
NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Materials Laboratory Division
Washington, D.C. 20594



May 4, 2016

MATERIALS LABORATORY FACTUAL REPORT

Report No. 16-034

A. ACCIDENT INFORMATION

Place : St. Thomas Virgin Islands
Date : September 7, 2015
Vehicle : M/V Carnival Liberty
NTSB No. : DCA15FM035
Investigator : [REDACTED]
NTSB OMS

[REDACTED]
USCG, MSD St. Thomas

B. COMPONENTS EXAMINED

Two bolts from fuel injection pump housing for diesel generator #4, cylinder 2 A

C. DETAILS OF THE EXAMINATION

Two bolts from fuel injection pump housing, as shown in Figures 1 and 2, were submitted to the Materials Laboratory for examination. One bolt was removed from the pump housing and the second bolt was found unattached from the housing, in a gallery where fuel/lube oil collects.

The bolts were submitted to 1) determine the presence of any tool marks or damage to the bolt threads; 2) determine the bolts were the appropriate type and material and 3) identify the material(s) found in the threads of both bolts.

The two bolts were visually examined using 20-200X zoom stereomicroscope. The attached bolt appeared to have some rotational wear on the crests of 3 of the threads (threads 11, 12 and 13, located 0.853 inch to 0.101 inch from the bottom of the bolt head). There was some foreign material inside the thread roots in approximately 10% of the thread root volume.

Using x-ray fluorescence (XRF), the bolt material was consistent with type 1215 carbon steel (UNS G12150). This is a resulfurized, rephosphorized steel. The bolt found detached from the manifold did not exhibit any wear on the thread crests. Most of the

thread root volume contained material with white and dark hues. Inspection using XRF found the bolt material to be consistent with type 1215 carbon steel.

The scrapings from the threads of both bolts were examined using Fourier-transform infrared spectroscopy (FTIR) with a diamond attenuated total reflectance (ATR) accessory in accordance to ASTM E1252-98 (American Society for Testing Materials E1252-98: *Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis and American Society for Testing Materials*). The spectrometer was used to collect and process infrared wavelength absorbance spectra of the unknown material.

The spectrum for the attached bolt scrapings contained spectral peaks that corresponded to particular functional groups found within the molecular structure of the unknown material. The presence of a broad spectral signature at $\sim 3340\text{ cm}^{-1}$ corresponds to an oxygen-hydrogen bond. A doublet peak at $\sim 2922\text{ cm}^{-1}$ and ~ 2852 corresponds to carbon-hydrogen stretching bonds. A strong single peak at $\sim 1735\text{ cm}^{-1}$ is indicative of a carbon-oxygen double bond. A single peak at $\sim 1594\text{ cm}^{-1}$ is indicative of a carbon-carbon double bond. A doublet at $\sim 1456\text{ cm}^{-1}$ and $\sim 1422\text{ cm}^{-1}$ is indicative of a carbon-hydrogen (2) bending bond. A doublet at $\sim 1371\text{ cm}^{-1}$ and $\sim 1325\text{ cm}^{-1}$ is indicative of a carbon-hydrogen (3) bending bond. A single peak at $\sim 1031\text{ cm}^{-1}$ is indicative of carbon-oxygen stretching bond. These signatures indicate that the material contains a methacrylate. A spectral library search was done on the attached scraping sample spectrum. No strong matches were found but several spectra of adhesives and thread locking compounds were found to have several significant similarities. Based on the visual examination of the attached bolt thread material spectrum and similarities to the known materials, the material found in the attached bolt threads is consistent with some type of thread locking compound.

The spectrum for the unattached bolt scrapings contained spectral peaks that corresponded to particular functional groups found within the molecular structure of the unknown material. The presence of a broad spectral signature at $\sim 3345\text{ cm}^{-1}$ corresponds to an oxygen-hydrogen bond. A doublet peak at $\sim 2921\text{ cm}^{-1}$ and ~ 2852 corresponds to carbon-hydrogen stretching bonds. A single peak at $\sim 1599\text{ cm}^{-1}$ is indicative of a carbon-carbon double bond. A weak peak at $\sim 1456\text{ cm}^{-1}$ can be indicative of a carbon-hydrogen (2) bending bond. A weak peak at $\sim 1376\text{ cm}^{-1}$ and can be indicative of a carbon-hydrogen (3) bending bond. A single peak at $\sim 1085\text{ cm}^{-1}$ is indicative of carbon-oxygen stretching bond. These signatures indicate that the material in the unattached bolt threads is a straight chained aliphatic hydrocarbon. A spectral library search was done on the unattached scraping sample spectrum. No strong matches were found. The unknown spectrum contained many similarities to several types of hydrocarbon based materials including paints, adhesives, fuel and lubricants. Based on the location where the unattached bolt was found, the material in the threads could contain one or several of these materials.


Chemist



Figure 1. Fuel pump housing bolt found attached to housing.



Figure 2. Fuel pump housing bolt found unattached from housing.