Performance of Loctite® Anaerobic Sticks in Underwater Applications

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December 7, 2020

Abstract

Loctite® Anaerobic adhesives are used in a variety of industries and applications to increase the reliability of mechanical fasteners. However, there have always been applications, such as overhead, difficult to reach areas, and underwater locations, where the use of a liquid Anaerobic adhesive is not feasible. With the introduction of semi-solid Anaerobic stick adhesives, many of those limitations have been overcome, but there are still questions around feasibility of using an Anaerobic underwater. This study compares the torque measured in assemblies prepared and cured underwater to those prepared at standard laboratory conditions. The results show that Loctite® Anaerobic Sticks can be used and cured underwater for temporary patches until full maintenance can be performed out of water.

Introduction

Anaerobic adhesives are commonly used in both Original Equipment Manufacturing (OEM) and Maintenance, Repair, and Overhaul (MRO) applications. These products are used to increase reliability because of their ability to seal and bond, prevent corrosion, and unitize mechanical assemblies. These adhesives are available in many formulations to meet the requirements of threadlocking, thread sealing, flange sealing, and retaining applications.

Loctite® offers these Anaerobic adhesives in a variety of forms, ranging from liquids to semi-solid sticks. Traditional liquid Anaerobic adhesives are commonly chosen for their ability to wick into the bond area and ensure complete coverage. There are many unique applications where the liquid form of Anaerobic adhesives can be used. However, some applications are better suited for the semi-solid stick adhesives. With the introduction of this line of products, Loctite® Anaerobic adhesives may be used in applications that were not previously possible, such as difficult to reach, overhead, and underwater locations. This is because they allow for cleaner and convenient manual application.

This study will be focusing on the semi-solid sticks, referred to as Anaerobic sticks, specifically those designed for threadlocking applications (Loctite® 248™ and Loctite® 268™). It will also only focus on the ability to cure and achieve strength underwater. Long term reliability is not in the scope of this paper. The goal of this paper is to evaluate the performance of Loctite® Anaerobic sticks when applied and cured underwater.

Definitions

Anaerobic Adhesive: Adhesives that cure in the presence of active metal ions and the absence of air. Anaerobic products are also referred to as machinery adhesives.

Anaerobic Sticks: Anaerobic adhesives supplied in a wax-like semi-solid form, that are conveniently packaged in self-feeding stick applicators. In this study we have used Loctite® 248™, a medium strength threadlocker stick, and Loctite® 268™, a high strength threadlocker stick.

Unseated Assembly: Bonded fasteners that have not been torqued to a pre-determined specification.

Seated Assembly: Bonded fasteners that are torqued, according to fastener size and material, to a pre-determined specification.

Breakaway Torque: The torque required to break the bond between the nut and the bolt when rotating an unseated assembly.

Breakloose Torque: The torque required to initially decrease the axial load or break the bond in a seated assembly.

Standard Laboratory Conditions: Regulated temperature and humidity of an environment to 70±2°F and 50±10% relative humidity.

Analysis

Methods:

The fasteners were assembled "as-received" with no pre-cleaning or pre-treatment. For underwater tests, all parts and adhesives were soaked in room temperature water for a minimum of 24 hours prior to assembly and all assembly procedures were completed underwater. Bench top tests were completed at standard laboratory conditions.

The Anaerobic stick was applied to the bolt in sufficient quantity to completely cover an area equal to the height of the nut plus two threads and was also applied to the threads of the nut. The parts were then assembled using one of the following procedures:

- **Unseated Assemblies:** The nut was threaded onto the bolt by hand, allowing two coated threads to protrude. If indicated, the assembly was performed underwater.
- **Seated Assemblies:** The Anaerobic adhesive was smoothed into the threads with a gloved finger, perpendicular to the threads to ensure consistent coverage. A spacer sleeve (3/8" steel collar) was placed on the bolt and the nut was then threaded onto the bolt by hand until it struck the spacer sleeve. The assembly was pre-torqued to 40 N-m using a Snap-On® Versa-torq1 torque tester. If indicated, application and torquing was performed underwater.

All assemblies, both unseated and seated, were allowed to cure for 72 hours at standard laboratory conditions or underwater as indicated. After curing, breakaway and breakloose (as applicable) were found using a Snap-On® Versa-torq1 torque tester.

Materials:

Table 1: Adhesives Evaluated

Product	Product Description	Batch Number
Loctite® 248™	Blue, fluorescent, semi-solid, medium strength threadlocker stick	3HP224LA
Loctite® 268™	Red, fluorescent, semi-solid, high strength threadlocker stick	3HP373EA

Table 2: Test Specimens

Substrate	Thread Size
Zinc Phosphate Bolt	3/8"
Zinc Phosphate Nut	3/8"
Steel Collar Spacer Sleeve	3/8"

Results and Discussion

The tables and graphs below compare the breakaway and breakloose torque of assembles prepared at standard laboratory conditions and underwater conditions.

Data:

As seen in Table 3, the breakaway torque of unseated assemblies prepared with both Loctite® 248™ and Loctite® 268™ has a significant decrease in strength when prepared underwater. When using Loctite® 248™, the breakaway torque measured was, on average, 66% lower for assemblies prepared underwater compared to those prepared at standard laboratory conditions. When using Loctite® 268™, the breakaway torque measured was, on average, 32% lower for assemblies prepared underwater. During the preparation of these assemblies underwater, it was noted that the adhesive became hard and crumbled. As a result, some of the adhesive was forced out of the threads when the parts were assembled. It is believed that this contributed to the lower breakaway torque in combination with the water exposure.

