THE CLOGGING OF FUEL STRAINERS

(MATERIAL SECTION REPORT)

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June 29, 1925
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THE CLOGGING OF FUEL STRAINERS

Several minor investigations into the cause of the clogging of strainers in airplane fuel systems have been accomplished at various times upon the receipt of specimen screens and of obstructing deposits. A sufficient number of cases have been presented to allow for definite conclusions regarding the source and remedy of this difficulty which has in many instances assumed rather serious proportions. There are instances in which motors ceased to function due to the lack of fuel supply occasioned by the clogging of strainers.

This report has been prepared from a study of the data contained in the several isolated reports and the recommendations are drawn to cover the various conditions which may be encountered in service.

CONCLUSIONS

The clogging of the fuel strainers in all the cases investigated, submitted from many sources, was attributed to one of the two following causes:

1. The accumulation of a jellylike precipitate of hydrated aluminum oxide which practically filled the screen meshes to the point where the passage of fuel was impossible. This precipitate is caused by the corrosion of the aluminum parts of the fuel system by water.

2. The accumulation of a fibrous material, either asbestos or cotton fibers, on the screen, with a formation of a dense mat which holds back the divided suspended matter, such as dirt and the corrosion products of metals which would ordinarily have passed through the screen.

The clogging produced by the corrosion products of aluminum by water has been overcome by treating the aluminum parts as described under Air Service Specification No. 98-20,004-A. This treatment has been found to be effective in eliminating serious corrosion of the aluminum parts.

The other type of obstruction produced by the fibers, the origin of which was traced to the filling hose, has been prevented by inserting a fine-mesh screen in the nozzle of the filling hose. The method in detail is as follows:

A 200-mesh copper screen is superimposed upon the coarser screen now in use. The object of this is to lend strength to the 200-mesh screen. The fineness of the mesh in this nozzle screen causes it to soon become clogged, but it has been found that the clogging material is readily removed by immersing the strainer in hot 15 per cent caustic soda solution and then momentarily dipping in concentrated nitric acid and immediately wash with hot water. This treatment is repeated if the first is not entirely successful. This screen removes any foreign matter from outside sources which would likely cause trouble in the fuel system.

MATERIAL

This report was compiled from the examination of fuel strainers of various types which became so badly filled up as to obstruct seriously or stop the flow of fuel. These strainers were made of brass screen, 80 mesh or finer. They had been forwarded to the engineering division by several activities over a period of about two years.

METHOD OF PROCEDURE

Chemical analysis was made of the deposits to determine their source. A quantitative analysis was usually made. The screens were examined under a microscope (25 diameters) to observe the way in which the material clogged the screen, and occasionally microphotographs were made.

RESULTS

The following is a summary of the results obtained from the examination of some of the individual exhibits:

1. Deposit from fuel strainer of lighter-than-air ship at Langley Field, February 12, 1923.

   Analysis

<table>
<thead>
<tr>
<th>Material</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water and organic matter</td>
<td>43</td>
</tr>
<tr>
<td>Aluminum oxide</td>
<td>55</td>
</tr>
<tr>
<td>Other metallic salts</td>
<td>2</td>
</tr>
</tbody>
</table>

   Only a small amount of organic matter was present. The water was probably mainly combined with aluminum in the form of the hydrated oxide. Traces of iron and copper salts, sulphates, carbonates, and chlorides were present.

   The screen was evidently obstructed by the corrosion products of aluminum with water from the aluminum gas tank with which the ship was equipped.

2. Lunkenheimer valve strainer clogged during endurance flight August 27, 28, 1923, at R. A. I. D., Coronado, Calif. Photographs of the entering and exit sides of this screen are included.

   Analysis.—The sediment consisted of a mat of asbestos and cotton fibers, mainly asbestos, which so closed the meshes of the screen that any suspended matter was caught on it and clogged the screen.

   The fibers came from the fuel hose lined with asbestos and stiffened with a flexible steel coil.

3. Deposit from gas tank strainer of VE-9, March 29, 1924.

   Analysis

<table>
<thead>
<tr>
<th>Material</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron</td>
<td>15</td>
</tr>
<tr>
<td>Aluminum</td>
<td>85</td>
</tr>
</tbody>
</table>

   In form of hydrated oxides.
This result shows the trouble was due to corrosion of iron and aluminum, mainly aluminum.

