# Diesel Particulate Filters' Feasibility Study Report

**Report's Period:**

2016/03/01 - 2016/03/31

Tehran - Iran

ASA
Azmoon Sanat Arvin

شرکت کنترل کیفیت هوا
وابسته به شهرداری تهران

معاونت حمل و نقل و ترافیک
شهرداری تهران
دفتر محیط زیست

FCE

هسته پژوهشی سوخت،
احتراق و آلایندگی

VERT certified for Health and Climate

## Abstract

Iran's big cities air pollution is one of the major challenges to authorities in view of public health. Tehran City, with about 9 Million resident, has been facing more and more air quality problems over the last decade. The criteria pollutants in Tehran are PM2.5, PM10 and NO2. Particulates and especially ultrafine particles have been identified as the most toxic component of the polluting mixture. Considering diesel engine operation concepts, these types of engines are one of the main source emission of ultrafine particles in urban areas. So controlling particulates emitted from these sources, is one of the first steps to improve air quality. Diesel Particulate Filters (DPFs) are well-known and effective way to reduce particles number and mass. Lately, the Iranian government decided to legislate DPF installation for High Duty diesel Vehicles (HDV). Both, national and international engine industries and experts are now challenged to comply according to the new upcoming standards.

Tehran city bus Company with more than 3500 diesel engine buses is one of the organization that can play important role in improving air quality. In January 2014, the City Council of Tehran decided to order the retrofit of the public bus fleet of the capital. So DPFs' feasibility study project is organized by Tehran Air Quality Control Company (AQCC). The project consists of two phases. Phase 1 is particle filter tests on engine lab was provided in Tabriz for approval of DPFs in Iran. During this phase different types of DPFs from various companies were tested according to VTF1[1] test procedure, by FCE[2] under supervision of VERT association. Table 1 gives some information about phase 1.


*Table 1. Phase 1 test procedures*

| Test Process | Evaluated data | Measurements devices |
|---|---|---|
| **Engine baseline test – 4PTS[3]** | • Exhaust Gas mixture.<br>• emitted PM, PN during test points<br>• Temperature and pressure analysis before and after DPF | • MRU (Gas Analyzer)<br>• NM3 (Particle counter)<br>• AVL sampling unit (particle mass collector)<br>• Pressure and Temperature sensors |
| **Engine Equipped with DPF** | | |
| **Regeneration test** | | |
| **PM and PN efficiency test** | | |

[1] . VERT filtration test
[2] . Fuel ,Combustion and Emissions group
[3] . Stationary 4-points-test cycle

After analyzing phase 1 results, approved DPFs were sent to Tehran, for fieldwork tests. 18 BRT[4] from different lines with various working paths, were selected and equipped with data logger by ASA[5] Company. By the time, 9 DPFs were installed on these samples and their data have been collected and analyzed from installation date. Analyzed data were published as monthly reports, including separated reports for first and second half of the months, and specified DPFs' operation status. Table 2 shows summary information about installed DPFs until 31/Mar/2016.

*Table 2. Installed DPFs*

| DPF Producer Company | Operation Report | | | Maintenance and Cleaning History |
|---|---|---|---|---|
| | Installation date | Working days | Bus mileage | |
| **HJS_01 (Passive system with FBC) V. ID: 78514 (line 4)** | 10/Sep/2014 | 568 days | 79070 km | DPF core was cleaned on Jun 13th after about 36000 km for the first time. |
| **Dinex_01 (Passive system with FBC) V. ID: 78515 (line 4)** | 22/Oct/2014 | 403 days | 49616 km | Filter core was changed on Feb 15th after 13253 km working. (High K-value and low additive dosage were reasons of the early cleaning.) |
| **PURItech (Passive system with FBC) V. ID: 78524 (line 4)** | 28/Jan/2015 | 429 days | 64696 km | DPF core was cleaned on Aug 12th after about 26500 km, for the first time. Considering system high backpressure, filter isolation defect, DPF core was removed on Sep 16th and installed on Nov 17th. The third cleaning was unavoidable after only 6 days working and was done on 29th Nov. System worked for two days and DPF was replaced by muffler on Nov 30 th . DPF was installed for the fourth time on Jan/19/2016 and was |

[4] . Bus rapid transient
[5] . Azmoon Sanat Arvin

| | | | | |
|---|---|---|---|---|
| | | | | replaced by muffler after only three days working because of high backpressure. |
| **HJS _02 (Active system with FBC - Electrical Heater) V.ID: 85423 (line 4)** | 19/Feb/2015 | 420 days | 66897 km | DPF was cleaned on 2016-02-03 for the first time. |
| **HJS_03 (Active system with FBC - Electrical Heater) V.ID: 33572 (line 2)** | 19/Feb/2015 | 407 days | 55613 km | DPF core was cleaned on Oct 5th after about 30801 km, for the first time. The second cleaning was done on Dec 19th. |
| **HJS_04 (Passive system with FBC) V.ID:85476 (line 10)** | 23/Feb/2015 | 403 days | 57194 km | DPF was cleaned on 22nd Jul for the first time and on 15th Dec for the second time after 44355 km mileage from installation |
| **Dinex_02 (Passive system with FBC) V.ID: 33637 (line 2)** | 02/Jun/2015 | This system works with DPF only for 21 days. | - | DPF had been removed after two weeks working on Jun 17th. After receiving cleaning machine, DPF was cleaned on Aug 10th and installed on Aug 22nd but worked only for ten days. The last cleaning was done on Sep 24th but cleaning issue was unavoidable after only three days working. Finally DPF was replaced by muffler on Sep 8th and system has been working from that date without DPF. |

| | | | | |
|---|---|---|---|---|
| **Tehag_01 (Catalyzed DPF) V.ID: 85182 (line 10)** | 24/Sep/2015 | 170 days | 8341 km | DPF has been working from installation date until now without any cleaning. |
| **Tehag_02 (Catalyzed DPF) V.ID: 33592 (line 2)** | 25/Jan/2016 | 66 days | 3841 | DPF has been working from installation date until now without any cleaning. |

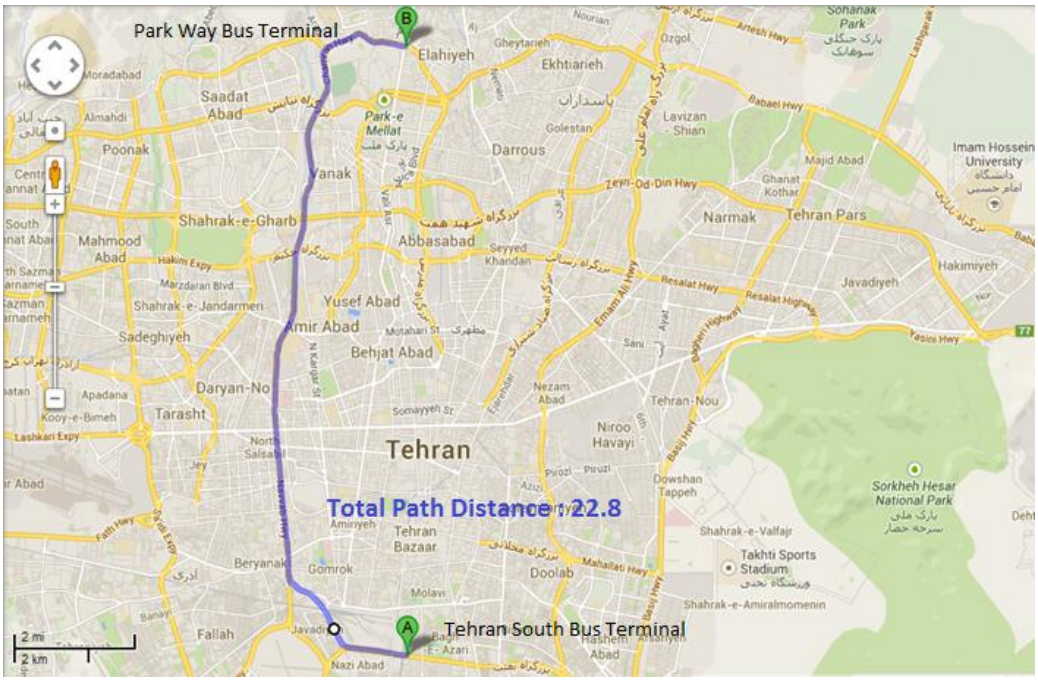
Table 3 represents DPFs' operation status during January. DPFs detailed information could be found in the next section.

*Table 3. DPFs' operation status during Feb*

| Vehicle ID | DPF Producer Company | Operation Status Mar/01/2016 - Mar/15/2016 | Operation Status Mar/16/2016 - Mar/31/2016 |
|---|---|---|---|
| **78514 (line 4)** | HJS_01 | 1 | 6 |
| **85423 (line 4)** | HJS _02 | 1 | 1 |
| **78515 (line 4)** | Dinex_01 | 6 | 6 |
| **78524 (line 4)** | PURItech | 5 | 5 |
| **33572 (line 2)** | HJS_03 | 2 | 2 |
| **33637 (line 2)** | Dinex_02 | 5 | 5 |
| **85476 (line 10)** | HJS_04 | 1 | 1 |
| **85182 (line 10)** | Tehag_01 | 1 | 1 |
| **33592 (line 2)** | Tehag_02 | 1 | 1 |

| Status Number | Operation Status | Description |
|---|---|---|
| 1 | Excellent | Pressure above 200 mbar<0.1% ($P200 \sim 0$) |
| 2 | Good | $0.1\% \leq P200 \leq 3\%$ |
| 3 | Maintenance required | $P200 > 3\%$ or DPF system blocking |
| 4 | Failed | DPF defect, black smoke, holes in the filter element |
| 5 | NO DPF | DPF was removed for cleaning or other issues |
| 6 | Bus was stationary | Bus related problems |

| | |
|---|---|
| Vehicle plate number | 78514 |
| Bus line | Number 4 (south to north bus line) |
| DPF producer company | HJS_01 (Passive system with FBC) |



## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 78514 |
| CPK data logger number | LN: 001496, DN: 1914, Sim +989218355923 |
| Bus line | Number 4 (south to north bus line) |
| Bus Terminals | Tehran South Bus Terminal - Park Way Bus Terminal |
| Total path distance | 22.8 km |
| DPF producer company | HJS_01 (Passive system with FBC) |
| Installation date | 10/Sep/2014 |
| Report period | 01/Mar/2016 – 15/Mar/2016 (fifteen days) |
| K value - DPF upstream | 1.8 [1/m] |
| K value – DPF downstream | 0.02 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF core was cleaned on Jun 13th. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 79070 km |
| Bus mileage over the period | 450 km |
| Working days over the period | 10 days |
| Stop days | 5 days |
| Data logger working days | 4 days |
| Working hours over the period | - |
| Average working hours per day (including stop days) | - |
| Bus average speed | - km/hr |
| idle speed time to all working time ration | 62.86 % |
| Total Bus fuel consumption over the period | 290 lit |
| Fuel consumption per hour | - lit/hr |
| Average fuel consumption | 0.65 lit/km |
| Total Bus additive consumption over the period | 0.14 lit |
| Average additive consumption | 309 cc/km |
| Additive consumption to fuel ration | 480 cc/1000lit |

Notice: Due to data logger problem, working hours and some related information was missed.

## Temperature, Pressure and Engine Speed Overview

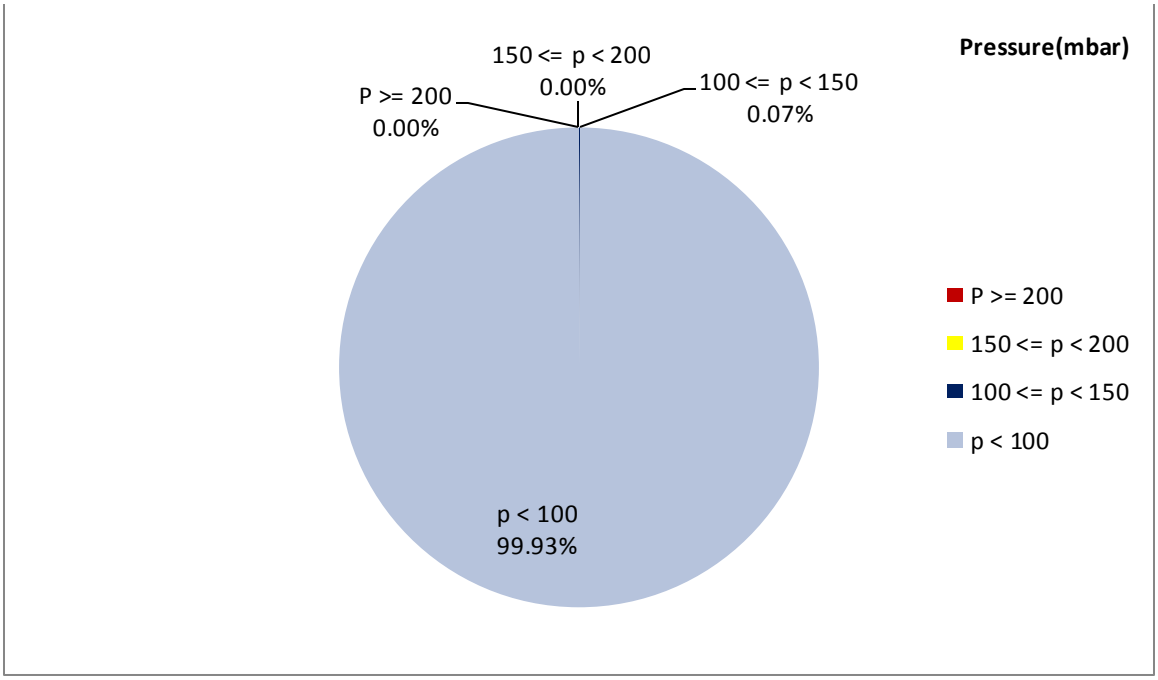



*Figure 1- Pressure distribution over the working hours*

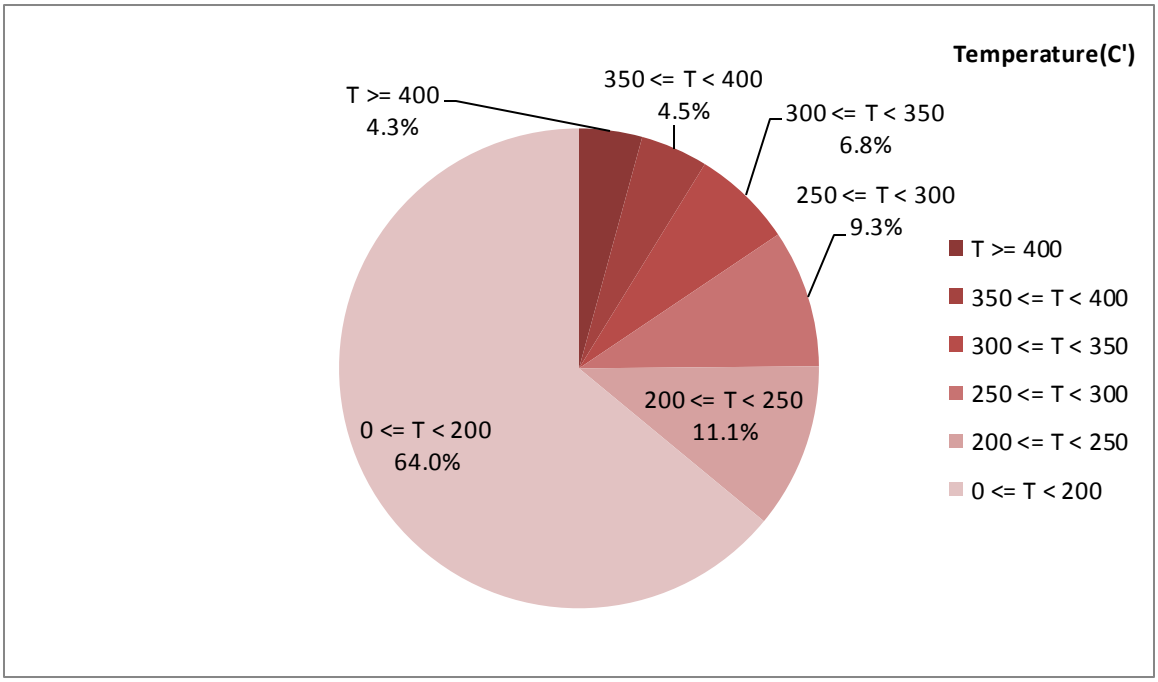



*Figure 2-Temperature distribution over the working hours*

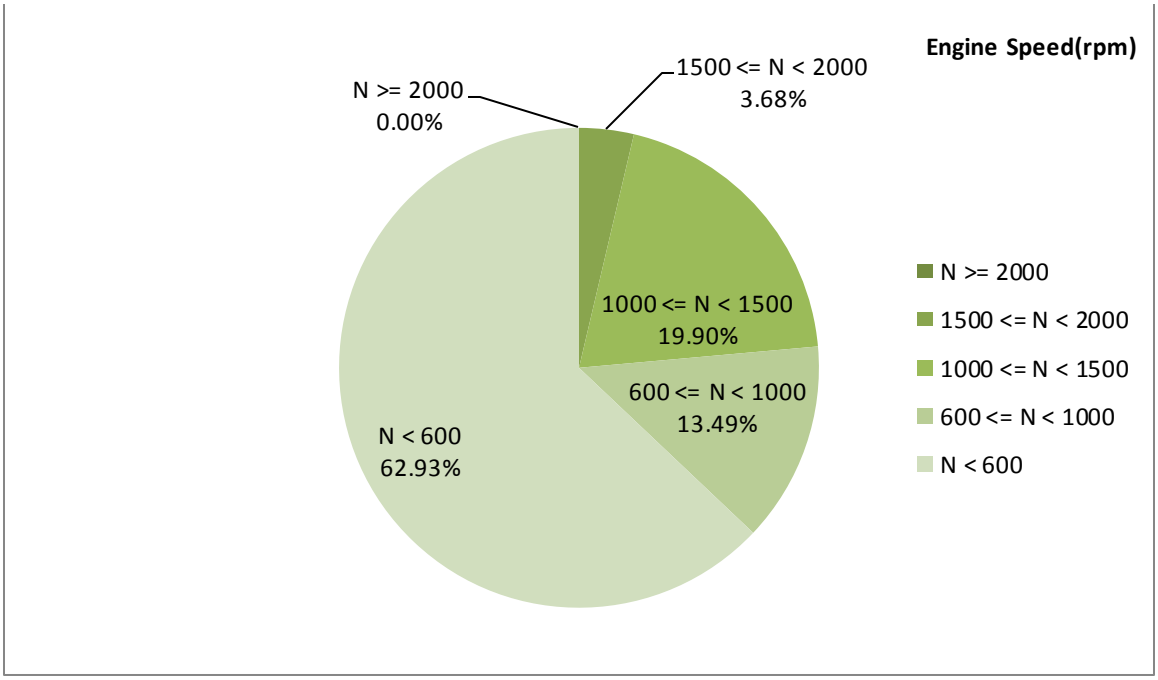



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 196.27 | 7.38 | 748 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 272 | 18.11 | 1090 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 530-50 | 108-0 | 1872-304 |

## Detailed Pressure Analysis

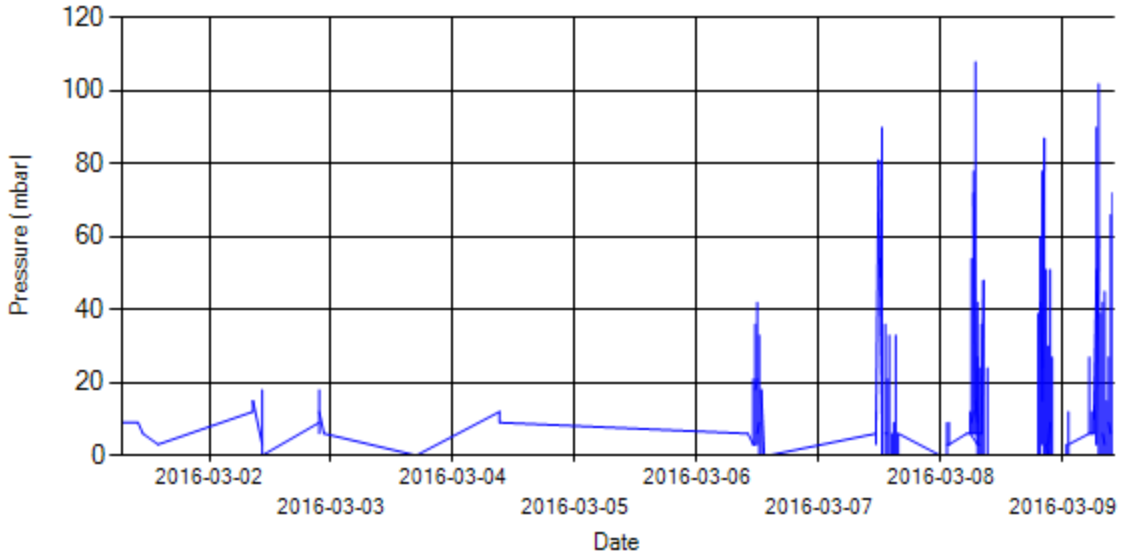



*Figure 4- Pressure distribution over the period*

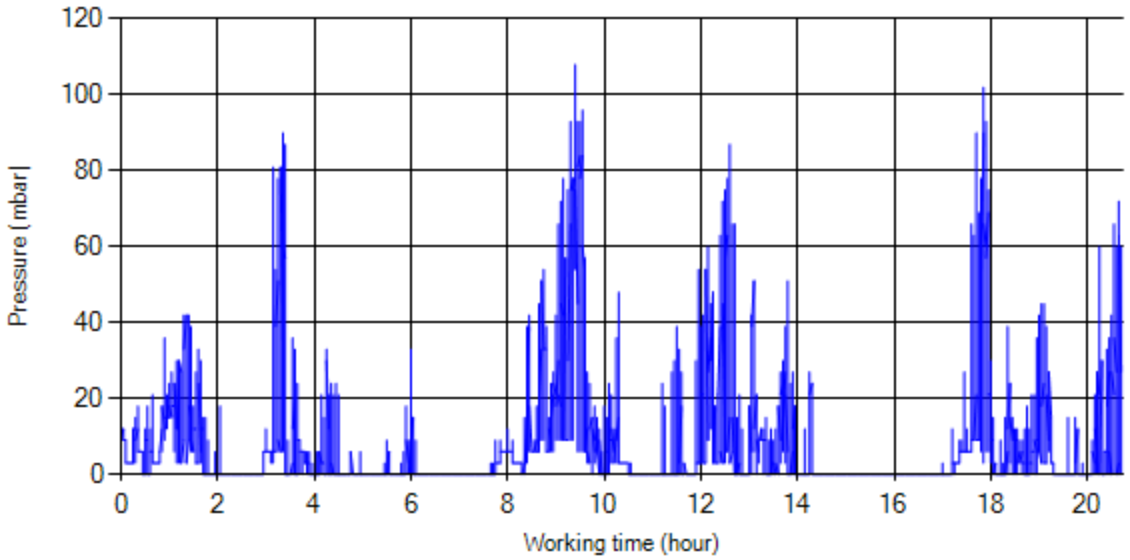



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

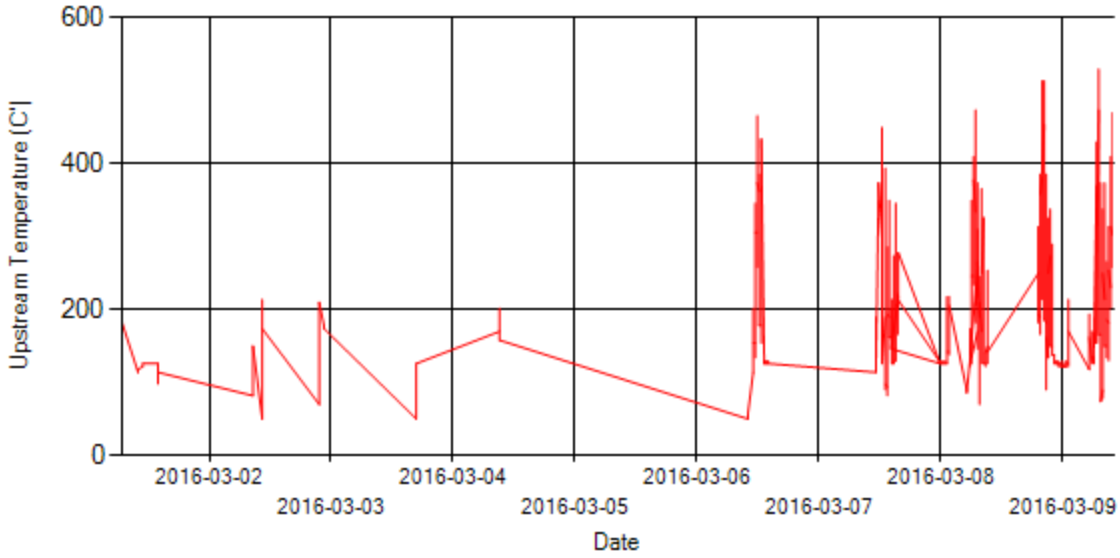



*Figure 6- Temperature distribution over the period*

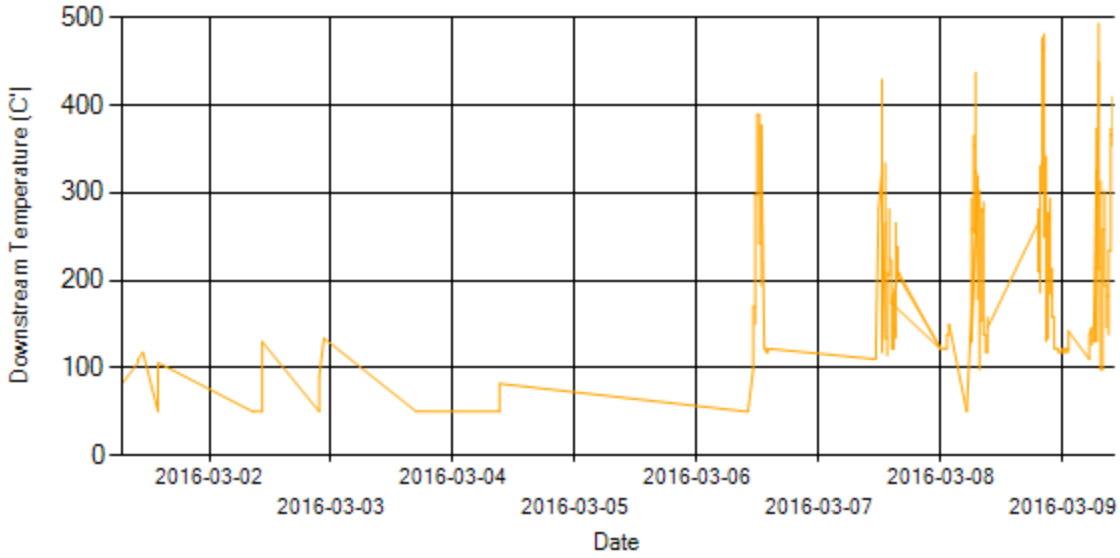



*Figure 7- Temperature distribution over the period*

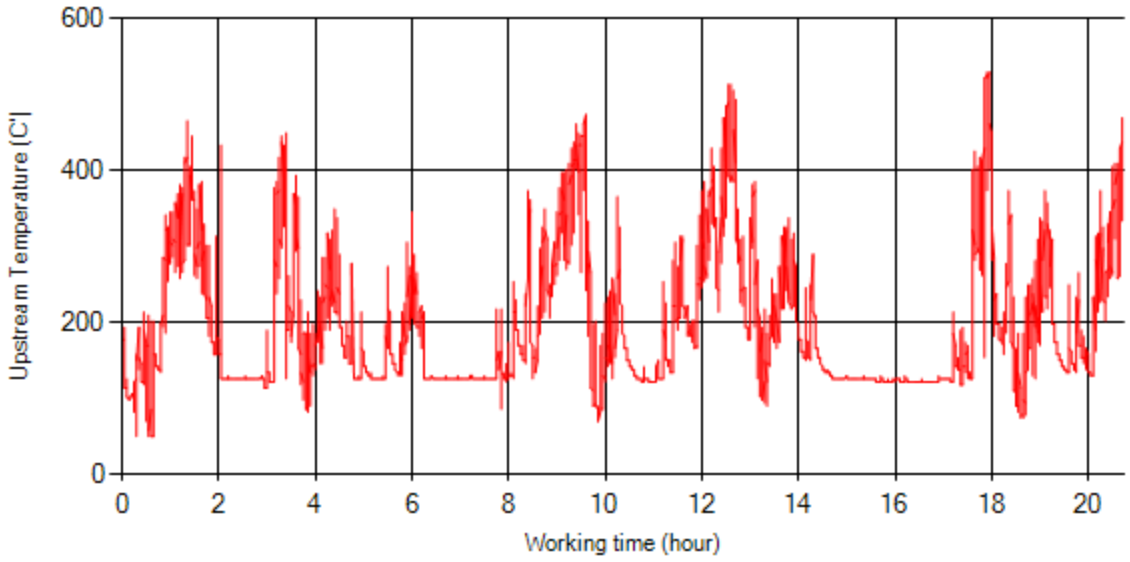



*Figure 8- Temperature vs. working hours*

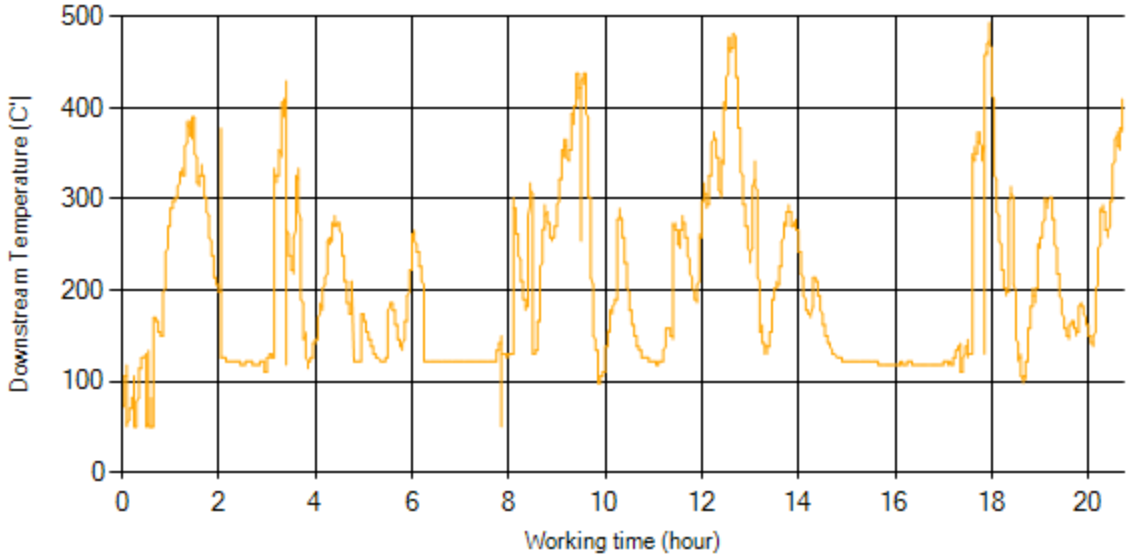



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

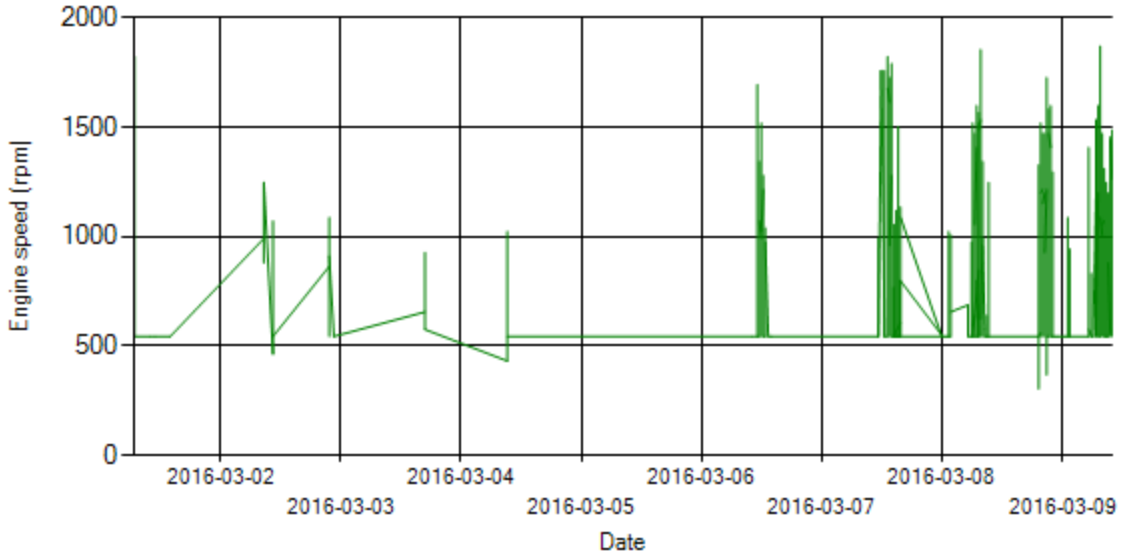



*Figure 10- Engine speed distribution over the period*

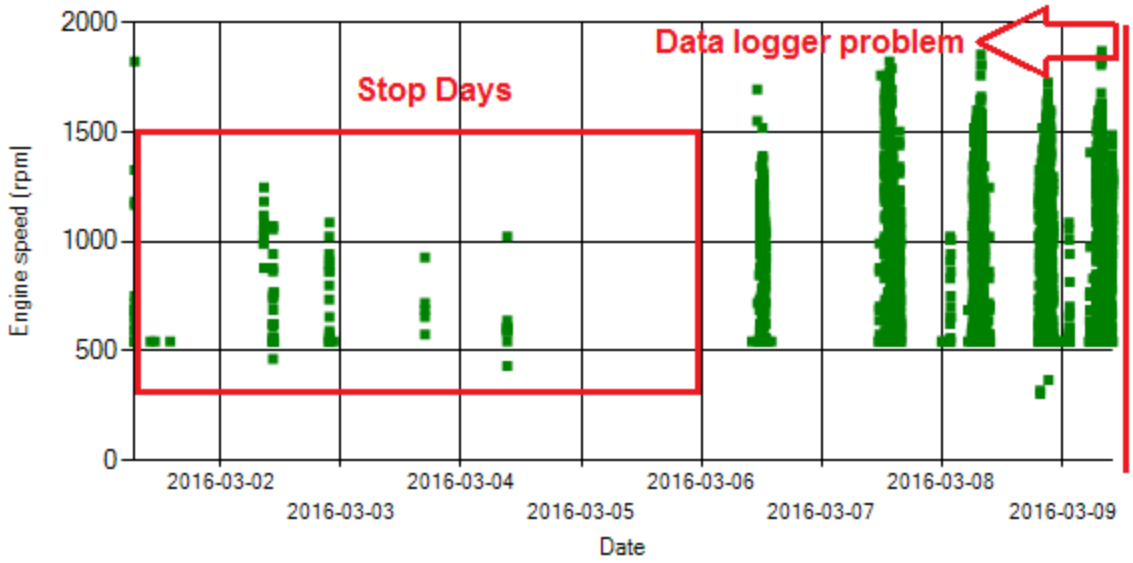



*Figure 11- Engine speed diagram for calculating CPK's working days*

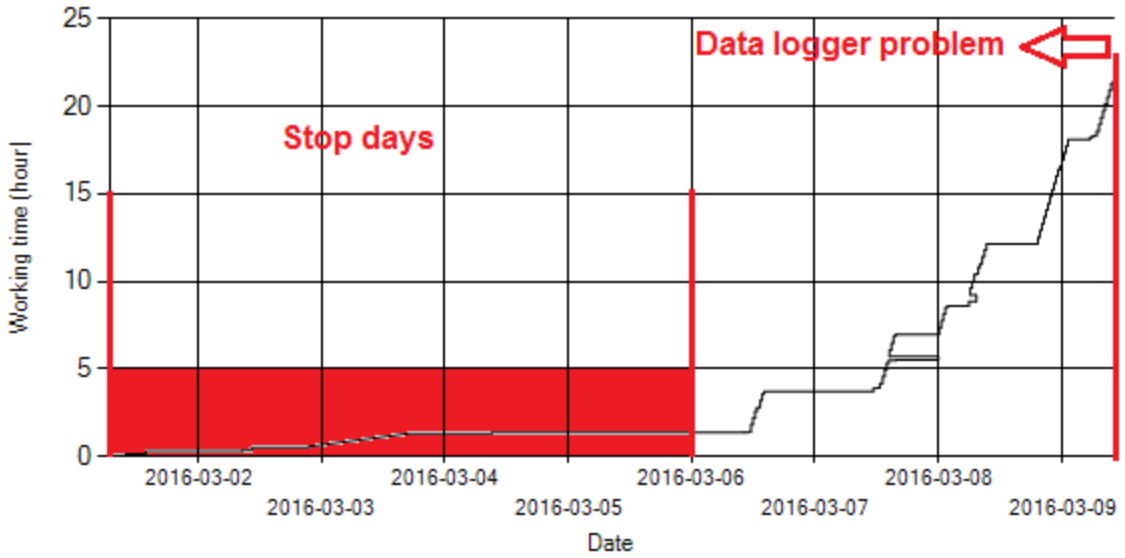



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data.

## Pressure-Engine Speed diagrams

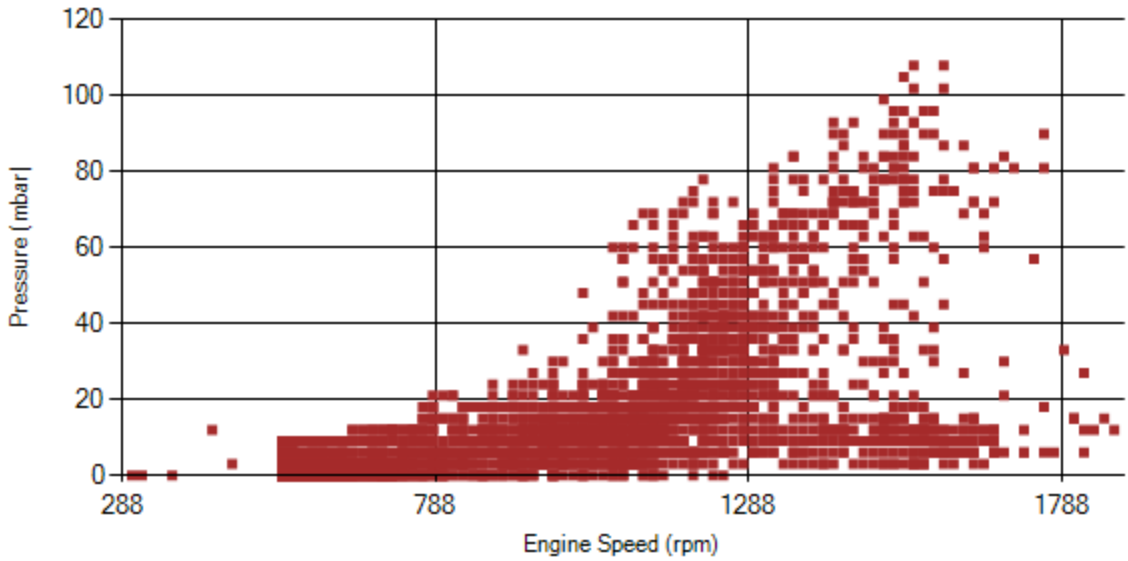



*Figure 13- Pressure against engine speed*

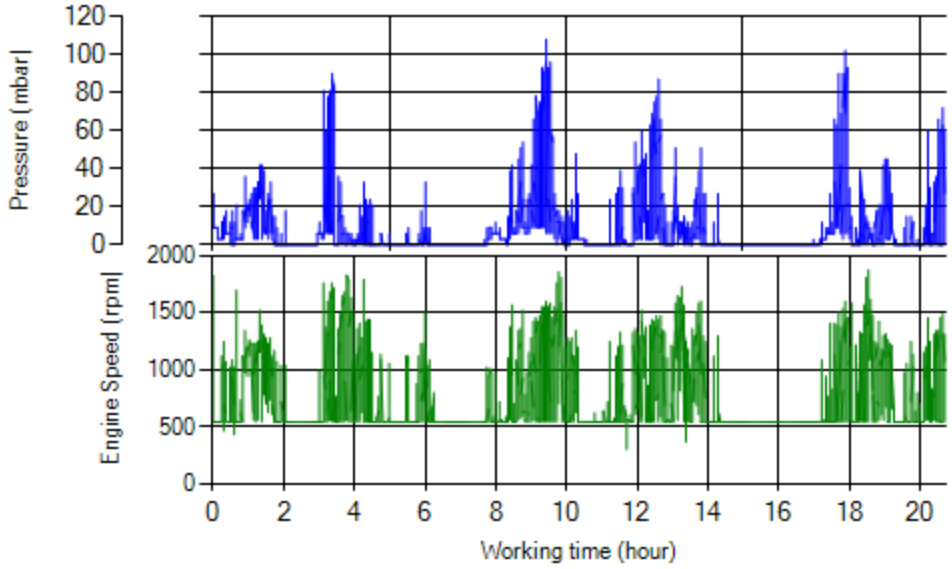



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

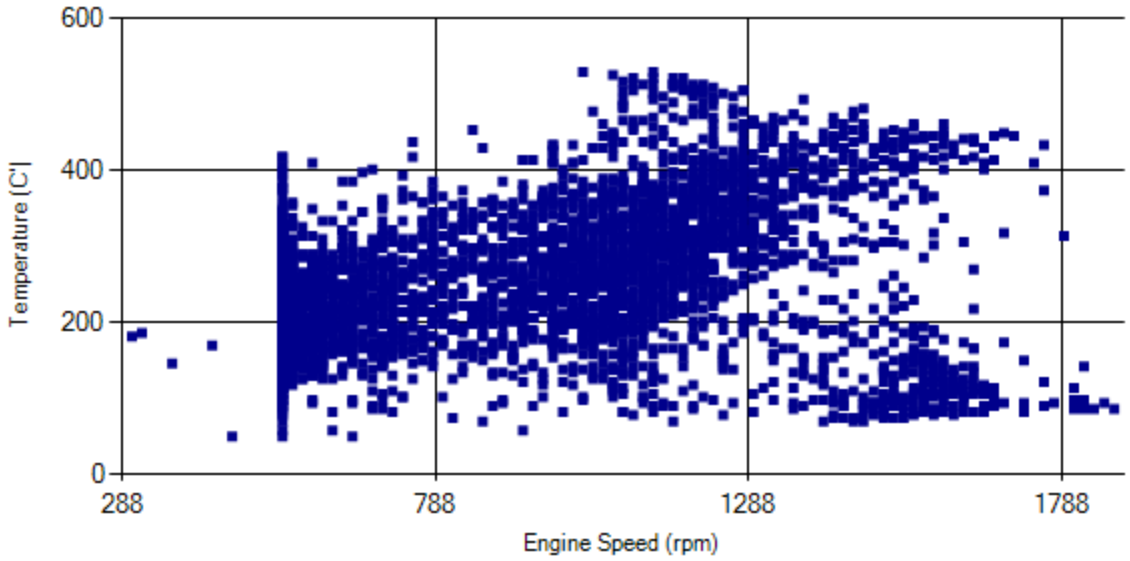



*Figure 15- Temperature against engine speed*

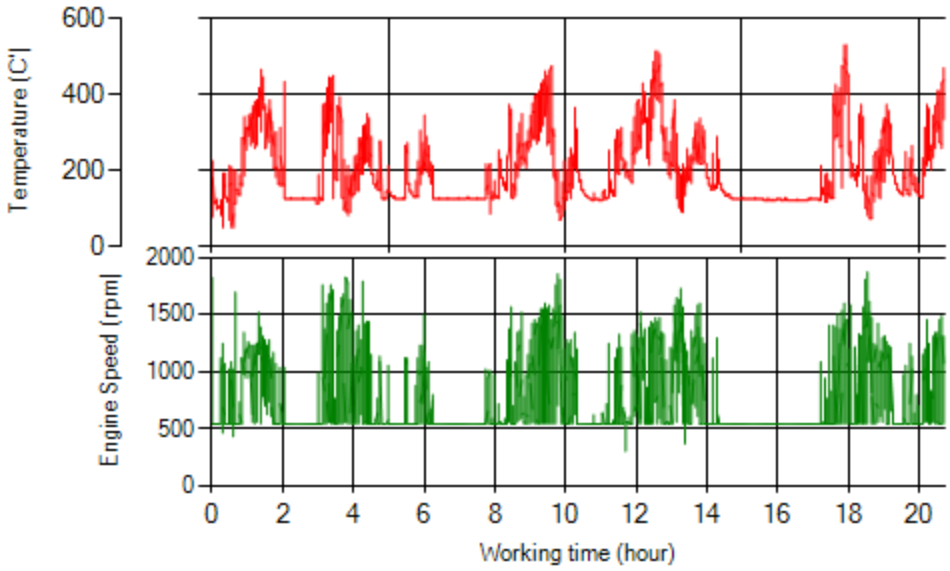



*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

Bus was almost stationary and only worked 20 hours which 62% working time was idle operation. Besides data logger got problem from March 10$^{Th}$ until end of the March.

Considering available data, system operation was excellent.

| | | |
|---|---|---|
| Filter operation status | Excellent ■ | Good ☐ |
| | Maintenance required ☐ | Failed ☐ |

| | |
|---|---|
| ASA Azmoon Sanat Arvin | Document Number: DPF2016031/1<br>Date: 10/Apr/2016 |

## Overall Information

*Table1- Overall Information*

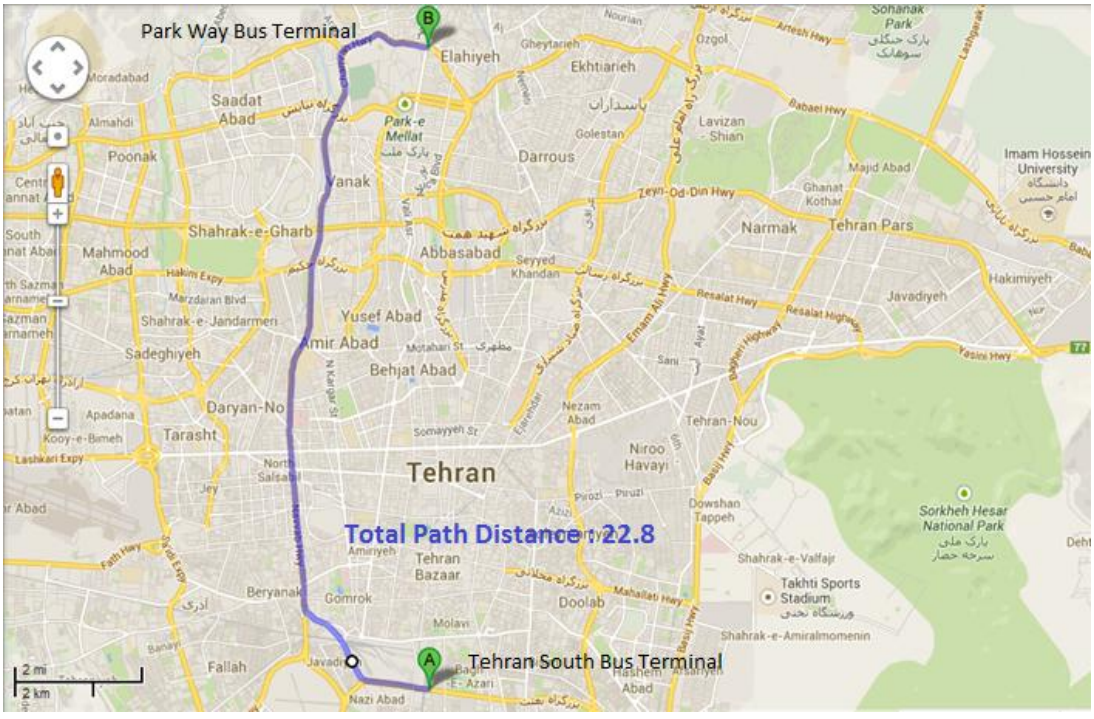
| | |
|---|---|
| Vehicle plate number | 78514 |
| CPK data logger number | LN: 001496, DN: 1914, Sim +989218355923 |
| Bus line | Number 4 (south to north bus line) |
| Bus Terminals | Tehran South Bus Terminal - Park Way Bus Terminal |
| Total path distance | 22.8 km |
| DPF producer company | HJS_01 (Passive system with FBC) |
| Installation date | 10/Sep/2014 |
| Report period | 16/Mar/2016 – 31/Mar/2016 (sixteen days) |
| K value - DPF upstream | 1.8 [1/m] |
| K value – DPF downstream | 0.02 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF core was cleaned on Jun 13th. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

**Notice: No data was available because of data logger update problem during this period.**

| | |
|---|---|
| Vehicle plate number | 85423 |
| Bus line | Number 4 (south to north bus line) |
| DPF producer company | HJS_02 (active system with FBC – electrical heater) |



## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 85423 |
| CPK data logger number | LN: 001505, DN: 2001, Sim Number +989218469621 |
| Bus line | Number 4 (south to north bus line) |
| Bus Terminals | South Bus Terminal - Park Way Bus Tehran Terminal |
| Total path distance | 22.8 km |
| DPF producer company | HJS_02 (active system with FBC – electrical heater) |
| Installation date | 19/Feb/2015 |
| Report period | 01/Mar/2016- 15/Mar/2016 (fifteen days) |
| K value - DPF upstream | 1.73 [1/m] |
| K value – DPF downstream | 0.02 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF was cleaned on 2016-02-03 for the first time. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 62767 km |
| Bus mileage over the period | 4246 km |
| Working days over the period | 15 days |
| Stop days | 0 day |
| Data logger working days | —* |
| Working hours over the period | - |
| Average working hours per day (including stop days) | - |
| Bus average speed | - |
| idle speed time to all working time ration | - % |
| Total Bus fuel consumption over the period | 2547 lit |
| Fuel consumption per hour | - lit/hr |
| Average fuel consumption | 0.6 lit/km |
| Total Bus additive consumption over the period | 1.1 lit |
| Average additive consumption | 273 cc/km |
| Additive consumption to fuel ration | 455 cc/1000lit |

—*Notice: Due to electrical problem, lots of the data was missed during the period. So next pages result' were driven considering available data.

