PLANT WATSON

MISSISSIPPI POWER

STEAM TURBINE CONTROL
FLUID MAINTENANCE
BEST PRACTISES

GLCC REOLUBE TURBOFLUID 46B

Lubrication Excellence 2003

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Abstract: The Unit 5 phosphate ester steam turbine control fluid in a GE turbine at Plant Watson had not been responding as expected to fluid purification and filtration so the root cause had to be identified and corrected. While this had not caused outages or valve problems, the potential was there and there was the likelihood of further fluid change-outs or having to obtain expensive add-on equipment. The fluid is GLCC Reolube Turbofluid 46B which is a 100% synthetic phosphate ester. The station staff and the fluid supplier, Forsythe Technology Inc., worked together to make a number of cost effective changes that resolved the problems. For the most part these changes were simple and inexpensive but the number of them and verification took time. In addition, practices had to be improved and it was found that some of the turbine supplier documentation was not correct.

Background

Plant Watson had been experiencing problems with the fluid previously used and the supplier had been unable to resolve them. In December 1992 the acid number was 0.94! The resistivity was also below the GE minimum and the particle counts in the 5-10 micron range were 1 ½ million. The maximum is 24,000. Consequently in 1993 the fluid was drained and changed to Reolube Turbofluid 46B which at that time was called FMC Durad EHB.

The first sample was tested in January 1993 showed that the fluid was in good condition. This meant that the drain was done well and the fluid remained in good condition for several years although the resistivity was on the low side and there were periods of high particle counts.

To improve the condition of the fluid extensive collaboration between the station personal and the fluid suppliers began so that the root cause could be identified.

Actions Taken

First, this was not easy. There was widely conflicting information from other fluid sources so that credibility had to be established and at the station it could be time consuming to get the required information on what practices were being followed and what was being used. Plus, as is common at most stations a number of different work groups were involved, at least at some stage, with the fluid. Possibly, as well because the condition of the fluid was not yet causing outages, there may have been reluctance to make time to make improvements. In addition, it can be become accepted that these fluids can give trouble even though this need not be the case.

Following the first use of 46B in January 1993 the station took periodic fluid samples which were sent to Forsythe. The results would be faxed back in about a week after they got the samples and copies by mail would follow. In addition, when a parameter was out of specification or not responding Plant Watson personal would often be contacted by phone, fax or more recently by e-mail. In addition, Forsythe, through its associate company Utility Service Associates, would also provide trend plots on the fluid condition. This testing and contact was very important and during these contacts information was exchanged that lead to a huge improvement in the condition of the fluid and to an improvement in the consistency of the results.

From the start it was recognized that the low resistivity was somehow related to the GE supplied purification system, called a TAFEFU (transfer and fuller's earth filtration unit). This was right but a dozen or so components that were all related had to be changed.

First, the fuller's earth housings (see Photo 1) only take one Hilliard HT718-00-CN fuller's earth cartridge. Consequently, there are only two in total. At a Hilliard recommended flowrate of ½ gpm per cartridge this is only 1 gpm. However, the operating manual says 2.4 gpm and is incorrect in not allowing enough contact time with the media. Plus, there is no flow gauge on the system and the dial on the Vickers flow control valve, see Photo 2, is not that easy to read but worse it is left handed so that when efforts were made to reduce the flow, it was being increased. Lastly, some of the pressure gauges were not functioning or had been removed. These had to be replaced with the right ones; note only phosphate ester compatible pressure gauges should be used. As a check, the pressure with new fuller's earth and new filter elements should be as follows;

Inlet to FE	Inlet to trap filter
5 psi	4 psi.

Too low a pressure can mean improper installation while too high means that the flow rate is too high or the fluid too cold. This raises another issue because if the fluid is too cold the pressure drops are higher and the purification media is not as effective. It had been only 100°F while GE recommends 110-125°F. This was raised.

While still on the TAFEFU, it has been reported that the fuller's earth cartridges have a shelf life of just six months. After this they require drying because absorbed atmospheric moisture will reduce their effectiveness. Starting in 1999, these FE cartridges were dried at 220°F for 18 hours before installation. Also, the installation procedures where changed to 'cake' the fuller's earth cartridges by running them on re-circulation for hours and then changing the trap filter (see Photo 3) after one week. Caking had been originally recommended by the turbine OEM but not more recently, however, it is still considered good to do it. In addition, the call-ups were changed so that the fuller's earth cartridges are changed every 3 months. They had not been that frequently earlier. Also, because the current style fuller's earth cartridges do not have as much media the same supplier was requested to provide the larger 7" OD versions. These are slightly more expensive but have much more media. There is also the possibility that at some occasions in the past that "will fit" FE cartridges had been used. These are now "no substitution" items.

