# Corrosion In Crevices

A never-ending struggle to detect, eliminate and stop corrosion takes place every moment of an aviation mechanic's work day. The story really begins on the drawing board where the designers opt for ever higher strength structural materials that will permit lighter airframes to carry more payload and fly higher and further. It then ends in a material failure after exposure to operational environments and associated stresses. Cracks form and then grow until either discovered through inspection or when the part breaks due to a critical combination of crack length and loads.

The number of water droplets (in some environments, salt water droplets) impacting a parked aircraft during an hour in a day would astound you. Even some "dry" days are really very wet due to moisture and humidity. Additional condensation (rain) and wash-down hoses make it an absolute certainty that things inclined to corrode will do so. That is why our normal anti-corrosion attempts merely slow down the corrosion process. But due to this constant effort a great deal of progress has been made and flight structures and equipment are becoming increasingly longer lived.

A "between a rock and a hard place" situation exists because higher-strength materials are more subject to crack propagation caused by corrosion than are more ductile materials. Even the best alloys still need protection. Paint, oxide conversion coatings, aladine, cladding with a resistant material, ion implantation, electroplating and other surface treatments help enormously. However, all these protective measures push us into more high tech regions where there is less and less room for error, where a mistake or glitch in the quenching process, an overly hard landing, a slipped screwdriver or other mistake will more easily initiate a crack that leads to a catastrophic failure.

You can liken the constant battle against corrosion to a fortress continually under siege. The enemy outside that fortress is as unrelenting as any chemical reaction can be. The wall of that fort is more sophisticated but thinner. The defenses inside the fortress are weaker, so the guards at the gate have to be increasingly alert. These fortresses are usually located at crevices where two parts join, sometimes at sudden changes in cross-section (bulkheads) or where one part slides through another (almost any landing gear).

In service, not all parts can be designed to shed water, for in fact, they tend to collect water, and their protective platings must be closely monitored. Other parts use "O" rings to keep out the water and moisture. These have to be especially watched because the platings on the inside of the parts are often fragile. The storage of parts is also critical. Condensation or even a spilled cup of coffee can place water between stacked parts. I was reminded of these possibilities when I saw a mechanic with very sweaty hands, lifting up a steel hydraulic arm. He wiped his brow with his hands, then grabbed the part and lifted it into place, leaving a coating of his salty perspiration on that part.

What happens when the protective layer, the fort's wall, is breached? General corrosion occurs in the exposed regions until pits are formed. This pitting is often aggravated by electrochemical effects if a nobler metal, e.g., chromium, is plated on that part. After pits form, things tend to get worse in a hurry. A more severe notch is formed, and fatigue resistance is severely lowered. Acid forms in the pit bottom, and cracks start propagating through stress corrosion cracking or corrosion fatigue. These crack locations are usually hidden, and the parts often have to be disassembled for proper inspection. Smaller or critical-sized flaws must be carefully searched and watched for as parts become smaller. Across the board, everyone concerned with aircraft structures is forced to deal with increasing parts sophistication. The mechanic must be more thoroughly trained to protect the protective layers on components.

A typical failure was a main landing gear shock strut assembly piston that fractured 0.183 inches above the metering stop. Analysis revealed that the piston failed during a landing rollout. The analysis further showed that the material (high strength steel) met specifications, except for plating deficiencies. This component is expected to be exposed to moisture and therefore, a sacrificial coating of cadmium had been applied. The corrosion pits indicated that they had formed opposite a crevice between the metering pin and the cylinder wall. These pits led to corrosion fatigue, stress fatigue and the final fracture. Thus, the part lost its initial corrosion protection, (possibly due to abrasion) then corroded and pitted. Cadmium was found in the corrosion pits, showing that these pits and cracks had been present during overhaul where the part had been (inadequately) inspected and refurbished by replating the cadmium. Placed back into service, the newly plated but still flawed piston finally broke up.

It is best to remember to keep the water away from the component during shipping, storage and use. Protect these surfaces — keep scratches away. Be aware that water will find a way into corners, scratches and crevices. Keep in mind the location of hidden crevices, and watch over them religiously. Be suspicious, nosy, and pushy even though things look OK on the outside.

## Another Version Of FOD

Foreign Object Damage (FOD) is a term still with us, but it's a term that does not really cover just exactly what FOD can do. Possibly, we should change FOD to another or more descriptive name. How about Aircraft Destroyer or Personnel Killer? FOD is a misleading term. Not only have aircraft been damaged by FOD, but maintenance and flight crews have been killed or injured.

