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THE EFFECTS OF FLUOROPOLYMER COATED FASTENERS ON NUT FRICTION FACTORS

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ABSTRACT

Fluoropolymer-industrial coatings containing PTFE, also referred to by the tradename Xylan® 1424, are applied in a thin film to provide both lubrication and corrosion resistance. Fluoropolymer coated fasteners are manufactured by a multitude of companies with varying manufacturing practices, procedures, and quality metrics. Fluoropolymer coated fasteners are being considered by major power producers to be used in natural gas transmission lines for their advertised and expected low coefficient of friction properties in place of standard carbon steel fasteners with manually applied lubrication. While some research exists for the nut friction factor of smaller diameter fluoropolymer coated fasteners, this paper will provide empirically obtained data and analysis of the nut friction factors for larger diameter fasteners, up to 2-1/4", acquired from four different fluoropolymer coated fastener suppliers advertising equivalent fluoropolymer coating specifications and resulting performance. This study is a milestone to further understand the repeatability and quality of fluoropolymer coated fasteners as supplied from one manufacturer to another.

INTRODUCTION

Polytetrafluoroethylene, or PTFE, was developed in 1938 by the chemist Dr. Roy J. Plunkett. Although its creation was an accidental and unexpected polymerization of a frozen, compressed tetrafluoroethylene sample, the waxy solid proved to be the most slippery substance known to man in conjunction with being inert to virtually all chemicals. The combination of chemical inertness and a low coefficient of friction, specific to PTFE, resulted in this material being an excellent fluoropolymer-industrial coating for metallic fasteners as one if its many applications that span a wide spectrum.

There are multiple methodologies for applying fluoropolymer coatings to metallic surfaces that are practiced throughout the industry. This study focusses on four fluoropolymer coated fastener suppliers that advertise equivalent fluoropolymer coating manufacturing specifications. The tested ASTM A193 B7 alloy steel studs and corresponding ASTM A194 Grade 2H carbon steel heavy hex nuts, over-tapped by approximately 0.010" (0.254 mm) to allow for clearance, started the fluoropolymer coating process with a cleaning, degreasing, and light sand/grit blasting to ensure the surfaces are free of oils and other unwanted particulate that could adversely affect the fluoropolymer adhesion process to the substrate. The studs and nuts then had a zinc phosphate sacrificial under coat, or base coat, applied followed by the fluoropolymer dry film coating of two varying thicknesses: 0.6 – 1.0 mil (0.015 – 0.025 mm) for "Suppliers A, B, C", and 0.7 – 1.2 mil (0.018 – 0.030 mm) for "Supplier D". The studs and nuts were then dried and baked in ovens at temperatures ranging from 400°F – 450°F (204°C – 232°C) for proprietary cure times dependent on the stud and nut geometry and mass. The result of the manufacturing process can be seen in Image 1 below:

Image 1: 3/4" (19 mm), 1-1/2" (38 mm), 2-1/4" (57 mm) Fluoropolymer Coated Fasteners