B5845

Bimodal Molecular Weight Polyethylene for Blow Molding

TOTAL PETROCHEMICALS

TOTAL

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What is Bimodal Technology?

In North America, most HDPE blow molding resins are based on *unimodal* (single reactor) process technologies and have performed well for many decades. However, the emergence of new applications with more severe operating requirements (lighter weight containers, improved environmental stress crack resistance) have pushed the performance demands on blow molding resins to new levels. Although today's class of unimodal HDPE blow molding resins generally perform very well in terms of top load, environmental stress crack resistance (ESCR) and drop impact strength, *bimodal* blow molding resins represent a significant improvement in all of these properties.

Total Petrochemical USA's Bayport, Texas plant has produced bimodal HDPE grades for over *two* decades. Following is a discussion on the differences between bimodal and unimodal blow molding resins.

Traditional Unimodal HDPE Blow Molding Resins

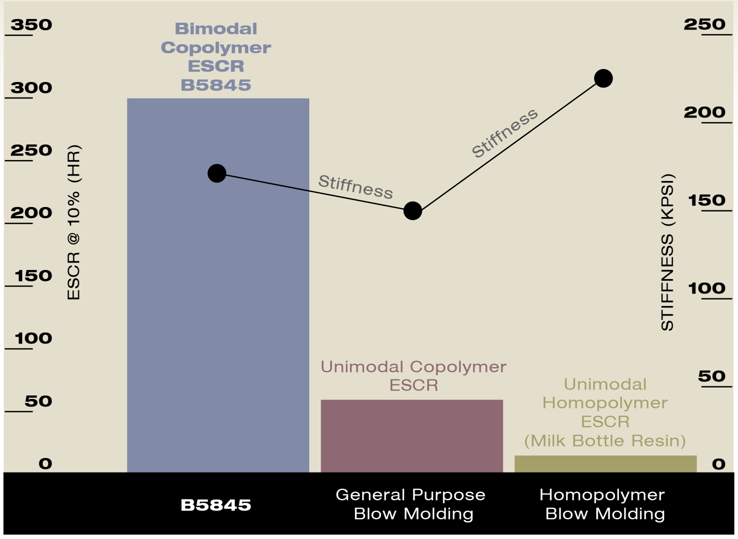
Unimodal HDPE blow molding resins are produced using one catalyst in one reactor. The result of this process is a polymer with a reasonably broad molecular weight distribution.

This broad range of polymer chain sizes includes both smaller molecules, which affect processability (e.g. extrusion flow rates), and much larger molecules, which influence physical properties such as top load strength, environmental stress crack resistance (e.g., ESCR) and drop impact strength.

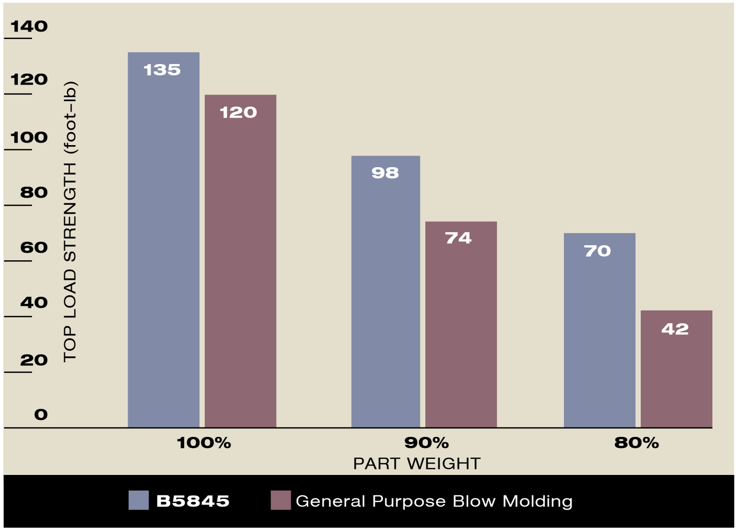
Density (or crystallinity) is a critical attribute for PE blow molding resins. For a given polyethylene material, reducing density improves many important physical properties related to ductility (or lack of brittleness), such as ESCR and impact strength.

