

INEOS Technologies

**Innovene G
Polyethylene**



FactFile 2011



The INEOS Technologies Innovene G gas phase polyethylene (PE) technology has a long operating and licensing heritage going back several decades. It has the reputation of a low cost process that produces high quality products 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 implementation. Reference plants include the INEOS PE plant at Grangemouth, UK (current capacity of 320 kta) and a licensee plant at SECCO, China (current combined capacity of the two lines 755 kta).
- Access to the INEOS product development, analytical facilities and pilot plant in Lavéra (France).
- 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 capabilities.
- INcat Polyolefin catalysts delivering optimum performance at low cost. The INcat catalyst range includes INcat SDX, Novacat Ziegler-Natta catalysts and INcat HPLL catalysts. Chromium catalysts are available through specified vendors.



The benefits of Innovene G technology include:

Process Advantages

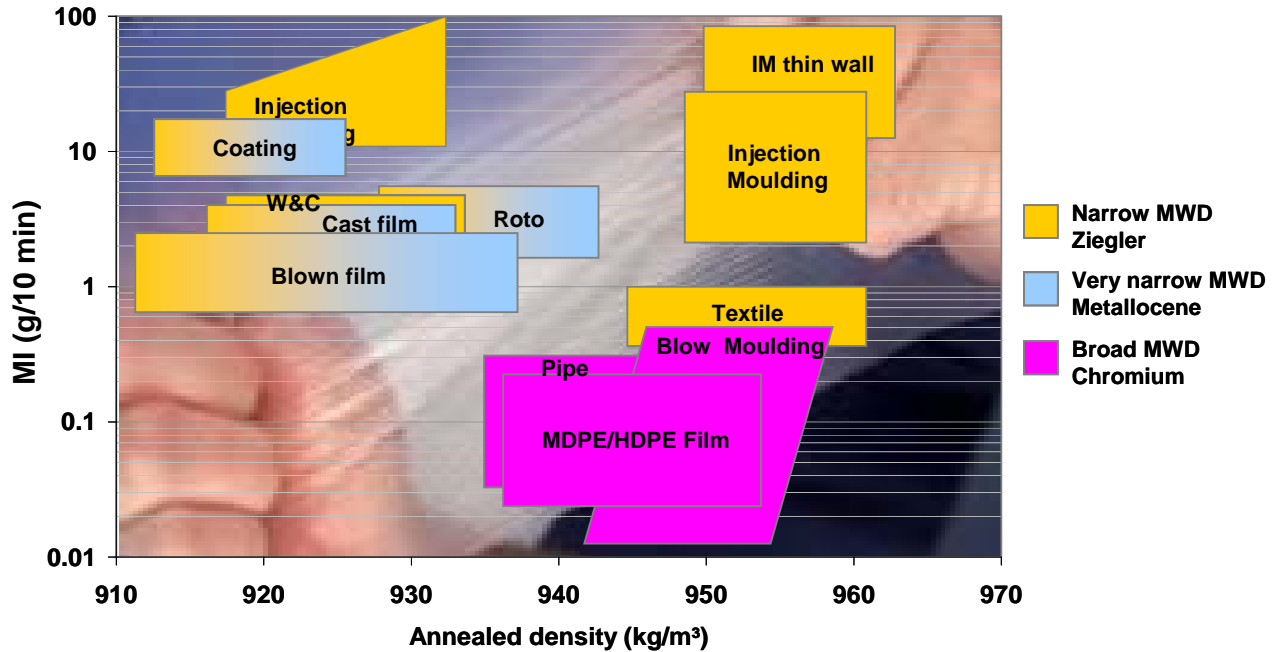
- Proprietary clean loop gas loop - no fouling, no plant shutdown for cleaning, no product cross contamination
- Direct injection catalyst system
- Patented enhanced high productivity (EHP) process - resulting in high on-stream times, superior reactor controllability and heat removal, higher liquid condensation levels and cost savings by reducing reactor diameter, recycle gas flows and compressor size.
- Competitive economics, low investment and lowest operating costs
- Quick and easy transitions. Commercially proven straight-forward changes between co-monomers, and between compatible catalysts
- Ziegler, Chromium, and Metallocene catalyst flexibility
- C8, C6 and C4 co-monomer flexibility
- Safe and environmentally clean operation

