

# Magnetic Eco-filtration: Ultra-dynamic fluid purification at the sub-micron level

Eng. César A. Gómez R.

[www.filtermaster.com.co](http://www.filtermaster.com.co)

E-mail: [cesar.gomez@filtermaster.com.co](mailto:cesar.gomez@filtermaster.com.co) – Research & Development Director  
Bogotá, D.C. – Colombia

## Abstract

This study presents the results obtained during pilot research tests to practically enable the incorporation of high-power vehicle magnetic filtration technology, available since 1994, to dynamically ultra-purify hydrocarbons, oils and fuel mixtures, to the ISO purity level required by the diesel designs of very low-emission eco-engines since 2000 in Colombia. This is due to the significant impact of exhaust emissions from traditional diesel/acpm transport (freight and passenger) and from urban industry, which negatively affects air quality and the health of users and citizens.

Starting with the first emissions inventory in the city of Bogotá (2009), I began investigating the root cause of the problem that forced the contingency of '**tropicalizing**' the eco-engines (EURO/EUI), that is, removing the original fuel injection system so that they would 'start' with the available diesel. This lost the promise of energy and environmental efficiency of the technology due to the blocking of the emissions control systems. Subsequently, the use of ACPM, a diesel blend with a portion of biodiesel, increased the content of polluting particles and water, which affected the dynamic lubrication cycle, also.

Contingency that led to the implementation of 'special measurement practices' of gases and particulate matter (opacity) quite far of the international air pollution standards to authorize urban buses 'operation'.

In the hydrocarbon distribution chain, various of stakeholders defend their delivery level of fuel "cleanliness" (parts per million), which is quite far from the delivery level of **fuel purity** (particles per milliliter). Last link of distribution chain, the fuel supply station (EDS), receives the accumulated of contaminants from the distribution process and is legally forced to carry out costly and ineffective "cleaning" practices.

Many of the local studies ignored 'mapping' fuel pollution at the particulate level, hence after 25 years there has been no progress despite signing a global mitigation commitment (COP21-2015); today, it seems that the world admits the same thing, there is no progress, why set new mitigation goals (COP30).

The lack of official support from state institutions drew support from public and private academia, despite the results of direct measurements from the current emissions inventory in Bogotá in 2009. Therefore, I developed the practical experimental designs just to have the 'homologated eco-filter prototypes' in order to obtain the authorization to drive the pilot tests at portals/stations of massive transport vehicles, urban/intercity, fuel production and blending plants, pipelines, fuel tank trucks, and fuel supply stations; within ISO 4406 standard sampling procedures and running all necessary analysis of polluting characterization and particle size distribution of all of the present components in fuel, gases and soot tests and under real-world conditions.

The findings revealed the real 'root cause' of the significant loss of engine performance, the great

# Magnetic Eco-filtration: Ultra-dynamic fluid purification at the sub-micron level

Eng. César A. Gómez R.

increase in emissions, and the loss of more than a half of the equipment's functional life.

## The Problem

Since 2000, the high socio-economic and environmental costs of modifying the original fuel injection system have been evident in the country. This modification, publicly referred to as the "tropicalization" of eco-engines, was necessary to operate on the high-particulate diesel/ACPM available; this occurred more than 25 years ago. As a result, over 50% of the factory-guaranteed energy efficiency was lost, emissions tripled, and the "functional" lifespan of the equipment was reduced by more than 50%: an extremely high operational cost with a maximum environmental impact.

## Eco-engine Technology

The results obtained up to 2016 allowed us to know with high precision about definition of the "Socio-economic impact of ultra-magnetic fuel ultra-purification on dynamic emissions mitigation with great energy efficiency gain." This work was presented at the 5th CIUREE conference held in Cartagena. (BENNETT, SEAN, 2010)

Manufacturers of high-pressure fuel injection (HPCR) systems defined the stringent purity requirements (COP21/ISO 4406) for fuels and lubricants to operate eco-engines that guarantee very low, practically 'absolute' emissions control thus promoting the environmentally responsible use of hydrocarbons. Technical sponsor of the absolute magnetic filtration systems manufacturer supplied prototype test filters for various testing scenarios, with an emphasis on hydrocarbon ultra-depuration. The exploration and measurement of the efficiency level of the eco-filters were continued in long,

medium, and very short-term operations. All of study cases, evidenced the great design flexibility and the high level of homologation of this technology to show that the absolute level ( $\beta_{200}$ ) of filtration was very easy to reach and profitable to incorporate into any operation with evolution in dynamic and reliable filtration equipment at the sub-micron level: evolution and innovation in efficient, automatic and reliable particle separation at this level, 100% reusable and durable equipment at a much lower value (best ROI) than any cost of conventional disposable filtration filter (GOMEZ R., César A., 2016).