Lastly, used 10" trap filter elements were examined and this showed that the elements were being misaligned. See Photo 4. As a result fuller's earth fines could bypass the trap filter and go right into the main reservoir. To prevent this from happening the trap filter was upgraded to a 20" filter element provided by Forsythe. This also had a better rating so it was a win win situation.

There continued to be instances of high particle counts so the sampling procedure was revised to make sure that enough fluid was being flushed out at first and that the sample valve was not being touched during the filling of the actual sample bottles. Plus, it was found that the bottles being used were ones from a bin that were uncapped. This was resolved by using capped sample bottles supplied by Forsythe.

One other modification that had been used at sister stations was the installation of instrument air to the reservoirs. While this had not necessarily been effective at improving the resistivity it has other advantages. Plus, the desiccant breather on the reservoir is an older type which does not have the integral filter element to prevent desiccant fines from getting into the reservoir. Getting both the desiccant in the main body and the color indicating desiccant in the sight glass changed properly had been problematic. Consequently, dry air purge was added in October of 1999. At the same time a contractor used a vacuum dehydrator on the fluid so that both combined to lower the water content. It has remained at a few hundred ppm.

Summary of Significant Improvements

1. Dry FE.
2. 20" trap filter element with better filter media.
3. Add dry air reservoir purge.
4. Increase FE changes to every three months.
5. Improve FE changes by caking and then changing trap filter.
6. Reduce TAFEFU flowrate to 1 gpm.
7. Add a flow gauge.
8. Install proper pressure gauges.
9. Raise fluid temperature.
10. Return to larger fuller's earth cartridges.
11. Improve sampling procedure.
12. Use clean sample bottles.

Results

For the last three years the fluid has consistently been within specification. This for the first time ever. Trend plots for the acid number, water content, small particle counts (5-10 micron) and resistivity are given in the Figures 1-4. Table 1 also explains the tests and their significance.

> **Acid Number:** Currently low which is good and averaging about 0.05 mgKOH/g over this year it is well below the GE limit of 0.20 mgKOH/g. This indicates that the purification media is being effective. See Figure 1. While not shown the metal content of the fluid has dropped as well and the magnesium content in particular is down from over 20 to 2 ppm.
>
> **Water Content:** Currently very low averaging about 200 over the year which is also good. It is well below the GE maximum of 2,000 ppm and most likely reflects the use of purge air on the reservoir. See Figure 2.
>
> **Particle Count:** Much improved with only one spike which would be of concern if associated with any maintenance activity or unusual system operation. Otherwise it could be sampling which should be addressed if it happens again. See Figure 3.
>
> **Resistivity:** Now well above the GE minimum of 5 Gohm.cm, which is good, plus it is still trending higher which is even better. See Figure 4.

By working closely with Forsythe and it's associated company, Utility Service Associates, it was possible to identify the many factors that had been contributing to the condition of the fluid not being up to the 'norm' for the same fluid in similar units. This was accomplished without having to change the fluid, or to add on auxiliary equipment although some component and procedures had to be upgraded. The procedures also had to cover the life of the fluid from supply issues with filters and media to operation, maintenance and condition monitoring. Good information that is both correct and complete is essential for such problem solving.

Conclusions

1. A number of simple but effective improvements made it possible to restore the fluid to specification without costly add-on equipment or outages.

2. Changes should be based on fact. Verify actual practices and independently check claims by others.

3. Effective fluid maintenance requires a champion to coordinate efforts and to keep the efforts going but resolution requires the active support of a number of different work groups.

4. The cause of the fluid 'problems' can be for more than one reason.

Photo 1: Showing typical fuller’s earth housings.
Flow is in parallel with one cartridge in each housing.