Market Advantages

- A broad range of market accepted LLDPE, MDPE and HDPE products based on a suite of tailored INcat catalysts and co-monomers
- High campaign-to-campaign consistency with minimal wide specification material
- High performance metallocene LLDPE products
- Outstanding C6 co-monomer LLDPE products
- Competitive commodity C4 LLDPE products
- Best in class MDPE and metallocene MDPE



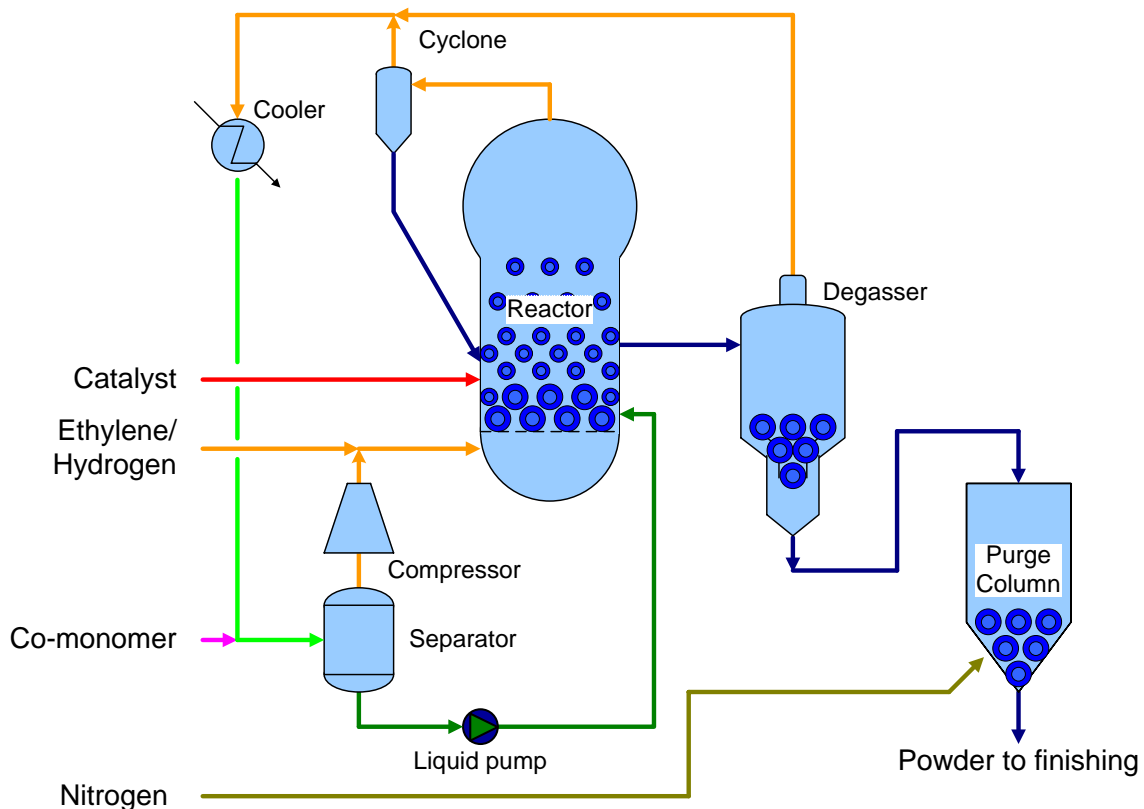
The Innovene G process offers a low-cost, flexible route to produce a broad range of LLDPE and HDPE products covering all polyethylene applications shown in following table:



As shown in above table Innovene G process gives products ranging from Chromium (PE80 pipe) to Ziegler to Metallocene grades with C4 C6 and C8 co-monomer all within the same platform.

Innovene G process can also provide metallocene products using the INcat HPLL metallocene catalyst. HPLL products are regarded in the market to have an excellent processability/performance balance. Key features of HPLL products include outstanding mechanical, optical and sealing properties coupled with very good processability. They can be used in conventional LLDPE extruders without expensive machinery modification or use of processing aid.

