

Polymer Technology

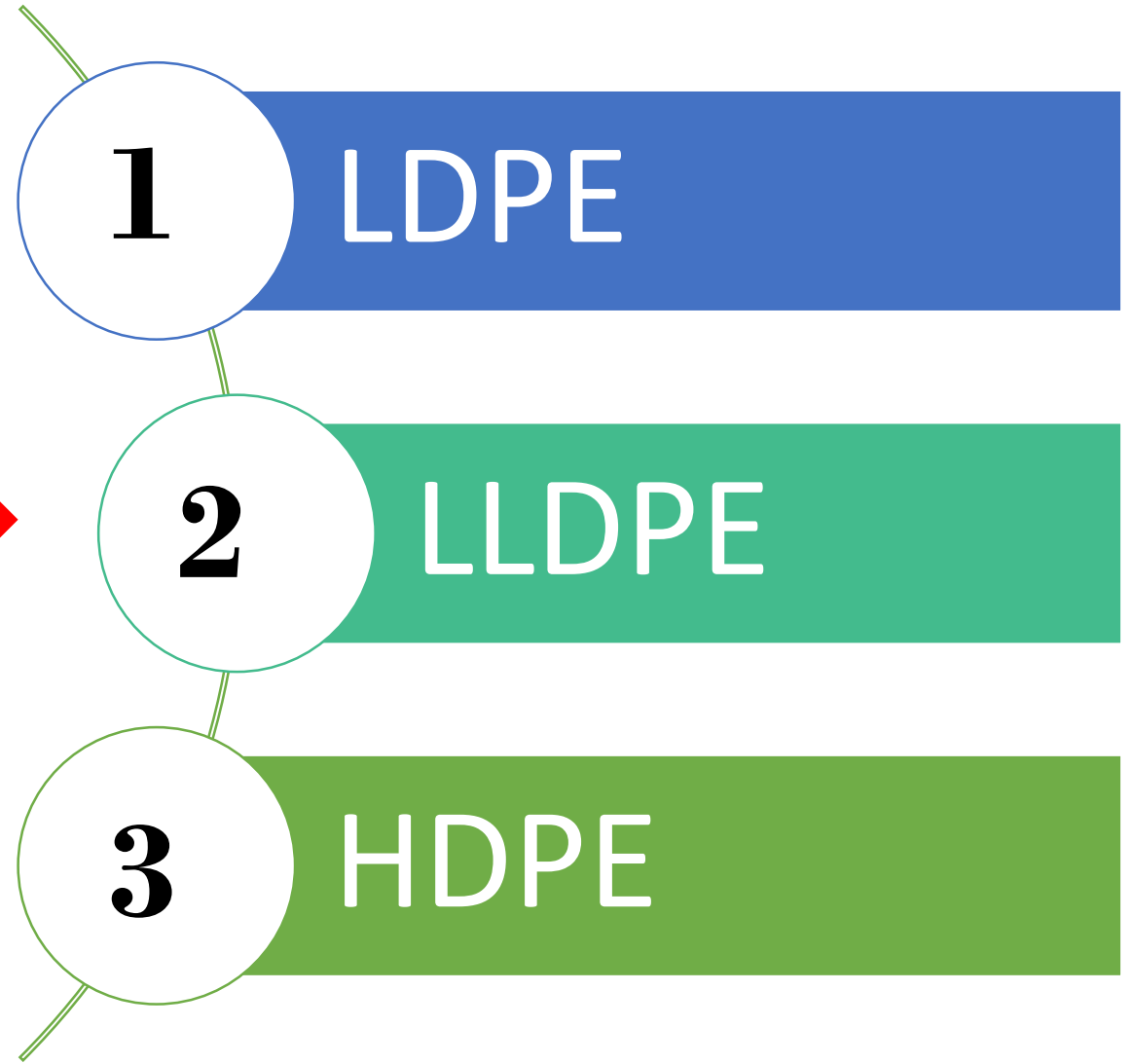
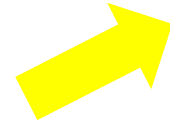
Industrial Polymer Manufacturing process

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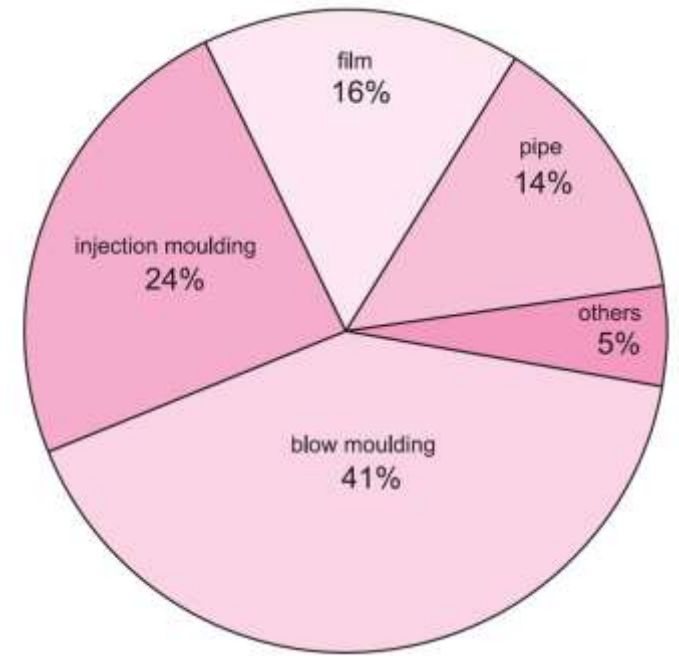
Polyethylene



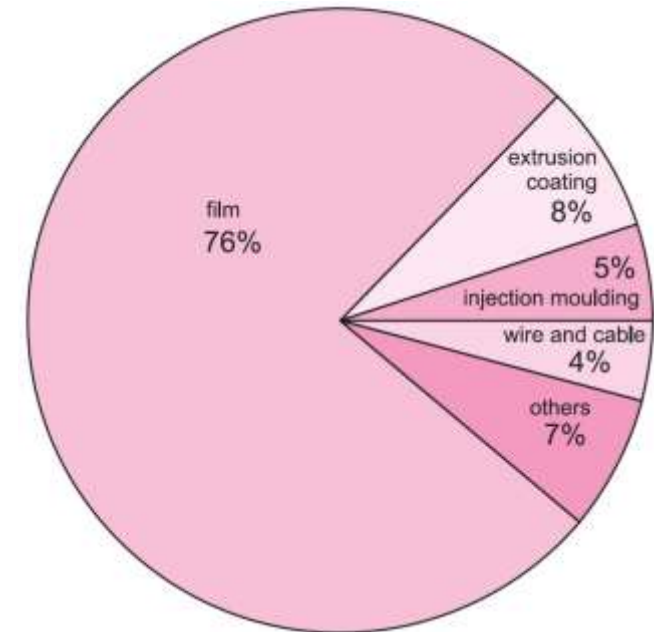
Uses of polyethylene

Process	HDPE	LDPE	LLDPE
Making film	Food packaging Shopping bags	Cling film Milk carton lining	Stretch film
Injection moulding	Dustbins Crates	Buckets Bowls	Food boxes
Blow moulding	Detergent bottles Drums	Squeezable bottles	
Extrusion	Water pipes	Flexible water pipes Cable jacketing	Cable coating

HDPE



LDPE/LLDPE





LDPE - Low-density polyethylene

Low-density polyethylene (LDPE) is a thermoplastic made from petroleum. It was the first grade of polyethylene, produced in 1933 by Imperial Chemical Industries (ICI) using a high pressure process via free radical polymerization. Its manufacture employs the same method today.

