Go the distance.

3M™ Silicon Nitride Fuel Pump Rollers

Improving engine performance and durability

- High strength and reliability
- Contact fatigue resistance
- High elastic modulus
- Light weight (60% lighter than steel)
- Tribological compatibility with metals (low coefficient of friction and excellent wear resistance)
In recent years, diesel engines have been increasingly subjected to higher fuel pressures and compressive loads as automotive manufacturers seek to meet stringent fuel economy and emissions standards. This industry trend places unprecedented stress on fuel pump rollers – and the commonly used steel components are failing early.

3M® Silicon Nitride Fuel Pump Rollers, manufactured by Ceradyne Inc., a 3M company, offer a more durable alternative to conventional rollers. These high-strength ceramic rollers are specially engineered to handle high contact stress levels in diesel fuel environments. 3M silicon nitride fuel pump rollers provide superior mechanical reliability at high speeds and loads – helping automotive OEMs meet the high pressures required to achieve emission standards.

Lightweight, high-strength ceramics
3M fuel pump rollers are made from 3M® Silicon Nitride 147-31N, a tough, lightweight ceramic material offering high stiffness and high Hertzian contact strength. 3M silicon nitride was selected for this application because – unlike metal and coated metal – it resists abrasion, helping extend component lifetime. At the same time, it allows the pumps to operate at higher pressure: 3M fuel pump rollers operate at contact stress levels of 1.1 to 1.6 GPa (160,000-230,000 psi), and the silicon nitride material can withstand Hertzian stresses up to 2.4 GPa (350,000 psi) or more.

Rolling contact fatigue behavior of 3M® Silicon Nitride 147-31N (Not for specification purposes)

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Stress (GPa)</th>
<th>Cycles (test time)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rig test production</td>
<td>1.1</td>
<td>2.45 x 10^6 (3000 hours)</td>
<td>Suspension, no failure</td>
</tr>
<tr>
<td>component</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rig test production</td>
<td>1.6</td>
<td>6.36 x 10^6 (2000 hours)</td>
<td>Suspension, no failure</td>
</tr>
<tr>
<td>component</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rig test production</td>
<td>1.5–2.4</td>
<td>6.3 x 10^7 (1000 hours)</td>
<td>Suspension, no failure</td>
</tr>
<tr>
<td>component</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCF machine</td>
<td>6.07</td>
<td>Characteristic Life 4.94 x 10^10 (95.7 hours)</td>
<td>Weibull Slope 1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCF machine</td>
<td>6.41</td>
<td>Characteristic Life 4.31 x 10^9 (83.3 hours)</td>
<td>Weibull Slope 1.2</td>
</tr>
</tbody>
</table>

3M silicon nitride also exhibits reduced friction when in contact with either cast iron or steel – allowing 3M fuel pump rollers to operate at higher speeds and stress levels with less lubrication than metal rollers.

Processing
3M silicon nitride materials and components are produced at fully dedicated manufacturing plants in the U.S. and Germany, using unique compositions and processing techniques. 3M silicon nitride 147-31N is processed by gas pressure sintering, which results in a fully dense and nonporous microstructure of interlocking needle-shaped grains. This, combined with the natural toughness of silicon nitride (with a fracture toughness of 6 MPam\(^{0.5}\)), provides outstanding contact fatigue resistance and mechanical reliability.

We use a patented grinding process and high-precision superfining and honing operations to machine OD/ID crown profiles on roller bearing elements. These grinding and crowning operations allow us to produce fully integrated silicon nitride replacements for steel counterparts.

Applications
Manufacturers around the world are successfully using 3M silicon nitride components in both oil lubricated and diesel fuel environments. 3M fuel pump rollers have provided solutions to specific problems in high-volume, heavy-duty diesel applications – such as high contact stresses combined with tribological wear, corrosion and lubrication problems.

Designed for common rail fuel pumps in both heavy- and light-duty diesel engines, 3M fuel pump rollers can help increase system capabilities and performance. They can be used to replace metal components in order to help resolve warranty problems with excessive wear, scuffing and galling. 3M silicon nitride has also proven to be a cost-effective alternative to metal components when the lifecycle cost of the system is taken into account.

Product is manufactured and sold by Ceradyne, Inc., a 3M company.

Warranty, Limited Remedy, and Disclaimer: Many factors beyond Ceradyne’s control and uniquely within user’s knowledge and control can affect the use and performance of a Ceradyne product in a particular application. User is solely responsible for evaluating the Ceradyne product and determining whether it is fit for a particular purpose and suitable for user’s method of application. User is solely responsible for evaluating third party intellectual property rights and for ensuring that user’s use of Ceradyne product in user’s product or process does not violate any third party intellectual property rights. Unless a different warranty is specifically stated in the applicable product literature or packaging insert, Ceradyne warrants that each Ceradyne product meets the applicable Ceradyne product specification at the time Ceradyne ships the product. CERADYNE MAKES NO OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OR CONDITION OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY IMPLIED WARRANTY OF NON-INFRINGEMENT OR ANY IMPLIED WARRANTY OR CONDITION ARISING OUT OF A COURSE OF DEALING, CUSTOM OR USAGE OF TRADE. If the Ceradyne product does not conform to this warranty, then the sole and exclusive remedy is, at Ceradyne’s option, replacement of the Ceradyne product or refund of the purchase price.

Limitation of Liability: Except where prohibited by law, Ceradyne will not be liable for any loss or damages arising from the Ceradyne product, whether direct, indirect, special, incidental or consequential, regardless of the legal theory asserted, including warranty, contract, negligence or strict liability.

Technical Information: Technical information, recommendations, and other statements contained in this document or provided by Ceradyne personnel are based on tests or experience that Ceradyne believes are reliable, but the accuracy or completeness of such information is not guaranteed. Such information is intended for persons with knowledge and technical skills sufficient to assess and apply their own informed judgment to the information. No license under any Ceradyne or third party intellectual property rights is granted or implied with this information.

© 3M 2015. All rights reserved.
Issued: 11/15 11147HB
98-0050-0038-9 Rev. B
3M is a trademark of 3M Company.
Used under license by 3M subsidiaries and affiliates.