DUAL-PHASE STEEL APPLICATION FOR HIGH VENT BACKBONE WHEEL CONCEPTS

Presented by
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Agenda

- The High Vent Wheel Concept
- High Vent Products
- Concept Challenges
- Dual Phase Solution
- Summary
The Concept: Offer a Steel Wheel and Trim System With Competitive Appearance to a Cast Aluminum Wheel.
High Vent Wheel Products - The Concept

The Result: Multiple Stylings with a Single Tooled and Validated Steel Wheel.
High Vent Wheel Products - The Concept

The Result: A Steel Wheel System Virtually Indistinguishable from a Cast Wheel at a Trimmed Steel Wheel Price.
BENEFITS:

- 3D Styling with Trim Options
  - Largest Windows of any Steel Wheel
  - Spoked Cast Wheel Appearance
  - Deep Spoke Appearance Without Weight Penalty
  - Zero Draft Angle Appearance with Trim
  - Euro-flange Appearance With Standard Weights
- Increased Geometry / Trim Flexibility
- Lower Initial / Replacement Costs
- Reduced Brake Temperatures
- Reduced Wheel Validation Costs/Timing
High Vent Wheel Products

- Kuhl Wheel
  - Individual Spokes to Rim
  - Riveted Attachment

- Struktur Wheel
  - Full Ring Interface to Rim
  - Welded Attachment
Kuhl Wheel
Riveted
Construction
High Vent Wheel Products

Drop Well-Full Ring Construction (Struktur)
THE CHALLENGES:

- Fatigue Strength
  - Open Channel Spokes vs Toroidal Geometry
  - Large Windows

- Formability
  - Deep Channel Draw
  - Deep Hub Draw
  - Thinning in Critical Stress Locations
  - Complex Window Pierce
High Vent Wheel Products
Fatigue Strength and Formability

Conventional Steel Wheel
Toroidal Structure

Struktur Steel Wheel
Channel Structure

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High Vent Wheel Products
Fatigue Strength and Formability

Conventional Wheel Disc Section

Struktur Wheel Disc Section

Toroidal Radius

Channel Section
High Vent Wheel Products
Fatigue Strength and Formability

Varying Depth
Channel Section

Deep 3D Draw
Location – High
Fatigue Stresses
High Vent Wheel Products – Fatigue Strength

RESULTS: 4 - RESULTS
STRESS - MAX PRIN MN: 27461 MAX: 52100
FRAME OF REF: PART

ROTARY LOAD 3000 Nm

VALUE OPTION: ACTUAL SHELL SURFACE: TOP

32.2 KSI
52.1 KSI

VOLKSWAGEN BEETLE
15x6.5 STRUCTURE WHEEL
CURB SIDE STRESS
DISC .215" RIM .115"
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NOVEMBER 12, 2002

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High Vent Wheel Products – Fatigue Strength

RESULTS: 4 - RESULTS
STRESS - MAX PRIN MIN: 40741 MAX: 68146
FRAME OF REF: PART

ROTARY LOAD 3000 Nm

VALUE OPTION: ACTUAL
SHELL SURFACE BOTTOM

43.1 KSI

30.1 KSI

VOLKSWAGEN BEETLE
16x6.5 STRUCTURE WHEEL
BRAKE SIDE STRESS
DISC .215" RIM .115"
HAYES LEMMERZ INTL
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High Vent Wheel Products
Dual-Phase Steel Solution

The Dual Phase Steel Solution

- Improved Fatigue Strength
- Improved Formability
- Typical Material for Wheels in Europe
Dual Phase Attributes (DP550/600 vs SAE060YLF HSLA)

- Higher Fatigue Strength
  - Higher Base Tensile Strength
    (87 ksi min. vs 75 ksi min.)
  - Greater Work Hardening
  - Paint Bake Hardening

- Formability
  - Lower Yield to Tensile Ratio
    (0.60 - 0.70 Typical vs 0.80 – 0.90)
Fatigue Life Comparison
Initial DP Evaluation – Conventional Wheels

Average Rotary Life Comparison - Dual Phase Steel
Saturn Drop Center Wheel

Dual Phase Supplier

 Rotary Life

Production - HSLA  DP Supplier #1  DP Supplier #2  DP Supplier #3  DP Supplier #4  DP Supplier #5  DP Supplier #6

0 50000 100000 150000 200000 250000 300000
Fatigue Life Comparison

Fatigue Life Evaluation – High Vent Wheels

16x7 5 Spoke Kuhl Wheel - Woehler Diagram
Rotary Bending Test

Rotary Moment (Nm)

Rotary Life (Cycles)

SAE060YLF HSLA Results Cycles
DP600 Results - Supplier #5
Log. (SAE060YLF HSLA Results Cycles)
Log. (DP600 Results - Supplier #5)
Dual Phase Concerns

- Cosmetics
  - Higher Si Chemistries ("Tiger Stripes")
    (Require Low Si/High Cr Chemistry)
- Formability
  - Higher Work Hardening (n-values)
    (Redesign Die Operations – More Forming Up Front)
- Production Consistency
  - DP Property Heat to Heat Variation
- Availability in North America of Low Si Version
High Vent Wheel Products – Other Solutions

Other Steel Solutions

- Stretch Flange (Bainitic Grade) Steel
  - Trials Scheduled

- TRIP Steels
Summary – High Vent Steel Wheels

- Provide an Alternative to Cast Wheels
  - Competitive Styling / Lower Cost
    (Removable or Permanent Trim)
  - Reduced OEM Validation Testing
- Utilizes Current Manufacturing Equipment
- Provide a Market for Hot Rolled Dual Phase Steel
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