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Fuel Oil Forensics: Using Scientific Evidence to Solve Fuel Problems

By Jerome P. Sava

Forensic evidence can broadly be defined as the collection and application of specific data to implicate or suggest the possible guilt or innocence of a suspect involved in some type of criminal or civil wrongdoing. We are all familiar with the current wave of reality and fictional detective series that emphasize the use of forensic methods to identify a culprit. This same methodical approach can be used when trying to determine the source of oil-related culprits ... gather the facts, identify the evidence, correlate the details, and draw conclusions. Often, our past experiences allow us to simultaneously perform these steps without being consciously aware of them. However, all too often, we find ourselves stymied as to the cause of a homeowner's complaint or, even worse, how to go about to identify and then resolve the problem. In the following case studies based on a host of real field experiences, I have concentrated on the more typical situations and ones that appear to arise frequently. The problems cited have been found to occur regardless of the quality of the incoming fuel, the source of the incoming fuel, the type of supply and transportation (i.e. shipped direct from a pickup point or first stored at the dealer's), or the volume of fuel moved by the dealer. In other words, the problems appear to be universal in nature and also beyond the concern or control of the major oil suppliers – to the perpetual detriment of the typical fuel oil reseller. Hopefully, the following cases will finally suggest a way out of this dilemma.

Case #1: The Mysterious Sludge

Problem: A company located in Connecticut would bring shipments of oil from a major terminal into his own storage facility of three 20,000-gallon tanks. At some point, it became evident that the service department was experiencing an inordinate amount of oil-related service calls and at an ever-increasing frequency. The servicemen reported that the filters were coated with a thick black residue, and also that the oil in the filter-wells exhibited a black color. The dealer checked the loading specs of the oil being supplied to him from his major oil supplier and found that the incoming oil was within ranges for #2 oil, with no evidence of sludge or sediment cited in any of the reports.

Despite these findings, out of necessity the oil dealer initiated a program whereby he had

the servicemen add a preventive maintenance dose of one quart of a sludge solvent to each problem 275-gallon tank, but to no avail. The service calls continued unabated.

Mission: Determine the cause and remedy for the black residue.

Gathering Clues: Samplings obtained from the bottom levels of each of the dealer's three tanks revealed a high level of a dispersed black sediment existing within the bottom three inches of each tank. Laboratory analyses found the black sediment to be solely composed of heavy hydrocarbon particulate, indicative of the early stages of sludge deposition. A comparative study with filters obtained at the homeowners' tanks found that the type of deposits were identical with those extracted from the dealers' tanks. Although a closer review of the loading specs did confirm the overall good quality of the incoming product, subsequent investigative studies found that the fuels had originated as hydrocracked product, had been transported by barge from the refinery to the major supplier, and had there been routinely commingled with other product.

Solution: The black sediment found in the dealer's tanks is typical of the type of hydrocarbon precipitate generated by the oxidation of fuel oil as a result of time, temperature, refining history, and hydrocarbon composition. Any fuel, regardless of initial quality, is subject to oxidation – a phenomenon that eventually leads to polymerization of the black sediment into a congealed mass commonly called “sludge”. The fact that the oil had been cracked, barge transported, and commingled, are all known conditions that tend to accelerate and worsen the thermal stability and oxidative tendency of the fuel.

The dealer's use of a sludge solvent was simply a case of “too little, too late”. Generally, such products are best used as shock treatments for specific problems in isolated situations ... and even then treatment ratios are generally twice that of typical treatment ratios. Generally, sludge solvents are not designed to resolve sludge problems plaguing an entire network of homeowners. A sludge solvent may very well provide critical help in dissolving heavy sludge deposits, but it is unable to prevent the detrimental oxidation/polymerization reactions ongoing while in storage.

Remedy: The first step was to reverse the trend of increased sludge calls by adding a double-dose of a specific shock treatment to the most troublesome tanks. To be truly effective, the treatment must contain a high KB solvency factor, along with wetting agents to penetrate and dissolve the existing sludge residue.

Simultaneously with this effort, the oil dealer initiated a chemical program with C & S to regularly add a multifunctional additive directly to the fuel as the oil was being delivered from the major supplier to the dealer. In order to facilitate this process, a unique additive injection system was designed to permit the automatic introduction of the additive, and at the proper ratio, at the dealer's terminal. Since the additive was blended with the incoming transport loads, it allowed the fuel oil to receive the full benefits of treatment even before it was ultimately delivered to the homeowner.

The specific additive used was chosen because of its high antioxidant activity and its proven ability to improve the stability of oil with less than ideal history, such as that

being transported to the dealer's tanks. In fact, a lengthy study sponsored by NORA and Brookhaven National Lab and presented at the recent Oilheat Visions Conference in Rhode Island, in part compared and tested the oil quality being provided by dealers of both untreated and treated oils. The study determined that additive treatment (coincidentally, the treated-oil dealer had been consistently treating with an additive produced by C & S Scientific) represents an important tool in improving or maintaining the stability of potentially unstable fuels.

