North Carolina Lube Oil By-Pass Filter Project

1) Brief Overview

The lube oil by-pass filter project was developed in an effort to prevent pollution by reducing the amount of used lube oil from engines being discarded to sewers, land-fills, incinerators, etc. The use of this filter system would reduce the frequency of oil changes, and perhaps completely eliminate them. In North Carolina, over 20,000,000 quarts of oil are sold annually for light trucks and automobiles, and more, of course, for heavy trucks and buses. A substantial amount of the used oil is discarded, and the oil from a single oil change could pollute over one million gallons of drinking water.

A lube oil by-pass filter is an additional oil filter installed on a vehicle and operates in parallel with the regular, full-flow oil filter. Within an engine, the by-pass filter system takes a sidestream of 10-15% from the regular oil flow at the discharge of the oil pump, cleans the oil as the engine runs, and returns it to the oil pan to be recirculated through the regular oil system.

This project also initiated the use of oil analyses to give the vehicle managers improved information on what was going on inside the engines, and to alert them to any possible needs for changing the oil and/or filters. An oil sample was taken at the time interval that the oil would normally have been changed and sent to a lab for analyses, usually a total of two weeks from sample to report.

The State of North Carolina has over 35,000 vehicles of all types and uses, and about half of these are school buses. In addition to the NC Division of Pollution Prevention and Environmental Assistance's (DPPEA) interests in preventing pollution, the senior managers of the Department of Public Instruction (DPI) were interested in improving the efficiencies and maintenance of their buses. Ten counties were selected for this program, and each provided six buses for this two year test program, so the program was set-up to include 60 buses total. NC includes mountains and sea shores and all types of climates and terrains in between, so counties were selected from all areas of the state.

DPPEA funded this test program with about $20,000 of grant monies to purchase, install, and initially change the oil in each of the 60 buses in the program. The program started in June of 1997, and ran through June of 1999. The results were of such value to the school bus managers that DPI specified the inclusion of a by-pass filter on all 580 of the new buses purchased for the year 2000, and did this without receiving any additional monies from the NC Legislature.

2) Technological Aspects

The thought of operating a vehicle for years, and even its entire life, without ever changing the lube oil was a concept that did not have wide spread acceptance, and was not easily sold to DPI. During the presentations to the county school bus managers and mechanics, there was considerable skepticism. We used reports of successful by-pass filter tests on over-the-road tractors having gone over 500,000 miles without an oil change, along with studies showing the wear of engines was due primarily to particles in the 1 to 5 micron size range, and a SAE report on by-pass filters in Iowa school buses done back in the '70s and '80s. The filter manufacturers claimed their filters cleaned-up the oil by removing at least 95% of the particles 1 micron in size or less as well as small amounts of fuel and water that get into the lube oil system. In addition to keeping the oil clean, the removal of the 5 – 10 micron particles should also reduce engine ware. There were articles about similar type filters having been used successfully prior to the '50s.

Many people believe oil "breaks-down" in an engine and thus can not be used over long periods of time. Some "experts" claim that oil only appears to break down when it becomes too viscous and/or too thin due to various materials getting into the oil, but the oil itself in fact does not change or break-down. We felt the experts, the reports, and the data adequately supported a thorough test of this filter system.

The use of periodic oil analyses was included in the program to supply the bus managers with improved information about what was going on within their engines, in an effort to give them a sound basis for believing the engines were not being damaged by not changing the lube oil at the frequencies done in the past. These analyses provided detailed information on changes in viscosity, soot levels, moisture levels, metals, dirt, and additives. This type of information would be of particular value in that any increases in metals would also indicate which specific parts of the engine were wearing.

The potential affect of the by-pass filters on engine warranties was a major concern to the school bus managers. The engine manufacturers provided written assurances that the use of these filters would not invalidate the warranties unless it could be proven the filters had caused the problems. Each of the filter manufacturers guaranteed they would replace an engine if it were ruined due to their filter.