## Temperature, Pressure and Engine Speed Overview

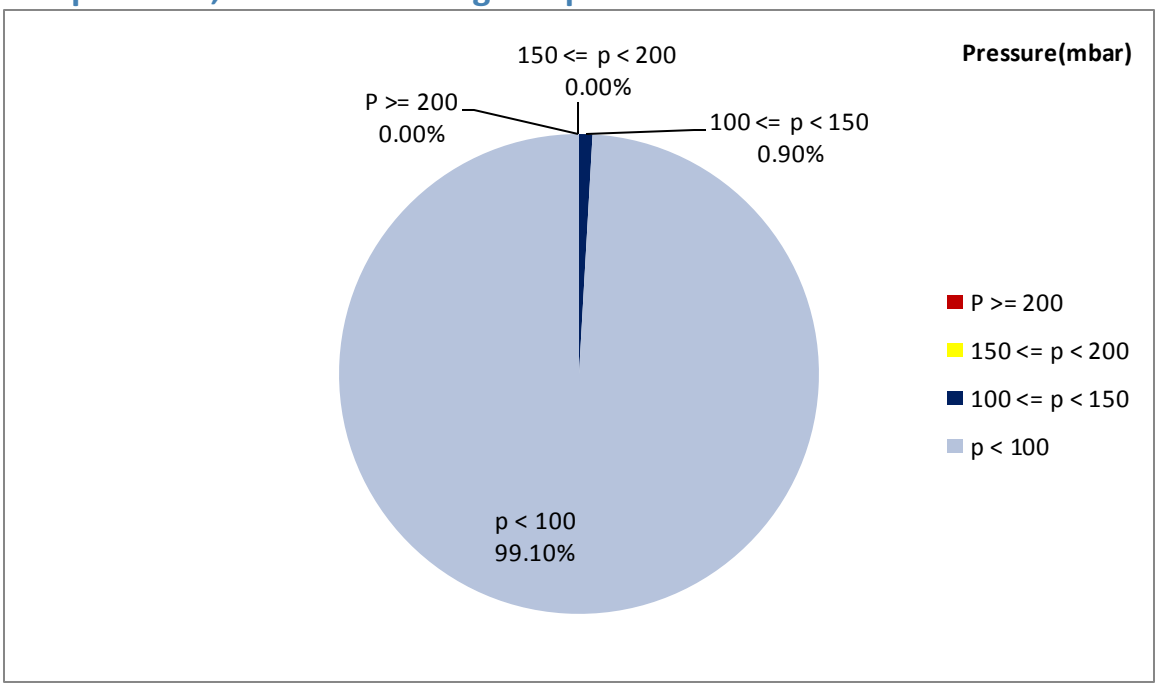



*Figure 1- Pressure distribution over the working hours*

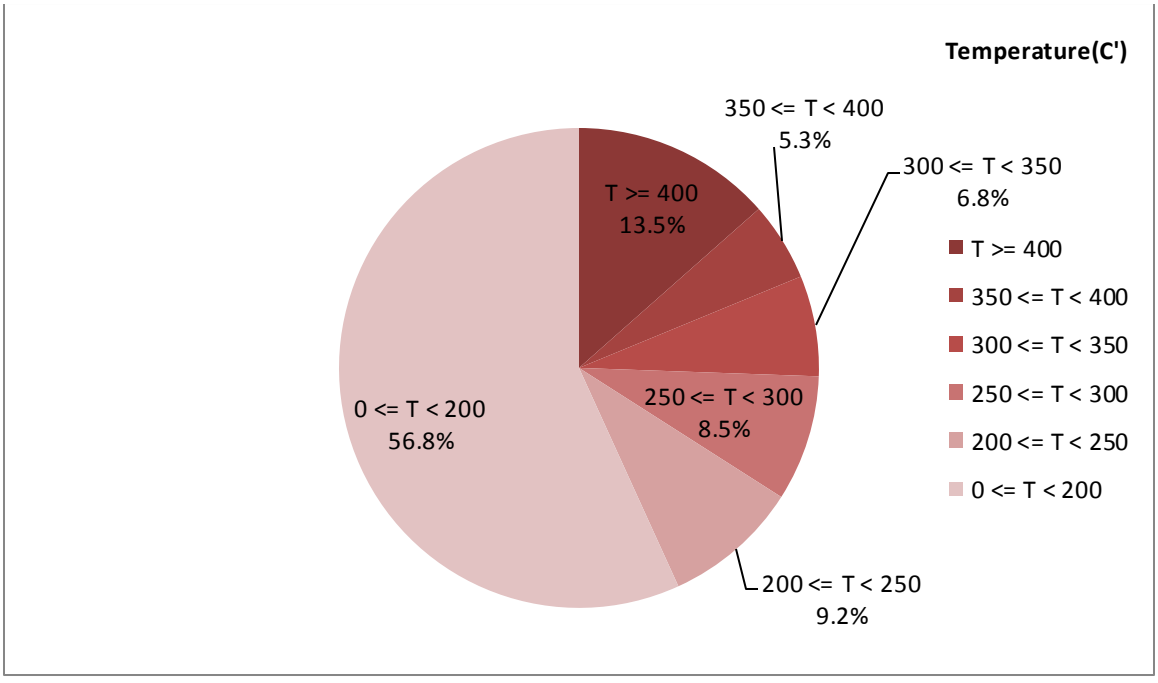



*Figure 2-Temperature distribution over the working hours*

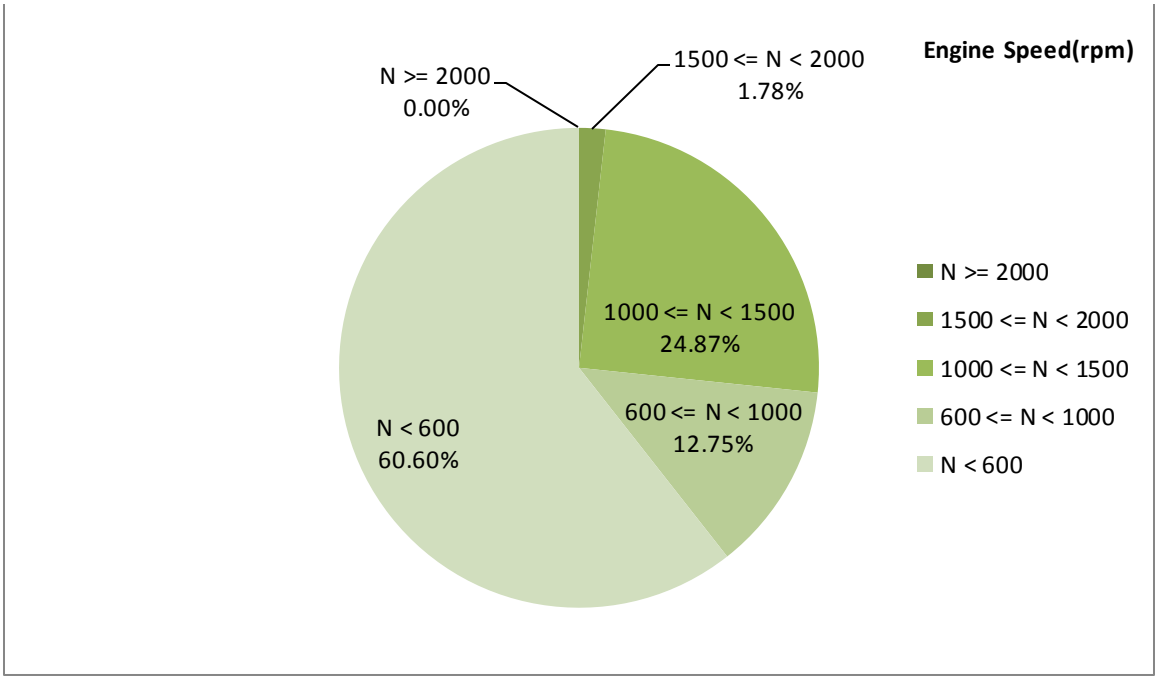



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 230.13 | 13.86 | 763 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 338.6 | 31 | 1098 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 626-54 | 132-0 | 1840-544 |

## Detailed Pressure Analysis

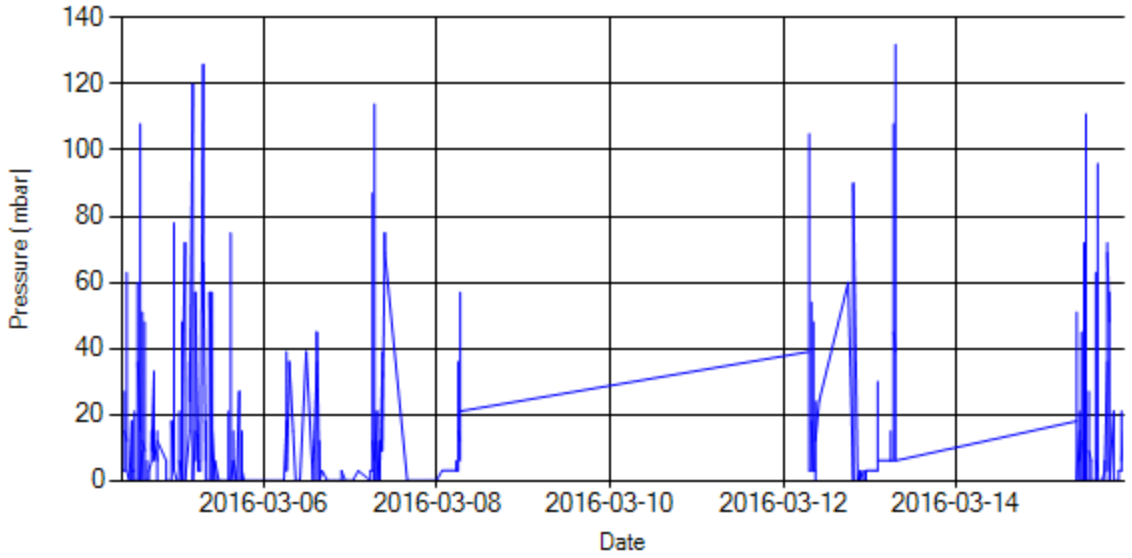



*Figure 4- Pressure distribution over the period*

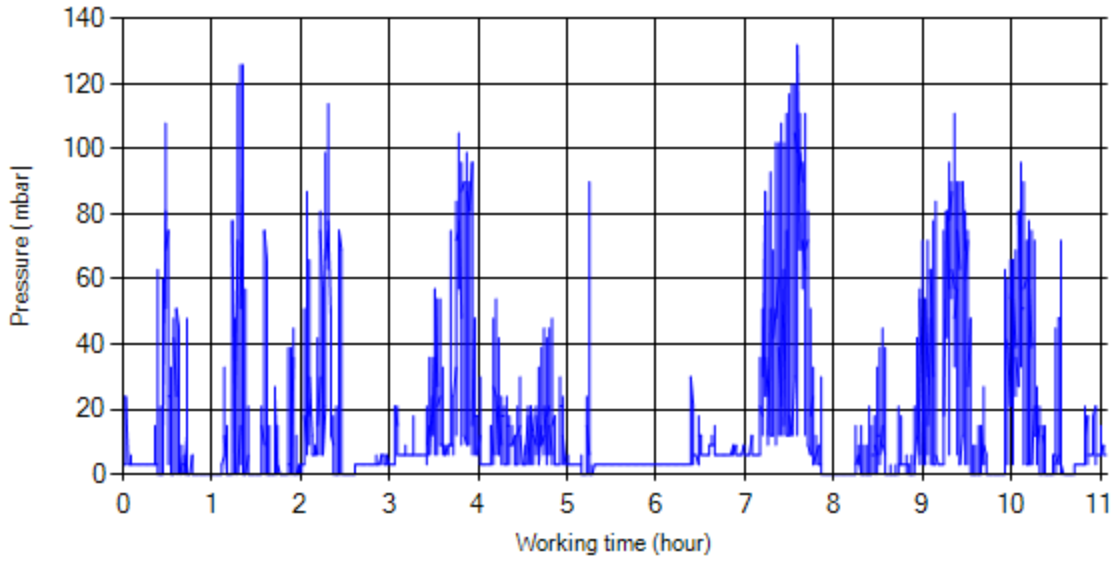



*Figure 5- Pressure vs. working hours*

## Detailed Temperature Analysis

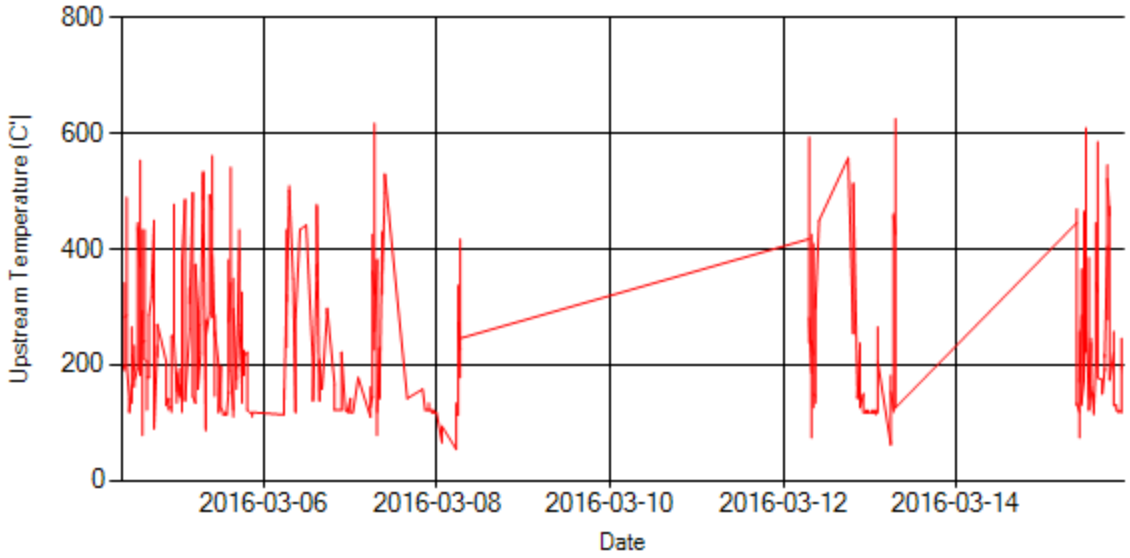



*Figure 6- Temperature distribution over the period*

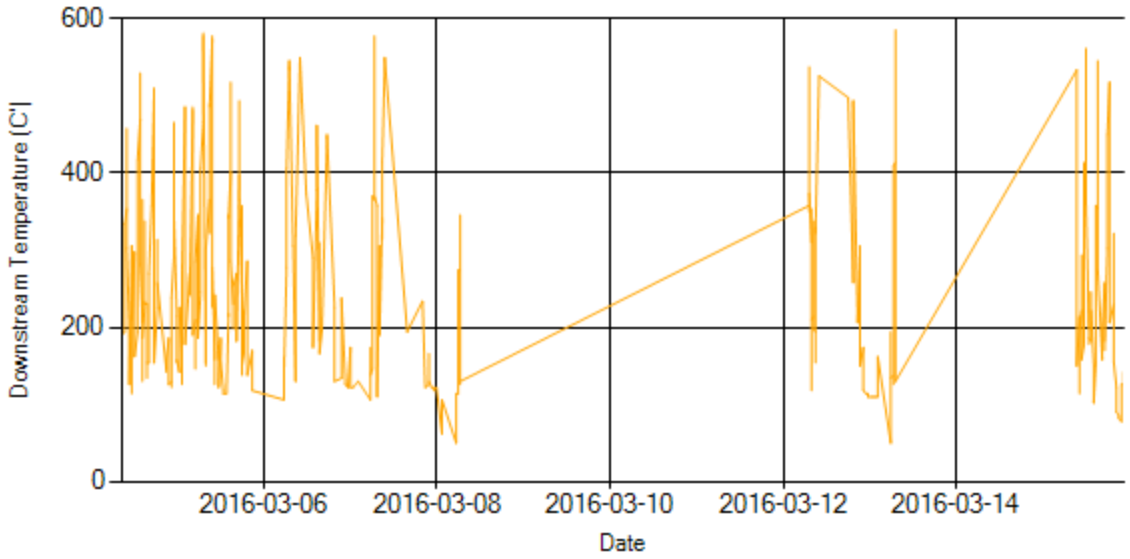



*Figure 7- Temperature distribution over the period*

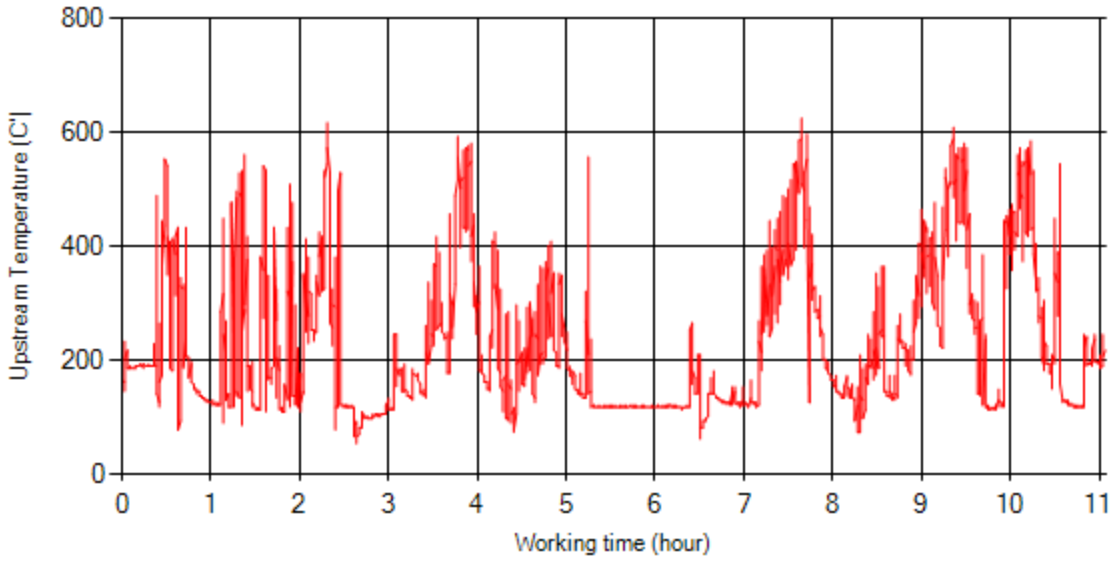



*Figure 8- Temperature vs. working hours*

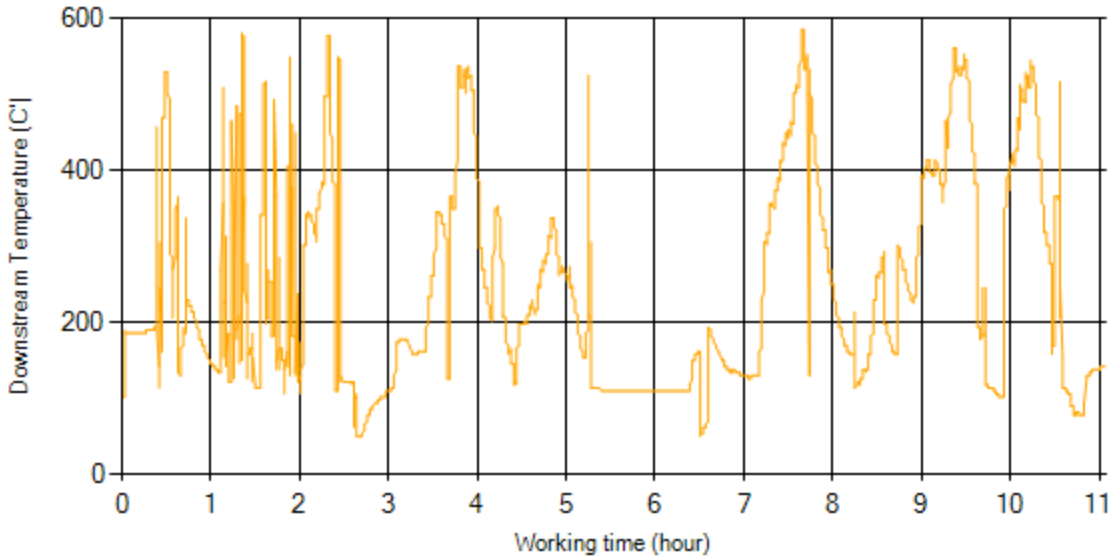



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

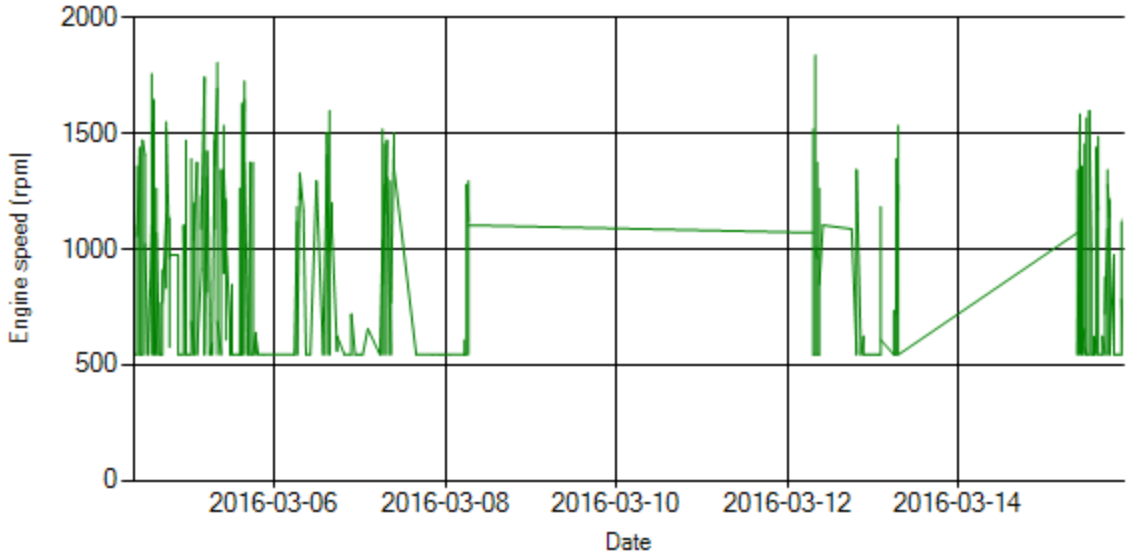



*Figure 10- Engine speed distribution over the period*

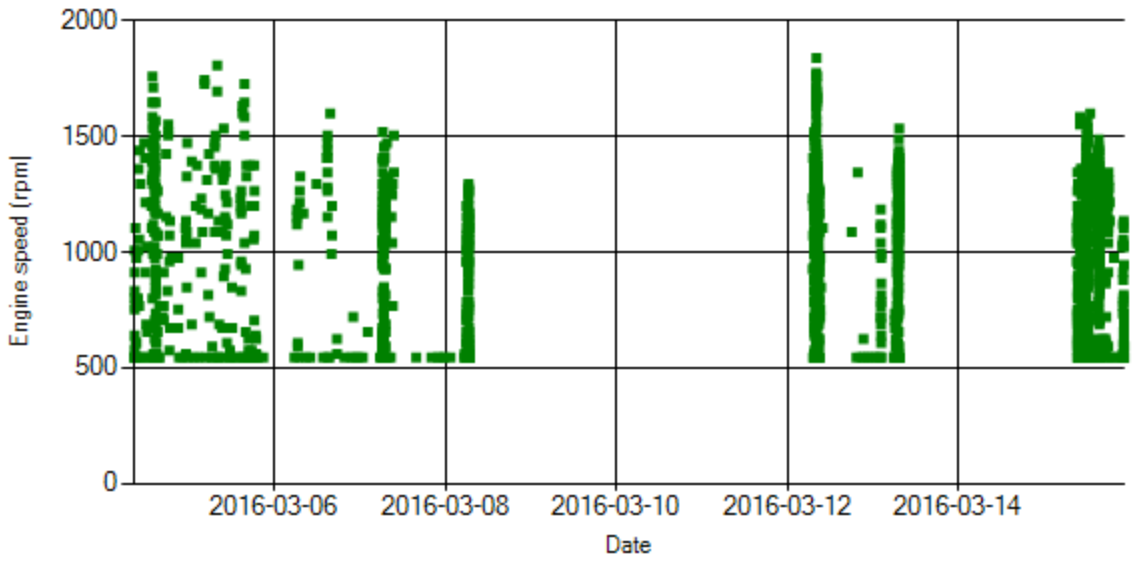



*Figure 11- Engine speed diagram for calculating CPK's working days*

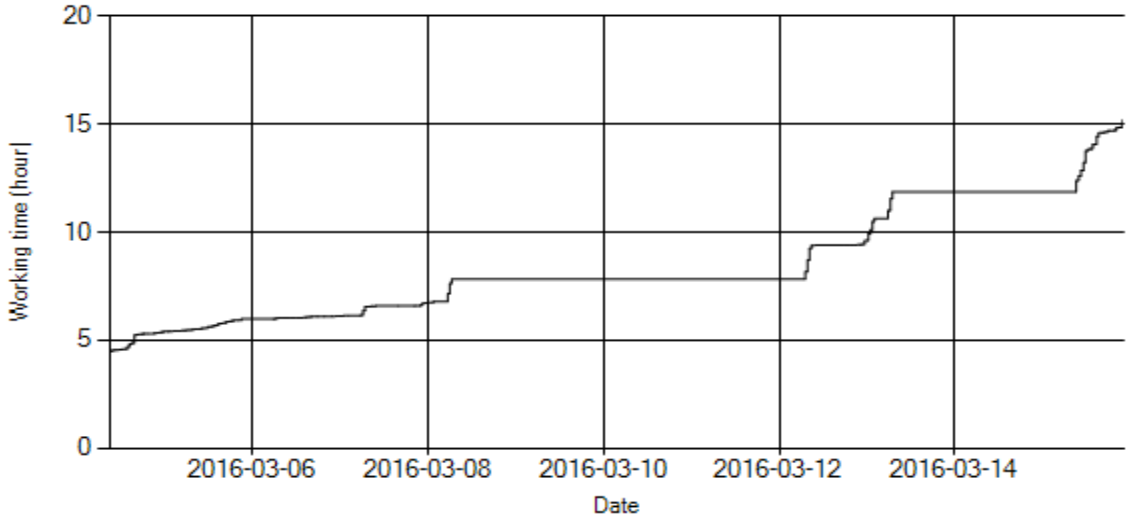



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data.
Notice: because of electrical problem and missing lots of data, stop days could not be calculated from figures 11 and 12.

## Pressure-Engine Speed diagrams

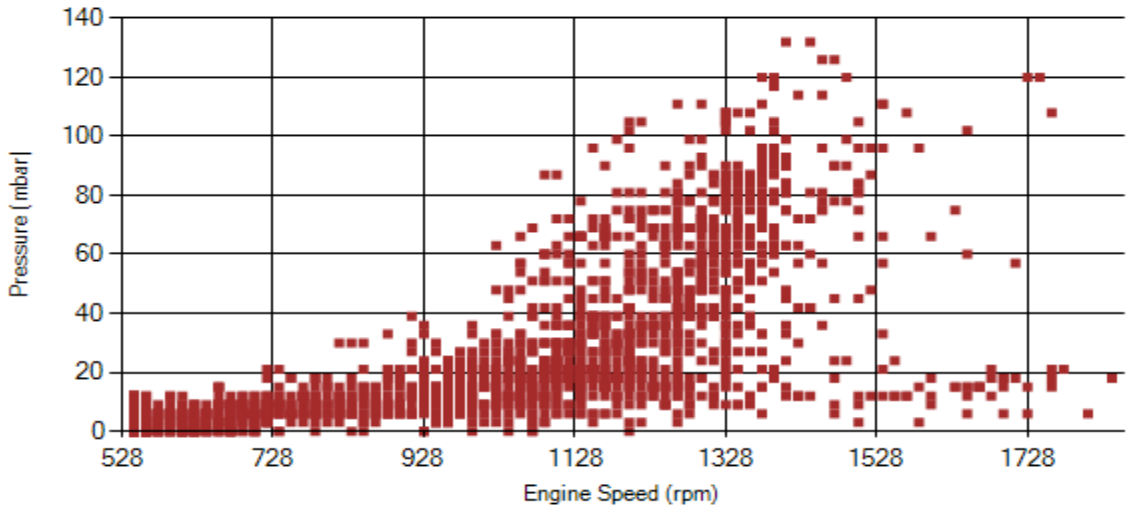



*Figure 13- Pressure against engine speed*

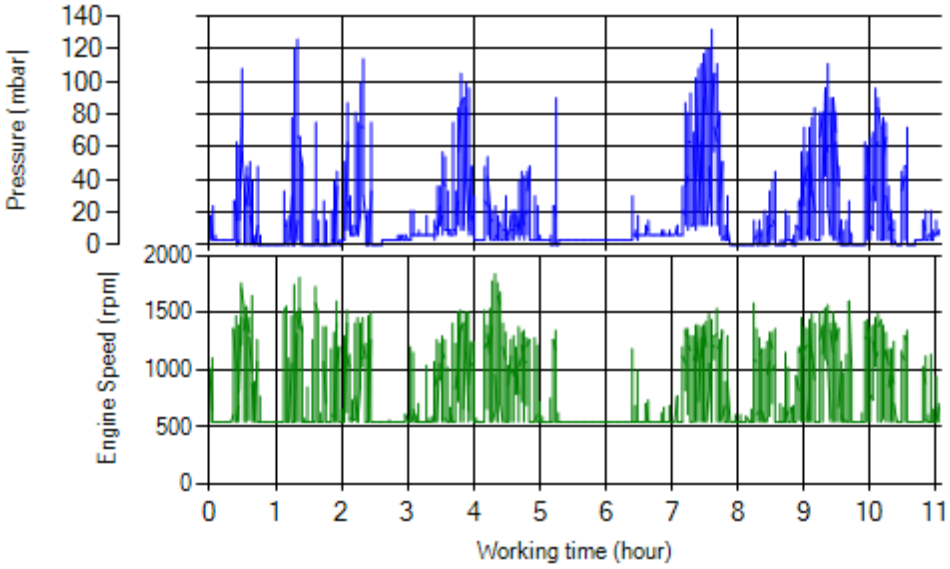



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

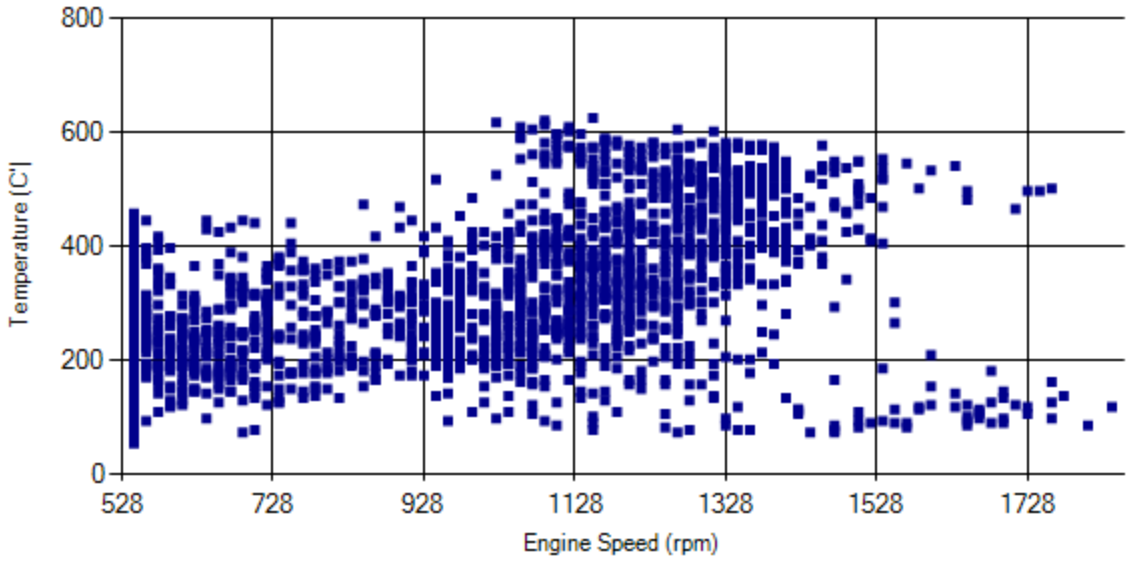



*Figure 15- Temperature against engine speed*

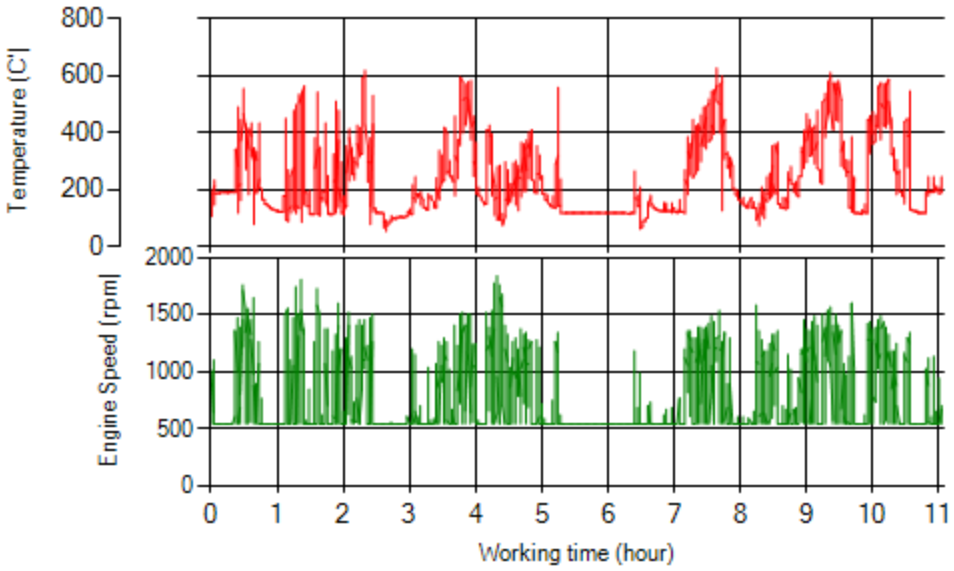



*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

- Due to missing lots of data, reliable judgment could not be done. But considering available data, DPF operation was excellent during the period.

| | | |
|---|---|---|
| Filter operation status | Excellent ■ | Good ☐ |
| | Maintenance required ☐ | Failed ☐ |

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 85423 |
| CPK data logger number | LN: 001505, DN: 2001, Sim Number +989218469621 |
| Bus line | Number 4 (south to north bus line) |
| Bus Terminals | South Bus Terminal - Park Way Bus Tehran Terminal |
| Total path distance | 22.8 km |
| DPF producer company | HJS_02 (active system with FBC – electrical heater) |
| Installation date | 19/Feb/2015 |
| Report period | 16/Mar/2016- 31/Mar/2016 (sixteen days) |
| K value - DPF upstream | 1.73 [1/m] |
| K value – DPF downstream | 0.02 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF was cleaned on 2016-02-03 for the first time. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 66897 km |
| Bus mileage over the period | 4100 km |
| Working days over the period | 16 days |
| Stop days | 0 days |
| Data logger working days | —* |
| Working hours over the period | - |
| Average working hours per day (including stop days) | - |
| Bus average speed | - |
| idle speed time to all working time ration | - % |
| Total Bus fuel consumption over the period | 2378 lit |
| Fuel consumption per hour | - lit/hr |
| Average fuel consumption | 0.58 lit/km |
| Total Bus additive consumption over the period | 1.1 lit |
| Average additive consumption | 268 cc/km |
| Additive consumption to fuel ration | 473 cc/1000lit |

—*Notice: Due to electrical problem, lots of the data was missed during the period. So next pages result' were driven considering available data.

## Temperature, Pressure and Engine Speed Overview

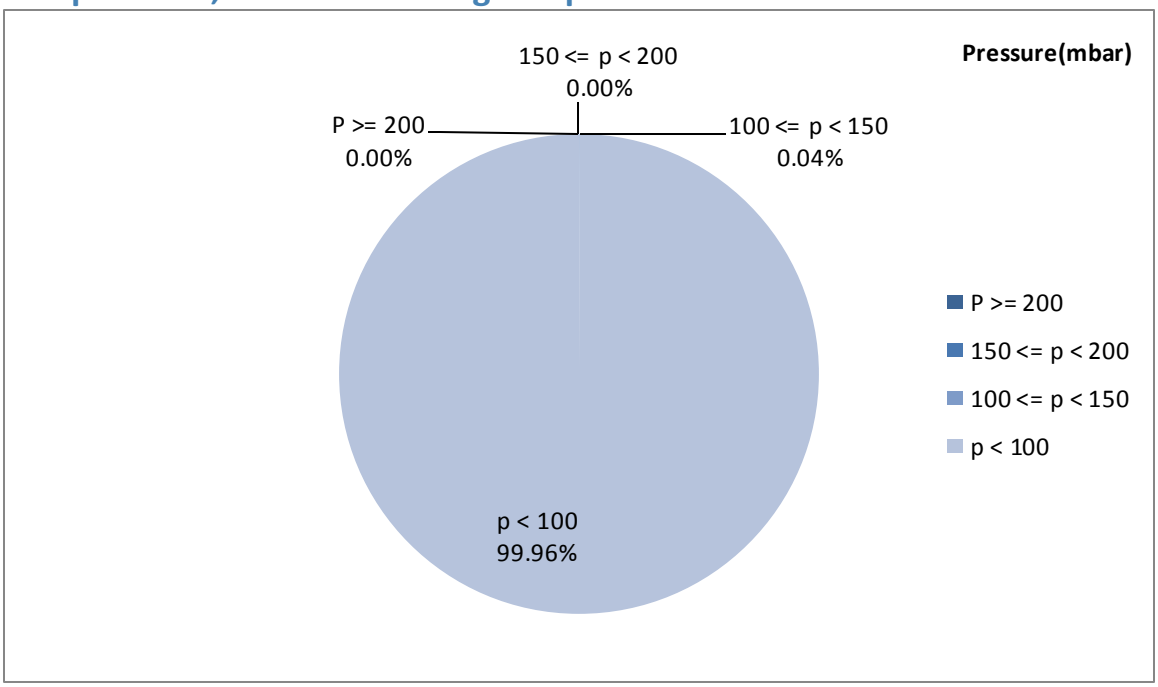



*Figure 1- Pressure distribution over the working hours*

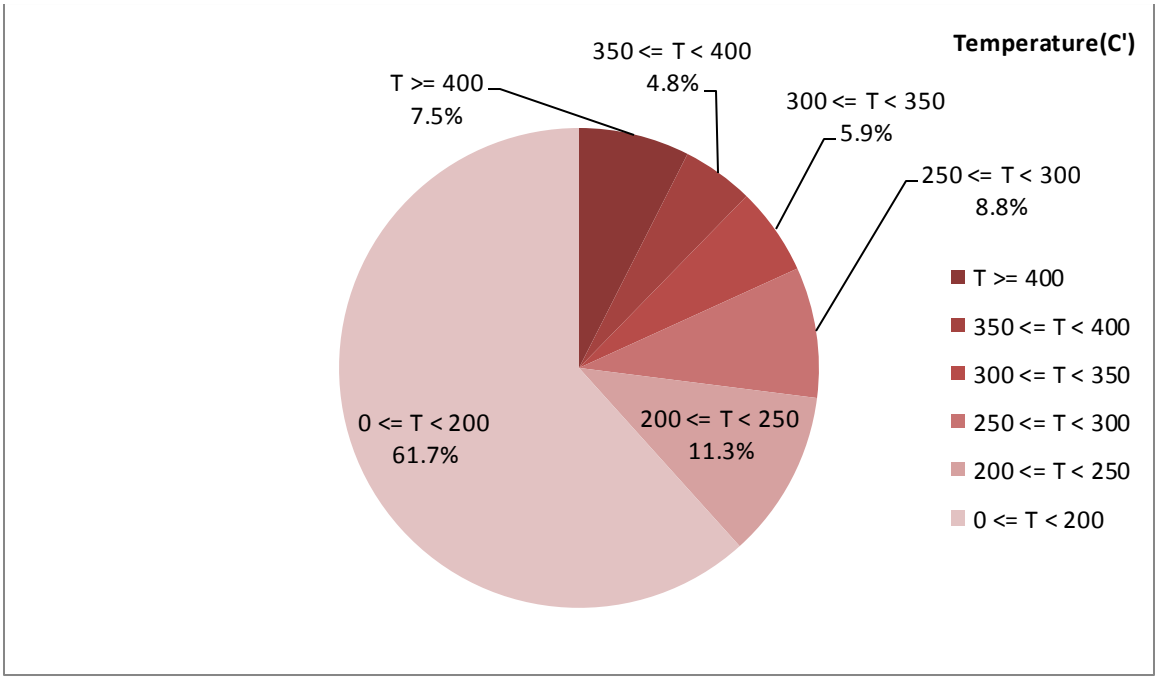



*Figure 2-Temperature distribution over the working hours*

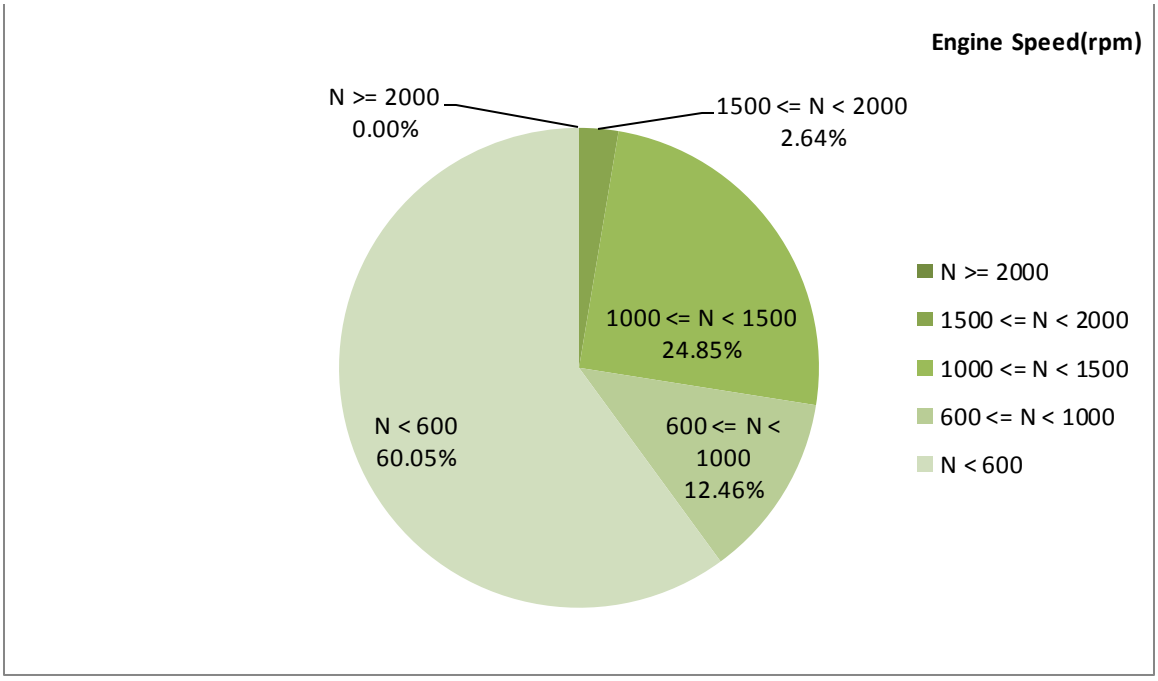



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 206.1 | 10.45 | 767 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 286.44 | 21.53 | 1102 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 582-50 | 108-0 | 1824-544 |

## Detailed Pressure Analysis

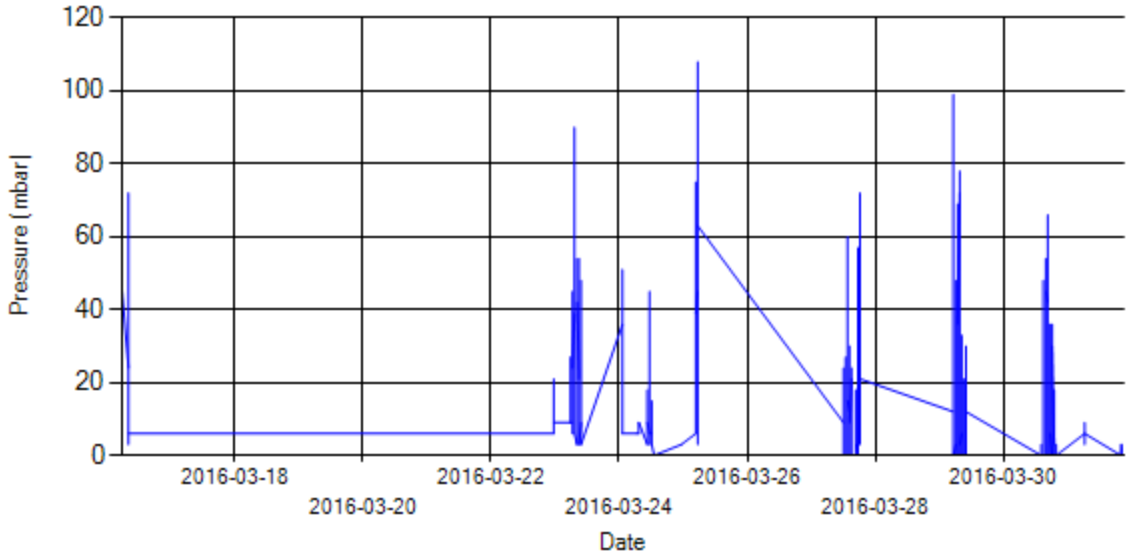



*Figure 4- Pressure distribution over the period*

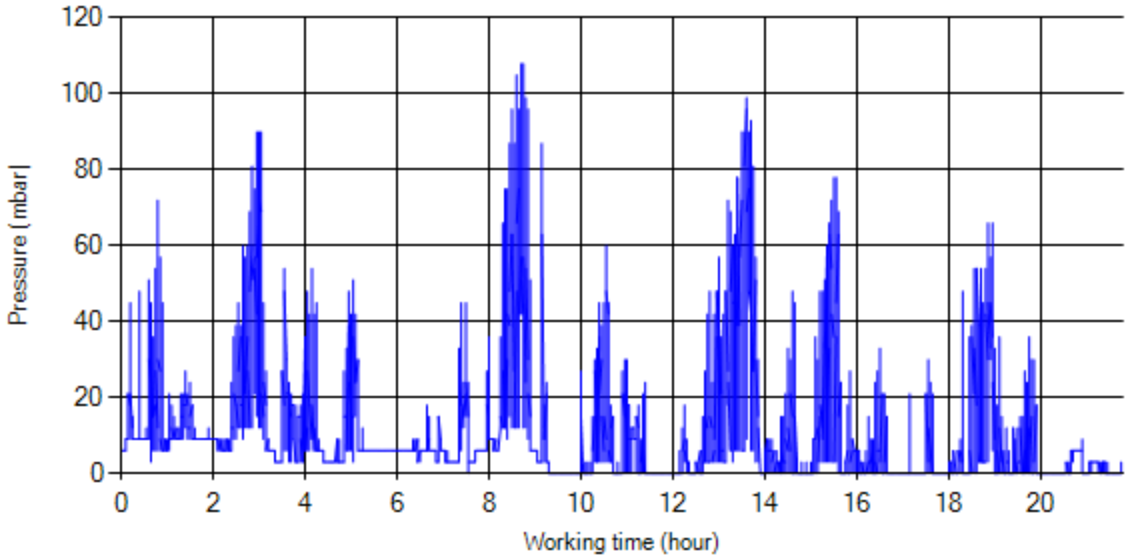



*Figure 5- Pressure vs. working hours*

## Detailed Temperature Analysis

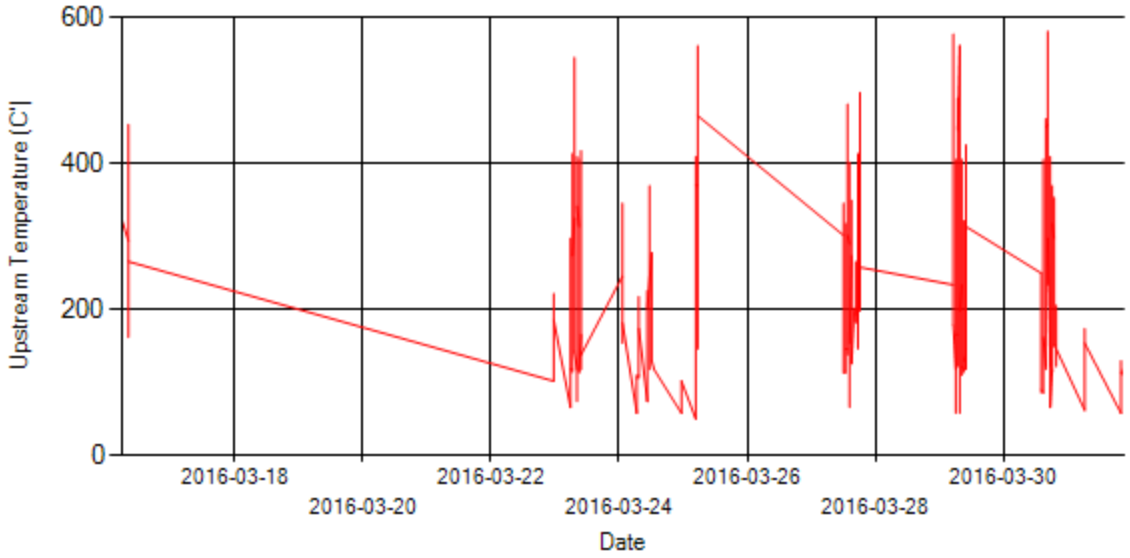



*Figure 6- Temperature distribution over the period*

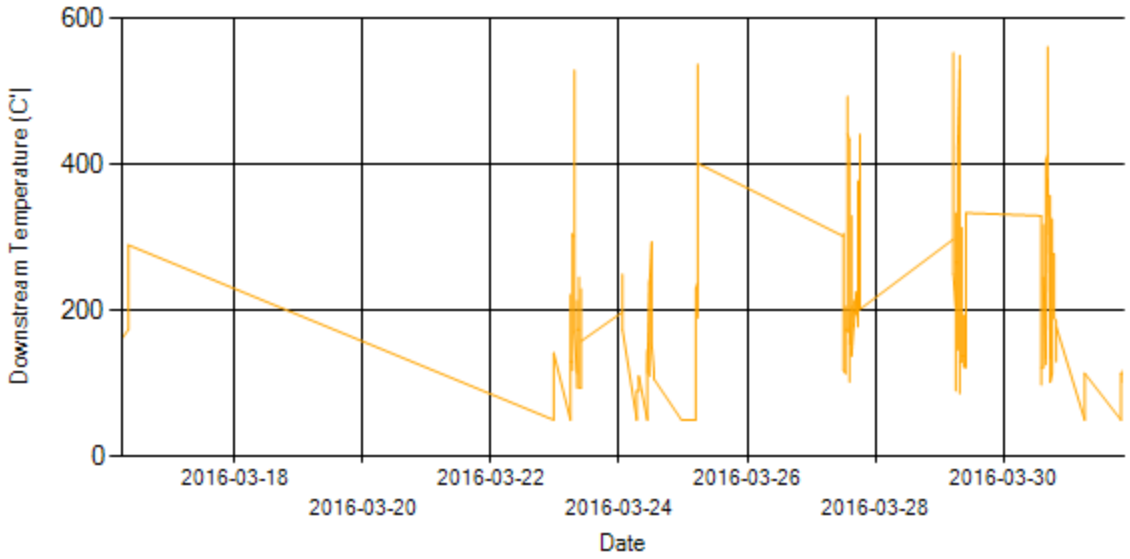



*Figure 7- Temperature distribution over the period*

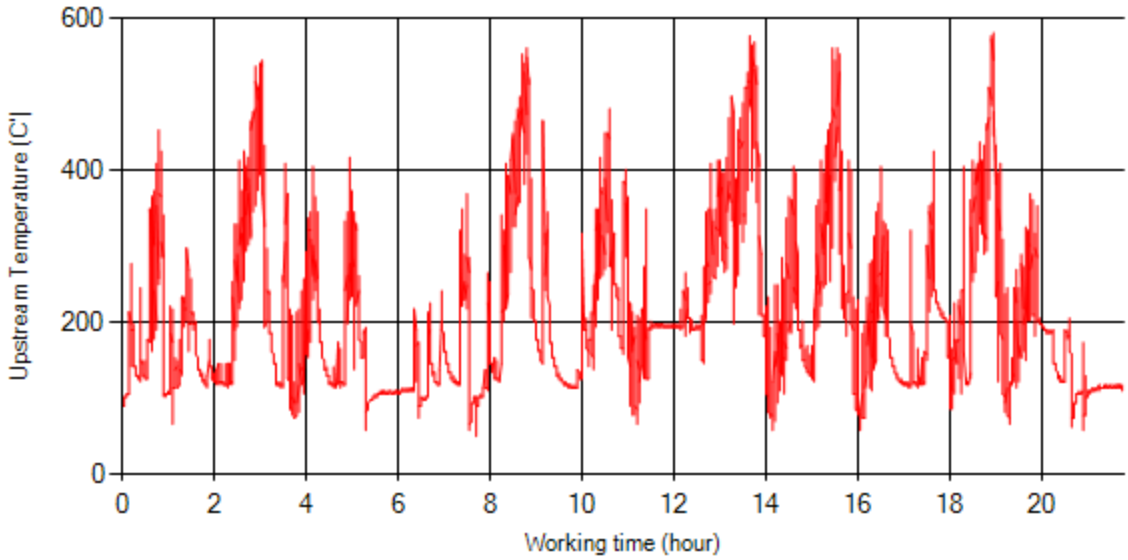



*Figure 8- Temperature vs. working hours*

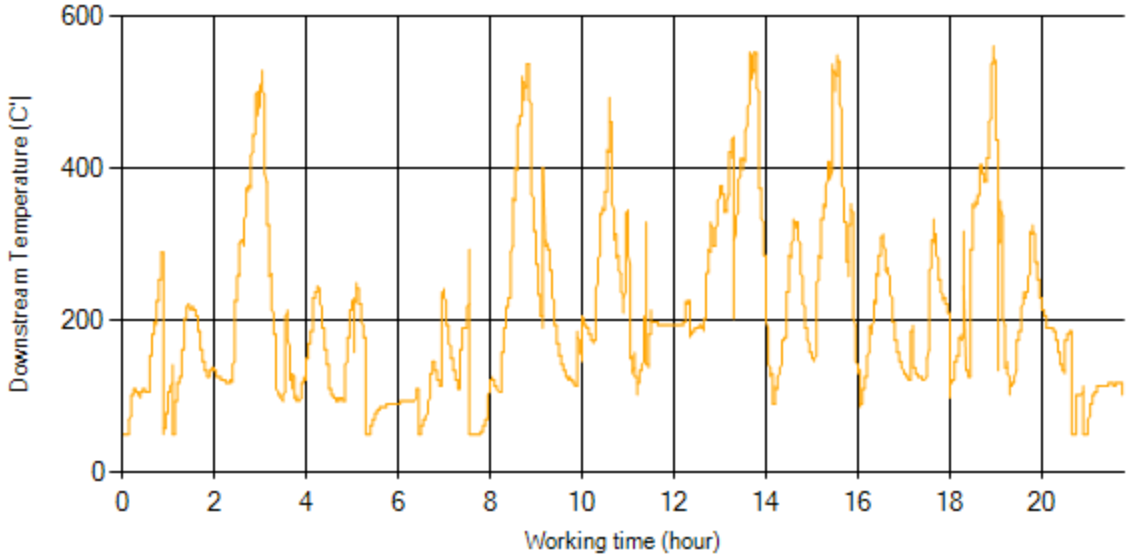



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

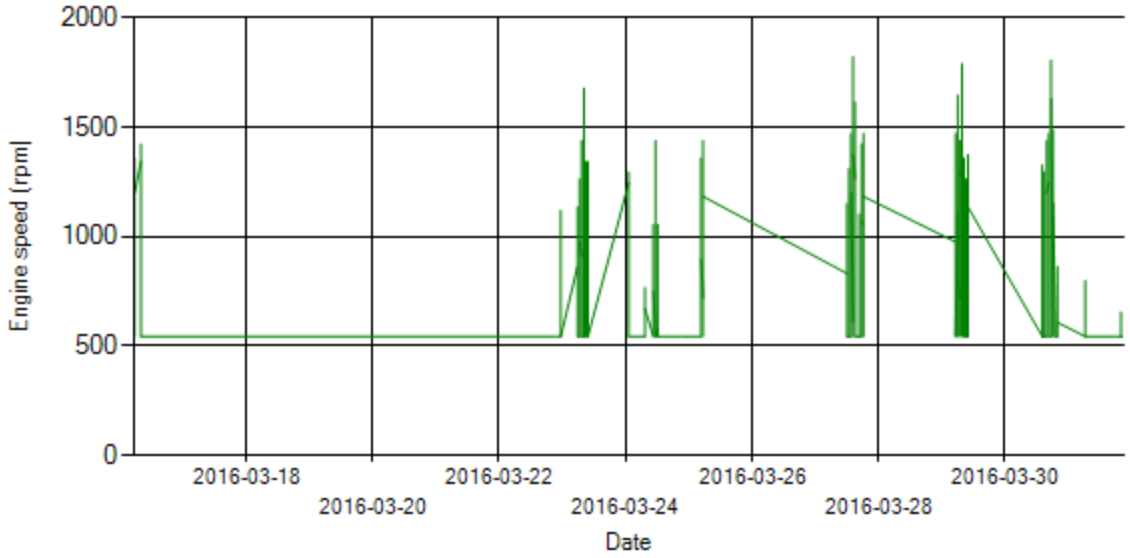



*Figure 10- Engine speed distribution over the period*

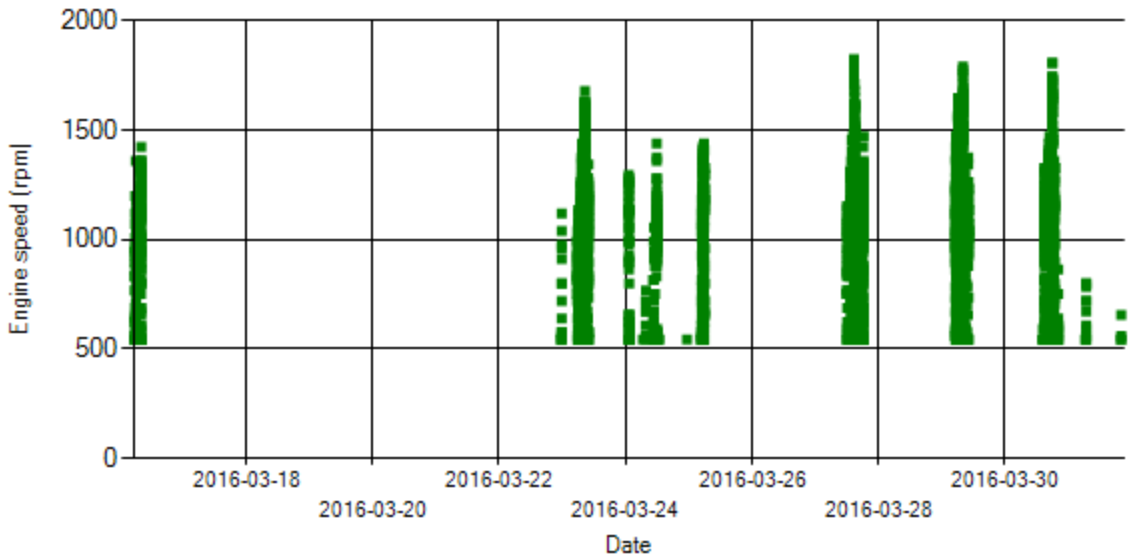



*Figure 11- Engine speed diagram for calculating CPK's working days*

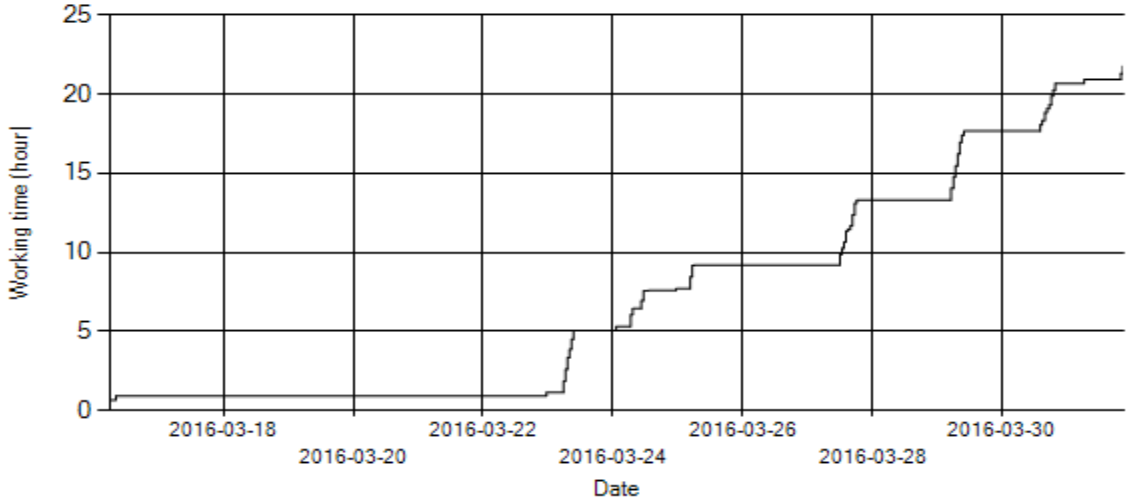



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data.
Notice: because of electrical problem and missing lots of data, stop days could not be calculated from figures 11 and 12.

