THE NEW STEEL TANK
— INNOVATIVE AND FUNCTIONAL

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Program Manager
Strategic Alliance for Steel Fuel Tanks (SASFT)
• Yesterday’s steel fuel tank
• Drivers for change
• Today’s steel fuel tank
  — Innovative
    ▪ Complex shape / design flexibility
    ▪ Durable steel systems
    ▪ Optimum fuel capacity
  — Economically viable
    ▪ Cost competitive and available
    ▪ Environmentally friendly
• Summary – The “footprint” of today’s steel tank
YESTERDAY’S STEEL FUELTANK

Characteristics:

- Simple shapes
- Large flange
  - 2D weld seam
  - Large radii
- Steel:
  - Terne coated
  - Low carbon
  - Wall thickness: > 1 mm
AUTOMOTIVE REQUIREMENTS

- Design flexibility – more complex shapes
  - Packaging restrictions
  - Driveshaft on AWD and RWD vehicles demands “saddle” shape tanks
- Increased durability
  - 15 years or 150,000 miles
  - External corrosion resistance
  - Internal resistance to various fuels
- Increased range/tank of gasoline
  - Volume/capacity
- Commercial issues:
  - Cost competitiveness
  - Availability/supply infrastructure
CHARACTERISTICS THAT NOW MEET TODAY’S REQUIREMENTS

- **Complex shape**
  - Facilitates packaging
  - Optimizes fuel capacity

- **Regulatory requirements**
  - Durability > 15 years
    - Multiple steel systems available
  - Low evaporative emissions
    - Inherent impermeability of steel

- **Customer/market requirements**
  - Lighter weight – wall thicknesses < 1.0 mm
  - High rigidity for shape stability
  - Resistance to broad range of fuels
    - Gasoline, flex fuels, diesel blends
  - Environmentally friendly
    - Material of choice for PZEV
    - Fully recyclable
TODAY’S STEEL FUEL TANK
COMPLEX SHAPE

Ford Mustang

Mercedes Benz
ENABLERS FOR COMPLEX SHAPE

- Improved formability

OLD STEELS
DQ/DQSK
(0.03 to 0.06 C)

NEW STEELS
IF
(< 0.005 C)

EXCELLENT DEEP DRAWING
STRETCHING & FLANGING

AUSTENITIC AND
FERRITIC STEELS

FORMING SIMULATION

COMPLEX SHAPED TANKS

TODAY’S STEEL FUEL TANK
COMPLEX SHAPE
ENABLERS FOR COMPLEX SHAPE (continued)

- Improved seam welding techniques

- Increased versatility
WIDE CHOICE OF STEEL ‘SYSTEMS’

- **Pre-painted steels (10μ epoxy films) over:**
  - Low carbon steels with various metallic coatings (and limited post painting)
    - EG Zinc – Nickel
    - HD Galvannealed
    - HD Aluminized

- **Post-painted steels (up to 300μ PVC-type coatings) over:**
  - Low carbon steels with various metallic coatings
    - HD Aluminized
    - HD Tin – Zinc
  - Stainless steels

- **Uncoated steels stainless steels**

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ALL DURABLE FOR BEYOND 15 YEARS

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www.autosteel.org
ALL STEEL SYSTEMS
– COMPATIBLE WITH DIFFERENT FUELS

• Gasoline

• Flexible fuels
  — Ethanol contents up to 85% (E85)

• Diesel fuels
  — High temperatures
    • durability is maintained
    • no sag or distortion
  — Cooling of fuel aided by the high conductivity of steel
  — Aggressive diesel fuels in North America
    • posing problems for a wide range of fuel system materials
    • new steel approaches being addressed
**TODAY’S STEEL FUEL TANK MAXIMUM FUEL CAPACITY**

**THREE CONTRIBUTING FACTORS**

*Volume Effects of Steel versus Plastic Shells*

<table>
<thead>
<tr>
<th>Example</th>
<th>Description</th>
<th>Additional Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Wall thickness of 0.8 to 1.0 mm compared to a thickness of 5 to 7 mm for a plastic tank</td>
<td><strong>Average Tank Surface 1.5 m²:</strong></td>
<td>+ 7.5 liters</td>
</tr>
<tr>
<td>• Reduced clearance with surrounding parts due to the absence of swelling</td>
<td><strong>Calculated Seam length 4m:</strong></td>
<td>+ 2.4 liters</td>
</tr>
<tr>
<td>• Optimized volume due to internal packaging of components, fuel and vapour lines</td>
<td><strong>Estimate:</strong></td>
<td>+ 1.5 liters</td>
</tr>
<tr>
<td>• Volume loss due to packaging constraints</td>
<td><strong>Estimate:</strong></td>
<td>- 4.0 liters</td>
</tr>
</tbody>
</table>

**Net Volume Advantage:** 7.4 liters
TODAY’S STEEL FUEL TANK
MAXIMUM FUEL CAPACITY

THREE CONTRIBUTING FACTORS

*Volume effects related to rigidity*

Plastic tanks — “stand-offs”—detract from fuel capacity

“Stand-offs”

NO “STAND-OFFS” IN RIGID STEEL TANKS — VALUABLE SPACE SAVED FOR FUEL
THREE CONTRIBUTING FACTORS

New welding technologies/joint designs

- enable smaller flanges and better use of engineering space

Conventional seam weld flange

Plasma or MIG weld - reduced flange

INCREASED FUEL CAPACITY: ~ 5-15%
Tank Joining Technology / Plasma Welding

Tesma has developed a more advanced tank joining technology, by applying and industrialising the Plasma Welding Technology into the fuel system market.