LLDPE - Linear low density polyethylene

LLDPE is a substantially linear polymer with significant numbers of short branches, commonly made by copolymerization of ethylene with short-chain alpha-olefins (for example, 1-butene, 1-hexene and 1-octene). LLDPE has higher tensile strength than LDPE, it exhibits higher impact and puncture resistance than LDPE.



HDPE – High Density Polyethylene

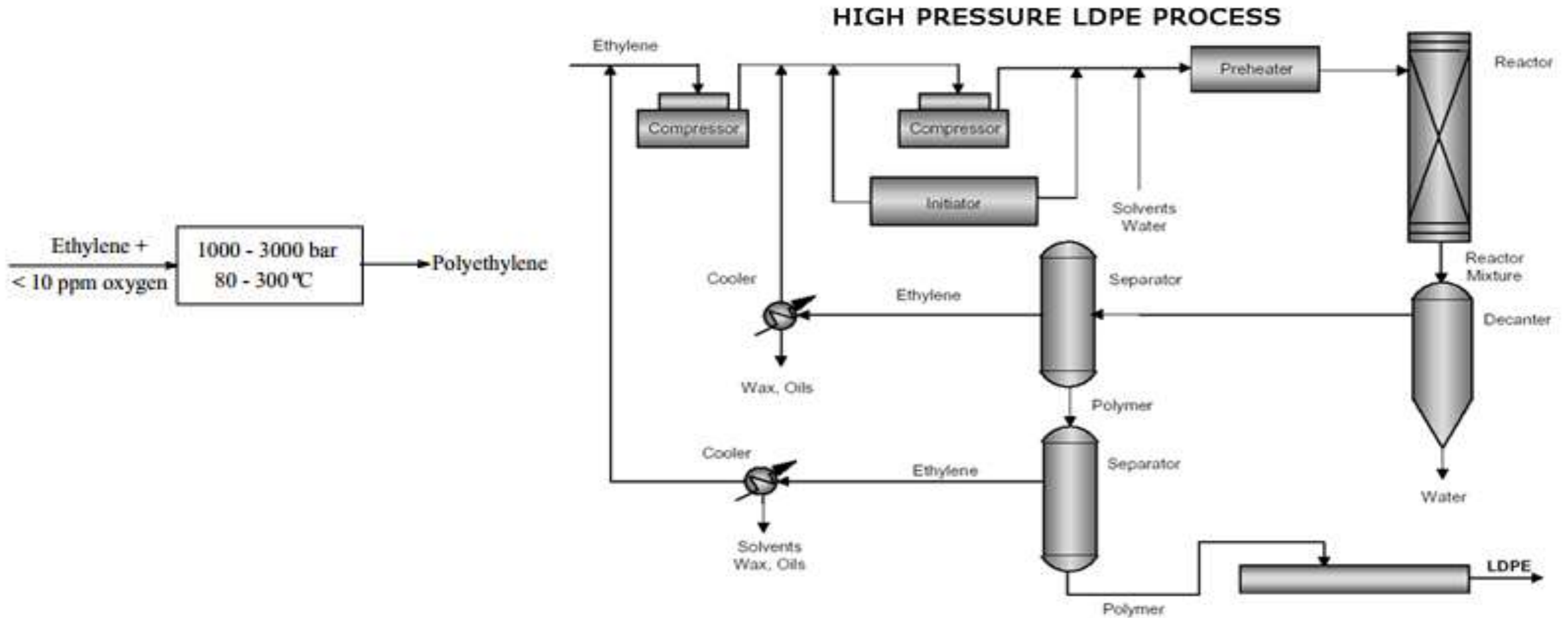
In 1953, Karl Ziegler of the Kaiser Wilhelm Institute (renamed the Max Planck Institute) and Erhard Holzkamp invented high-density polyethylene (HDPE). The process included the use of catalysts and low pressure, which is the basis for the formulation of many varieties of polyethylene compounds. Two years later, in 1955, HDPE was produced as pipe. For his successful invention of HDPE, Ziegler was awarded the 1963 Nobel Prize for Chemistry.



HDPE has little branching, giving it stronger intermolecular forces and tensile strength than LDPE

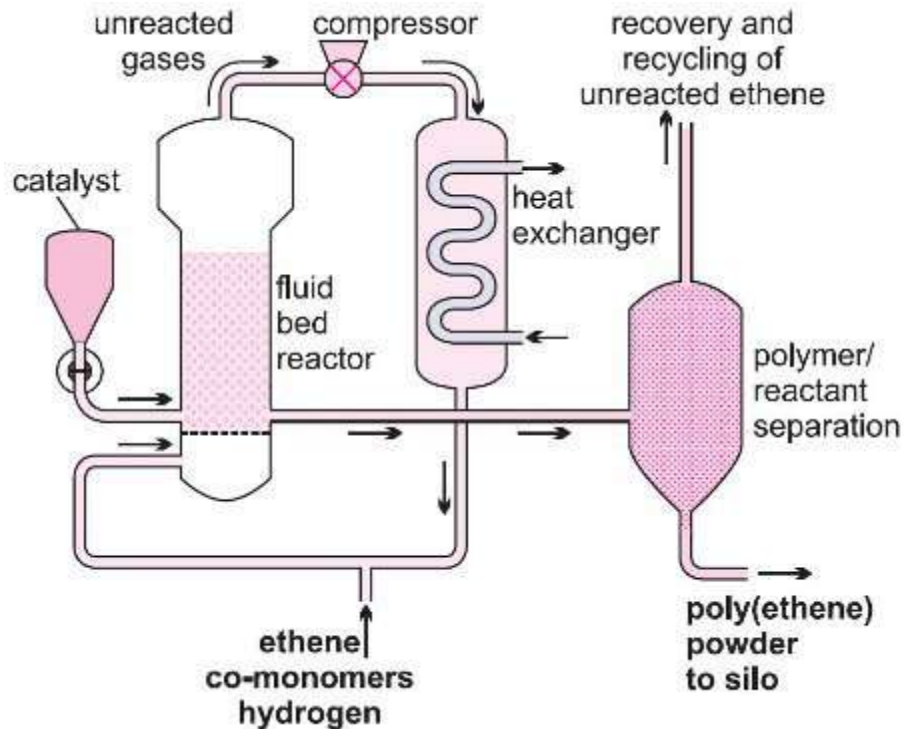
Production Process of LDPE (High Pressure Process)

LyondellBasell (Lupotech) technology is the most used technology by LDPE plants globally. A close second is the Univation (Unipol) technology which is also used a lot for the production of LDPE worldwide.