4. Deposits from finger-type fuel strainers from P-312 and several other ships at McCook Field, February and March, 1925.

These fuel strainers were all clogged with asbestos fibers from the filling hose on the 200-gallon filling trucks. A mass of these fibers first collected on the screen and served as a filter for dirt and iron rust, which probably came from the bottom of the truck. Over a pint of such material was found when cleaning one of the trucks.

5. Deposit from fuel strainer of Lawrence L-4 motor, June 4, 1925.

Analysis

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum compounds</td>
<td>80</td>
</tr>
<tr>
<td>Iron, copper, zinc comp</td>
<td>Balance</td>
</tr>
</tbody>
</table>

The strainer was cylindrical type and was nearly full of the gelatinous precipitate of hydrated aluminum oxide, indicating corrosion of aluminum by water.

6. Deposit from fuel strainer of airplane A. S. 25-49 at Bolling Field. Photographs of entering and exit sides of this screen are included.

Analysis

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton fibers</td>
<td>30</td>
</tr>
<tr>
<td>Silica</td>
<td>20</td>
</tr>
<tr>
<td>Iron oxide</td>
<td>5</td>
</tr>
<tr>
<td>Aluminum oxide</td>
<td>30</td>
</tr>
<tr>
<td>Copper salts</td>
<td>10</td>
</tr>
<tr>
<td>Zinc and lead salts</td>
<td>5</td>
</tr>
</tbody>
</table>

The sample originally contained considerable moisture. The analysis was run on a dried sample and is only approximate.

The cotton fibers apparently were the primary cause in the clogging of the screen.

DISCUSSION OF RESULTS

Examination of the results and photographs under magnification show that the trouble with all the fuel strainers was due either to fibrous material or the jellylike corrosion products of aluminum. Other samples have been examined with the same results. Only enough examples were given in this report to show the different types of deposits.

The examination of the entering and exit sides of the clogged screens under magnification as shown by the accompanying photographs reveals that where lint was present, it was the primary cause of obstruction. These fibers, whether asbestos or cotton, first entwined themselves into the wire strands of the strainers and built up the mat filter. The entering side of the screen then shows that foreign matter in the fuel, either corrosion products or dirt, or both, forms on this fiber mat.

It seems that the corrosion products of metals other than aluminum are not sufficiently voluminous to cause clogging or do not adhere to the screen unless a mat of some fibrous material is first deposited. These fibers in all cases examined were either cotton or asbestos. The only possible source of these fibers is thought to be the fuel hose. Some types of hose are lined with asbestos which contains some cotton, while others are a cotton fabric base which would be a source of the cotton fibers in case the hose became sufficiently disintegrated in service.

The presence of corrosion products of aluminum is due to aluminum or aluminum alloy parts of the fuel system being corroded by water. Water is usually present in small amounts in the fuel system, due to the condensation of atmospheric moisture whenever the temperature drops sufficiently. Carburetor bowls are usually attacked in this way. It is perfectly clear that while the corrosion of other metals may be a contributing factor, by far the larger part of the stoppage of strainers by corroded metals was due to the corrosion of aluminum. Even where the screen is first matted with fibers from the hose, aluminum usually furnishes most of the material caught on the screen.

If the cast-aluminum parts of the fuel systems are treated by the Z-D process in accordance with Specification No. 98-20,904-A and if a 200-mesh screen is superimposed on the screen in the nozzle of the filling truck, it is believed that the inherent difficulty will be overcome.
Fig. M1326-1.—Plate 5072. Magnification, 25 diameters. Remarks: Lunkenheiner strainer exit side

Fig. M1326-2.—Plate 5073. Magnification, 25 diameters. Remarks: Lunkenheiner strainer entering side

Fig. M1326-3.—Plate 6583-A. Magnification, 25 diameters. Remarks: A.S. No. 25-49 strainer exit side

Fig. M1326-4.—Plate 6582-A. Magnification, 25 diameters. Remarks: A.S. No. 25-49 strainer entering side