## Pressure-Engine Speed diagrams

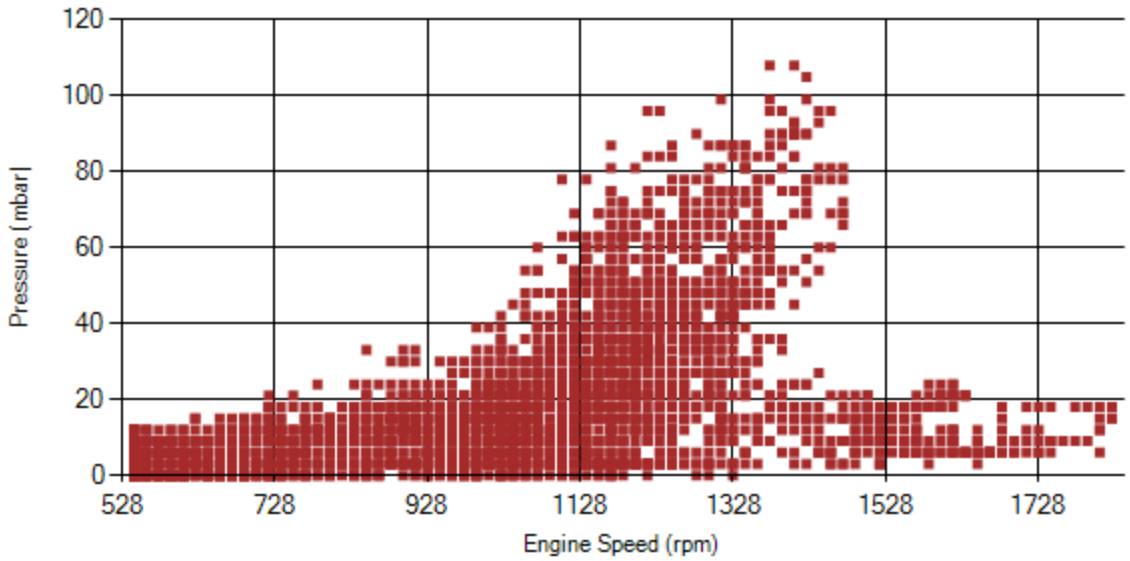



*Figure 13- Pressure against engine speed*

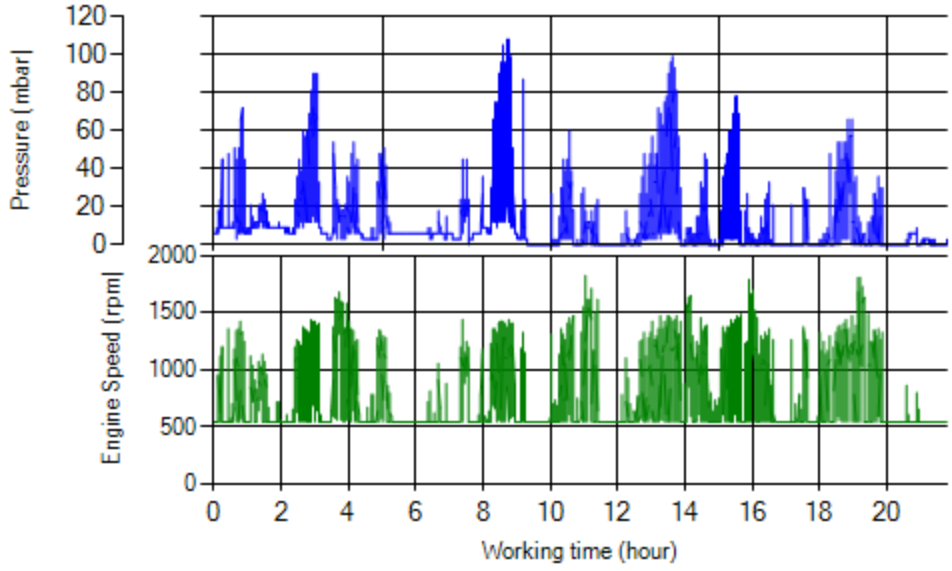



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

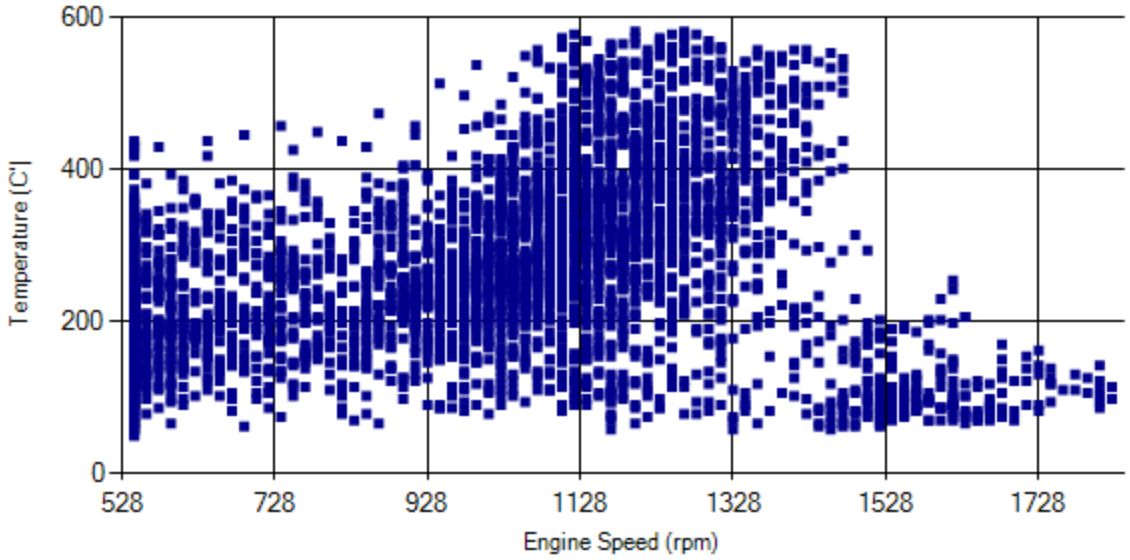



*Figure 15- Temperature against engine speed*

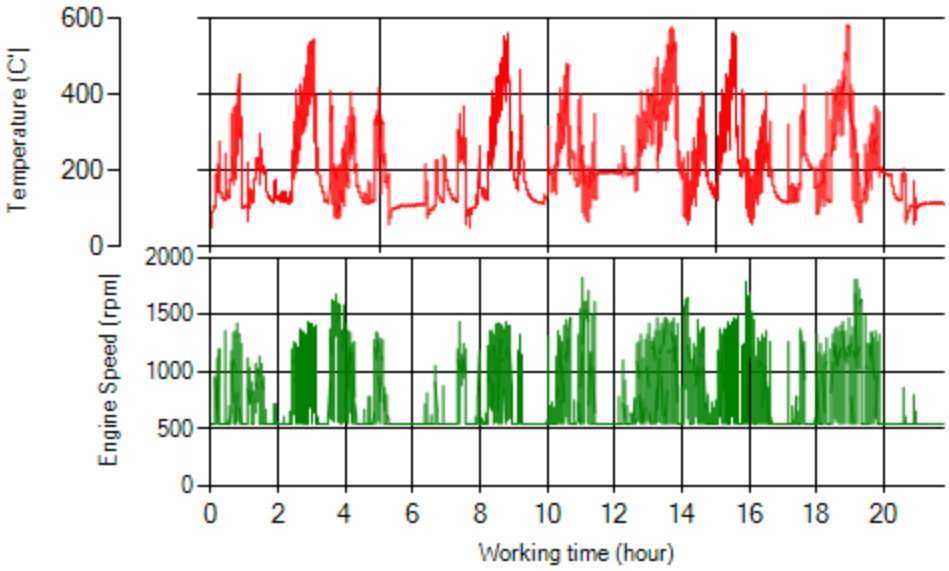


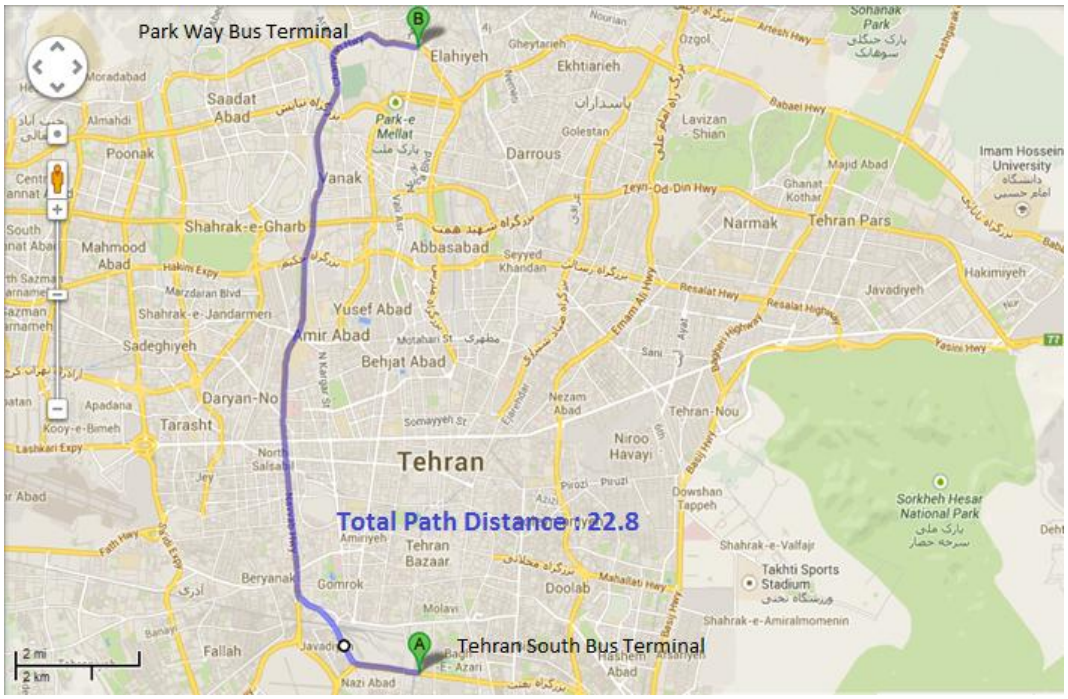

*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

- Due to missing lots of data, reliable judgment could not be done. But considering available data, DPF operation was excellent during the period.

| | | |
|---|---|---|
| Filter operation status | Excellent ■ | Good ☐ |
| | Maintenance required ☐ | Failed ☐ |

| | |
|---|---|
| Vehicle plate number | 78515 |
| Bus line | Number 4 (south to north bus line) |
| DPF producer company | Dinex_01 (Passive system with FBC) |



## Overall Information

*Table1- Overall Information*

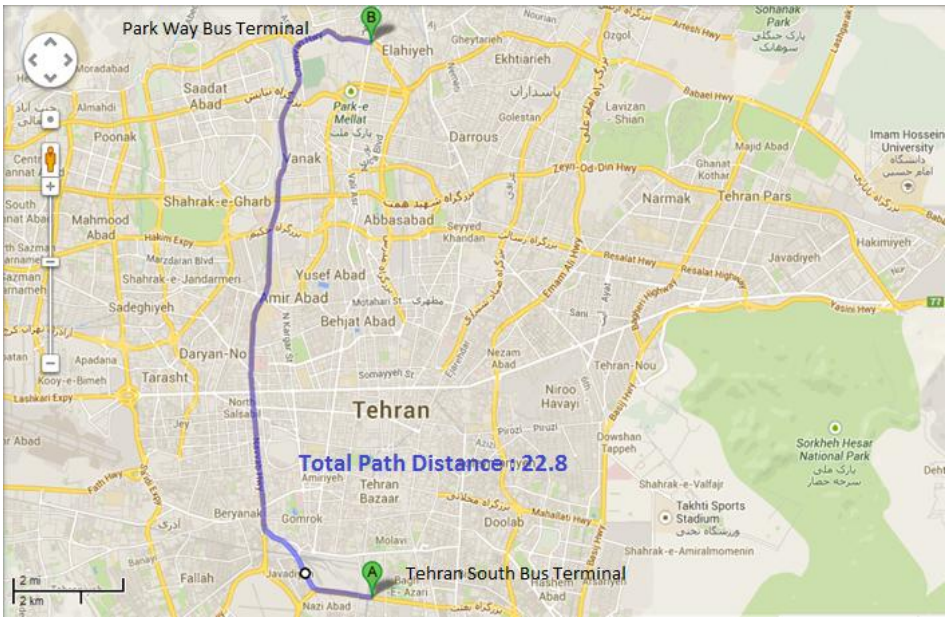
| | |
|---|---|
| Vehicle plate number | 78515 |
| CPK data logger number | LN: 001490, DN: 1954, Sim Number +98000000000 |
| Bus line | Number 4 (south to north bus line) |
| Bus Terminals | Tehran South Bus Terminal - Park Way Bus Terminal |
| Total path distance | 22.8 km |
| DPF producer company | Dinex_01 (passive system with FBC) |
| Installation date | 22/Oct/2014 |
| Report period | 01/Mar/2016 – 31/Mar/2016 (thirty one days) |
| K value - DPF upstream | - [1/m] |
| K value – DPF downstream | - [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | Filter core was changed on 15/Feb/2015. |
| Dosing status | Dosing value was reduced by 70% on March February 15th. ( Secondary value/Initial value=0.3) |

**Notice: Bus has been stopped from Sep 18th until now due to technical problems (related to Bus Company).**

| | |
|---|---|
| Vehicle plate number | 78524 |
| Bus line | Number 4 (south to north Bus line) |
| DPF producer company | PURItech (Passive system with FBC) |

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 78524 |
| CPK data logger number | LN: 001443, DN: 1930,Sim +989218786219 |
| Bus line | Number 4 (south to north Bus line) |
| Bus Terminals | Tehran South Bus Terminal - Park Way Bus Terminal |
| Total path distance | 22.8 km |
| DPF producer company | PURItech (Passive system with FBC) |
| Installation date | 28/Jan/2015 |
| Report period | 01/Mar/2016 – 15/Mar/2016 (fifteen days) |
| K value | 1.70 |
| K value | 1.70 |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF core was removed on Jul 22nd and was cleaned on Aug 12th for the first time.<br>Considering system relatively high backpressure, filter isolation defect and air filter's deformation, DPF core was removed on Sep 16th and installed on Nov 17th.<br>The third cleaning was unavoidable after only 6 days working and was done on 29th Nov. System only worked for two days and DPF was replaced by muffler on Nov 30th.<br>DPF was installed for the fourth time on Jan/19/2016 and was replaced by muffler after only three days working because of high backpressure. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 63258 km |
| Bus mileage over the period | 2683 km |
| Working days over the period | 15 days |
| Stop days | 0 day |
| Data logger working days | 15 days |
| Working hours over the period | 206 hours 25 minutes |
| Average working hours per day (including stop days) | 13 hours 45 minutes |
| Bus average speed | 13 km/hr |
| idle speed time to all working time ration | 52.81 % |
| Total Bus fuel consumption over the period | 1556 lit |
| Fuel consumption per hour | 7.5 lit/hr |
| Average fuel consumption | 0.58 lit/km |
| Total Bus additive consumption over the period | - lit |
| Average additive consumption | - cc/km |
| Additive consumption to fuel ration | - cc/1000lit |

## Temperature, Pressure and Engine Speed Overview

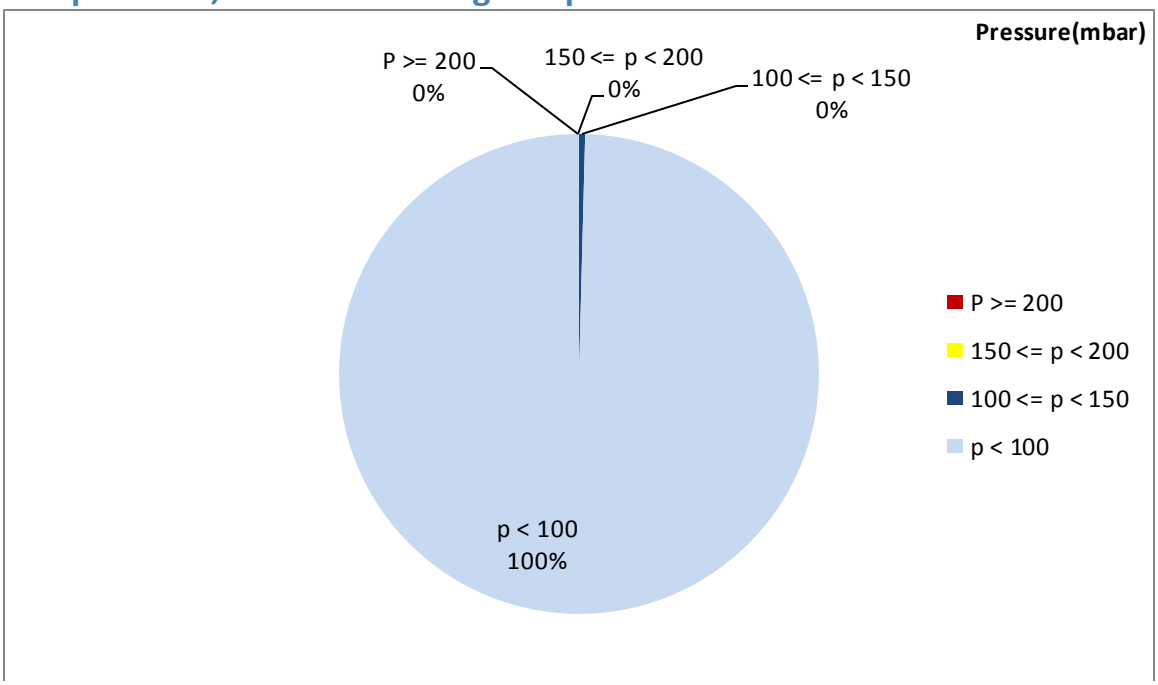



*Figure 1- Pressure distribution over the working hours*

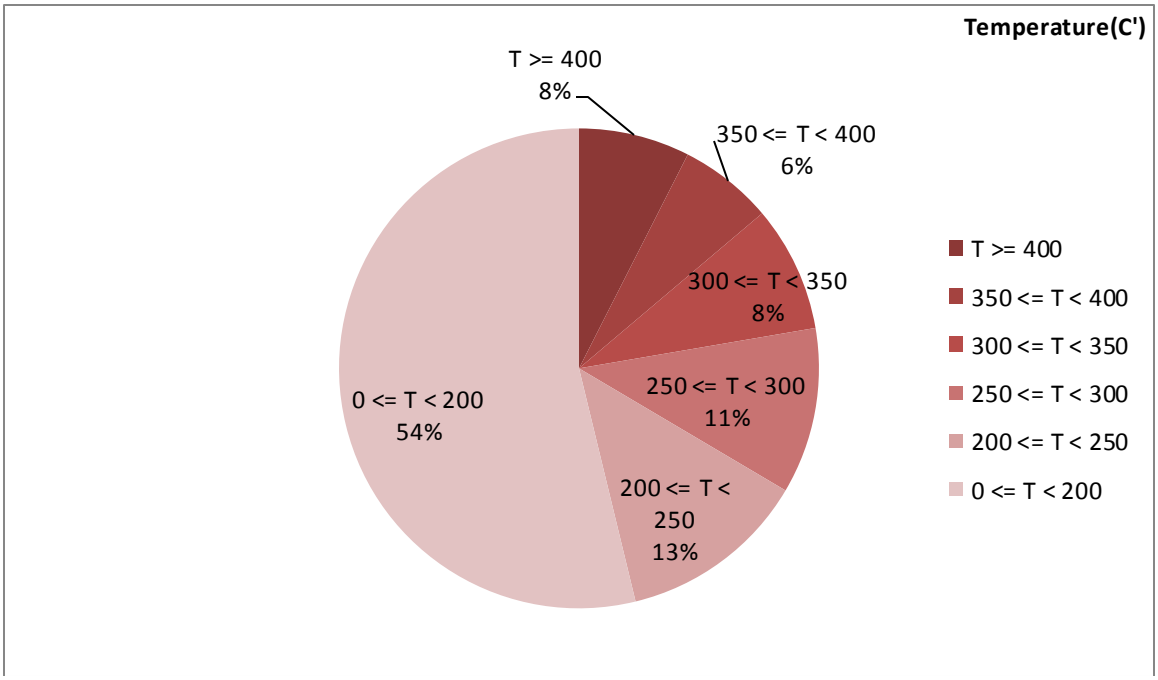



*Figure 2-Temperature distribution over the working hours*

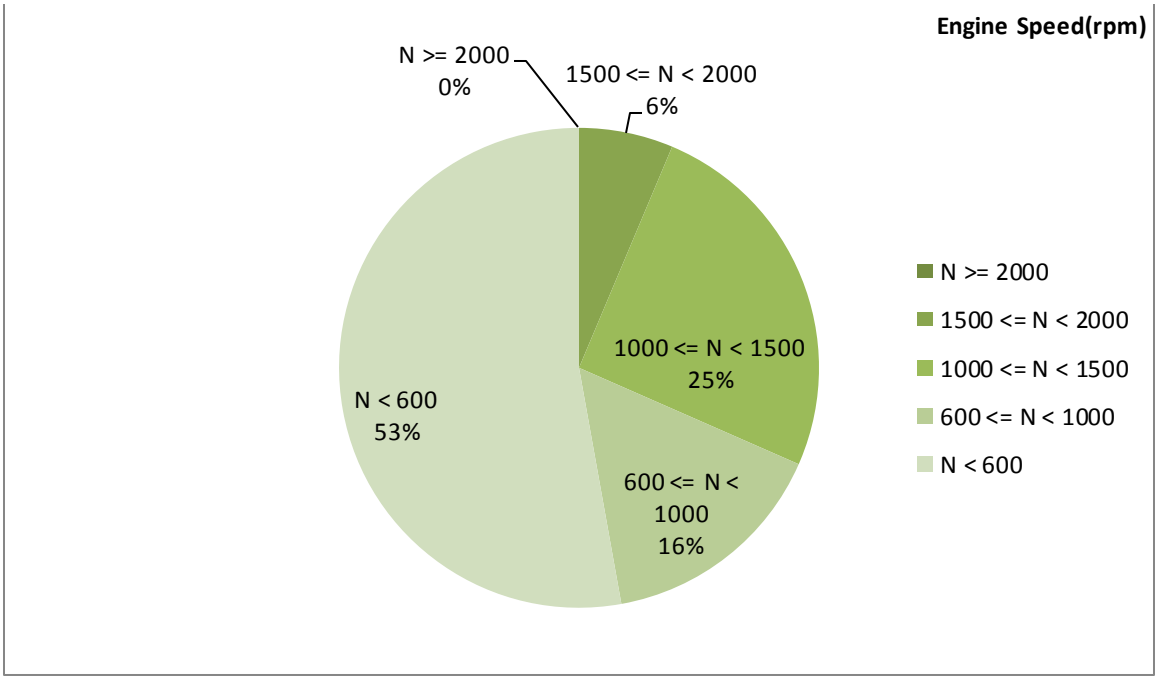



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 219.1 | 5.3 | 823 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 285.39 | 11.12 | 1134 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 546-50 | 123-0 | 2000-272 |

## Detailed Pressure Analysis

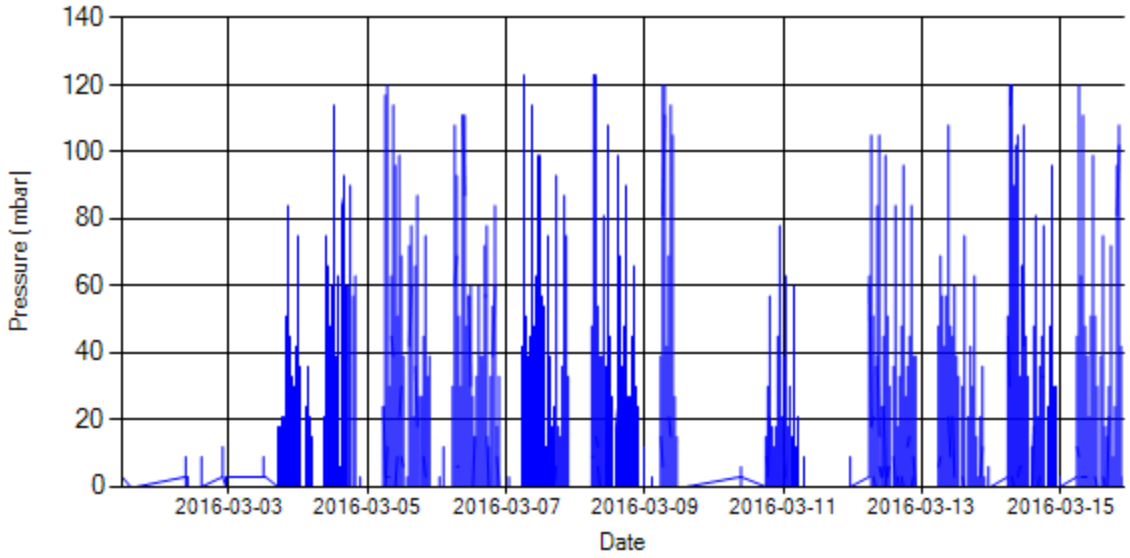



*Figure 4- Pressure distribution over the period*

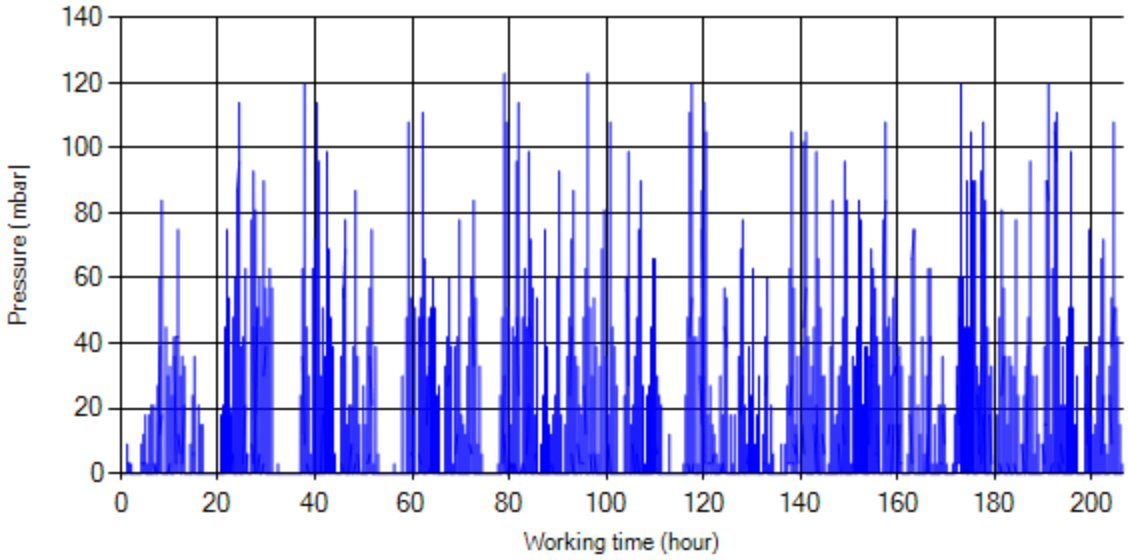



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

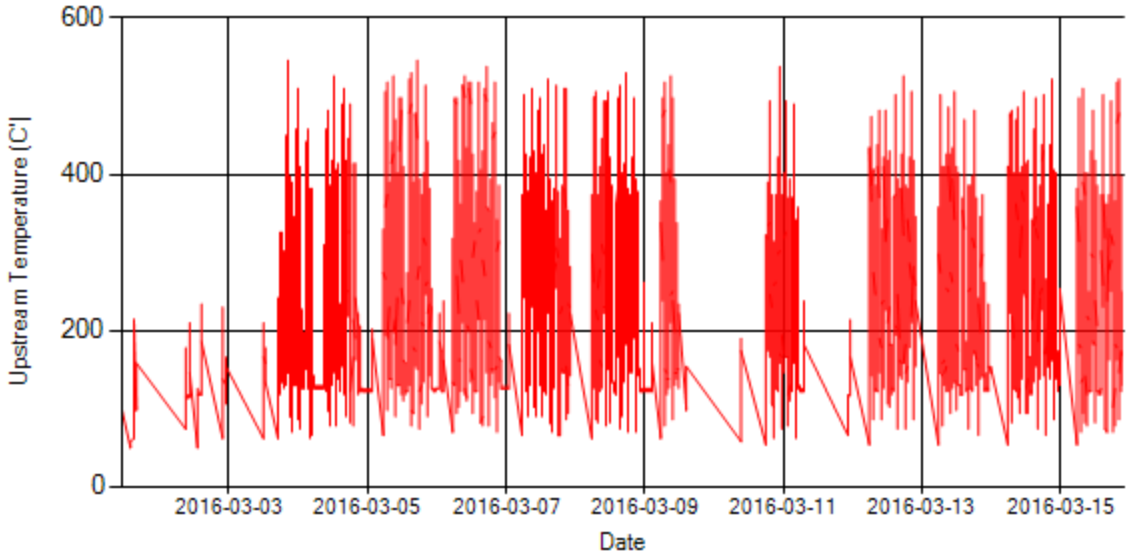



*Figure 6- Temperature distribution over the period*

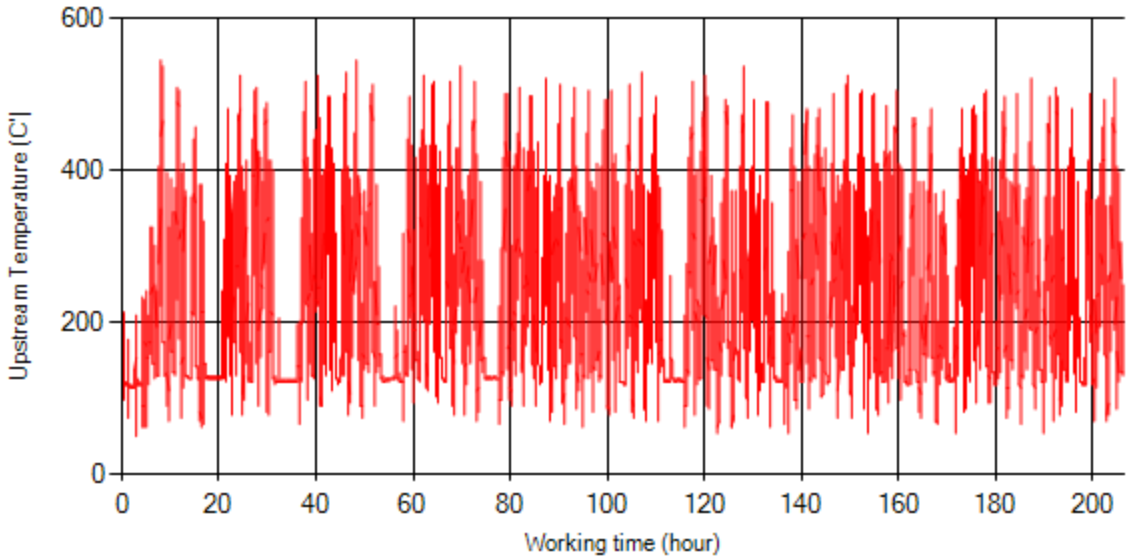



*Figure 7- Temperature vs. working hours*

## Engine Speed Diagrams

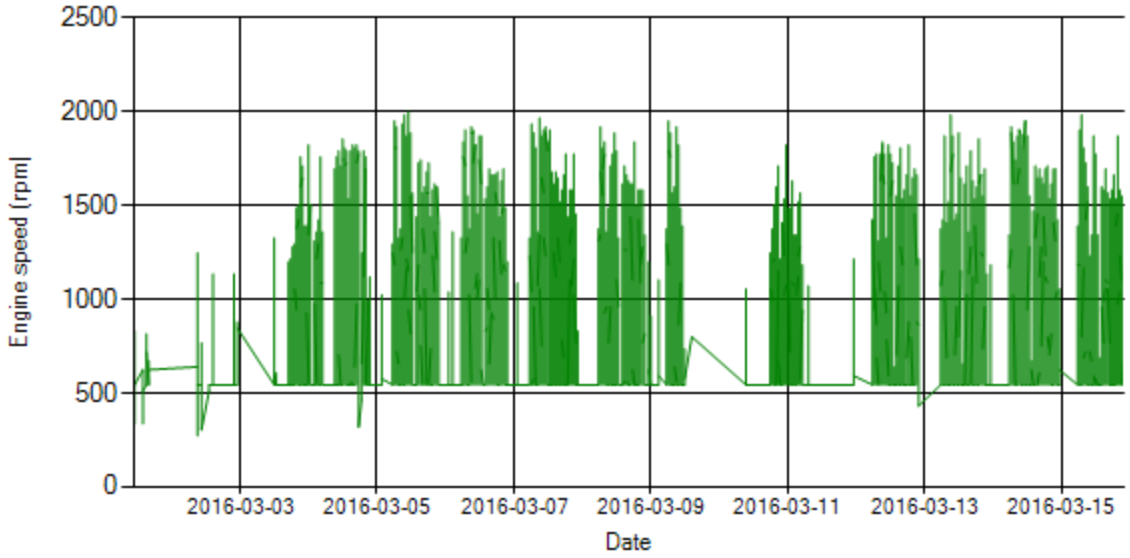



*Figure 8- Engine speed distribution over the period*

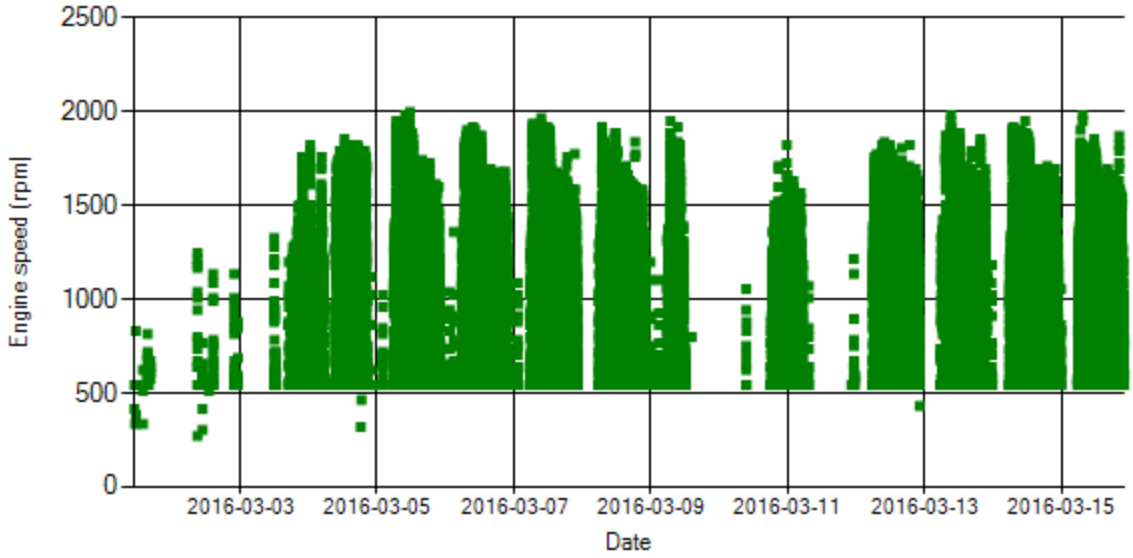



*Figure 9- Engine speed diagram for calculating CPK's working days*

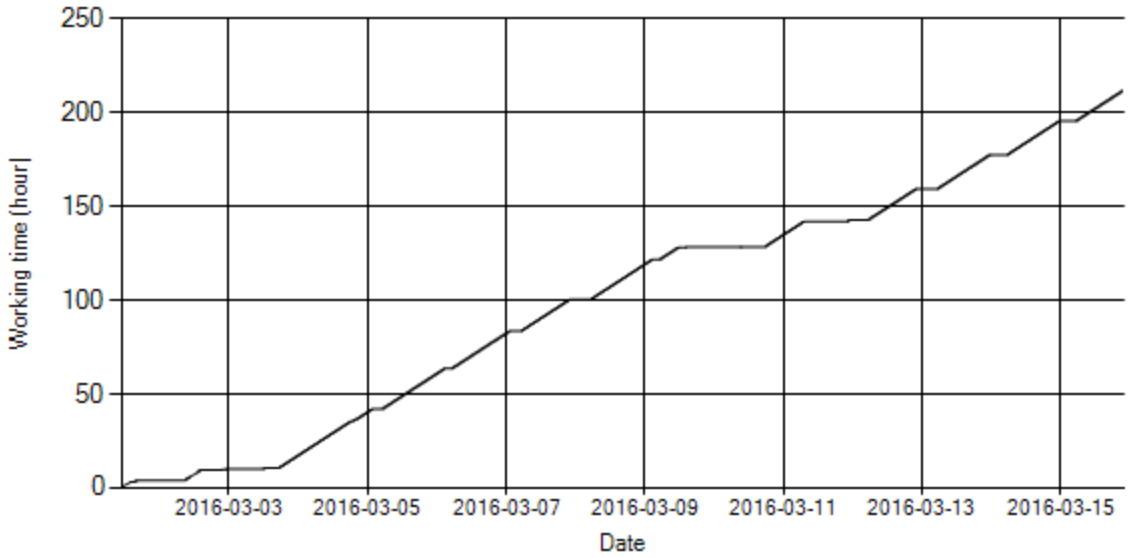



*Figure 10- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 10. The lines parallel with Date axis show days without data logger data.

## Pressure-Engine Speed diagrams

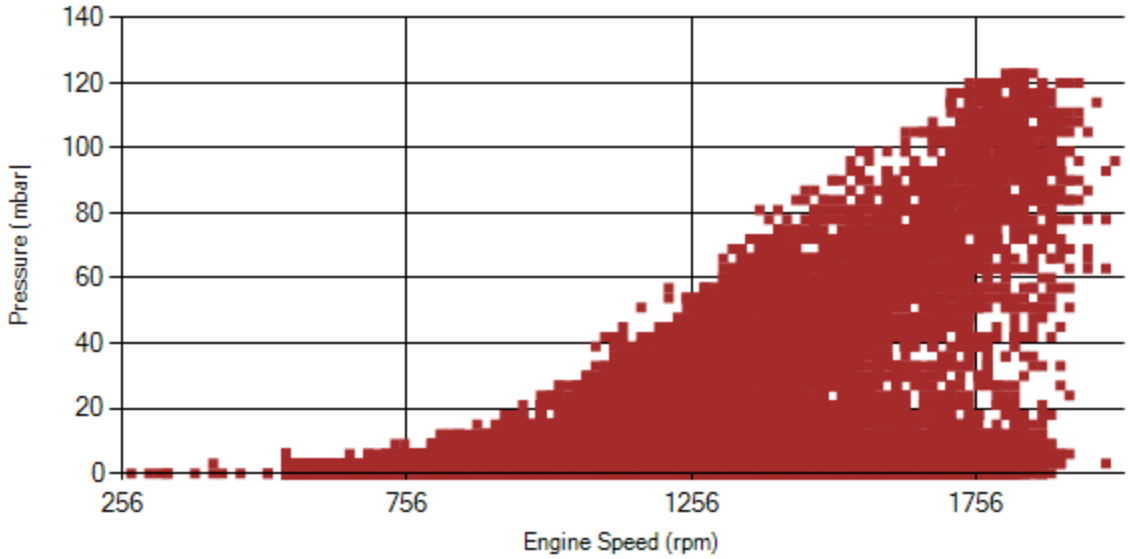



*Figure 11- Pressure against engine speed*

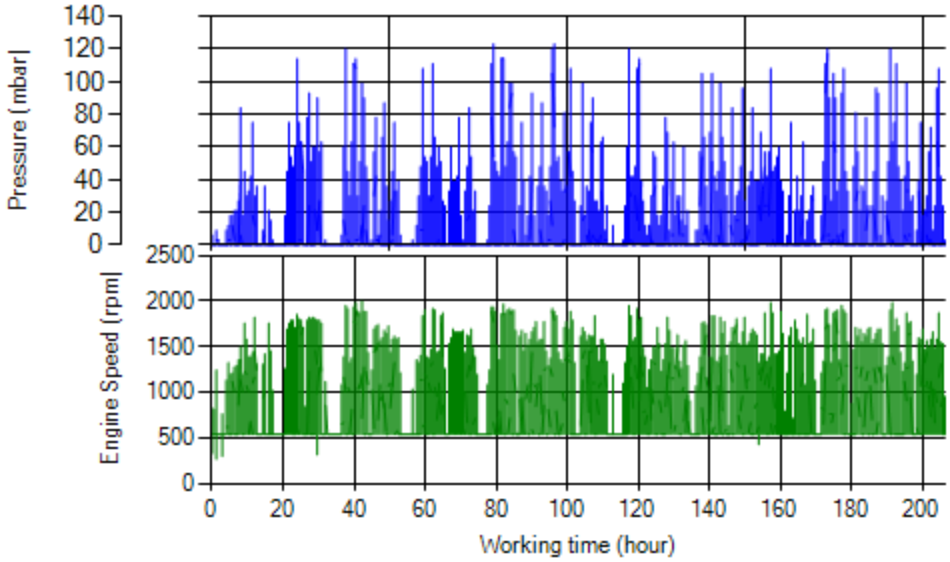



*Figure 12- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

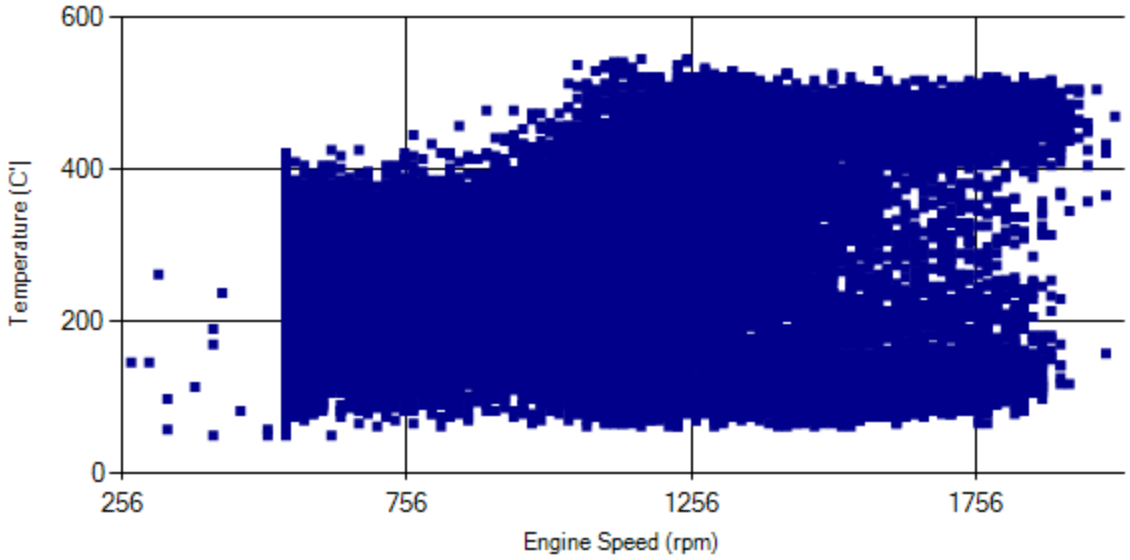



*Figure 13- Temperature against engine speed*

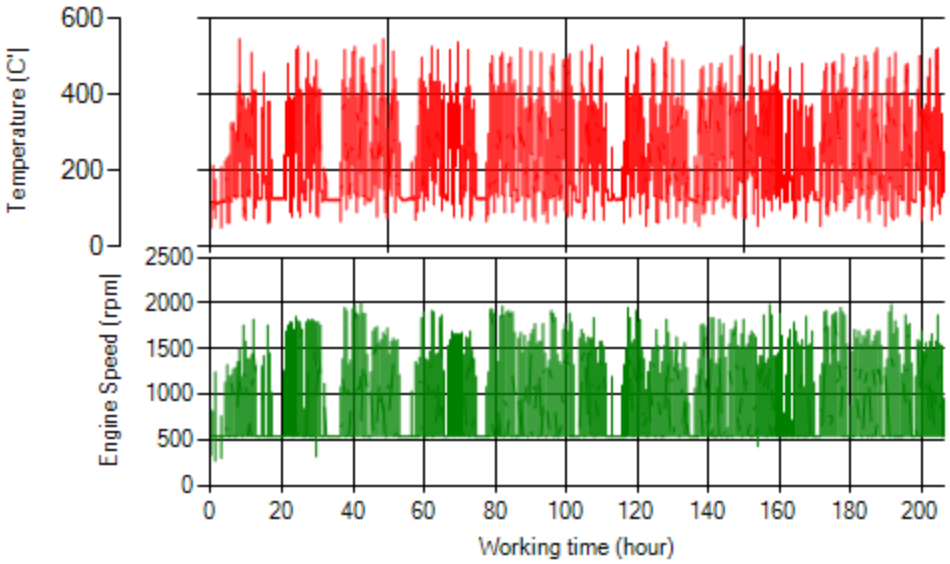



*Figure 14- T, N distribution vs. working hours*

## Filter Operation Analysis

**Notice: System was working without DPF during this period.**

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 78524 |
| CPK data logger number | LN: 001443, DN: 1930,Sim +989218786219 |
| Bus line | Number 4 (south to north Bus line) |
| Bus Terminals | Tehran South Bus Terminal - Park Way Bus Terminal |
| Total path distance | 22.8 km |
| DPF producer company | PURItech (Passive system with FBC) |
| Installation date | 28/Jan/2015 |
| Report period | 16/Mar/2016 – 31/Mar/2016 (sixteen days) |
| K value | 1.75 |
| K value | 1.75 |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF core was removed on Jul 22nd and was cleaned on Aug 12th for the first time.<br>Considering system relatively high backpressure, filter isolation defect and air filter's deformation, DPF core was removed on Sep 16th and installed on Nov 17th.<br>The third cleaning was unavoidable after only 6 days working and was done on 29th Nov. System only worked for two days and DPF was replaced by muffler on Nov 30th.<br>DPF was installed for the fourth time on Jan/19/2016 and was replaced by muffler after only three days working because of high backpressure. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 64696 km |
| Bus mileage over the period | 1438 km |
| Working days over the period | 9 days |
| Stop days | 7 days |
| Data logger working days | 9 days |
| Working hours over the period | 106 hours 28 minutes |
| Average working hours per day (including stop days) | 7 hours 5 minutes |
| Bus average speed | 13.5 km/hr |
| idle speed time to all working time ration | 53.17 % |
| Total Bus fuel consumption over the period | 791 lit |
| Fuel consumption per hour | 7.4 lit/hr |
| Average fuel consumption | 0.55 lit/km |
| Total Bus additive consumption over the period | - lit |
| Average additive consumption | - cc/km |
| Additive consumption to fuel ration | - cc/1000lit |