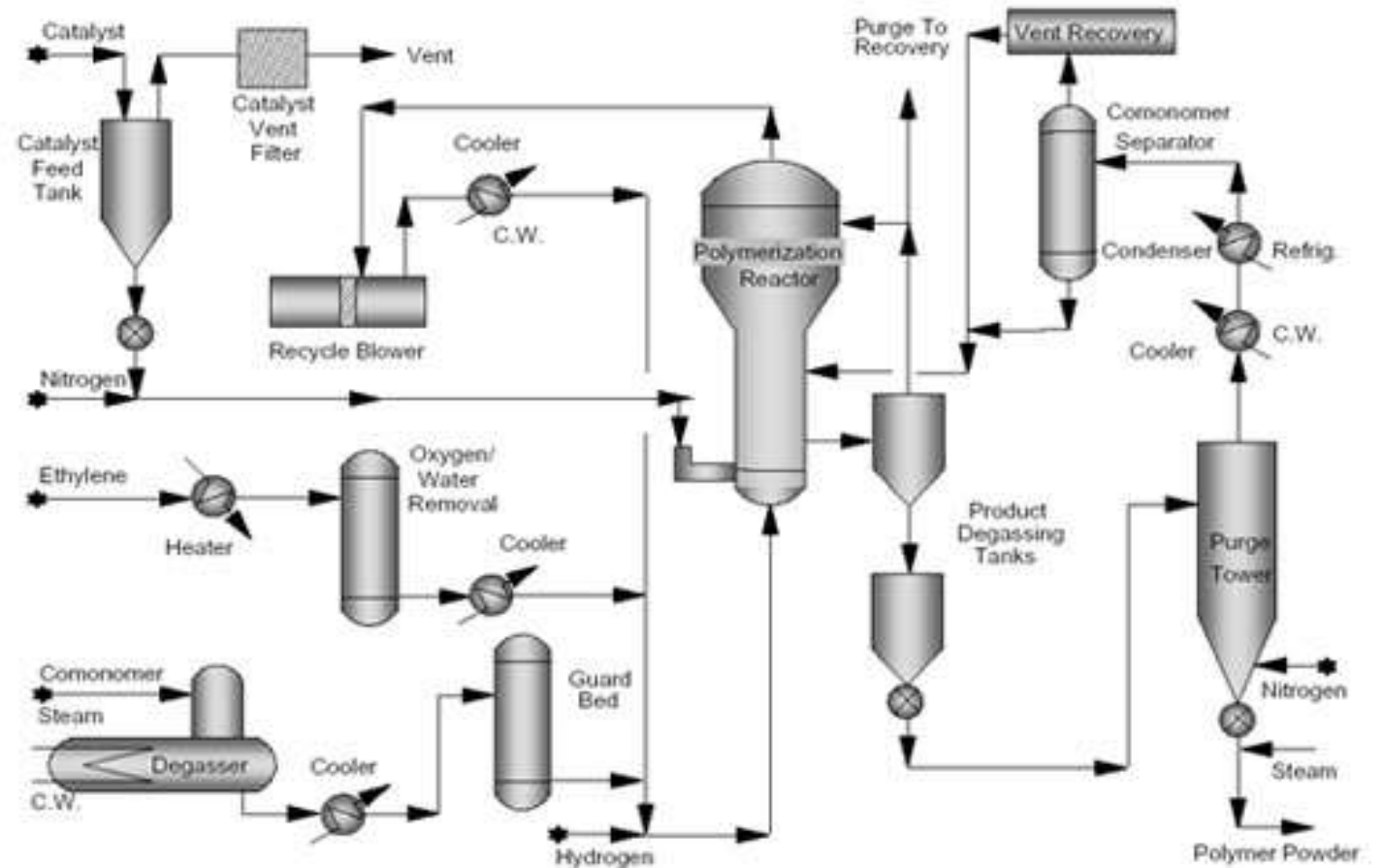


Production Process of LLDPE (Low Pressure Process)

Major Licensors of technology for LLDPE include Univation, Ineos, Basell, Mitsui and Westlake. Univation's unimodal UNIPOL swing process, which offers its Super Condensing Mode Technology (SCM-T)



Gas - Phase LLDPE/HDPE swing process





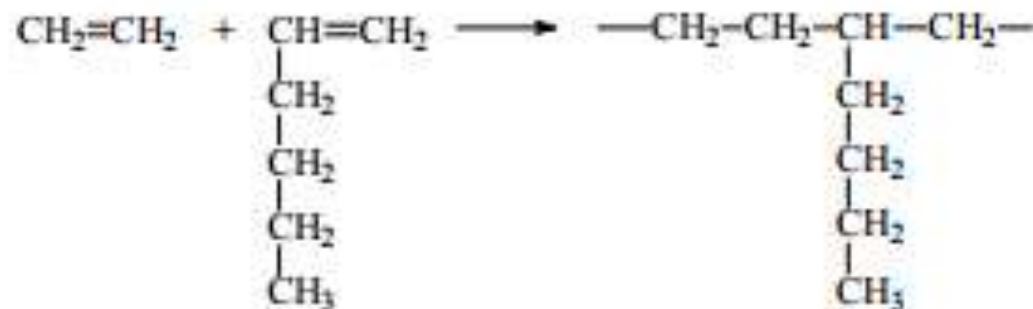
LDPE

In the late 1950's, DuPont Canada first applied the low pressure process to the production of LLDPE. LLDPE is made by copolymerising with a small amount of another monomer, typically butene, hexene or octene.

