



Environmental Report

Air Emission Survey



Client: Boreas Air
Study Location: Emmyvale Monaghan, Co Monaghan
Our Reference: H18TC93-BA
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Contents

1. Instruction	3
2. Background	3
3. Health and Safety	4
4. Hypothesis	4
5. Products Tested	4
6. Location of Test	5
6.1. Site Conditions	5
7. Method	6
8. Data and Results	7
9. Analysis	15
10. Conclusions based on findings	16
Appendix 1 Site Photos	18

Images

Figure 1: Ariel image showing the property location	5
Figure 2: Line Graph showing VOC emissions with different Air Filters	11
Figure 3: Bar chart showing VOC Emissions in Different vehicles using a Variety of Filters	12
Figure 4: Pie Chart Showing Improvement from used air filter to Boreas Air filter	13
Figure 5: Pie Chart Showing Improvement from New Standard Filter to Boreas Air Filter	14

Tables

Table 1: Machines Toyota 02-8FDF 30 and Toyota 02-5FDF 35	8
Table 2: Machines Toyota 02-5FDF 35, TOYOTA 02-7FDF 30, TCM FD18 T3, YALE GDP20	9
Table 3: Machines YALE GDP20, Toyota Hiace Van	10



1. Instruction

Our Client Boreas Air have instructed Bellew Environmental as Specialist Environmental Consultants to assist with the testing of Volatile Organic Compound (VOC) emissions on Diesel vehicles. We have been instructed to assess emissions using a range of filters and determine if there is a change in VOC levels emitted in addition to this we will assess which filter if any allows for the least VOC's thus which filter reduces emissions from Diesel Vehicles.

2. Background

Boreas Air is a material developed to protect all types of air intake filters. The idea is innovative and versatile in design. The idea for the product came about as the result of an Ash Vacuum, used to clean out fireplaces, was 'clogging' within seconds of having begun the vacuum process thus having to attempt to clean the actual waste several times whilst continuously emptying the Vacuum collector and clear the filter. The patented material will help prevent dust and debris impeding the airflow through any type of air filter, as the protected filter now has a smooth static neutral surface. The Boreas Range has been independently tested for ability to maintain Air flow in Machines in which it is used. It has subsequently been approved by Dundalk Institute of Technology, CREDIT and Dr. Thomas Dooley DkIT School of Engineering.

The design of the product means the existing and original air filters, when retrofitted with the Boreas Air wrap, would have a smooth static neutral surface, unique to this filter, this means that the material including dust and debris which is sucked into the filter chamber is mostly expelled due to turbulence within the chamber. As the Boreas Air material is treated to remain static neutral, dust is not attracted, as an unprotected air filter will become statically charged and therefore attract dust / debris, restricting the airflow through the unprotected air filter. The turbulence is present in the filter chamber, even if the air filter is not protected, but the dust / debris will lodge in the crevices of an unprotected air filter and hence restrict / block the airflow through the unprotected air filter. Restricted / blocked air intake filter cause increased maintenance, downtime, increased wear and energy costs.



There are several current industrial users who have recommended the product and have shown that it provides significant improvements in their businesses or personnel lives.

3. Health and Safety

Health and safety is paramount during any investigation, particularly on site:

- During the investigation precautions were taken to ensure the test area remained well ventilated and background air was regularly tested.
- There were several pieces of heavy machinery on site, care was always taken, when vehicles were moving, to check in the vicinity if there was anyone inspecting the machinery at low levels.
- Care was also taken to not spend extensive periods at low levels where emissions were at their highest concentration.
- HI Viz clothing was worn by all personnel on site during the investigation this ensured all people were clearly visible.
- Earmuffs were a consideration and available however the noise was not persistently loud that these were deemed necessary.
- Care was taken during all investigations and inspections to ensure there was no damage to vehicles or equipment on site.

It should be noted that normal business activities were being carried out on site during this site investigation.

4. Hypothesis

The hypothesis being considered is that;

The use of BorasAir as a retrofit add on to traditional filters can significantly reduce the Volatile Organic Compound levels being emitted from the combustion of fuel in diesel engines.