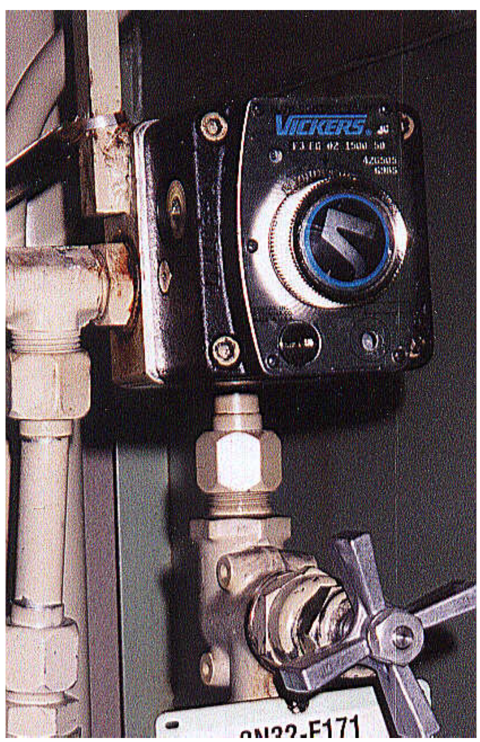

Photo 2: Showing a flow control valve.

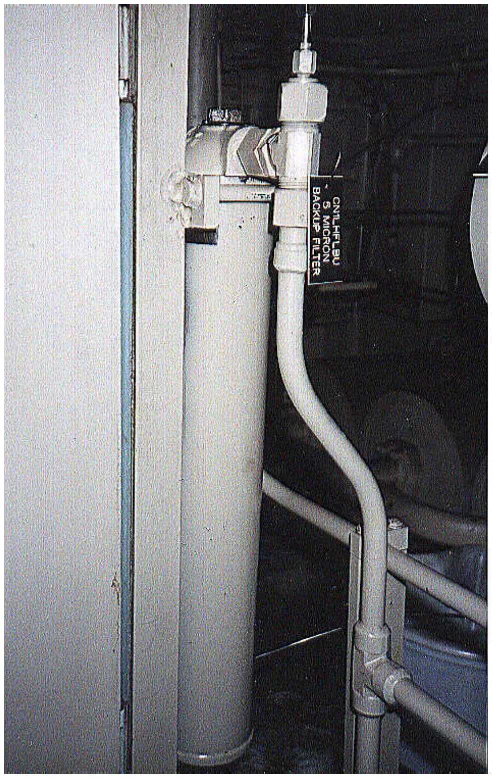

Photo 3: Showing a PL310 trap filter housing.

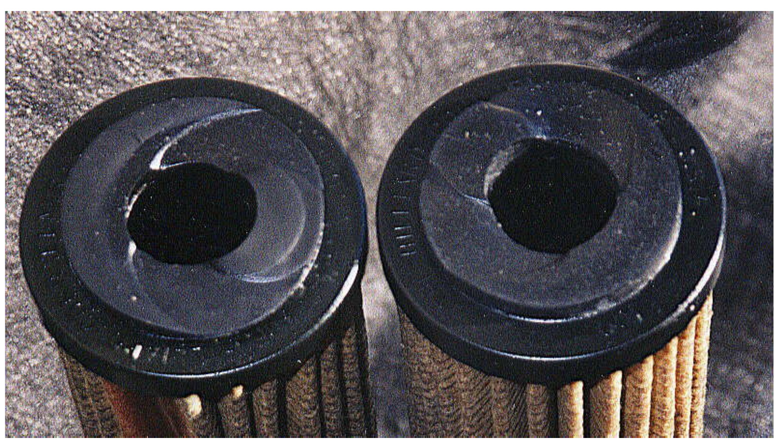

Photo 4:Showing the short 10” trap filter elements that were misaligned.

TABLE 1

EXPLANATION OF TEST TERMS

PARAMETER	EXPLANATION
Acid Number	As fluid is used, acidic compounds can be formed. Normally controlled at <0.2 mg KOH/g by purification media such as fuller's earth. Too high at any time can lead to later problems and shortened fluid life.
Water Content	Esters can hydrolyse so the water content has to be controlled. Water can also reduce the effectiveness of most purification media and/or cause rusting.
Electrical Resistivity	Must be kept high to prevent electrokinetic wear of servo-valve internals. Normally controlled by fuller's earth purification media.
Particle Count	Too high can lead to shorter fluid lives, servo and or solenoid valve problems with sticking and screen/filter blockage. Resample and determine source if still high.