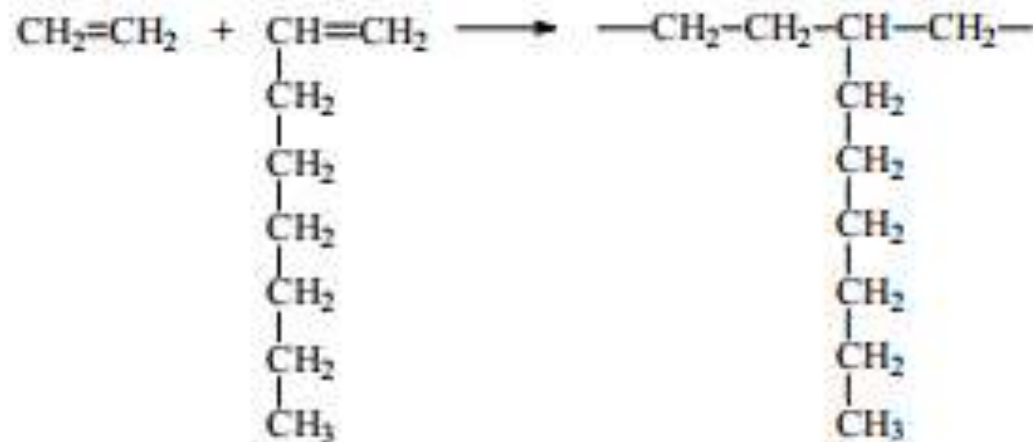
- with butene:



- with hexene:



- with octene:



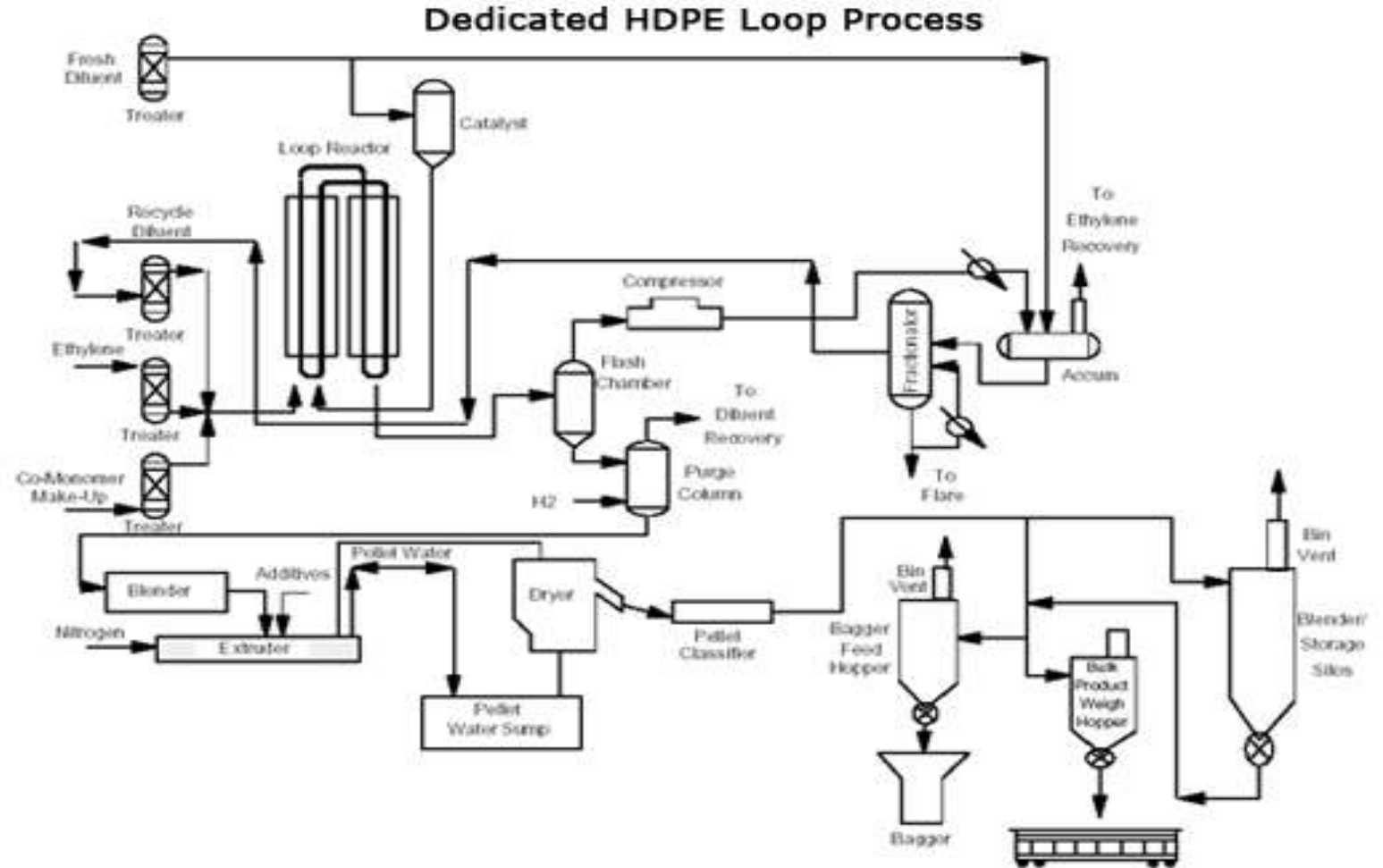
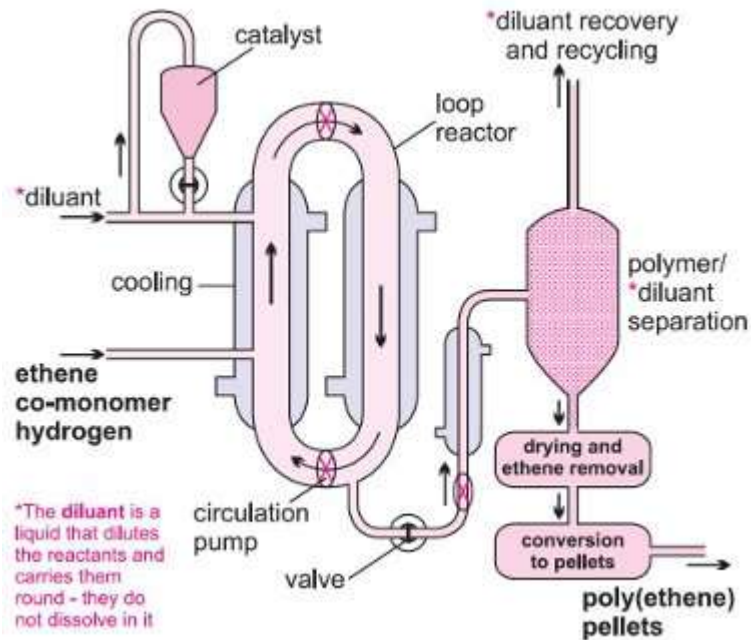
LLDPE

