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**The Achilles Heel of Natural Gas
Vehicles:
The Symptoms, Diagnosis and Prevention of
Oil Carryover**



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Introduction

A large transit agency was experiencing engine performance problems with their natural gas buses. Their contracted service technician, responsible for maintenance of the fueling station, diagnosed the problem as an engine issue. NGVi was brought in after explaining to agency management that the sealed fuel system onboard the vehicle allows gas to flow only one way, making it improbable that the oil could leak from the engine into the onboard fuel system.

The technician in question, like many working on natural gas vehicles, assumed a vehicle problem even though the majority of engine performance issues are attributable to oil carryover, which is a problem that begins at the fueling station. If the vehicle is hard to start, hesitates under acceleration, runs rough or stalls frequently, chances are the problem is with oil from the natural gas fueling station compressor carrying over into the vehicle fuel system. Once the compressor oil gets into the on-board fuel system of a vehicle and travels through the high-pressure regulator to the fuel rail and fuel solenoids, it can be very costly to repair. In one such instance, a relatively new bus had to be repaired at a cost in excess of \$2,000 due to oil carryover. Fortunately, oil carryover is a preventable issue. This paper explains how to identify, solve, and then prevent the problem in the future.

Diagnosis

Natural gas used for vehicular application and delivered from a CNG fueling station must be free of any solid material, water or oil. The heart of the natural gas fueling station is the compressor and most compressors require lubrication (oil). Over time, it is impossible to prevent some amount of the lubricant from leaking into the fuel stream. Specific equipment, called a coalescing filter, is designed to remove any liquid or solid contaminate in the high-pressure natural gas. They need to be installed downstream of the compression system, before the compressed natural gas enters the time-fill or high-pressure storage system, as well as onboard the vehicle's fuel system, to ensure that oil does not get into the onboard fuel storage cylinders and ultimately into the engine.

Ordinarily, a technician would use computer diagnostics to evaluate an engine performance issue. In the case of oil carryover, when the OEM vehicle is plugged into the computer, it will not show an engine problem because the problem is with the fuel. There are several inspections you can perform to verify oil in the vehicle's fuel system.

1. Remove and inspect the vehicle's fuel injector or spark plug. If it's black or if there's oil on the fuel injector or spark plug, it's an indication that there is oil in the vehicle's fuel system coming from the fueling station's compressor.
2. If there's a coalescing filter on the vehicle, depressurize the system and unscrew the bowl on the bottom of the filter housing. Look inside the filter bowl and determine if there's liquid oil in the bottom of the coalescing filter housing. If there is, it means there's oil in the entire fuel system, including the onboard fuel cylinders.
3. If the vehicle doesn't have a coalescing filter, depressurize the fuel system and remove the high pressure regulator to inspect for oil. If you find oil, there's oil in the entire fuel system, including the onboard fuel cylinders.
4. If for some reason you must remove the onboard fuel storage cylinder from the vehicle, if you drain the cylinder, the presence of oil would provide further verification that the oil is coming from the fueling station's compressors. It is not recommended that you remove the cylinder just to prove the existence of oil.

Solution

Fuel provided by a third party

The fueling station operator may not want to hear that the station is the source of the problem. You can demonstrate oil carryover by putting a Q-Tip inside the vehicle's receptacle, remove it show them the oil and explain the oil is coming into the vehicle via the fueling receptacle. Then go to the station fueling nozzle and repeat the Q-Tip exercise. Again, you should see oil on the Q-Tip, proving your point.

As demonstrated by the transit example in the opening paragraph, if there's oil in the vehicle onboard fuel system it has to be coming from the fueling station because the fueling system onboard the vehicle is sealed and gas only flows in one direction – toward the engine.

