INEOS Technologies

Innovene PP
Polypropylene



FactFile 2011

Innovene PP has a long operating and licensing heritage dating back to the 1970s. It has a reputation as a low cost process that produces high quality polypropylene (PP) 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 execution. Reference plant is located in Geel (Belgium) operated by INEOS. Current nominal capacity is 280 kta using the most recent Innovene PP technology. The site provides its expertise for Innovene PP plant operation and training.
- Access to the INEOS product development, analytical facilities and pilot plant in Naperville (USA).
- Use of Operator Training Simulators which provide realistic and practical training that helps to ensure trouble-free plant commissioning.
- 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 range includes INcat CDi and the INcat P series, high activity Ziegler-Natta catalysts.

The benefits of Innovene PP technology include:

Process Advantages

- Proven dual reactor Impact Copolymer technology
- Plug flow reactor that minimises back-mixing and achieves narrow residence time distribution hence very uniform and consistent products
- No plugging of reactor enables operating efficiencies greater than 96%
- Transition times significantly shorter than any other process resulting in lowest quantity of off-spec material
- Quick process start-ups
- Very competitive economics: low investment and operating costs
- Low maintenance cost: only 1.5% of the initial investment cost
- Safe and environmentally clean operation

Market Advantages

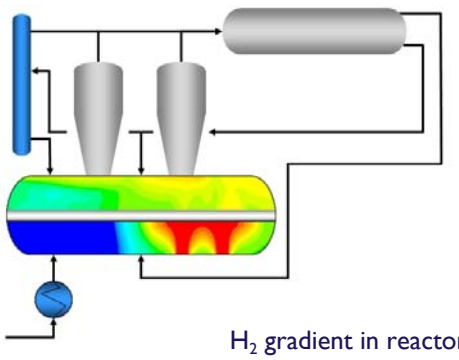
- Full suite of high performance polypropylene (HP, RCP, ICP) products based on a single catalyst, INcat CDi
- Impact copolymers of outstanding stiffness/ toughness balance across a wide MFR range.
- Random copolymers of exceptional clarity, and transparency.
- Leading technology for fibre and high speed BOPP applications
- Superior product consistency even during start-up and shut-down phases.
- Advanced catalysts for broad molecular weight distribution and high rubber content products

The benefits of INstage Process Enhancement

On top of the standard Innovene PP process INEOS Technologies developed the INstage process enhancement for the production of advanced broad molecular weight distribution polypropylene products. It is available for addition to new or existing Innovene PP plants to deliver even more capability for tailored product design.

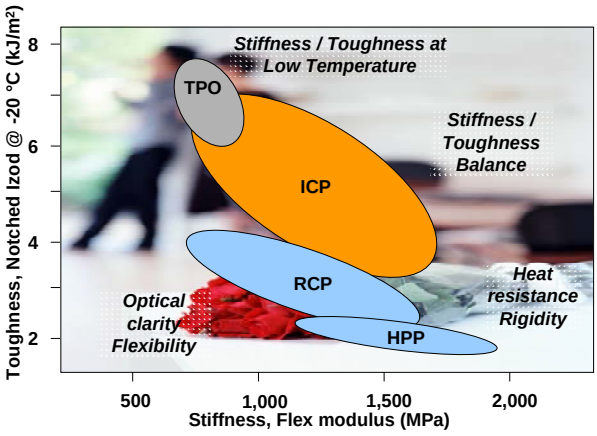
INstage Process Enhancement Advantages:

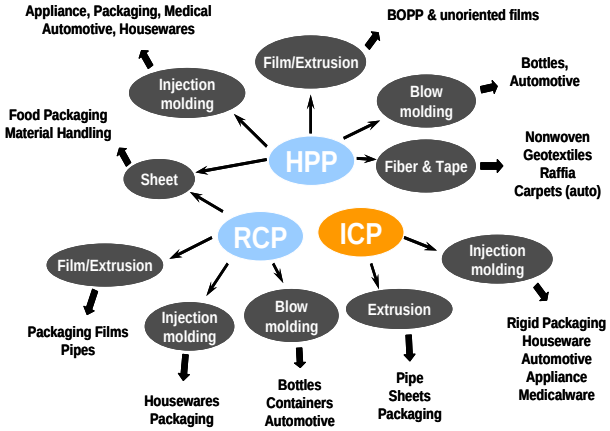
- Products with controlled molecular weight distribution
- H_2 staging in a single reactor
- Broad molecular weight distribution ICPs when using two reactors in series
- Compatible with existing and future INEOS INcat catalysts
- Suitable for new build or retrofit projects