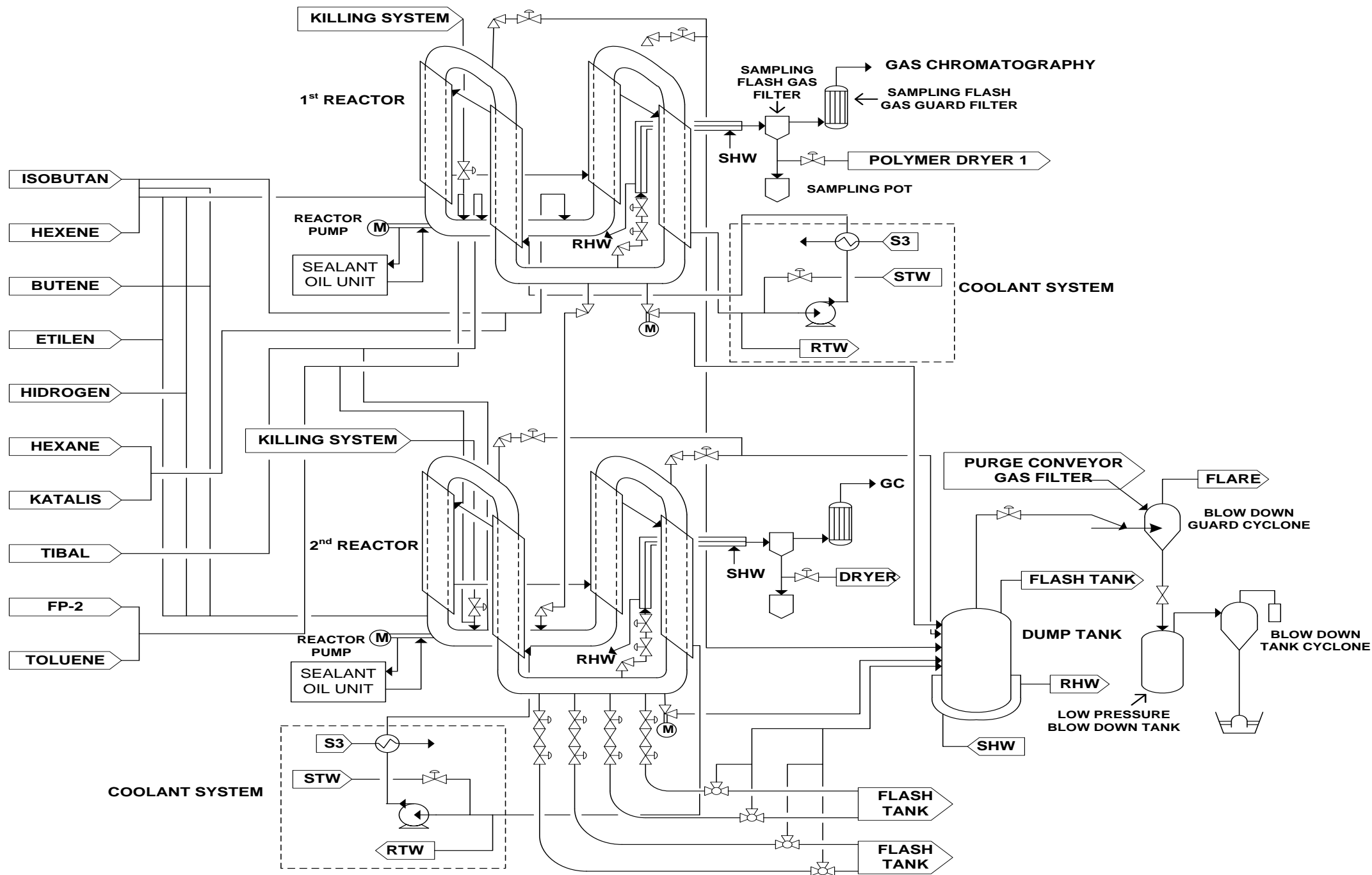
Short-Branched

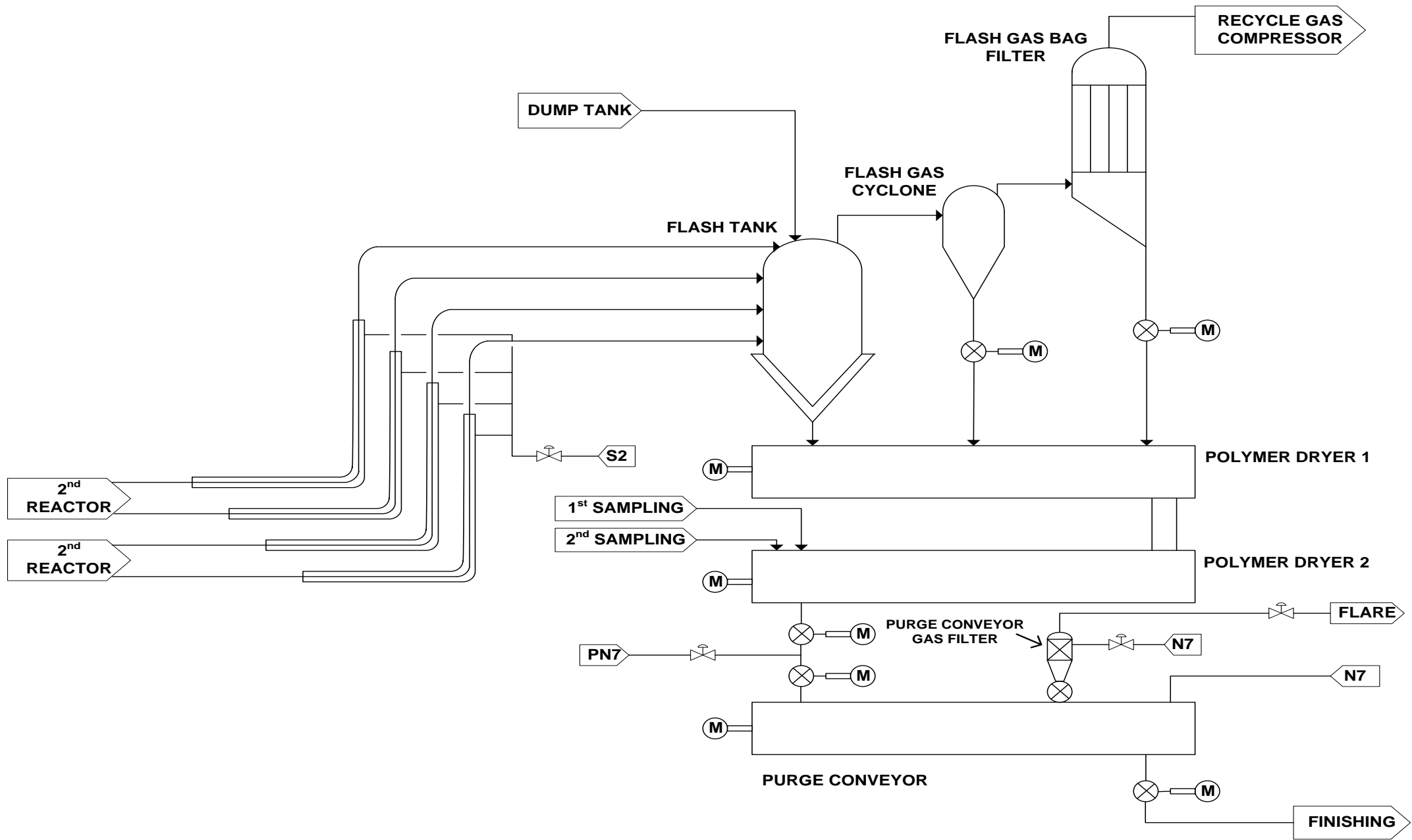


Production Process of HDPE (Low Pressure Process)