Table 3: Average Breakaway Torque Results on Zinc Phosphate Nut and Bolt Assemblies [in.-lb.]		
Assembly Location	**Adhesive**	**Breakaway Torque [in.-lb.]**
Bench	Loctite® 248™	182.5
Underwater		61.7
Bench	Loctite® 268™	203.8
Underwater		138.6

As seen in Table 4, the breakloose torque of seated assemblies prepared with Loctite® 248™ and Loctite® 268™ also had lower strength when prepared underwater. However, the decrease in strength was not as high as the decrease found in unseated assemblies. On average, the breakloose torque measured for assemblies prepared underwater was 16% lower for Loctite® 248™ and only 6% lower for Loctite® 268™ when compared to assemblies prepared at standard laboratory conditions.

Due to the results found for the unseated assemblies, the Anaerobic stick adhesive was smoothed into the bolt threads prior to threading the nut onto the bolt for all seated assemblies. It is believed this change in preparation method, along with the pre-torquing of assemblies allowed for higher strength to be achieved underwater. In general, torquing assemblies to a pre-determine specification allows the adhesive to spread more uniformly in the threads. Having more even coverage allows for better adhesion to the surface of the fasteners and could contribute to the higher breakloose torque values.

Table 4: Average Breakloose Torque Results on Zinc Phosphate Nut and Bolt Assemblies [in.-lb.] Pre-Torqued to 40 N-m		
Assembly Location	**Adhesive**	**Breakloose Torque [in.-lb.]**
Bench	Loctite® 248™	381.0
Underwater		319.0
Bench	Loctite® 268™	396.2
Underwater		371.8

Overall, breakaway and breakloose torque of assemblies prepared underwater will be lower than the torque values found at standard laboratory conditions. However, in both preparation methods, the Anaerobic adhesive was able to cure and provide significant strength, which supports the application and use of these products in underwater locations.

Graphs:

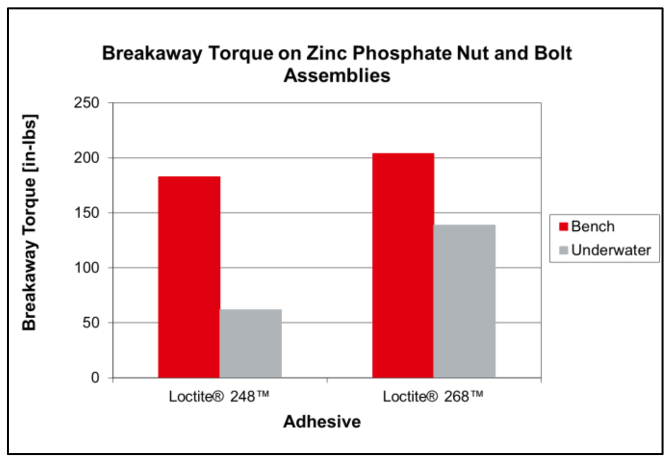

Figure 1: Breakaway Torque of unseated assemblies bonded with Loctite Anaerobic Threadlocker Sticks.

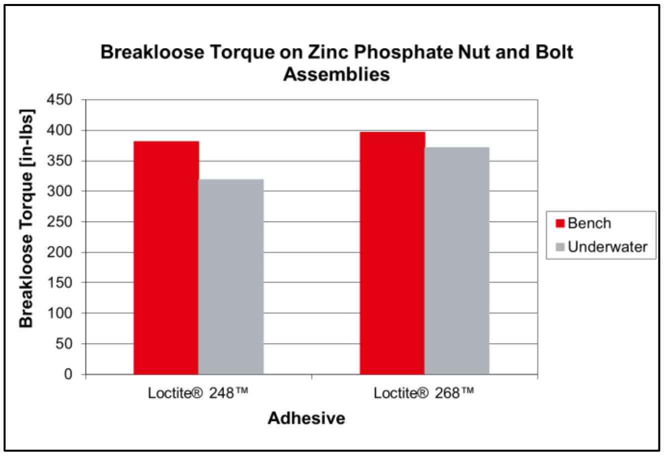

Figure 2: Breakloose Torque of pre-torqued assemblies bonded with Loctite Anaerobic Threadlocker Sticks.

Conclusions

Loctite® Anaerobic stick adhesives are commonly used for a variety of OEM and MRO applications. This study finds that their use in underwater applications will not yield the same strength as applications at or near standard laboratory conditions. However, the Anaerobic stick adhesives are able to cure and achieve significant strength at these non-ideal conditions. Additionally, techniques such as pre-torquing and smoothing the adhesive into the threads to allow the Anaerobic stick adhesive to be applied more uniformly and provide better coverage of the bond area could improve the final strength achieved.

As a result, these adhesives can be considered for underwater applications, but only be used as a temporary patch until full maintenance, out of water, can be performed. The results only show the strength developed after 72 hours of cure and water exposure. Extended underwater tests should be performed to determine the long term reliability of this solution as well as the effects of corrosion.

References

1. Loctite® How to Increase Reliability and Prevent Threaded Assembly Failure Manual, 2020.