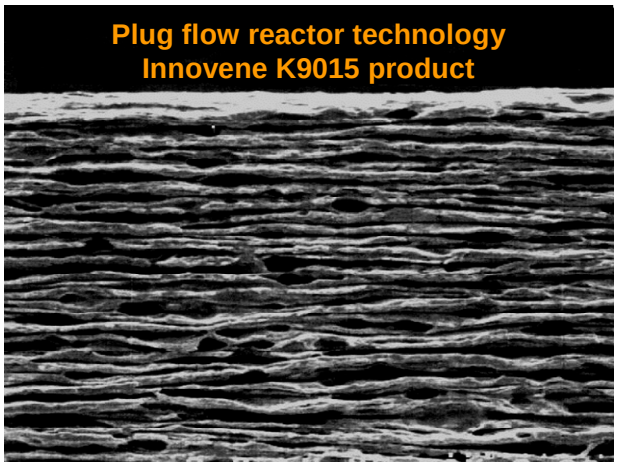
H_2 gradient in reactor

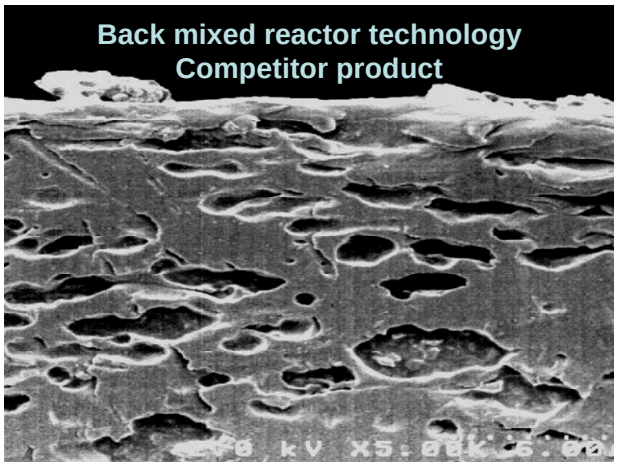
The Innovene PP Process offers a low-cost and flexible way to produce a very wide range of HP, RCP, and ICP resins covering all of the following polypropylene applications: unoriented & BOPP film, fibre & tape, blow moulding, injection moulding, thermoforming and pipe. The following tables give an overview of the product applications.