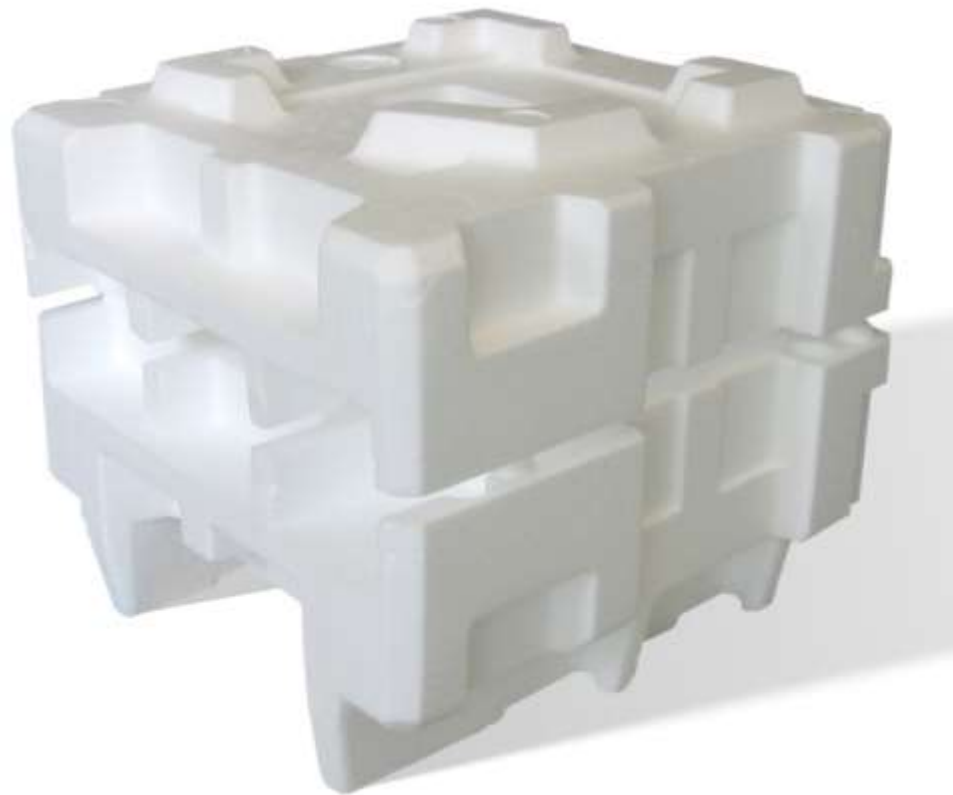
Ineos and LyondellBasell are the leading technology licensors for HDPE. Loop process is primarily an HDPE-dedicated process







Polystyrene



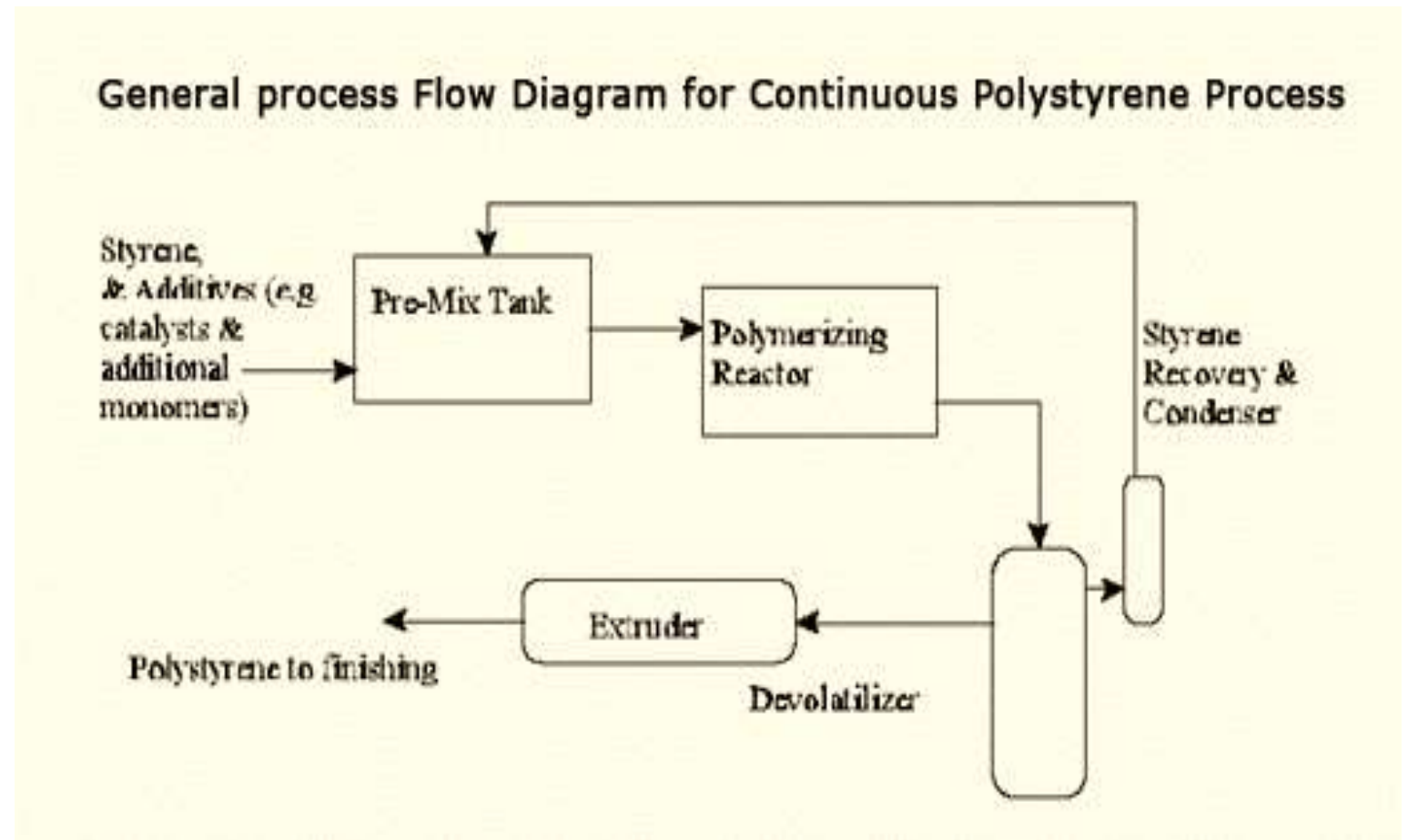
PS – Polystyrene

Polystyrene was discovered in 1839 by Eduard Simon, an apothecary in Berlin. From storax, the resin of the Turkish sweetgum tree *Liquidambar orientalis*, he distilled an oily substance, a monomer that he named styrol. Several days later, Simon found that the styrol had thickened, presumably from oxidation; into a jelly he dubbed styrol oxide ("Styroloxyd").