## Temperature, Pressure and Engine Speed Overview

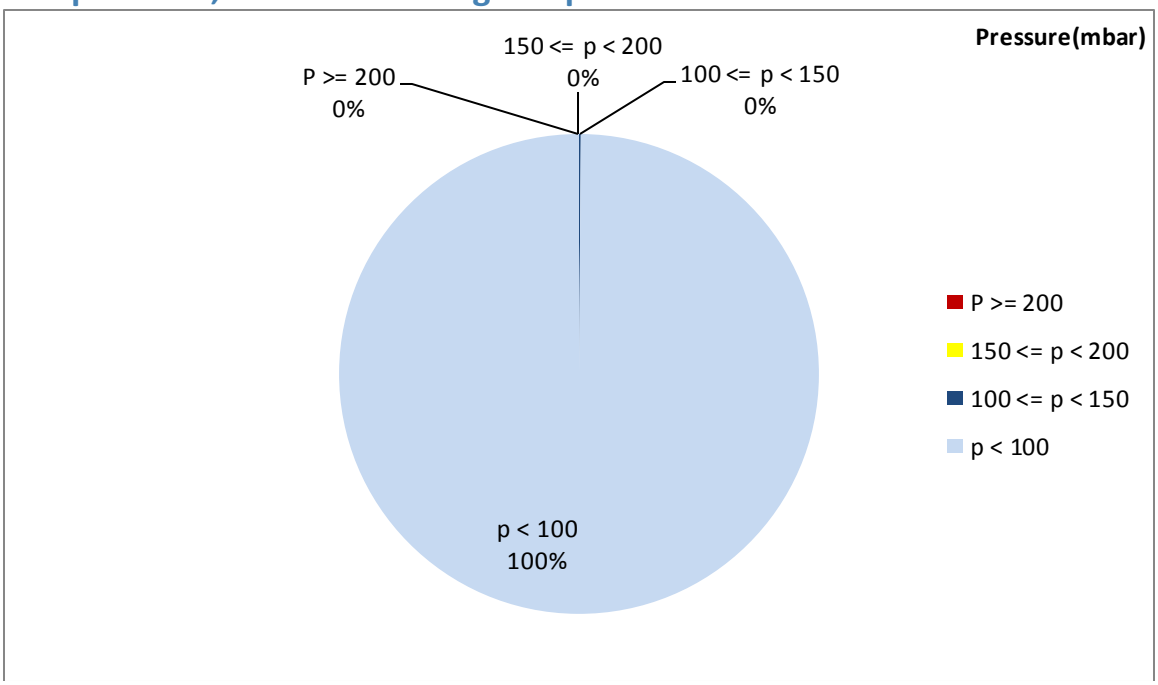



*Figure 1- Pressure distribution over the working hours*

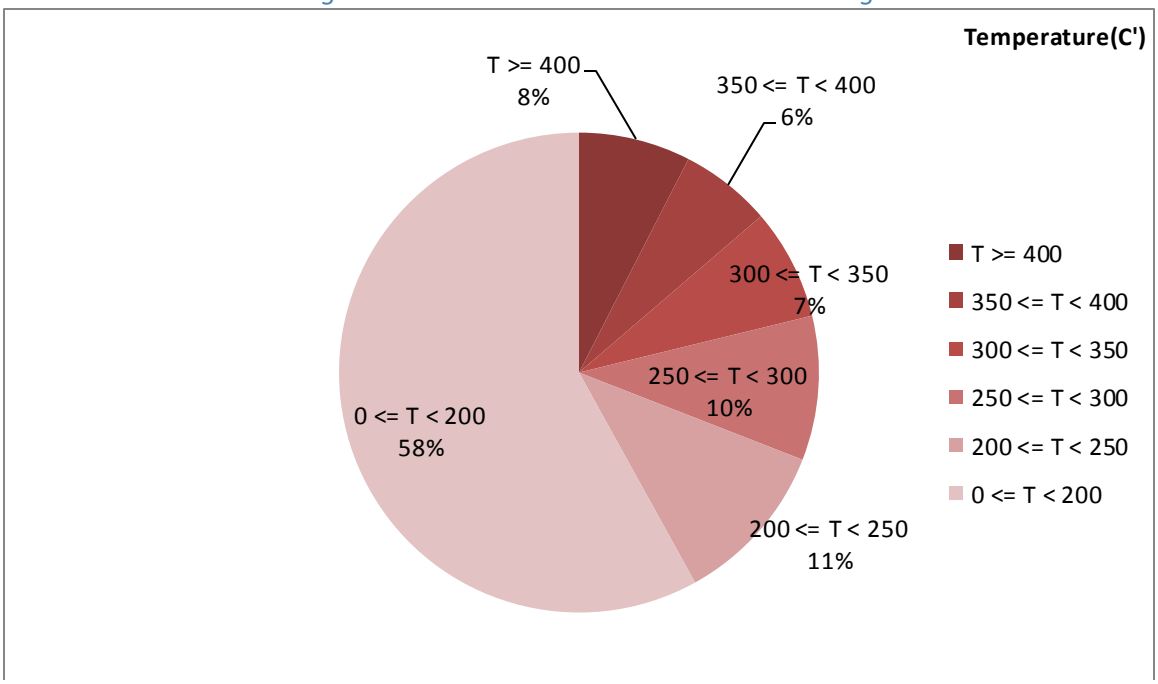



*Figure 2-Temperature distribution over the working hours*

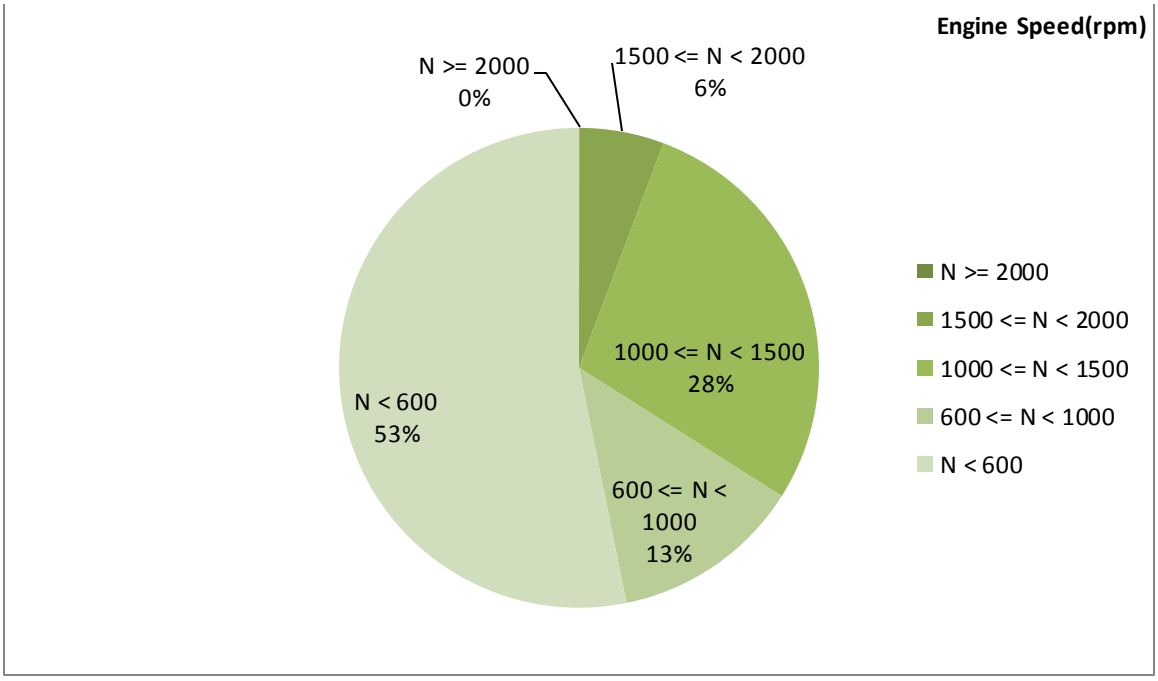



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 211.47 | 5.47 | 828 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 280.1 | 11.25 | 1150 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 530-50 | 123-0 | 2048-384 |

## Detailed Pressure Analysis

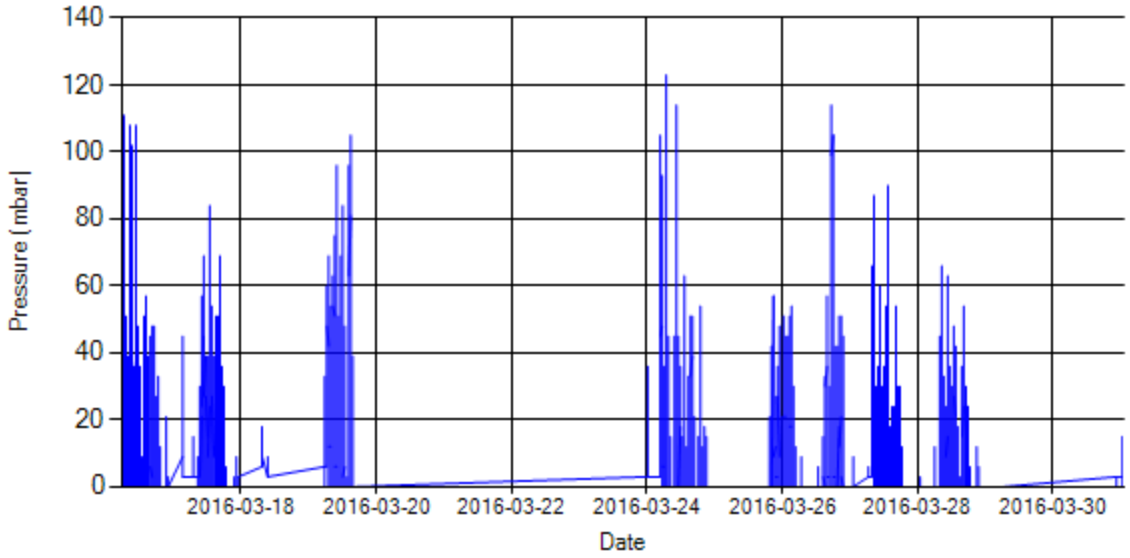



*Figure 4- Pressure distribution over the period*

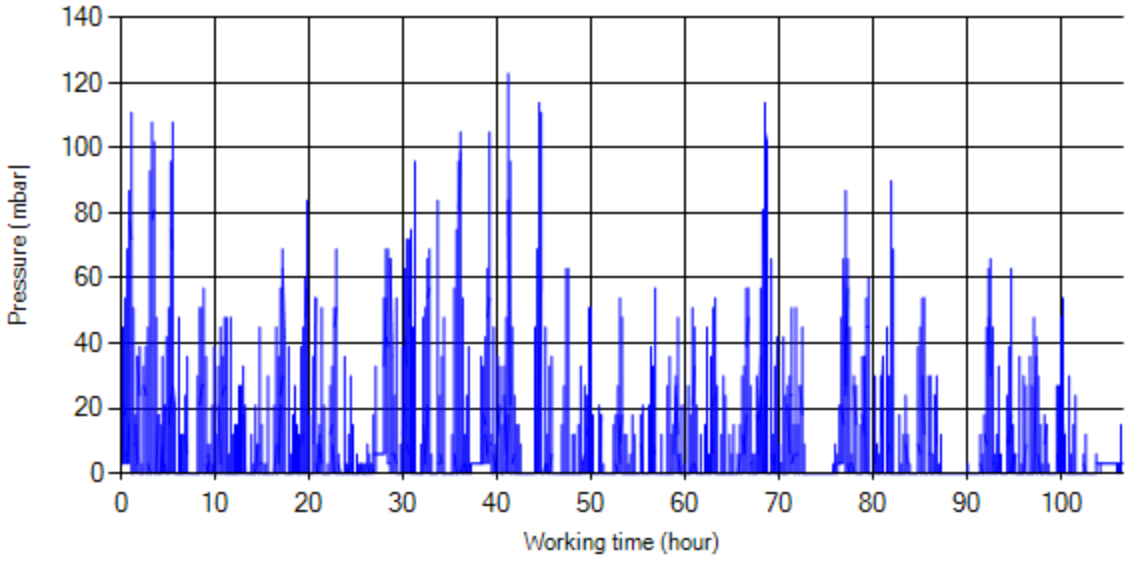



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

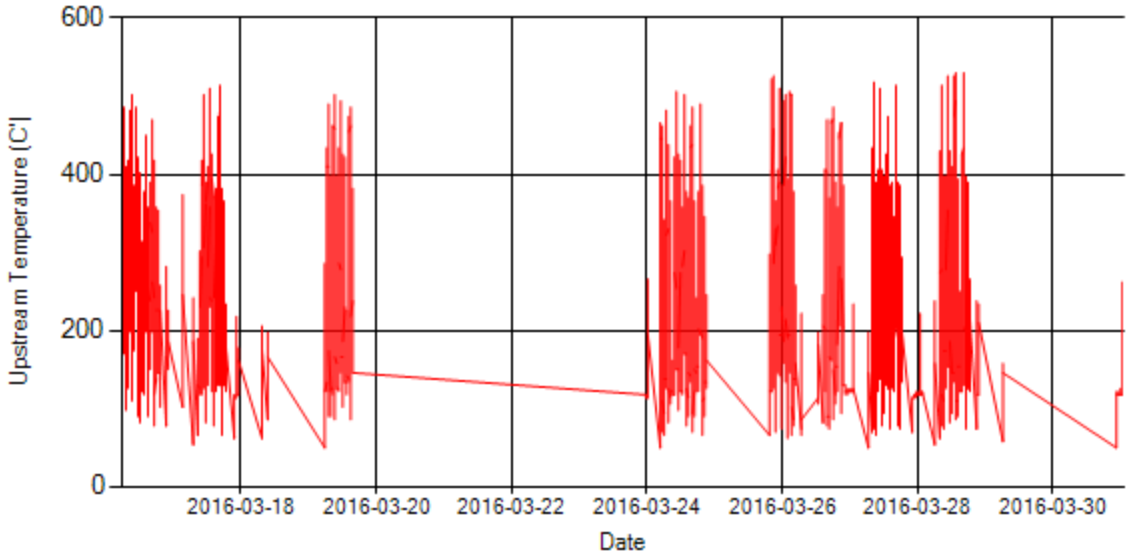



*Figure 6- Temperature distribution over the period*

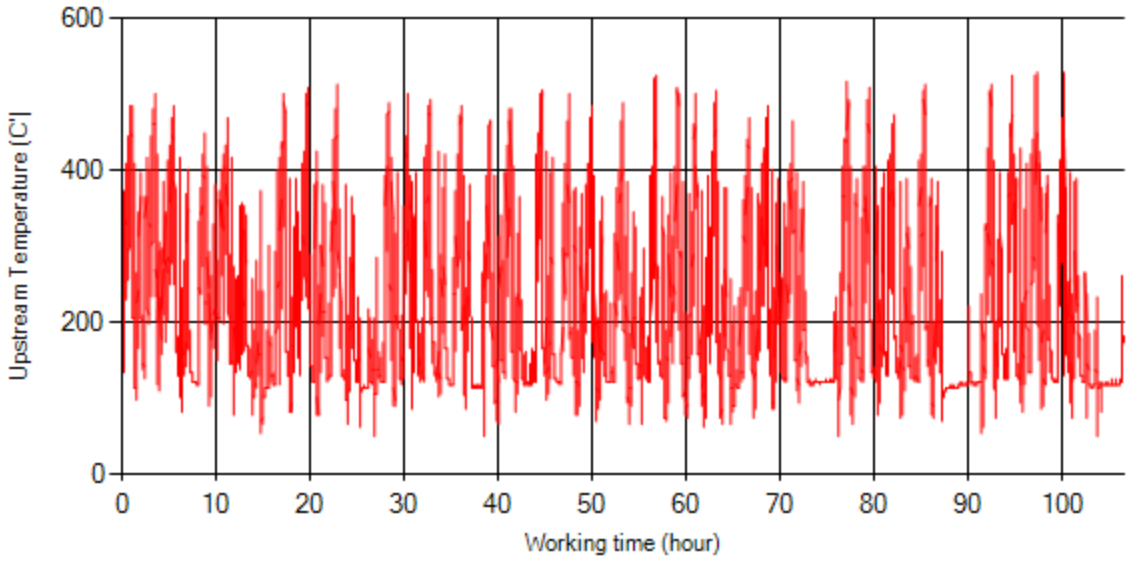



*Figure 7- Temperature vs. working hours*

## Engine Speed Diagrams

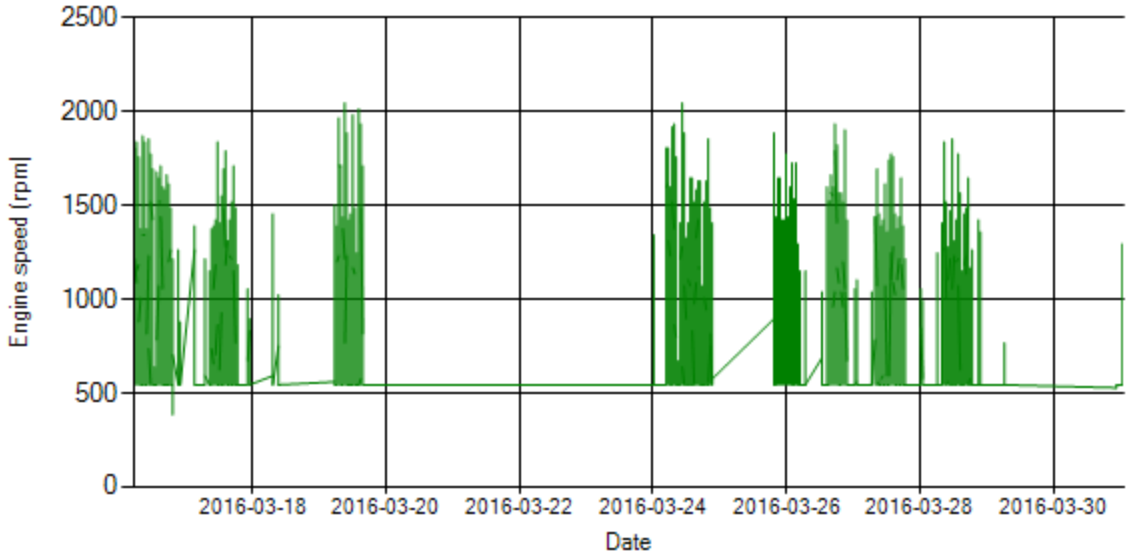



*Figure 8- Engine speed distribution over the period*

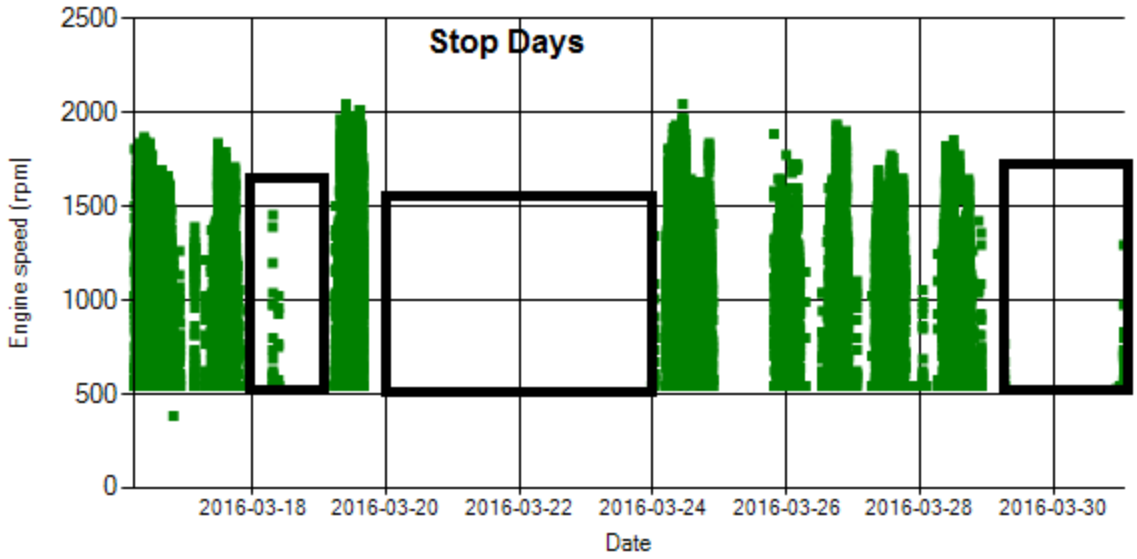



*Figure 9- Engine speed diagram for calculating CPK's working days*

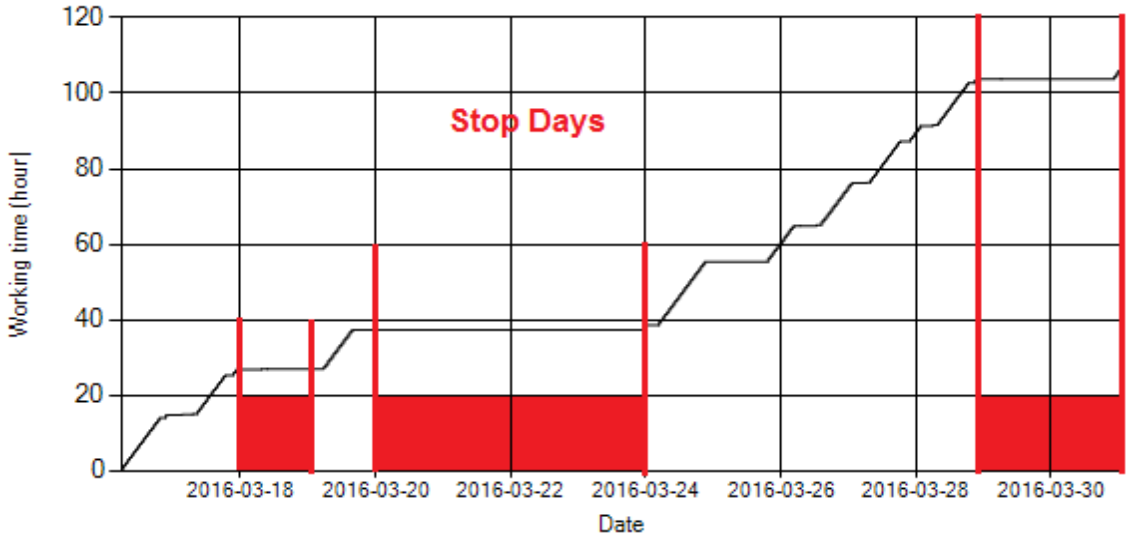



*Figure 10- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 10. The lines parallel with Date axis show days without data logger data. As it is clear from the figure, bus was stationary for 7 days.

## Pressure-Engine Speed diagrams

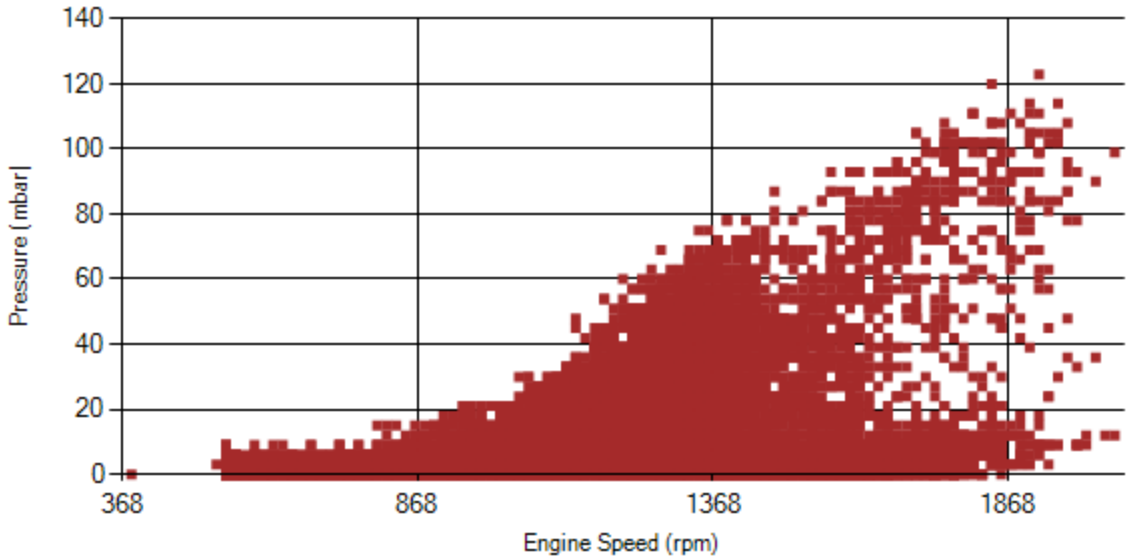



*Figure 11- Pressure against engine speed*

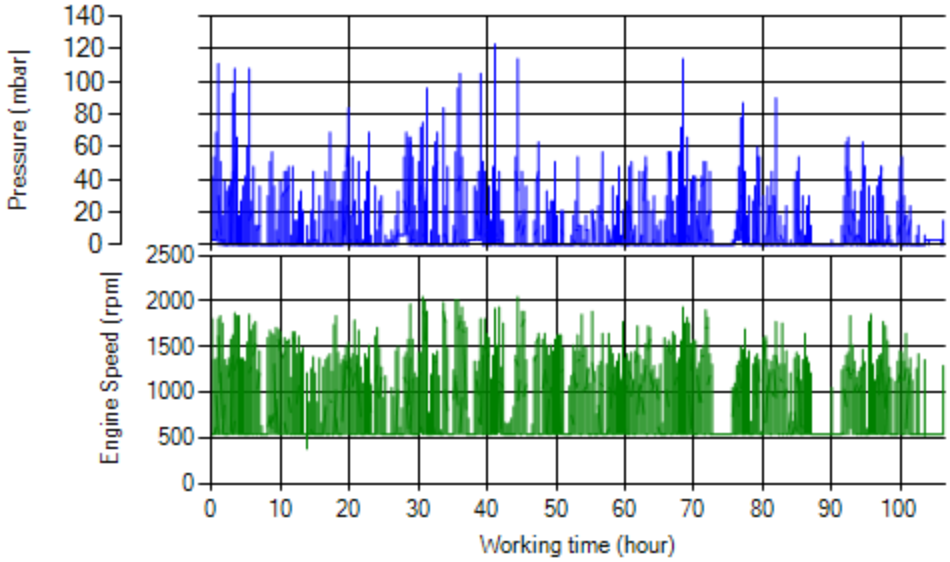



*Figure 12- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

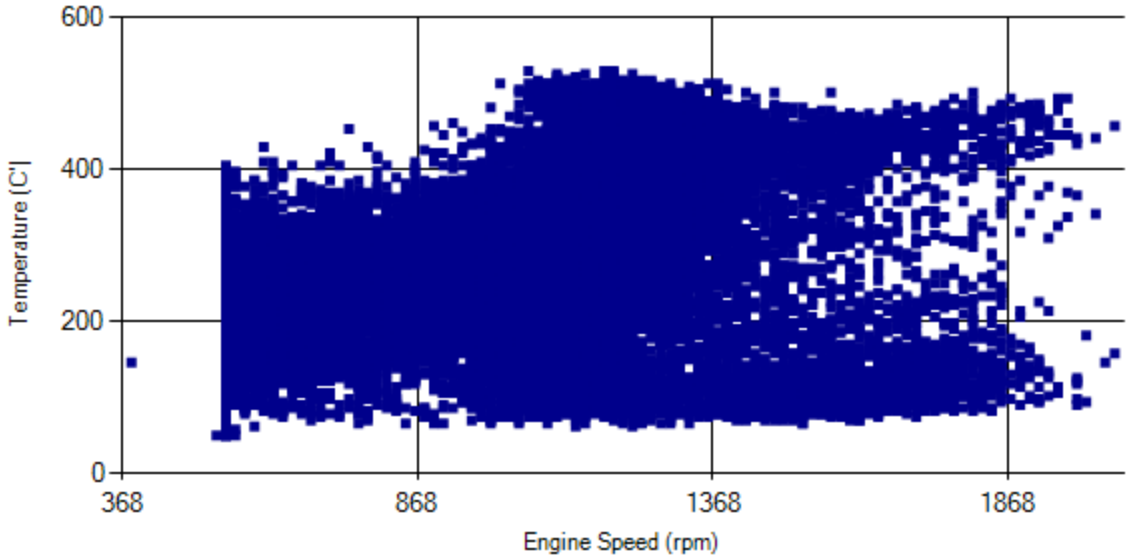



*Figure 13- Temperature against engine speed*

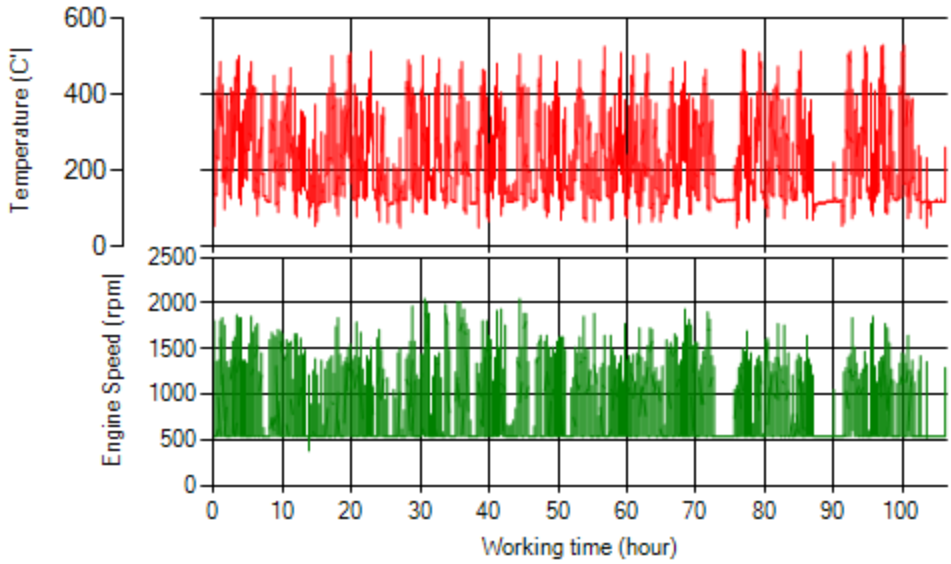
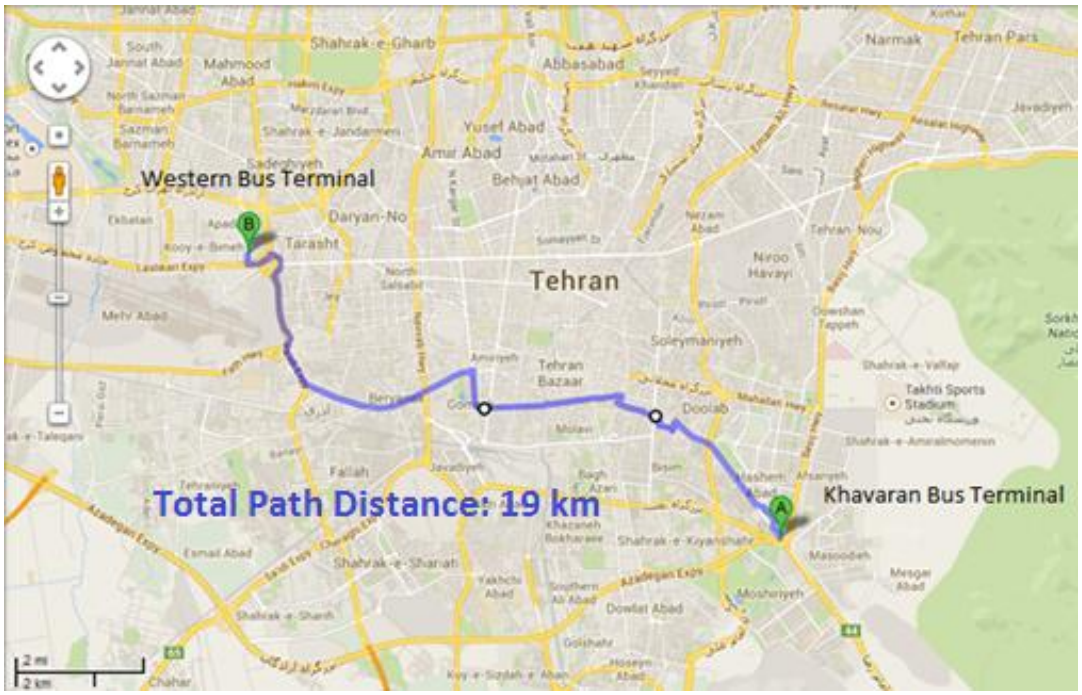



*Figure 14- T, N distribution vs. working hours*

## Filter Operation Analysis

**Notice: System was working without DPF during this period.**

| | |
|---|---|
| Vehicle plate number | 33572 (28958) |
| Bus line | Number 2 (west to east bus line) |
| DPF producer company | HJS_03 (active system with FBC – electrical heater) |

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 33572 (28958) |
| CPK data logger number | LN: 001521, DN: 1995, Sim Number +989218469643 |
| Bus line | Number 2 (west to east bus line) |
| Bus Terminals | Khavaran Bus Terminal - Western Bus Terminal |
| Total path distance | 19 km |
| DPF producer company | HJS_03 (active system with FBC – electrical heater) |
| Installation date | 19/Feb/2015 |
| Report period | 01/Mar/2016 – 15/Mar/2016 (fifteen days) |
| K value - DPF upstream | 1.90 [1/m] |
| K value – DPF downstream | 0.02 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF was cleaned on Oct 5$^{th}$ for the first time. The second cleaning was done on Dec 19$^{th}$. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 54103 km |
| Bus mileage over the period | 1943 km |
| Working days over the period | 14 days |
| Stop days | 1 day |
| Data logger working days | 14 days |
| Working hours over the period | 169 hours 8 minutes |
| Average working hours per day (including stop days) | 11 hours 16 minutes |
| Bus average speed | 11.5 km/hr |
| idle speed time to all working time ration | 52.94 % |
| Total Bus fuel consumption over the period | 1263 lit |
| Fuel consumption per hour | 7.5 lit/hr |
| Average fuel consumption | 0.65 lit/km |
| Total Bus additive consumption over the period | 0.6 lit |
| Average additive consumption | 308 cc/km |
| Additive consumption to fuel ration | 475 cc/1000lit |

## Temperature, Pressure and Engine Speed Overview

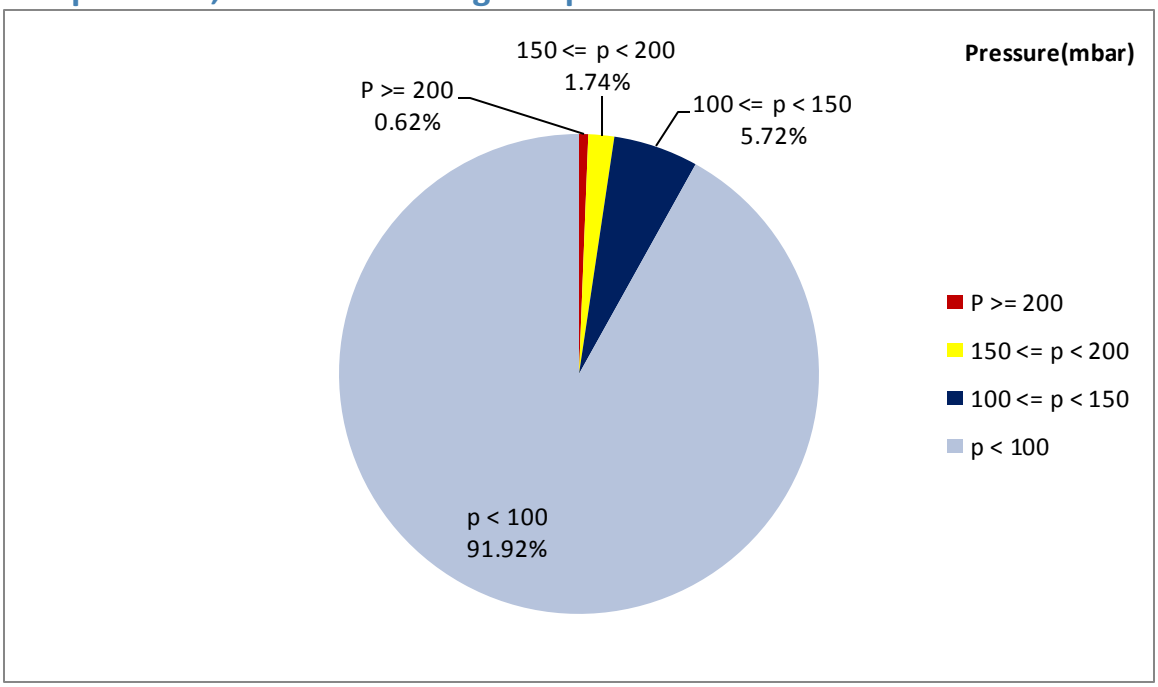



*Figure 1- Pressure distribution over the working hours*

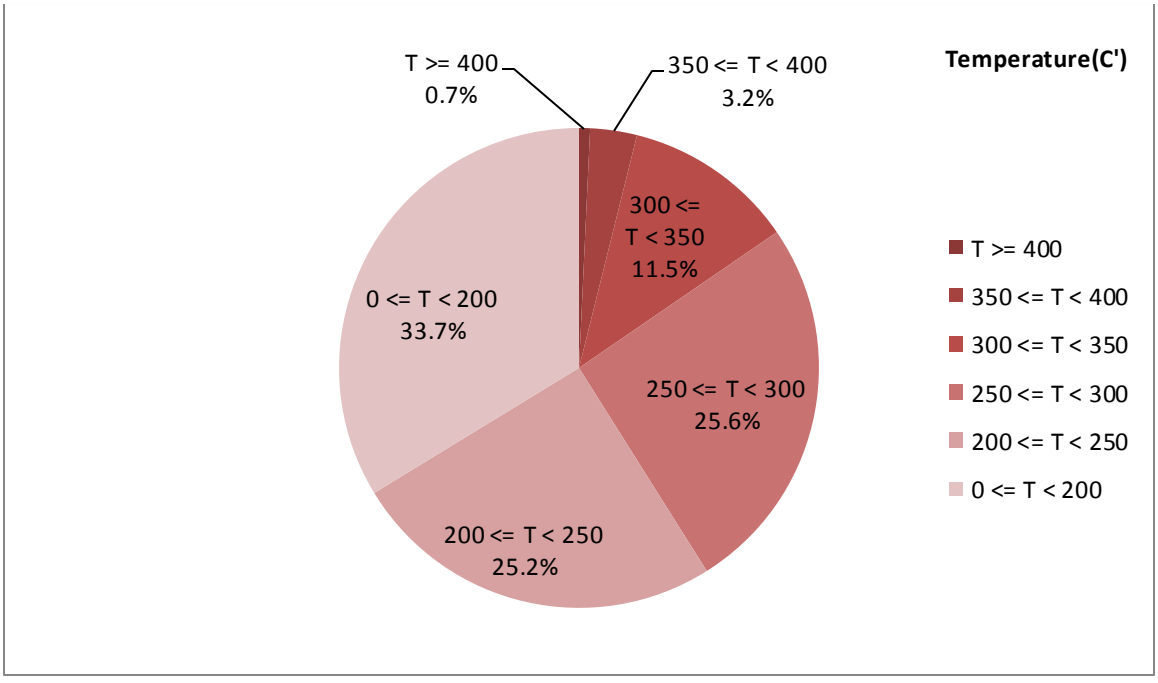



*Figure 2-Temperature distribution over the working hours*

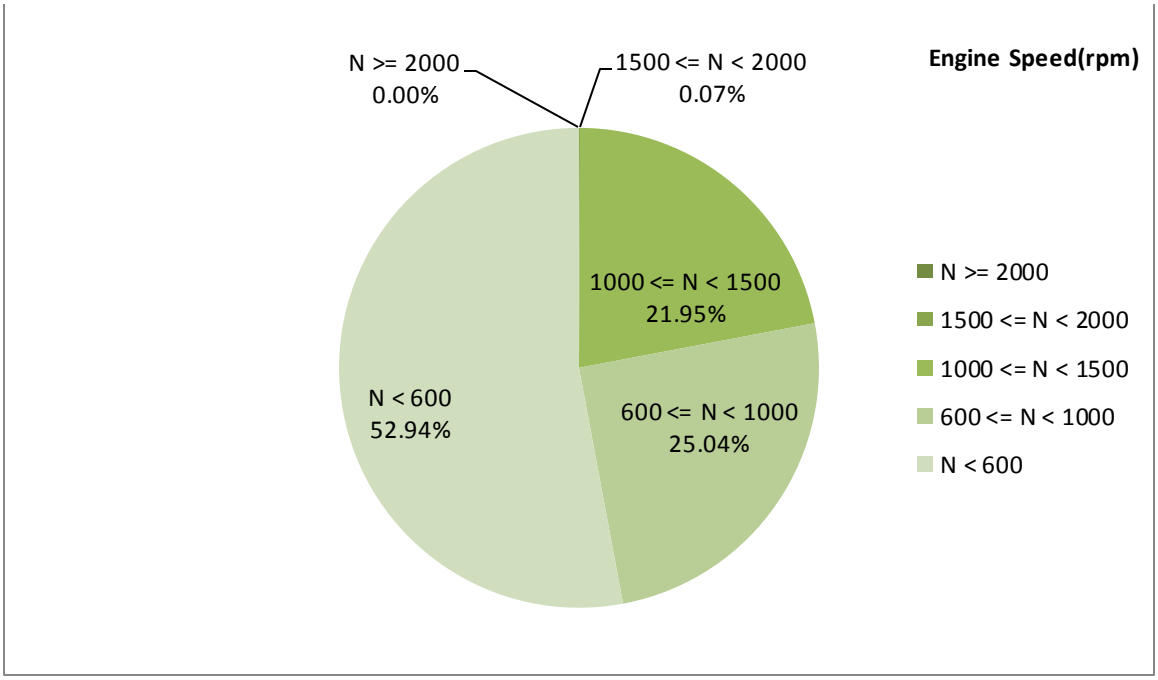



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 231.26 | 35.28 | 738 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 278.74 | 65.83 | 953 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 490-50 | 387-0 | 2064-400 |

## Detailed Pressure Analysis

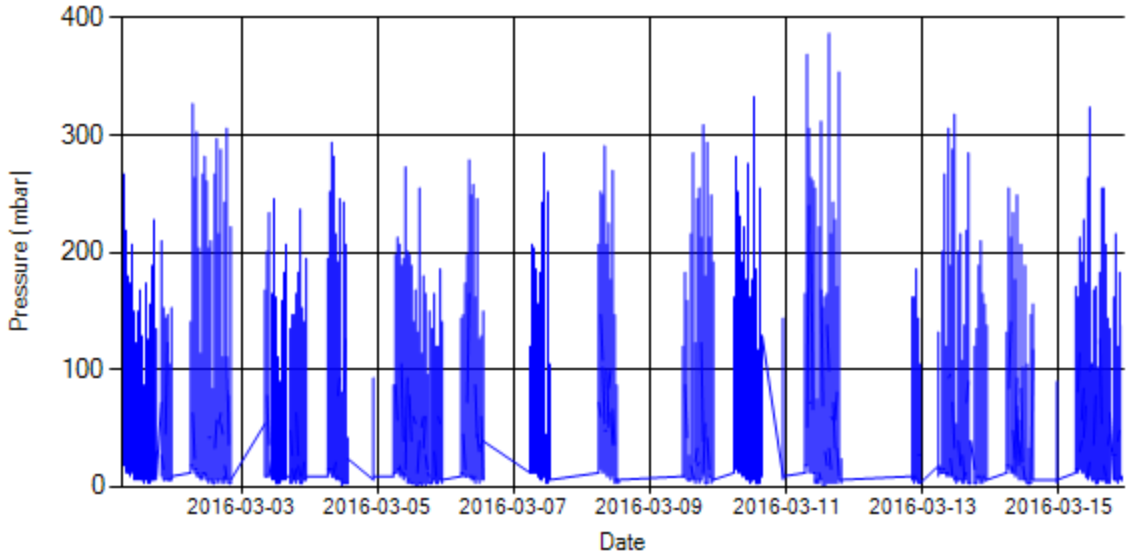



*Figure 4- Pressure distribution over the period*

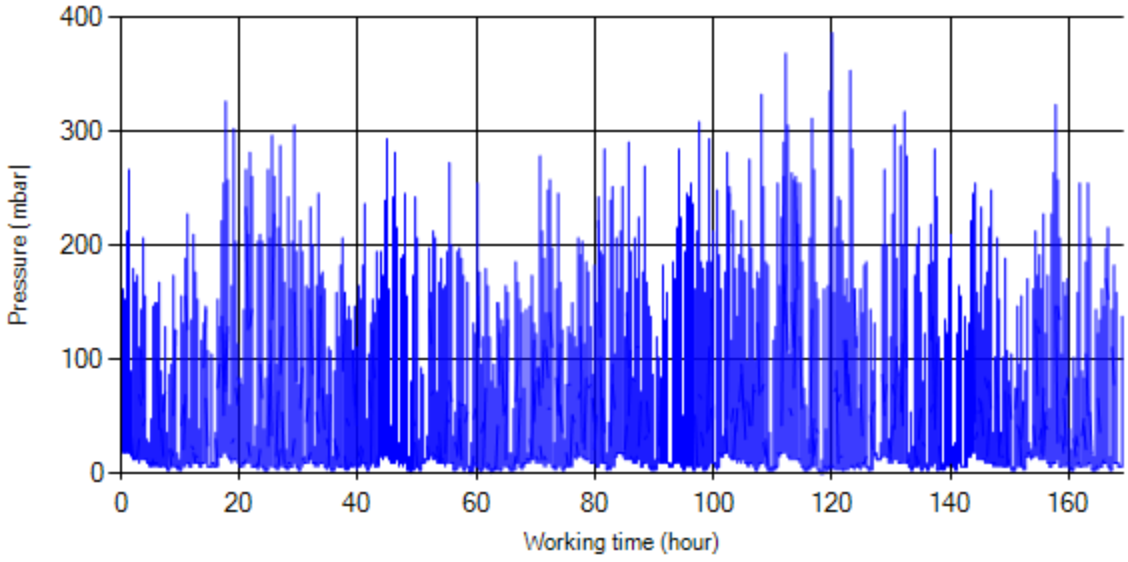



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

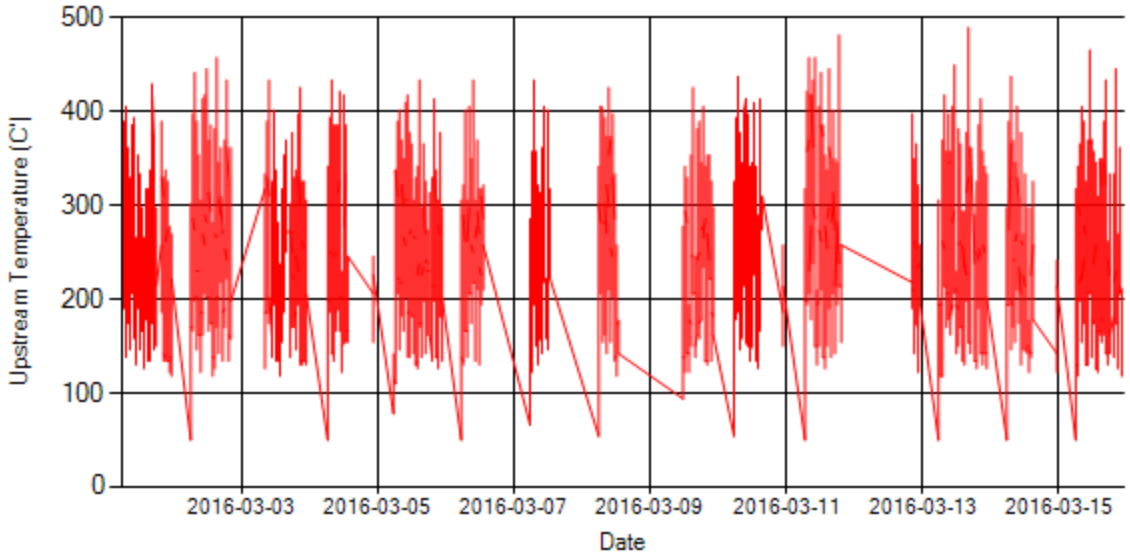



*Figure 6- Temperature distribution over the period*

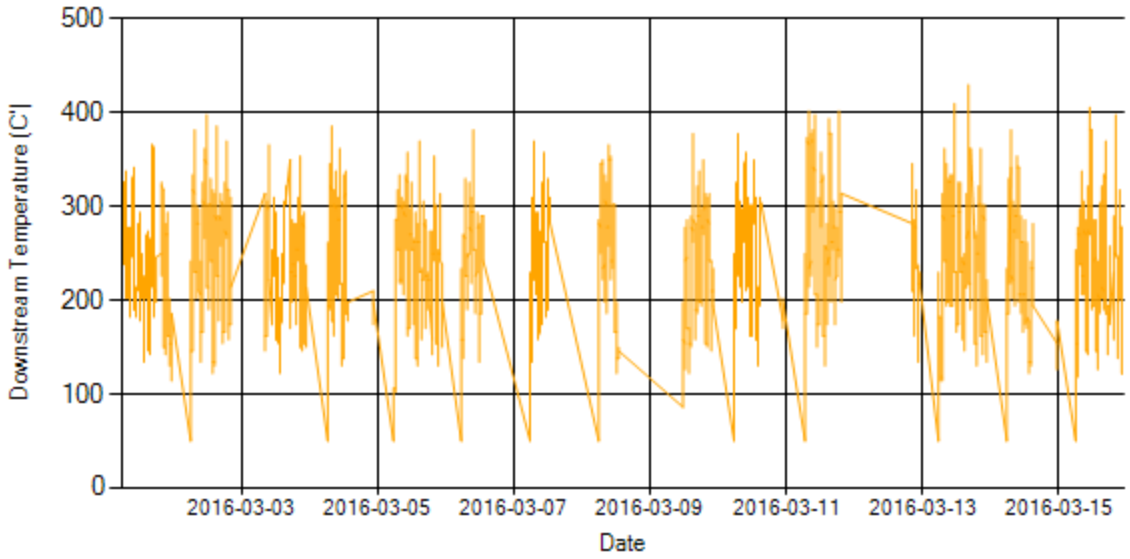



*Figure 7- Temperature distribution over the period*

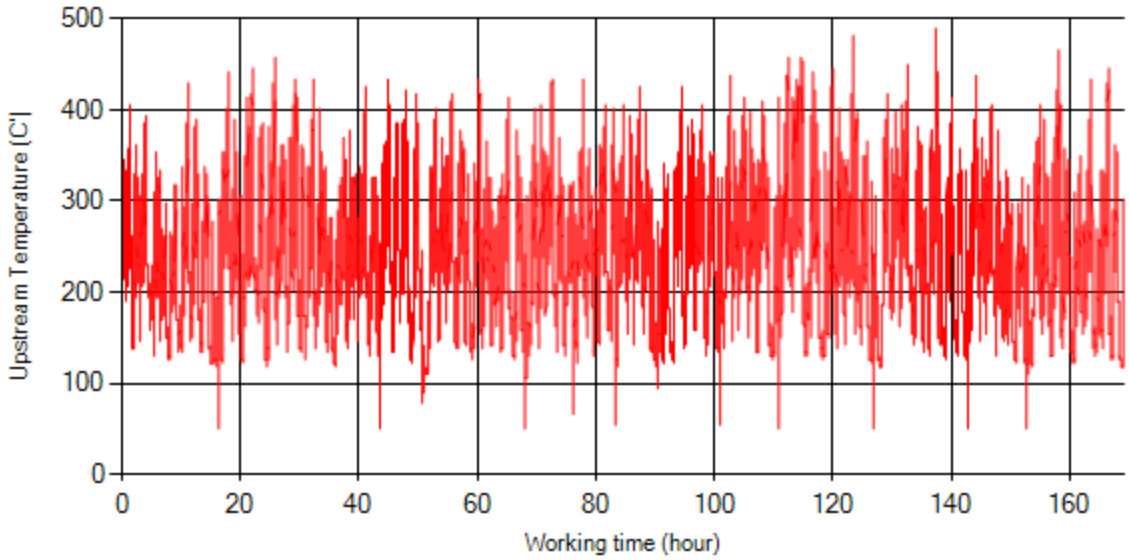



*Figure 8- Temperature vs. working hours*

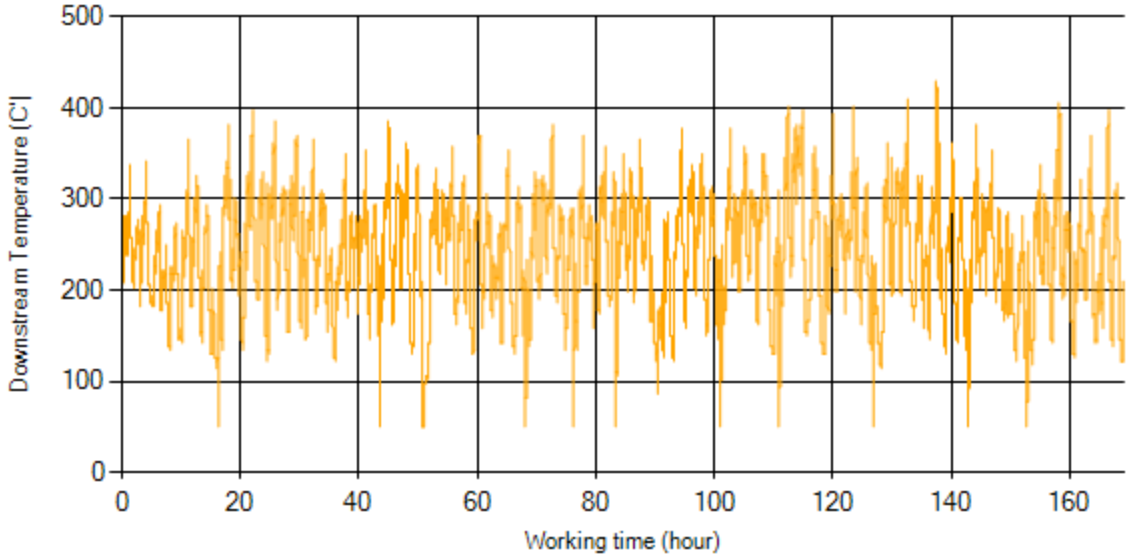



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

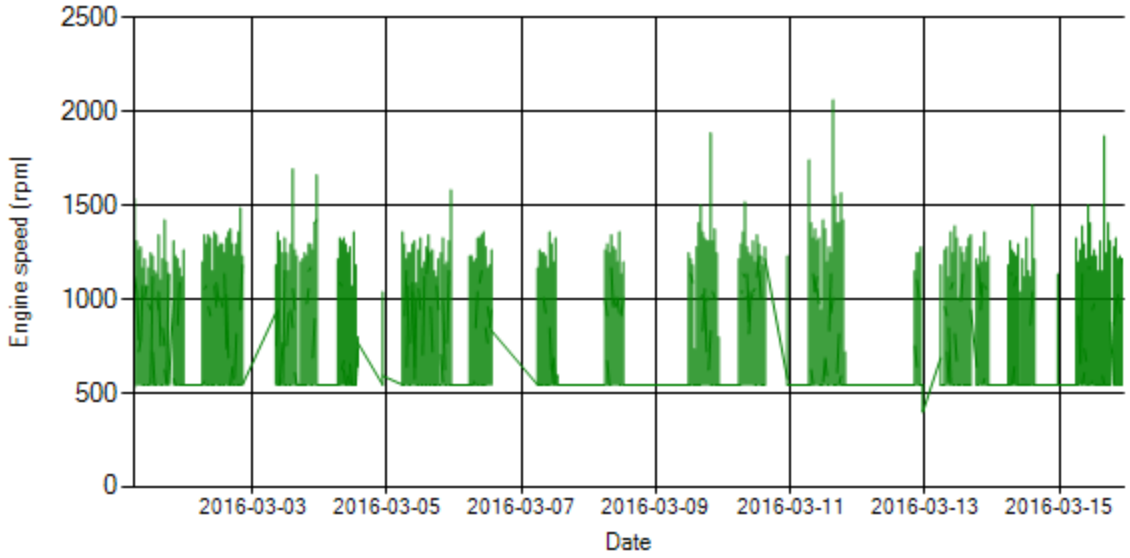



*Figure 10- Engine speed distribution over the period*

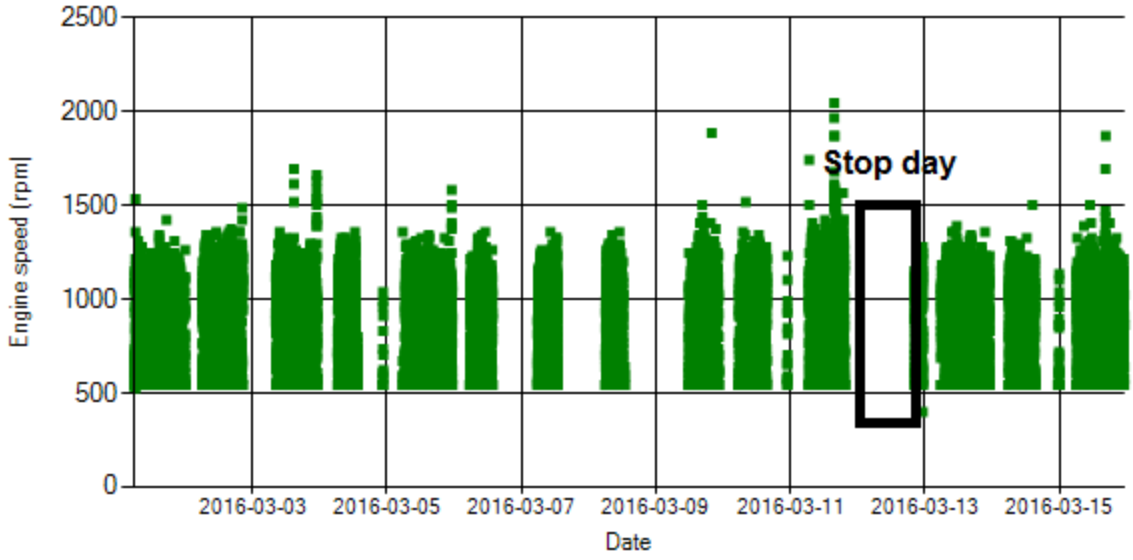



*Figure 11- Engine speed diagram for calculating CPK's working days*

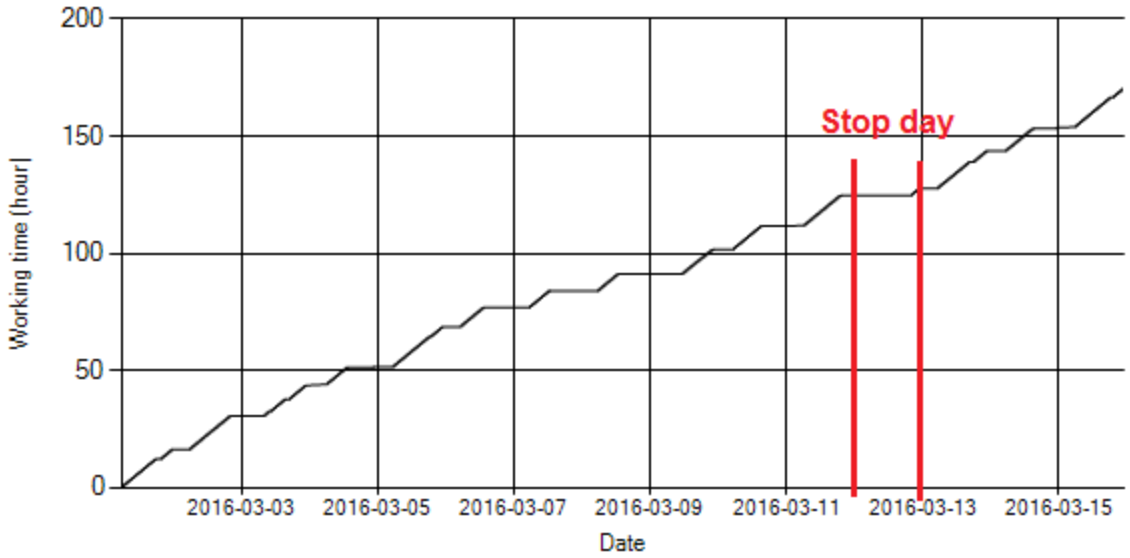



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data. As depicted in Figure 12, bus was stationary on 12$^{th}$ of March.