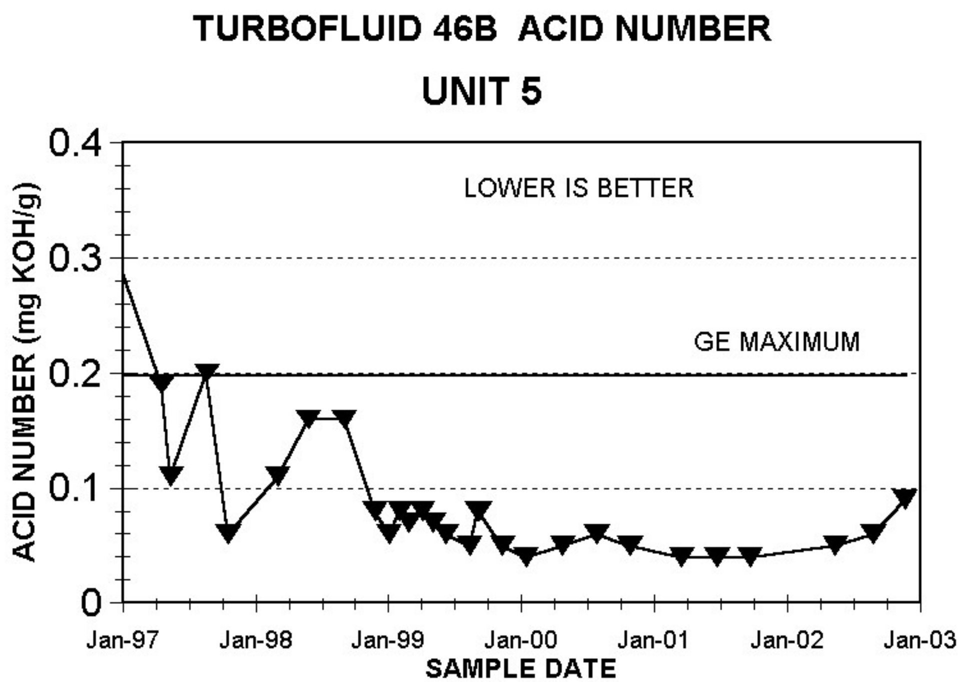

Figure 1: Acid Number.

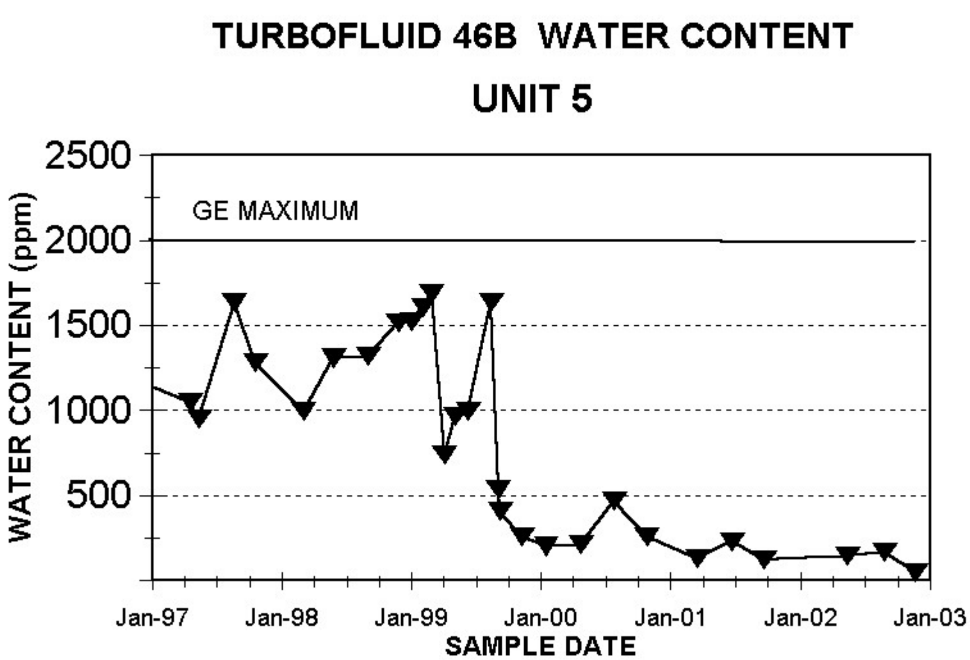

Figure 2: Water Content.