Production Process of Polystyrene

Solution (bulk) polymerization is commonly referred to as mass polymerization in the industry. The vast majority of all polystyrene produced today is produced via this technology. The common solvents used in this process are the styrene monomer itself and ethyl benzene. The two types of mass polymerization are batch and continuous, of which continuous mass is by far the most popular.



Polypropylene

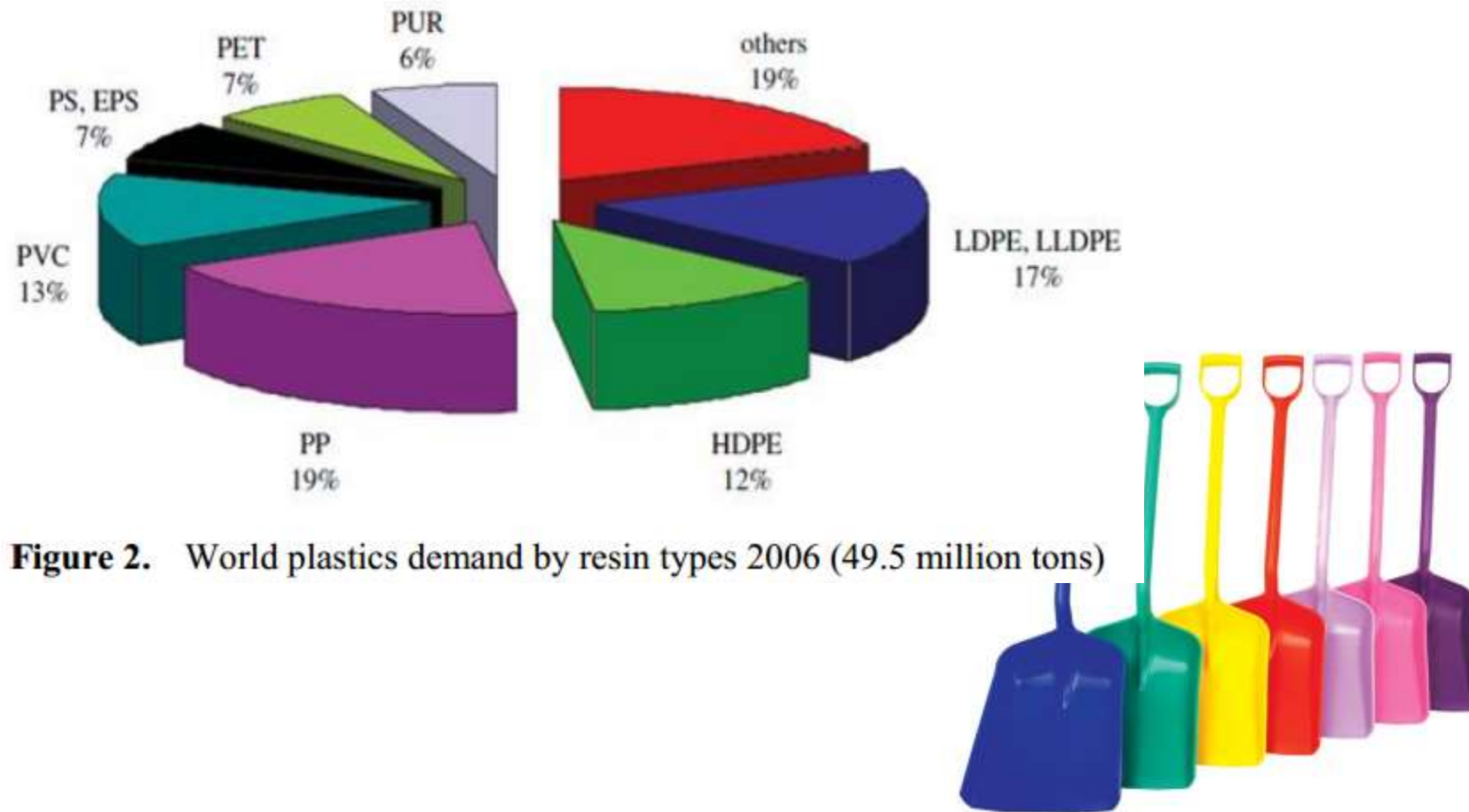


Figure 2. World plastics demand by resin types 2006 (49.5 million tons)



PP – Polypropylene

Polypropylene (PP) is one of the numerous derivatives of propylene $\text{CH}_3\text{-CH=CH}_2$. Depending on the type of polymerization and catalyst used, the polymers may present an orderly and disorderly configuration. Propylene was first polymerized to a crystalline isotactic polymer by Giulio Natta as well as by the German chemist Karl Rehn in March 1954

