Adhesive solutions for electric drive systems and power electronics

Erwin Rauh – Business Development Manager
e-Mobility & Powertrain
Serving the Automotive Industry
Trends & Future Mobility Concepts

**e-Mobility**
Assembly, Protection and Integration of batteries and electronic components

**Lightweight Design**
New architecture designs required to reduce weight and increase safety
Serving the Automotive Industry
Henkel e-Mobility Solutions

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<th>Focus Today:</th>
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<td>Power Generation / e-Drive</td>
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<tr>
<td>Power Conversion</td>
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<tr>
<td>Power Storage / Battery</td>
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</table>
Henkel e-Mobility Solutions
Systematic approach for Electric Vehicles

**Power Storage / Battery**
- Battery Cell
- Battery Module
- Battery Pack
- Battery Control Module
- 48 V for Mild Hybrid

**Power Generation / e-Drive**
- Electric Drive System
- Starter Generator for Mild Hybrid

**Power Conversion**
- Converter / Inverter
- DC/DC Converter
- Charging Module
- Onboard Charger

Broad technology portfolio for different components
Henkel e-Mobility Solutions for EV e-Drive Systems

Key challenges include:

**Material & Processing cost**
- Short cycle times
- Automated production process

**Lifetime Performance**
- Temperature resistance
- Serviceability

**Safety and Reliability**
- Thermal management
- Oil / ATF resistance

**Power Ratio Enhancement**
- Thermal management of e-motor
- Electrical insulation performance
Simplified Processing
- Long open time
- Automated processing
- Single and dual component materials

Formed-in-Place
Benefits
Cured-in-place

Lower Cost
- 4-5 times less expensive than molded gaskets
- Relaxed machining requirements
- Inventory reduction

Increased Reliability
- Seals surface imperfections
- True metal to metal design
-Eliminates gasket relaxation

Henkel e-Mobility Solutions
Liquid Gasketing Benefit
Polyacrylates – New High Performance Liquid Gaskets

Performance

Greener Technology

Gas permeation resistance is up to 10 times better than “market standard” silicone.

![Diagram showing gas permeation comparison between silicone and polyacrylate]

- Silicone
- Polyacrylate

Better sealants = Better cars = Better planet

Graz/Spielberg, May 9 to 10, 2019
Electrification & All-Wheel Drive Congress
Polyacrylates – New High Performance Liquid Gaskets

Performance

Polyacrylate Liquid Gaskets do not promote oil foaming!

Some rubber plasticizers and other extractable mix with fluid and can create foaming of the oil (e.g., Silicones)
Polyacrylates – New High Performance Liquid Gaskets
Comparison to Silicones in practice

**500 Hrs. 150°C, Castrol SAF-PD oil**

Solution for Aggressive Automatic Transmission and Axle Oil Additive Packages

<table>
<thead>
<tr>
<th>Dog Bones</th>
<th>Shear Strength</th>
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<tbody>
<tr>
<td>Henkel (Loctite) &amp; Competitive Silicones</td>
<td>Silicone Dissolved</td>
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<tr>
<td>Loctite 5820 Polyacrylate</td>
<td>99% Elongation at Break – Dogbones Still Intact</td>
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<td>1.5 MPa Shear Strength, Cohesive Failure</td>
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Electrification & All-Wheel Drive Congress
Polyacrylates – New High Performance Liquid Gaskets
Comparison to Silicones in practice

168 hours @ 150 °C in Castrol BOT 750 A

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500 hours @ 150 °C in Castrol BOT 750 A

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Polyacrylates – New High Performance Liquid Gaskets
Formed in Place - Features

- High elongation
- Seals non-machined flanges reliably
- Ability to combine multiple substrates
- Seals complex designs
- Seals joints with movements
**Polyacrylates – New High Performance Liquid Gaskets**