Density is controlled by the incorporation of *comonomers* into the polymer at relatively small levels during polymerization. These

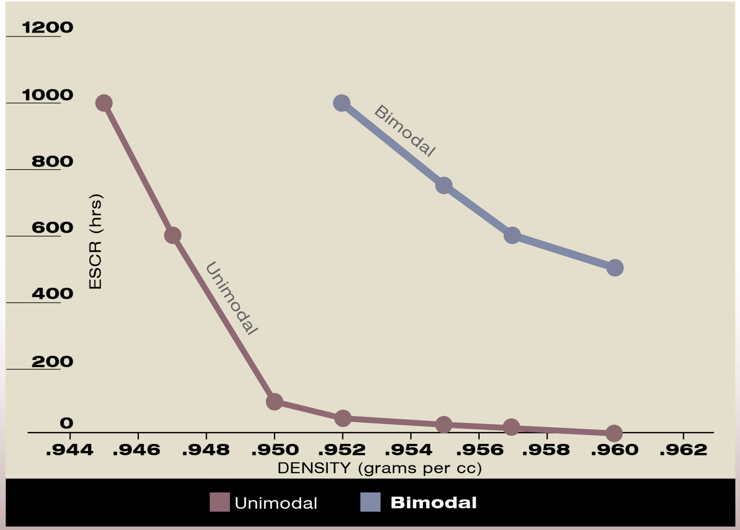
ESCR_Stiffness



Top Load Nominal Part Weight



Advantages of B5845



comonomers create short *side chain branches*, which act to “disrupt” the crystalline structure and lower density. However, this process is not completely efficient, because the comonomer preferentially goes into the smaller, lower molecular weight chains, which are less effective (than the longer polymer chains) at influencing physical properties.

This tendency for comonomer incorporation into shorter polymer chains limits the environmental stress crack resistance (ESCR) and drop impact properties for a unimodal resin at a given density. This limitation is particularly important for blow molding, where top load strength (favored by higher density) must be balanced with ESCR (favored by lower density) and drop impact resistance.

Bimodal Resin Technology

Bimodal resins are based on essentially the combination of two polymers, a high molecular weight (HMW) polymer and a low molecular weight (LMW) polymer.

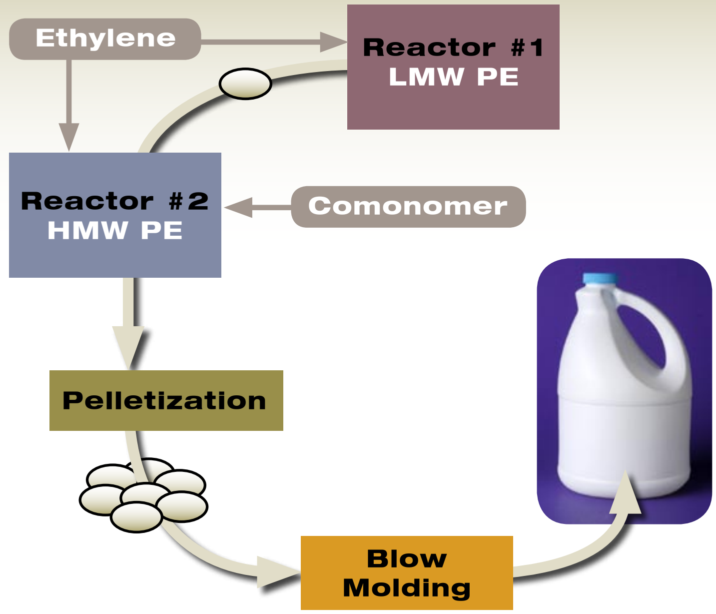
Normally, these resins are produced using two polymerization reactors in series (LMW and HMW), each operated under separate process conditions. This process allows all of the comonomer to be incorporated into the high molecular weight fraction, where it is most needed to influence properties. The result of this technology is a substantial leap in physical properties at a given resin density.