At the heart of the Innovene G process is a highly efficient and robust gas phase fluidised bed reactor that combines circulation, heat exchange and reaction volume within one system. This efficient configuration, with its clean gas recycle loop, is the basis for the straight forward operation that enables low operating and investment costs whilst producing tailored market accepted high quality products.



If required the ethylene, hydrogen and co-monomer first pass through a feed purification system to remove poisons. The technology uses the same catalyst injection system for all the catalysts, whether Ziegler-Natta, Chromium or metallocene, and is a simple low cost system.

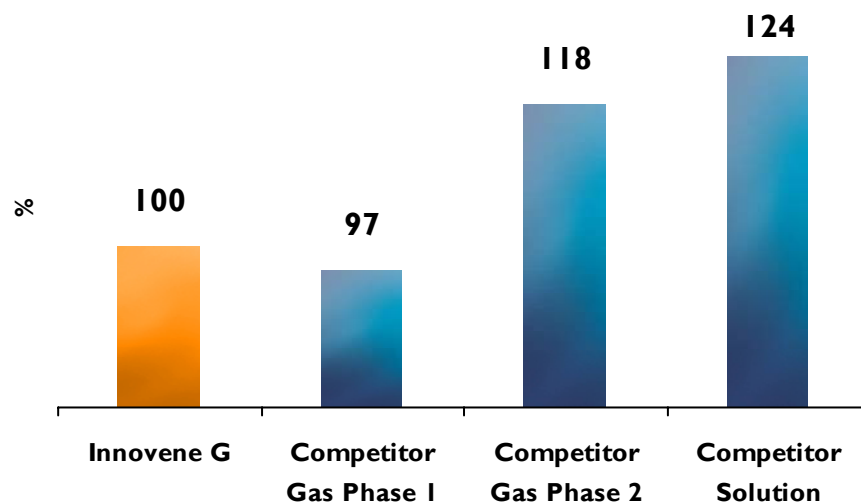
The ethylene, co-monomer and catalyst are continuously fed into the reaction loop. In the reactor, the PE powder bed is kept fluidised by the feed gas. Polymerisation takes place in the bed at modest pressures, and temperatures.

The fine PE powder is separated from the gas stream leaving the top of the reactor in the cyclones and the fine PE powder is recycled to the reactor. The loop gas is cooled upstream of the gas compressor and the gas and condensate are separated. The separate streams are fed back into the reactor via the Enhanced High Productivity (EHP) system. The gas is recycled as fluidising medium via the loop compressor while the liquid condensate is recycled via the liquid pump, ensuring a proper dispersion and vaporisation of the liquid as it enters into the reactor.

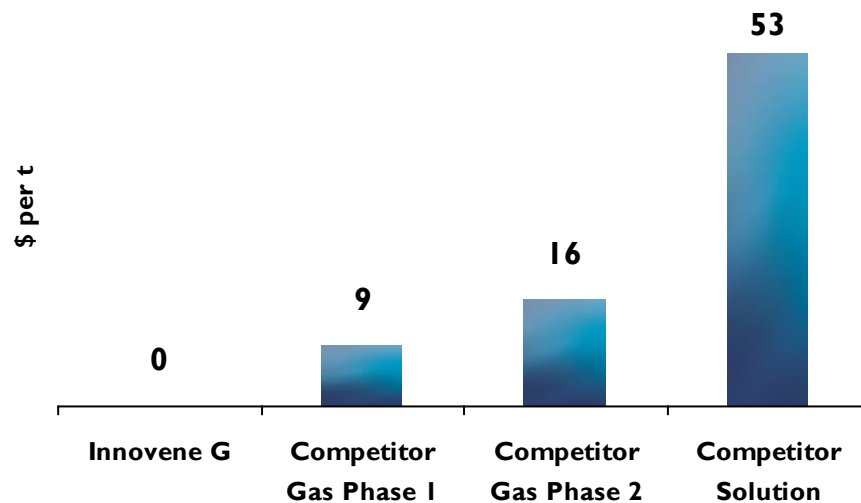
The polymer powder is extracted from the reactor via a proprietary system. The powder is degassed and the hydrocarbons are returned back to the reaction loop. Any hydrocarbons which remain adsorbed in the powder are degassed in a purge column. No further degassing treatment is required downstream.