5. Products Tested

The vehicles tested in this sample were Diesel Forklifts and one Van. The reason for testing these vehicles was accessibility and availability. The age of the vehicles ranged significantly



as did the hours on each machine. In addition to this the engine types and sizes also varied. Parameters recorded included

- Make and Model
- Engines Size and Type
- Age/Hours
- Temperature
- Filters

6. Location of Test

The location of the test was carried out at ES Forklifts Business Premises. ES Forklifts, MONAGHAN OFFICE Carrigans Emyvale Co.Monaghan (ROI) Eir Code: H18 TC93

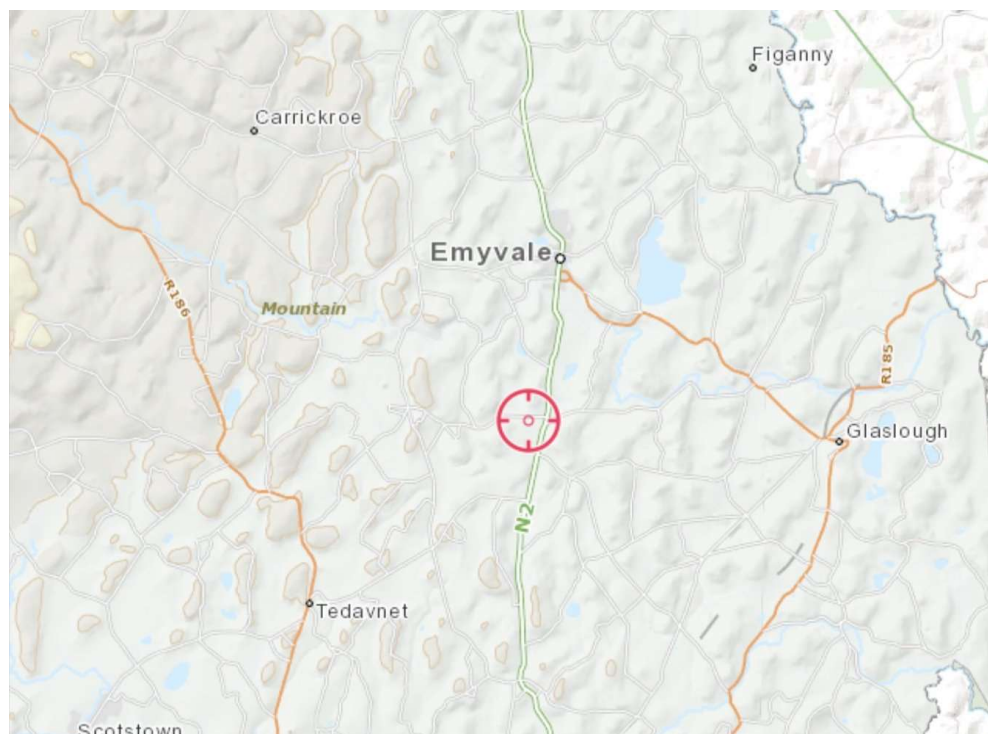


Figure 1: Ariel image showing the property location

6.1. Site Conditions

The weather conditions on site on the day were cool with a slight breeze. There were light intermittent showers, no external testing was carried during the showers. Upon arrival, there was a brief introduction with all parties on site during the investigation, there was some background information surrounding the vehicles and



products being tested. There was a verbal programme of events, what was to be tested, where it was located and when it would be tested, testing began around 10.00am and continued to approximately 1.45pm

7. Method

Upon arrival, the calibration of the Minirae 3000 Portable Handheld VOC monitor was checked and verified. A new Air filter was applied to the nozzle, this was primarily for filtering particulate matter and preventing residual moisture entering the PID.

Temperature was recorded on each machine upon initial start-up and then again, several minutes later when the engine had 'warmed up', the reason for the varied temperature monitoring was to determine if there was a significant difference in VOC's emitted upon start up and compare that with the VOC's Emitted during warmer engine temperatures

Upon identification of all test vehicles, each machine was identified by Make and Model of vehicle, Engine model and size, age of engine and Hours recorded on the machine during the test. There was a Van included in the Test and Make and model of the van was recorded, in conjunction with Miles on the odometer and age of vehicle.

The method of VOC monitoring was that the nozzle of the PID was placed at the end of each exhaust. It was placed at the same point for all vehicles to ensure the same conditions were met for each test range on each vehicle. VOC'S were monitored until the figure recorded on the PID stopped and held the same figure for 3 seconds or the figure on the display began to drop. At this point the highest figure was recorded. This method of recording was applied for all tests.

