Soy Based Foam Technologies for Automotive Seating

Goals and Opportunities

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Advance Materials & Seat Comforts

SoyFoam™ Renewable Comfort

LEAR CORPORATION

Ontario Agri-Food Technologies & SOY20/20 Joint Meeting

September 21, 2007

Soybean History in Automotive

SoyFoam™
Renewable Comfort

Henry Ford testing the impact strength of a soy flour composite decklid, 1940.

- In 1928, Henry Ford became interested in farm chemurgy, which applies chemistry and allied sciences to transform farm crops into new industrial products in the belief that industry would increasingly turn to the soil as a practical source for many of its raw materials, and eventually many components of finished cars could come from farms.
- Nearly 80 years later, the emphasis on soybean solutions has shifted to purely environmental reasons.
- Consumers are not only aware of the need for more environmentally responsible vehicles and lightweight, high-performance or recyclable materials, they also expect automakers and suppliers to implement "green" manufacturing practices to protect the environment.
- SoyFoam™ is an environmental solution developed in conjunction with Lear's Core Dimension Product Strategy, which focuses on seven dimensions of consumer preference – Safety, Comfort & Convenience, Commonization, Craftsmanship, Environmental, Flexibility and Infotainment.

EnviroTec™
Environmental Systems

LEAR CORPORATION
www.lear.com

Lear SoyFoam™ - Overview

Description:

- Substitute ~OH functionalized soybean oil for petroleum based Polyols and adjust and optimize processing and up to 10 additives in foam formulation to maximize mechanical performance.
- Use this new foam in automotive products meeting all performance requirements.

Applications:

- Head restraints
- Armrests
- Seat Foam

EnviroTec™
Environmental Systems

Status – Production Ready

- Completed successful plant trials to optimize Soy content up to 5% level in Seating and 24% in H/R.
- Ford Motor Co. granted Lear seating system SoyFoam™ Material Readiness Approval Jan ’07.
- Now have commercially available low and high density Soy polyol formulations that meet all material and performance requirements.
- SoyFoam™ technology is applicable to any existing or future programs for any head restraint, armrest, and seating foam application

Benefits of SoyFoam™

ENVIRONMENTAL BENEFITS

- **Environmentally responsible “green” themed product addressing consumer awareness of products developed from renewable agicultural feedstocks.**
- **Contributes to corporate initiatives, “environmentally responsible” corporate mission and other OEM environmentally friendly focus.**
- **Soybeans are a 100% renewable resource, grown locally and globally.**
- **2 kg of CO2 is removed from the atmosphere per kg of soy polyol vs. over 3.5 kg of CO2 added to the atmosphere per kg of petroleum polyol.**
- **Soybean oil processing into Polyol results in a 100% reduction in CO2 emissions and 60% lower required conversion energy versus petroleum.**
- **Reduction of up to 2/3 of Volatile Organic Compound (VOC) and fogging emissions is also possible.**

COST OPTIMIZATION

- **Foam material cost optimization and control through reduction of petroleum price dependency.**
- **Worldwide availability of renewable polyolefin sources will lead to improved long-term price stability.**