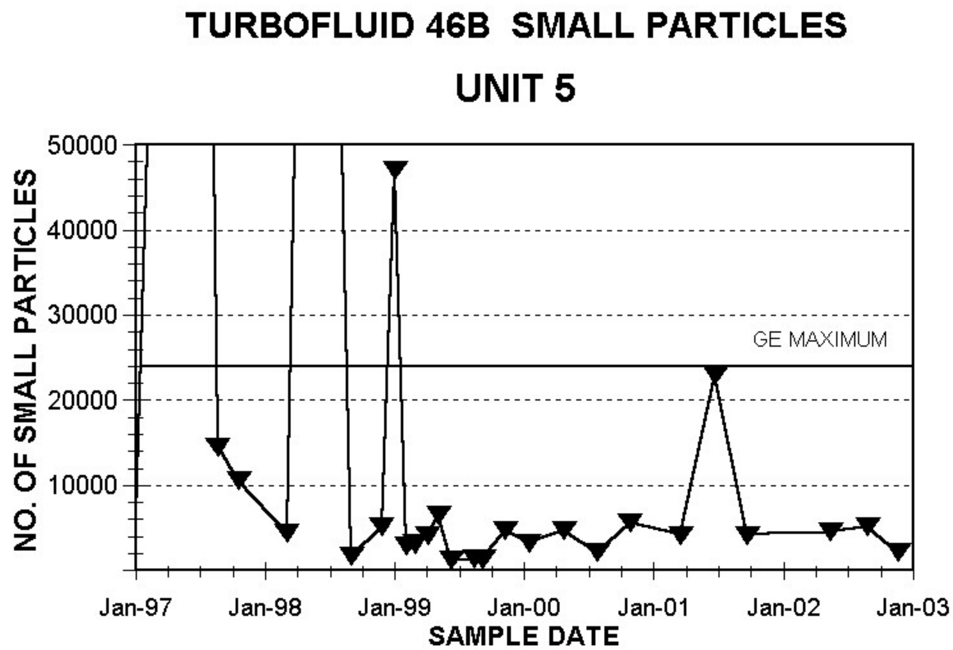

Figure 3: Small Particles (5-10 microns optical count).

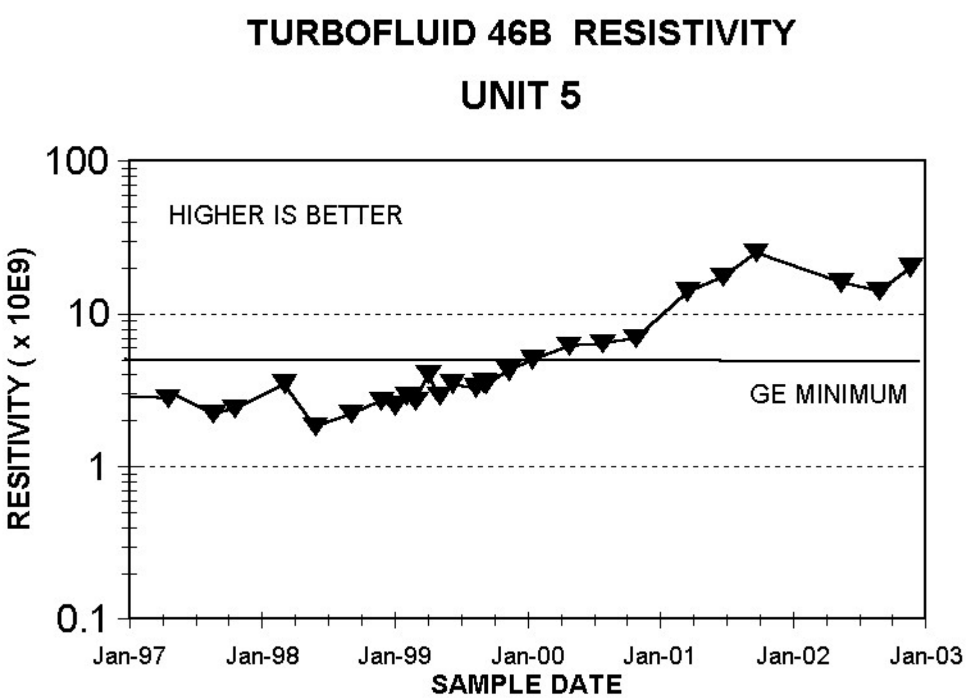

Figure 4: Resistivity