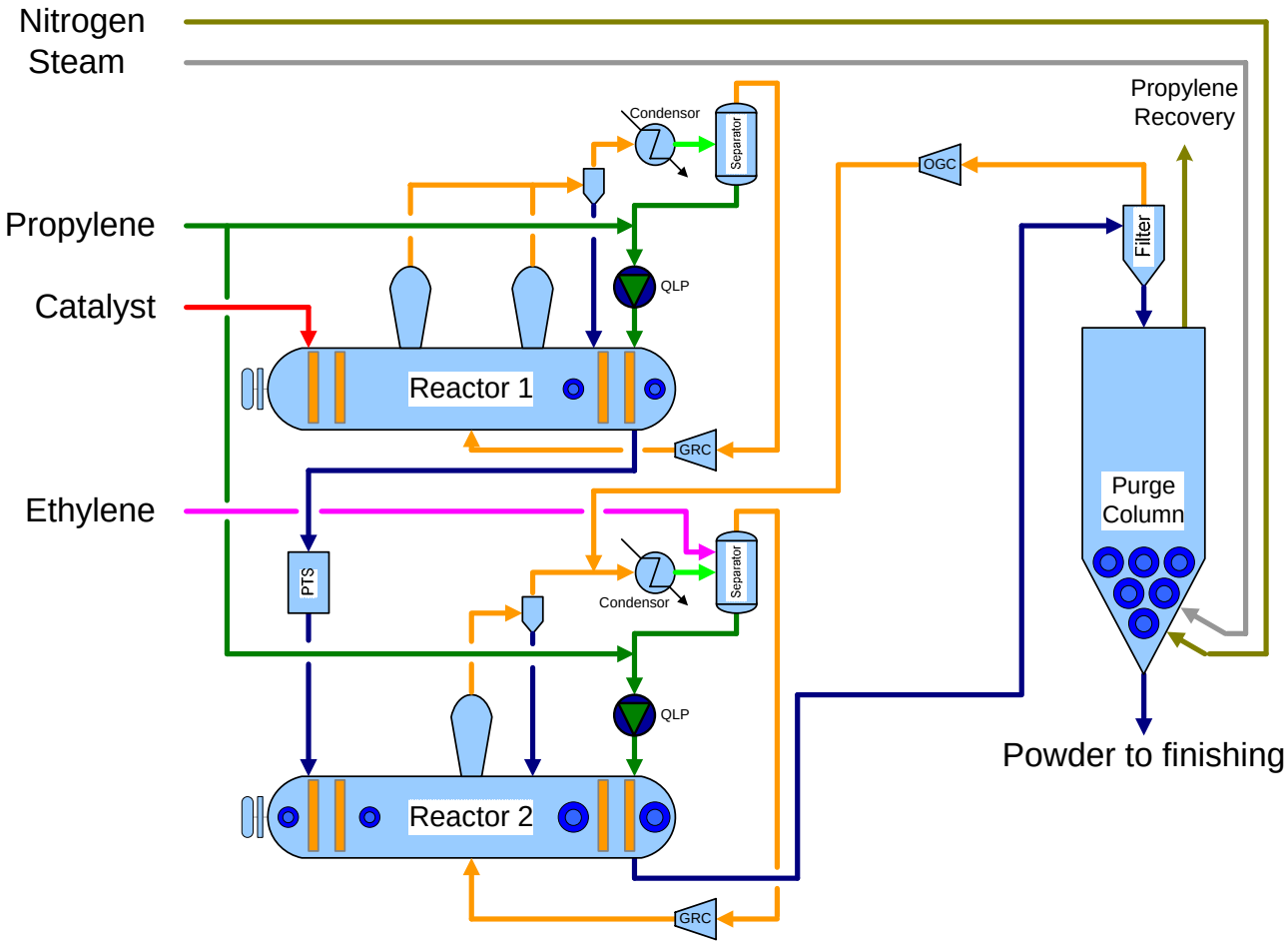


Due to the nature of the Innovene PP plug flow reactor, ethylene incorporation in impact copolymers is very efficient and rubber dispersion highly homogeneous, as shown in the pictures below. This translates into ICP's of unusual stiffness / toughness balance that offer performance advantages in demanding applications like automotive, sporting goods, industrial transport components and home appliances.





At the heart of the Innovene PP process are the highly efficient and robust gas phase plug flow reactors which combine heat exchange and reaction volume all in one system. This plug flow reactor is the basis for the straight forward operation that enables the lowest operating and investment costs whilst producing market tailored high quality products.



If required propylene and ethylene first pass through a feed purification system to remove impurities.

Fresh propylene, together with recycled liquid propylene enters the first reactor where catalyst is added. Hot reaction gas leaving from the domes of Reactor 1 is separated from fines before being cooled down. Fines are recirculated into Reactor 1. Condensed propylene is recycled to the reactor via a pump. Gaseous propylene is recycled via a compressor as fluidisation medium.

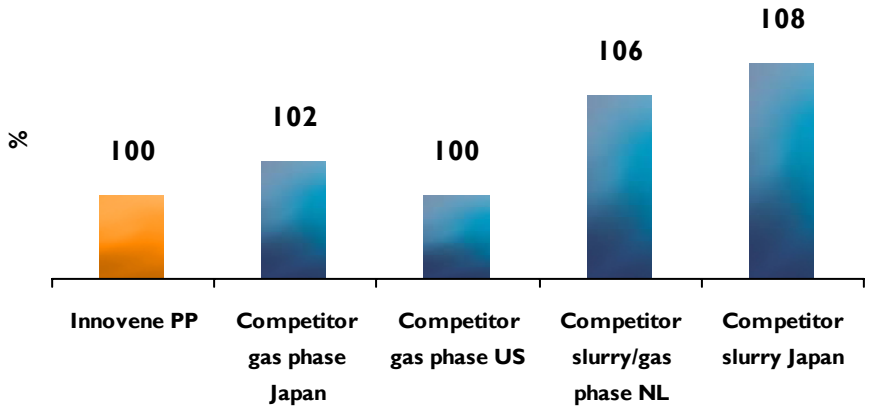
Via intermediate buffer powder transfer system, homopolymer powder from Reactor 1 is fed into Reactor 2. When making homopolymer this reaction continues in Reactor 2 by adding fresh and recycled propylene. To make random copolymer, or impact copolymer, ethylene is added to the propylene feed to the second reactor. Condensed and gaseous propylene are recycled in a similar arrangement to Reactor 1