By the end of the heating season, the number of service calls were down to normal figures, and equally as important, the appearance and quality of the fuel was maintained at a high level.

Case Closed

CASE # 2: The Gray Filters

Problem: An upstate New York dealer reported that he was running into many reports of clogged filters and nozzles. Inspection of the filters revealed a gray and slimy residue that was obviously setting up an impervious matting and thereby stopping the flow of oil. The dealer suspected a gelling problem so added kerosene to help thin out the fuel, but the problems just continued unabated. Upon questioning, it was learned that the filters were pulled during cold temperatures, but that even when the temperature was above freezing, there was no letup in service calls. He was at a loss to know what to do next.

Mission: Determine the cause and the remedy for the gray filters.

Gathering Clues: The filter samples were collected and tested. It was observed that the gray slimy residue on the filters did not dissolve or soften even at room temperature. Also, sampling of the critical homeowner tanks further revealed that most tanks were outside and contained positive and significant bottom water accumulations. Furthermore, a cross-sectional sampling of the tanks found an intermediate layer of a frothy and cell-laden liquid. The dealer further reported that most instances of clogging occurred closely after an oil delivery had been made to the tank.

Solution: The dealer's suspicion that the problem was due to gelling can be immediately ruled out since that type of slimy residue would not have existed at room temperature. In fact, any separated paraffin would have readily re-dissolved back into clear oil once the temperature climbed above the cloud point of the fuel (about 15F). The intermediate frothy layer detected in the tank samplings is indicative of the evolution and development of biological microorganisms – especially with the added presence of a significant water accumulation at the bottom of the tanks. The nature of the callbacks is

also suggestive of organisms since the cells are light in density and, as a result, tend to be readily dispersed with agitation and ultimately collected on the filters. Once the filters are contaminated, they will not self-clean regardless of temperature or turbulence and, in fact, tend to grow exponentially in such an environment.

Remedy: As much as possible of the water layer and the intermediate frothy layer was pumped out of each affected tank. This procedure was followed by the introduction of a special chemical shock treatment to the remaining oil in order to destroy the existing organisms while simultaneously creating an environment non-conducive to further organic contamination. At the same time, the chemical action also assisted in the breaking down of any of the existing cells so as to facilitate their harmless removal from the oil system during the normal combustion process.

Case Closed

Case#3: The Elusive Water

Problem: An oil dealer in mid-Pennsylvania supplied heating oil to a large complex of attached townhouses. A separate oil handling system, involving a 550-gallon underground tank, lines, and burner heated each row of attached homes. In early December, one of the buildings was suddenly plagued with a series of no-heat calls. However, each time the serviceman went to the site he could not discover any reason for the problem. The filter was clean without any observable residue of sludge or algae; a sampling of the oil tank using water-indicating paste rubbed on an oil stick did not suggest the presence of water; and an analysis of the oil taken at the filter-well satisfied all specifications for an acceptable #2 oil.

Mission: Determine the cause and the remedy for the no-heat calls.

Gathering Clues: A review of the dates for the no-heat calls found that they all occurred when the temperatures fell below 32F but not below 20F. The filters collected by the serviceman during each service call were analyzed and found to be clean on the surface, but with traces of water entrapped within the filter material itself. A sampling of the oil tank, using a "Bacon Bomb" sampling device, found that four-inches of an oil/water mix existed at the bottom of the tank – the suction line for the tank was at the 3-inch level. The fill line itself was covered with a too-large and non-threaded cap.

Solution: The evidence all pointed to only one possible cause for the no-heat calls – the high presence of water in the fuel being delivered to the burner. The oil-paste failed to detect this water content since the oil and water in the tank had, over time, been commingled into an oil/water emulsion. The paste "saw" only the oil that had coated the water droplets and so failed to indicate any presence of water. The filters themselves

clogged with frozen water particles whenever the temperature dropped below freezing, thereby preventing the flow of oil even though the filters appeared clean of any contaminants. The final significant point was that the suction line was low enough to allow the oil/water mix to be delivered through the lines to the burner site – with obvious adverse results.

Remedy: The bottom of the tank was first pumped out so as to remove as much of the oil/water mix as possible. Next, an oil/water dispersant was added to the tank to ensure the gradual and harmless removal through combustion of any remaining oil/water accumulation. Also, an anti-icing agent was added to the tank to prevent any further problems with frozen water particles. Finally, a new and tightly sealed cap and fill outlet was installed to eliminate any future possibility of external water contamination.

Case Closed

A Summation of the Three Cases:

These cases identify three well-known public enemies of fuel oil; sludge, micro-organisms, and water. Although all three culprits tried to hide their identity, a methodical investigation and review of available information, coupled with laboratory analysis and interpretation, resulted in the unmasking of these troublemakers. Unfortunately, the cases are representative of an “MO” that dealers must all too often have to confront. Hopefully, the details described in these cases will help the fuel oil dealer become more knowledgeable of the causes and the corrective actions that are available to foil the culprits before they have a chance to cause serious problems for both the dealer and the homeowner.