## Pressure-Engine Speed diagrams

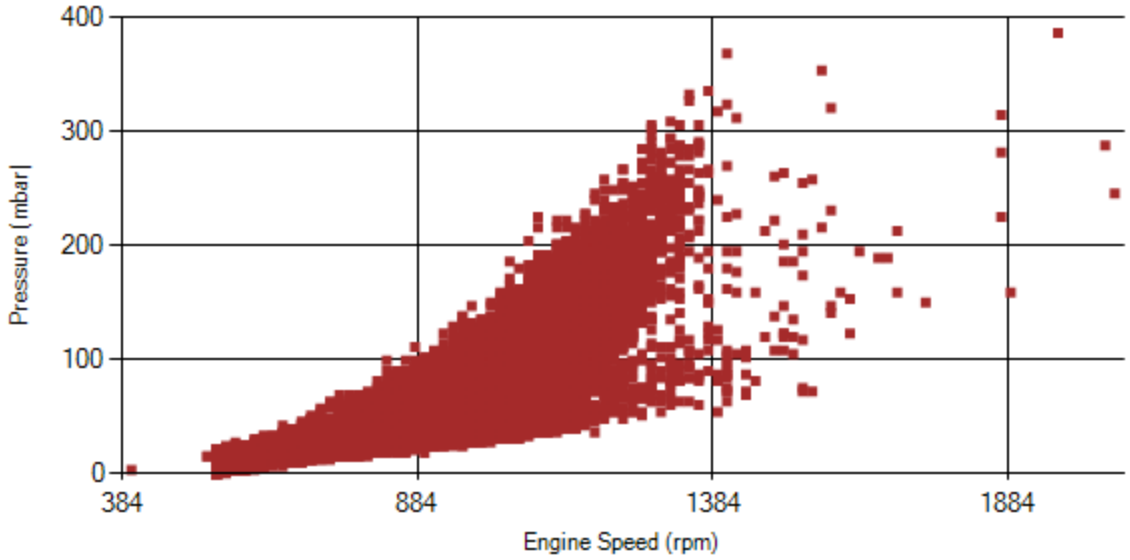



*Figure 13- Pressure against engine speed*

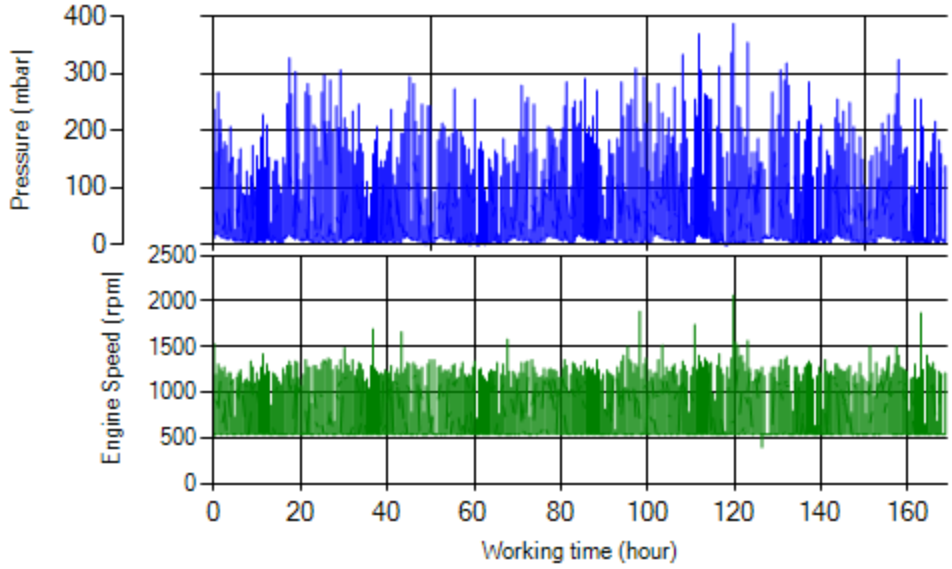



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

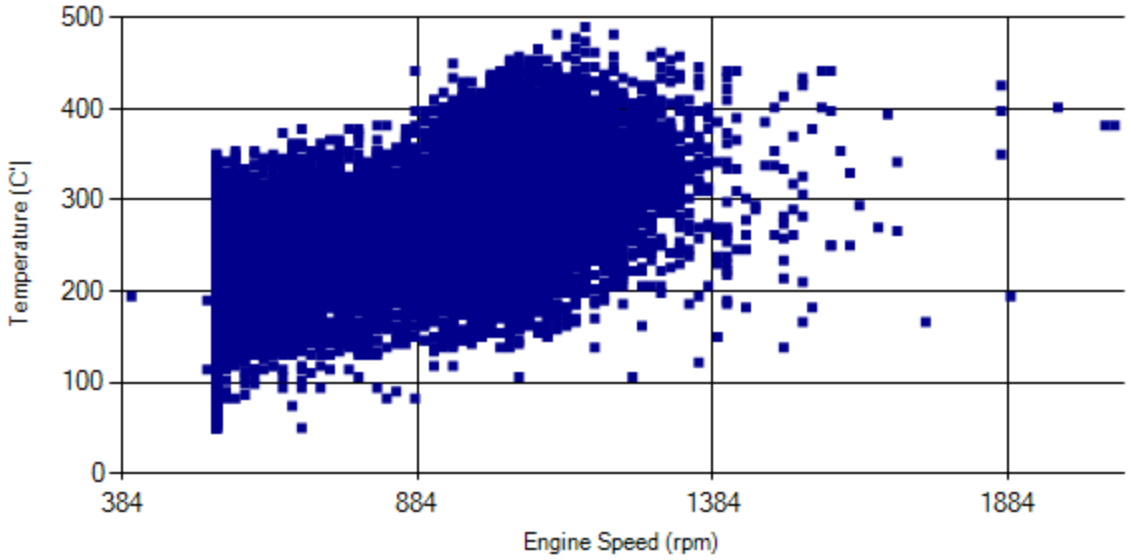



*Figure 15- Temperature against engine speed*

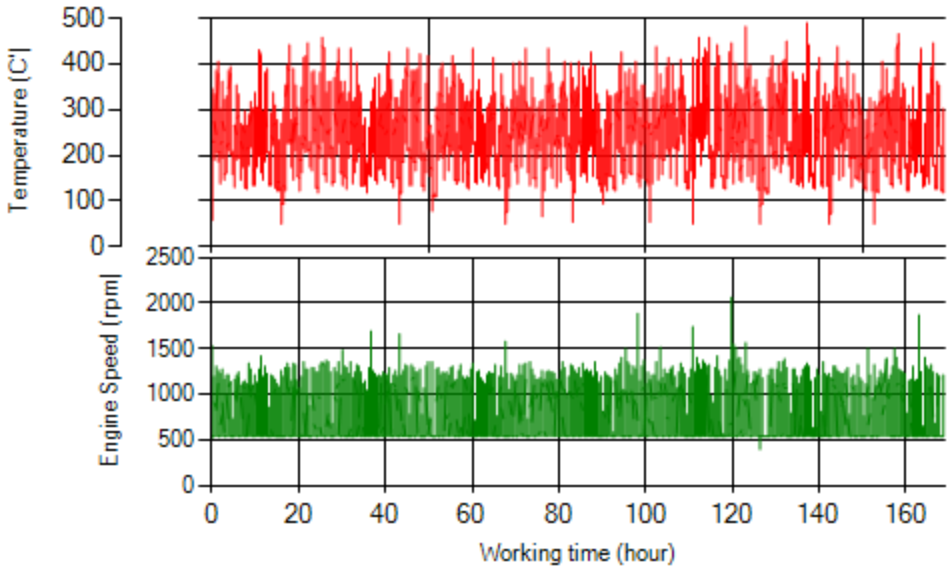



*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

- As depicted in figure 1, 0.62% of total working time pressure is above 200 mbar and 2.36% above 150 mbar during this period.

- Figure 2 displays flow temperature distribution for DPF's upstream. It can be obviously observed only 3.9% of total working time temperature is above 350°C, so it could be concluded that active regeneration plays important role on working this DPF.

| | | |
|---|---|---|
| Filter operation status | Excellent ☐ | Good ■ |
| | Maintenance required ☐ | Failed ☐ |

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 33572 (28958) |
| CPK data logger number | LN: 001521, DN: 1995, Sim Number +989218469643 |
| Bus line | Number 2 (west to east bus line) |
| Bus Terminals | Khavaran Bus Terminal - Western Bus Terminal |
| Total path distance | 19 km |
| DPF producer company | HJS_03 (active system with FBC – electrical heater) |
| Installation date | 19/Feb/2015 |
| Report period | 16/Mar/2016 – 31/Mar/2016 (sixteen days) |
| K value - DPF upstream | 1.90 [1/m] |
| K value – DPF downstream | 0.02 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF was cleaned on Oct 5$^{th}$ for the first time. The second cleaning was done on Dec 19$^{th}$. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 55613 km |
| Bus mileage over the period | 1500 km |
| Working days over the period | 12 days |
| Stop days | 4 days |
| Data logger working days | 12 days |
| Working hours over the period | 136 hours 49 minutes |
| Average working hours per day (including stop days) | 9 hours 7 minutes |
| Bus average speed | 11 km/hr |
| idle speed time to all working time ration | 57.99 % |
| Total Bus fuel consumption over the period | 930 lit |
| Fuel consumption per hour | 6.8 lit/hr |
| Average fuel consumption | 0.62 lit/km |
| Total Bus additive consumption over the period | 0.45 lit |
| Average additive consumption | 298 cc/km |
| Additive consumption to fuel ration | 480 cc/1000lit |

## Temperature, Pressure and Engine Speed Overview

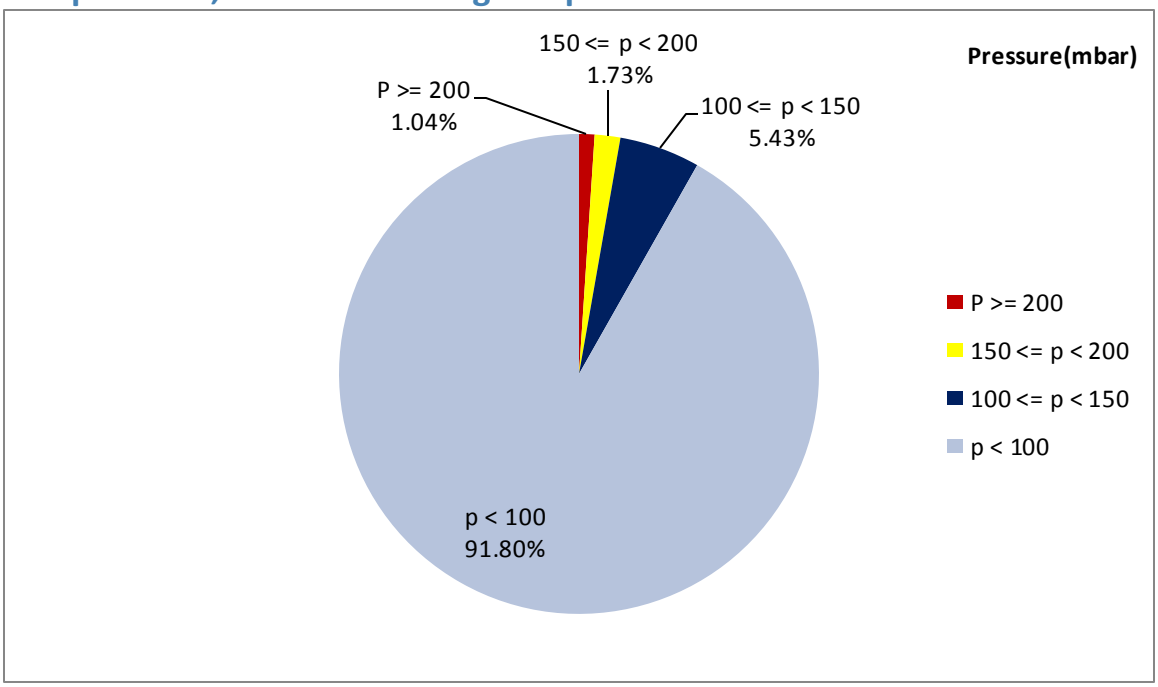



*Figure 1- Pressure distribution over the working hours*

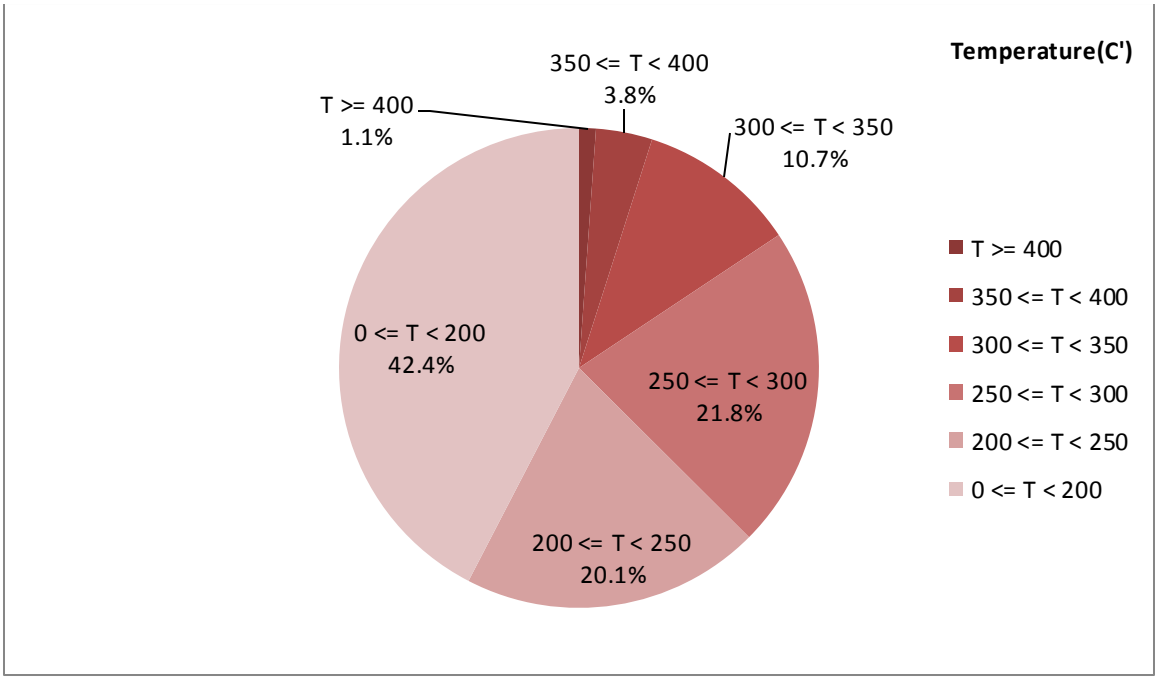



*Figure 2-Temperature distribution over the working hours*

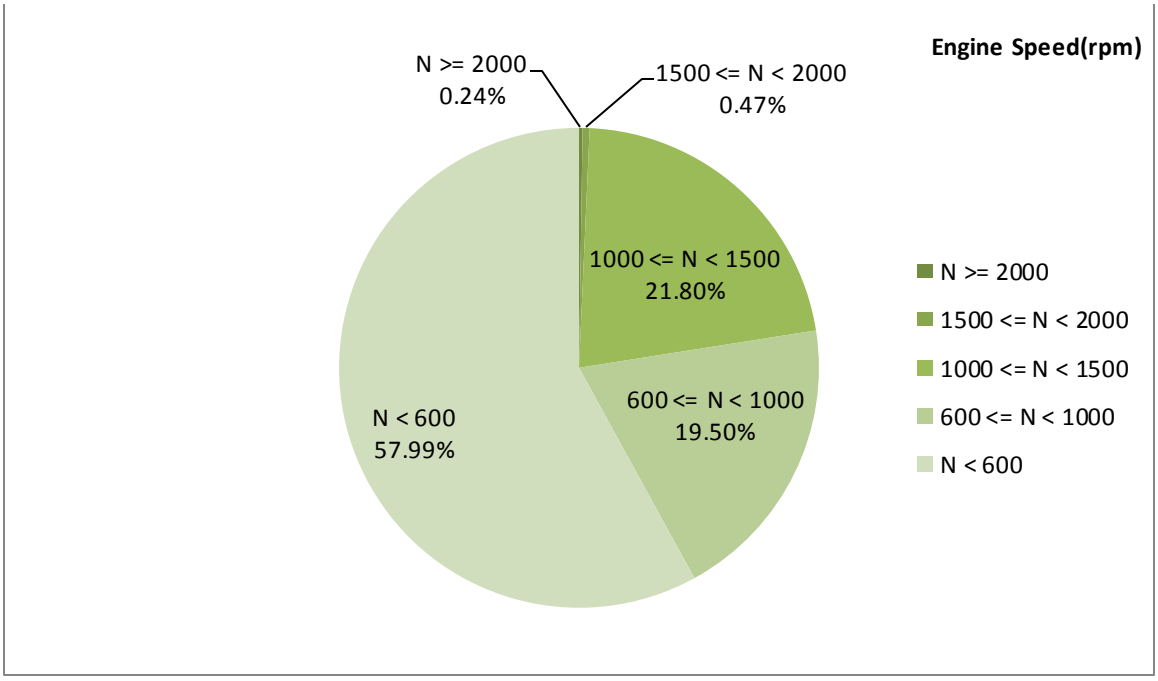



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 220.68 | 34.78 | 733 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 284 | 71.21 | 992 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 486-50 | 450-0 | 2208-464 |

## Detailed Pressure Analysis

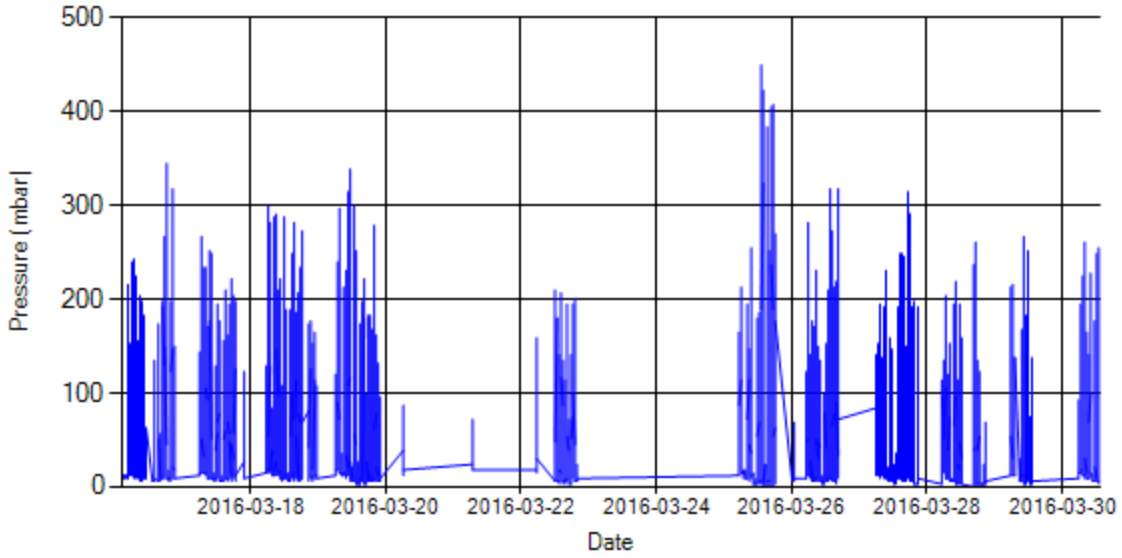



*Figure 4- Pressure distribution over the period*

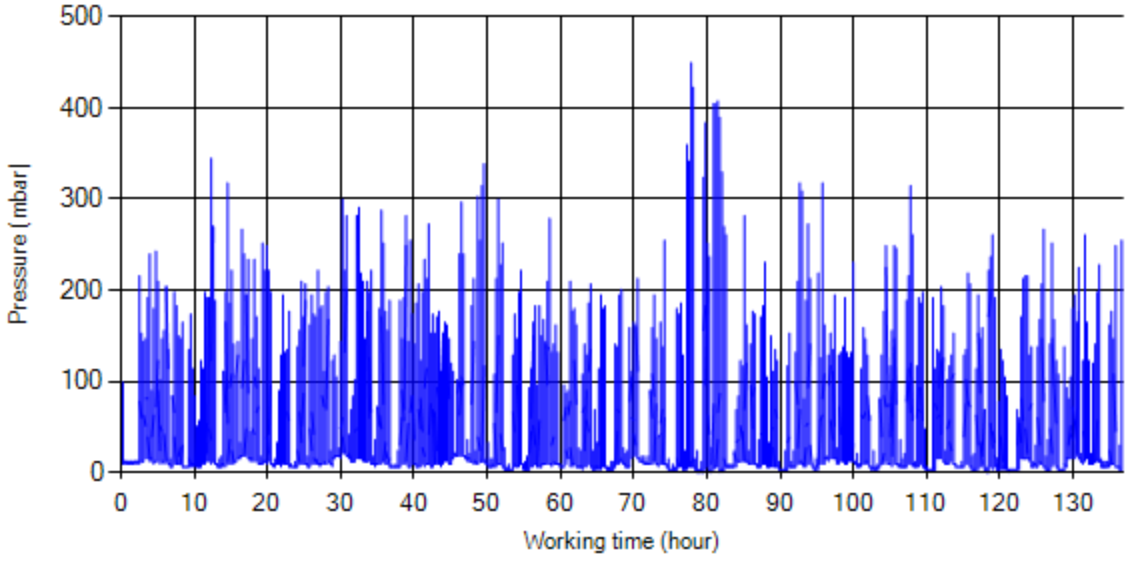



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

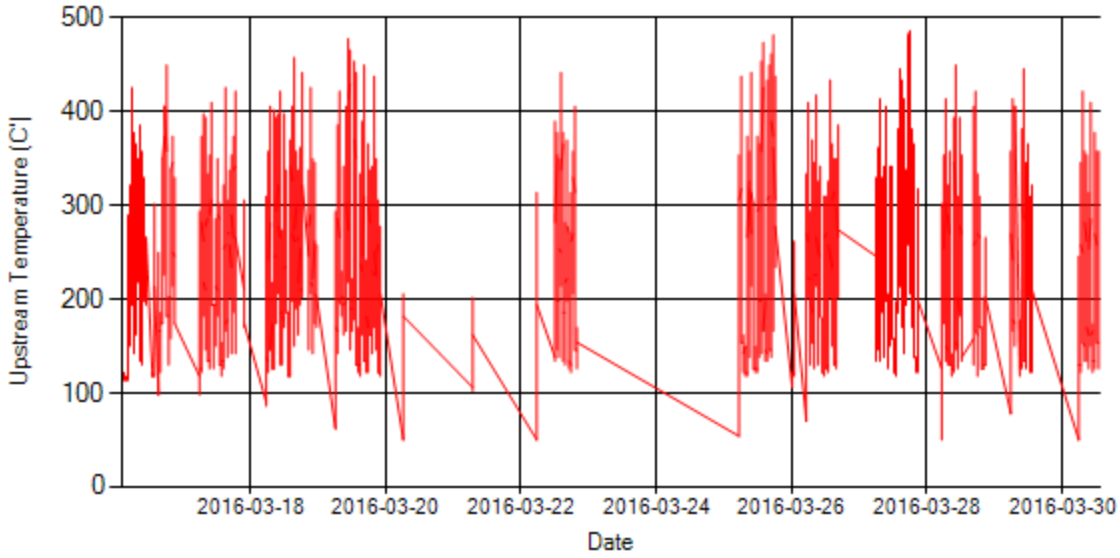



*Figure 6- Temperature distribution over the period*

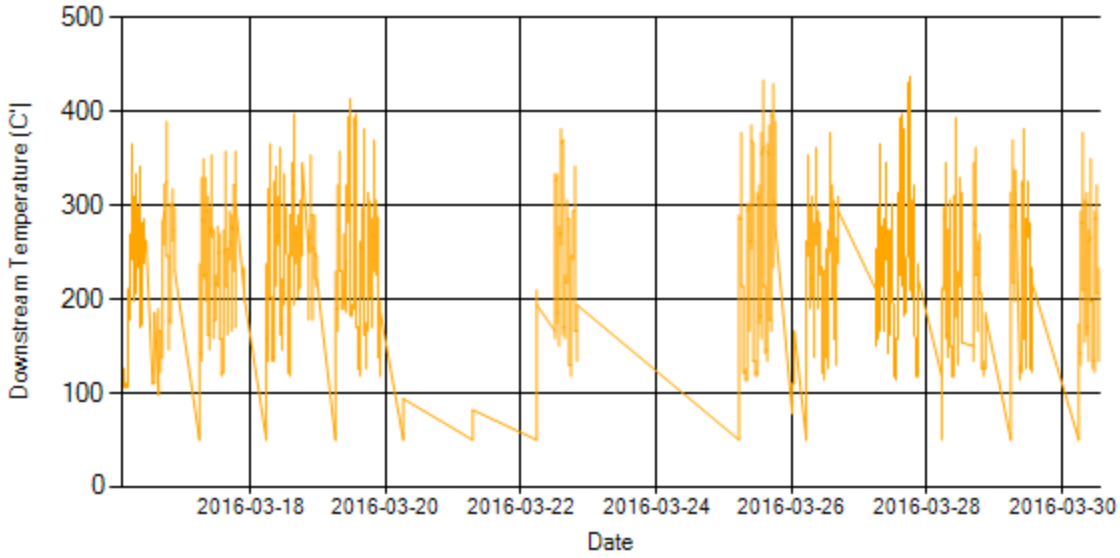



*Figure 7- Temperature distribution over the period*

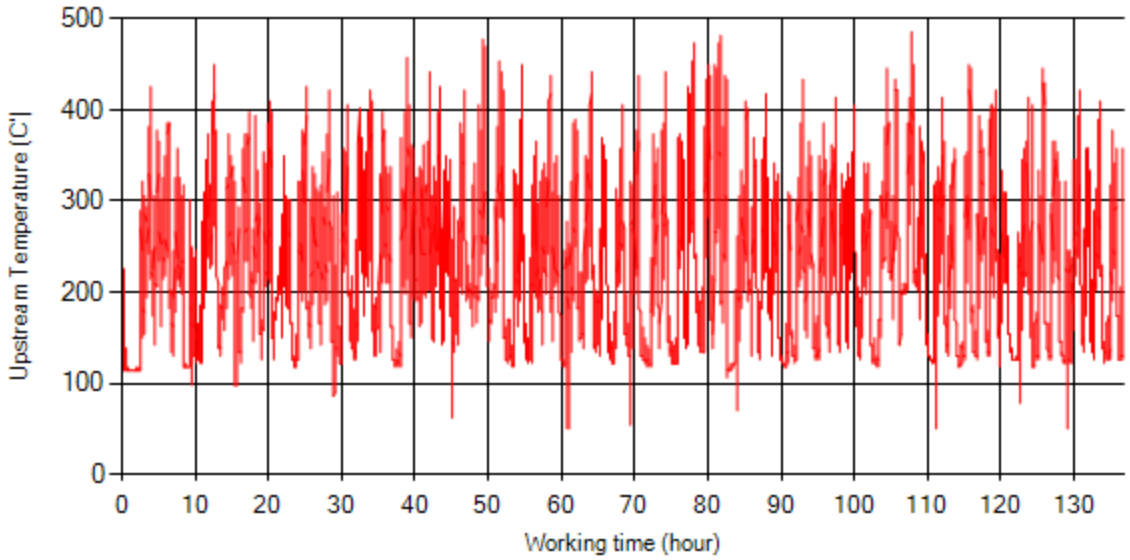



*Figure 8- Temperature vs. working hours*

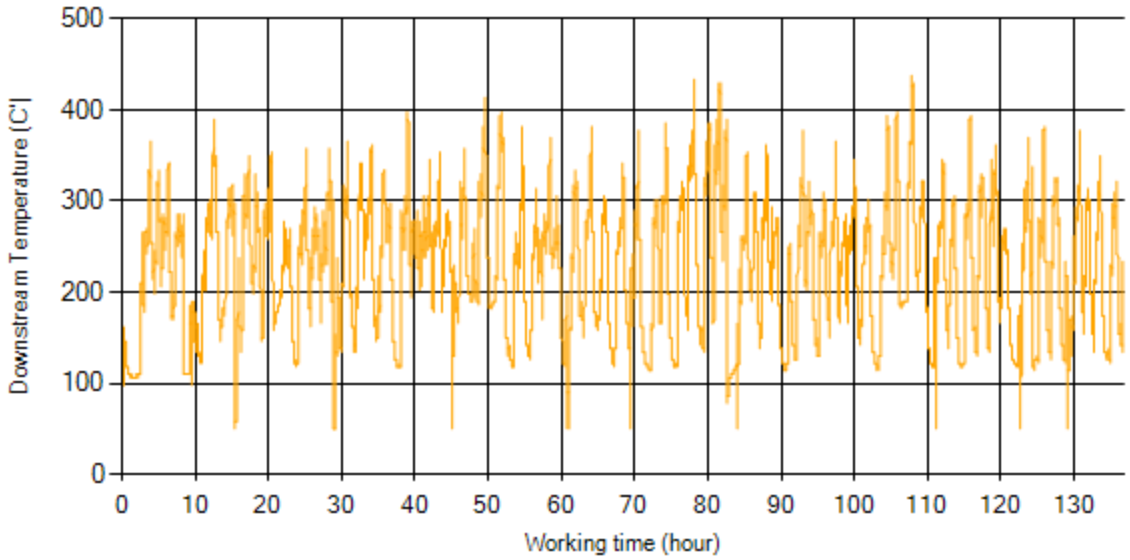



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

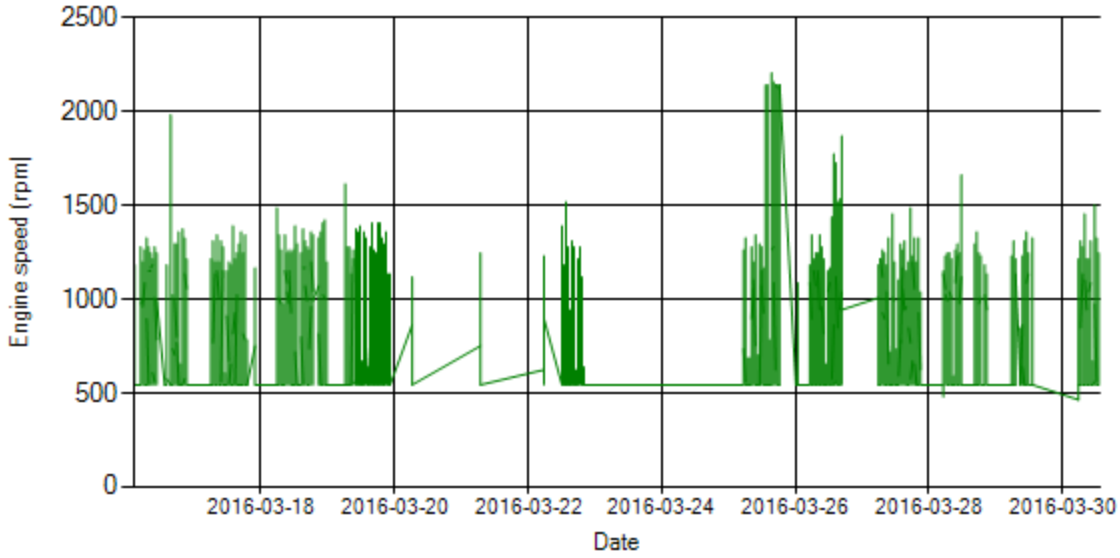



*Figure 10- Engine speed distribution over the period*

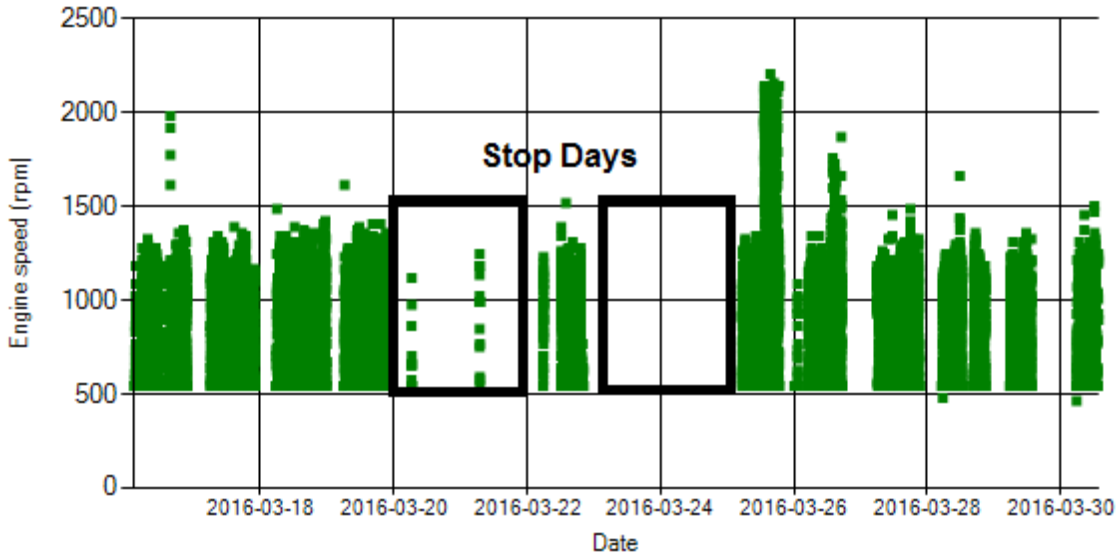



*Figure 11- Engine speed diagram for calculating CPK's working days*

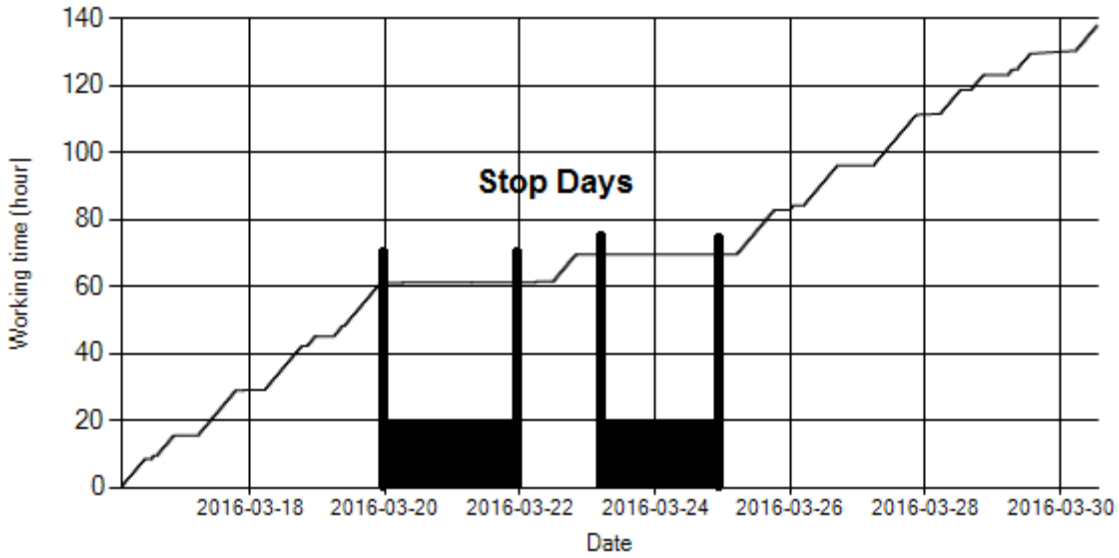



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data.

## Pressure-Engine Speed diagrams

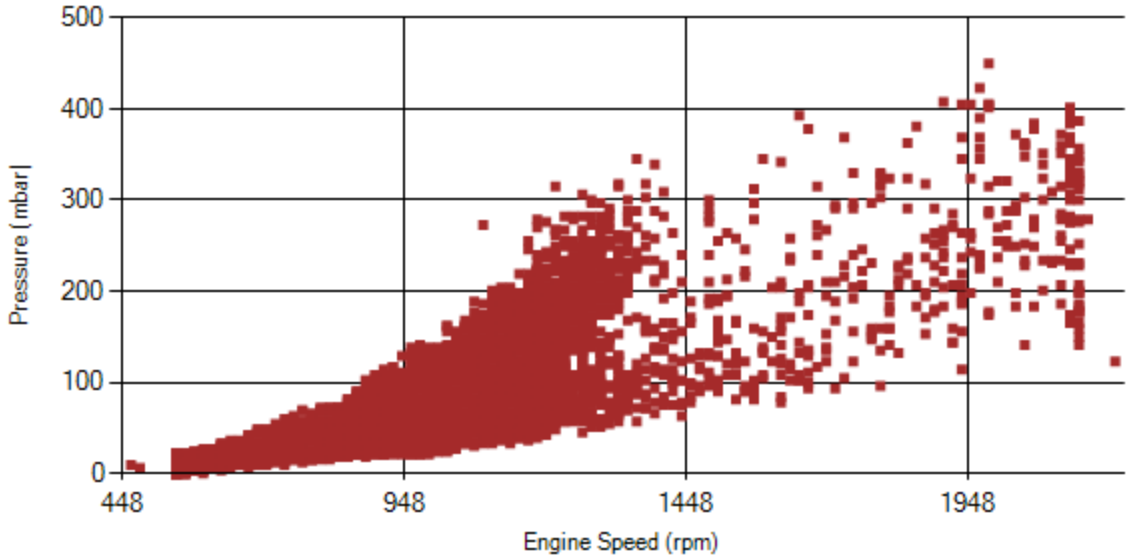



*Figure 13- Pressure against engine speed*

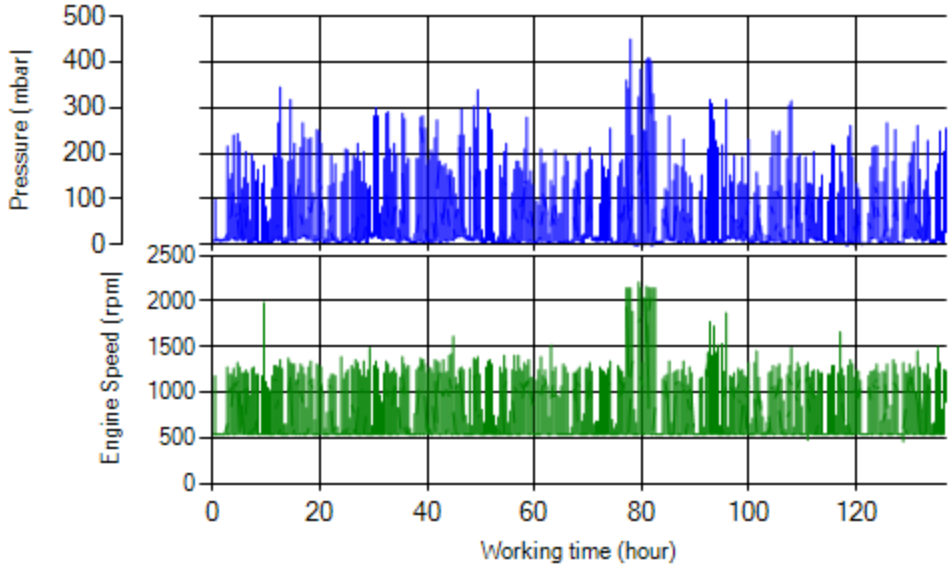



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

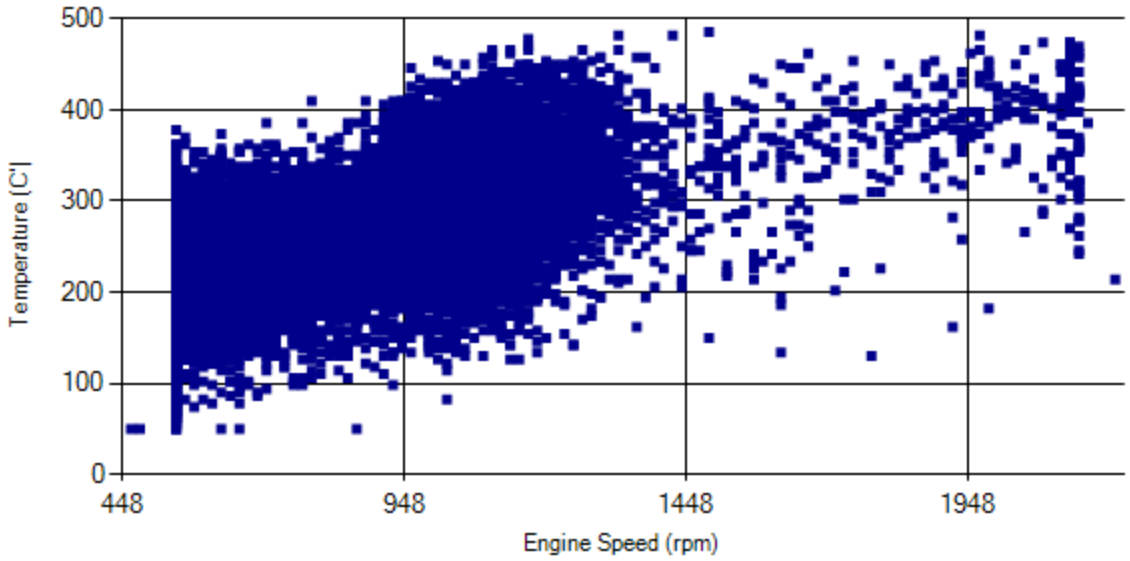



*Figure 15- Temperature against engine speed*

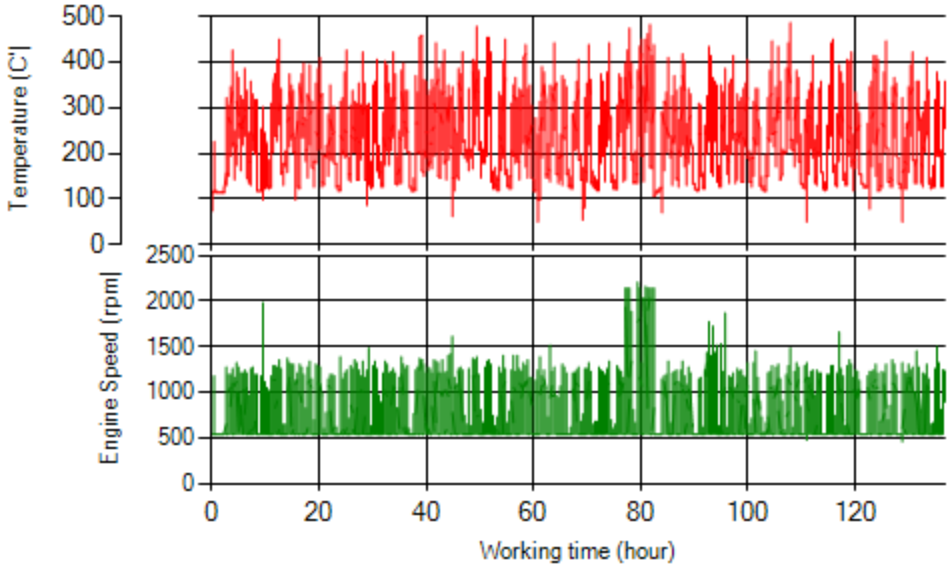



*Figure 16- T, N distribution vs. working hours*

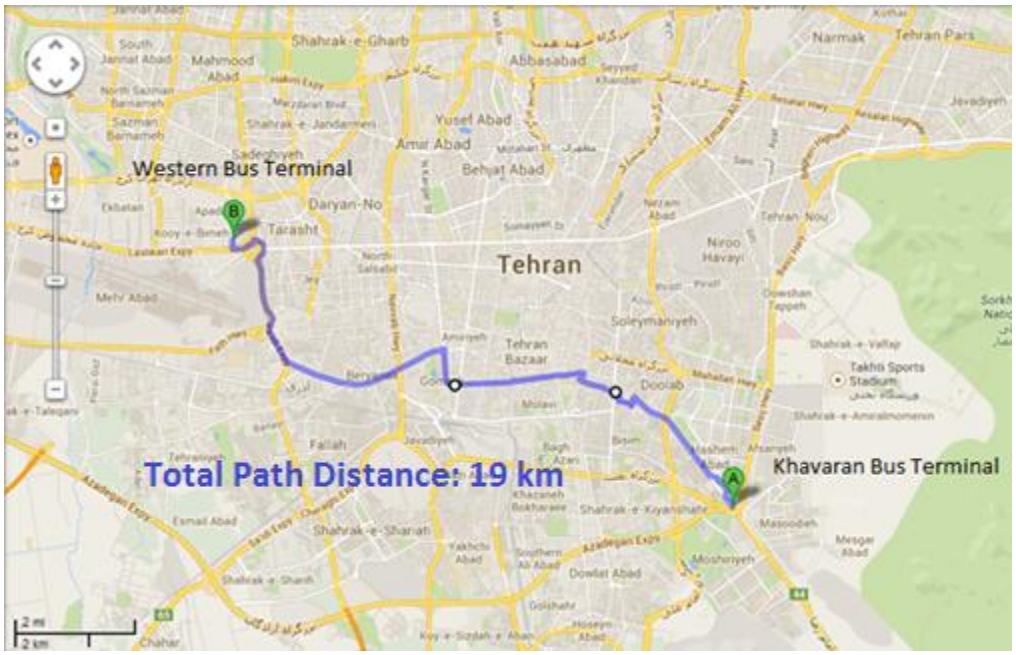
## Filter Operation Analysis

- As depicted in figure 1, 1.04% of total working time pressure is above 200 mbar and 2.77% above 150 mbar during this period.