Eco-filters for diesel, oil, and exhaust were installed on the lowest-performing metro bus into the twin-fleet and quickly it becomes the most efficient and reliable. Samples of sludge were collected from fuel dispensers at terminals and service stations for contaminant characterization analysis. It was fully demonstrated that magnetic filtration technology would achieve the fuel purity level required by the eco-engine manufacturers (RAJAEIFAR, 2019).

The results were conclusive, achieving a high ISO 12/9/6 purity code with prototypes, resulting in a proven benefit for the 'modified fuel injection' fleet and differentiating the eco-bus by better fuel and lubricant performance, with less gas opacity and greater reliability than those shown by the other modified engines.

The following physical effects were determined that make the combined magnetic eco-filtration technology absolute at the sub-micron level (ISO-4406 particles 4, 6 and 14 microns) (GOMEZ R., César A., 2025):

- ◆ Design flexibility allows homologate with 100% of compatibility the incorporation of high-power magnetic fields train (rod) into

# Magnetic Eco-filtration: Ultra-dynamic fluid purification at the sub-micron level

Eng. César A. Gómez R.

containers of the size of nominal vehicular and industrial filters.

- ◆ Standardized filter elements made of stainless-steel cloth-media combined with a core of magnetic fields into ss-rods guarantee 99.5% of efficiency into ss-hard, durable and reusable cases just offering high autonomy, easy cleaning and absolute efficiency.



- ◆ Eco-friendly technology what eliminates the current 'pollutant' disposal of used filters and lube oils.
- ◆ Greatest contribution of the technology is to guarantee the operation of eco-engines in Colombia: 'use of high-pressure multi-fuel injection rail systems (HPCR) fully synchronized to emissions control systems (catalytic conversion and soot-DPF).
- ◆ It adds significant value by automatically incorporating dynamic dialysis of the oil cycle to technically manage the recycling of the base lubricant.



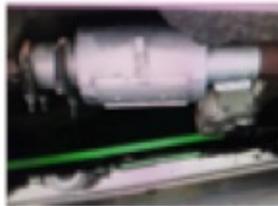
- ◆ The high magnetic power of the multi-field train along the rods generates physical effects that separate and retain all solid, semi-solid, ferrous and non-ferrous particles, microorganisms, and water, these effects are: static charge, static adhesion, surface tension, and biocidal, keys to fit absolute dynamic depuration of fluids.
- ◆ The flow resistance and clogging (bypass) of magnetic eco-filters are much lower than those of 'nominal', cellulose (paper) and/or plastic media-filters: energetic saving for gaining efficiency.
- ◆ Consumption of fuel and lube oils is minor, no filters' by-passes harmonize operation of emissions control systems.

## The solution

Given the global commitments in Climate Change to mitigate emissions, the demanding conditions of eco-engine manufacturers, and the number of actors involved in the distribution and delivery of fuel mixtures for consumption in the country, all of pilot studies were designed and run with the direct participation of directors and operators of the maintenance thru operation logs, comparing daily during 12 months, the performance of the 'eco-buses' against the rest of the fleet's same model units; the result: eco-engines exceed expectations just trespassing from the poorest level to the best performance in years of operations even keeping installed the same low pressure fuel injector.

# Magnetic Eco-filtration: Ultra-dynamic fluid purification at the sub-micron level

Eng. César A. Gómez R.



