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SUBJECT:

Environmental Limitations of Air Tractor Ram Air Engine Induction System

APPLICABILITY:

All Turbine Air Tractors equipped with Air Tractor Ram Air Engine Induction Installations

SUMMARY:

The purpose of this Service Letter is to provide information on the service experience and environmental limitations of the Air Tractor Ram Air Engine Induction System.

DISCUSSION:

When Air Tractor developed the Ram Air system for our turbine aircraft, it was with a strong desire to bring better, more efficient airflow to the engine. The original air inlet with the two barrel filters has always proven itself as a reliable air source for the engine, but is fairly inefficient due to the flow path the air must take to get to the engine.

The Ram Air system was designed to provide a more efficient path to the engine that took advantage of the ram air pressure that is developed when the aircraft is moving through the air. There were some limitations to this design in that there was much less room for air ducting in the narrow forward section of the cowling and that that there was much less room for the filter element. The new design meant that a traditional flat or barrel shaped air filter could not be used when considering the large amounts of air that a PT6A engine consumes every second.

A large, complex curved paper-element air filter was developed by a filter manufacturer for Air Tractor. During the testing process,

this filter performed well. Once in production, operators were reporting that the new inlet and filter resulted in lower fuel consumption, better climb performance, and ITTs that were 15-20°C lower than before. These operators were ecstatic about the new system and were impressed by the improvements in engine performance.

Although excited about the success of the system with these operators, we began to receive negative feedback from some operators who flew their aircraft from grass and dirt strips. These operators were reporting that grass, bugs, and even bird feathers were getting past the air filter and were found laying on the engine FOD screen. We were concerned by these findings and began to investigate and search for a solution. It was quickly found that the new paper-element air filter had variations from filter to filter that, although seemingly minor, caused the filter to not fit perfectly in the engine plenum. In some cases, this resulted in small gaps around the filter that could, in some situations, allow debris to work its way past the filter.

Effort was made to find a solution to the air filter variations, but with limited success. Each possible solution resulted in further compromises and became a maintenance challenge on those aircraft. It was decided to pursue a different type of filter material that could be manufactured so that it sealed well around the perimeter to prevent debris from working around the edges of the filter. This is when the move was made to the Brackett foam type air filter. This is a 3 layer laminated foam filter that is built slightly oversize so that when it is placed in the filter frame, it is pressed tightly around the perimeter.

This filter was tested for airflow performance, chemical resistance, fit, function, and longevity at Air Tractor and offered on a trial basis to several of the customers who were operating off of dirt/grass strips who were having the trouble with the paper filters. This testing went on through a full spray season with great reports from the customers using the new filter media. The customers also

enjoyed the easier maintenance aspects of the new filter material. Other improvements were made at this time as well to provide a better plenum seal in locations other than the filter perimeter.

A pleated paper or fiber type filter works like a very fine net. Any particle that is larger than the openings in the net cannot pass through and are held in place. Any particle smaller than the opening will pass through. The new foam filters work differently. The foam is porous and is laminated with increasingly smaller pore sizes. The entire filter is then soaked with a sticky liquid "wettant". Air flow through the foam filter has no straight path, it must weave its way through the small passages of the filter. As it does, any particulate material will come into contact with the filter material and get trapped in the wettant and held in place.

At this point, we were optimistic that this new filter media would solve the issues that customers were having. For the first couple of years, this seemed to be the case. We heard nothing but positive feedback from the new filters.

Then we began to hear from customers who operated in very dusty conditions. These customers began to report that very fine dust was making its way through the foam filter media. This was unexpected to us and we began to investigate. We received samples of the dirty filters and found that the dust was approximately as fine as talc or ground cinnamon. We were finding that the very fine dust had completely coated every tiny surface of the filter and left no exposed wettant to capture any more dust. The filter was still effective at trapping larger particles, but the fine dust was able to work through the filter, eventually being ingested into the engine.

The filter was effectively trapping the very fine dust until the filter had become fully saturated. Once saturated, the filter effectivity is quickly diminished. The solution to this is to change the filter often in dusty environments to prevent operating with a saturated filter.