- Figure 2 displays flow temperature distribution for DPF's upstream. It can be obviously observed only 4.9% of total working time temperature is above 350°C.

| | | |
|---|---|---|
| Filter operation status | Excellent ☐ | Good ■ |
| | Maintenance required ☐ | Failed ☐ |

| | |
|---|---|
| Vehicle plate number | 33637 (34119) |
| Bus line | Number 2 (west to east bus line) |
| DPF producer company | Dinex_02 (Passive system with FBC) |

**Notice: System was working over this period without DPF.**

## Overall Information

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 33637 (34119) |
| CPK data logger number | LN: 001492, DN: 1933, Sim +989210000000 |
| Bus line | Number 2 (west to east bus line) |
| Bus Terminals | Khavaran Bus Terminal - Western Bus Terminal |
| Total path distance | 19 km |
| DPF company producer | Dinex_02 (Passive system with FBC) |
| Installation date | 02/Jun/2015 |
| Report period | 01/Mar/2016 – 15/Mar/2016 (fifteen days) |
| K value - DPF upstream | - [1/m] |
| K value – DPF downstream | - [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF has been removed after two weeks working on Jun 17th. After receiving cleaning machine DPF was cleaned on Aug 10th and was installed on Aug 22nd but worked only for ten days. The last cleaning was done on Sep 24th but cleaning issue was unavoidable after only three days working. Finally DPF was replaced by muffler on Sep 8th and system have been working from that date without DPF. |
| Dosing status | Additive dosing was increased 60% of its initial value for tests two and three. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage over the period | 3146 km |
| Working days over the period | 15 days |
| Stop days | 0 day |
| Data logger working days | 15 days |
| Working hours over the period | 241 hours 52 minutes |
| Average working hours per day (including stop days) | 16 hours 7 minutes |
| Bus average speed | 13 km/hr |
| idle speed time to all working time ration | 52.62 % |
| Total Bus fuel consumption over the period | 2013 lit |
| Fuel consumption per hour | 8.3 lit/hr |
| Average fuel consumption | 0.64 lit/km |

## Temperature, Pressure and Engine Speed Overview

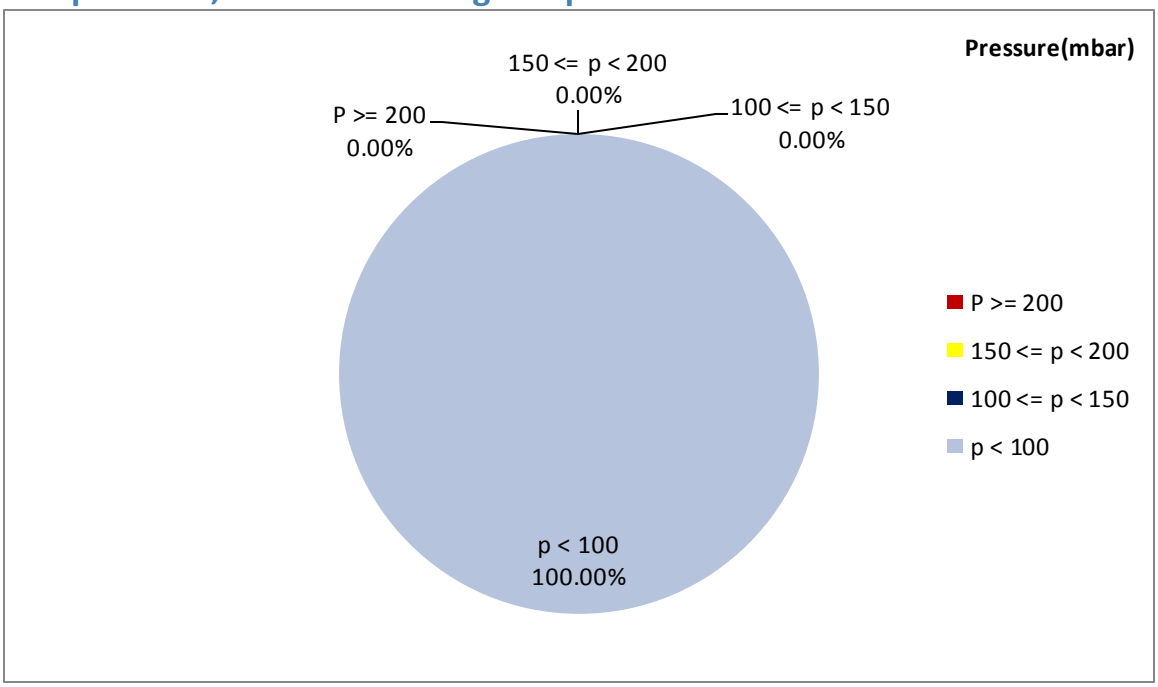



*Figure 1- Pressure distribution over the working hours*

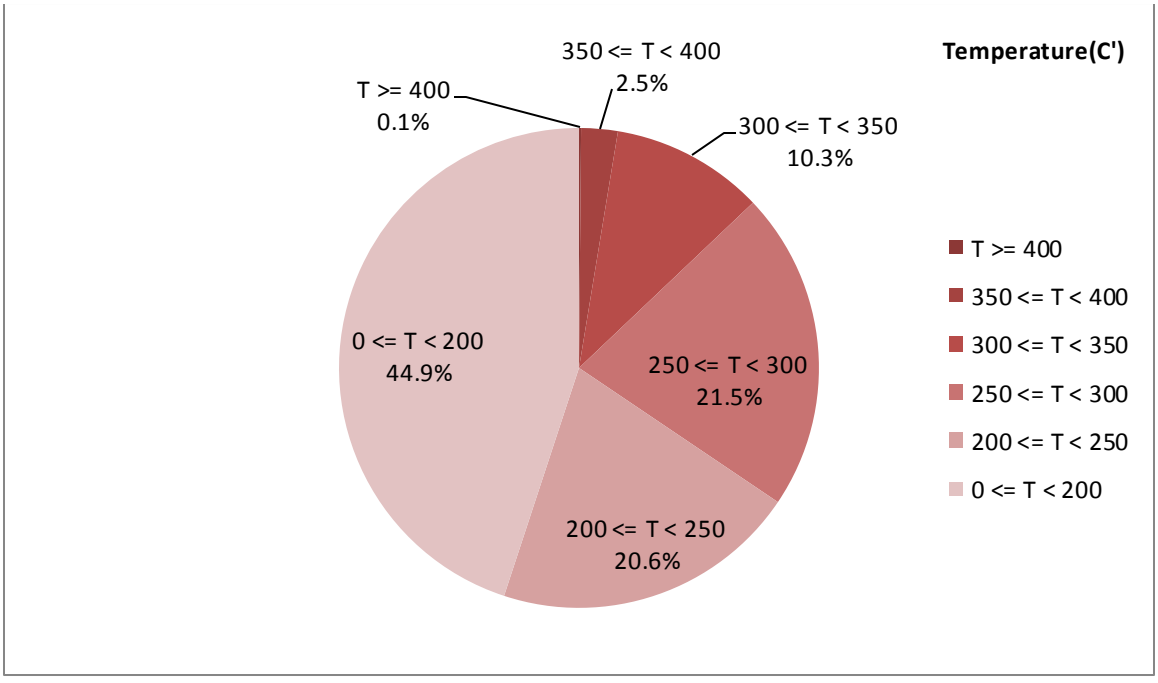



*Figure 2-Temperature distribution over the working hours*

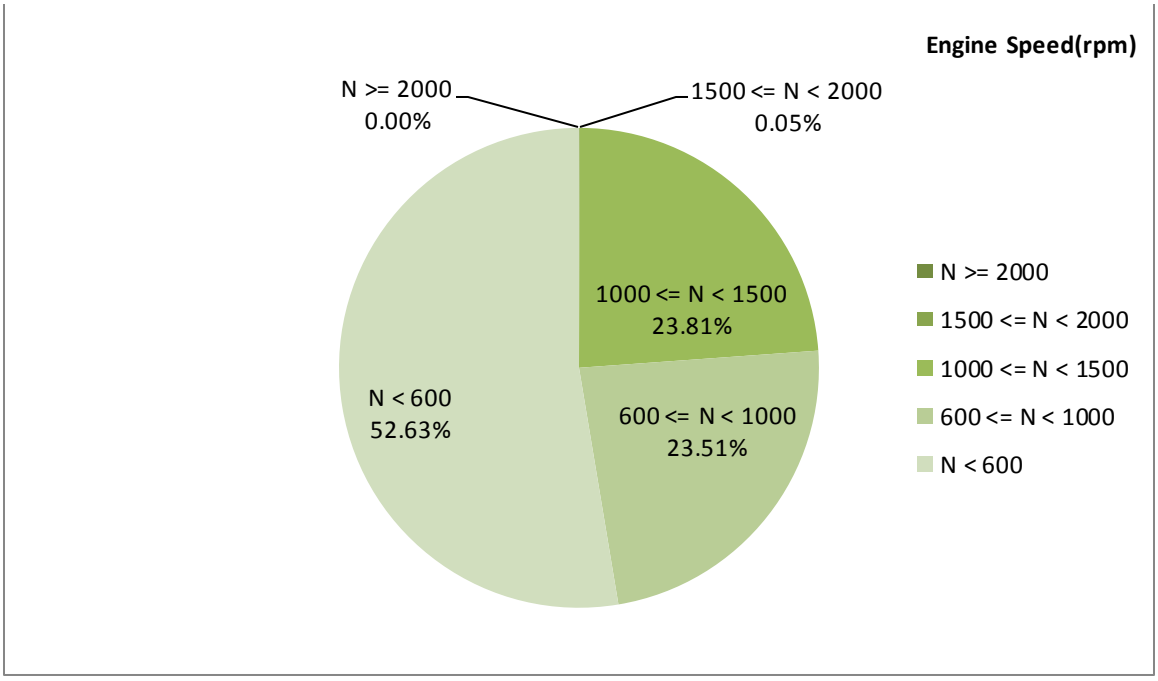



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 213.35 | 0.99 | 746 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 269.21 | 2.09 | 968 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 446-50 | 66-0 | 1808-288 |

## Detailed Pressure Analysis

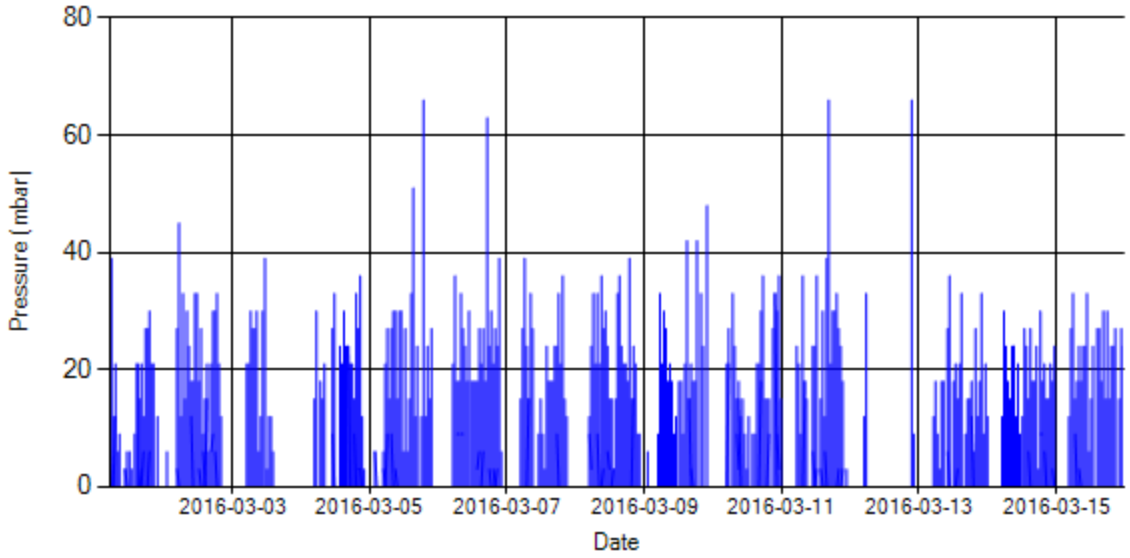



*Figure 4- Pressure distribution over the period*

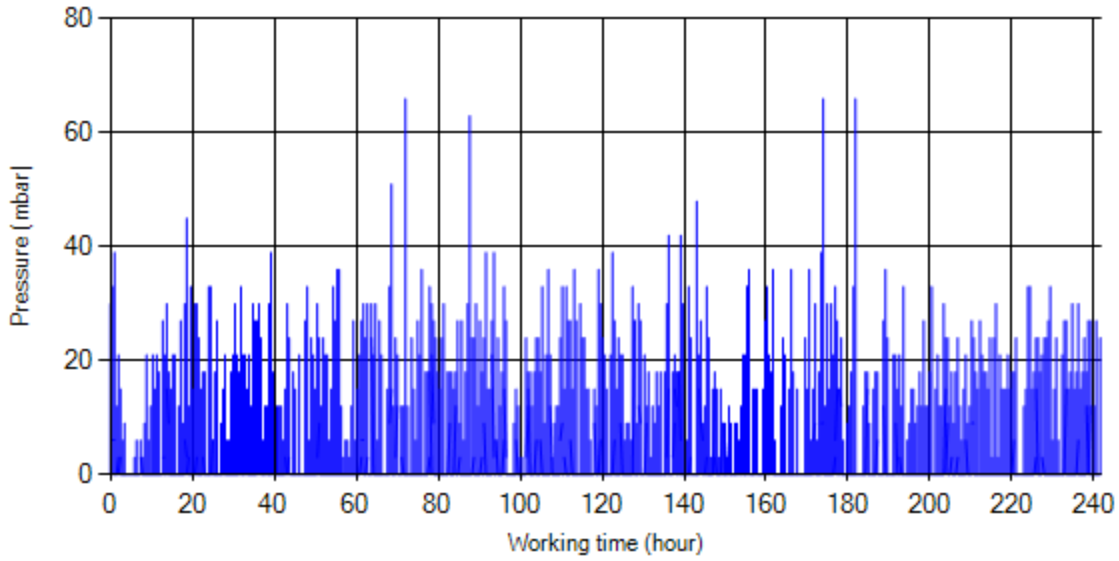



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

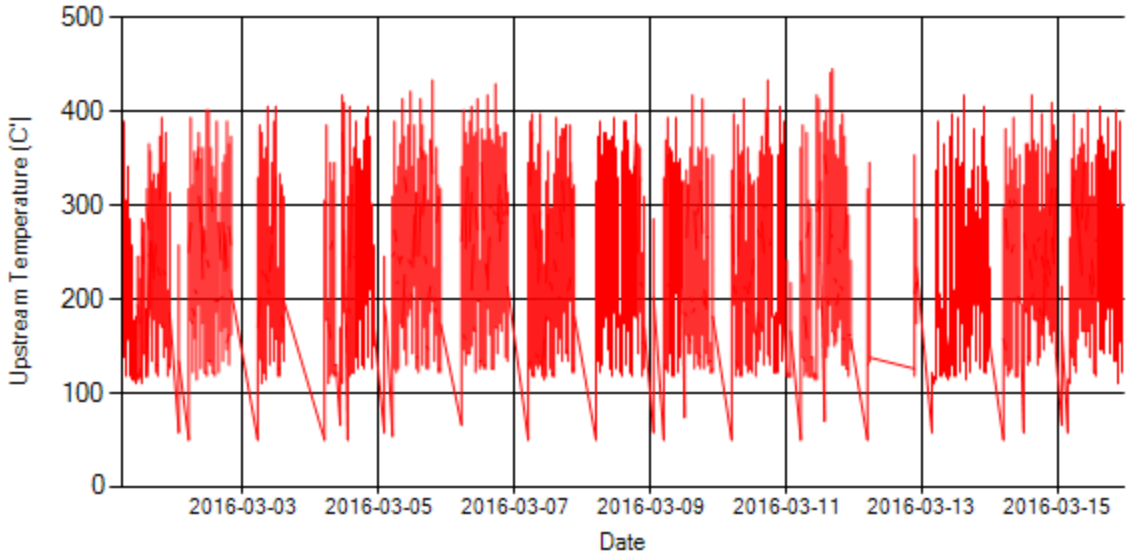



*Figure 6- Temperature distribution over the period*

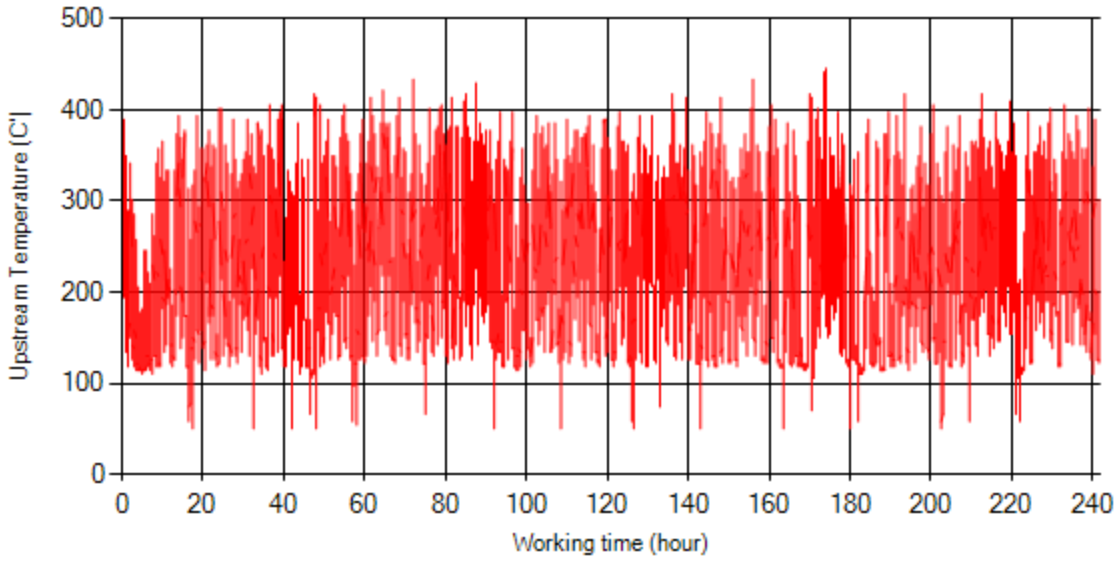



*Figure 7- Temperature vs. working hours*

## Engine Speed Diagrams

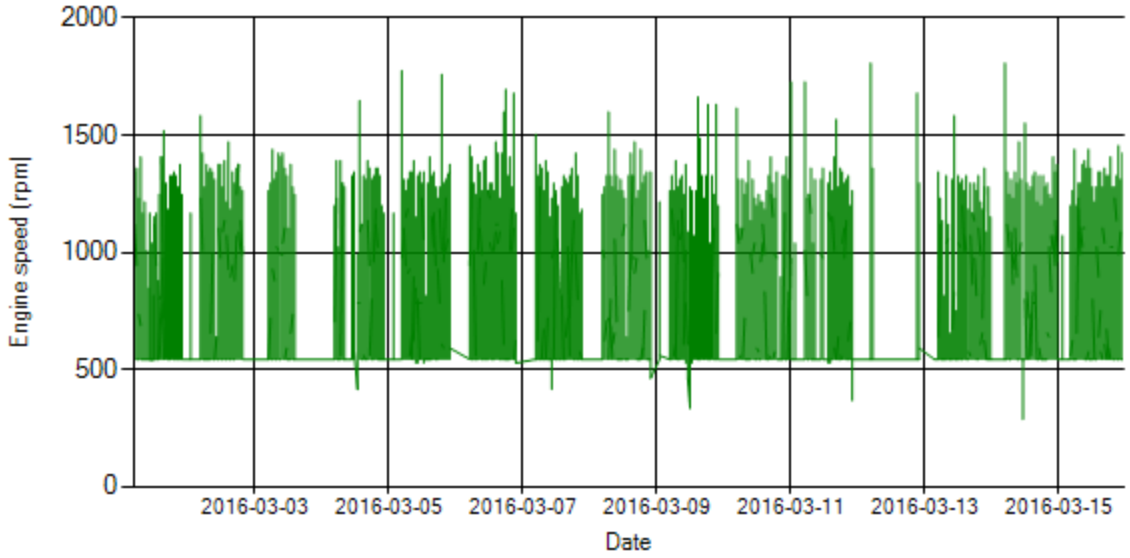



*Figure 8- Engine speed distribution over the period*

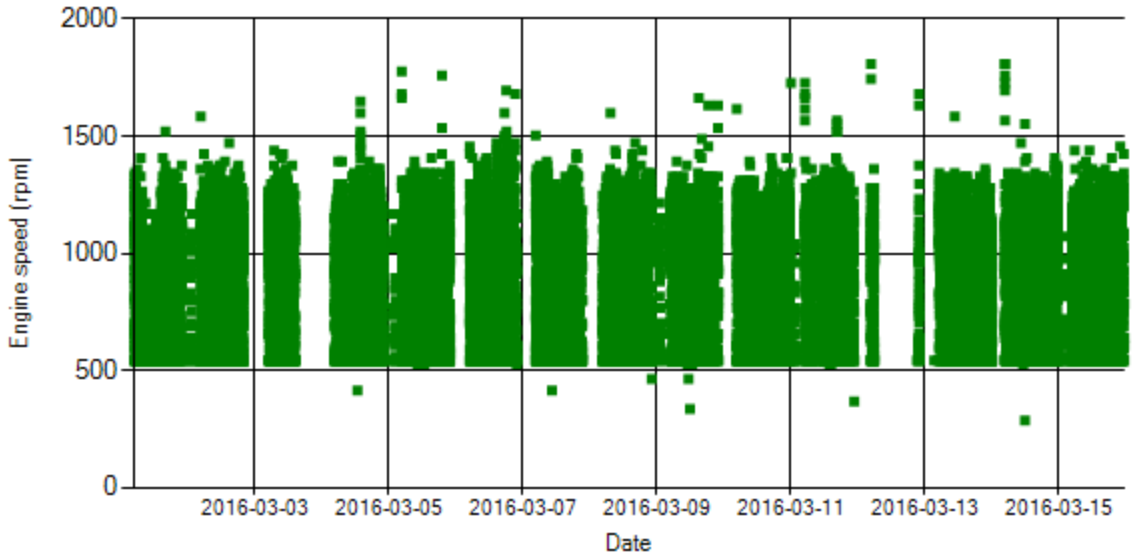



*Figure 9- Engine speed diagram for calculating CPK's working days*

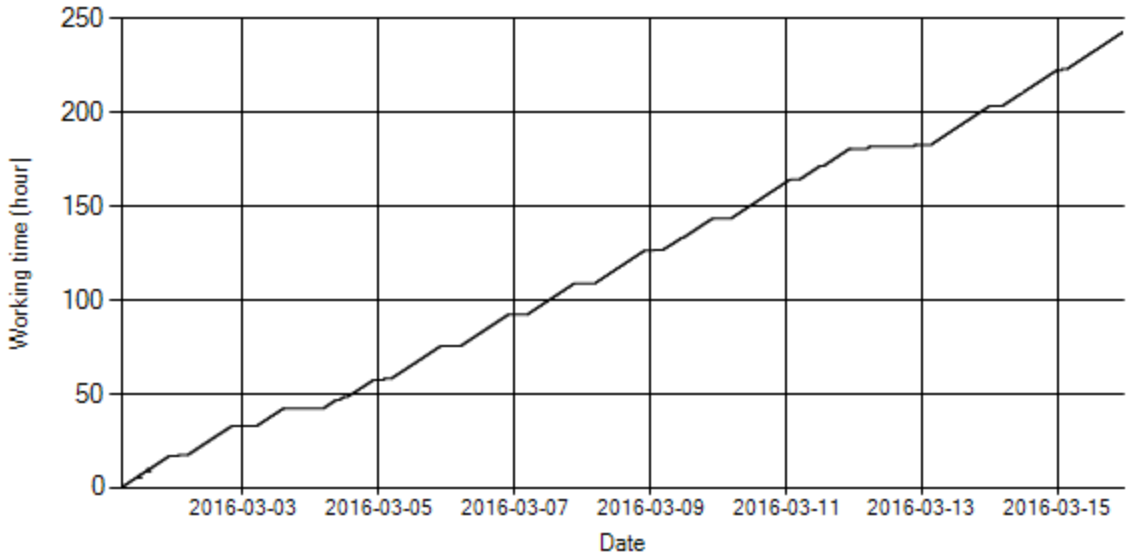



*Figure 10- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 10. The lines parallel with Date axis show days without data logger data. As depicted in Figure 10, system was working all days during the period.

## Pressure-Engine Speed diagrams

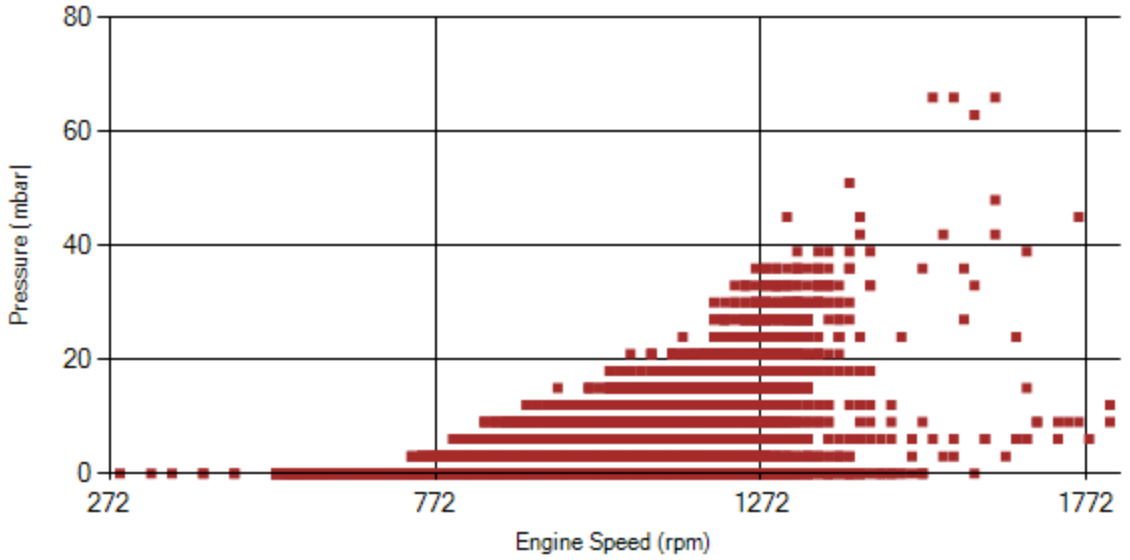



*Figure 11- Pressure against engine speed*

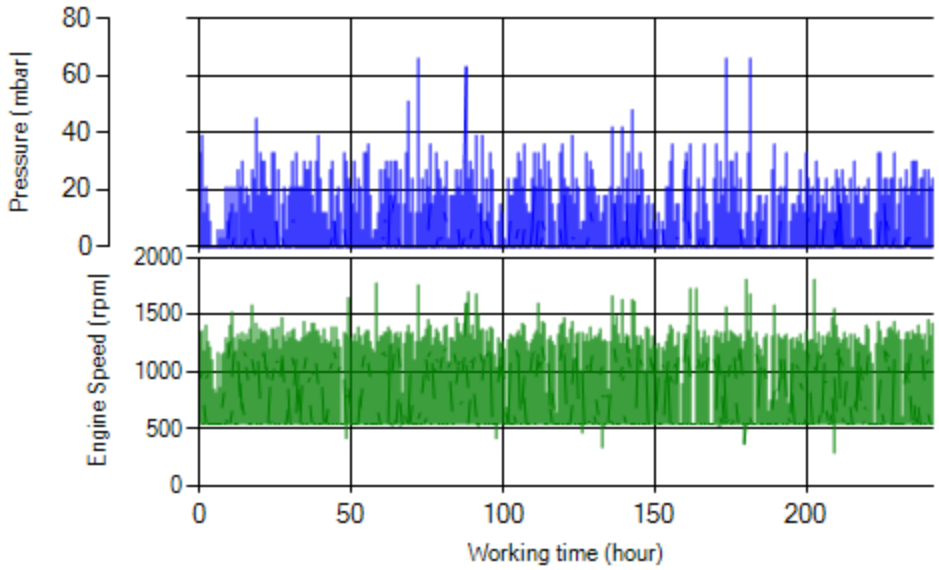



*Figure 12- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

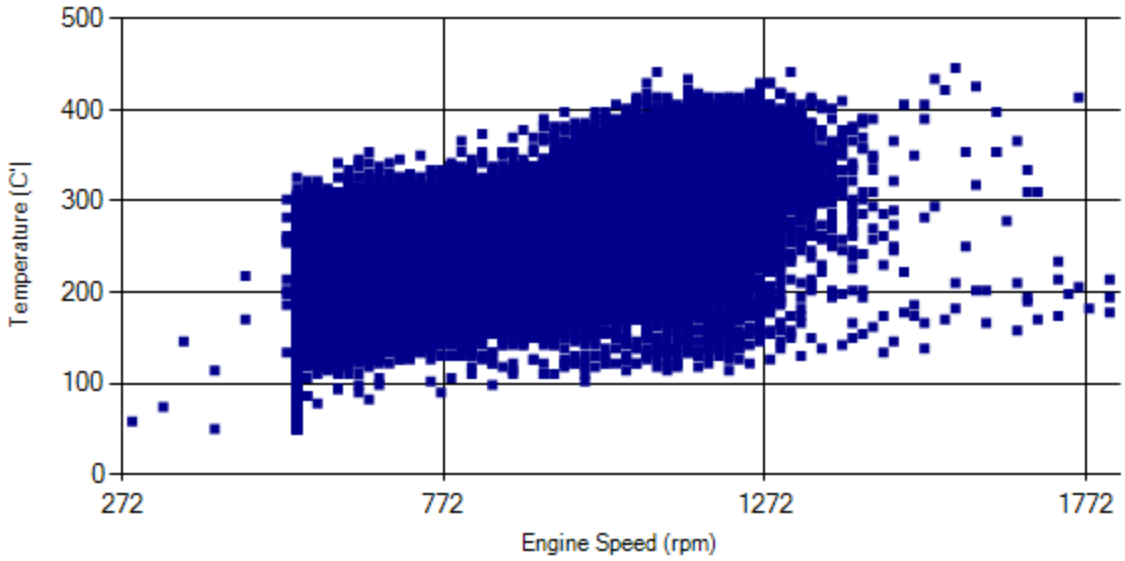



*Figure 13- Temperature against engine speed*

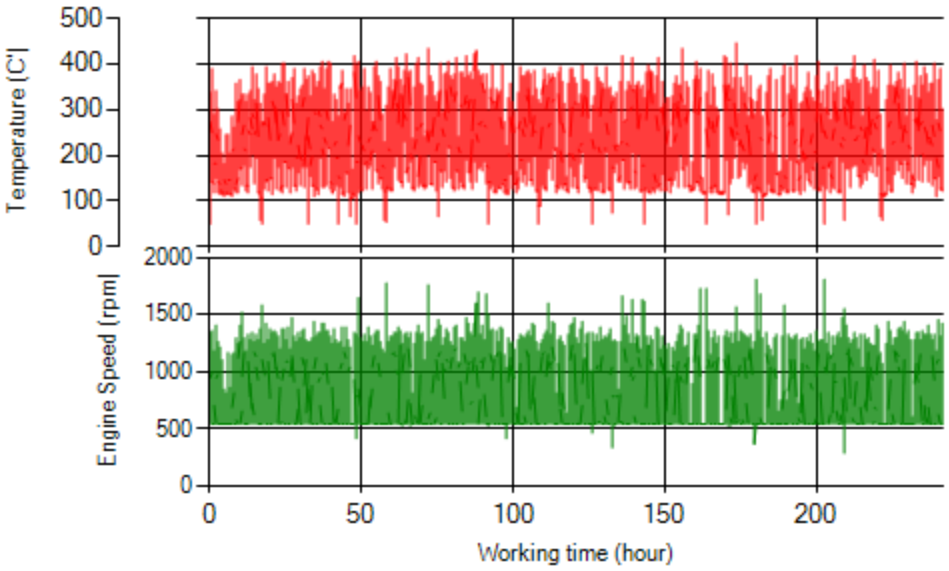



*Figure 14- T, N distribution vs. working hours*

## Filter Operation Analysis

**Notice:** System was working over this period without DPF.

**Notice: System was working over this period without DPF.**

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 33637 (34119) |
| CPK data logger number | LN: 001492, DN: 1933, Sim +989210000000 |
| Bus line | Number 2 (west to east bus line) |
| Bus Terminals | Khavaran Bus Terminal - Western Bus Terminal |
| Total path distance | 19 km |
| DPF company producer | Dinex_02 (Passive system with FBC) |
| Installation date | 02/Jun/2015 |
| Report period | 16/Mar/2016 – 31/Mar/2016 (sixteen days) |
| K value - DPF upstream | - [1/m] |
| K value – DPF downstream | - [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF has been removed after two weeks working on Jun 17th. After receiving cleaning machine DPF was cleaned on Aug 10th and was installed on Aug 22nd but worked only for ten days. The last cleaning was done on Sep 24th but cleaning issue was unavoidable after only three days working. Finally DPF was replaced by muffler on Sep 8th and system have been working from that date without DPF. |
| Dosing status | Additive dosing was increased 60% of its initial value for tests two and three. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage over the period | 2047 km |
| Working days over the period | 14 days |
| Stop days | 2 days |
| Data logger working days | 14 days |
| Working hours over the period | 194 hours 48 minutes |
| Average working hours per day (including stop days) | 12 hours59 minutes |
| Bus average speed | 10.5 km/hr |
| idle speed time to all working time ration | 59.32 % |
| Total Bus fuel consumption over the period | 1290 lit |
| Fuel consumption per hour | 6.6 lit/hr |
| Average fuel consumption | 0.63 lit/km |

## Temperature, Pressure and Engine Speed Overview

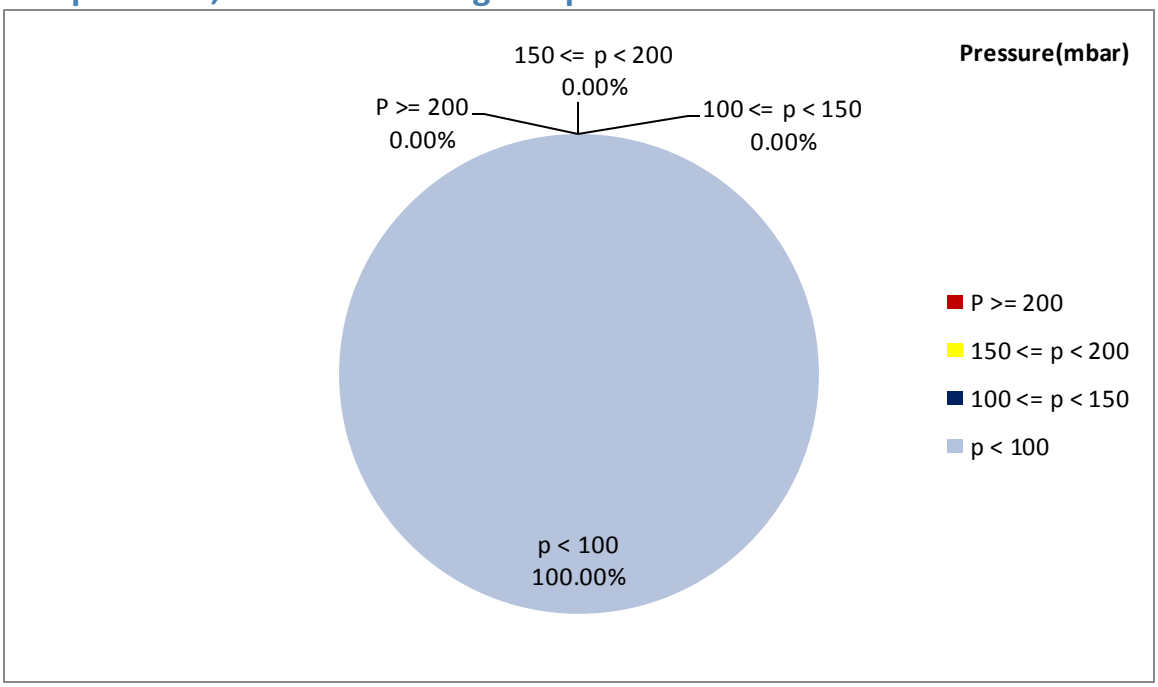



*Figure 1- Pressure distribution over the working hours*

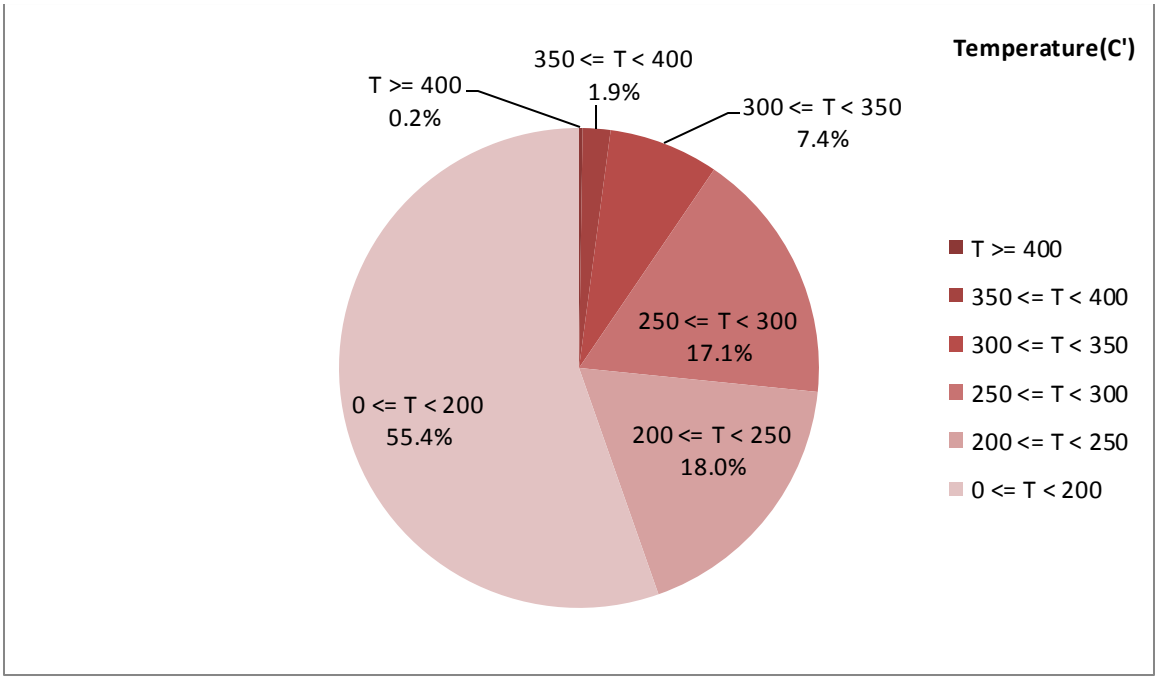



*Figure 2-Temperature distribution over the working hours*

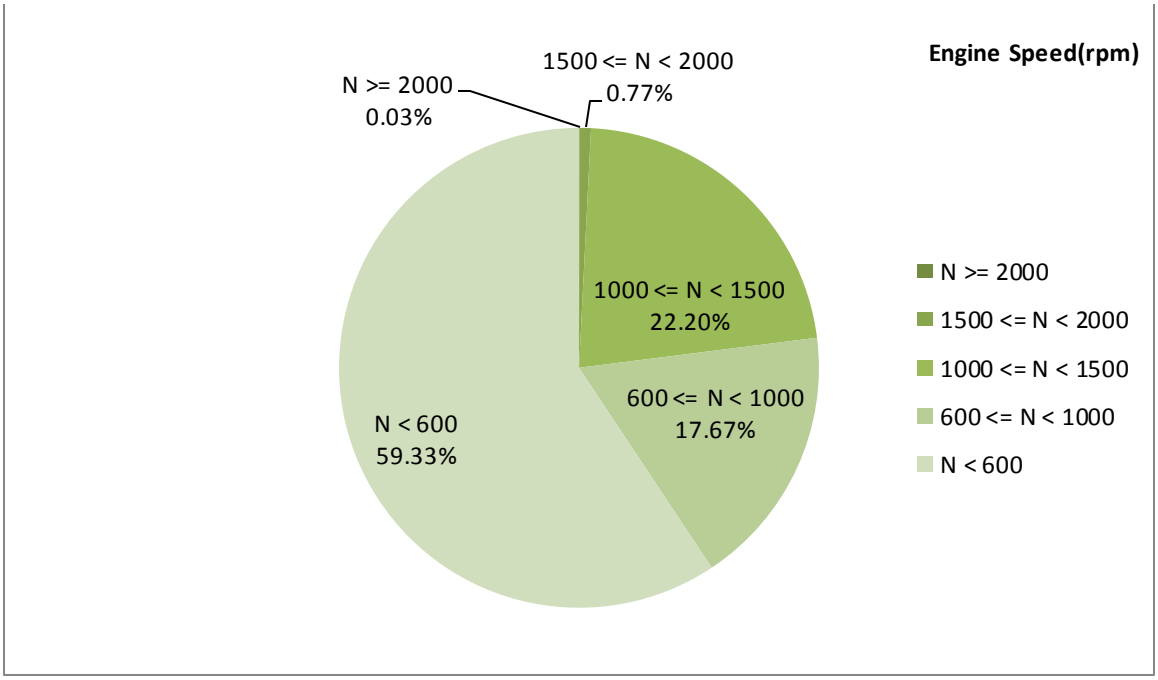



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 194.73 | 0.97 | 735 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 264.03 | 2.39 | 1012 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 466-50 | 78-0 | 2160-272 |

## Detailed Pressure Analysis

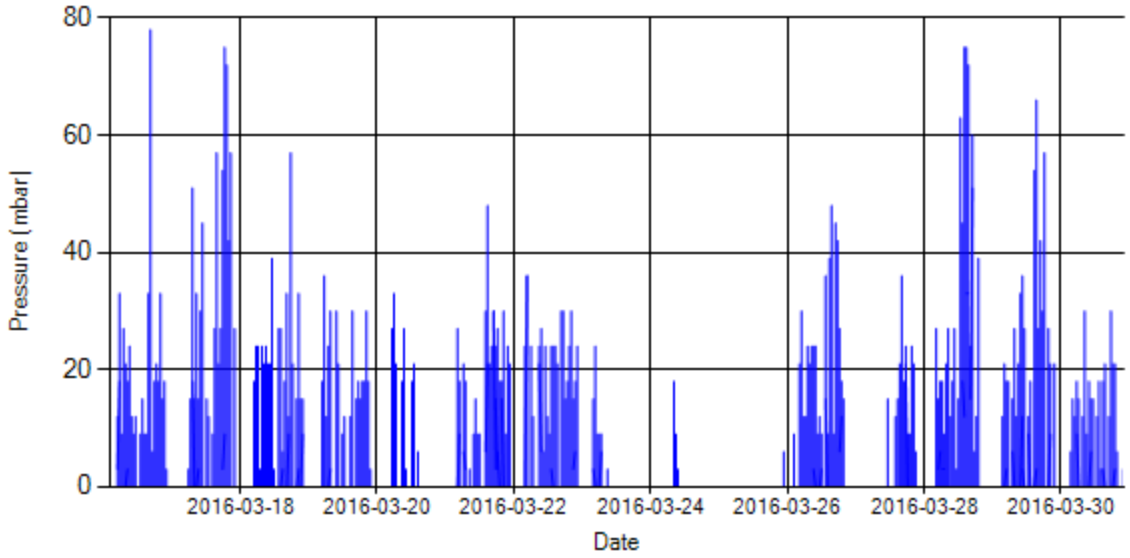



*Figure 4- Pressure distribution over the period*

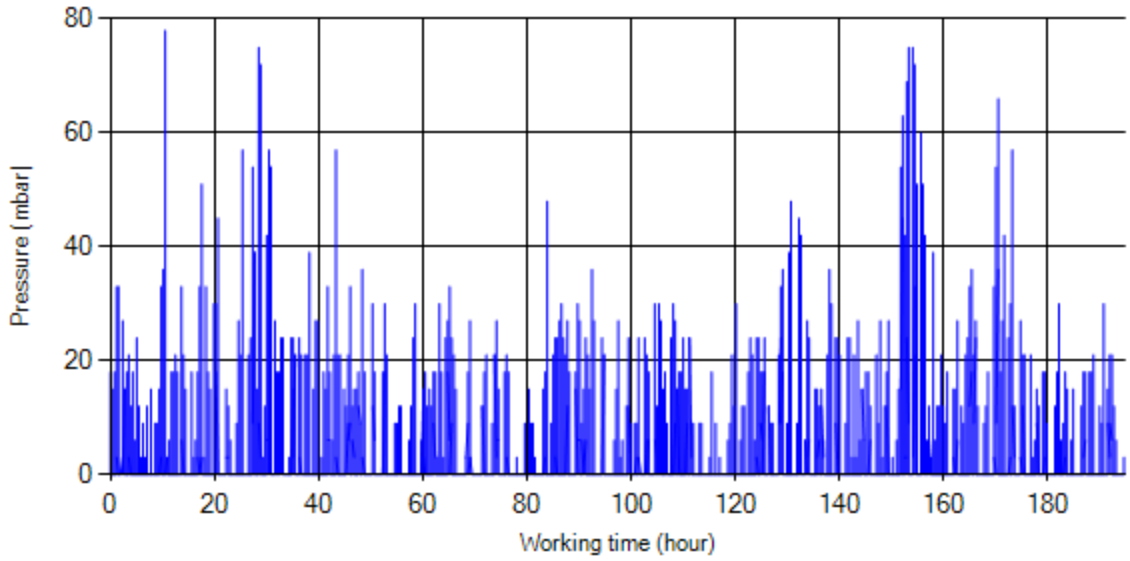



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

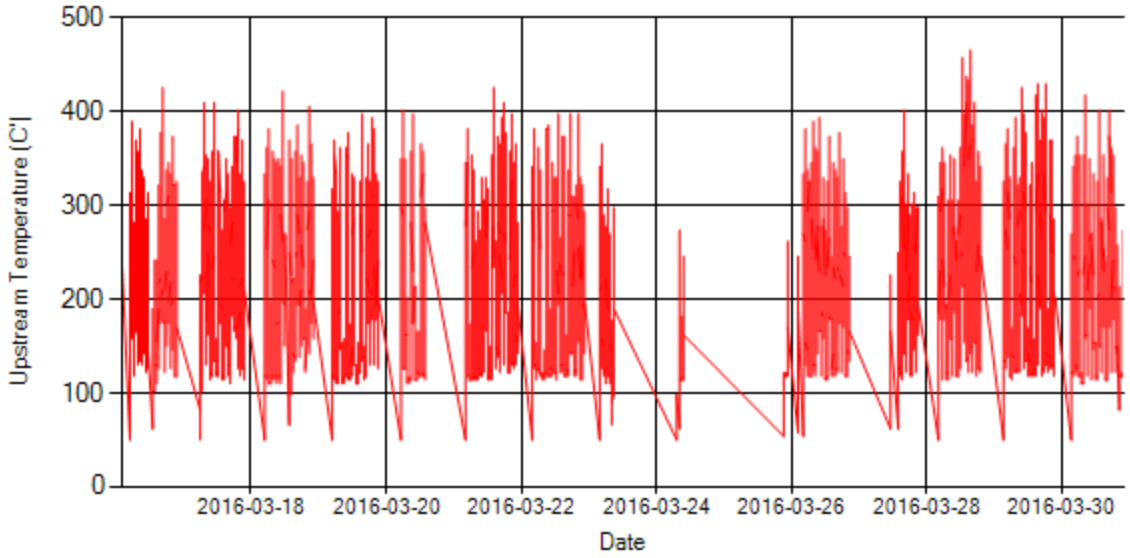



*Figure 6- Temperature distribution over the period*

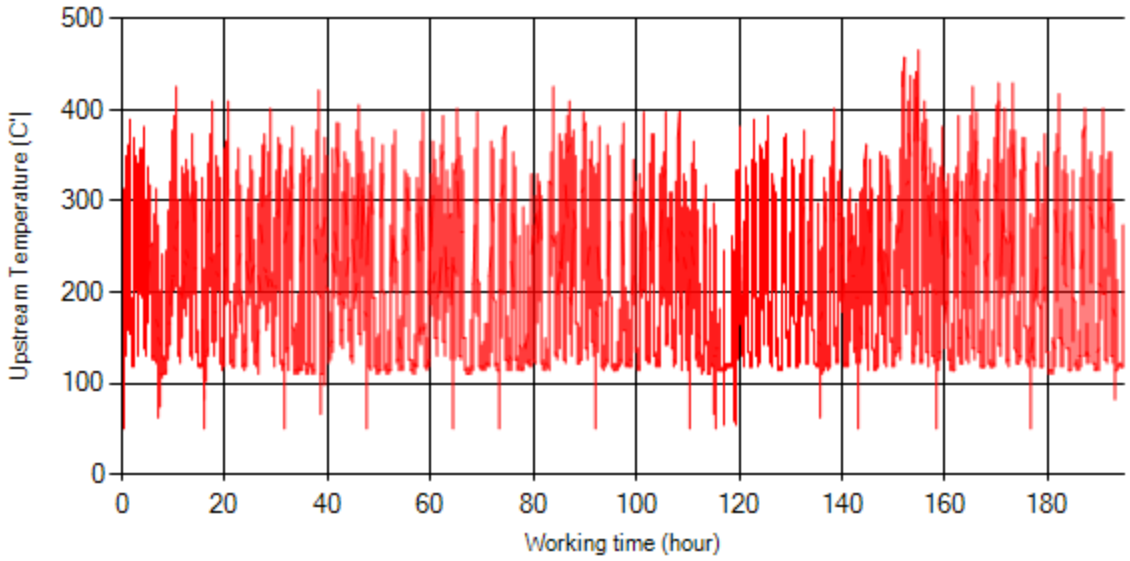



*Figure 7- Temperature vs. working hours*

## Engine Speed Diagrams

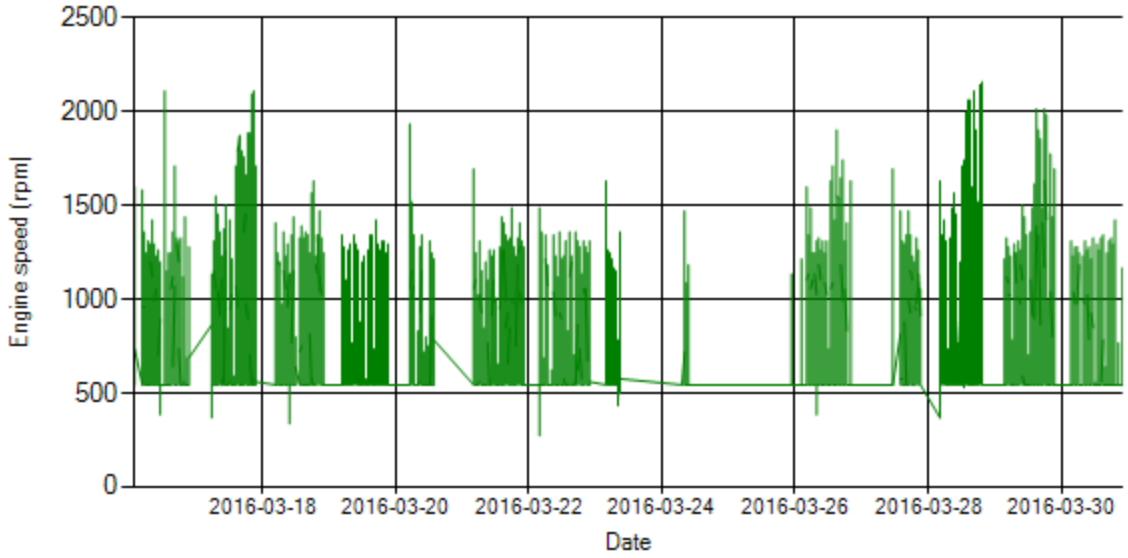



*Figure 8- Engine speed distribution over the period*

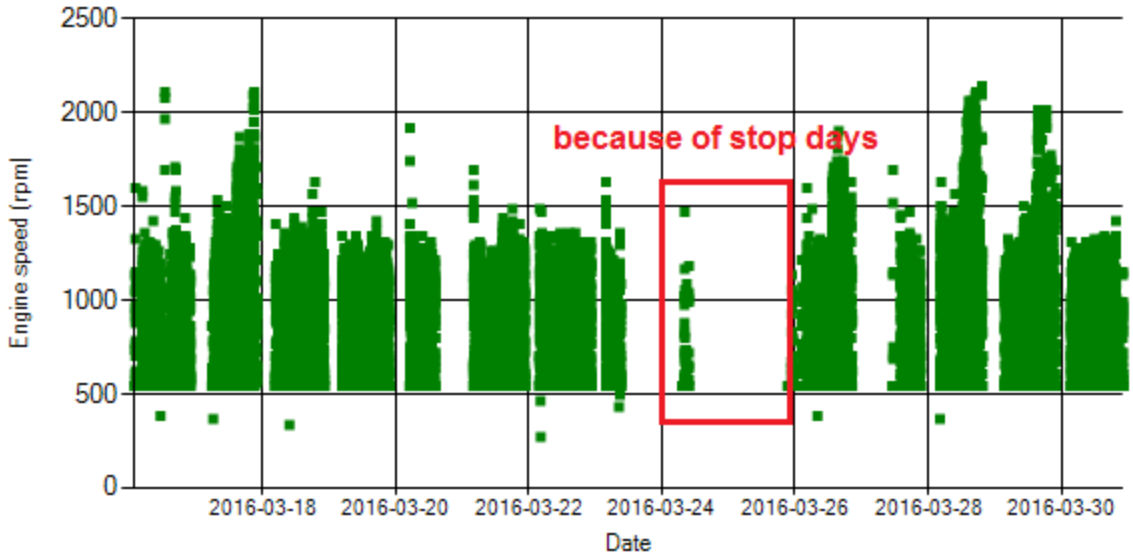



*Figure 9- Engine speed diagram for calculating CPK's working days*

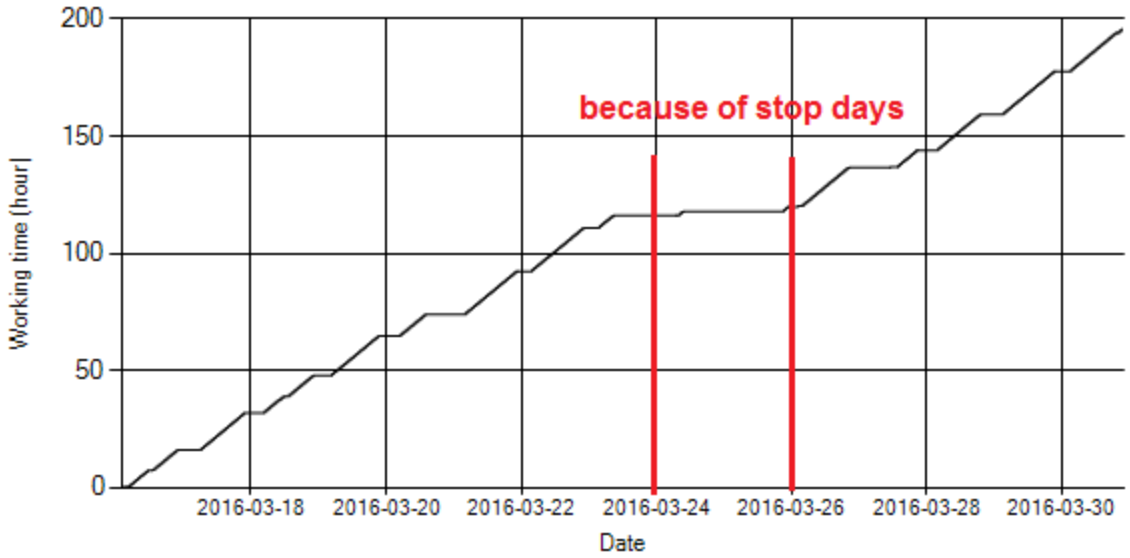



*Figure 10- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 10. The lines parallel with Date axis show days without data logger data. As depicted in Figure 10, vehicle was stationary for two days.