The Air Filters were changed by Mr Savage, an experienced person who regularly deals with mechanics of these vehicles. The wrapping of the Boreas Air filter was carried out by both Mr Savage and Mr Woods both are proficient personnel and experienced at fitting the Boreas air wrap onto existing filters to create the retro filter.



The Air Filter on the PID had to be changed at regular intervals due to the degradation of the filter. There was suit and moisture build up within the filter, however as we were not measuring either parameters during this investigation these were not quantified. There were 5 filters used during this investigation.

8. Data and Results

Table and Graphed results



Client: Boreas Air
Our Ref: H18TC93-BA
Date: 20.03.2017

Air Emission Survey											
Machine Name	Date	Vehicle Age	Machine Hours	Filter (Old/ New/Boreas)	Engine Model	Engine Size	Temperature	Temperature Location	VOC ppm	% Improvement from worst VOC to Boreas Air VOC	% Improvement from New standard air Filter VOC to Boreas Air VOC
Forklift											
Toyota 02-8FDF 30	20.03.2017	2011	8423	Old Filter	2.5L IDZ-III No Electronics (Dumb System)	2.5L	30.4°	Engine	107.1		
Toyota 02-8FDF 30	20.03.2017	2011	8423	Old Filter	2.5L IDZ-III No Electronics (Dumb System)	2.5L	61.9°	Engine	104.7		
Toyota 02-8FDF 30	20.03.2017	2011	8423	New Filter	2.5L IDZ-III No Electronics (Dumb System)	2.5L	61.9°	Engine	64.4		
Toyota 02-8FDF 30	20.03.2017	2011	8423	Boreas Filter	2.5L IDZ-III No Electronics (Dumb System)	2.5L	61.9°	Engine	18.7		
Toyota 02-5FDF 25 (25-27 yrs)	20.03.2017	1993		Old Filter (recently changed)	3.5L 1Z	3.5L	31.2°	Engine	135.4	82.54%	70.96%
Toyota 02-5FDF 25 (25-27 yrs)	20.03.2017	1993		Old Filter (recently changed)	3.5L 1Z	3.5L	69.4°	Engine	116.6		
Toyota 02-5FDF 25 (25-27 yrs)	20.03.2017	1993		New Filter	3.5L 1Z	3.5L	69.4°	Engine	116.1		

Table 1: Machines Toyota 02-8FDF 30 and Toyota 02-5FDF 25



Client: Boreas Air
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Air Emission Survey

Machine Name	Date	Vehicle Age	Machine Hours	Filter (Old/ New/Boreas)	Engine Model	Engine Size	Temperature	Temperature Location	VOC ppm	% Improvement from worst VOC to Boreas Air VOC	% Improvement from New standard air Filter VOC to Boreas Air VOC
Toyota 02-5FDF 25 (25-27 yrs)	20.03.2017	1993		No Filter	3.5L 1Z	3.5L	69.4°	Engine	81.2		
Toyota 02-5FDF 25 (25-27 yrs)	20.03.2017	1993		Boreas Filter	3.5L 1Z	3.5L	69.4°	Engine	54.1	60.04%	53.40%
Toyota 02-7FDF 30	20.03.2017	2001	10452	Old Filter	3.5L 3Z	3.5L	4°	Engine	178.8		
Toyota 02-7FDF 30	20.03.2017	2001	10452	Old Filter	3.5L 3Z	3.5L	67°	Engine	177.6		
Toyota 02-7FDF 30	20.03.2017	2001	10452	New Filter	3.5L 3Z	3.5L	67°	Engine	84.1		
Toyota 02-7FDF 30	20.03.2017	2001	10452	Boreas Filter	3.5L 3Z	3.5L	67°	Engine	33.1	81.49%	60.64%
TCM FD18 T3	20.03.2017	2011	7404	Old Filter	2.7L NISSAN TD27	2.7L	15°	Engine	65.3		
TCM FD18 T3	20.03.2017	2011	7404	Old Filter	2.7L NISSAN TD27	2.7L	45°	Engine	76.1		
TCM FD18 T3	20.03.2017	2011	7404	New Filter	2.7L NISSAN TD27	2.7L	45°	Engine	61.1		
TCM FD18 T3	20.03.2017	2011	7404	No Filter	2.7L NISSAN TD27	2.7L	45°	Engine	55.5		
TCM FD18 T3	20.03.2017	2011	7404	Boreas Filter	2.7L NISSAN TD27	2.7L	45°	Engine	41.7	36.14%	31.75%
TCM FD 25 Z5T	20.03.2017	2002	2354	Old Filter	ISUZU C240 2.4L Diesel	2.4L	12.1°	Engine	54.4		
TCM FD 25 Z5T	20.03.2017	2002	2354	Old Filter	ISUZU C240 2.4L Diesel	2.4L	49.6°	Engine	64.1		
TCM FD 25 Z5T	20.03.2017	2002	2354	New Filter	ISUZU C240 2.4L Diesel	2.4L	49.6°	Engine	52.1		
TCM FD 25 Z5T	20.03.2017	2002	2354	No Filter	ISUZU C240 2.4L Diesel	2.4L	49.6°	Engine	53.1		
TCM FD 25 Z5T	20.03.2017	2002	2354	Boreas Filter	ISUZU C240 2.4L Diesel	2.4L	49.6°	Engine	38.1	40.56%	26.87%
YALE GDP20	20.03.2017	2000	7784	Old Filter	MAZDA XA 2.5L	2.5L	11.6°	Engine	79.1		
YALE GDP20	20.03.2017	2000	7784	Old Filter	MAZDA XA 2.5L	2.5L	55.1°	Engine	73.1		