BEES Analysis

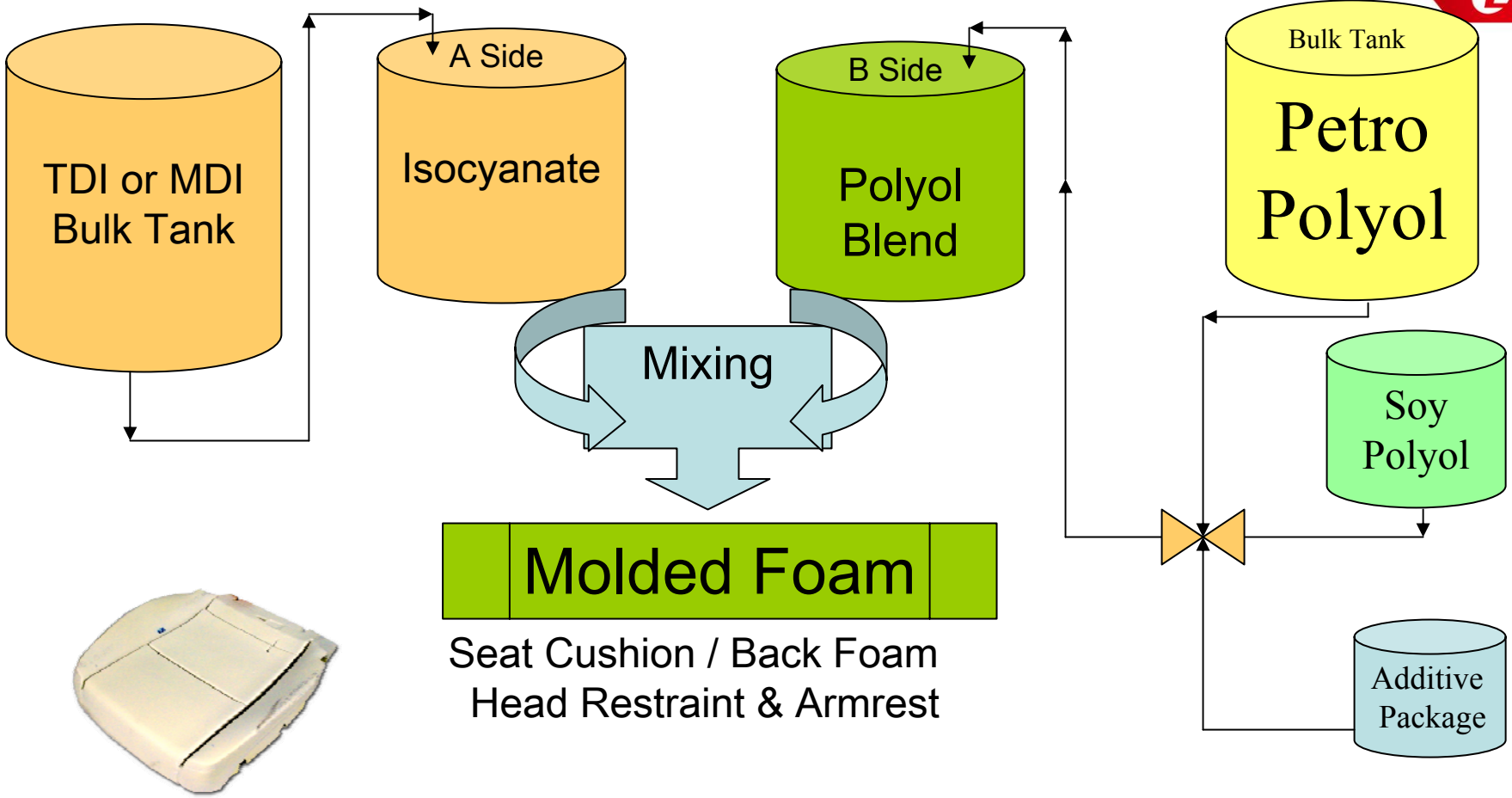
Application Areas and Foam Technology

- Seat, Head Restraint & Armrest foam with MDI technology has 16-24% Soy content
- Seat, Head Restraint & Armrest foam with TDI technology has 5% Soy content
- Further Development can maximize the Soy polyol use and replace Petroleum polyol

LEAR SOY Technology w/ LOW VOC POLYOL

Reduced up to 66% in VOC and Fog Emissions

Soy Foam Manufacturing Process Flow



Seat Cushion / Back Foam
Head Restraint & Armrest

TDI – Toluene Di-Isocyanate (Seating / H/R / AR Foam) – Low / Medium / High Density system
MDI – Methylene Di-Isocyanate (Seating / H/R / AR Foam) High Density system

Soy Foam Head Restraint – MDI Technology

- 1st soy foam automotive head Restraint part in collaborative project
- Able to produce part with acceptable “feel”

1. “Foam on post” placed on fixture
2. Vacuum compresses foam
3. Plastic covering placed on foam
4. Final trim piece placed over foam
5. Vacuum released

SOY Based Seat Foam – TDI Technology

- First production scale trial conducted at Renosol plant in September ’06. (several run to mold seat validation parts since then)
- New TDI formulation has 5% Soy content
- Molded Front Seat Cushion and Back foam
- Process parameters adjusted for Soy formulation
  - Index / Ratios
  - Pour Pattern
- Maintain production targets on weight, hardness and dimensions
- Molded foam parts met Lear production quality standards
- Successfully built seats with Soy foam pads to verify seat assembly process