## Pressure-Engine Speed diagrams

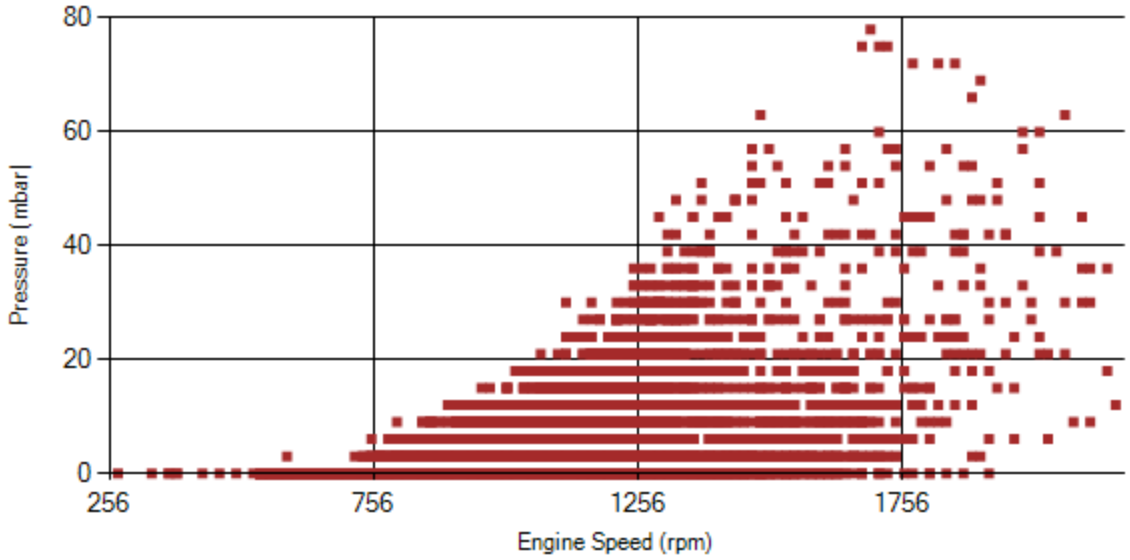



*Figure 11- Pressure against engine speed*

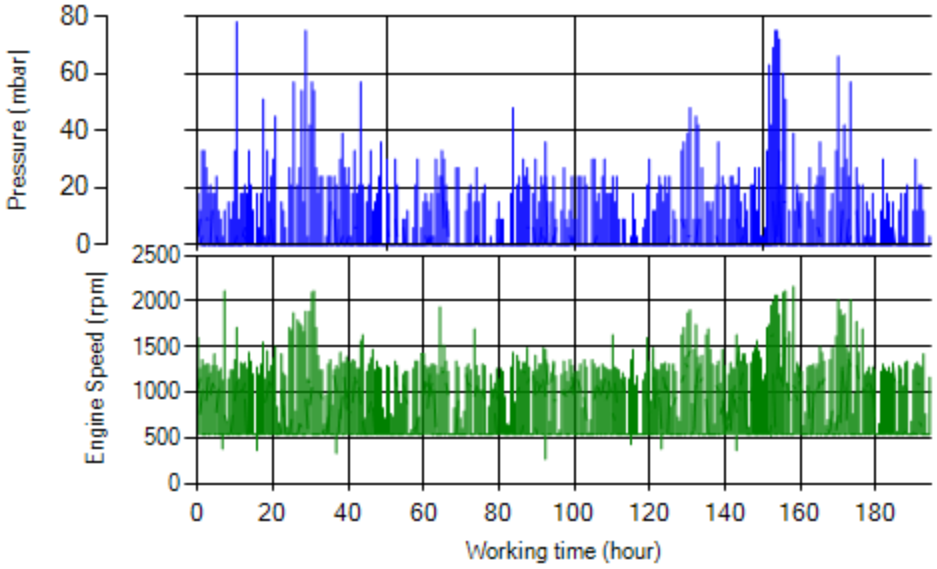



*Figure 12- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

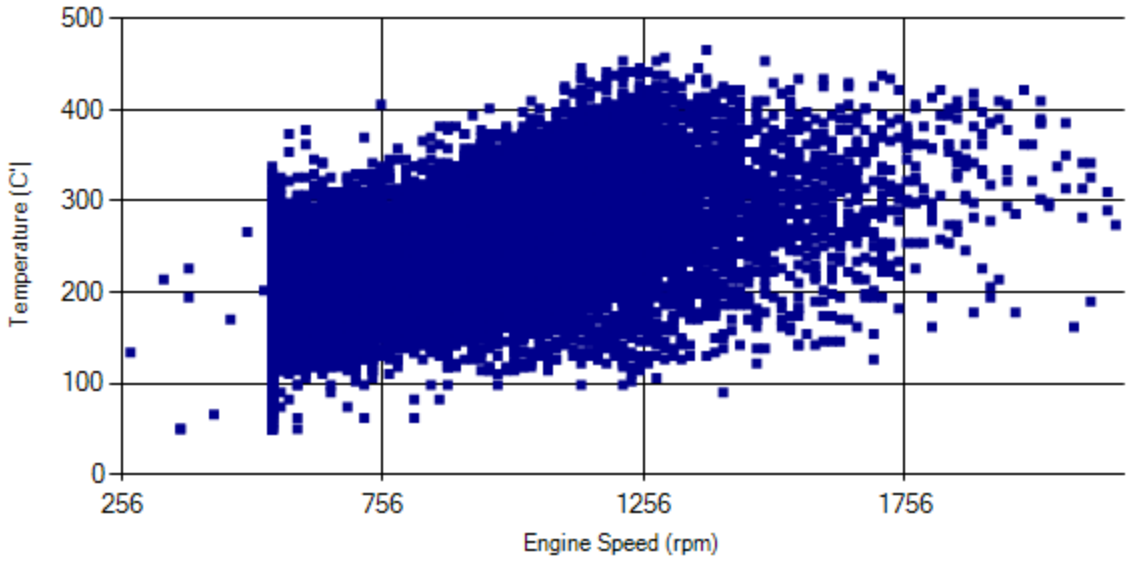



*Figure 13- Temperature against engine speed*

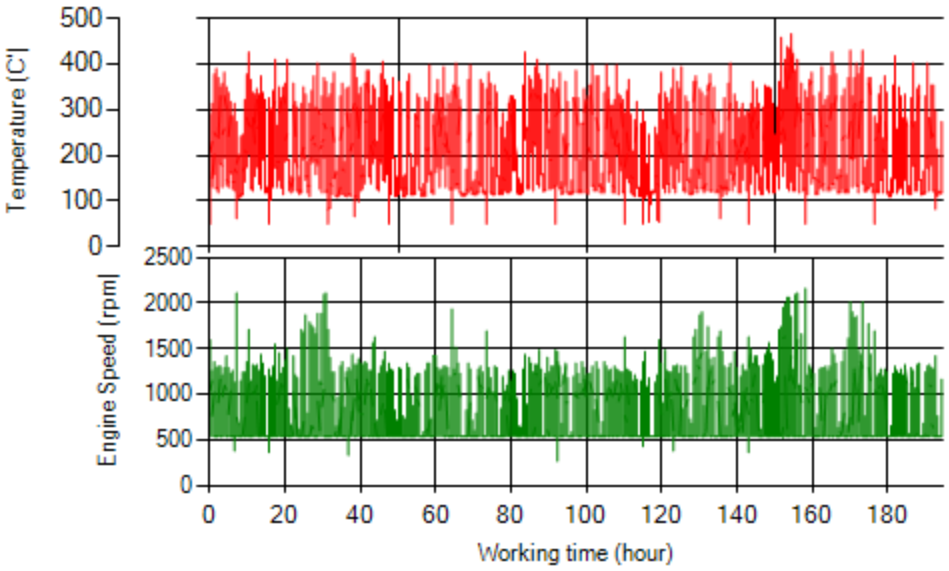
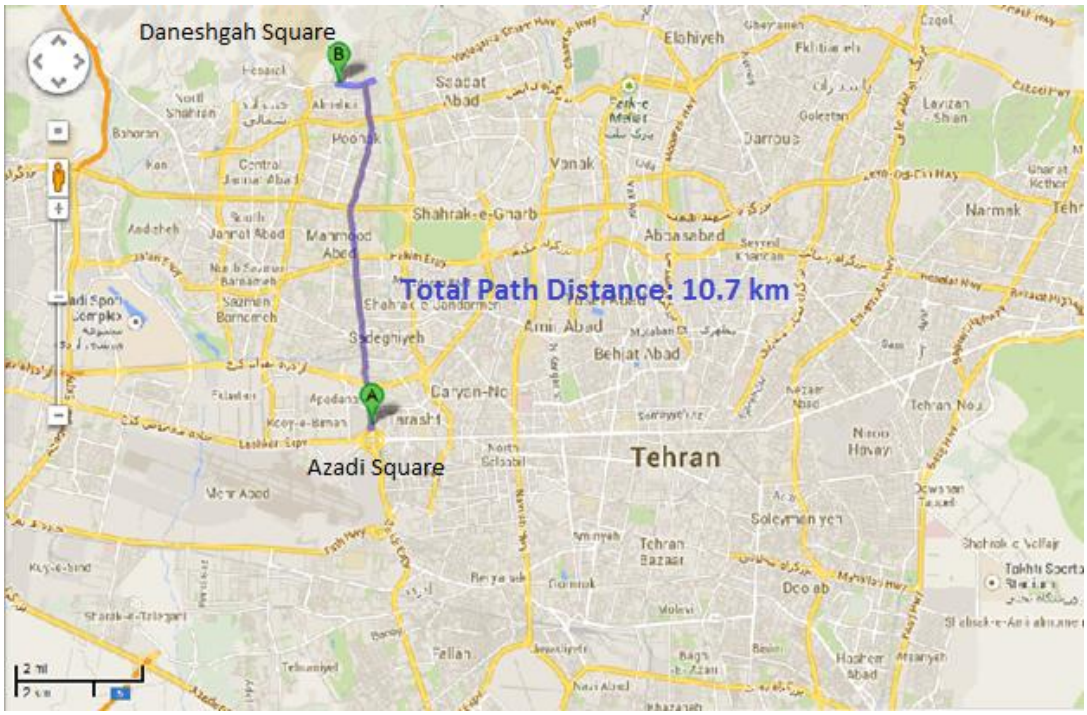



*Figure 14- T, N distribution vs. working hours*

## Filter Operation Analysis

**Notice:** System was working over this period without DPF.

| | |
|---|---|
| Vehicle plate number | 85476 |
| Bus line | Number 10 (south to north Bus line) |
| DPF producer company | HJS_04 (Passive system with FBC) |

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 85476 |
| CPK data logger number | LN: 001508, DN: 2003, Sim +989218469624 |
| Bus line | Number 10 (south to north Bus line) |
| Bus Terminals | Azadi square - Daneshgah square |
| Total path distance | 10.7 km |
| DPF producer company | HJS_04 (Passive system with FBC) |
| Installation date | 23/Feb/2015 |
| Report period | 01/Mar/2016 – 15/Mar/2016 (fifteen days) |
| K value - DPF upstream | 1.90 [1/m] |
| K value – DPF downstream | 0.02 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF was cleaned on 22nd Jul for the first time and on 15th Dec for the second time after 44355 km mileage from installation date. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 55234 km |
| Bus mileage over the period | 1118 km |
| Working days over the period | 10 days |
| Stop days | 5 days |
| Data logger working days | 10 days |
| Working hours over the period | 124 hours 14 minutes |
| Average working hours per day (including stop days) | 8 hours 16 minutes |
| Bus average speed | 9 km/hr |
| idle speed time to all working time ration | 72.47 % |
| Total Bus fuel consumption over the period | 704 lit |
| Fuel consumption per hour | 5.7 lit/hr |
| Average fuel consumption | 0.63 lit/km |
| Total Bus additive consumption over the period | 0.33 lit |
| Average additive consumption | 337 cc/km |
| Additive consumption to fuel ration | 470 cc/1000lit |

## Temperature, Pressure and Engine Speed Overview

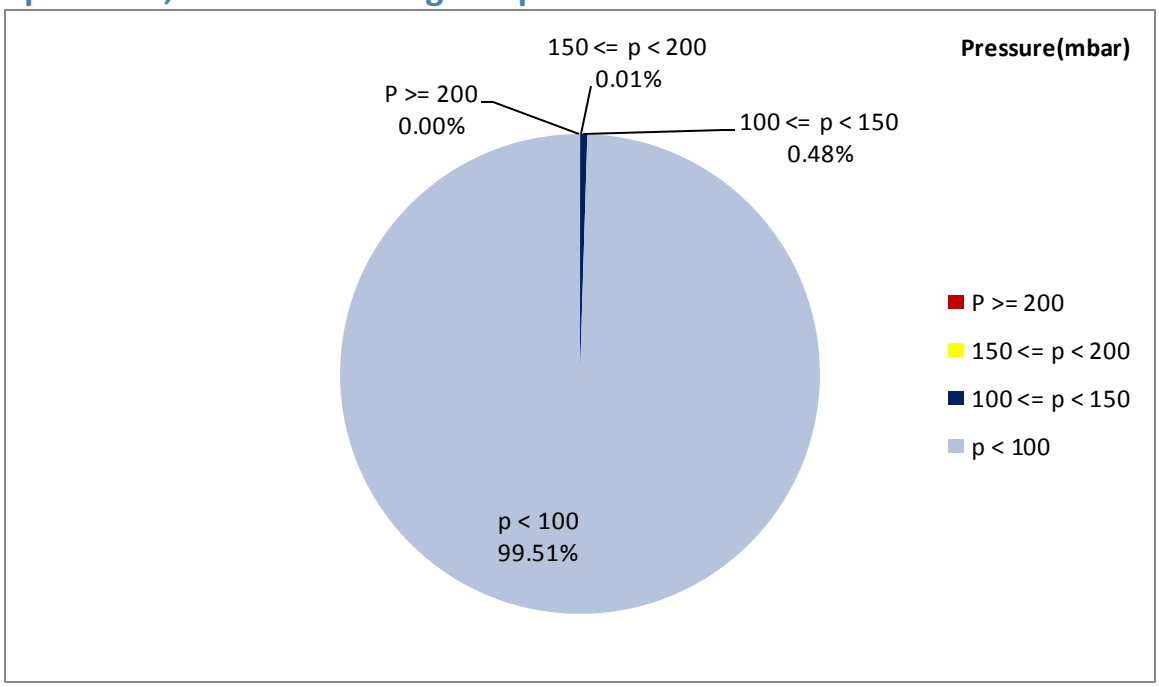



*Figure 1- Pressure distribution over the working hours*

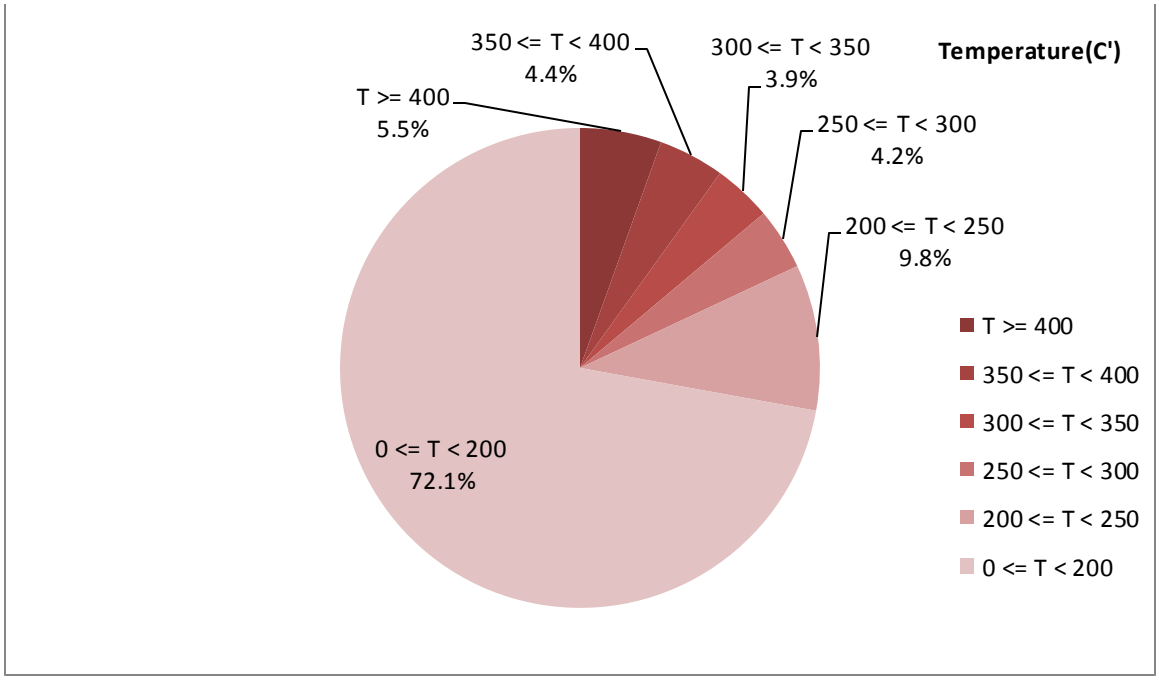



*Figure 2-Temperature distribution over the working hours*

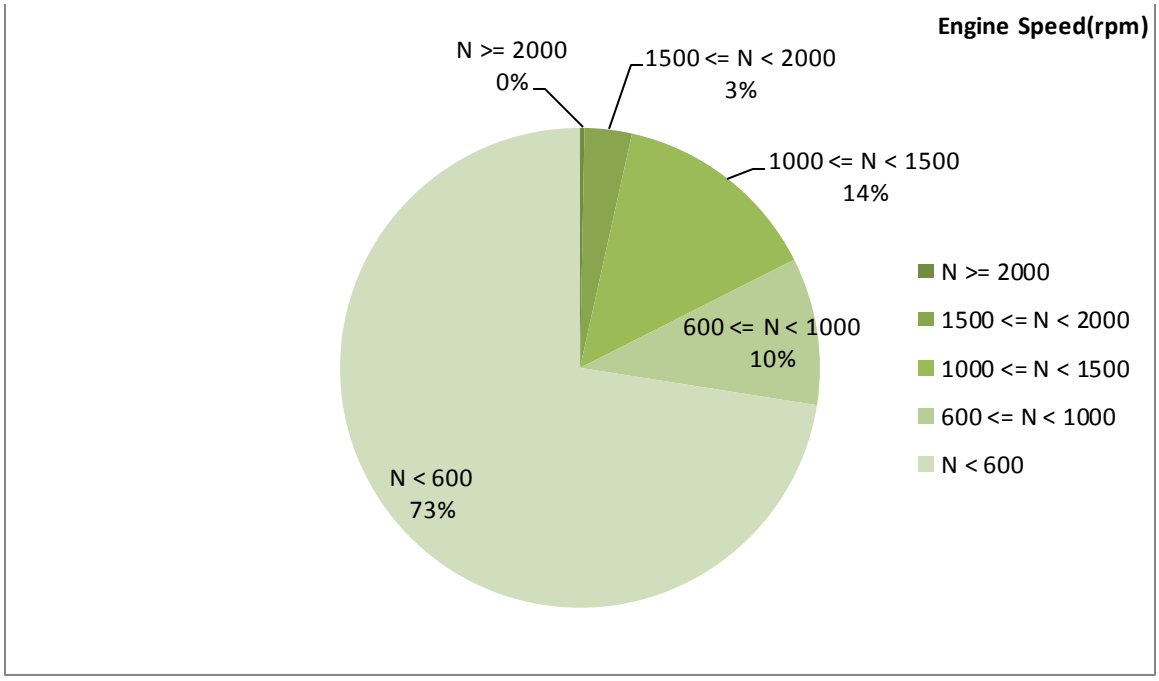



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 187.92 | 8.76 | 715 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 270.09 | 23.27 | 1120 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 566-50 | 165-0 | 2384-272 |

## Detailed Pressure Analysis

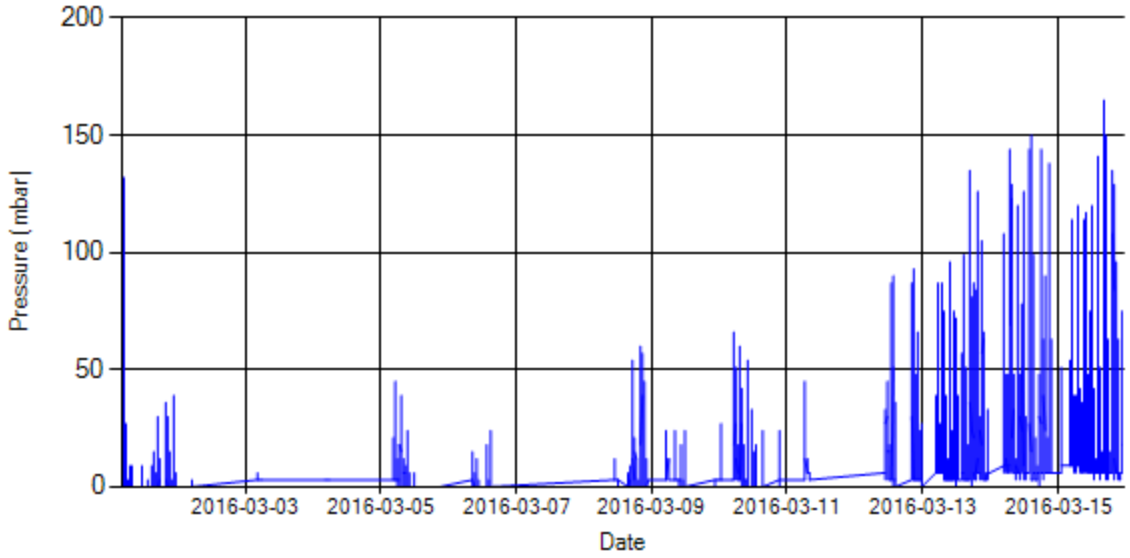



*Figure 4- Pressure distribution over the period*

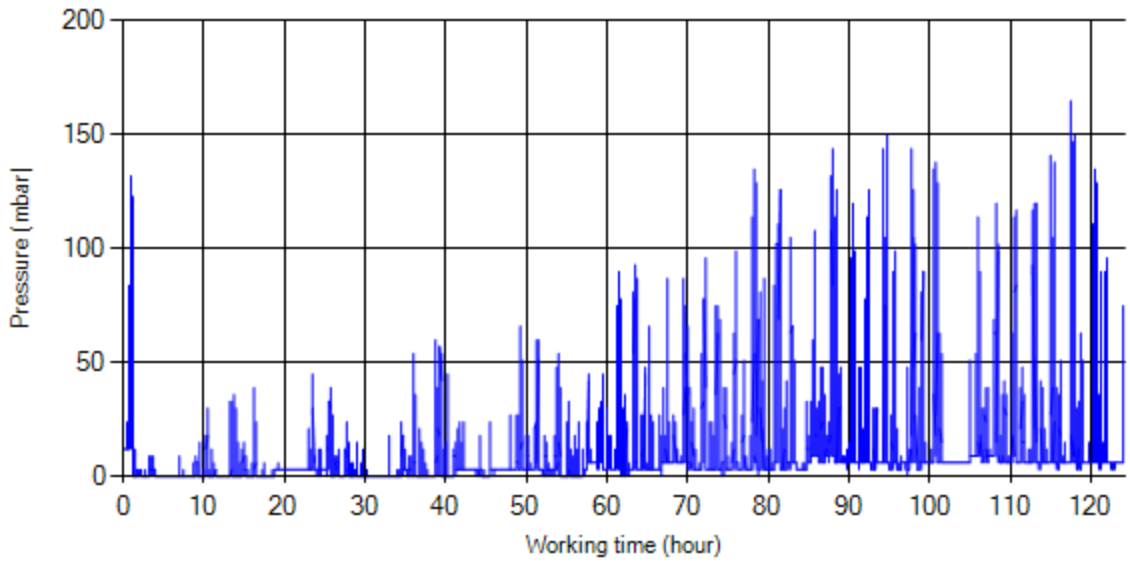



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

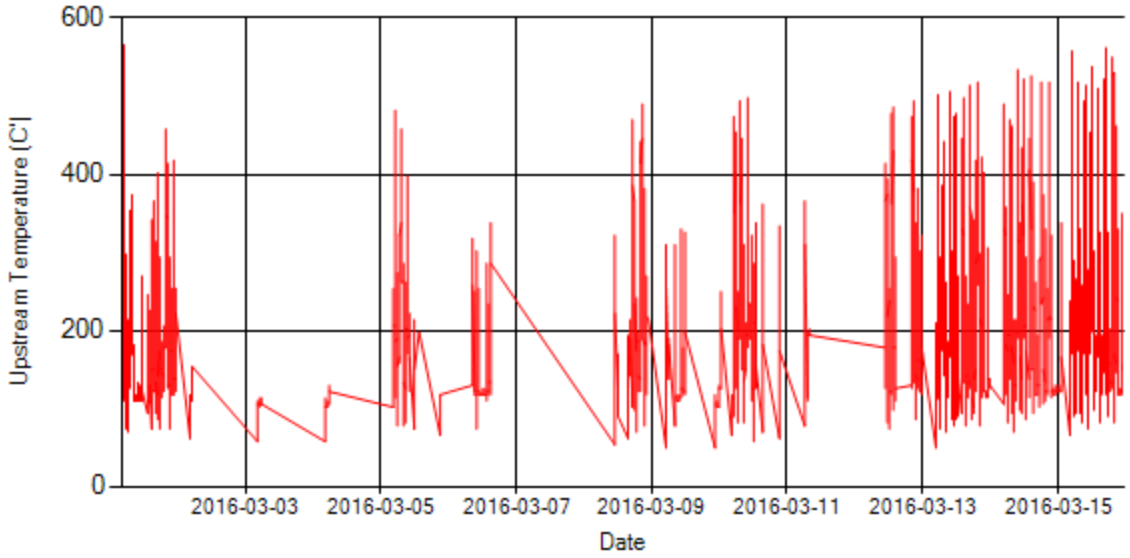



*Figure 6- Temperature distribution over the period*

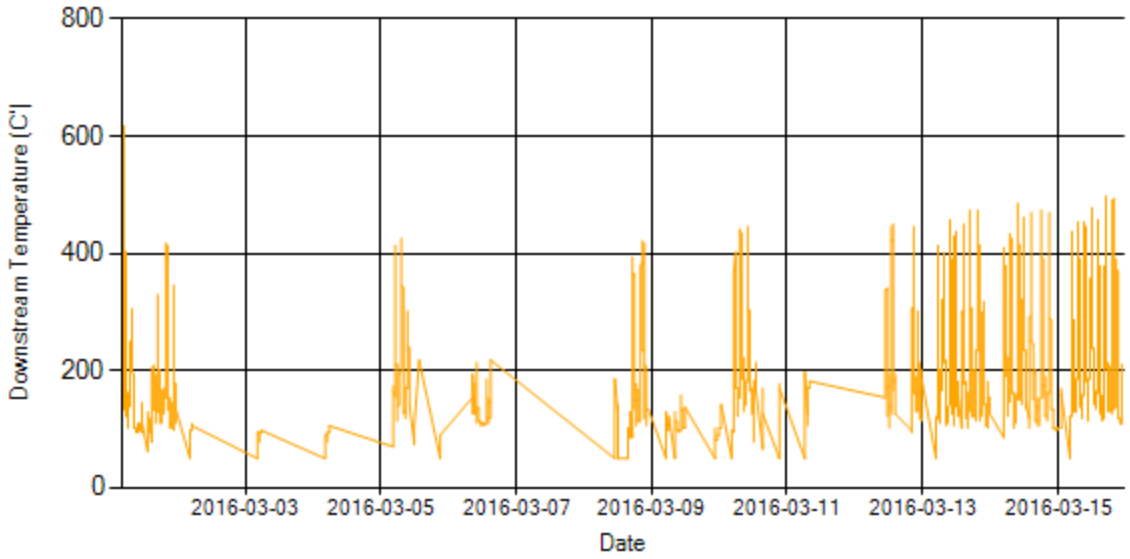



*Figure 7- Temperature distribution over the period*

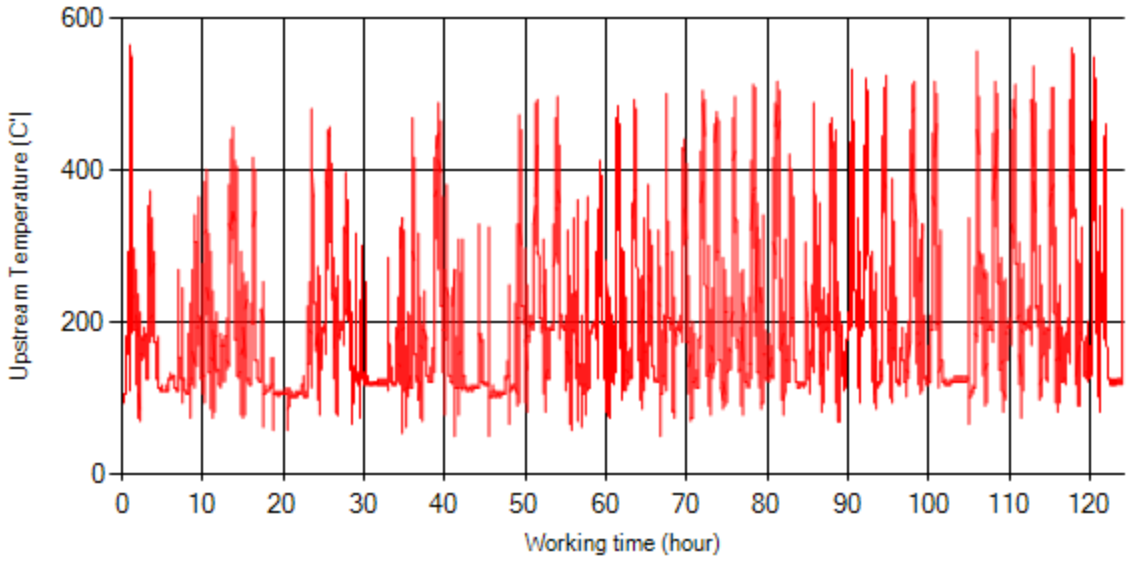



*Figure 8- Temperature vs. working hours*

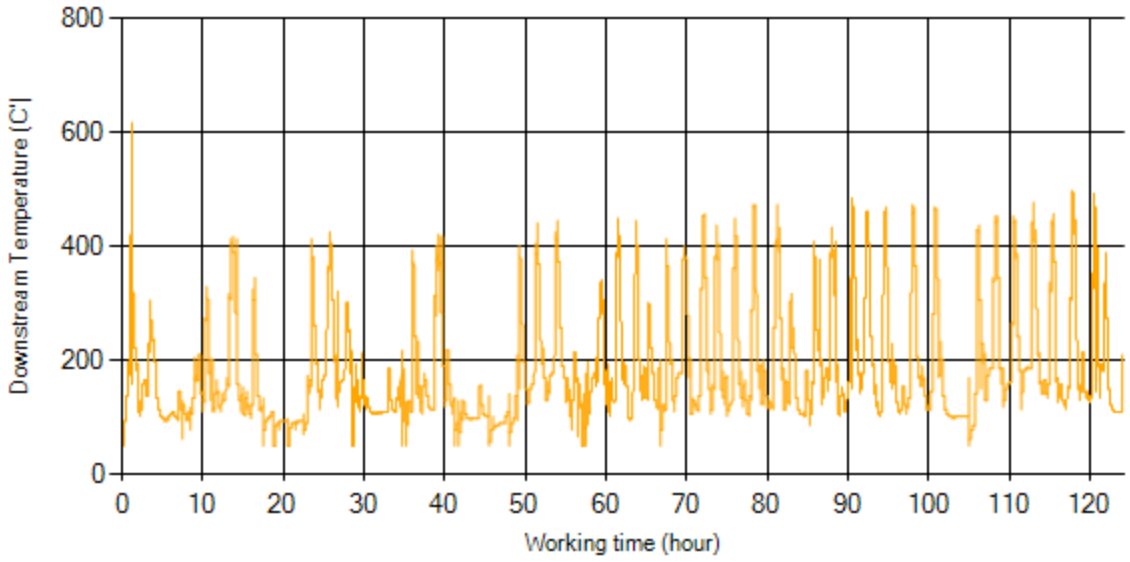



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

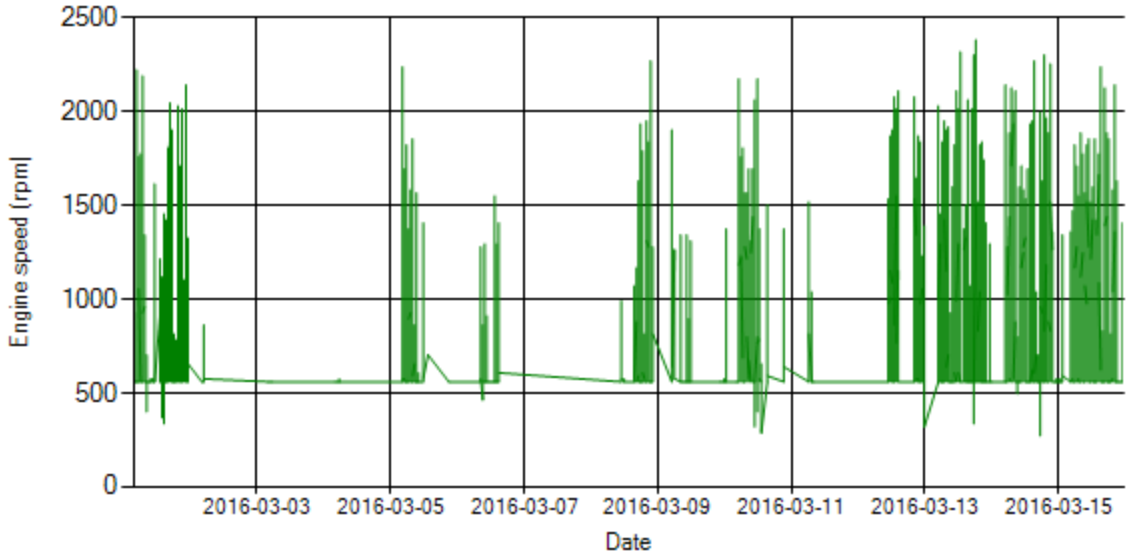



*Figure 10- Engine speed distribution over the period*

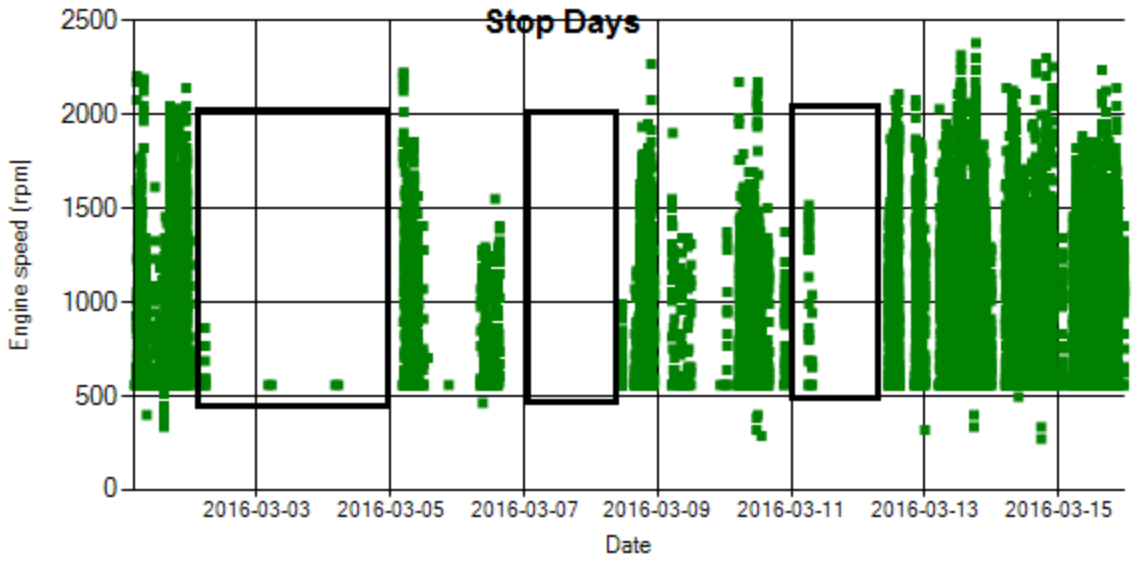



*Figure 11- Engine speed diagram for calculating CPK's working days*

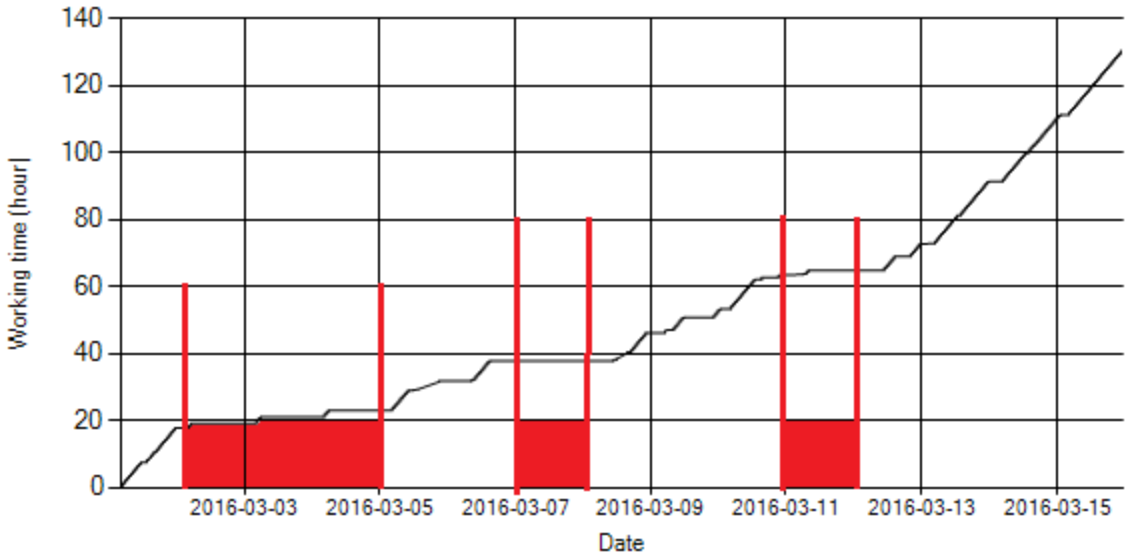



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data.

## Pressure-Engine Speed diagrams

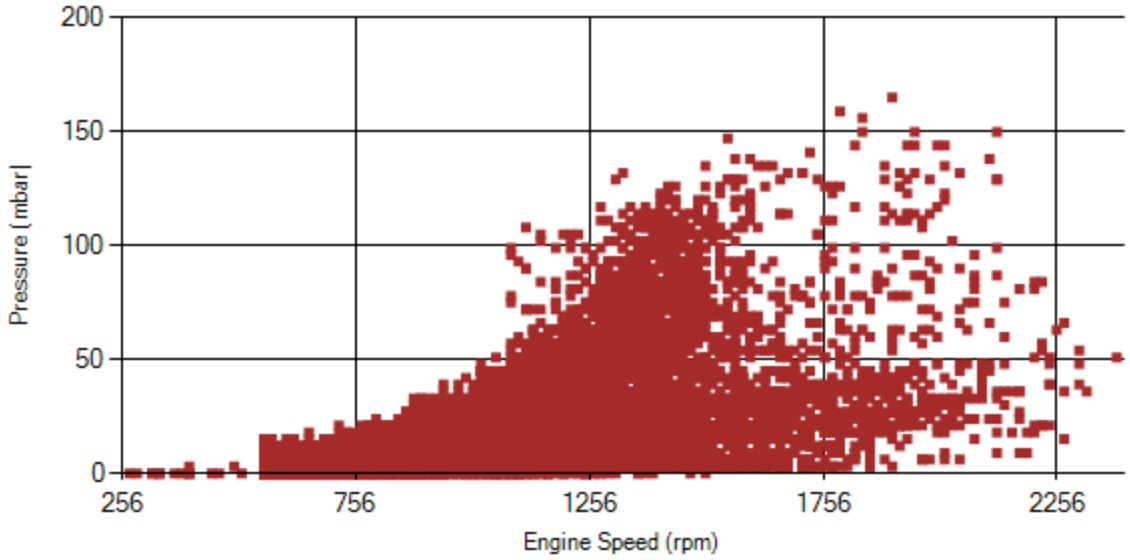



*Figure 13- Pressure against engine speed*

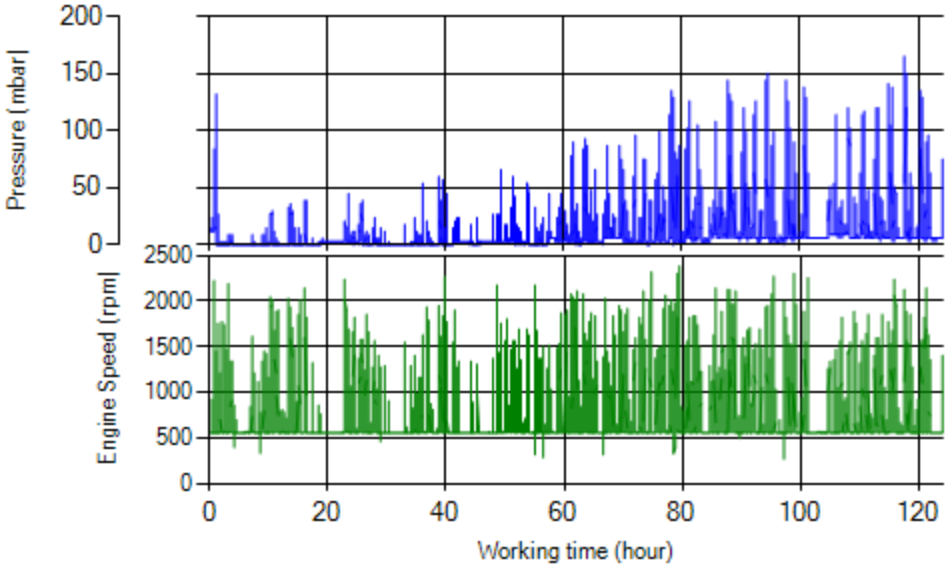



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

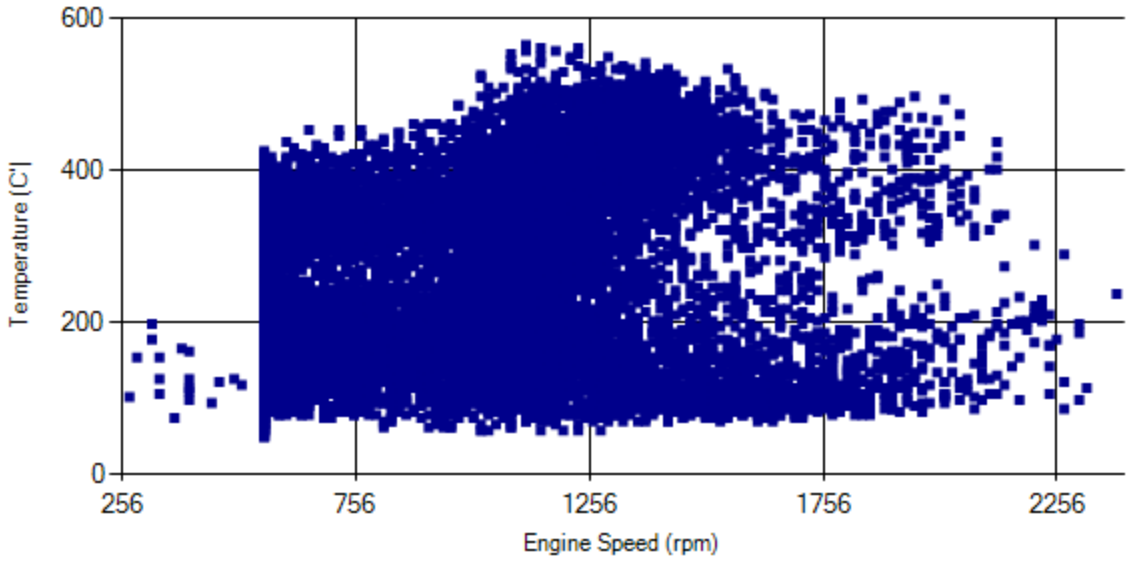



*Figure 15- Temperature against engine speed*

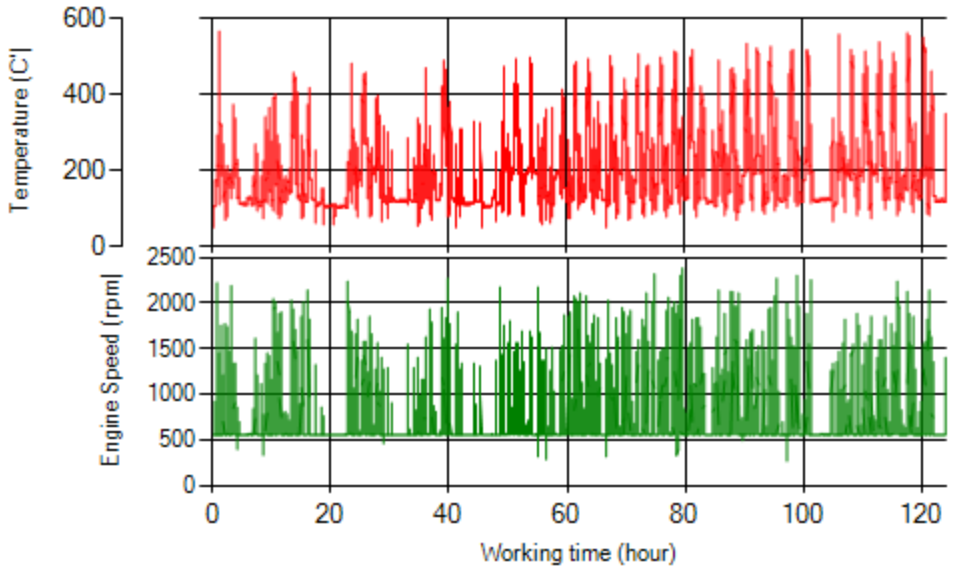



*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

- As depicted in figure 1, only 0.01% of working time pressure was above 150 mbar.
- It can be obviously observed that 5.5% of total working-time temperature is above 400 ℃ and 9.9% above 350℃.

| | | |
|---|---|---|
| Filter operation status | Excellent ■ | Good ☐ |
| | Maintenance required ☐ | Failed☐ |

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 85476 |
| CPK data logger number | LN: 001508, DN: 2003, Sim +989218469624 |
| Bus line | Number 10 (south to north Bus line) |
| Bus Terminals | Azadi square - Daneshgah square |
| Total path distance | 10.7 km |
| DPF producer company | HJS_04 (Passive system with FBC) |
| Installation date | 23/Feb/2015 |
| Report period | 16/Mar/2016 – 31/Mar/2016 (Sixteen days) |
| K value - DPF upstream | 1.90 [1/m] |
| K value – DPF downstream | 0.02 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | DPF was cleaned on 22nd Jul for the first time and on 15th Dec for the second time after 44355 km mileage from installation date. |
| Dosing status | Dosing value has been kept constant from installation date until now. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 57194 km |
| Bus mileage over the period | 1960 km |
| Working days over the period | 11 days |
| Stop days | 5 days |
| Data logger working days | 11 days |
| Working hours over the period | 170 hours 30 minutes |
| Average working hours per day (including stop days) | 10 hours 39 minutes |
| Bus average speed | 11.5 km/hr |
| idle speed time to all working time ration | 65.78 % |
| Total Bus fuel consumption over the period | 1176 lit |
| Fuel consumption per hour | 6.9 lit/hr |
| Average fuel consumption | 0.6 lit/km |
| Total Bus additive consumption over the period | 0.55 lit |
| Average additive consumption | 280 cc/km |
| Additive consumption to fuel ration | 469 cc/1000lit |