Three different types of by-pass filters were selected to be tested. The Purodyne filter (formerly called TFP) which was thought to be a top-of-the-line filter with its strong housing, canister type filter element, oil flow indicator, and heater for removing water, fuel, etc was included. It was the highest cost of the three. The Enviro Filter was included because of its inexpensive paper filter element and overall low cost. The Amsoil Dual-Guard filter was included because of its easy spin-on element change, and it used a wood based filter media. Amsoil's Tri-Guard system including synthetic oil was also included to test for the potential benefits of synthetic oil.

The test program was set-up for each county to test two Enviros, two Amsoil Dual-Guards, one Amsoil Tri-Guard, and one Purodyne filter system over a two year period. In addition to the functioning of the filters, we were also very interested in the various aspects of changing and disposing of the used filter elements.

The current practice is to change the oil filters at 6,000 mile intervals. A school bus in NC drives about 7,000 miles per year on average.

3) Goals and Results:

A) Goals

1) to test the effectiveness of by-pass filters

2) to test the effectiveness of the school bus managers in installing and managing this new type of operation

3) to develop the financial aspects of these filters

4) the long range goal of this project is to completely eliminate oil changes on all vehicles, and the consequent elimination of the disposal of the used oil

The use of oil analyses will hopefully lead to other improvements in managing the maintenance of the buses by giving the managers better information with which to make decisions based on data, as opposed to set schedules.

A cleaner, more consistent oil may also improve fuel efficiencies due to lower friction levels in the engines, so the appropriate records were set-up to monitor for increased miles per gallon (MPG.) The use of synthetic oil was also included in this program to see if it would increase the MPGs.

A cleaner, more consistent oil may also reduce the maintenance of engines and extend their lives. There have been reports of over-the-road tractors running over 500,000 miles without an oil change and essentially no engine wear after tearing down for inspection. The Dade County Florida school bus manager has had very good success in this area over several years.

B) Results

The test program was considered to be very successful. DPI included by-pass filters in the specifications for new buses beginning with the purchase of buses for the year 2000.

Goal 1: Due to work loads coupled with unavailable labor and managerial changes, 12 buses out of the original list of 60 did not participate in the program. Of the 48 that did, 32 of them got through the two years without an oil change. And they are now well into

the third year without oil changes. Some of the 16 changes were done due to information in the lab analyses, and some were done by mistake. During this two year period, we would have expected at least 96 oil changes for the 48 buses in the program. Even allowing for the changes by mistake, 76 out of the possible 96 changes were eliminated, or 79%. The elimination of these oil changes also saved the labor time to make the changes. It is estimated that these filters will save the NC DPI about $100,000 per year in operating expenses.

The bus managers continued to change the full-flow oil filter at the regular 6,000 mile interval, but it is now believed that the full-flow filters in parallel with a by-pass filter remove very little, if anything, and the change interval for full-flow filters will probably be lengthened substantially, with consequent substantial labor savings.

The by-pass filter elements were changed only when a specific reason arose. Most of the by-pass filter elements were not changed during the two year test program. Of those that were changed, it was concluded that the Amsoil Dual-Guard element was the easiest and least messy to handle.

The managers liked the oil analyses very much. In addition to specific numbers, the lab reports included specific advice if a test result were out of line with an expected result. Soot levels in the engine oil are generally a major concern for diesel engines, and an upper limit of 4% had been set at the outset of this program based on the experiences of the mechanics. Throughout the two years of this program, it was very rare to see soot levels above 1%. The viscosities remained very uniform for the most part, but a few buses were changed due to rising viscosities. In a few instances, the by-pass filter element was changed when the lab analyses showed numbers rising, and in every case, the numbers returned to the expected ranges without changing the oil. In a few instances, the lab results showed a need to watch carefully for leaking gaskets, dirt in the oil pan, etc. Some managers started including other buses in this part of the program.

We did not see differences between the performances of the three different filters tested in their abilities to keep the oil clean and uniform.

At the end of the first year, there appeared to be an improvement in miles per gallon, but the data did not confirm this at the end of the second year. The synthetic oil did not appear to provide improved MPG.

