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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, a division of AFVi, 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.  
[Click here](#) for AFVi's Technical Paper: *Clause and Effect: What to Look For In an Effective Natural Gas Transportation Fuel Contract*.
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:

1. **CNG Fueling Station Design Certification Course**

CNG Fueling Station Design Certification is a two-day course which provides comprehensive training for public and commercial sector professionals needing to learn the most up-to-date methods and practices for sizing, designing, specifying, and constructing a CNG fueling station – ideal for engineers, designers, owners and those interested in acquiring a CNG fueling station. Attendees receive a certificate of course completion, upon getting at least 70% correct on the course exam.

2. **CNG Fueling Station Operation & Maintenance Certification Course**

This two-day course, provides complete, in-depth instruction on proven, "best practices" for natural gas fueling station operation and maintenance – ideal for station maintenance personnel who need to develop and implement effective routine maintenance and safety plans. Attendees receive a certificate of course completion, upon getting at least 70% correct on the course exam.

3. **NGV Drivers and Mechanic Safety Training**

This one-day course is devoted to training drivers and mechanics on safe vehicle fueling and maintenance of today's natural gas vehicles. The training will deliver all the information necessary to insure that your NGV fleet is driven, fueled and maintained to meet or exceed current safety standards. Trainers are welcome and will go through the same training as Drivers and Mechanics and will also receive "Train the Trainer" instruction and all course materials and support software.

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

There are several **technical papers and publications** that augment the information included here. They include:

1. [An Ounce of Prevention: The Nuts and Bolts of CNG Fuel System Inspection](#)
2. [Clause and Effect: What to Look For In an Effective Natural Gas Transportation Fuel Contract](#)
3. [Natural Gas Vehicles: The Decision Starts Here](#)