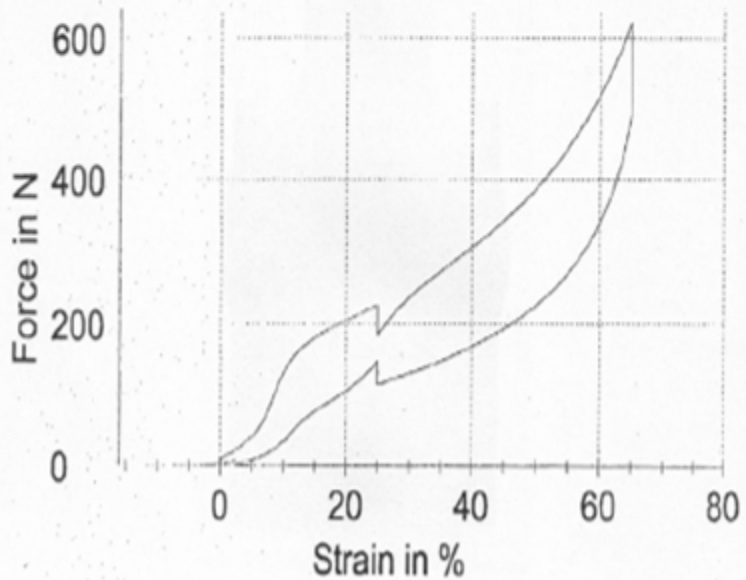
Front Seat Cushion Foam – TDI Technology

Results:

Nr	t 0 mm	F 25% Fapply N	F 25% Fremove N	F 65% Fapply N	Force at 25 % Fapply N
1	37.88	221.84	147.81	602.49	183.06

Nr	Force at 25 % Fremove N	Force at 65 % Fapply N
1	147.79	496.95

Series graph:



SOY Foam

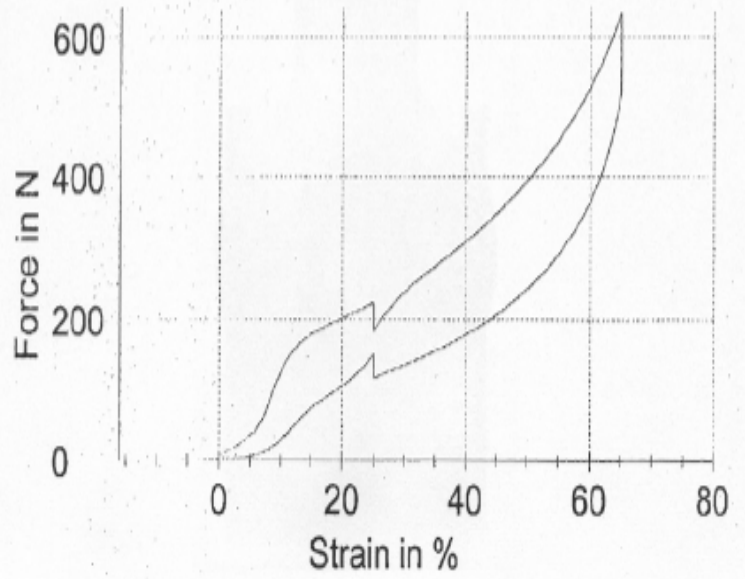
Density 37 Kg/m^3
IFD: 280N +/-22

Results:

Nr	t 0 mm	F 25% Fapply N	F 25% Fremove N	F 65% Fapply N	Force at 25 % Fapply N
1	37.88	220.45	151.56	618.16	183.57