Bimodal resin technology delivers a substantial improvement in critical blow molding performance properties, to include:

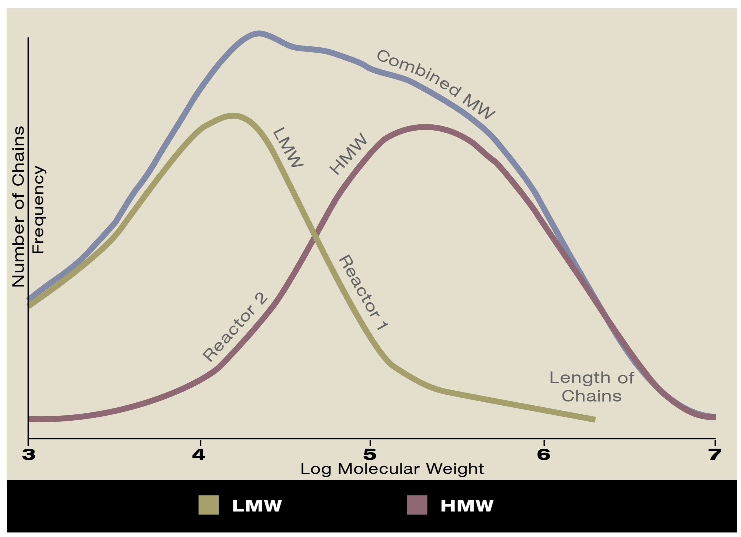
> Increased environmental stress crack resistance (ESCR)
> Increased top load resistance for higher stacking requirements
> Ability to lightweight containers while maintaining drop impact resistance

Ultimately, this range of improved performance equals longer service life and increased confidence that the blow molded container will maintain its integrity through even the most demanding of environments.

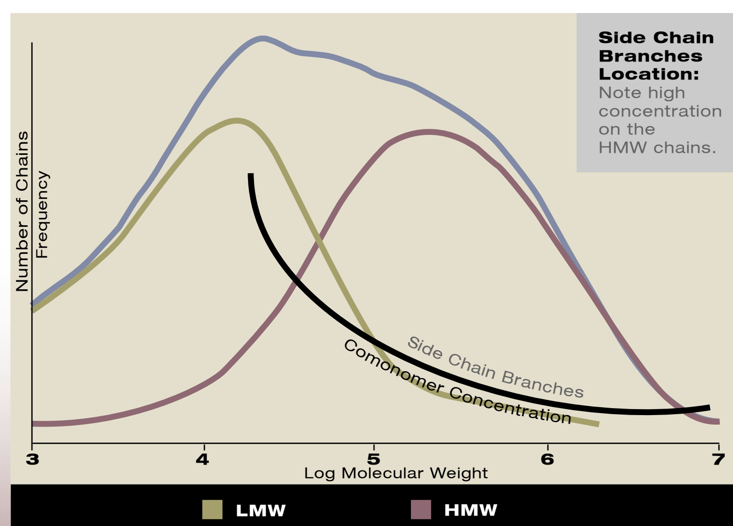
Generic Bimodal Reactor System



A Bimodal Molecular Weight Distribution



Comonomer Incorporation



Comparison Blow Molding Data

	BIMODAL COPOLYMER **B5845**	UNIMODAL COPOLYMER GENERAL PURPOSE BLOW MOLDING	UNIMODAL HOMOPOLYMER BLOW MOLDING
Melt Index (g/10 min.)–ASTM D1238	0.45	0.35	0.7
Density (g/cc)–ASTM D792	0.957	0.955	0.962
ESCR @ 10% (hrs)–ASTM D1693, Cond. B	300	60	15
Flex. Modulus (psi)–ASTM D790	170	150	225

Small Part Blow Molding
Bimodal Resins

Advantages

> Ability to lightweight packages
> Suitable for packaging aggressive liquids
> Incorporate more PCR

Customer Opportunities

Package Weight Reduction

> Cost Savings

Enhancing Package Attributes

> Drop Impact Improvement
> Top Load Improvement

Maintain Processing Capabilities

> Improve process capabilities on packages that have already been light weighted

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