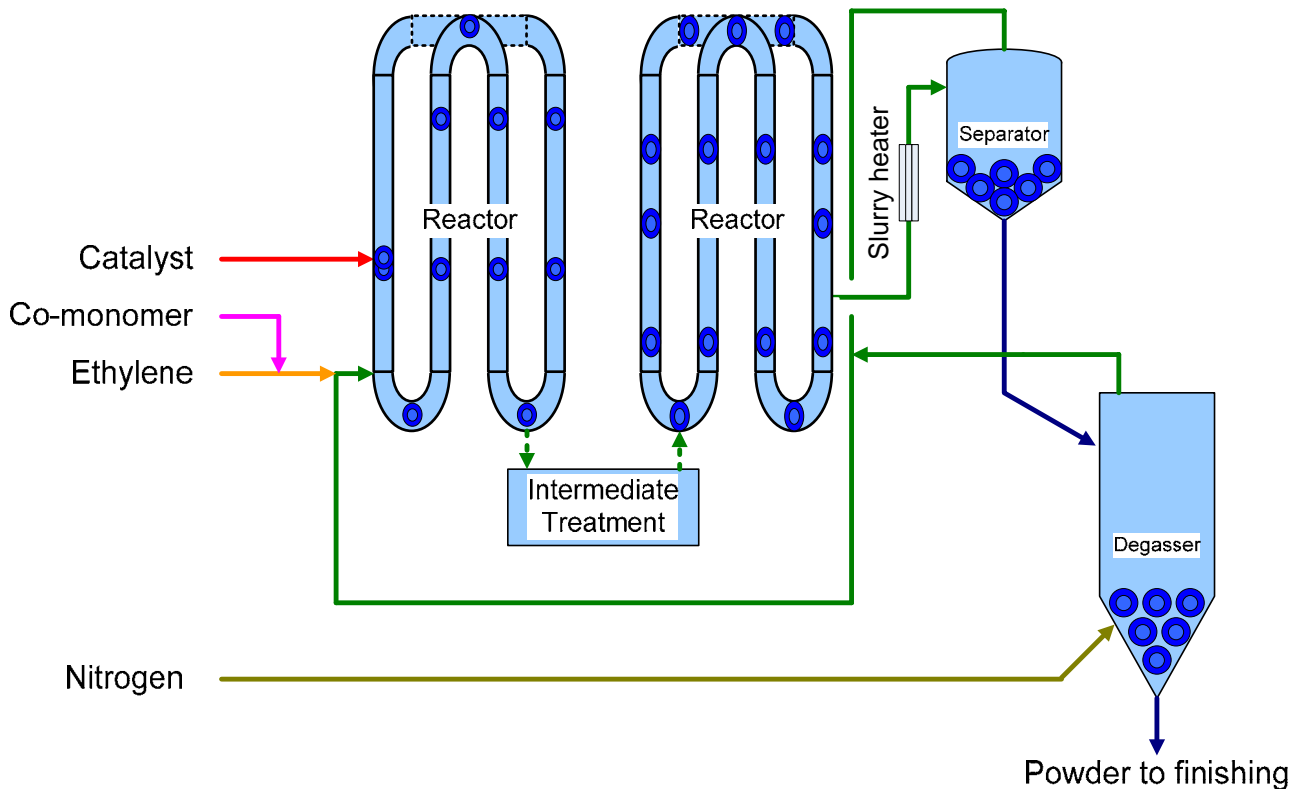
Using INcat MT Ziegler-Natta, INcrease, or normal chromium catalysts, Innovene S units are capable of producing both mono-modal and bi-modal molecular weight distribution resins with outstanding characteristics. This flexibility allows licensees to provide the optimum material for customer applications.

Innovene S Technology and its products are continuously being developed and improved. For example by extending the Innovene S capability to manufacture Linear Low Density Polyethylene resins using standard Ziegler catalyst. INEOS recently introduced Linear Low Density grades for Blown and Cast Film to its grade slate. This makes Innovene S a technology able to produce performance products such as Pressure Pipe PE100 and commodity products in LL/MD and HD fields using the same platform.

INEOS Technologies continues to invest heavily to maintain the competitiveness of Innovene S technology in both the short and long term. Please find in below chart the overview of Innovene S product applications.



At the heart of the Innovene S slurry process is the simple but highly efficient and robust loop reactor which combines circulation, heat exchange and reaction volume all in one piece of equipment. This dual loop is the basis for the straight forward operation that enables low operating and investment costs whilst producing market accepted high quality products.



The solid catalyst is fed to the reactor via a dedicated injection system. The polymerisation reaction takes place in a slurry of isobutane. Monomer, co-monomer and solvent are injected and controlled independently in both reactors. This feature enables a high degree of control over product architecture, especially in bi-modal production.