Table 2: Machines Toyota 02-5FDF 25, TOYOTA 02-7FDF 30, TCM FD18 T3, YALE GDP20



Client: Boreas Air
Our Ref: H18TC93-BA
Date: 20.03.2017

Air Emission Survey

Machine Name	Date	Vehicle Age	Machine Hours	Filter (Old/ New/Boreas)	Engine Model	Engine Size	Temperature	Temperature Location	VOC ppm	% Improvement from worst VOC to Boreas Air VOC	% Improvement from New standard air Filter VOC to Boreas Air VOC
YALE GDP20	20.03.2017	2000	7784	New Filter	MAZDA XA 2.5L	2.5L	55.1°	Engine	39.5		
YALE GDP20	20.03.2017	2000	7784	Boreas Filter	MAZDA XA 2.5L	2.5L	55.1°	Engine	31.1	60.68%	21.27%
Van											
Toyota Hiace Van	20.03.2017	2004	303492	Filter (500 mile)		2.0L	30.3	Engine	15.1		
Toyota Hiace Van	20.03.2017	2004	303492	Quarry Replicated filter			30.3	Engine	22.6		
Toyota Hiace Van	20.03.2017	2004	303492	Boreas Filter			30.3	Engine	10.9	51.77%	27.81%
Notes:	1. Background air in test area was 5.7ppm with the door open. 2. Quarry Replicated filter was filled with Gypsum dust from quarry. Filter installed in Toyota Hiace van to replicate quarry conditions. 3. Test on Machine Toyota 02-7FDF 30 at High RPM creates intense heat at exhaust, this melted filter on PID. This produces high figure of 16000ppm peak level for the PID. This level is not included in the results as the melting plastic likely caused the increased VOC's at this sample point										