If you own the fueling station

There should be a coalescing filter inside the housing of each dispenser, one for each hose. The fueling station also should have no less than two coalescing filters between the discharge of the compressor and the inlet to the high pressure storage system. These filters should be located as close to the storage as possible, because the gas has more opportunity to cool and the oil to drop out and be captured in the filter element. The filters should be inspected and drained periodically. If upon inspection there is oil in the coalescing filter bowl, the filters should be drained daily until there is no more oil.

The vehicle

If there is a coalescing filter in the fuel system you must drain the coalescing filter several times a week until liquid oil ceases to flow. First depressurize the system and unscrew the bowl on the bottom of the filter housing. Look inside the filter bowl and determine if there's liquid oil in the bottom of the coalescing filter housing. If oil is present, then you may have to repeat the depressurization and drain process several times a week. You also can clean the spark plug and the fuel injectors. In severe cases, it could take several weeks to remove the oil from the system.

Prevention

Fortunately, there are many ways to prevent oil carryover problems. The following five recommendations provide a starting point to eliminate oil carryover and improve fuel system operation and reliability.

Recommendations:

1. Fuel quality standard with liability clause in contract for third party fuel.
Read NGVi's Technical Paper: *Clause and Effect: What to Look For in an Effective Natural Gas Transportation Fuel Contract* at www.ngvi.com.
2. At least the minimum number of coalescing filters on the fueling station.
3. At least the minimum number of coalescing filters on the vehicle.
4. For CNG vehicle operators/maintenance technicians, develop and implement comprehensive preventative maintenance practices, including routine filter inspection for vehicles.
5. For station owners/operators, implement training specific to the CNG fueling equipment operated including operation, diagnostic and maintenance practices necessary to ensure clean fuel, highest fuel system safety, operation and reliability.

Conclusion

Once the recommendations above are implemented the oil carryover issues should cease and thereby eliminate the poor vehicle performance caused by oil carryover. However, training and maintenance, on both the station and vehicle sides, are crucial to keep the issue from returning. It is important that the equipment installed to facilitate the removal of oil be properly sized, located and maintained. With maintenance technicians properly trained in the current maintenance and operation practices specific for the equipment installed at their station or on their vehicles, they will be able to diagnose a potential equipment or system problem well in advance of equipment failure, thus ensuring the cleanest fuel, highest fuel system safety, operation and reliability.

NGVi Options

NGVi offers **training and consulting services** on natural gas as a transportation fuel. Training sessions that cover the topic of oil carryover include:

- **CNG Fueling Station Design Training**

The course teaches you how to size station equipment appropriately to meet the fleet's/customer's needs and how to specify the right equipment to ensure safe operation. You will learn the national codes and regulations that CNG fueling stations are subject to, and the critical factors in the construction process. You also will learn how to plan, size and develop a budget for constructing a CNG station. Students who successfully complete the course and pass a written exam receive a certificate verifying that you have received training in the latest fueling station technologies.

- **CNG Fueling Station Operation and Maintenance Training**

This two-day course provides complete, in-depth instruction on proven, "best practices" for natural gas fueling station operation and maintenance. It provides the basis for developing and implementing effective routine maintenance and safety plans.

The comprehensive curriculum for the course covers everything from a basic introduction to compressed natural gas (CNG) to how to conduct a natural gas fuel station safety inspection. Whenever feasible, students will tour an operating CNG fueling station, applying what they have learned and reviewing the most critical operation and maintenance characteristics of the station. Upon completion of the training, students have the framework for a complete maintenance plan, ready to implement, including a safety evaluation checklist.

Students who successfully complete the course exam (70% or more correct), receive a certificate of completion for this course.

- **NGV Technician and Fleet Operations Safety Training**

You will receive detailed training on the safe operation of dispensing equipment and safety systems located at the fueling station and on vehicles. Mechanics receive in-depth instruction regarding safe maintenance practices, fire safety systems located at the maintenance facility, the fueling station and on NGVs, as well as safe operation of natural gas dispensing equipment.

For more information about these and other consulting services, contact Leo Thomason at 702-254-4180 or via email at info@ngvi.com.