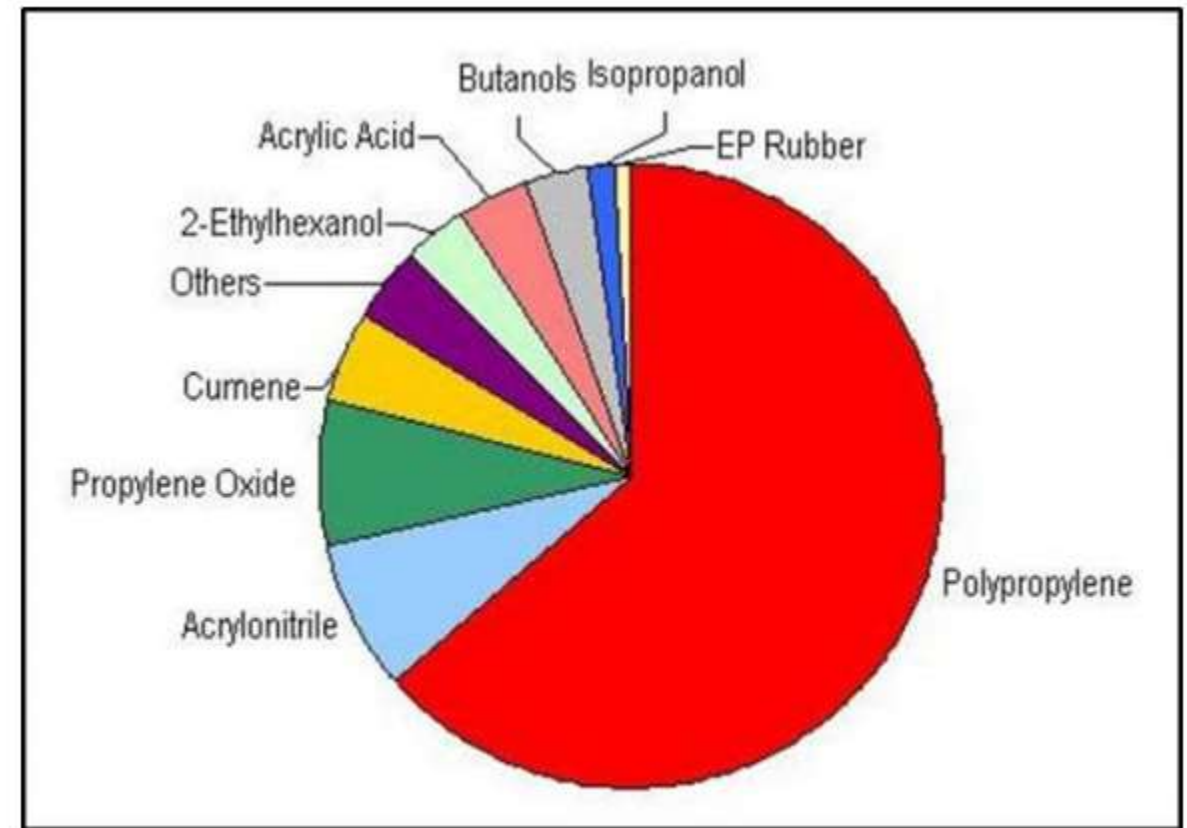


Figure 3. Global propylene consumption (two-thirds for polypropylene)

Production Process of Propylene

The two technologies primarily used to produce polypropylene are vapor- or gas- phase process and a slurry process that uses bulk slurry in liquid propylene as reaction medium.

UNIPOL polypropylene process technology is a gas-phase technology that is occurred in a fluidized bed reactor system. The process is stable and predictable.

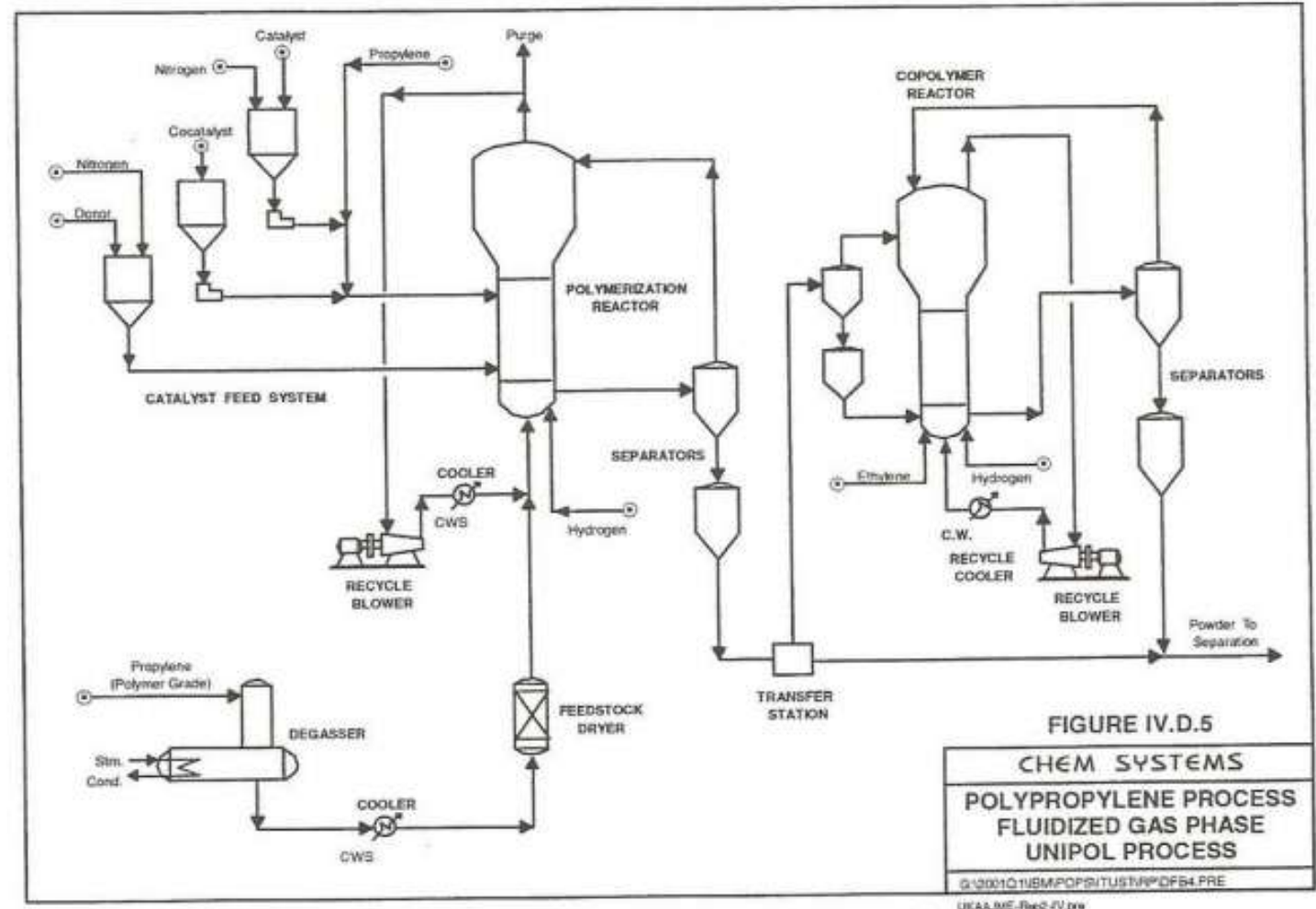


Figure 4. Polypropylene fluidized gas-phase UNIPOL process (stage 1)

The Basell Spheripol process combines the bulk slurry reactor for producing homopolymers with the fluidized bed gas-phase reactor for heterophasic copolymers. In the process, a catalyst and cocatalysts are injected into pre-polymerization loop to initiate the polymerization.

Polypropylene Spheripol Process