Detailed traceability of current operation on the road under same conditions with the rest of the fleet, along with sampling of fuels, gases, and lubricants, allowed for conclusive results in the laboratory and on-site analyzers regarding the technical and economic benefits, even with the modified injection system operating at a low pressure (700 psi) by using **23/22/19** polluted fuel, which it was five times less efficient than fabricator's original fuel injection (EUI/EURO-3500psi). Field performance indicators versus the promised originals made it possible, just to measure and infer the negative technical, economic, and environmental impacts of the wrong action: doubling costs, reducing the functional life by more than half, and tripling emissions. The original EURO design injection system was removed rather than depurating the diesel/acpm delivery to demanded value by the manufacturers - ISO code **18/16/13** (2000).

Analysis of the total collateral damage resulting from the action of using engines with highly contaminated diesel/acpm at the level of particles (+40,000 p/ml), revealed the following findings in the operating workshops of all fleets: a) carrying out innocuous and/or paradigm practices, without any technical support, costly and 'subtracting' the impact on engines: periodic cleaning of receiving tanks, fuel loading contingencies and 'removal' of moisture with different paper filters totally useless, b) 'delaying' the change of filters and oil in all vehicles to 'reduce' the costs and c) 'idle start' of 20-40 minutes to 'warm' the starting power: waste of fuel.

Now, availability of portable and in-line particle and water content counters allowed to incorporate real time measurement of the purity of the hydrocarbon unloaded for final delivery and use, in addition to the multi-functionality of the ultra-purification (ISO level) unit.

Correlation of all of the results from the different studies carried out into hydrocarbon sector around fuels, provided the complete characterization and size distribution spectrum in order to conclude that the certification of the delivered ISO purity code should be done at the supply station (EDS) and lubrication centers.

On-site stationary measurements of lube oil, gases, and soot, as well as laboratory and opacimeter readings, yielded significantly lower values than the dynamic measurements. Just, in the case of exhaust soot, the reading was approximately 600 grams/km!

It was necessary to integrate all the findings obtained since 2011, in order to configure and define the functional capacity of the eco-filtration unit.

# Magnetic Eco-filtration: Ultra-dynamic fluid purification at the sub-micron level

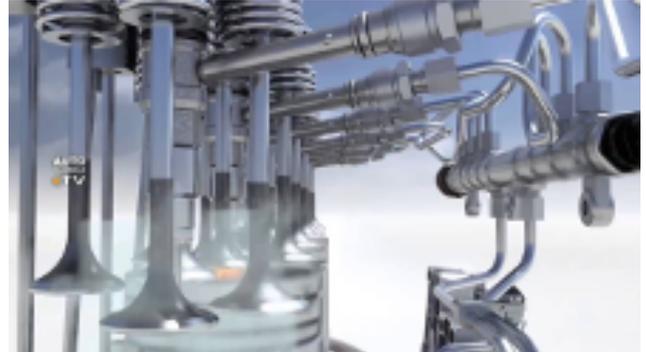
Eng. César A. Gómez R.



Extensive route testing at fleet portals for engines and dispensers at portals and service stations defined the fuel tanker unit size to maintain current delivery dynamics.



In 2012, eco-engine manufacturers introduced the very high pressure (+35,000 psi – HPCR) multi-injection common rail system, which requires a minimum purity of -14 microns, ISO code 12/9/6.



The extension of studies on dynamic magnetic ultra-purification of liquid fuels to compressed natural gas (VNG) yielded highly efficient results for a Y-type purifier for VNG dispensers at supply stations. Although these purifiers were not installed in local dispensers, results demonstrating their autonomous operation obtained in other countries were shown. A complete information about the technology can be found on the website [oneeyeindustries.com](http://oneeyeindustries.com)



Technical workshops in universities, companies and plants during more than 11 years of research brought the design, manufacture and installation of industrial magnetic separators in the oil sector for the dynamic ultra-purification of large volumes of natural gas in **Reficar**.

# Magnetic Eco-filtration: Ultra-dynamic fluid purification at the sub-micron level

Eng. César A. Gómez R.



others even to be measured, results of this 'very particular operation' authorized in our country (GOMEZ R., 2022).

These are the inferred rating indicators of the real-word of this key action in climate change just adopting the environmentally responsible use of hydrocarbons:



## Conclusions

The absolute and clean technology of magnetic eco-filtration is evolving and transforming processes in an environmentally sustainable and highly cost-effective manner through energy efficiency gains, reduction of environmental liabilities, and by representing the most efficient energy transition guide for hydrocarbons, reliably and profitable at mitigating more than 70% of current climate change emissions in Colombia.

