

NATIONAL TRANSPORTATION SAFETY BOARD

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



February 21, 2017

MATERIALS LABORATORY FACTUAL REPORT

Report No. 17-020

A. ACCIDENT INFORMATION

Place : Austin, Pennsylvania
Date : October 16, 2017
Vehicle : Piper PA-28-161, C-GYSN
NTSB No. : ERA17FA017
Investigator : Timothy W. Monville, AS-ERA

B. COMPONENTS EXAMINED

Tempest engine-driven vacuum pump model AA3215CC.

C. DETAILS OF THE EXAMINATION

An overall view of the submitted vacuum pump is shown in figure 1. The flange at the drive end of the pump housing was fractured, and the shear coupling for the drive shaft was not recovered. The labels on the pump indicated it was a Tempest model AA3215CC dry air pump with serial number 07M222. According to aircraft maintenance logs, the pump was installed on May 13, 2015, and was stamped with Eaglerock Aviation work order number 3734. Flight records indicated the airframe had 10,723.4 hours time in service (TIS) at the time the pump was installed and had 11,555.8 hours TIS 5 days before the accident, a difference of 832.4 hours TIS.

The inlet tube for the vacuum pump was fractured where it intersected the housing. Fracture features on the inlet tube were rough and irregular, consistent with ductile overstress fracture. The outlet tube, indicated in figure 1, was intact and rotated when manipulated by hand forces. The outlet tube is shown in figure 2 partially unscrewed from the housing outlet hole. White material consistent with Teflon thread tape was observed on the threads. A sample of the thread tape was removed and analyzed using Fourier-transform infrared spectroscopy (FTIR). Results showed an FTIR spectrum consistent with Teflon.

The Operators Manual and Installation Instructions for Tempest AA3200, AA240, and AA400 series dry air pumps¹ was reviewed. The manual stated, "Teflon tape or other thread compound on threaded fittings or port threads may be ingested into the pump. These substances will bind up lubrication dust and cause FOD damage leading to failure."

¹ Downloaded on February 10, 2017 from tempestplus.com.

Two screws with heads at the outlet end of the housing hold the pump housing together. Intact blue torque seal paint was present on one of the screw heads. Intact blue torque seal paint was also present on the vane inspection port.

The pump was disassembled, and as it was disassembled, the vanes and corresponding vane slots in the rotor were sequentially numbered from 1 to 6 starting with an arbitrarily-selected vane. An overall view of the pump components after disassembly is shown in figure 3. The rotor was fracture into 6 relatively large pieces and many smaller pieces. The vanes were largely intact as shown in figure 3, but vanes 1 and 4 each had a small piece fractured from the outward face of the vane at the outlet end.

A piece of debris was noted on the interior of the housing near one of the air outlet holes, and a close view of the debris is shown in figure 4. The piece of debris was examined using FTIR, and the results showed a spectrum that was consistent with acrylonitrile butadiene styrene. No evidence of debris consistent with Teflon thread seal was observed.

The larger pieces of the rotor were carefully reassembled with mating fractures placed in close proximity and with vanes located in the slots. Next, the outward ends of the vanes 1, 2, and 6 with single cracks intersecting the base of the slots were each pushed away from the direction of rotation as if the core rotated relative to the outer edge of the vane and relative motion of the cracks was noted. After each vane was displaced, the rotor was reassembled before testing the next vane. The result of this displacement on vane 1 is shown in figure 5. Cracks intersecting the slots of vanes 1, 2, and 6 (see unlabeled arrows in figure 5) opened with a tensile crack opening displacement consistent with overstress fracture of the core material. Similar displacements of vanes 2 and 5 resulted in crack openings at the ends of the slot with shear displacements across the crack opening, which is not characteristic of possible fracture mechanisms for the core material. Cracks intersecting the ends of slots 4 and 5 had a crack branching pattern consistent with fracture initiating at the center hole of the rotor then branching to the ends of slots 4 and 5. The slot for vane 3 was intact.

The reassembled rotor and vanes were replaced into the housing, and the housing was reassembled with the screws for holding the housing together partly screwed back into place. The screw for the vane wear inspection port was removed. Vanes covered approximately 2/3 of the inspection port, indicating the vane wear was at a level allowed for continued service.

Matthew R. Fox
Senior Materials Engineer



Figure 1. Overall view of the submitted vacuum pump.



Figure 2. Close view of the outlet tube partially unscrewed from the housing. Teflon thread tape was present on the threads.