Table 3: Machines YALE GDP20, Toyota Hiace Van

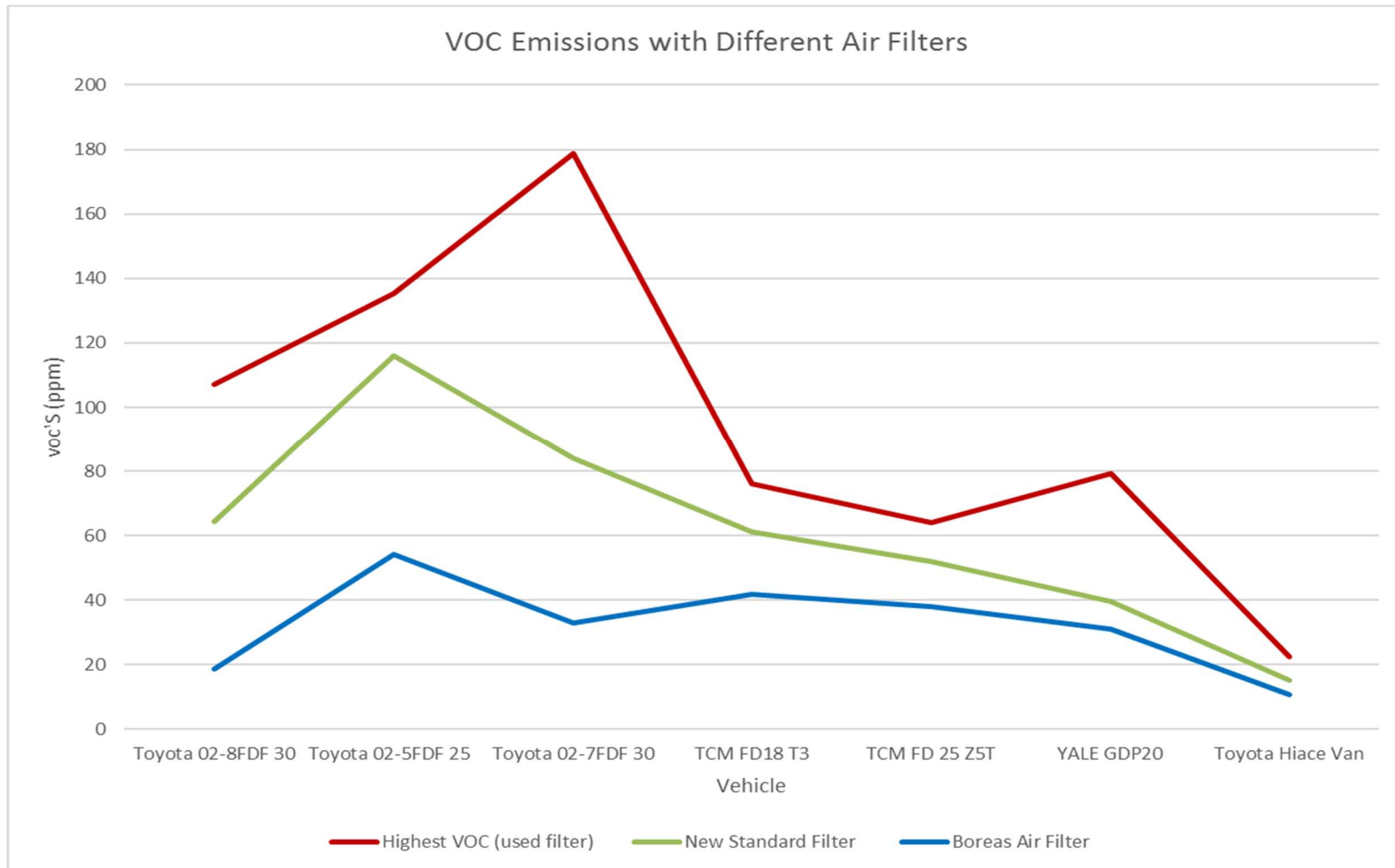


Figure 2: Line Graph showing VOC emissions with different Air Filters

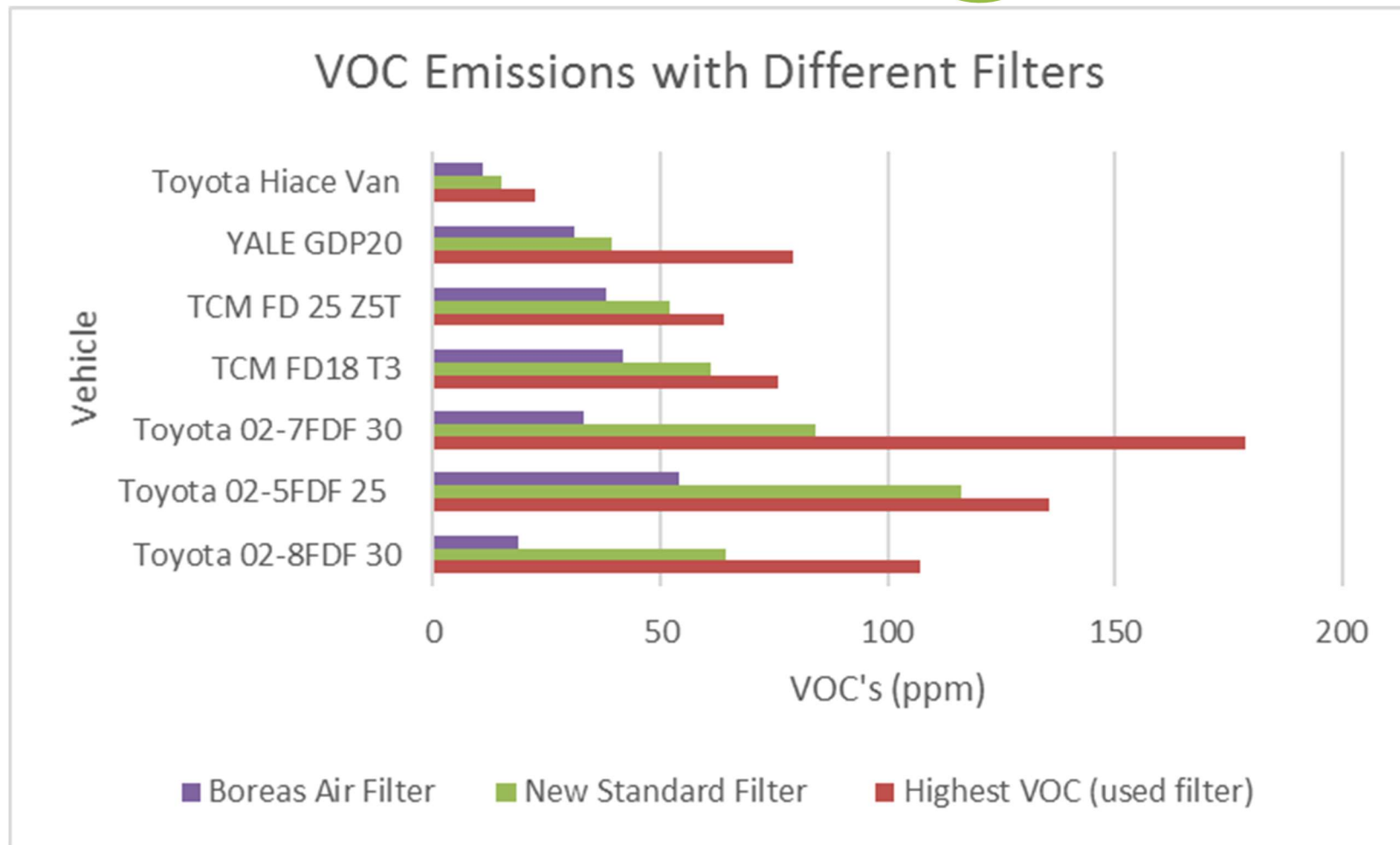


Figure 3: Bar chart showing VOC