Goal 2: The insertion of this type of filter into the existing maintenance program required changes in the record keeping system that was used to schedule oil changes. There were no blank spaces in the system to easily accommodate the additional information needed to properly manage the by-pass filters. But the managers, including those maintaining the central record system, developed an effective alternative to handle this situation. The mechanics doing the oil changes were also very interested in making this program work and took special precautions to ensure the oil was not changed, which worked for the most part as explained above. This included special labels and other reminders about the by-pass filter on a particular bus.

The managers accepted and began using the oil analyses immediately, and to the point of requesting not to make a program-wide change of the by-pass elements after the first year. They pointed out, and rightly so, that the analyses did not indicate changes were needed. Although not explicitly stated, it is believed they were very interested in using their manpower for other priority needs.

Goal 3: The original financial analyses indicated there might also be a good return-on-investment (ROI.) Assuming oil changes would be done every three years and an oil pan holding 25 quarts, the test results indicate a minimum ROI of about 38% if the most expensive filter were installed. Installing the less expensive filters could produce ROIs in the 75% range. We of course expect the oil changes to be much less frequently than every three years. The recent new EPA low NOx regulations have caused the engine manufacturers to adjust the engines such that they will produce more soot, which will necessitate more oil changes. In order to not increase the frequency of oil changes, the manufacturers have increased the size of the oil pans, which would raise the ROI.

This test program was not of long enough duration to evaluate the potential benefits of reduced engine maintenance, but it is expected this could easily turn out to be the major financial benefit of this system.

Goal 4: This goal has not yet been reached, but we believe the day is coming.

4) Transferability

This technology and its substantial benefits are easily transferable to all types of vehicles, regardless of the type of fuel used. Most of our school bus managers and mechanics quickly and easily adapted to this new way of maintaining and improving the efficiencies of the buses, even though it meant changing the recordkeeping system they had been using for scheduling oil changes. The savings in manpower easily compensated for the minor changes and additional attention required to operate this program successfully.

In addition to the pollution prevention benefits, the very good financial benefits should help motivate the use of this filter system throughout various types of fleets, and someday in individual cars.

A particularly valuable transferable aspect of this test is its potential use in view of the new low NOx diesel engines prescribed by the EPA. In order for the engine manufacturers to meet the new NOx levels, one of the modifications they are making is to change the timing settings of the engines, which will most likely cause the soot levels in engines to rise substantially. The new school buses purchased for the year 2000 have larger oil pans, supposedly to accommodate the anticipated higher soot levels. This change would obviously increase the amounts of used oil. The by-pass filters could negate this negative aspect of the new low NOx regulations.

5) Integration into DPI's activities

DPI specified the Amsoil Dual-Guard by-pass filter in each of the 580 new school buses purchased for the year 2000. DPI did not get additional monies to purchase these filters, whose installed cost was about $250,000; they took it out of their budget for buying new buses. It will be interesting to see if the savings over the years motivate the DPI management to also retrofit part or all of their existing fleet.

An additional benefit of this program is that the filters can be gradually worked into the system, or done all at the same time, depending on the financial resources and manpower available. The installation and maintenance of these filters is quite easy to learn.

All of these new buses will become part of the lab analyses program, and other buses without by-pass filters will probably be included, as has already been done in some counties.

6) Resources for the project

Money: DPPEA provided $20,000 of grant monies to fund this project. The DPPEA grant monies have been used primarily over the years as "seed" money to encourage managements to approve the testing of new potentially viable technologies. This specific program has been successful in helping develop a very effective pollution prevention program that was subsequently adapted and expanded by an operating management, with an initial investment of over ten times the grant money provided.

Equipment: Several by-pass filters were available on the market, and three of them were chosen for this project. When a bus reaches the end of its usefulness, the by-pass filter can be transferred to a new bus.

Many school buses were available, managed by good managers interested in improving their operations and efficiencies.

Lab Analyses: The NC DOT had a contract with Petroleum Products Monitoring of Athens, GA to test oil samples for about $6 each.

Installation and labor: Each of the counties installed most of the filters using their own mechanics. The installation was facilitated by special adaptors and valves for taking the oil stream from the discharge of the oil pump, and returning the oil to the oil pan.