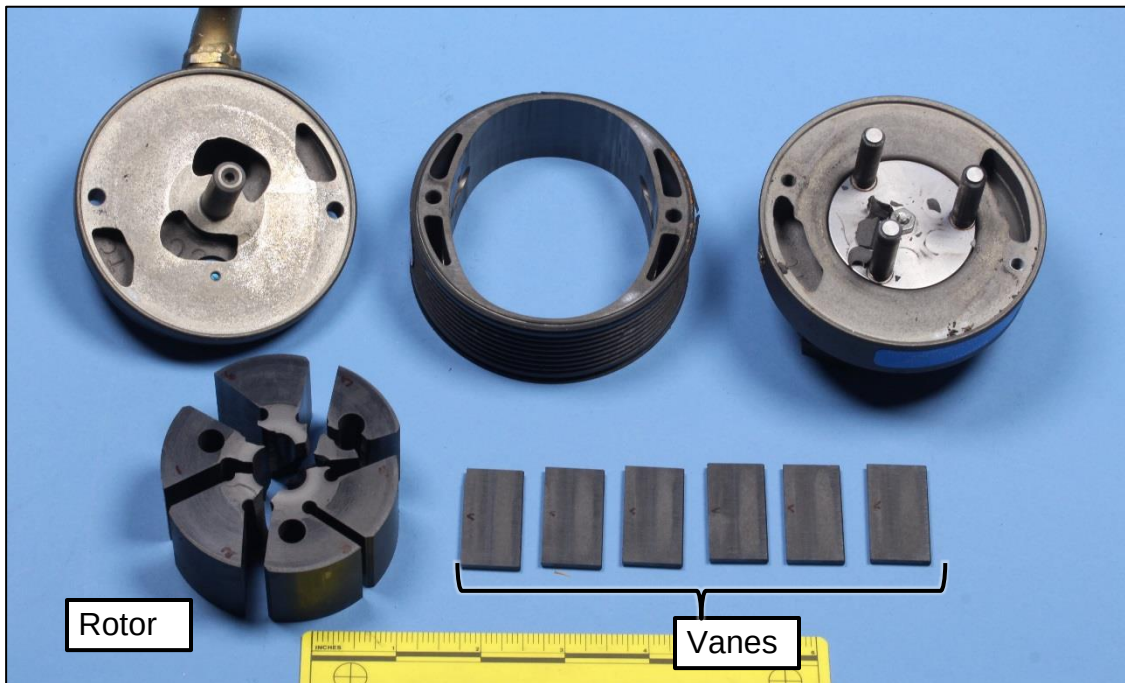


Figure 3. View of the pump components after disassembly.



Figure 4. Piece of debris observed on the interior of the pump housing near an air outlet hole.

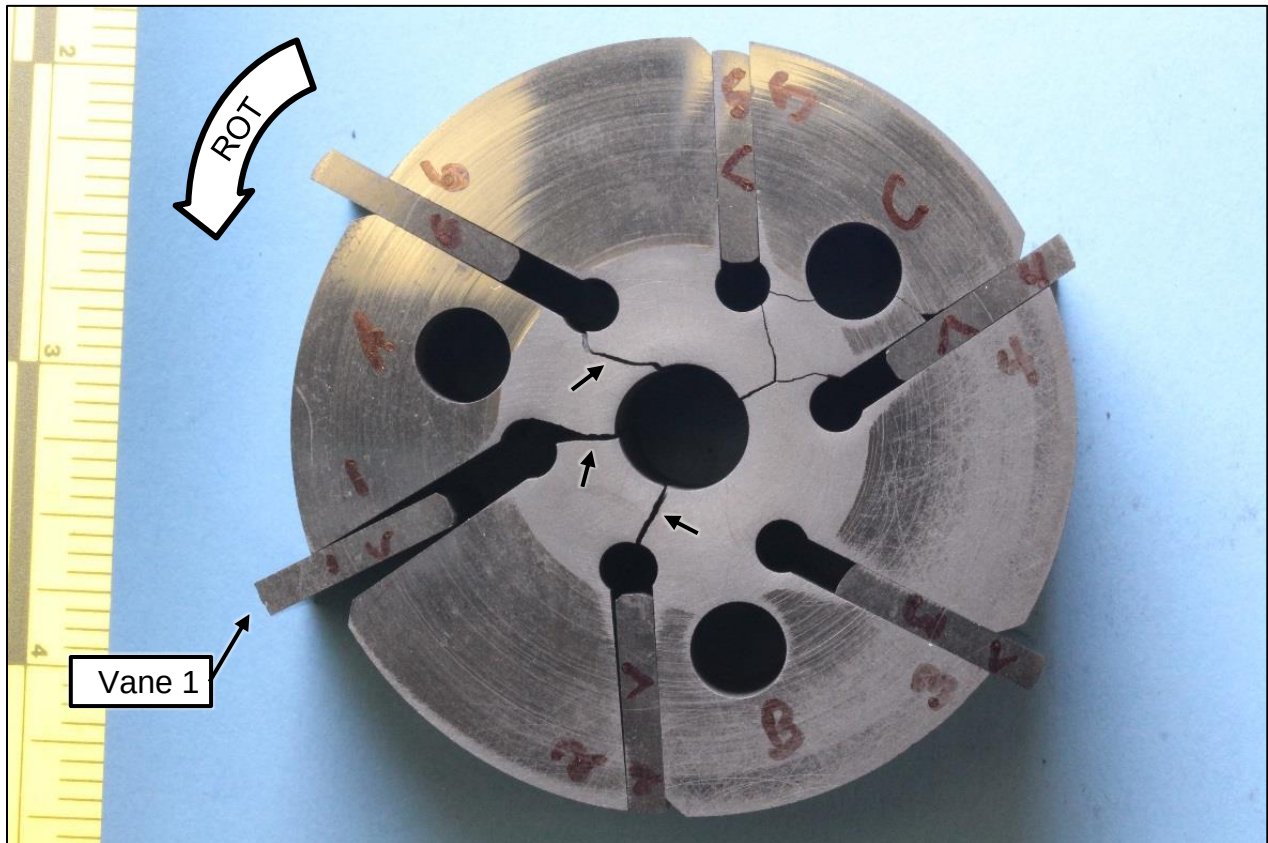


Figure 5. Close view of the fractured core with vanes numbered 1 to 6 starting with an arbitrarily-selected vane. Vane 1 is shown rotated slightly, leading to a tensile opening displacement of several of the fractures intersecting vane slots 1, 2, and 6 as indicated with unlabeled arrows.