The slurry exits the reactor through a slurry heater where the solvent/diluent is vaporised. The polymer powder is then separated from the gas. The gas is condensed and the remaining liquid solvent, with residual dissolved monomer, is recycled to the reactors.

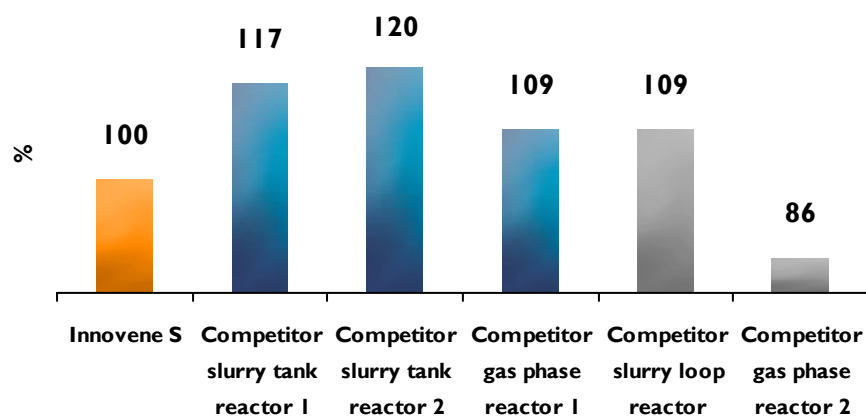
Any hydrocarbons which remain adsorbed on the powder are removed in the degasser and recycled back to the reactors. No further degassing treatment is required downstream.

Plants designs are available to manufacture 600 kta PE in a single line.

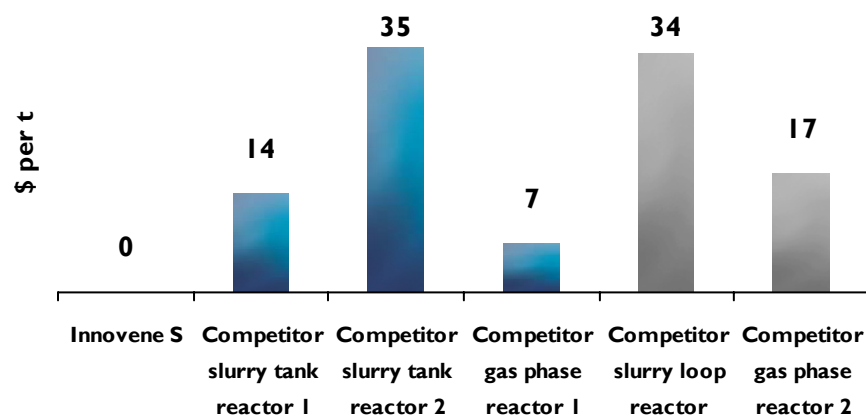
Innovene S is a leading process in economic performance. The recent Chemsystems Nexant PERP report* shows both capital costs and operating economics (see below) when compared with main competing technologies for a 400 kta bi-modal plant.

The comparison below is for technologies capable of delivering the full range of HDPE products, including bi-modal PE100 (see the PE100 website, www.pe100plus.net, for further info). In addition, for reference only, two competitor technologies with just mono-modal capability are shown in grey.

The Nexant based comparison indicates that the Innovene S slurry technology has a 9-20 % Capex advantage over competing bi-modal technologies. The Nexant data also show that Innovene S plant has lower variable cost of between \$7 and \$35 per ton. This corresponds with a saving of \$3 - \$14m annual saving for a 400 kta plant.



Capital Cost Comparison between Innovene S and other technologies (Nexant Research)



Variable Cost Comparison between Innovene S and other technologies (Nexant Research)

* Nexant Chemsystems PERP Program, PERP 09/10-3, January 2011

Today over 2.2 million tonnes of annual capacity is operating using Innovene S technology, and approximately 2.5 million tonnes of annual capacity is either in design or under construction in a further six projects. Innovene S plants have been in operation since 1965.

