



Fenlon Asta™, The Revolutionary Technology for:

Higher Bearing Performance



Greater Load-
**Bearing
Capacity**



**Extreme
Temperatures**

Through the combined efforts of Fenner chemists and engineers, customers, third-party researchers, and the expertise of the Michelin Group, Fenner Precision Polymers unveils the revolutionary new bearing liner; Fenlon Asta™. In this BearingNEWS exclusive, Mr. Michael J. Knight, Senior Product Manager, Technical Textiles, discusses the significance of this new development, the remarkable effort undertaken to achieve it, and its impact on the bearing industry.

Q: Can you tell us about your background and current role at Fenner Precision Polymers?

Education wise, I have a B.S. in Textile/ Polymer Chemistry from NC State University. Multiple years of experience in Fibers/ Polymers, Additives, Thermoset & Thermoplastic Resins, and the processes that go along with each of these to include extensive Composite material knowledge. As Product Manager at Fenner, I am responsible for the P&L and New Product Development for the Technical Textiles business at Fenner Precision Polymers.

Q: Which industries and applications are you mainly serving with Fenner Precision Polymers solutions?

The Technical Textile business at Fenner includes Fabri Cote™ elastomeric coatings business in Los Angeles, CA and the Fenlon™ Self-Lubricating Fabrics business in Manheim, PA. Focusing on the Fenlon™ business, these applications frequently include metal on metal contact, high vibrations, or extended stationary periods. Our fabrics are used in a wide variety of applications such as plain spherical, thrust, rod end, journal, and pendulum bushings & bearings, meeting the needs of the most demanding, critical applications from airplane landing gear to earthquake protection systems. With this, we are excited to introduce the new Fenlon Asta material for AS81820 Type A (100k+ cycles) certifications for Fixed Wing aircraft as well as AS81819 certs for Rotor Craft applications.

“Fenner is the most vertical producer of Low Friction Solid Lubricating fabrics, controlling the production inputs to deliver the highest quality products and solutions”

Q: Fenner Precision Polymers mentions three main advantages: Advanced Manufacturing, Customized Solutions and Materials Engineering. Can you provide more detail on this?

It takes, in short, a Technical Textiles expert with the most advanced manufacturing, production and testing capabilities and a history in the most demanding applications. A company with world-class materials engineering capabilities. We are the most vertical producer of these type of Low Friction Solid Lubricating fabrics and control the production inputs to deliver the highest quality products and solutions. We offer individual solutions designed specifically to meet the technical requirements of the application. We pride ourselves on having clear technology leadership in materials engineering and manufacturing.

Q: You mentioned that you have been working on the new self-lubricating bearing liner project for 3 years. Can you share more about the project?

Realizing there was a specific market requirement for the Type A (100k+ cycles)

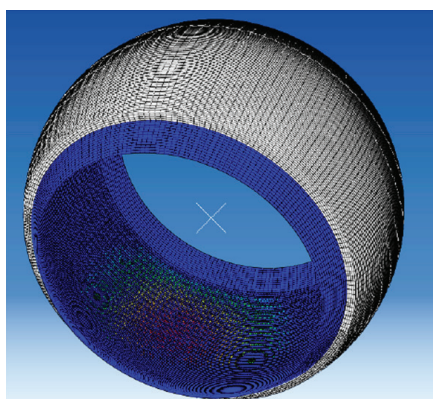
qualification under AS81820, we set forth a challenge to develop the Fenlon™ Asta to meet and surpass this challenge. As a Michelin Group Company, we were able to assemble a team of experienced and educated experts in the fields of Tribology, Finite Element Analysis and Material classifications to enhance our project success. Fenner was committed to finding a better way to meet this customer need. That meant the company not only had to develop and introduce a new high-performance liner that would meet the standard, but it also needed to create a laboratory test method that would replicate real performance for Fenlon customers. This method had to accurately predict wear profiles, coefficient of friction, and load capacity for each unique application. Fenlon Asta was three years well spent!

“Fenlon Asta is the answer for 250,000+ cycles, with the tightest tolerances possible...”

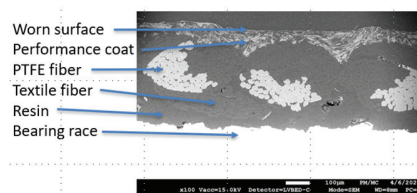


Q: What are Fenlon Asta Liners exactly? And how are they used in bearing applications?

Bearings are critical components in many aeronautics' applications, from landing gear and wheels to wings and other structural elements. One of the most vulnerable points in a bearing's structure is the location where the bearing's ball and race (or outer ring) come in contact. In the past, these surfaces, generally steel, were lubricated with greases and oils, which require frequent change-outs and replacement. Bearing manufacturers have now turned to low-friction, solid-lubricant fabric liners made of polytetrafluoroethylene (PTFE) that meet or surpass the performance of their liquid predecessors, without the constant maintenance and environmental impact of oils and greases.



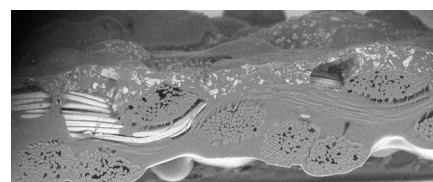
Q: What are the load and temperature tolerances for Fenlon Asta liners?



