Innovative PPS Blow-Molded Air Duct for Turbocharged Diesel Engine

High Performance Polymers for Automotive Powertrain Applications

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Ticona Engineering Polymers
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Challenge to the Automotive Industry

Increasing Demands

- Impact on the environment
- Dependence on fossil fuels
- Assuring the viability of our business
One EU Solution…

Diesel Engine Technology

- TDI technology
- 30-35% more efficient than gasoline engine
- Improvements in fuel – ULSD, B5, B20
- [Since 2006] > 50% new EU car registrations were diesel powered

…Continues to Evolve

- Reducing complexity
- Reducing weight
- Reducing cost
Röchling and VW Golf TDI

Product Challenges to Charge Air Duct Design

**Product**
- Reducing weight
- Reducing cost

**Performance**
- New "system" demands from turbocharger
  - Increase in charge air pressure: > 2 bar (29 psi)
  - Increase in charge air temperature: > 200°C
Test Conditions for Charge Air Duct

Pressure Pulsation Test According to VW

- Temperature of ambient air: 125°C ± 5°C
- Long-term test
  - Temperature of test medium: 205°C ± 5°C
  - Pressure pulsation test at: 1.2 bar ± 1.1 bar (over pressure)
  - Number of pressure cycles: 1,000,000 cycles
- Short-term test
  - Temperature of test medium: 230°C ± 5°C
  - Pressure pulsation test at: 1.4 bar ± 1.3 bar (over pressure)
  - Number of pressure cycles: 100,000 cycles
Airflow Through a Turbocharged Engine

1 – Intake air
2 – Clean air
3 – Charge air duct (hot side)
4 – Charge air duct (cold side)

A – Air filter
B – Turbo charger
C – Charge air cooler
Charge Air Duct – Design Challenges

1. Blowmolding charge air duct

2. Bracket material, and attachment

3. Coupling system (rubber hose)
Design Solution…

Re-design of VW Golf Charge Air Duct (hot side)

- Replacing AL with Fortron® PPS
- Reduce cost through innovative processing techniques
  - optimizing process methodology
  - increased manufacturing efficiencies
- Improved bracket joints through in-mold processing technology
Material Solution…

PPS

- Innovative bonding process during PPS blow molding operation
- Design concept involved two different materials
- Ticona developed two PPS grades for application
- Result – Improved joint strength between the brackets and the blow molded air duct
Fortron® PPS Properties

- Continuous service temperature up to 240°C
- Very good dimensional stability
- Inherent flame resistance
- Excellent resistance to automotive “chemicals” (i.e., fuels, coolants, UTH fluids, greases, etc.)
- High hardness and stiffness
- Extremely low creep behavior
- Low CLTE, comparable to aluminum
- Very low water absorption
- Ease of processing
Prior History – Fortron PPS and CAC

Charge Air Cooler Tank

Requirements:
- Replace aluminum
- Temperature resistance
- Pressure pulsation tests at 220°C over 500,000 cycles (overpressure max. 2.1 bar)
- Chemical resistance
- Sufficient toughness for crimping process

OEM: MAN
Prior History – Blow Molding Fortron PPS

- Linear PPS blow molding grade
- High melt strength
- Medium flow
- Excellent property profile
- Designed for automotive and general industry applications
Blow Molding with Fortron 1115L0

Drying

\[ T_{Dr} = 80 - 100°C / 3 - 4 \text{ h} \]

Cylinder Temperatures

Feeding: 120 - 180°C*
Cylinder: 290 – 310°C
Head: 280 – 300°C
Nozzle: 280 – 290°C

* Depends on design of feeding zone

Mold Wall Temperature: 140 - 150°C
Fortron 1115L0

Product Profile

- Linear PPS blow molding grade
- 15% glass fiber reinforced
- High melt strength
- Designed for standard blow molding as well as suction blow molding
- Excellent properties
- Weldable with all standard welding technologies
Key Design Challenge!
Joining Brackets to the Air Duct

1. Welding
2. “JectBonding™*” directly in blow molding tool
3. “JectBonding™*” in a second operation (with injection molding tool)

*patented by Röchling Automotive
Advantages of “JectBonding”
A New In-mold Assembly Process

JectBonding into the blow molding tool
- Improved adhesion - part has not cooled down
- No tool change necessary
- Shorter cycle times
- Improved appearance
- Robust process

Number of injection bondable elements is limited

JectBonding into a separate injection molding tool
- Excellent adhesion - surface of carrier part is partially melted
- High joint strength
- High degree of design freedom
- Significantly improved appearance

Additional injection molding tool necessary

Consistent Part Geometry, Scrap Reduction, Cost Savings
Röchling Charge Air Duct

OEM: VW

Materials: Fortron® 1115L0, and FX4330T7

- Passenger car diesel engines
- Suitable up to 230°C
- 30% weight reduction
- 25% cost savings
- First commercial PPS blow molding application in car series (VW Golf)
Special Acknowledgements

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Thank you for your attention

Questions?

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