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NUT FACTOR ANALYSIS OF ALUMINIUM IVD COATED AND CADMIUM ELECTROPLATED HIGH STRENGTH FASTENERS

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Abstract - *Fasteners are defined as machine elements that can be easily installed and removed with hand or power tools. Different types of fasteners are used in aerospace applications. For high strength fasteners, different types of coatings are used for improving surface protection and achieving desired mechanical and surface properties. Nut factor analysis of aluminium IVD and MOS2 coated fasteners and cadmium coated fasteners has been carried out using friction test. Fasteners made out of high strength alloy steel materials namely 35NCD16 is used in this study.*

Key Words: (Size 10 & Bold) Key word1, Key word2, Key word3, etc (Minimum 5 to 8 key words)…

1. INTRODUCTION

Fasteners are machine elements that can be easily installed and removed with hand or power tools. Screws, bolts, nuts and rivets are common types of fasteners. The terms bolts and screws do not refer to specific types of fasteners, but rather how they are used (i.e. the application). Selecting the right fastener material from the vast array of materials available is required and careful consideration may need to be given to strength, temperature, corrosion, vibration, fatigue and many other variables. There are three major steel fasteners used in industries: stainless steel, carbon steel, and alloy steel.

Most of the fasteners are coated with different kind of materials using different processes to improve their functional properties. Ion Vapor Deposition (IVD) is a physical vapor deposition process for applying pure aluminum coatings to various parts for corrosion protection. A vacuum vessel of various sizes, called an Ivadizer is used for coating process. Its useful service temperature limit is 925ºF. Cadmium is the most common aerospace fastener plating material. Plating is done by electro-deposition process. Since cadmium melts at 600ºF, its useful service temperature limit is 450ºF.

35NCD16 is a high strength low alloy mainly used in Shear bolt for light alloy structure of launch vehicles. 35NCD16 fasteners are classified into class II, based on the ultimate tensile strength (1250MPa).

In this paper nut factor analysis of aluminium IVD and MOS2 coated fasteners and cadmium coated fasteners is done using friction test. Friction test is conducted for each in Al. IVD and MOS2 coated fasteners & Cd plated fasteners. Aluminum IVD coated and Cadmium coated M14 bolts made of 35NCD16material is used for this study.

2. EXPERIMENTAL DETAILS

Friction test is conducted for each in Al. IVD and MOS2 coated fasteners & Cd plated fasteners. Nut factor computations done corresponding to preload steps of 50KN (39% YS), 77KN (60% YS), 86KN (67% YS) and 116 KN (75% UTS). Test sample details:

M14 x 1.5 x 33 L HSHCS – PS15760 -35NCD16 - Al. IVD & MOS2 coated

M14 x 1.5 x 33 L HSHCS – PS14012 -35NCD16 – Cd plated

2.1 Experimental setup for friction test

Generally 60% of YS is the design preload for M14 fasteners and the same works out to 77 KN. At present, these fasteners are applied with a torque of 144 Nm to achieve the desired preload. Hence torque tension tests were done with computation steps at 50 KN, 77 KN, 86 KN and 116 KN. The test setup is given in Fig1.The equipment has preload force transducer and the thread friction torque transducer fitted with strain gauges connected to a full Wheatstone bridge. The thread friction torque transducer is braced against the preload force transducer using an axial bearing, which allows the thread friction torque to be measured independently. The shaft of the torque/angle transducer is fitted with strain gauges, and the sensor signals and supply voltage are coupled via extremely low-wear slip rings. An incremental encoder disc with 360 apertures is also fitted to the transducer shaft for measurements of angle of rotation. Nut factor can be calculated using the equation:

T= K*F*D where
K = nut factor,
F= force / preload,
D= diameter of the fastener,
T= torque

Figure 1: Schatz Torque Tension Testing Machine

2.2 Results and discussion

Table 1 and 2 shows the results of friction for Aluminium IVD and MOS2 coated fasteners. Table 3 and 4 shows the results of friction for Cadmium plated fasteners.

Table 1. Friction test results of aluminium IVD and MOS2 coated fasteners

Sl no	Force			
	50KN		77KN	
	Torque Nm	Nut factor	Torque Nm	Nut factor
1	96.7	0.13809	135.58	0.12569
2	92.07	0.13148	130.74	0.12125
3	94.62	0.13512	124.54	0.1155
4	86.97	0.12419	111.17	0.10306
5	94.83	0.13542	124.54	0.1155
6	89.52	0.12778	121.42	0.11261
7	80.72	0.11522	117.21	0.10866
8			101.49	0.09412
9			111.43	0.1033
	Kmin	**0.11522**		**0.09412**
	Kmax	**0.13542**		**0.12569**
	Kaverage	**0.12961**		**0.11086**