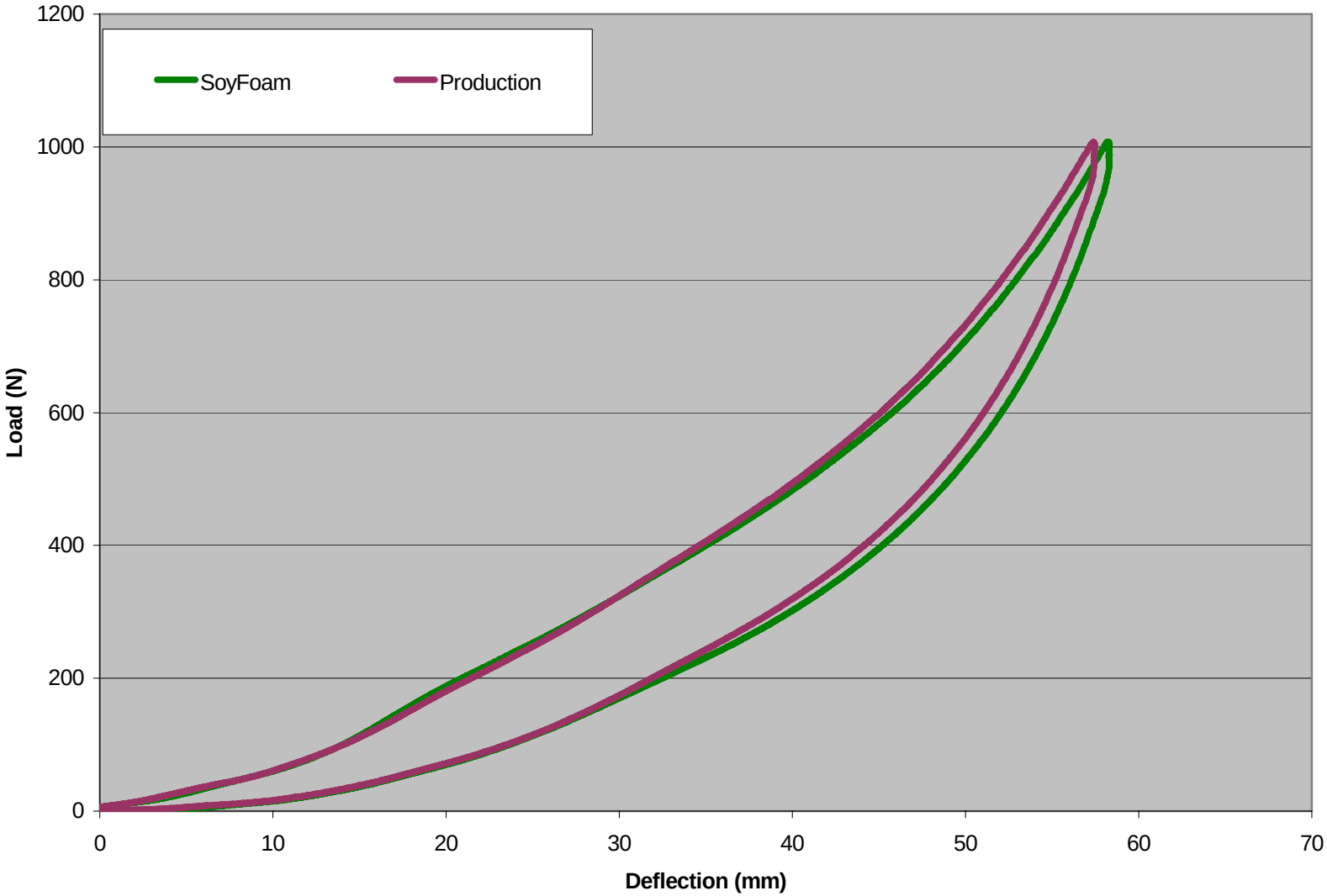
Nr	Force at 25 % Fremove N	Force at 65 % Fapply N
1	151.55	522.30

Series graph:



Production Petro-Foam

Load Deflection Behavior in Front Seat Cushion



Dynamic Comfort / H-point / Sear performance test completed

Development Partnership

- **Material / Formulation Development**
  - Ford Motor Company – Research & Innovation Center
  - Urethane Soy Systems Company
  - Bayer Corporation
  - Renosol Seating Corporation
  - United Soybean Board USB – New Uses Committee

- **Manufacturing / Process Development**
  - Lear Detroit and Lear Hermasillo Plant
  - Lear / Renosol Seating – Farwell, MI

- **Product Development / Validation**
  - Lear Seat Systems Division
    - Advance Materials & Comfort Engineering
    - Safety Group
    - Seat Design and Engineering
  - Third Party Material Testing

Lear Strategy and Customer Goals

- Global Customer interest in Soy Technology
- Short and long term initiatives
  - Lear internal developments
  - Foam operation upgrade for Soy foam launches
  - Development strategy with soy polyol sources
  - Partnership with foam molders / suppliers

Bio-Technologies Opportunities

- A preliminary life cycle analysis indicates that replacement of petroleum-based Polyols with BiOH Polyols results in 36 % less global warming emissions,
- A 61% reduction in non-renewable energy use, and a 23% reduction in the total energy demand. For every million pounds of BiOH Polyol produced to replace petroleum- based Polyols, about 2,200 barrels (nearly 700,000 pounds) of crude oil are saved.

YOUR ENVIRONMENTAL FOOTPRINT MATTERS.

TAKE BIG STEPS.

Protecting our planet is important. That's why we've made **Environmental Systems** one of our seven Core Dimensions™ of product innovation. Working closely with our customers, we're reducing the environmental impact of our seating products and processes, and improving fuel efficiency with lightweight, high-performance materials. **SoyFoam,™** an industry first, is a soybean oil-based, flexible foam material up to 24% renewable compared with traditional non-renewable petroleum-based foam. It also reduces our dependency on volatile energy markets and reduces carbon dioxide emissions. The steps we take today can help create a greener tomorrow.

To see the Lear difference, go to lear.com.

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ADVANCE RELENTLESSLY

www.lear.com