**Joint Design Considerations**

**Flexible flanges (elastomeric sealants)**

- Min. flange overlapping width 5 mm, around bolts 3 mm
- Chamfer width min. 2 mm, Radius corresponding – filled with sealant to compensate for micro movement by elongation
- Ensure correct flange alignment
- Surface characteristics
  - Ra 0.5 to 8 µm
  - Rz 5 to 90 µm
  - Rmax < 100 µm
- As cast surfaces possible
- Max. gap between mating surfaces <0.3 mm (instant seal test)
Polyacrylates – New High Performance Liquid Gaskets
Loctite AA 5820

**LOCTITE® AA 5820**
**Flange Sealant**

- First commercial liquid gasket based on polyacrylate (ACM) rubber in the Powertrain market
- Sealing of the electronic housing, compatible with the Gapfiller from Bergquist
- Non-corrosive, low odor, low volatility, no oil foaming

**Application Examples**

**General Benefits**

- Superior, long term resistance in axle and transmission fluids
- Superior oil resistance
- Flexible, joint movement tolerant
- 10x better hydrocarbon permeation resistance than other liquid gaskets
- Excellent adhesion to aluminum, cast iron, stamped steel and plastics
Polyacrylates – New High Performance Liquid Gaskets Cured In Place

Static gaskets

Solid gaskets

- Single Layer Steel (SLS)
- Multi-Layer Steel (MLS)
- Soft Gasket Material (SGM)
- Composite (COM)

Liquid gaskets

- Formed-In-Place (FIP)
- Cured-In-Place (CIP) (In Situ, Fast Gasket)
Polyacrylates – New High Performance Liquid Gaskets
Cured-In-Place Gasket Technology

CIPG: Cured-in-Place Liquid Gasket

A solution that allows you to dispense a compression gasket directly into parts with almost any bead profile. With virtually no knit line. Within seconds.

UV-CURE FOR HIGH PERFORMANCE COMPRESSION GASKETS

- Increased production efficiency
- Reduced manufacturing cost, complexity, inventory and scrap
- Significantly reduced knit line

Recommended products:
LOCTITE 5884™ (polyacrylate)
Polyacrylates – New High Performance Liquid Gaskets
Cured-In-Place Gasket Technology

- High precise bead tolerances (including overlapping): ±0.10mm
Polyacrylates – New High Performance Liquid Gaskets
Compression Gaskets - Introduction

- A system sealed by compression will be tight when the min compression will result in the min sealing force/pressure and the max compression won't exceed the elastomer's strain limit. Consequently, this leads to an optimal sealing compression range.

- Hence, the bead geometry is a very important characteristic of CIP gaskets. Height and width must be adjusted according specific guidelines to suit the application conditions and mating flanges.
Polyacrylates – New High Performance Liquid Gaskets
Features of Oil Resistant CIP Gasket Loctite AA 5884

- Long-Term resistance: Engine oil and ATF
- Temperature Range: -40°C to 150°C
- Compression Set (1000h aged in fluid): ≤ 55%
- Elongation (1000h aged in fluid): ≥ 150%

Improve the elastomeric component and compression resistance
Polyacrylates – New High Performance Liquid Gaskets
Joint Design Considerations

**Flange design:** Bolt force line

**Sealing verification:** Pressure sensitive film
Polyacrylates – New High Performance Liquid Gaskets
Cured-In-Place Gasket - Compression

Minimum required compression
- The minimum sealing force of a CIPG is at ≥15% compression and corresponds to a contact pressure of 1.5 MPa*.

Maximum allowed compression
- The maximum strain is achieved by 45% compression**.

