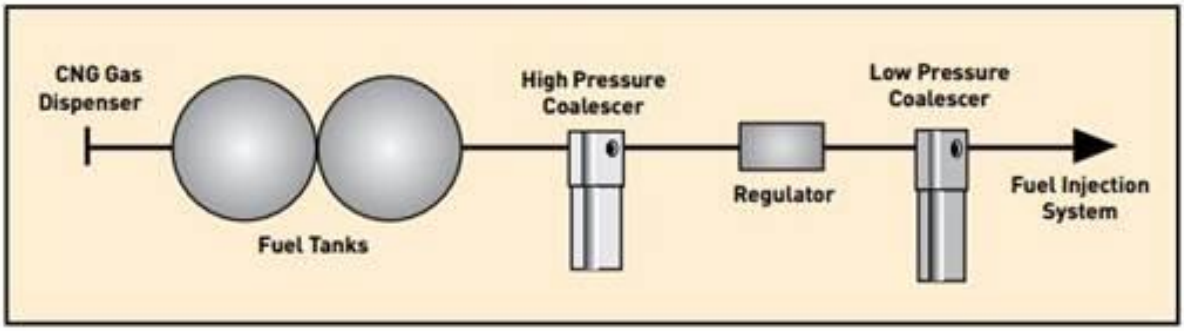
How and Why is Oil Getting Through Your Vehicle's Coalescing Filters?



Oil carryover is a major concern for anyone owning, operating, servicing or maintaining natural gas vehicles (NGVs). Its presence can result in hard starting, rough idling, hesitation under acceleration, or stalling. The oil itself usually comes from the lubrication that's applied to compressors at compressed natural gas (CNG) fueling stations. While it's true that well-maintained stations should have suitably sized and properly located filters to catch varying amounts of contaminants, it's still possible for oil to get through.

Heavy-duty NGVs use one or two coalescing filters, depending on the engine model. High-pressure filters are located upstream of the high-pressure regulator. When low-pressure filters are used, they are placed downstream of the regulator. Each filter is designed to remove as much oil in liquid and aerosol form as possible.

Dan Ryan, Engineering Manager of the Finite Airtek Filtration Division at Parker Hannifin Corporation, offers insight into how these filters work, and answers some commonly asked questions posed by vehicle technicians during their **NGV training**.

Question: **Trainers sometimes hear reports from truck fleet technicians saying there is no oil found in the high-pressure coalescing filter, but oil is found downstream in the low-pressure coalescing filter. The filters are drained and serviced regularly, yet oil contamination is still found in the engine's fuel system components. From your expertise and experience, what would help?**

Answer: Two factors that influence coalescing (liquid and aerosol removal) efficiency are the velocity of the gas traveling through the element, and the grade of the filter element — hence the oil aerosols carried by the gas. The velocity of the gas traveling through the filter media is a function of several factors. First, the amount of fuel required by the engine affects gas velocity. Clearly, an engine at wide-open throttle uses much more gas than an engine at idle. Second, the pressure of the gas in the fuel system also has a big effect on the gas velocity.

When gas is compressed to a high pressure, the gas molecules are packed closer together. The actual flow rate through the filter when the system pressure is 3,600 psi is much lower than the flow rate of the gas through the filter at 250 psi system pressure for any given throttle position. If we do the math, the flow rate at 3,600 psi is 0.07 times the flow rate at 250 psi. If we include the pressure variation with the difference between the flow rate at idle versus the flow rate at wide-open throttle, we are asking the coalescing filter to operate over a wide range of flow conditions and the ability of the filter element to remove liquid aerosols can drop off dramatically.

The simplest solution to improve coalescing efficiency on the high-pressure side of the regulator is to make sure that the highest efficiency filter element is mounted in the housing. For most CNG applications, that means a Finite® Grade 6 filter element. The Grade 6 element is rated 99.97% efficient at removing liquid and aerosols, versus the 95% rating of the Grade 10 filter element. That is a significant improvement, meaning that the Grade 6 element is about 170 times more efficient than the Grade 10 element. The tighter Grade 6 element does not lose as much filtration efficiency in low flow rate conditions as the Grade 10 filter element.

