Major Chemicals and Plastics We Use Every Day

F803

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Topics

1. History of chemistry, and significant discoveries in the 19th century. Nitrogen fertiliser.
2. Plastics and rubber
3. (a) Polyethylene and (b) Silicones
4. Chlorine containing chemicals and polymers.

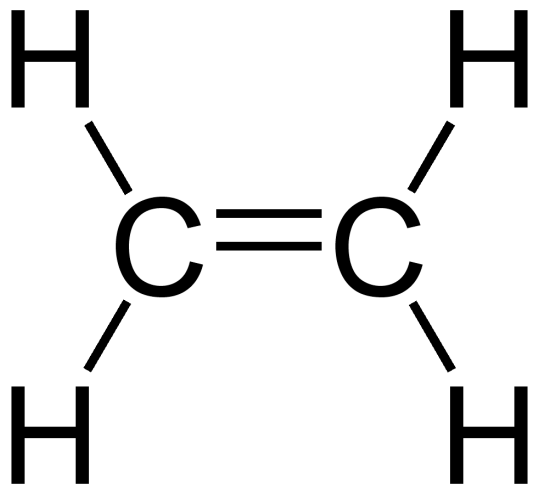
Status in 1950

- Ethylene is not polymerised by free radicals under normal conditions.
- Does polymerise at high temperature and pressure, first manufactured in 1939. But the polymer quality is poor. Called LDPE.

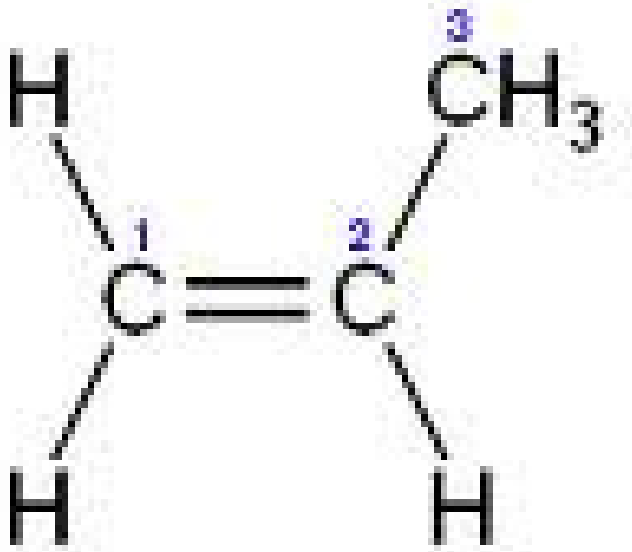
Discovery

- Prof Karl Zeigler in 1952, trying to make some exotic compounds of ethylene and aluminum, found he had made polyethylene.
- Was not a free radical process, so he had discovered a new reaction and a new polymer. Became “Directed Polymerisation”
- Difficult to scale up, probably due to the complexity and hazard of the catalyst.
- 1955 Prof G Natta published on the structure of the polymer chain.

Ethylene



Propylene



Development

- First polyethylene production in 1955.
- First polypropylene production in 1957.
- Zeigler and Natta shared the Nobel Prize in 1963.
- Ethylene-propylene copolymers made, are elastomers with outstanding durability.
- Continued research has led to 3 generations of improved catalysts.
- 2010: 100 billion kilos of polyethylene produced in the world, the largest volume plastic or chemical. This would occupy 1 acre about 20 meters deep.

Processing Videos

- http://www.youtube.com/watch?v=bit-D1NnfjI Injection molding
- examples
- http://www.youtube.com/watch?v=T01i_vp2mJE&NR=1 Blow molding
- Cf with thermoset. Milk bottles would be 1-stage blow molding
- http://www.youtube.com/watch?v=uw9FYnBp5C8&feature=related blown film extrusion
- Compare with fiber mfg.
- 3-layer laminate, 5 meters wide
- 10,000 kg/hour

ACC Resin Statistics Annual Summary
2008 vs. 2007

PRODUCTION, SALES & CAPTIVE USE

(millions of pounds, dry weight basis)(1)