After talking with Pratt & Whitney engine experts, it was determined that this fine dust caused no immediate threat to the engine, but could cause increased wear on the compressor blades over time. It was pointed out that most other PT6 powered aircraft operate their entire lives without any protection from very fine dust. It was not ignored that most other PT6 powered aircraft operate from paved runways and do not operate at the low altitudes that ag pilot's spend their time.

We are continuing to work in house and with the filter manufacturer on solutions to adequately filter out these very small dust particles. We must be careful that our solution to this problem results in a safe product. A solution that catches all of the dust, but gets choked up and cannot deliver enough air to the engine would be an unsafe solution and that would not be acceptable. We will continue to work to find a solution to this issue and we will present this solution as soon as we can.

Unless you are certain that no dust is getting through your air filter, routinely check the inside of your engine plenum. If the back side of the filter is dirty or if there is a layer of dust inside the engine plenum around the engine inlet, then the steps described below should be applied in your operation.

OPERATIONAL SOLUTIONS:

We understand that those of you that are operating in very dusty environments are experiencing increased maintenance and may suspect some accelerated wear to the compressor blades. Below are some suggestions that you may wish to put into action that may reduce dust ingestion and may reduce engine wear that you may be seeing.

1) Replace filters regularly. The number one solution to dust ingestion is to change air filters as often as necessary. There is no substitute for installing a new filter at regular intervals. If there are any signs of dust on the aft face of the filter, the filter should be changed. In some very dusty operations, this is required

at 15 to 20 hour intervals. We are aware that operators in dusty environments were changing their barrel filters this often on the original air inlets as well. This requirement has not changed.

2) Inspect filter condition daily. In conditions with very fine dust, the filter can become saturated quickly. We suggest checking the filter condition daily from the back side of the filter. This can be done by opening the alternate air door and looking at the back side of the filter with a flashlight. At the first sign of dust showing through the back side of the filter, the filter should be replaced. Don't forget to close the alternate air door immediately after this inspection.

3) Blow out filter regularly. Filter life can be extended if the filter is cleaned with compressed air regularly. Remove the filter from the airplane and use compressed air to blow the dust out of the filter from the back side. This won't return your filter to new condition but it will add a little extra life.

4) If dry, consider applying a foam filter treatment. After blowing the filter out, if the filter seems dry because the dust has absorbed the surface wettant of the filter, consider applying a foam filter treatment, such as "PJ520 Foam Filter Oil Treatment Spray" made by PJ1. Again, this is not a replacement for installing a new filter.

For the majority of operators, in-flight operations do not involve significant amounts of airborne dust that the engine is ingesting. It is the ground operations that create the dusty conditions. By modifying the way that ground operations are conducted, you should be able to significantly reduce the airborne dust around the aircraft.

The aircraft operator knows more about his operation than anybody. If you know of an operation that results in a lot of dust being blown around the nose of the airplane, you can try to limit dust ingestion by using a little creative thinking. Some ideas are listed below:

5) Reduce operations from dusty airstrips and loading areas. We know that this is not always something that is possible. However, if the aircraft can be operated from a paved surface, this can greatly reduce the chances of ingesting large amounts of dust.

6) Do not use reverse thrust when operating in dusty areas. Operating with the propeller in reverse on a dusty surface will kick up more dust than any other single action. And this dust gets kicked up right into the engine inlet.

7) Keep dust down in loading areas. A feathered propeller can also kick up a lot of dust that can be ingested into the engine. If your loading area is not paved, it would be helpful to wet down the ground around the propeller to keep dust from being kicked up.

8) Wet down a dirt runway. If the equipment is available and water is readily available, wetting down the runway to keep the dust down before takeoffs and landings could be beneficial.

9) Avoid closely spaced takeoffs, landings, and ground operations. Formation takeoffs and closely spaced landings on dusty strips can cause the trailing planes to ingest a lot of dust. Likewise, taxiing airplanes in close proximity in dusty conditions will increase the amount of dust that will be ingested.

10) Keep the inlet clean when not operating the aircraft. If the aircraft is left outside during conditions of blowing dust, place a cover over the engine inlet to prevent the dust from blowing into the inlet. Make sure to remove the cover before starting the engine.

In general, operating in dusty conditions will increase the maintenance requirements of your aircraft. If you can reduce the amount of airborne dust that your aircraft is exposed to, it will reduce the risk of dust being ingested by your engine.