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Solid Film Lubricants

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They are used in aircraft, brake systems, tanks, seat belts, weapons, ball joints, and fasteners

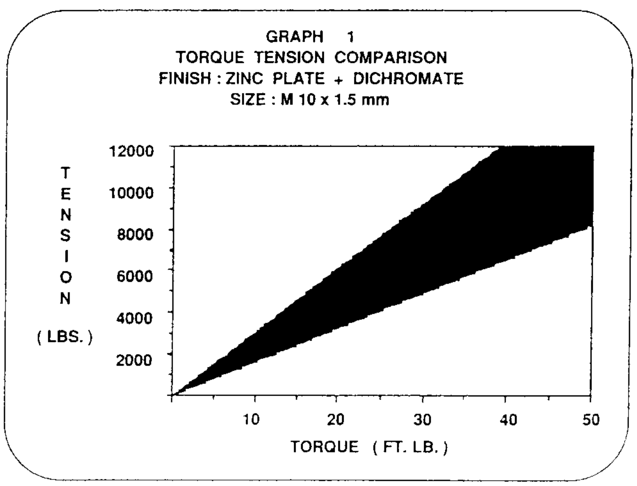
What are solid film lubricants?

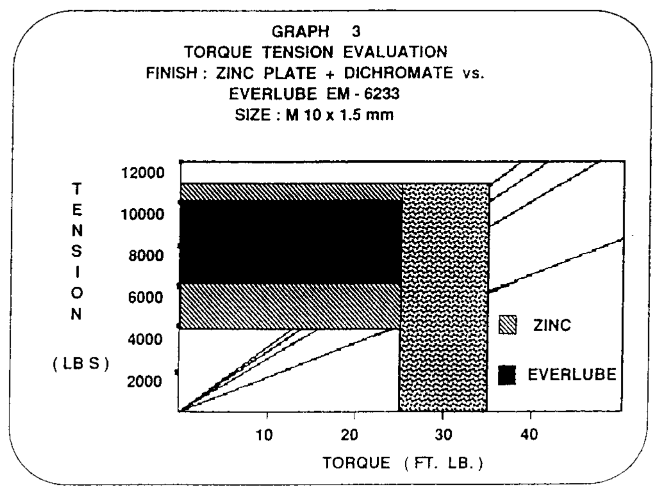
Solid film lubricants are dispersions of various lubricating solids in one of a number of various binder systems designed to reduce friction and prevent galling. When used as a fastener finish, these materials greatly reduce tension variability by as much as 70%.

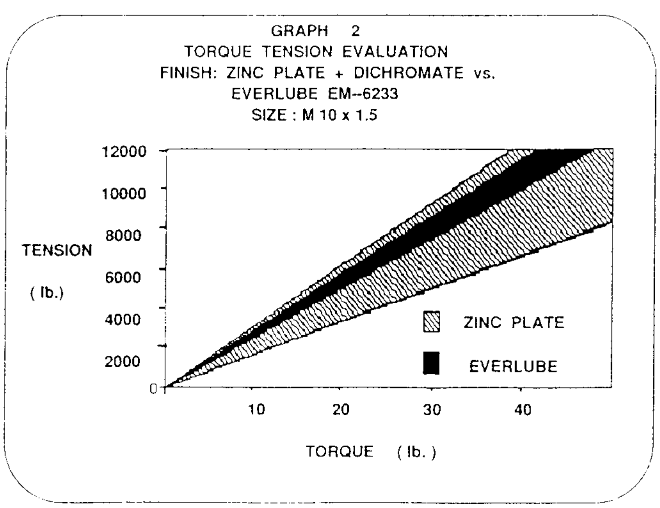
The typical lubricating solids used to achieve this characteristic are molybdenum disulfide, graphite, fluorcarbons, and other soft metals. The lubricating pigments do vary significantly in their performance depending upon the loading, surface speeds, and concentration. They work best when used in combination with each other.

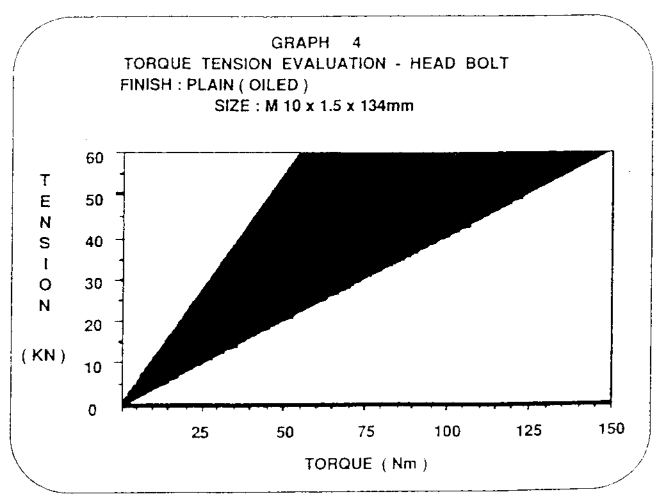
It is possible to blend these lubricating solids into a solid film lubricant to achieve a specific torque/tension range as you will see later. Currently we have available solid film lubricant coatings that will deliver K-factors as low as 0.10 on up through 0.19.