We all know that FOD can damage and injure, and we know that preventing FOD is the only way to ensure that we do not lose an aircraft or personnel to this cause. Let's clean up thoroughly after each job whether that job was done on the outside of the aircraft or inside. Find that dropped nut, washer, or clipped off piece of safety wire. That work area must be "signed off" in your mind as being left clean. This is another way to fight that battle of FOD.

---

# The FAA's Mechanical Reliability Reporting/ Service Difficulty Reports

Just as a reminder: The FAA's Service Difficulty Program objective was, and is, to achieve prompt and appropriate correction of conditions adversely affecting continued airworthiness of aeronautical products though the collection of Service Difficulty and Malfunction or Defect Reports; their consolidation and collation in a common data bank; analysis of that data; and the rapid dissemination of trends, problems and alert information to the appropriate segments of the aviation community and the FAA.

To refresh your mind on the details to be reported, we suggest that you read the Federal Air Regulations 121.703, Mechanical reliability reports. (Please note that paragraph (10) is not applicable for air carrier reporting.)

## B-727 Fire Bottle Gauge Visibility

In many instances, B-727 fire bottles have been replaced at high cost due to the visibility (or invisibility) of the fire bottle gauge glass. These gauges get covered with scratches caused by the gauge pointer vibrating under the glass and scratching it. This vibration of the pointer and ensuing glass scratchings does not jeopardize the operational status of that bottle. Some of the bottles aboard the same aircraft show no scratches due to their tighter mounts or location. This can cause confusion. Fire bottles with scratched or worn dial glass may remain in service as long as the pressure scale is readable and falls within the pressure allowances for a given bottle temperature.

## DC-9 Wheel Bearing Seals

Carriers have reported some recurring problems with DC-9 wheel bearing seals. This is a problem that surfaces regularly, and is often due to bearing seals being rotated during the final stages of the wheel installation. This results in improperly torqued outboard bearings and in wobbling wheels.

Several carriers completed modifications by which rotation could be detected more easily. These were tried and resulted in a period of no problems. But then the problem resurfaced, resulting in several wobbly installations. As in the previous cases, brakes had to be replaced while a speed transducer and several mounting parts were also rejected. In several cases, this also necessitated replacement of the inner strut and, at a later date, caused the part to be scrapped.

Engineering at the carriers went back to the drawing boards but requested that the mechanics review their installation procedures contained in the carrier's maintenance manuals.

Most carriers recommend that when installing a wheel, the antirotation lip on the bearing seal must be kept in the slot in the spacer. To accomplish this, it is mandatory (contrary to wheel installation on many aircraft), to support the wheel during installation of the wheelnut so as to prevent the bearing (and seal and spacer) from being forced outward. If this were to happen, there is a chance the antirotation lips slip out of the slot and the bearing seal rotates along with the wheel when rotated during the torquing process. The bearing is then only torqued at two spots, namely both antirotation lips, and fracture of the lips is the ultimate result. In some cases, rivets were installed above antirotation lips, which remain visible when the nut is installed. When the wheel is rotated, it is imperative that these rivets do not move.

# To Measure Is To Know

Or is it? Each measurement gives a value, but the main question is whether it is the correct one. This is not as easy as it seems, because the results of any measurement are of course dependent on the correct choice of the measuring instrument. (Electronic technicians take note). A critical area for measuring is contact resistance. Measurement of very low contact resistances, like in ground bondings, using a conventional universal meter (resolution 100 milli-Ohm), often results in highly unreliable readings with deviations up to 1000 percent.

This is caused by thermo-electric and galvanic voltages as well as semiconductor effects in certain crystals. A conventional milli-Ohm meter of the bridge type often has too small a resolution and moreover, it is not handy to use since the results are influenced by the length of the probes and the bonding resistance between probes and the measured surface.

To prevent such problems in cases of low resistance measuring (i.e., 100 milli-Ohm or less), use an AC milli-Ohm meter.

A useful AC bonding meter is manufactured by AVTRON and is type T477W. This meter makes it possible to measure bonding resistances of less than 2 Ohm. For instance, this meter is prescribed to measure bonding resistance of less than 0-.5 Ohm such as on the R/A antenna mountings in the Flame Sprayed panels of the B-747.