As the aeronautics industry is demanding more, they want their aircraft to go faster and have greater payload capacity. That puts greater pressure on aeronautics components suppliers. Thus, our customers need higher performance from their bearings. They will need to have greater load bearing capacity – up to 500 MPa. They will have to withstand wider temperature extremes, up to 482+ degrees. And, as per AS81820 Type A, they will need to be capable of reaching 100,000+ cycles, helping lower maintenance costs. In short, Fenlon Asta enables bearing products to test the limits of time and space. Go beyond where they've ever gone before and endure stresses and conditions that are totally new. To meet these demands, you need bearing liners that are not just innovative but something more. You need liners optimized for maximum bearing capacity, withstanding 250,000+ cycles, with the tightest tolerances possible...Fenlon Asta is the answer!

Q: How do Fenlon Asta liners reach beyond 100,000 cycles?

Of course our formulations and material science is proprietary...but I can expand on the Fenner advantage...It takes advanced material science not just to customize and manufacture state-of-the-art self-lubricating fabrics, but to specify, design, and fabricate them. We at Fenner Precision Polymers have advanced applications engineering expertise, including needs assessment and product design and development of finished materials. We have industry-leading manufacturing capabilities in weaving, warping, and coating fabrics and we have the widest range of yarns, fabrics, and resins, including PTFE, polyester, aramids, and fiberglass. We have state-of-the-art testing capabilities to ensure the finished materials meet your specifications. From resin development to lab testing and FEA testing to customer testing, the Fenlon Asta formulation consistently outperformed the other new formulations that Fenner considered addressing the most common complaint from customers working to achieve Type A qualification. The team, as a result,





— From resin development to lab, FEA, and customer testing, Fenner Precision Polymers applies state-of-the-art testing capabilities to ensure finished products meet customer specifications, including AS81820 Type A requirements.

met its goal of introducing a new bearing liner, Fenlon Asta, and developing a testing process that allowed Fenner to predict whether a specific liner would support a bearing manufacturer's goal of meeting AS81820 Type A requirements.

We provide a variety of Fenlon materials into exciting markets outside of the Aviation industry to include Automotive & Recreational Vehicles, Energy/Sound Dampening, Vibration/Noise reduction,

Seismic and Infrastructure to name a few. Fenlon Asta is being explored in some of these adjacent markets recently due to the improved and functional properties. New Product Development continues to be a pillar of the Michelin and Fenner -focused Strategy long term. Using the vertical manufacturing capabilities, technical knowledge and input from our global development team and the continued advancement of our material science capabilities, we are confident the Fenlon Asta project will not be the last... in fact we expect a new announcement soon for a completely different type of Fenlon product...more to follow!

Thank you very much for the time and opportunity to offer my passion and enthusiasm for Fenlon products, Fenner Precision Polymers and the Michelin Group capabilities to Bearing News. Respectfully, Michael J. Knight

Q: How can Fenlon Asta liners help bearing manufacturers achieve AS81820 Type A certification?

Not only do we expect to meet but exceed 100,000 cycles, reaching as many as 250,000 cycles in particular end-use applications. To develop an alternative product that would more consistently meet the 100,000-cycle requirement, the company launched this new product development project relying on the skills of Fenner chemists and researchers, design, and production engineers. It involved customers and third-party researchers and drew on the expertise of Fenner's corporate parent, the Michelin Group, with some activities taking place concurrently over the three-year period. By documenting proven tribological performance in our published Fenlon Asta White Paper, our customers can feel comfortable we have done our homework up front to make their qualification and validation more reliable and efficient.... Success!

Q: Lastly, how do you see the future of applications which require self-lubricating fabrics such as the Fenlon Asta Liners? What role will you and Fenner continue to play in creating these types of advancements for the bearing industry?



*Michael J. Knight,
Senior Product Manager,
Technical Textiles Fenner Precision Polymers*



Fenner Precision Polymers (FPP)

Michelin 3rd Party research unfolded through the various stages of development

FPP decided to introduce a bearing liner product which could fulfill the stringent AS81820 “Type A” requirements. However, without the ability to build bearings, FPP was reliant on customer or external testing which was difficult to coordinate. As a matter of fact, by the end of the project external testing completely disappeared from the market. Thus, it was necessary for FPP to develop its own capabilities to test bearing liners for durability.

Michelin has extensive experience with durability/abrasion testing to predict tire wear performance, as well as personnel who specialize in test method development. A first version of the wear test was developed using existing tribometers at Michelin. This “alpha version wear test” was used to rank 7 potential bearing liners. The 7 candidates

were then tested using a now-defunct external test at Rexnord. The alpha test successfully predicted the performance of 6 out of 7 liners, narrowly missing the last liner. The Michelin test was not completely successful, and it was decided that a larger machine better suited for the high pressures bearing liners experience should be installed at Fenner.

A project was initiated to purchase a larger tribometer for use at Fenner, and work is ongoing to transfer the Michelin bearing liner test method to the new machine and to complete the validation.

By finding a new application for Michelin’s extensive equipment/personnel capabilities in wear test development a new capability was developed for FPP. By creating an internal bearing liner wear test FPP will

be able to anticipate customer needs for diverse markets and applications.

What would have been lost without this collaboration?

Without combining the expertise of Michelin and FPP, the team would have had to design a wear method from scratch, which would have taken longer and could have yielded inferior results.

What specifically made the collaboration a key to the project’s success?

The key to the project’s success was combining Michelin’s expertise (test development, wear performance, finite element modelling, microscopy...) with FPP knowhow about bearing liner formulation and design.