Emissions in Different vehicles using a Variety of Filters



Percent Improvement from used Air filter to Boreas Air

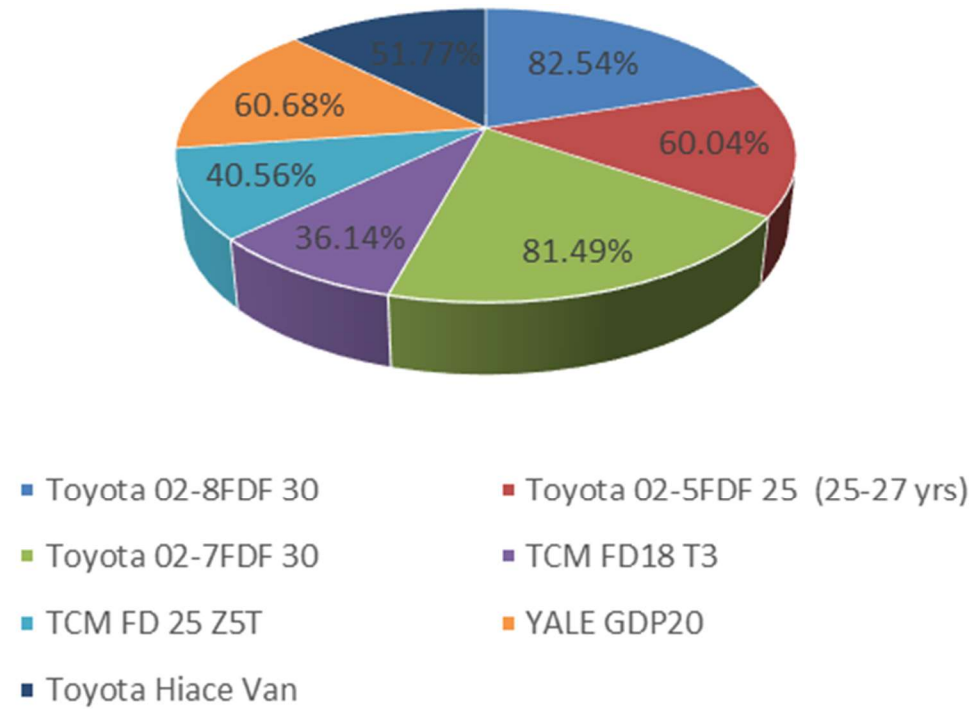


Figure 4: Pie Chart Showing Improvement from used air filter to Boreas Air filter