The Model T477W Bonding Meter is self-contained and is ideal for aircraft system bonding testing. Power is obtained from a rechargeable battery pack. The unit is handy for the line technician in that it is contained in a protective carrying case complete with interchangeable probes, and a battery charger. The low voltage output will not ignite flamable gas, and is certified by the Underwriters Laboratory.

# Composite Delamination — A Definition

A composite panel has its greatest strength in the direction of the fibers. Suppose such a panel is made up of a few layers of cloth with fibers at 90 degrees to each other. Forces applied parallel to the fibers will have no consequence. However, an object falling or a person walking on the panel will exert a force (load) in a direction perpendicular to the fibers. This may result in failure of the resin between the layers of cloth. This is called delamination.

The panel is then no longer solid, but consists of, for instance, two layers which are no longer connected at that particular spot. Obviously, this means that there is a considerable decrease in strength. Added danger lies in the fact that, because of the impact resistant paint layer, local damage is hardly ever visible. Delamination can also occur because water enters between the fibers or in a honeycomb structure and then freezes and expands at low temperatures.

# Tools To Fly By

Finally, after all of these years, we have a tool supply house with a catalog compiled exclusively for the aviation mechanic. In the past, we scrounged through a multitude of tool catalogs to find the few special and normal tools we needed. But now there is a listing (with clear illustrations) provided by Aircraft Tool Supply, a company that deals solely in tools and equipment for the aircraft industry and the aircraft mechanic. In specializing in this area, they have made available to the technician a complete listing of tools and equipment that can accomplish the varied jobs assigned. It is a mail-order operation that assures you that the catalog will be correct in its descriptions.

Each page illustrates the tool and its use and the catalog also contains charts to help in the selection of rivets and other hardware — and it's free for the asking. Just write to Aircraft Tool Supply Co., P.O. Box 370, 1000 Old US-23, Oscoda, MI. 48750, U.S., and ask for catalog No. 186A. Their hot line number is 1-800-248-0638.

---

## The Aviation Technician Goes High Tech

Tools, troubleshooting techniques, maintenance manuals, and all of the aviation mechanic's tools are going high tech. For example, have you seen the Portable Balancing System known as the PBS 4000? This unit is lightweight but powerful enough to provide vital information for gas-turbine engine balancing, diognostics and troubleshooting. It is a micro-computer system and accomplishes its tasks on the wing or in the test cell.

It instantly identifies vibration problems. That eliminates the mechanic using his sense of feel, smell, taste and judgement. The unit characterizes broad-band and synchronous vibration, which is vital information for diagnosing engine problems. It provides this information within minutes, on the first trial run. The unit also balances automatically. With a single keystroke, the PBS 4000 calculates the optimal placement and size of standard trim balance weights.

The high resolution cathode ray tube screen displays easy-to-read graphics which indicate the proper correction weight positions on the engine. Existing balance weights are taken into account, eliminating the need to remove them before balancing. Yes, it is an electronic computer trouble-shooter too, and adds this ability to perform engine diagnostics. Using its display of the frequency spectrum of vibration signals, we get a detailed analysis of engine problems.

Data can be acquired and analyzed on two channels, producing simultaneous transient surveys of both broadband and synchronous vibration in different parts of the engine. A compromise balance solution can be calculated for both channels. The unit utilizes the weighted least squares influence coefficient method, a proven and effective technique for balancing high-performance rotating machinery. It calculates and automatically stores influence coefficients for each engine model. Once these data have been established, the system can compute balance corrections in one run for any engine of that design. The unit is a step forward in engine maintenance technology in that it reduces time required for engine balancing by up to 80 percent. It stores the balancing information for each engine design eliminating the old trial and error approach. This results in significant labor and fuel savings for engine maintenance operations. In performing "compromise" balance solutions for multiple channels, it simplifies the balancing of complex engines, and at the same time stores the vital information for engine maintenance records. The end result is that it reduces aircraft downtime due to vibration.

This unit is compact and fully self-contained for true portability and, with interchangeable software, is usable over a wide range of engine designs and speeds. With its ease of operation, it assists the aviation mechanic in resolving vibration or balancing problems on todays complex powerplants.

Courtesy MTI, Inc.