Advantages

- Optimized Tank volume due to small welding flange
- Complex 3D weld seam with narrow concave shape feasible
- Low energy input
- Low investment

Courtesy:
Dr. G. Pozgainer
(Magna Steyr)
REDUCED FLANGES — OPTIMIZE FUEL CAPACITY

Small flanges produced by plasma & MIG welding

Audi A8

BMW 3 series
REDUCED FLANGES — OPTIMIZE FUEL CAPACITY

SASFT Developmental fuel tank

Overlap joint design

JOINT DESIGN/WELD PROCESS OPTIMIZATION CONTINUING
Increased technical/performance requirements of fuel tanks are increasing the cost competitiveness of steel tanks.

- **PLASTIC TANKS**
  - Monolayer plastic tanks
  - Multilayer (LEV II)
  - Multilayer PZEV

**Increased competitiveness of steel tanks**
TODAY’S STEEL FUEL TANK SUPPLY INFRASTRUCTURE

INDEPENDENT STEEL TANK MANUFACTURERS – SASFT MEMBERS

Americas/Europe

Asia

GLOBAL SUPPLY INFRASTRUCTURE
Steel Fuel Tanks — the choice for PZEV

Steel Fuel Tanks . . . the choice for PZEV vehicles

California Air Resources Board:

- Certified gasoline PZEV models
  - 14 in 2003
  - 23 in 2004
  - 29 in 2005
  - 40 in 2006

<table>
<thead>
<tr>
<th>Company</th>
<th>Model Year</th>
<th>Model Name/Type</th>
<th>Emission Rating</th>
<th>Tank Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford</td>
<td>2005</td>
<td>Escape - Hybrid - 2WD, 4WD</td>
<td>ATPZEV</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>Focus - Wagon - 2X3/2X4/2X5</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>Fusion</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
<tr>
<td>DaimlerChrysler</td>
<td>2004</td>
<td>Sebring - Sedan</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>Stratus - Sedan</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>325C1 - Coupe</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>3251 - Sedan</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2005</td>
<td>3251 - Wagon</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
<tr>
<td>Toyota</td>
<td>2004</td>
<td>Civic - Hybrid</td>
<td>ATPZEV</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>Accord - EX/LX Sedan</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2004</td>
<td>Elantra - GLS &amp; GT</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2005</td>
<td>Spectra - 2.0L</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2004</td>
<td>Mazda 3 - 2.0L/2.3L</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>Mazda 6 - 2.3L</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2006</td>
<td>Tribute HEV 4WD</td>
<td>ATPZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2005</td>
<td>E350 - 3.5L</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2006</td>
<td>Mariner HEV 4WD</td>
<td>ATPZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2005</td>
<td>Galant DE &amp; ES2.4L</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td>Nissan</td>
<td>2004</td>
<td>Altima 2.5, 2.55, 2.55L</td>
<td>PZEV</td>
<td>Steel</td>
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<td>2004</td>
<td>Sentra 1.8, 1.85</td>
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<td>2004</td>
<td>Legacy 2.5 GT Sedan</td>
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<td>2004</td>
<td>Legacy 2.5 GT Wagon</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2004</td>
<td>Legacy L Sedan/Wagon</td>
<td>PZEV</td>
<td>Steel</td>
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<td></td>
<td>2004</td>
<td>Outback Ltd Sedan/Wagon</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td>Toyota</td>
<td>2004</td>
<td>Camry LE, SE or XLE</td>
<td>PZEV</td>
<td>Steel</td>
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<tr>
<td></td>
<td>2004</td>
<td>Prius – Hybrid</td>
<td>ATPZEV</td>
<td>Steel/plastic bladder</td>
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<tr>
<td></td>
<td>2004</td>
<td>S60 2.4 Sedan</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>V70 2.4 Wagon</td>
<td>PZEV</td>
<td>Steel</td>
</tr>
</tbody>
</table>
TODAY’S STEEL FUEL TANK SUSTAINABLE

COMPARISON OF EOL FOR PLASTIC & STEEL FUEL TANKS
FULLY RECYCLABLE

Allows compliance to End Of Life (EOL) Regulations

The End Of Life (EOL) legislation of the European Union defines more stringent targets for recycling after utilization of the cars.

<table>
<thead>
<tr>
<th>Year</th>
<th>Recycling</th>
<th>Energy Recovery</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>80%</td>
<td>5%</td>
<td>15%</td>
</tr>
<tr>
<td>2015</td>
<td>95%</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Courtesy: Dr. G Pozgainer (Magna Steyr)

Reusing or recycling material reduces the amount of waste and conserves natural resources, while burning or disposing of waste consumes energy that could otherwise be used in production.
THE ‘FOOTPRINT’ OF TODAY’S STEEL FUEL TANK

- DURABILITY
- INNOVATION
- DESIGN FLEXIBILITY
- OPTIMUM FUEL CAPACITY

+ COST COMPETITIVE
- ECONOMIC ISSUES
- GLOBAL AVAILABILITY
- ENVIRO-FRIENDLY

THE ‘INNOVATIVE’ CHOICE FOR AUTOMAKERS