Percent Improvement from New standard air Filter to Boreas Air

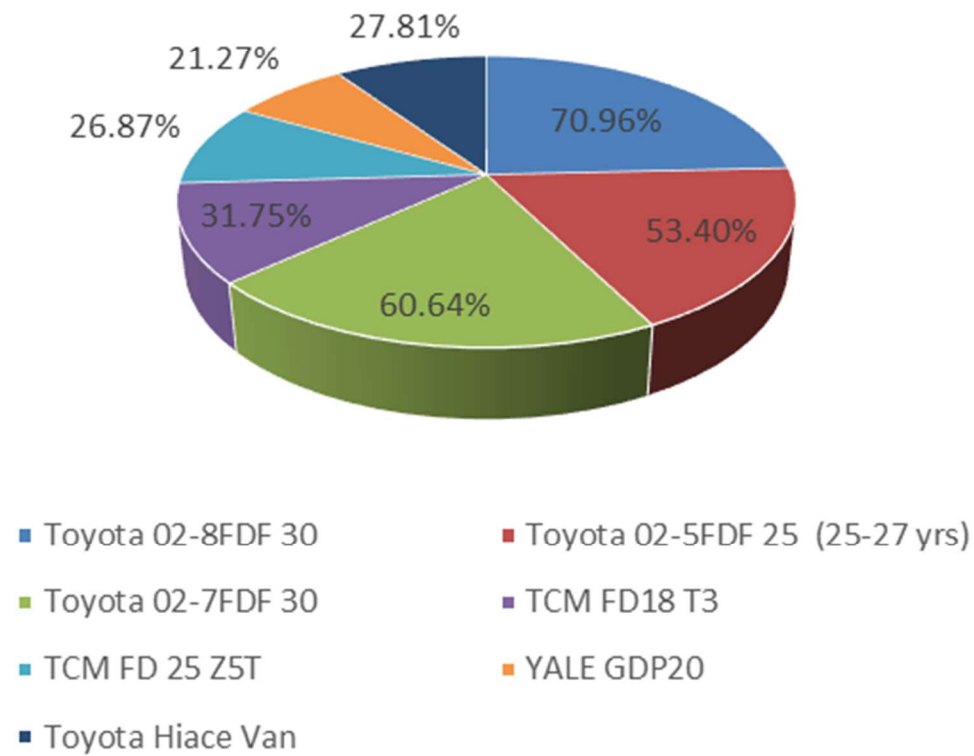


Figure 5: Pie Chart Showing Improvement from New Standard Filter to Boreas Air Filter



9. Analysis

The results have shown that the VOC emissions from the Diesel forklifts vary significantly from machine to machine, all changes in VOC Concentration were measured against the Worst VOC Concentration for the machine being measured. As expected the older machines emitted the most VOC's during the Investigation, however the oldest Machine was, surprisingly not the Worst. It should be noted that although the Toyota 02-7FDF 30 and the Toyota 02-5FDF 35 were the two worst offenders in terms of emissions, consideration should be given to the much larger Engine in both machines compared with the other machines in the sample.

Toyota 02-7FDF 30, a 2001 machine, recorded the highest VOCs during the whole investigation, VOC's peaked at 178.8ppm with an old filter. When a new filter was installed the VOC's dropped to 84.1ppm an improvement of 53% on the worst VOC recording for this machine. The Original Filter was then wrapped with Boreas Air, the VOC's recorded after the installation of this showed further reductions peaking at 33.1ppm this was a total improvement of 81.5% on the original 178.8ppm. There was an improvement of 60.6% from the new filter change and the Boreas Air Filter.

The oldest Toyota 02-5FDF 35, a 1993 Machine, recorded VOC's of 135.4ppm with an old used air filter. When the old filter was changed on this machine to a new standard air filter the VOC's recorded a drop to 116.1ppm. This filter was then wrapped with the Boreas Air, the VOC's recorded further reductions from the original with a reduced constant of 54.1ppm this was a total improvement of 60% on the original 135.4ppm. There was an improvement of 53.4% from the new filter change and the Boreas Air Filter.