## Sophisticated Flight Line Instrument Calibration

Air data available on the flight line is a great aid to easing aircraft maintenance. It is available via new air data test equipment now on the market. This highly sophisticated, yet easy to operate, equipment is capable of providing fully automatic calibration of aircraft instruments including altitude to 80,000 feet, airspeed to 850 knots, rate of climb to +9,000 feet/min, and mach number to 2.5. High accuracy levels are achieved by the use of vibrating cylinder transducer technology. These include accuracies of ±7 feet at 50,000 feet altitude, reducing to ± 1 foot at sea level, and ± 0.01 knot at 500 knots. The system stability is better than .005 percent per year allowing up to 12 months between recalibrations.

The control system has the ability of being operated via IEEE 488 or RS 232 data interfaces and is capable of controlling into a widely varying volume with no adverse effects on stability. Facilities for monitoring leak rate and aircraft envelope characteristics to ARINC 565 are also included.

Two versions of this equipment are available. The 300 series for either portable or lab use, is contained within a lightweight alloy case and weighs less than 50 pounds. The 100 series, which is housed in a welded steel weather-proofed towable 4 wheel trolley is for flight line use. (See cover photo.) The control system for either unit is a hand held terminal which the operator can use in the aircraft cockpit. This terminal provides all of the read-out data on an LCD display for both demand and achieved values, thus allowing the entire calibration procedure to be carried out by one person.

Priority has been concentrated on ease of use and many features are incorporated for the protection of both the instrument itself and the aircraft instruments under calibration. Simple prompts are provided in the terminal display to ensure easy operation while illegal entries are prevented.

The equipment is extremely cost effective as used for flight line calibration on the European Tornado aircraft.

From Druck Limited

# DC-10/A-300 Generator Lubrication

In the past, there have been many generator problems on the DC-10 and A-300 aircraft caused by the generator bearing and its lubrication.

A short review of the subject goes back to the development of these big generators which supply 90KVA. They were developed by Westinghouse, which experimented with an oil bath lubrication system when the generator was first placed in service. However, the oil seal showed a tendency to leak, resulting in bearing breakdown caused by a lack of oil. Westinghouse then decided to modify the system to wick-lubrication. The wick draws oil at one end while the other end presses against a conical ring, which in turn supplies the bearing with oil.

This method proved to be more of a headache than a success so another modification was made. This one worked. The plain main bearing was replaced by a carefully engineered precision bearing (still wick-lubricated) and the bronze auxiliary bearing made way for a ball bearing. The final modification to be implemented was the conversion of oil lubrication of the bearings to grease lubrication.

This had been a long trial period but the grease lubrication method proved to be successful. It appears that the carriers involved will gradually modify their DC-10 and A-300 generators from oil lubrication to grease lubrication.

During the modification period, there may be two types of generators in use. This calls attention to the fact that adding oil to a grease lubed generator could result in unpleasant consequences. So **do not fill grease lubricated bearings with oil.**

---

# Engine Oil vs. Hydraulic Oil — Don't Confuse Them

On a B-727 flight somewhere in the United States, the crew experienced a slowly decreasing oil level on No. 3. The engine was shut down when the oil pressure started fluctuating. Shortly thereafter, the No. 1 engine oil filter bypass light illuminated and this engine was also shut down.

The subsequent investigation showed the engine oil was found to be contaminated with hydraulic oil (Skydrol). This was an incident that could have had disasterous consequences and surely was not unique to this one carrier. Similar occasions have occurred for the same reason on other carriers.

Both the engine and hydraulic systems are serviced with special filling units that should be properly labeled. Besides, the pungent odor of Skydrol immediately marks the difference in oils. There have been cases, however, where the “smeller” of the line service mechanic was not functioning due to clogged sinuses or such.

It is suggested that the servicing crew be alerted to smell the oils prior to use if the filling units are not clearly labeled. If the mechanic has any doubts of the contents, and his sense of smell is in doubt, he should ask someone else who is aware of the odor differences to give it the smell test. Of course the engine oil and hydraulic oil filling units should be adequately labeled to preclude any mistake being made.

# Maintenance Alerts

## DC-10 Uncommanded Acceleration of No. 2 Engine On The Line

During maintenance at the gate, the maintenance crew started No. 2 engine to trouble-shoot a no-acceleration squawk by the previous crew. After engine start, the speed increased to 90 percent with the throttle lever at idle. The aircraft jumped out of the nose chocks and moved forward. The No. 1 engine nose cowl contacted the passenger airstairs and an emergency shutdown of No. 2 was performed. The parking brakes had been set and only nose chocks were used.