Polymer powder from Reactor 2 is separated from reaction gas in the Filter on top of the Purge Column. The reaction gas is recycled to Reactor 2 via a compressor. Any hydrocarbon traces which remain adsorbed on the powder are degassed in the purge column. No further degassing treatment is required downstream.

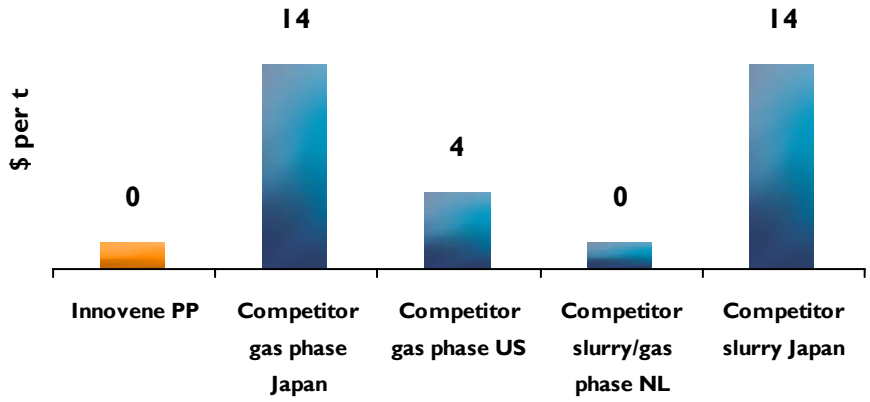
Plant designs are available to manufacture 500 kta PP in a single line

Innovene PP process is a leading process in economic performance. The recent Chemsystems Nexant POPS report* shows both competitive capital costs and operating economics (see below) when compared with its main competing technologies for a 400 kta ICP plant.

From the Nexant data can be seen that Innovene PP has a low Capex amongst competing technologies. The Nexant data also shows that Innovene PP plant has lower variable cost of between $4 and $14 per ton corresponding to a $1.6 - $5.6m annual saving for a 400 kta plant.



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



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

* Nexant Chemsystems POPS Program, Report, PolyOlefins Planning Service (POPS) Technology Review, August 2008

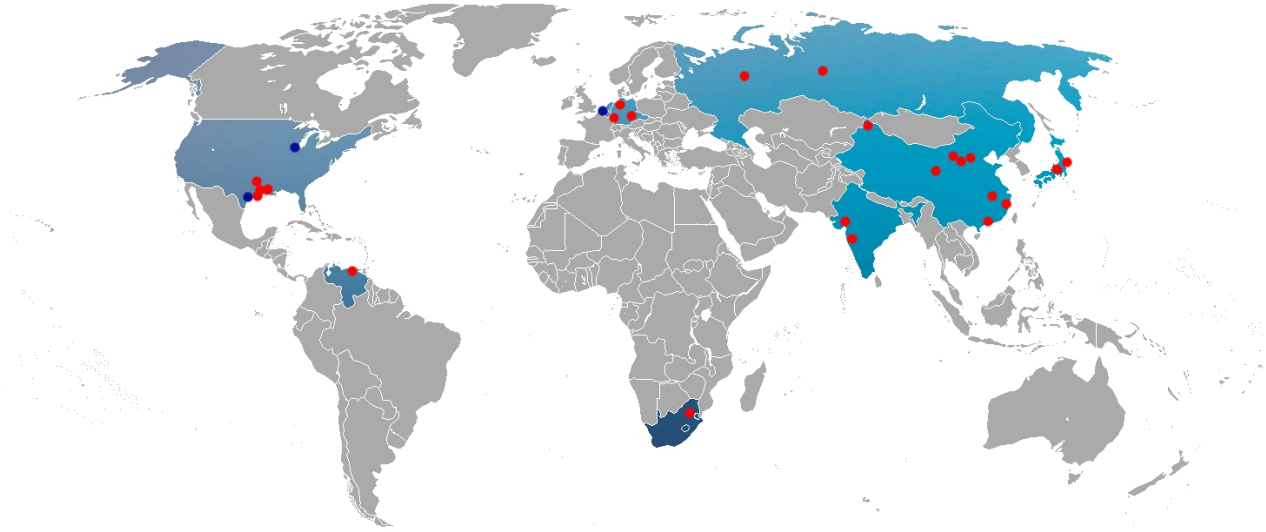
Today over 3.4 million tonnes of annual capacity is operating using Innovene PP technology, and approximately 2.6 million tonnes of annual capacity is either in design or under construction in a further six projects.