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

Innovene G process 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 the main competing technologies for a 500 kta metallocene plant. The Nexant data show that Innovene G plant has lower variable costs of between \$9 and \$53 per ton corresponding to a \$5-25m annual saving for a 500 kta plant.



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



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

* Nexant Chemsystems PERP Program, Report LLDPE 07/08-1, October 2008

Today over 5.6 million tonnes of annual capacity is operating using Innovene G technology, and approximately 2.1 million tonnes of annual capacity is either in design or under construction in a further five projects. Innovene G plants have been in operation since 1975.

Plants in Operation

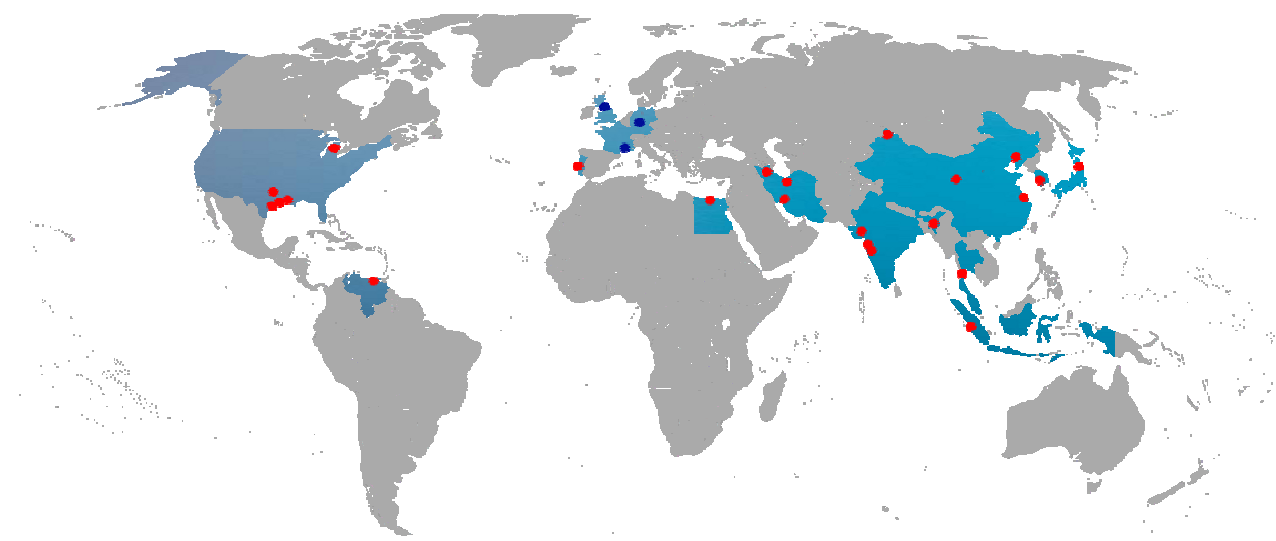
Client	Location	Start up	Cap. kta	Client	Location	Start up	Cap. kta
INEOS	France	1975	50	NPC	Iran	1994	60
INEOS	France	1985	240	Samsung Total	Korea	1994	100
INEOS	Germany	1991	200	Formosa Plastics	USA	1995	200*
INEOS	UK	1990	160	PEMSB	Malaysia	1995	250*
INEOS	UK	2001	320	CNTIC	PRC	1995	150*
Quantum	USA	1988	100	TPC	Iran	1997	100
Ube Industries	Japan	1989	50	Chevron Phillips	USA	1998	250
TPE	Thailand	1990	90	PT Titan	Indonesia	1998	200
Chevron Phillips	USA	1990	350*	Westlake	USA	1998	220*
CNTIC	PRC	1990	125*	Formosa Plastics	Taiwan	2000	240
Sinopec/LCIC	PRC	1991	60	Sidpec	Egypt	2000	225*
RIL	India	1991	220*	NPC Alliance	Philippines	2000	200*
PT Titan	Indonesia	1993	250*	Amir Kabir	Iran	2005	300
Westlake	USA	1993	200	SECCO	PRC	2005	755*