Finally, in many applications, the low-pressure filter element can be changed to a Finite Grade 6 to improve coalescing efficiency of the filter on the downstream side of the regulator. We recommend that fleet maintenance technicians check with the engine manufacturers to make sure that the small, additional differential pressure caused by the tighter Grade 6 element (about two to three additional psi of pressure drop across a Grade 6 versus a Grade 10) won't affect engine tuning or performance.

Q: **Can you explain the different types and Finite grades of media inside Parker filters?**

A: The filter media grades indicate both the coalescing (liquid and aerosol removal) efficiency of the filters as well as the pore size, or the size of the smallest particles, that are removed. Here is a chart showing the performance of the four different Finite media grades:

Finite Grade	Coalescing Efficiency	Absolute Particle Size Rating
10	95%	1 micron
8	98.5%	0.7 micron
6	99.97%	0.3 micron
4	99.995%	0.2 micron

Absolute Particle Size Rating represents what particle size the filter is at least 99.9% efficient at removing. Not all grades are available in all filter housings. The coalescing filter elements manufactured by Parker Finite are made from wet-laid borosilicate microglass fibers. The filtration efficiency is definitely related to the size of the fibers in the filter element. If the fibers are too large, such as the fibers in a cellulose filter element, then the liquid aerosol droplets won't hit and cling to the fibers, and liquid removal efficiency will be poor. The glass fibers in a

Parker Finite coalescing filter element are bound together with an epoxy resin binder that gives the filter element strength and integrity.

Q: **Are you aware of lower priced/lower quality filters available in the marketplace that are causing headaches for fleets?**

A: Not all aftermarket filter elements are made from the same materials (borosilicate microglass fibers with an epoxy resin binder) as the original equipment filter elements. This can drastically change the overall performance of the filter, allowing more liquids to go downstream and foul the regulator, or the fuel rail and the injectors. If the binder that holds the filter element's fibers together isn't fully compatible with CNG and all possible compressor lubricants, both mineral and synthetic, then the element can weaken, fail, and be carried downstream by the gas flow, fouling fuel system components. Also, the material the seals are made from on a genuine Parker Finite element were chosen after much research by Parker Finite engineers and our partners at the Parker divisions that specialize in formulating custom rubber compounds for seals in CNG service.

Q: **Does Parker recommend which Finite grades to use, the number of filters needed, and where to install them? Or is that left up to the CNG vehicle fuel system engineers?**

A: We work with the fuel systems engineers and use our more than 20 years of experience in this industry to make recommendations based on scientific fact, lab testing, and over-the-road experience shared with us by our many customers.

As mentioned previously, we first recommend Grade 6, a very efficient grade of filter media. Sometimes differential pressure can be an issue for the fuel system designer, so we ask that they use the most efficient filter media possible that will still give them the differential pressure (Delta P) performance they require.

We usually recommend they use both high-pressure and low-pressure filter housings, but sometimes space or budget concerns won't allow for two filters on one vehicle. If that's the case, we recommend the single filter be installed downstream of the regulator. With the pressure held constant by the regulator, the performance of the filter can be easily predicted because the flow rate variation is caused solely by the difference in flow between idle and wide-open throttle. A low-pressure filter is almost always physically larger than a high-pressure filter, so sometimes size or plumbing constraints will rule out a filter on the low-pressure side of the regulator. In that case, we go back to recommending the high-efficiency media, Grade 6, for the high-pressure filter housing.

Whether your NGV is using Parker Finite coalescing filters or any other reputable brand serving the NGV market, oil carryover can be avoided with one simple tactic: the Q-tip test. Before the driver or technician begins fueling the vehicle at the CNG station, swab the fueling nozzle. If oil is present, alert the fueling station operator, and, if possible, do not fuel your vehicle at that station. This may sound trivial or inconvenient, but a single Q-tip could save your entire fleet from months of revenue loss and aggravation.