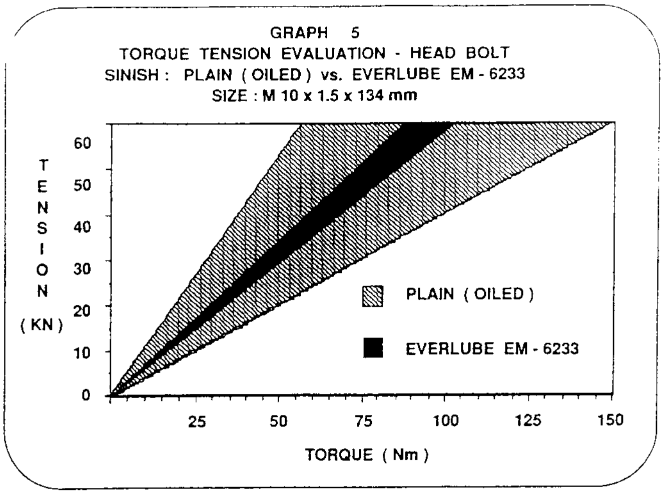
The first example of a lubricant's ability to reduce torque/tension variability and ultimately clamp load variability is shown in Graphs 1, 2, and 3. Graph 1 displays the typical 6 sigma range (scatter) that is to be expected when using zinc-plated fasteners (±30-35%). Graph 2 depicts the dramatic reduction in torque/tension variability through the use of a solid film lubricant,

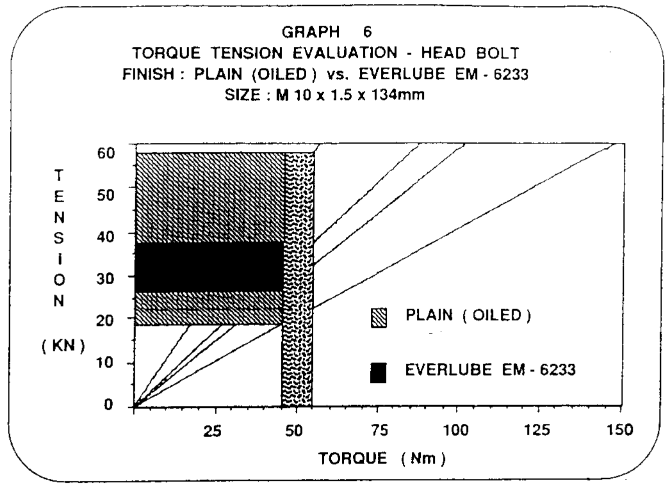












in this case Everlube EM-6233. This represents an 80% reduction in torque/tension variability. Graph 3 translates this reduction into a more meaningful result. We have arbitrarily selected a torque range of 25-35 ft-lb. By selecting ±3 sigma tension value at the min/max torque value for each finish, we are able to get a comparison of achievable tension ranges.

Instead of living with a tension variation of 7000 lb for zinc plate, we can reduce that variation 50% to only 3750 lb through the use of a solid film lubricant and who wouldn't like that?

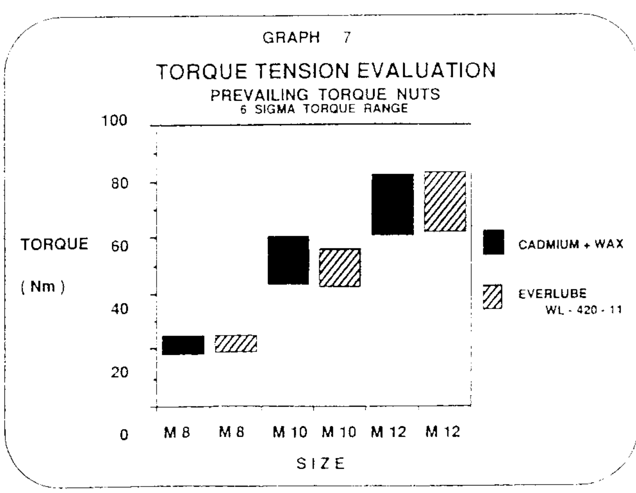
The next comparison involves engine head bolts, comparing plain (oiled) finished bolts with EM-6233 coated bolts. Graph 4 shows again the typical scatter to be expected (±30-35%).

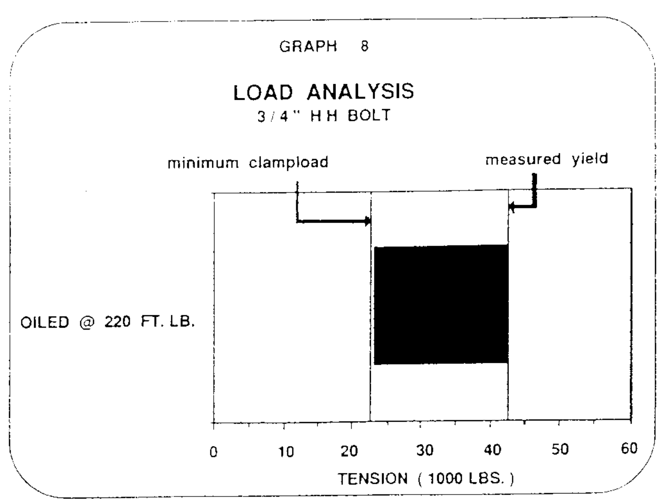
Graph 5 illustrates the overlay of solid film coated bolts. The solid film coated bolts show an 85% reduction in scatter. Graph 6 again translates this torque/tension variation to clamp load variability. As you can see with the oiled bolts, you could expect 9000 lbs variation in clamp load as compared to only 2500 lbs with the solid film lubricant coated bolts.