The evident and negative whole impact of great content of particles - solids, semisolids/organic, microorganisms - and of + 1500 parts per million (ppm) of water – fuel hygroscopicity -, pollutants currently present in diesel/acpm have consolidated an expensive waste of resources: reduction of combustion efficiency (+50%), loss of performance and functional life of the equipment (+50%), blockage of the catalytic conversion systems of gases and 'sequestration' of soot, rapid deterioration of the lubrication cycle with increased engine erosion, among

The inconsistency in acquiring emissions mitigation commitments (COP21-2015) and the serious effect of making decisions without addressing the root cause of the problem, maintains absolute disobedience to the mitigation commitment so far, with the highest technical, socio-economic and environmental detriment.

Harmonizing the hydrocarbon purity required by equipment manufacturers reduces costs, transforms with energetic gain and guarantees minimal emissions and footprint; this effect, already proven by eco-engine manufacturers and the incorporation of dynamic ultra-purification (< 1µm) (dialysis) of lube oil cycle for extending the functional life of equipment with management for technical recycling of base lubricant, make of this technology, the very reliable tool for driving the clean, profitable and sustainable hydrocarbons global transition.

Since 2000, we have been misusing diesel fuel by removing the fuel pressure injection system and misusing eco-engines: we have multiplied fuel and equipment costs and tripled emissions, losing more than COP \$+280/km.ton transported.

# Magnetic Eco-filtration: Ultra-dynamic fluid purification at the sub-micron level

Eng. César A. Gómez R.

## Bibliografía

- GOMEZ R., César A. (2016). *Impacto socio-económico de la ultra-depuración magnética de combustibles en la mitigación dinámica de emisiones y en mayor eficiencia energética*. Cartagena: V CIUREE.
- RAJAEIFAR, T. A. (2019). *Emissions from urban bus fleets running on biodiesel blends under real-world operating conditions: Implications for designing future case studies*. Newcastle: ELSEVIER.
- GOMEZ R., César A. (2025). *Eco-filtración Magnética*. Cartagena: ACIEM.
- GOMEZ R., C. A. (2022). Obtenido de filtermaster.com.co.
- BENNETT, SEAN. (2010). *Modern Diesel Technology: Diesel Engines*. (C. Learning, Productor) Obtenido de Modern Diesel Technology: <http://www.delmar.cengage.com>

## Anexo



The socio-economical impact of the magnetic ultra-filtration of fuels in the dynamic mitigation of emissions with energetic efficiency.

Author: Eng. César Augusto Gómez Rojas

ONE EYE INDUSTRIES, INC.  
Calgary, CANADA  
[www.oneeyefilter.com](http://www.oneeyefilter.com)  
FILTERMASTER COLOMBIA S.A.S.  
Bogotá, D.C. COLOMBIA  
[www.filtermaster.com.co](http://www.filtermaster.com.co)  
Cell: 371-310557902  
Cesar.Gomez@filtermaster.com.co  
February 2016, English version Rev.01  
PhiYo@oneeyefilter.com

### ABSTRACT

In general, the conventional filters are nominal, disposable and lag behind the new eco-design requirements of today's rotary equipment. Industries associated with crude oil, gas and/or bio-diesel have resisted the incorporation of more efficient and reliable magnetic filtration solutions which are reusable, autonomous and totally environmentally friendly eco-filters of simple, proven and homologated design. These magnetic filters have a patented technology with powerful concentrated fields of magnetic power to guarantee

the off line contamination at sub-micron level, which exceed ISO 4406 standard.

Autonomous and powerful magnetic filtration ensures the required purity of fuel, lube, hydraulic and any fluid. This allows for sustainable and considerable costs savings in fuel (3-8%), lube oils (15-25%+) and equipment (10-20%) by effectively reducing wear rate, increasing the quality and stability of fluids to optimize efficiency and process profitability.

Finally, this type of magnetic filtration reduces energy usage, contributes to cleaner emissions, and significantly reduces the number of contaminated cellulose filters being disposed of in landfills or polluting the environment at large.

### KEYWORDS

Absolute; Autonomous; Eco-filtration; Environmental Efficiency; Harmonization; Tribology.