Jack Poley

# Real-world oil analysis

*Forget about getting all the facts—in the field you have to work with the information at hand.*

Let's continue our discussion on concepts in oil analysis data evaluation from a worm gear drive in an industrial manufacturing plant. There are 17 reports available for this component, as we'll inspect the most recent samples to present, as shown in Figure 1.

At first glance this looks sudden but, looking at the Fe pattern now, we can see that the two previous samples were predictive of the wear event in the most current sample, perhaps not as boring as I claimed. Si (silicon) has dramatically increased, as well and, with no evidence to the contrary, is likely indicative of abrasive contamination.

At this point the expert system recommended diagnostics, ferrography or micropatch analysis and mechanical inspection (if indications from diagnostics and ferrography/micropatch are suggestive). Well, if one isn't going to buy particulate monitoring routinely, don't expect a ferrography invitation to be accepted, either. The machine continued to work without service or incident.

| Lab# | 341224 | 330227 | 320366 | 311941 |
|---|---|---|---|---|
| Lube | 17087 hrs | 15463 hrs | 14006 hrs | 12609 hrs |
| Comp | 0 hrs | 0 hrs | 0 hrs | 0 hrs |
| L/F | N / N | N / N | N / N | N / N |
| Fe | 76 | 33 | 24 | 17 |
| Al | 0 | 0 | 1 | 0 |
| Cu | 237 | 105 | 84 | 60 |
| Pb | 1 | 0 | 0 | 0 |
| Si | 18 | 4 | 4 | 4 |
| Mo | 0 | 0 | 0 | 0 |
| Cr | 0 | 0 | 0 | 0 |
| Sn | 29 | 16 | 13 | 12 |
| Na | 0 | 0 | 0 | 0 |

Youngest Oldest

Figure 1

One curious point is the absence of increased Si when the Fe values were beginning to grow. I occasionally speculate about the possibility of dirt being introduced into a component by, say, a dirty transfer vessel, but having particle size too large to detect the Si indicator (another case for a large particle screening technique for unfiltered systems). Once the dirt takes its bite from the component's part, it may then break into a small enough particle to be detected by routine spectrometric analysis.

If the beginning Fe increases were not related to the more serious Fe levels then, of course, some other cause might be proposed. If one is prone to looking at any change as real, then one might propose that the first group of samples showed 0-3 ppm Si, then we have a few 4 ppm Si values, and the jump to 18 ppm, confirming a long growing pattern over greater than two years. And now, too, we know we have a continuous lube service interval so that concentration growth of some sort seems reasonable.

In any event it seems a good bet we have abrasives at this juncture, and maybe we have a spectrometer that is very well-tuned and can be relied on when single-digit wear metal growth occurs.

This kind of math is, in my view, risky when applied to Si, Fe, Al, Cu or Pb. There are normally too many variables in sample homogeneity and spectrometer precision and standardization to firmly rely on 1-2 ppm wear metals movement events. Such decisions are a matter of style and aggressiveness. If one is going to get that fancy, one needs to take into consideration the true time between samples and any lube top-up that occurred, when it occurred.

The full report of the most recent sample is shown in Figure 2 and represents the latest sample available

| | |
|---|---|
| DIAGNOSTIC ADVISORIES | • Conduct external, non-invasive inspections, such as clearances or endplay, and similar diagnostics, as may be appropriate<br>• Performing Analytical Ferrography on this sample may help clarify these results<br>• Performing Micropatch Filter Analysis may help clarify these results |
| MECHANICAL ADVISORIES | Based on any diagnostics efforts undertaken, as well as onsite information available, consider inspecting the following areas for abnormal wear:<br>• BEARINGS<br>• Bushings/Thrusts<br>• Gear or Shaft<br>• Seal(s) or vents and breathers for wear or compromise<br>• Bearings or Bushings/Thrusts |
| Lube / Filter Maintenance | • Check oil storage and handling methods for abrasives entry<br>• To minimize residual contamination retention, and with the likelihood that abrasives are present, FLUSH SYSTEM with lubricant normally used in this sump. If preferred approach<br>• Check sampling procedures - be certain that sample containers are not contaminated in the course of extracting the samples |
| Observations and Reasoning | • Upward copper trend is ALARMING, suggesting close monitoring, or possibly maintenance action<br>• Abrasives are rated at HIGH and actionable level<br>• Copper may represent gear metal (bronze)<br>• Logical Copper Source: Gear or Thrust<br>• Iron level appears to be associated with Silicon ("dirt"), suggesting general wear from ABRASIVES<br>• Tin may be from Bearing Cage material<br>• Copper and Iron logical sources, dependent on ratio, suggest BUSHING or THRUST metal, along with Gear, Shaft or Bearing wear |

| | 11/03/09 | 07/14/09 | 03/26/09 | 12/09/08 |
|---|---|---|---|---|
| Analysis Date | 11/03/09 | 07/14/09 | 03/26/09 | 12/09/08 |
| Lab Sample ID | 353568 | 341224 | 330227 | 320366 |
| Lube | 0 | 0 | 0 | 0 |
| Component | 0 hrs | 0 hrs | 0 hrs | 0 hrs |
| Oil/Filter Chg'd | N / N | N / N | N / N | N / N |
| Iron | 143 | 76 | 33 | 24 |
| Aluminum | 0 | 0 | 0 | 1 |
| Copper | 434 | 237 | 105 | 84 |
| Lead | 2 | 1 | 0 | 0 |
| Silicon | 18 | 18 | 4 | 4 |
| Molybdenum | 0 | 0 | 0 | 0 |
| Chromium | 1 | 0 | 0 | 0 |
| Tin | 50 | 29 | 16 | 13 |

| | 11/03/09 | 07/14/09 | 03/26/09 | 12/09/08 |
|---|---|---|---|---|
| Analysis Date | 11/03/09 | 07/14/09 | 03/26/09 | 12/09/08 |
| Lab Sample ID | 353568 | 341224 | 330227 | 320366 |
| Lube | 0 | 0 | 0 | 0 |
| Component | 0 hrs | 0 hrs | 0 hrs | 0 hrs |
| Oil/Filter Chg'd | N / N | N / N | N / N | N / N |
| VIS 40 | 439 | 442 | 435 | 434 |
| Water | 0.0 | 0.0 | 0.0 | 0.0 |
| AN 664 | 0.83 | 0.59 | 0.5 | 0.46 |

| | 11/03/09 | 07/14/09 | 03/26/09 | 12/09/08 |
|---|---|---|---|---|
| Analysis Date | 11/03/09 | 07/14/09 | 03/26/09 | 12/09/08 |
| Lab Sample ID | 353568 | 341224 | 330227 | 320366 |
| Lube | 0 | 0 | 0 | 0 |
| Component | 0 hrs | 0 hrs | 0 hrs | 0 hrs |
| Oil/Filter Chg'd | N / N | N / N | N / N | N / N |

Figure 2

for this component and, not surprisingly, the situation has worsened. Having disparaged single-digit wear metal growth above, I do like the Ni (nickel) value of 9 ppm as real, given the iron growth. Even the 4 ppm Ni, one sample prior is potentially valid because Ni is one of several wear metals that rarely reaches double digits. Sn (tin) and Cu are accelerating, too, and the composite picture does not look good.

It is unfortunate the previous sample did not persuade maintenance to change out the fluid and flush the system, simply to purge abrasives, as it is possible a cleanup will allow the component to heal itself. Now it may be too late. Even if it's not too late, tangible life has been lost on this component. *Money left on the table*, once again.

We'll try to report follow-up, hopefully not a post-mortem, in a future column.

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