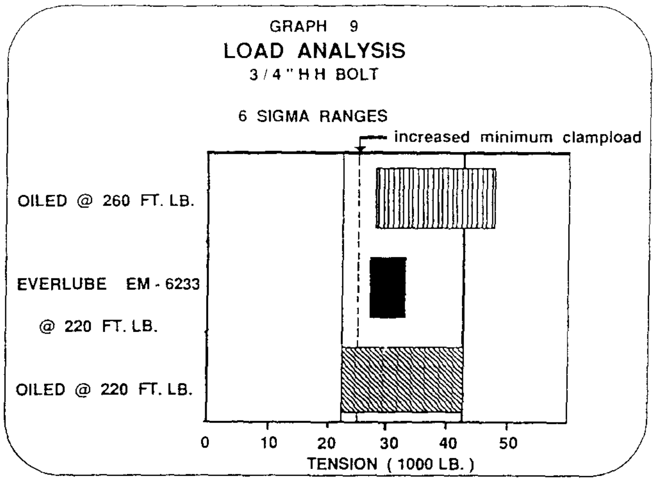
Which bolts would you rather have in your engine?

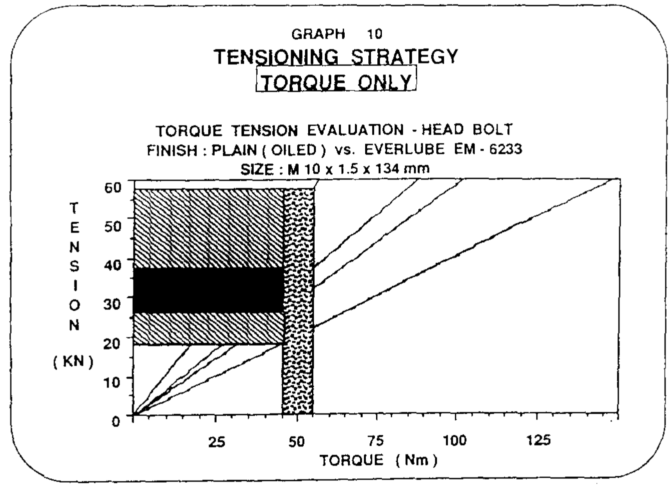
Graph 7 depicts a solution to the decade long search for a cadmium replacement. Here we are looking at the 6 sigma torque ranges for three sizes of all-metal prevailing torque locknuts at their respective clamp loads. I don't think you could get any closer to duplicating the torque/tension performance of cadmium.This data was based on a 20-piece sample. Several other tests have been run with this coating over different manufacturer's nuts and at different test labs. The results were all the same. Everlube WL-420-11 performed the same as cadmium.

This last series of graphs will show how you can design with solid film lubricants to make existing designs work under increased load requirements without the need for major design changes. Graph 8 depicts the current status of a









joint requirement. The minimum/maximum clamp load requirement is 22,500/42,500 lbs.

What happens when the load requirement go up?

The darkened area shows the 6 sigma tension capability of the current fastener/finish.

As is shown, the current situation is only marginally acceptable. What does the engineer do? Increase the torque? Increase the size of the fastener? Change the design? "NO" to all of the above. The easiest and most cost effective solution is to use a solid film lubricant. Graph 9 shows the current situation at the first level. Level 3 shows the effect of increasing torque. Level 2 shows the solution. By utilizing a solid film lubricant as the fastener finish, the manufacturer was able to easily achieve the increased minimum clamp load without exceeding the yield point. As a bonus, the reduced variability ensures joint integrity as compared to the original condition.

Data indicates that solid film lubricants do minimize clamp load variability. This is true regardless of which tensioning strategy you utilize. As demonstrated, it is certainly true in torque only applications (Graph 10).

In torque/angle applications (Graph 11), solid film lubricants reduce tension variability further still by reducing the variability at the point the angle of rotation begins. This ultimately shows up as reduced clamp load variability. Even in yield control applications (Graph 12), solid film lubricants help reduce variability because the sensing equipment can more easily anticipate the onset of yield. There is a more abrupt change in the slope of the curve when solid film lubricant coated bolts are used. In addition, you will realize increased clamp load by virtue of the reduced torsional windup.

These materials can be custom formulated to meet specific torque/tension requirements. They can be applied over phosphate or platings to achieve your most demanding corrosion-resistant goals as well. For more information contact the author.