Investigation revealed that the casing of the No. 2 engine push-pull control cable had pulled out of its end fitting. This allowed the outer races to contact the structural support, thereby restricting the movement of the control. This necessitated replacement of the No. 2 engine push-pull control cable and the No. 1 engine nose cowl.

Nose chocks, as in this case, are not adequate even though the parking brakes are set. When that close to the terminal and its associated equipment, and when performing an engine run, all wheel chocks should be placed in position.

## Cessna Single Engine Aircraft/Seat Track Wear

Judging by the number of complaints involving gouging of the lock pin holes, bent lock pins, excessive clearance between the track rails and the seat rollers, and the occasional case of the seat slipping rearward on takeoff, these areas are not getting as much attention as they should be. Dust and debris accumulations on the seat rails contribute to this problem, and so can overweight pilots. Since we can do little about the latter, we can suggest improved cockpit cleanliness, a close check at each inspection, and the replacement of parts when necessary. It might prevent an accident, or an embarrassing incident.

Note: The following was recently received from a mechanic via a

Malfunction or Defect Report.

The seat stop is forcefully rammed into the top of the seat rails each time the seat is moved backwards in positioning for different pilots. Eventually, the rail is grooved and then cracks. This process can be retarded by gluing a small piece of hard rubber channel to the underside of the stop. The rubber from a MS21919 DG clamp works very well.

This alert was previously published (1984) but there was a recent report of the seat in a Cessna 170A sliding aft during takeoff resulting in loss of control and damage to the aircraft. Investigation of the seat runners revealed severely worn and elongated seat pin latch holes. The seat pin latch was able to slip out of the latch hole.

## Cessna Model 172 Skyhawk/ Brake Master Cylinder

A mechanic had three reports of inoperative brakes within two days. Two reports were on Cessna 172 aircraft, and the other was on a Cessna 182. All had the same symptom, no brakes and unable to bleed the system.

Disassembly of each master cylinder disclosed the P/N 22FH632 nut was too far up on the shaft, thus closing the gap for replenishing fluid in the brakes. Further investigation disclosed that with each brake application, the cylinder return spring rotated the nut up the shaft. The submitter suggests a new nut each time that the nut is adjusted.

## Piper Model PA-28-151 Warrior/Questionable Filter

During inspection of fire damage caused by improper starting techniques, it was noted that the induction oil filter had been charred by flames. Upon removal of the filter from its meshed housing, the submitter discovered that instead of the proper filter, several layers of 1/4 inch thick foam had been substituted.

These appeared to be sections cut from the style of filter used in a window air conditioner. The filter was badly burned and deteriorated. The submitter states that the this type of filter would not be able to withstand the temperature and conditions associated with the engine compartment environment and could possibly lead to ingestion of filter material and subsequent engine damage.

## The Effects Of Facial Hair On The Efficiency Of Oxygen Masks

The FAA and the U.S. military have conducted studies to determine the influence of beards and mustaches on the efficiency of oxygen masks.

Their conclusions are that a definite reduction in performance occurs when facial hair is present along the sealing surface of crew and passenger masks.

This reduction is proportional to, among other things, the amount of hair present, the type of mask in use, and the activity level to which the individual is subjected.

One manufacturer feels that these study results should be brought to the attention of all operators, and advised that future revisions to Pilot's Operating Handbooks will contain the following warning:

### WARNING

> Beards and mustaches should be carefully trimmed so that they will not interfere with the proper sealing of an oxygen mask. The fit of the oxygen mask around the beard or mustache should be checked on the ground for proper sealing. Studies conducted by the Federal Aviation Administration conclude that oxygen masks do not seal over beards and mustaches.

## Anti-Icing Additives — Take Care When Adding

While proper fuel sampling and sumping is essential in preventing the formation of ice due to free water in the fuel, it will not eliminate the hazard of ice blockage of fuel flow. Under certain conditions, water in suspension or solution may form ice crystals. Since water in suspension or solution is not removed by sumping, the formation of ice crystals must be prevented by adding anti-icing additives, such as isopropyl alcohol or ethylene glycol monomethyl ether (EGME), to the fuel. Both additives absorb water and reduce the freezing point of the mixture. Teledyne Continental Motors and Avco Lycoming approve the use of both additives in their engines, subject to approval by the respective airframe manufacturers. When alcohol or EGME are used, instruction for their proper use must be carefully followed. Obtain and follow the aircraft and engine manufacturer's recommendation regarding the use of anti-icing additives in the fuel of your aircraft. Also be aware that some additives are hazardous to people and the environment.♦