Plants in Operation

Client	Products	Location	Start up	Capacity kta
INEOS	HRI	USA	1992	142
INEOS	HRI	Belgium	1996	280
INEOS	HR	USA	1999	250
Chisso	HRI	Japan	1987	65
Yokkaichi	HRI	Japan	1990	65
SABIC	HI	The Netherlands	1996	240
Beijing Yanshan-Sinopec	HRI	P.R. China	1998	200
SABIC	HR	Germany	2000	250
Chemopetrol	undiscl.	Czech Republic	2002	250
SABIC	HRI	The Netherlands	2002	300
Yangzi	HRI	P.R. China	2002	200
BYPC	HR	P.R. China	2005	120
Secco	HRI	P.R. China	2005	250
Sasol	HRI	South-Africa	2007	300
Dushanzi	HR	P.R. China	2009	250
Dushanzi	HRI	P.R. China	2009	300

Plants in Design or Construction

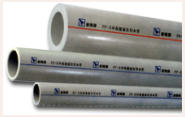
Client	Products	Location	Est. S.U.	Capacity kta
Sibur, Tobolsk	HR	Russia	2012	500
Sibur	HRI	Russia	2013	200
Yulin Petrochemical Company	HRI	P.R. China	2013	300
OPaL	HRI	India	2013	340
SABIC	HRI	The Netherlands	Tbd	400
Essar	HRI	India	Tbd	450
Essar	HRI	India	Tbd	450
Sinopec Maoming Company	HRI	China	Tbd	200
Yanan Yanchang	HRI	China	Tbd	300
Ningxia Baofeng Energy Group	HRI	China	Tbd	300



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

Typical Grade Slade Products

Material Type	Grades	MFR g/10 min	Main application
HP	F1003C	3.4	BOPP; flexible packaging, overwrap, metalised film
	C1608	8.0	Cast film for flexible packaging, bread bags, cereal box liners
	S1001	1.2	Heavy duty strapping, cordage
	S1012	12	Staple fibers for carpet face yarns; continuous filament for straps and belts
	K1105	5.0	Injection moulded heavy wall parts for appliances, dishwashers, food processors
	K2550	50	High flow injection moulding of thin wall containers, food trays

Material Type	Grades	MFR g/10 min	Main application
RCP	S3040	38	Non-woven high speed spinning spunbond, fine denier staple fiber
	K4812	12	Injection stretch blow moulding of thin walled containers
	K4840	40	Caps & closures, housewares, clarified food containers
	B4801	1.5	Small to medium size blow moulded bottles requiring high transparency
	T4401	0.3	Hot & cold pipe
	T4502	1.9	Extruded sheet and profiles, thermoformed packaging, extrusion blow moulded containers & bottles

Material Type	Grades	MFR g/10 min	Main application
ICP	K8003	2.5	Blow moulded heavy duty & automotive parts
	K9005	5	High impact injection and blow moulded parts for automotive and industrial use
	K9015	15	Automotive bumper fascia & exterior trim
	K8544	44	Housewares, appliances, rigid packaging & furniture
	K7110	105	TWIM & high speed injection moulding of refrigerated dairy containers
	T7001	0.30	Extrusion: Non-pressure pipes, sheet
	T8102	1.2	Extruded corrugated sheet
	T8702	1.9	Thick wall injection moulded freezer to microwave packaging

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