* As the polymer chains rearrange to reduce the internal energy, or stored force, a loss of sealing force occurs (or stress relaxation).
** Max compression for Loctite 5884
Polyacrylates – New High Performance Liquid Gaskets
Cured-In-Place Gasket - Design guideline

> Henkel CIP Design Guideline:
Enables Excel calculations to ensure the right design

**Flange Design**

**Groove Design**

**Step Design**

A typical recommendation of surface finishing for CIPG is

- $Ra \in [3.2, 12.5] \, \mu m$
- $Rz < 35 \, \mu m$
- $R_{max} < 50 \, \mu m$

Moreover, the sealing surface must be free of nicks, burrs or scratches.
On the dispensing side, the surface must be also free of grease and oil.
Polyacrylates – New High Performance Liquid Gaskets
Loctite AA 5884

**LOCTITE AA 5884**

- With Loctite 5884, Henkel provides the automotive industry with a high performance liquid dispensed polyacrylate compression gasket which can be cured within seconds.
- Henkel’s dedicated technical resources provide assembly solutions on site to improve your product and productivity.

**Benefits**

- Improved process reliability
- Automatically pre-applied on part
- No tooling costs
- Fast process
- Adhesion to aluminum, cast iron, stamped steel and plastics for transportation

**Features**

- Excellent oil resistance (up to 8X better than silicone)
- 10X better hydrocarbon permeation resistance than other liquid gaskets
- Non corrosive
- Does not promote oil foaming unlike other sealants
Henkel e-Mobility Solutions
Key Applications for the E-Drive Value Chain

<table>
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<tr>
<th>E-Transmission</th>
<th>Electric Motor</th>
<th>Assembly &amp; Integration</th>
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<td>1 Magnet Bonding</td>
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<tr>
<td>2 Impregnation Service</td>
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<tr>
<td>3 Retaining</td>
<td>3 Thermal Potting</td>
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</table>

Comprehensive technology portfolio for large-scale E-Drive production
An electric transmission is a machine in an electric drive system, which provides controlled application of the power. The transmission refers simply to a gearbox that uses gears and gear trains to provide speed and torque conversions from a rotating power source to another device. The electric transmission is assembled into a electric drive system housing.

### Product recommendation

<table>
<thead>
<tr>
<th>Technology</th>
<th>Application Detail</th>
<th>Gasketing</th>
<th>Impregnation Service</th>
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<td>shaft-hub connection</td>
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Electric Motor E-Drive System

Definition
An electric motor is an electrical machine that converts electrical energy into mechanical energy. The electric motor runs with alternating current (AC). The motor is assembled into an electric drive system housing.

Product recommendation

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<td>Loctite AA 331</td>
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**Electric Drive Housing (Assembly & Integration)**

**E-Drive System**

**Definition**

The housing of an electric drive system is in general aluminum casted parts and includes the electric motor and transmission.

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<tr>
<td>Loctite 5188</td>
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Henkel e-Mobility Solutions
Key Applications for Power Conversion Components

Onboard Charger

1. Gap Filler/Pad
2. Thermal Potting
3. Thermal Adhesive

Inverter/Converter

4. Solder
2. Potting
3. Gap Filler/Pad
1. Gasketing

DC/DC Converter

1. Gasketing
2. Gap Filler/Gap Pad

Electric Pumps

2. Solder
1. Gasketing
5. Potting
4. Thermal Adhesive
3. Gap Filler/Gap Pad

Comprehensive technology portfolio for large-scale battery production
Electric Drive Management System
E-Drive System

**Definition**
A electric drive management system (EDMS) is any electronic system that manages the rotation of the motor shaft and the electric transmission to bring torque power on the axles.

An electric drive system is built together with one EDMS = Inverter / Converter.

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</tbody>
</table>
Electric Pumps
Power Conversion System

**Definition**

An electric pump is a pump which is powered by electricity, and used to force a liquid or gas to flow in a particular direction.

More and more electric pumps are used in Full hybrid and battery electric vehicle. The pumps are used for Thermo Management, so cooling, of batteries and interior heating ventilation.

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Henkel e-Mobility Solutions
Key Take-Aways

1. Long-lasting **Partnerships** with OEMs and Tier-1
2. Comprehensive application & process **Know-How**
3. Broad **Technology portfolio**
   - Conductive Coatings
   - Thermal Interface Material
   - Assembly Adhesives
   - Liquid Gasketing

> Partner with us to drive the future together!
THANK YOU!