Resin	Production			Total Sales & Captive Use		
	2008	2007	% Chg 08/07	2008	2007	% Chg 08/07
Epoxy (2)	583	642	-9.2	603	653	-7.7
Urea and Melamine (3)	2,798	3,471	-19.4	2,848	3,448	-17.4
Phenolic (3)	4,233	4,838	-12.5	4,122	4,362	-5.5
Total Thermosets	7,614	8,951	-14.9	7,573	8,463	-10.5
LDPE (2)(3)	7,003	7,927	-11.7	7,143	7,999	-10.7
LLDPE (2)(3)	12,058	13,584	-11.2	12,385	13,379	-7.4
HDPE (2)(3)	16,247	18,222	-10.8	16,823	18,373	-8.4
PP (2)(4)	16,768	19,445	-13.8	17,235	19,361	-11.0
ABS (2)(4)	1,133	1,270	-10.8	1,111	1,273	-12.7
Other Styrenics (2)(4)	1,455	1,726	-15.7	1,407	1,670	-15.7
PS (2)(3)	5,220	6,015	-13.2	5,364	5,995	-10.5
Nylon (2)(4)	1,148	1,295	-11.4	1,164	1,302	-10.6
PVC (3)	12,789	14,606	-12.4	12,948	14,634	-11.5
Thermoplastic Polyester (2)(4)	8,159	8,745	-6.7	9,805	10,364	-5.4
Total Thermoplastics	81,980	92,835	-11.7	85,385	94,350	-9.5
Subtotal	89,594	101,786	-12.0	92,958	102,813	-9.6
Other Resins (5)	11,952	14,007	-14.7	11,204	13,066	-14.3
GRAND TOTAL	101,546	115,793	-12.3	104,162	115,879	-10.1

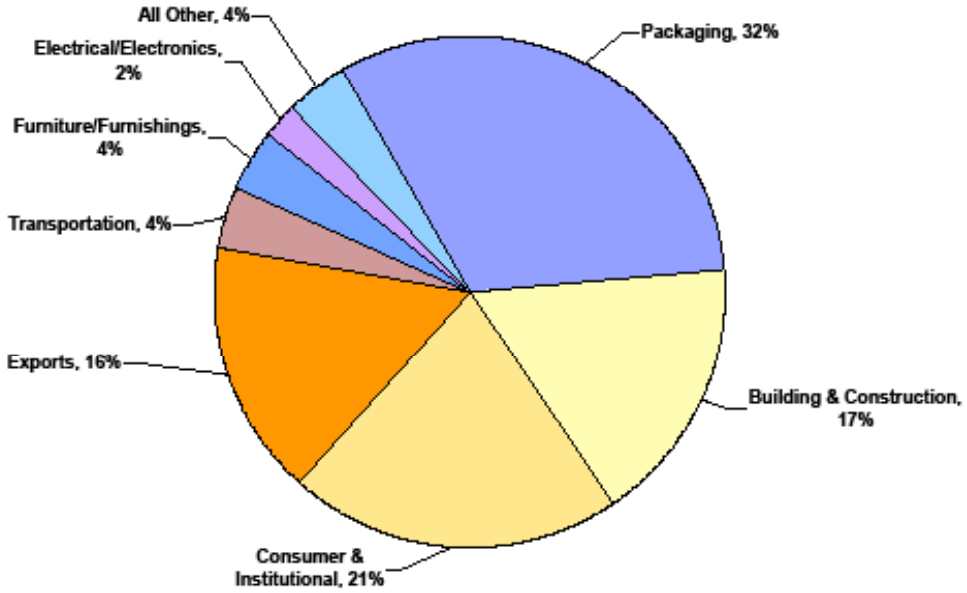
(1) Except Phenolic resins, which are reported on a gross weight basis.
(2) Sales & Captive Use data include imports.
(3) Canadian production and sales data included.
(4) Canadian and Mexican production and sales data included.
(5) Includes: engineering resins, polyurethanes (TDI, MDI and polyols), unsaturated (thermoset) polyester, and other resins.

Sources: Plastics Industry Producers' Statistics Group (PIPS), as compiled by Veris Consulting, LLC; ACC

American Chemistry Council

American Chemistry Council

2008 Percentage Distribution of Thermoplastic Resins
Sales & Captive Use by Major Market



Resins Comprising Market Distribution:

- Low Density Polyethylene (LDPE)
- Linear Low Density Polyethylene (LLDPE)
- High Density Polyethylene (HDPE)
- Polypropylene (PP)
- Polystyrene (PS)
- Styrene Butadiene Latexes (SBL)
- Nylon
- Polyvinyl Chloride (PVC)

SOURCE: ACC Plastics Industry Producers' Statistics Group, as compiled by Veris Consulting, LLC.

Success

- Great contributions by outstanding scientists for over 100 years; from Baekland to Carothers to Zeigler, both in materials and understanding.
- Allows highly functional, inexpensive molded parts, containers, films, fibers and coatings to be made which were not possible 100 years ago.
- Huge growth in production; polyethylene growing from almost nothing in 1950 to 100 billion kilos today.
- A huge technical success story.

The Cost

- Packaging is the largest application of plastics; - used once and disposed.
- Leads to lots of waste for recycle or disposal.
- Not readily biodegradable or suitable for incineration.
- Ends up polluting the land and oceans.

Recycling

- Few pairs polymers are compatible when mixed.
- Different phases have poor adhesion to each other,
- Strength of a polymer mixture is usually poor.
- Mixed polymers have little value as scrap.
- Recycle #1 is thermoplastic polyester
- Recycle #2 is polyethylene.

Great Pacific Garbage Patch