* twin lines

Plants in Design or Construction


Client	Location	Est. S.U.	Cap. kta	Client	Location	Est. S.U.	Cap. kta
OPaL	India	2015	720*	ESSAR	India	tbd	400
BCPL	India	2013	220	Polimerica	Venezuela	tbd	430
Repsol YPF	Portugal	tbd	300	Not disclosed, Metallocene refit	Not disclosed	2013	Not disclosed


* twin lines





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

Typical Grade Slade Products


Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
LL C4 Film 	LL0205AF	0.5	920	Sacks, stretch/agricultural films, medium duty sacks
	LL0209AA	0.9	920	General purpose blown film grade
	LL0220AA	2	920	General purpose blown & cast film grade
	LL0410AA	0.8	926	Thin film, shrink film (blend)
	LL0640AA	4	930	Cast Display films


Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
LL C6 Film 	LL8109AA	0.9	918	Lamination, Liners, High Performance thin film
	LL6209AA	0.9	920	High strength film, coextrusion, sacks, deep freeze packaging,
	LL6130AA	3	920	Cast stretch film
	LL6910AA	1.0	936	Lamination, Coextrusion, Boil in bags


Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
Metallocene Film 	PF6130AA	3.5	918	Cast Stretch Film for High Performance wrapping
	PF6212AA	1.2	920	High performance thin film, Blown Film, Food Packaging, High Clarity film for collation shrink, Lamination, Blown Stretch
	PF6612AA	1.2	926	Collation shrink-wrap; consumer packaging


Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application	
Blow Moulding 	HD5802GA	0.2	958	Household Chemicals, motor oil bottles, lightweight containers.	
	HD5502GA	0.2	955	Containers and bottles up to 20L.	
			HLMI g/10 min	Density kg/m ³	
	HM5250GA	4	950	Large Blow Moulded containers up to 150 l for Industrial chemicals and technical items.	
	HM5301EA	10	953	1-60 litre containers for packaging aggressive products	

Typical Grade Slade Products (continued)

Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
Injection Moulding 	HD5218EA	21	952	Housewares, food containers, Caps, general purpose
	HD5226EA	30	953	Housewares, Ice cream and frozen food containers
	HD5740UA	4.5	957	Crates UV stabilized
	HD6080UA	8.4	960	Crates UV stabilized, recycle bins, hardhats, general purpose
	LL0550AA	50	925	Lids, housewares

Application	Grades	MI5 g/10 min	Density kg/m ³	Main application
Pipe 	PC3902BK	0.85	949	Black MDPE PE80 - gas & water transportation
	HD5403GA-P	0.35-MI2	954	Large diameter corrugated pipe
	PC4401BK	12- HLMI	955	Black PE80 - water pipe, industrial pipe, large diameter pipes

Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
Rotomoulding 	HD3560UA	6	935	General purpose, toys, technical parts, boats, kayaks, highway devices, UV resistant
	PF3850	5	938	High performance. High stiffness, agricultural, tanks, playground, recycling banks, manhole inspection. UV resistant
	HD3840UA	3.8	938	High stiffness, agricultural, tanks, playground, recycling banks, manhole inspection. UV resistant
	HD4330UA	3	943	High stiffness, agricultural, tanks, underground. parts, manhole inspection, kayaks UV resistant

Application	Grades	MI2.16 g/10 min	Density kg/m ³	Main application
Other 	LL0507AA	7	924	Extrusion coating, component for blending with LDPE
	HD5410EA	0.9	954	Extrusion of monofilaments
	PF1315AA	15	914	m-LLDPE for extrusion coating, injection moulding and compounding with a basic antioxidant additive package
	WCI 4507 S	0.7	945	Telecom-Solid Insulation- HD Insulation
	WCPI 2024 U	2.4	920	Nat- Unstabilised LLDPE (Monosil process)
	WCPI 3041 U	4.1	930	Nat- Unstabilised LLDPE (Monosil process)



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