Table 2. Friction test results of aluminium IVD and MOS2 coated fasteners

Sl no	Force			
	86KN		116KN	
	Torque Nm	Nut factor	Torque Nm	Nut factor
1	147.5	0.122521	185.12	0.11398
2	140.52	0.116684	166.8	0.1027
3	133.91	0.111195	168.73	0.10386
4	118.35	0.098274	141.56	0.08716
5	135.42	0.112384	178.31	0.10976
6	132.3	0.109858	169.93	0.1046
7	126.31	0.104848	160.3	0.0987
8	107.63	0.089342	129.96	0.08002
9	121.73	0.101081	160.98	0.09912
	Kmin	**0.089342**		**0.08002**
	Kmax	**0.122521**		**0.11398**
	Kaverage	**0.1073541**		**0.09999**

Average nut factor of aluminium IVD coated fastener = (0.12961+0.11086+0.1073541+0.09999)/4=0.111955

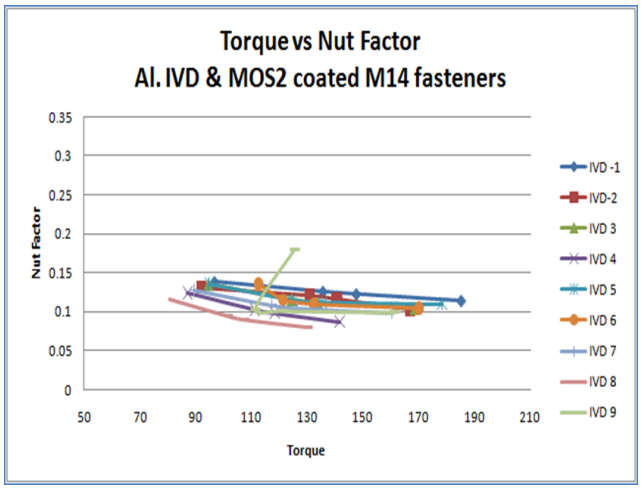

Chart 1. Torque vs nut factor - Al. IVD and MOS2 coated fasteners

Table 3. Friction test results of Cadmium plated fasteners

Sl no	Force			
	50KN		77KN	
	Torque Nm	Nut factor	Torque Nm	Nut factor
1	174.35	0.249022	259.24	0.240451
2	131.83	0.188291	213.24	0.197785
3	165.66	0.23661	261.01	0.24209
4	118.82	0.169709	181.9	0.168716
5	157.9	0.225526	244.82	0.227076
6	176.64	0.252292	262.46	0.243438
7	197.72	0.282401	296.55	0.275057
8	190.28	0.271774	296.87	0.275354
9	201.47	0.287757	295.88	0.274436
	Kmin	**0.169709**		**0.168716**
	Kmax	**0.287757**		**0.275354**
	Kaverage	**0.240376**		**0.238267**

Table 4. Friction test results of Cadmium plated fasteners

Sl no	Force			
	86KN		116KN	
	Torque Nm	Nut factor	Torque Nm	Nut factor
1	282.34	0.234474	344.95	0.212389
2	238.21	0.197826	301.6	0.185698
3	287.08	0.238328	349.12	0.214957
4	203.86	0.169299	273.24	0.168237
5	270.32	0.224492	337.98	0.208098
6	289.42	0.24027	362.23	0.22299
7	321.01	0.266589	384.72	0.236713
8	329.13	0.273332	402.41	0.247768
9	323.3	0.26849	396.01	0.243828
	Kmin	**0.169299**		**0.168237**
	Kmax	**0.273332**		**0.247768**
	Kaverage	**0.23478889**		**0.215630889**

Average nut factor of cadmium coated fastener = (0.240376+0.238267+0.2347889+0.215630889)/4=0.24

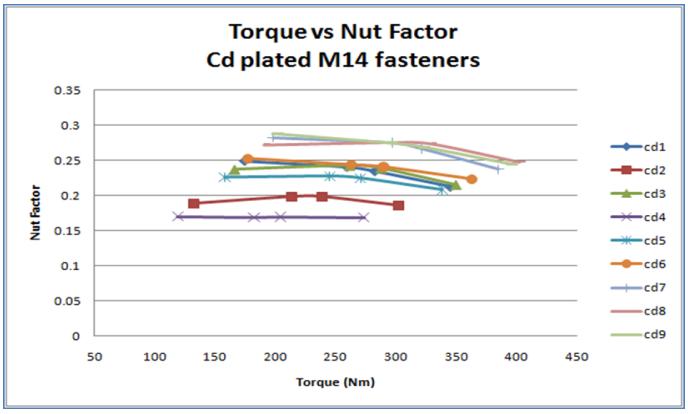

Chart 2. : Torque vs nut factor - cadmium coated fasteners

3. CONCLUSIONS

Friction test is conducted for each in Al. IVD and MOS2 coated fasteners & Cd plated M14 fasteners and nut factors for each step is calculated. Average nut factor of aluminium IVD and MOS2 coated fasteners and cadmium plated fasteners is calculated. Nut factor of fasteners varied with coating, threading tolerance, surface roughness, lubrication and material selection. . From the results it is found the average nut factor of Aluminium IVD and MOS2 coated fastener is lower than cadmium plated fastener.

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