Air Bag

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Final Year Textile
Where it all started???

• The key factor for growth and innovation - the 18th century industrial revolution.
• Invention of many new technologies.
• Machine started to do work for us.
• Mobitech – textiles related to the Automotives
History

- Dr Allen. S. Breed – the ball in tube inertial sensor for crash detection – Chrysler bought it in 1967
- Eaton, Yale & Town Inc – Autoceptor Crash Restraint
- GM – 1970 – Air Cushion Restraint System
How does an Airbag work???

- 30% safer - airbag for frontal safety
- Airbag deployment timing - 1/20th of a second
Different airbag positions
Fabric types

- Airbag are made of compact, plain woven fabrics, or basket woven, twill is also used sometimes.
- Yarns used – Nylon 6.6, Nylon 6, Nylon 4.6, and polyester
- Major requirements
  - High strength on both axis
  - High tear propagation resistance
  - High anti-slip properties of the seams
  - Resistance against aging
  - Defined dimensional stability
  - Defined air permeability
- The amount of fabric needed depends on two main factors. They are, – The position of the airbag in the car, and – The market it serves.
- Most of the driver side airbags are coated, and lower denier yarns that yield strong and lighter-weight fabrics are used.

<table>
<thead>
<tr>
<th>Yarn Type</th>
<th>Typical Size</th>
<th>Fabric Construction (per 10 cm)</th>
<th>Coated Weight (g/m²)</th>
<th>Thickness (mm)</th>
<th>Stiffness (kgf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nylon 6.6</td>
<td>840d</td>
<td>98 X 98</td>
<td>280</td>
<td>0.38</td>
<td>1.36</td>
</tr>
<tr>
<td>Nylon 6.6</td>
<td>420d</td>
<td>193 X 193</td>
<td>260</td>
<td>0.34</td>
<td>1.80</td>
</tr>
<tr>
<td>Nylon 4.6</td>
<td>420d</td>
<td>181 X 181</td>
<td>245</td>
<td>0.32</td>
<td>1.20</td>
</tr>
</tbody>
</table>
• To manufacture airbag material, the warp yarn is supplied on a beam.
• One dip One nip process – polyacrylic coating.
• The size is adhered to the yarn by passing it between squeeze rollers and then through series of cooling rods.
• Encapsulating the yarn with size means that the ends are prevented from rolling during drying and wind-up. A gas fired dryer dries the size.
• At this stage other compounds suitable for warp preparation can be added, like the grafting compound designed by Reeves brothers. Grafting compound stops excessive fabric fraying, yarn pull-out, and distortion. The soft nature of the compound makes the airbag pliable.
Weaving Process and Finishing

- All 3 Modern shuttle-less technologies
- The fabric’s tensile strength and the elongation are strongly influenced at the weaving stage
- Weaver’s Responsibility – engineering uniform air permeability across the whole fabric
- Double rapier with double shedding mechanism was also tried – double flat fabric – to overcome air permeability problems

<table>
<thead>
<tr>
<th>Properties</th>
<th>Current Neoprene Products</th>
<th>New Silicone Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass GSM</td>
<td>280</td>
<td>265</td>
</tr>
<tr>
<td>Stiffness</td>
<td>1.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.38</td>
<td>0.34</td>
</tr>
<tr>
<td>Stiffness</td>
<td>0.12</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Percentage of Elongation

Days of exposure, 120°C
Design parameters for rapier loom

- Full width temple
- Sley race instead of supporting teeth
- Selvedge rollers
- Knot stop motion
- Controlled weft yarn break
- Take up roller with rubber coating
- Warp used in this need not twisted or sized but intermingled

Y-Axis: Air permeability in L/min/100cm²
X-Axis: Fabric width in cm
Design parameters for projectile loom

- Robust design
- Cam motion
- Filament equipment
- Electronically controlled warp let-off
- Warp tensioner
- Projectiles D12 with large clamping surface
- Full width temple

Y-Axis : Air permeability in L/min/100cm²
X-Axis : Fabric width in cm
Post Chemical Finishing processes

- Post finishing – It is cut into panels, which are then sewn together.
- Laser cutting is done – fast and accurate. It fuses the edges of the fabrics to prevent fraying and reduces costs by eliminating cutting.
- Airbags are sewn with nylon 6.6, polyester, and Kevlar aramid yarns. The sewing patterns and stitch densities are carefully chosen to maximize performance.
- After sewing – Folded inside its cover – like a parachute, the fabric is folded with extreme care to ensure smooth deployment.
- A variety of folds are suitable, including the accordion fold, reversed accordion fold, pleated accordion fold, and overlapped folds.
- Packing should allow for tethers joined to the bag to control its protrusion into the car during deployment.
- Cover can be fitted over the bag to protect it from abrasion – DuPont made jacket Tyvek AC spun-bonded polyethylene for this purpose to release the airbag when it inflates.
• To maintain the quality of airbags, there are more than 50 different types.
• Cost of validation is very high.
• The full certification of a complete airbag module costs approximately $100,000.
• There are many testing standards ASTM, SAE, and Automotive Occupant Restraints Councils.
• Different related ASTM standards – ASTM D1423, ASTM D1422, ASTM S 3786, ASTM D3787, ASTM D5034...
Performance Tests & Standards (cont...)

- ASTM D1423 – Yarn from package – amount and direction of twist
- ASTM D1422 – Yarn from airbag fabric
- Fiber identification – double beam spectrophotometer
- Size on the fabric – extraction using any suitable solvent
- Mass per unit area – a full width sample is taken with selvedges
- ASTM – air permeability testing using calibrated orifice method
- ASTM D3786, 87 – Bursting strength
- ASTM D5034 – Fabric breaking force
- ASTM – Oscillatory cylinder method – fabric abrasion resistance
Fatalities & Damages

- Airbag can injure or kill
- Condition is more severe when seat belts are not worn
- Injuries such as abrasion of the skin, hearing damage from the extremely loud 165-175 dB deployment explosion, head injuries, eye damage, and broken nose, fingers, hands or arms, burns due to heat can occur as the airbag deploys.

- 3.3 million airbag deployments, 6,377 lives saved and countless injuries saved.

Safety precautions

- Rear most comfortable seating
- Slightly recline the back of your seat (10 inches from the steering)
- Point the airbag toward your chest
- Children 12 and under—Rear Seating for children (never in front).
Scope – The Future

- Different applications – aircraft seating to motorcycle helmets, wearable airbags
- Prospects
  - More economical
  - Lighter weight
- Improved sensors – ‘Smart’ – size and weight of the occupant, presence
- Side impact airbags – door panels – head/knee bolsters (energy absorbing pads) – complement airbags
- Rear seat airbags – consumer demand is not expected to be high
- Hybrid inflator – combination of inert gases and heat from propellant to significantly expand the gas – techno-economic
- Retrofit designs are on the pipeline
Thank You one and all

Your Thoughts!

and Queries?