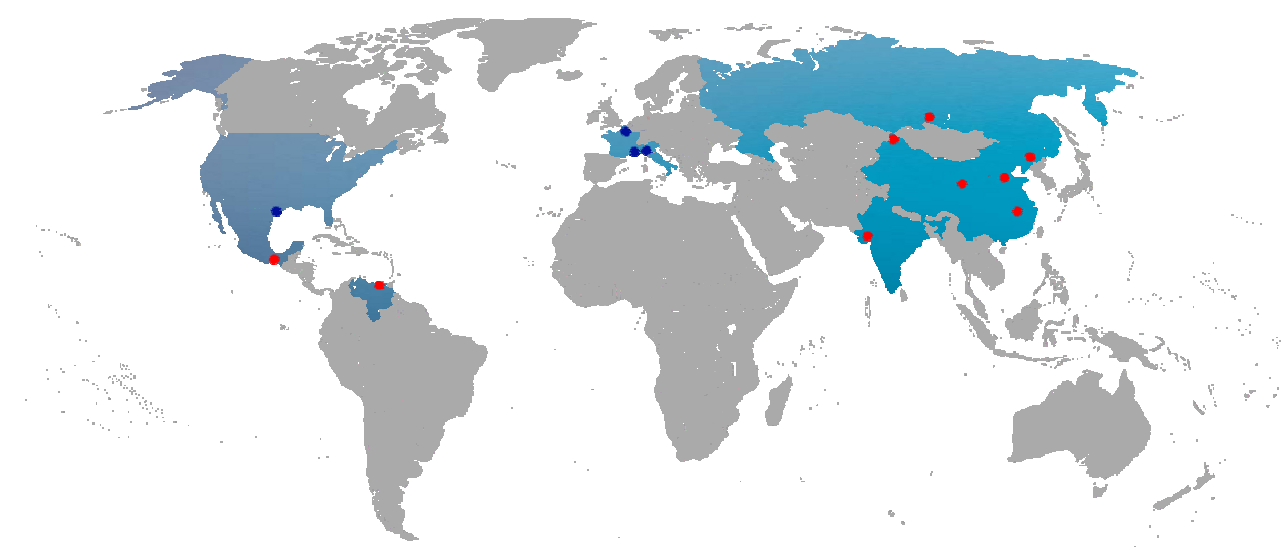
Plants in Operation

Client	Location	Start up	Capacity kta
INEOS	Italy	1965	195*
INEOS	France	1971	195*
INEOS	Belgium	1992	200
INEOS	Belgium	2002	300
INEOS	USA	2009	455*
PETROCHINA Dushanzi Petrochemical	China	2009	300
SINOPEC Tianjin Petrochemical	China	2010	300
LIAONING Huajin Chemicals	China	2010	300

* multiple lines


Plants in Design or Construction


Client	Location	Est. S.U.	Capacity kta
SINOPEC Wuhan Petrochemical	China	2012	300
Essar	India	Tbd	400
Polimerica	Venezuela	Tbd	400
YULIN Petrochemical Company	China	2012	300
APP Rosneft	Russia	2015	345
Braskem Idesa Etileno XXI	Mexico	2015	410
			340




Innovene S Plants (Red - Third Party, Blue - INEOS)


Typical Grade Slade Products


Application	Grades	HLMI g/10 min	Density kg/m ³	Main application
	J38-20	20	938	MDPE for thin film, bags, liners, blend component.
	J44-15	11.5	946	HDPE HMW film for high strength/stiffness, thin film, bags, liners
	J44-20	20	944	HDPE for thin film, bags, liners, blend component.
	J53-10	10	953	High strength/stiffness thin film, bags, liners
	J50-08	6.5	950	Bimodal Film - Very thin tough film, downgauging
	J53-08 N2000	8	953	Bimodal Film - Very thin tough film at very high line speeds, downgauging, higher stiffness

Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
	HD6007S	0.6	964	Uniloy fresh milk bottles
	A60-30N0078	0.42	960	Continuous extrusion fresh milk bottles
	B50-35H-011	0.35	950	Household chemicals, pharmaceutical and cosmetic containers.
	HD2502S	0.2	955	Household chemicals, pharmaceutical and cosmetic containers and bottles up to 20L
	ZBM58-30	0.3	958	Bi-modal BM- high performance grade for downgauging, high ESCR

Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
	K44-11-128	12	947	130-170 L drums and automotive parts, 4-20 L fuel cans
	HM4560UA	6.8	947	IBC and tanks requiring excellent ESCR and UV Resistance
	HM5411EA	10	952	5 – 25 L drums
	K54-05	5	954	210 L drums

Typical Grade Slade Products (continued)

Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
Injection Moulding 	T60-800	8.5	961	Pallets, bins, crates, hardhats
	T50-200	2	952	Industrial parts, closures
	T50-800	8	953	Garden products, pails, shopping carts, wheel hubs
	T50-2000	20	953	Caps, closures, toys, house wares, general purpose, thin wall parts
	T50-3600	36.5	953	Ice cream and frozen food containers
	T50-5500	51	951	Thin wall food containers

Application	Grades	MI5 g/10 min	Density kg/m ³	Main application
Pipe 	K38-20	0.85	938	Extrusion of non-pressure rated pipes
	PC4014	0.5	952	Ducting
	TUBI21 N3000	0.3	959	Black PE100 bimodal - gas and drinking water
	TUBI31	0.85	954	Black HDPE PE80 bimodal – gas and drinking water, sewers, industrial
	TUBI71	0.85	948.5	Black MDPE PE80 – gas and water
	K44-08-123	8.75 (MI 21.16)	955	Black HDPE PE80 & PE3408 – large diameter



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