Toyota 02-8FDF 30 was the next worst offender amongst the machines measured. This machine Recorded VOC's of 107.1ppm with an old used filter. Upon installing a new clean standard filter the VOC's dropped to 64.4ppm and this was further reduced by installing the Boreas Air Filter, which when recorded showed VOC's of 18.7ppm, an improvement of 82.5% on the original VOC recording for this machine. There was an improvement of 71% from the new filter change and the Boreas Air Filter.

The YALE GDP20 machine differed from the rest of the machines in the sample in that the exhaust was in a vertical position, in comparison, all other machines had a horizontal with decreasing gradient exhaust. The VOC's recorded on this machine with the old used filter were 79.1ppm however upon installation to a new standard filter this dropped to 39.5ppm and further dropped to 31.1ppm with the installation of the Boreas air filter. This machine showed an overall improvement of 60.6% from the original recording. There was an improvement of 21.2% from the new filter change and the Boreas Air Filter.



A further machine the TCM FD18 T3 was monitored and high VOC's of 76.1ppm for this machine. This reduced to 61.1ppm with the installation of a new standard filter; this further reduced to 41.7ppm with the installation of the Boreas Air filter this showed an overall reduction in VOC's of 36.1% from the worst VOC recorded on this machine. There was an improvement of 31.8% from the new filter change and the Boreas Air Filter.

TCM FD 25 Z5T was the last Forklift and most efficient of all the forklift machines tested. This machine recorded 64.2ppm at 49.6°C with an old filter. This was the only machine that recorded lower VOC Concentration when the engine heated up than initial start-up. The VOC concentration dropped to 52.1ppm with installation of a new standard Air Filter. The VOC concentration further reduced to 38.1ppm this was an improvement of 40.5% on original highest recorded VOC on this machine. There was an improvement of 26.9% from the new filter change and the Boreas Air Filter.

The Toyota Hiace Van recorded 15.1ppm with a near new filter (500 miles). Quarry replicated filter was installed in this van. The conditions were recreated by obtaining some Gypsum quarry dust from a local quarry. The filter was saturated in the gypsum dust. This filter was installed in the van and VOC's of 22.6ppm were recorded. Lastly the Boreas Air filter was installed and VOC's of 10.9 ppm were recorded. The improvement of the Boreas Air filter from Quarry condition filter was 51.8% and the improvement of near new Filter (500 mile) to Boreas air filter was 27.8%.

10. Conclusions based on findings

The conclusions based on the analysis have shown that significant reductions are recorded with the change from old used filter to new filters. These reductions are further increased using the Boreas Air wrap, with the Boreas Filter allowing for the most significantly reduced VOC's in all samples analysed. Some machines have shown greater improvements than others however the reduction in all samples indicated that vehicles should be maintained and where possible use the Boreas Air Filter to further reduce VOC emissions giving the best possible result.

The study has shown that there can be significant environmental savings generated using the Boreas Air product. This is an important factor in the monitoring of machines on sites and particularly in large cities where the significant reduction of air pollution is now the target of many governments through the implementation of Euro 5 and now Euro 6.



There are current trials in progress to test the hypothesis that the Boreas air filter can generate Fuel savings and as a direct result financial savings. Some of the trial clients have already generated savings.

McArdle Skeath a large haulage operator, monitor fuel efficiency rigidly. Upon installation of Boreas Air filters the company have saved 9%, in the week beginning 03.04.2017 and 7% in the week beginning 27.03.2017. These figures are based on the data from one lorry.

A1 generators tested a loaded 26 KVA generator. The Generator was filled with 1/2 half litre of fuel with an unprotected air filter, the duration of service was 13 minutes, the machine was then tested again with ½ litre of fuel however the second time the filter was protected with Boreas Air, the duration of service was 19 minutes. This was 6 extra minutes of service on ½ fuel using the BoreasAir.

Mr Woods Van Toyota Hiace is generating a 14% Fuel Saving, monitored over the last Month.

David Mc Keown has found using the Boreas Air Filter compare with the standard air filter, that he is generating a 14% Fuel Saving on his fleet of Toyota Hiace Vans.

Bellew Electrical Wholesale Ltd have trialled the Boreas Air Filter on one Van over a two week period. Savings generated on this Vehicle were 10% over the 2-week period. Bellew Electrical are rolling the product installation out across the fleet.



Appendix 1

Site Photos