## Temperature, Pressure and Engine Speed Overview

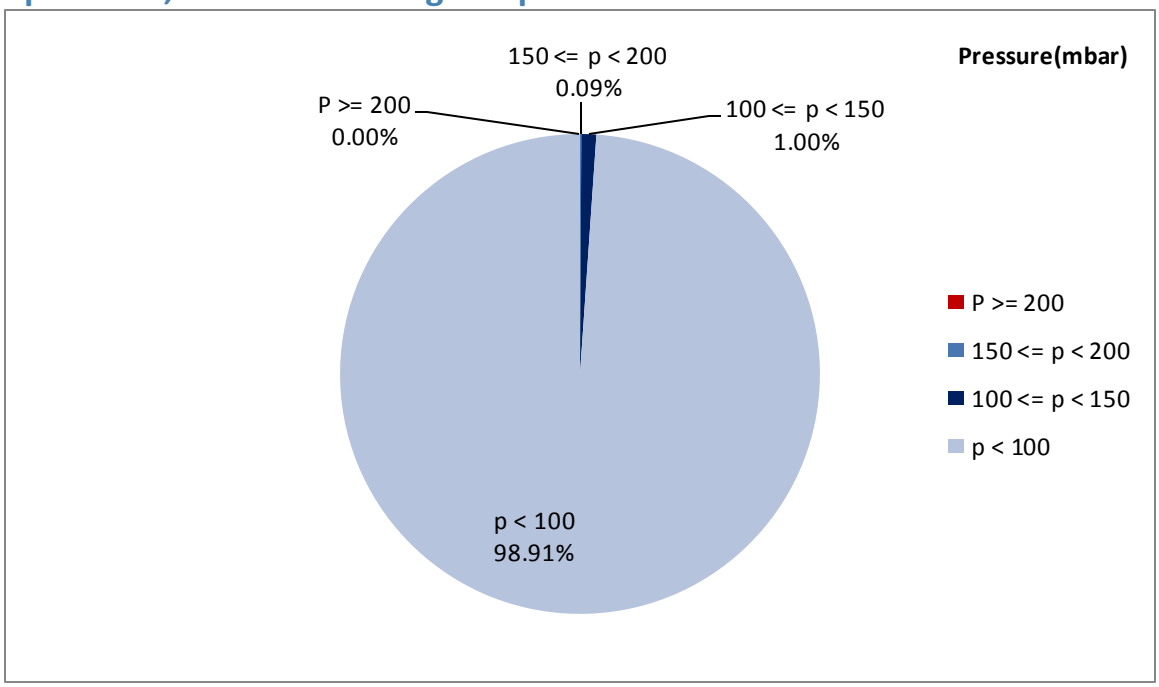



*Figure 1- Pressure distribution over the working hours*

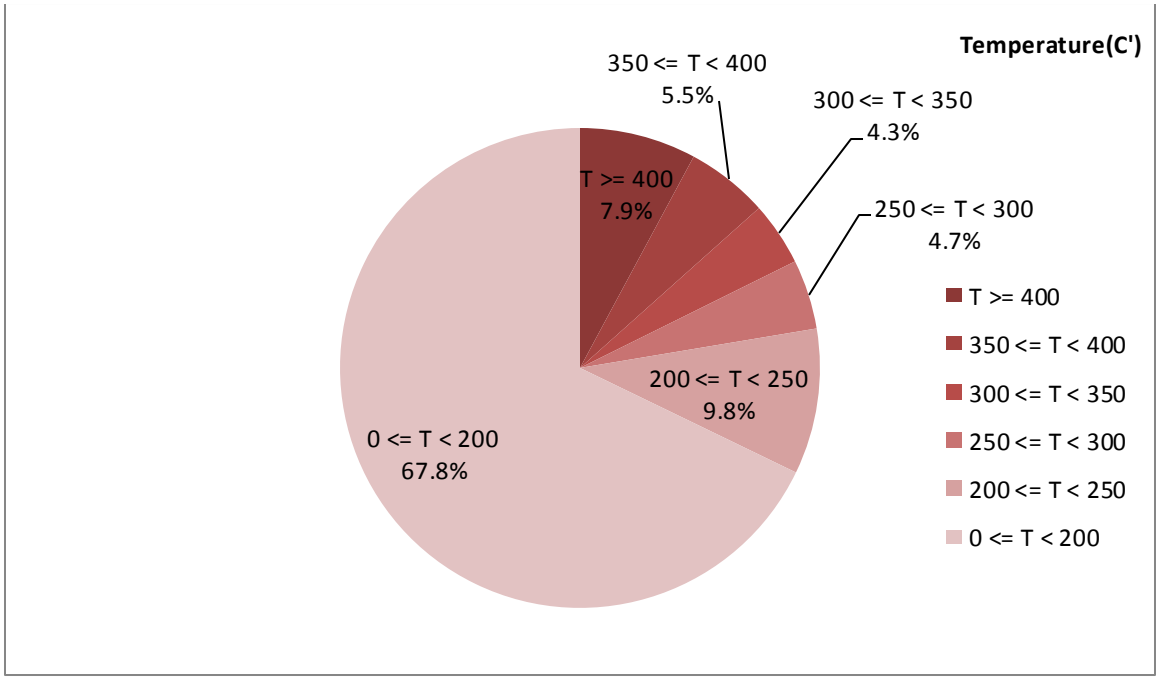



*Figure 2-Temperature distribution over the working hours*

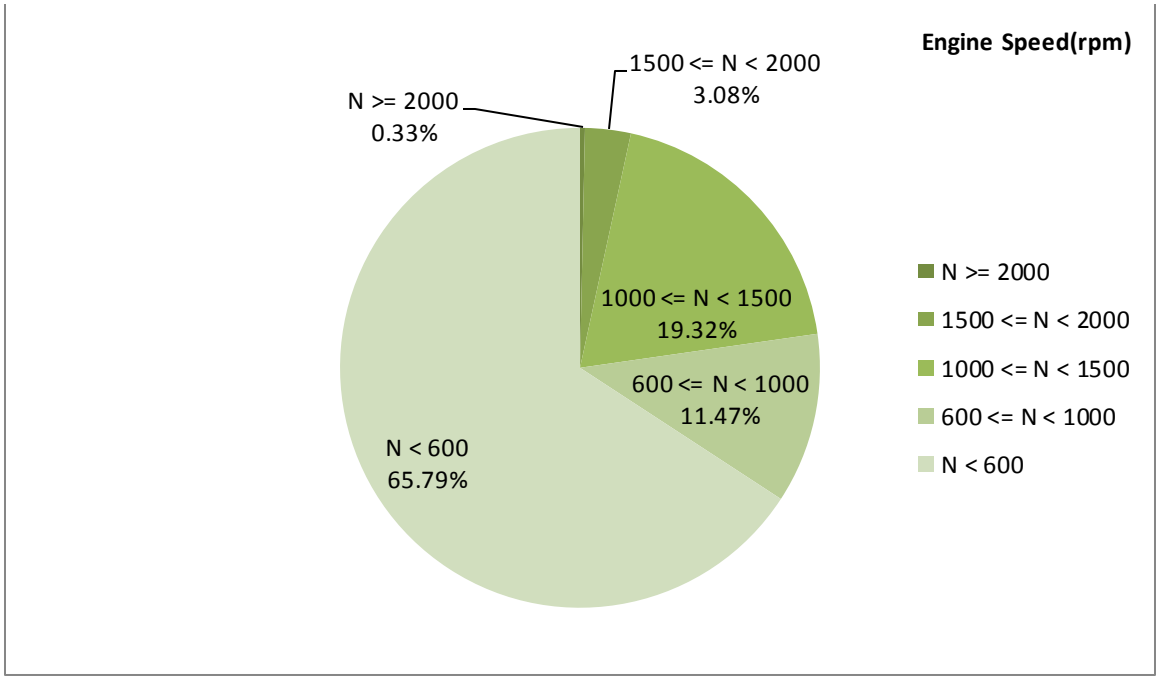



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 207.17 | 15.11 | 753 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 276.65 | 32.27 | 1119 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 578-50 | 177-3 | 2336-336 |

## Detailed Pressure Analysis

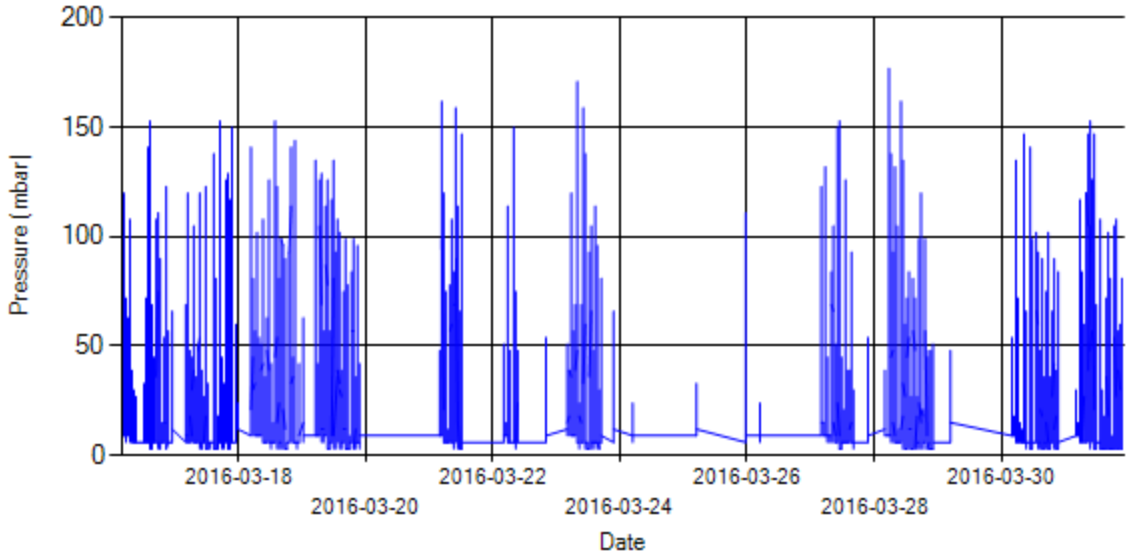



*Figure 4- Pressure distribution over the period*

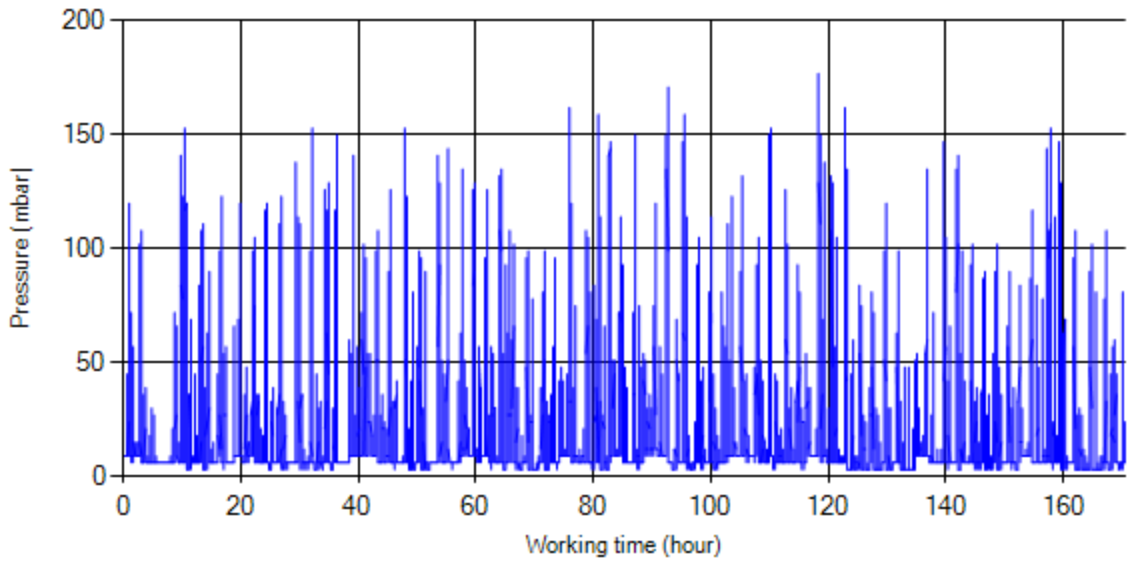



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

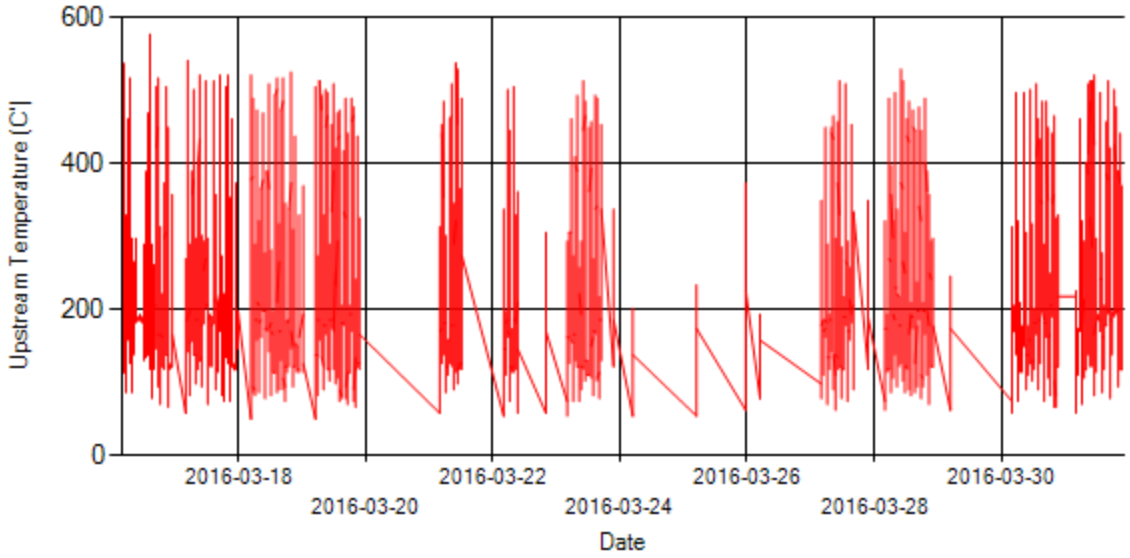



*Figure 6- Temperature distribution over the period*

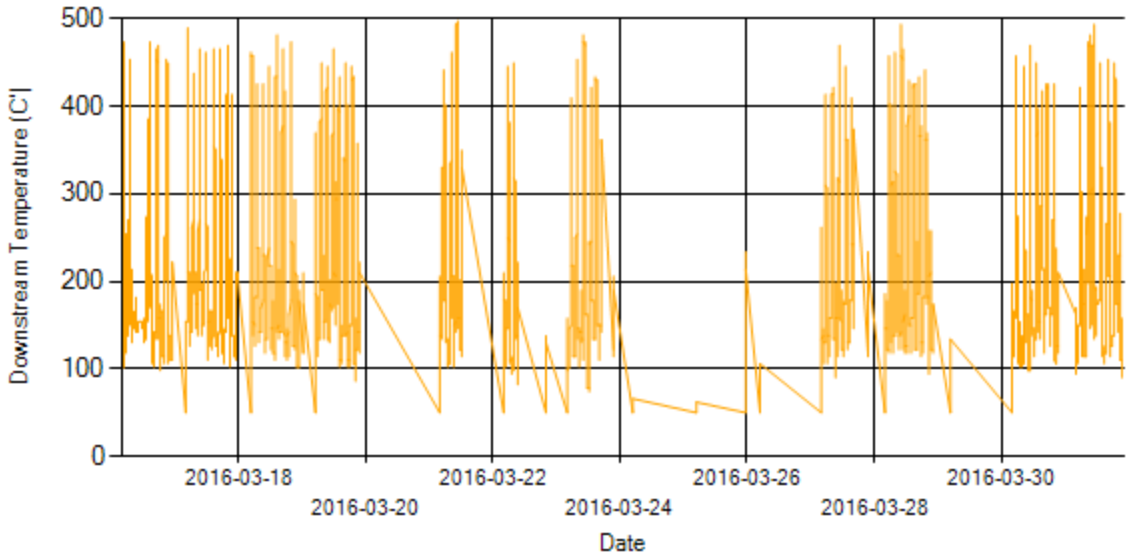



*Figure 7- Temperature distribution over the period*

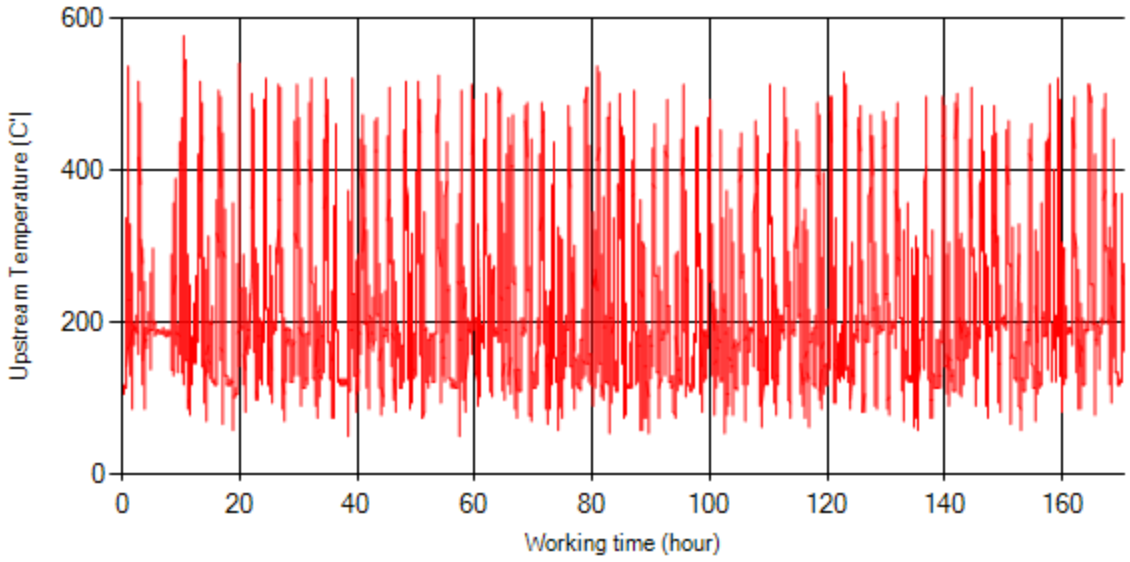



*Figure 8- Temperature vs. working hours*

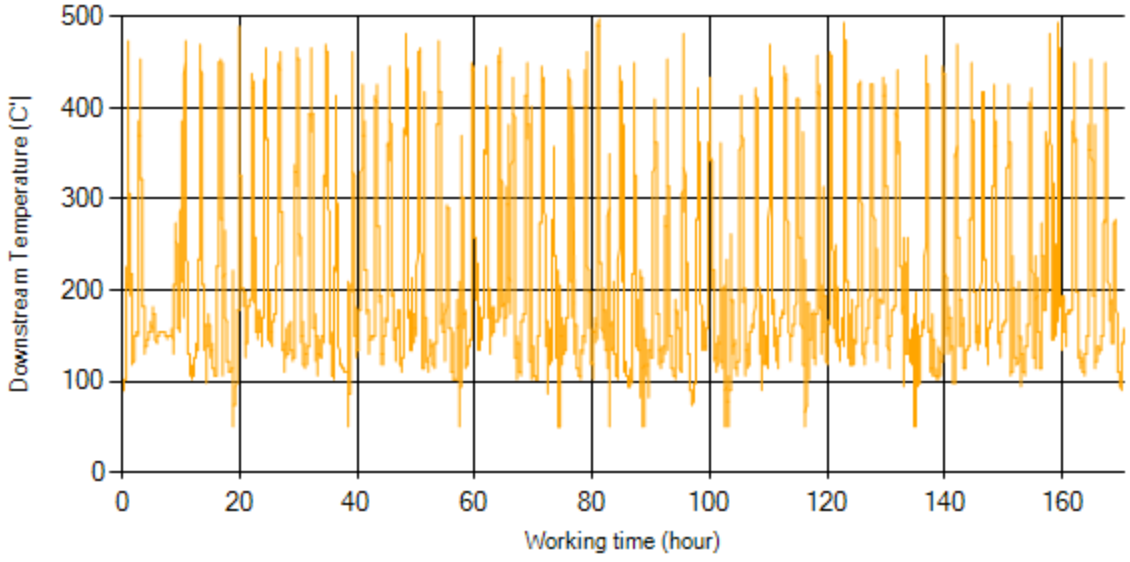



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

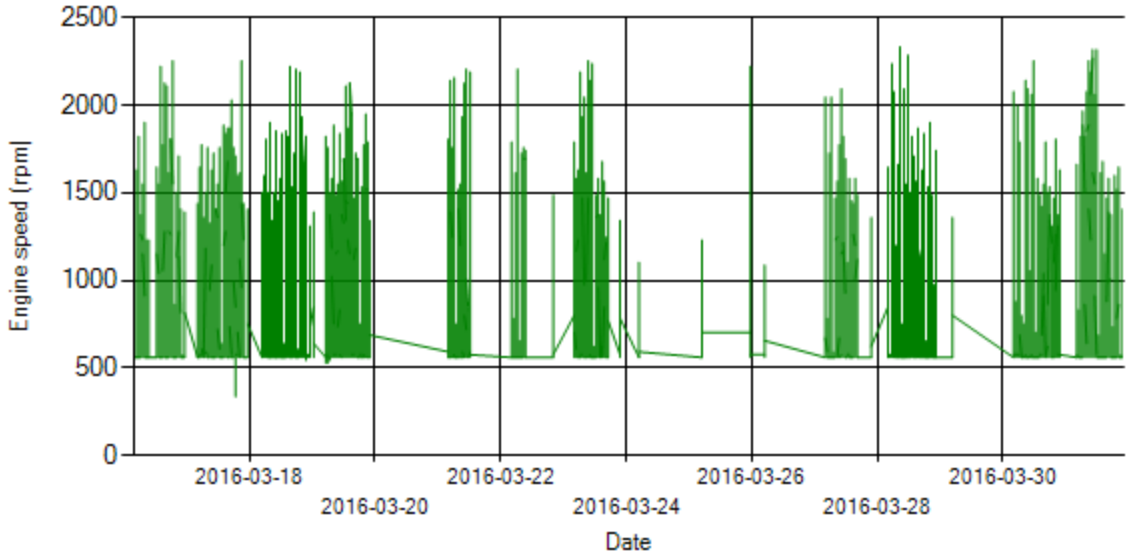



*Figure 10- Engine speed distribution over the period*

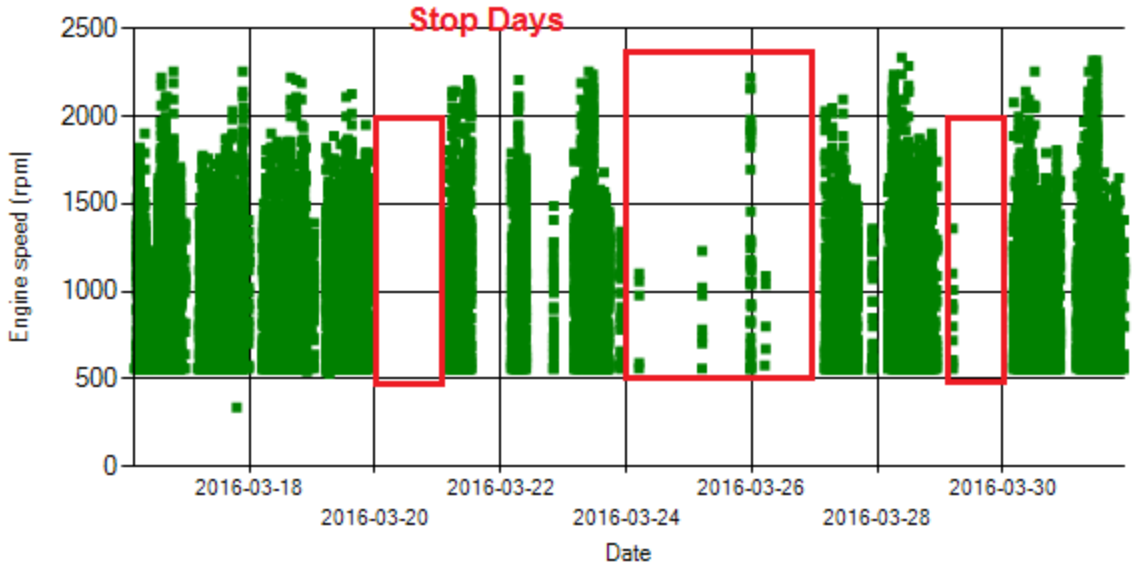



*Figure 11- Engine speed diagram for calculating CPK's working days*

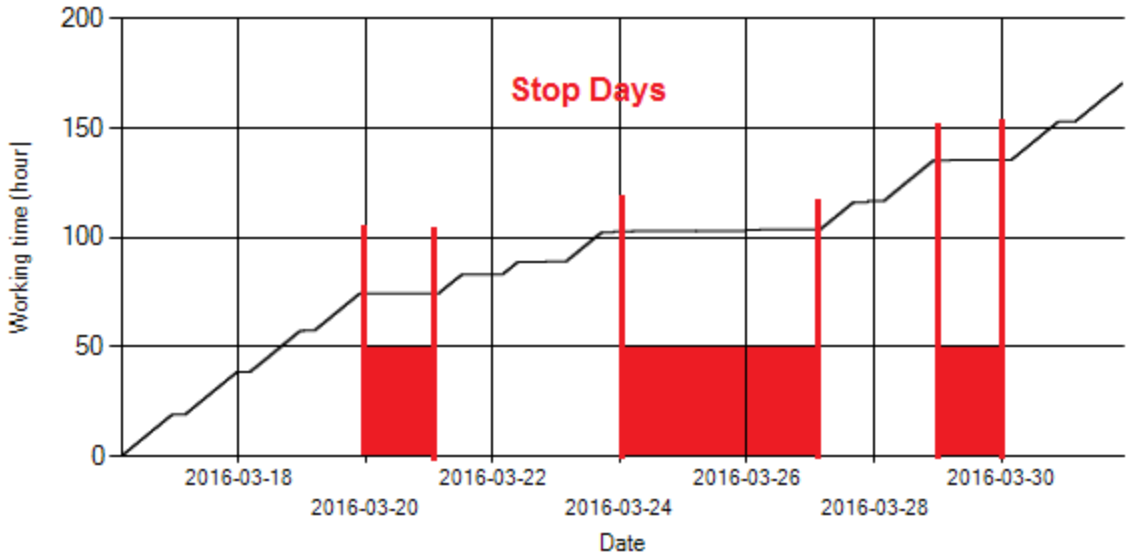



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data.

## Pressure-Engine Speed diagrams

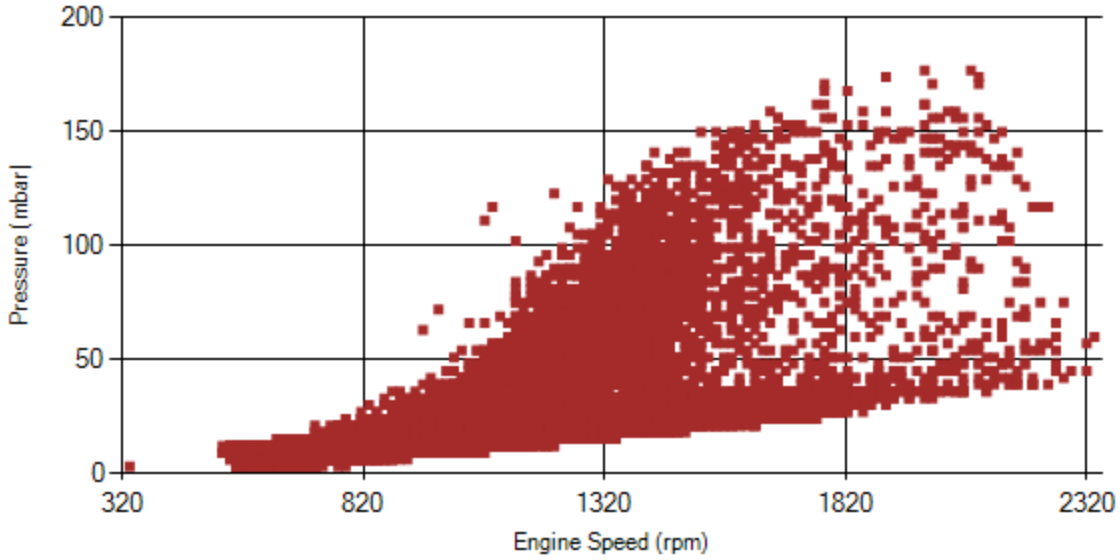



*Figure 13- Pressure against engine speed*

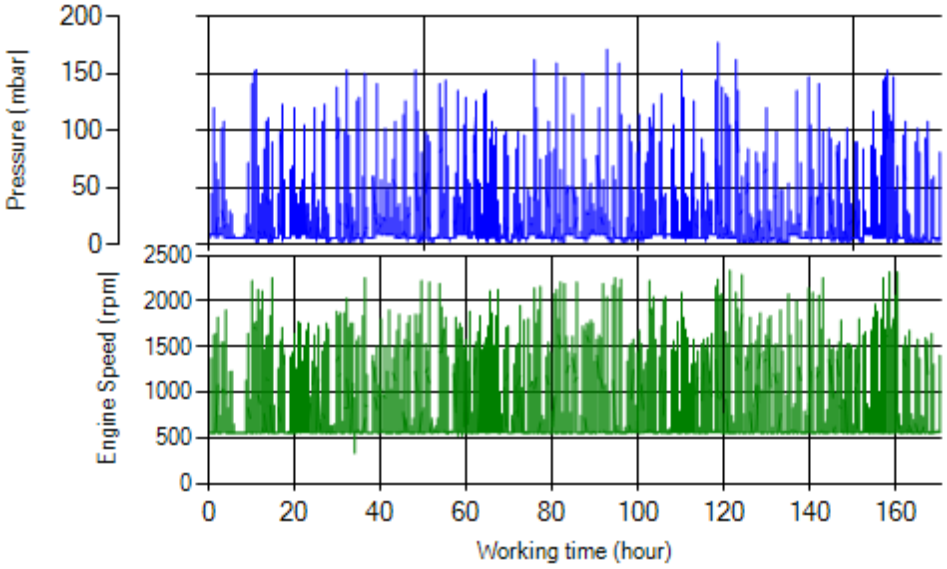



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

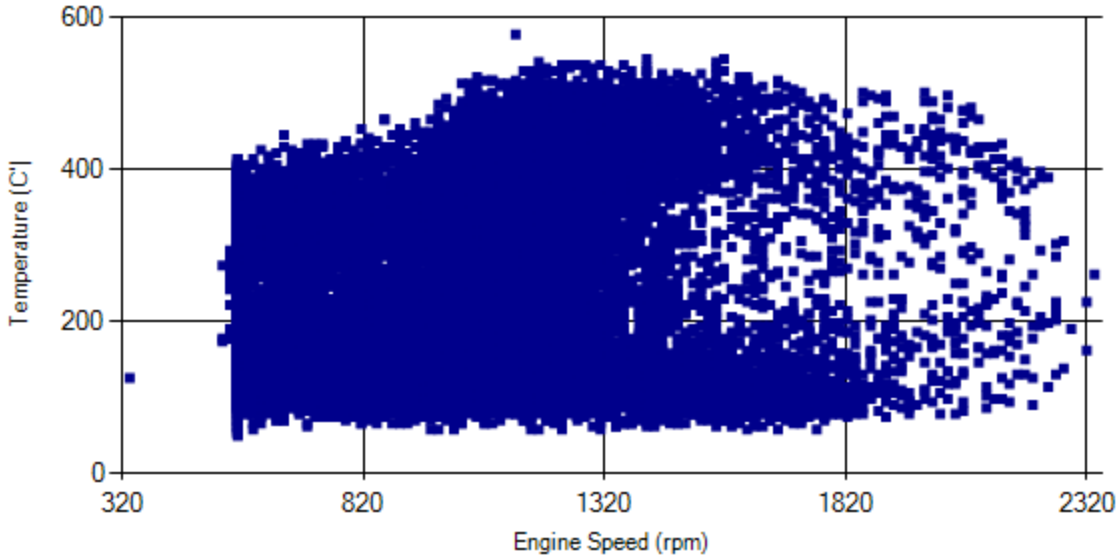



*Figure 15- Temperature against engine speed*

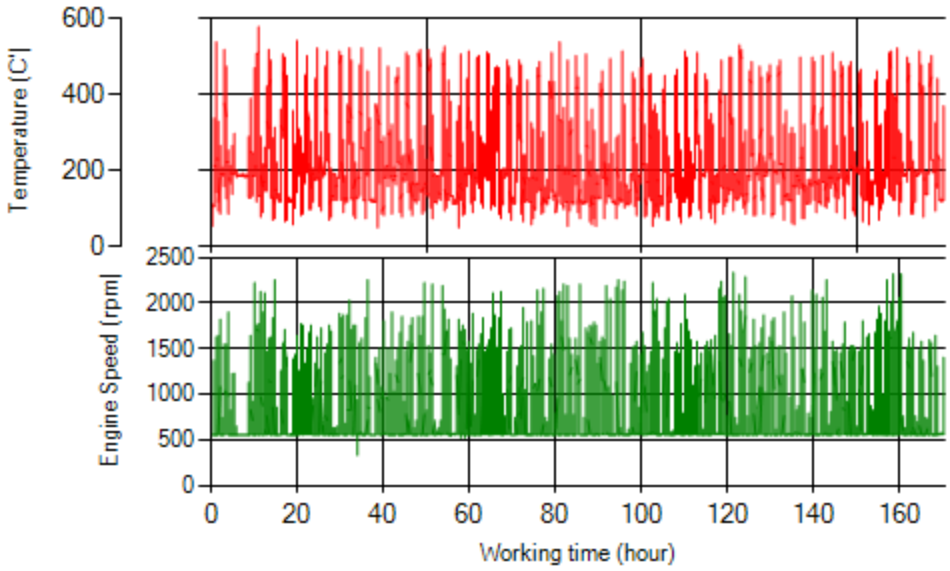


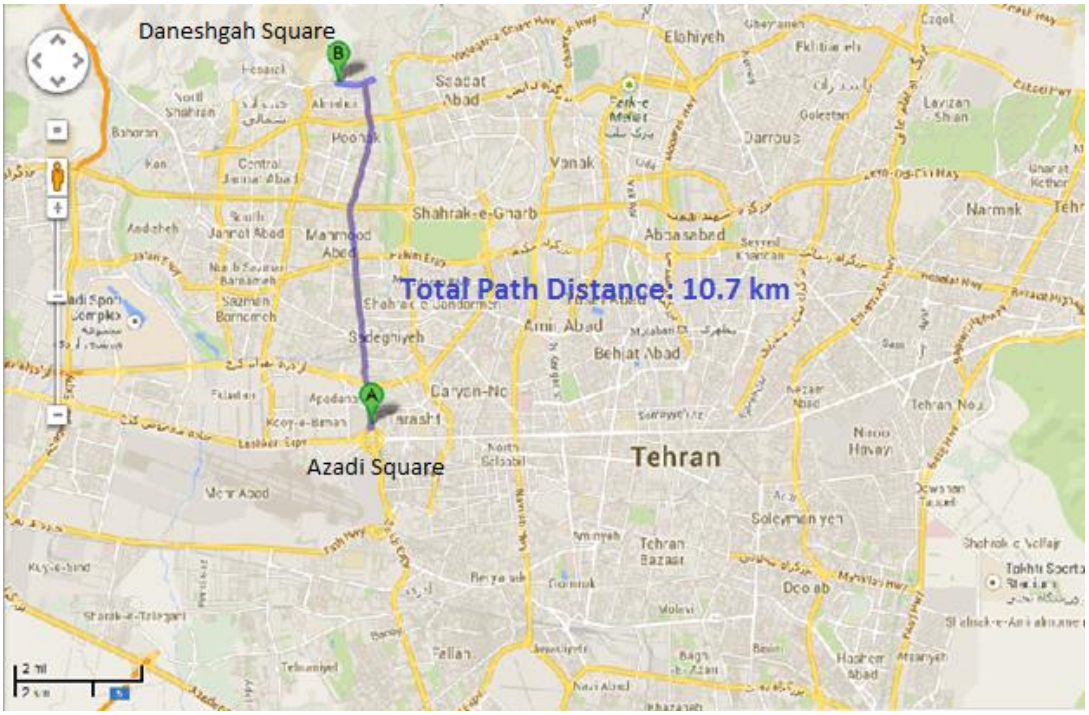

*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

- As depicted in figure 1, only 0.09% of working time pressure was above 150 mbar.
- It can be obviously observed that 7.9% of total working-time temperature is above 400 ℃ and 13.4% above 350℃.

| | | |
|---|---|---|
| Filter operation status | Excellent ■ | Good ☐ |
| | Maintenance required ☐ | Failed☐ |

| | |
|---|---|
| Vehicle plate number | 85182 |
| Bus line | Number 10 (south to north Bus line) |
| DPF producer company | Tehag_01 (Catalyzed DPF) |



## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 85182 |
| CPK data logger number | LN: 001502, DN: 1999 |
| Bus line | Number 10 (south to north Bus line) |
| Bus Terminals | Azadi square - Daneshgah square |
| Total path distance | 10.7 km |
| DPF producer company | Tehag_01 (Catalyzed DPF) |
| Installation date | 24/Sep/2015 |
| Report period | 01/Mar/2016 – 15/Mar/2016 (fifteen days) |
| K value - DPF upstream | 1.80 [1/m] |
| K value – DPF downstream | 0.04 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | Filter have been working from installation date without any cleaning. |
| Dosing status | This system doesn't use additive. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 8341 km |
| Bus mileage over the period | 352 km |
| Working days over the period | 8 days |
| Stop days | 7 days |
| Data logger working days | 8 days |
| Working hours over the period | 69 hours 7 minutes |
| Average working hours per day (including stop days) | 4 hours 36 minutes |
| Bus average speed | 5.1 km/hr |
| idle speed time to all working time ration | 81.49 % |
| Total Bus fuel consumption over the period | 253 lit |
| Fuel consumption per hour | 3.6 lit/hr |
| Average fuel consumption | 0.72 lit/km |

## Temperature, Pressure and Engine Speed Overview

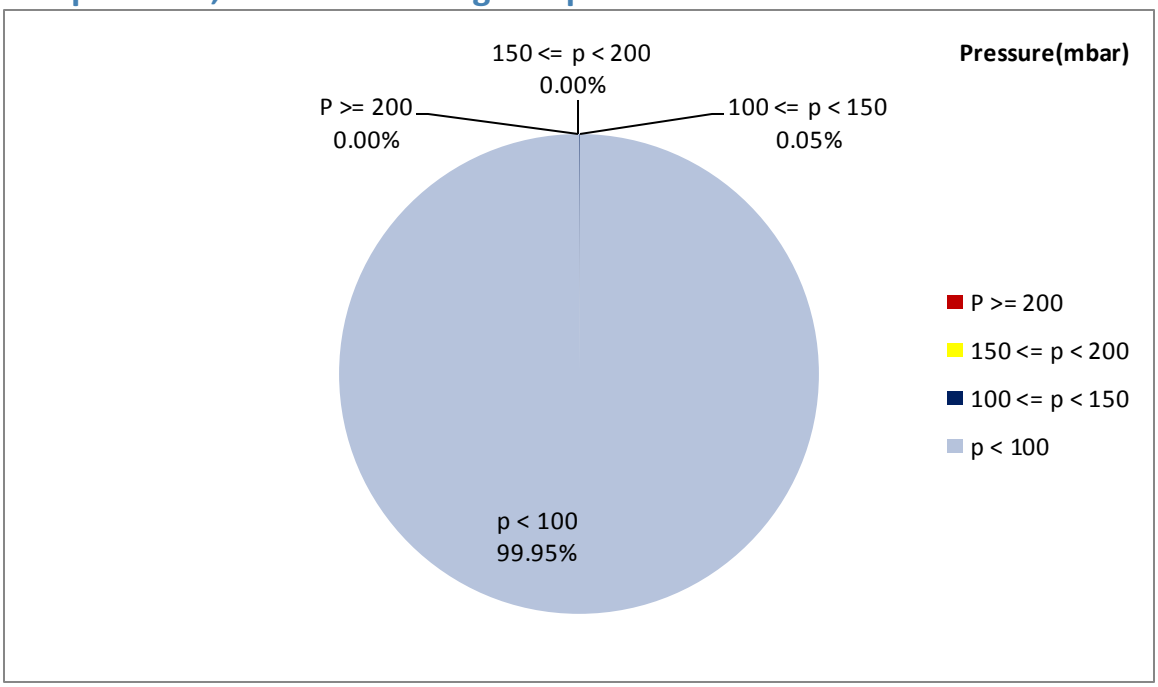



*Figure 1- Pressure distribution over the working hours*

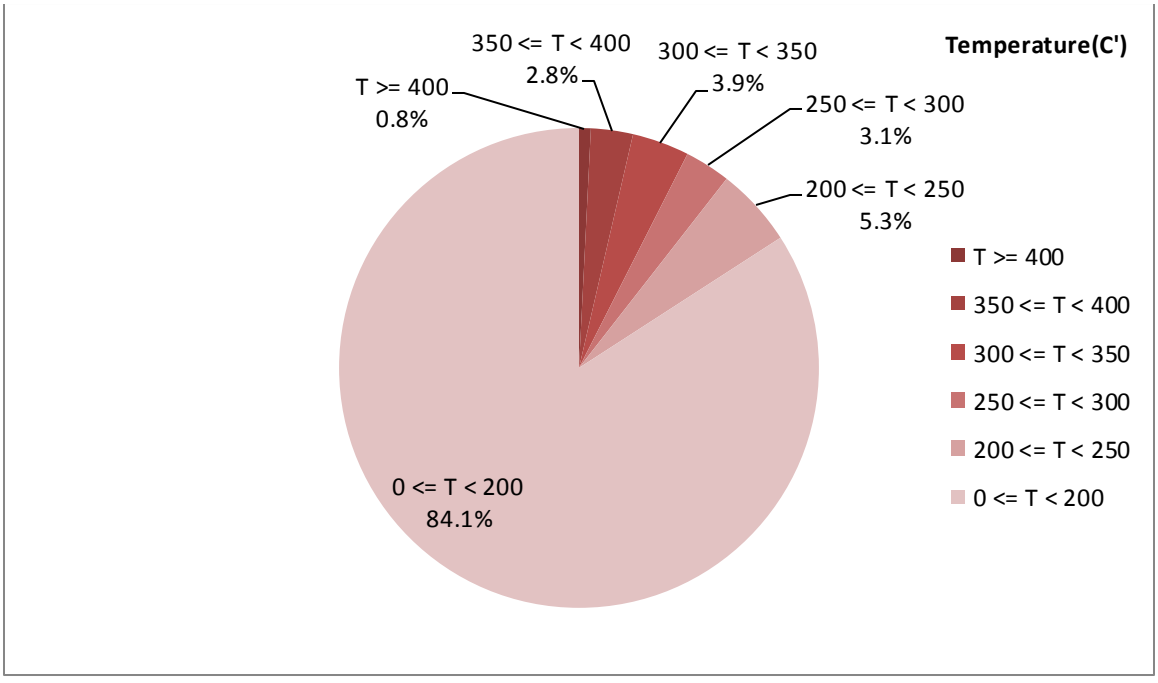



*Figure 2-Temperature distribution over the working hours*

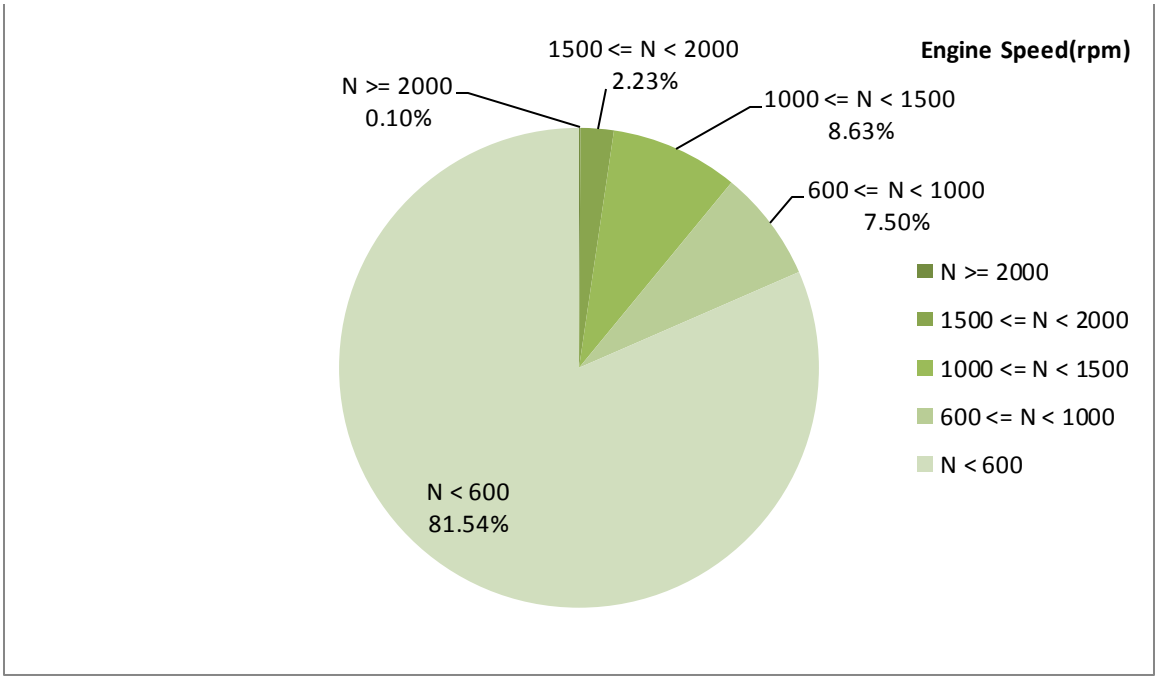



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 153.24 | 3.17 | 657 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 241.97 | 14.89 | 1104 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 454-50 | 114-0 | 2224-272 |

## Detailed Pressure Analysis

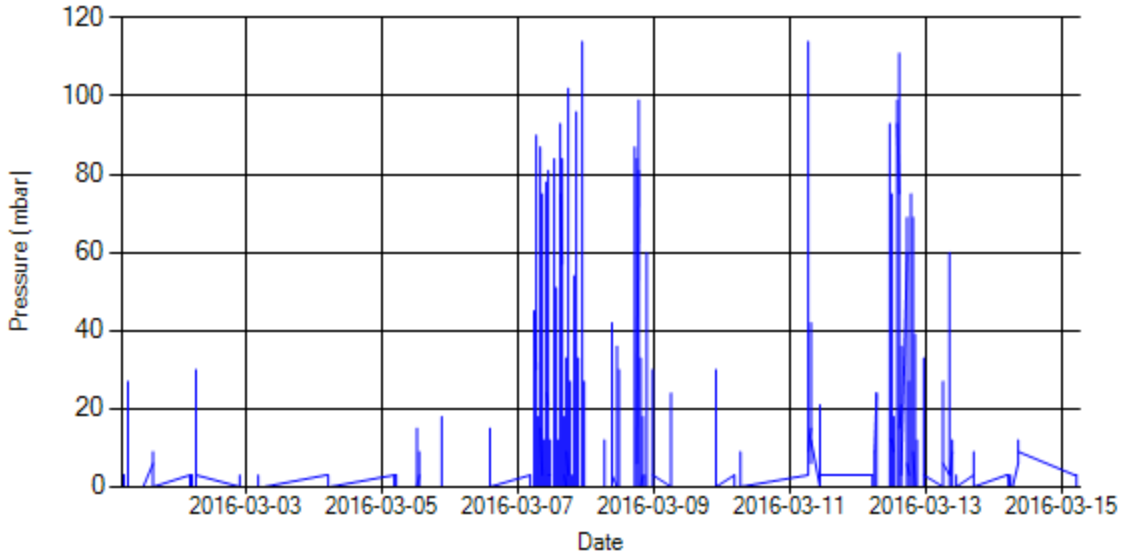



*Figure 4- Pressure distribution over the period*

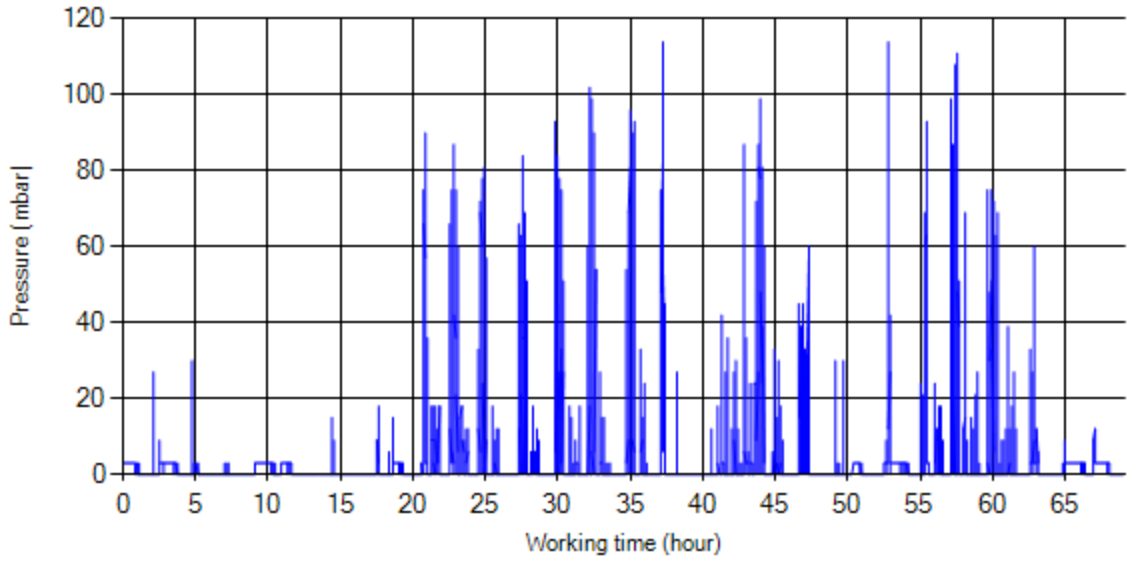



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

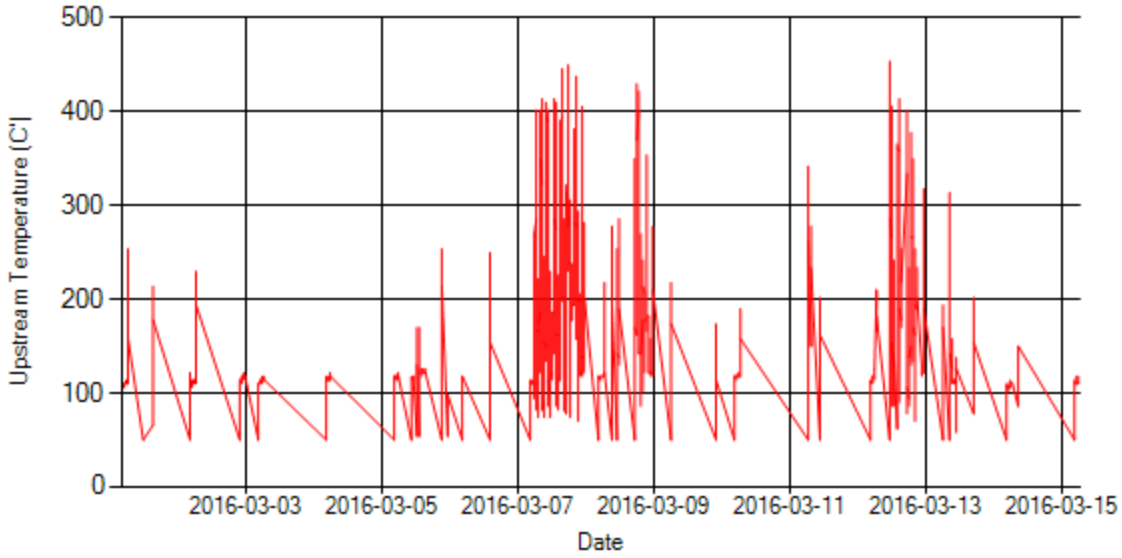



*Figure 6- Temperature distribution over the period*

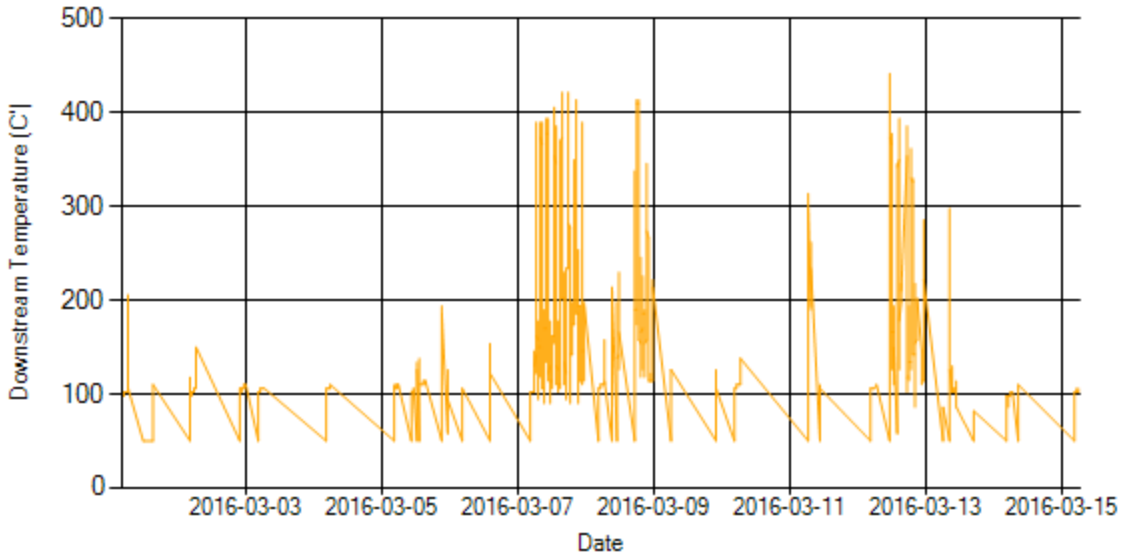



*Figure 7- Temperature distribution over the period*

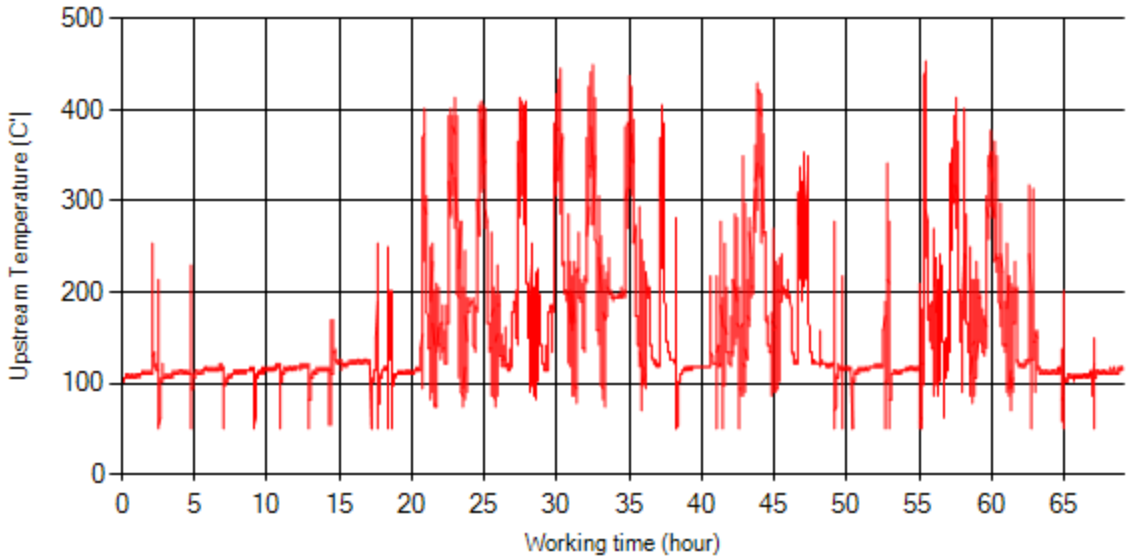



*Figure 8- Temperature vs. working hours*

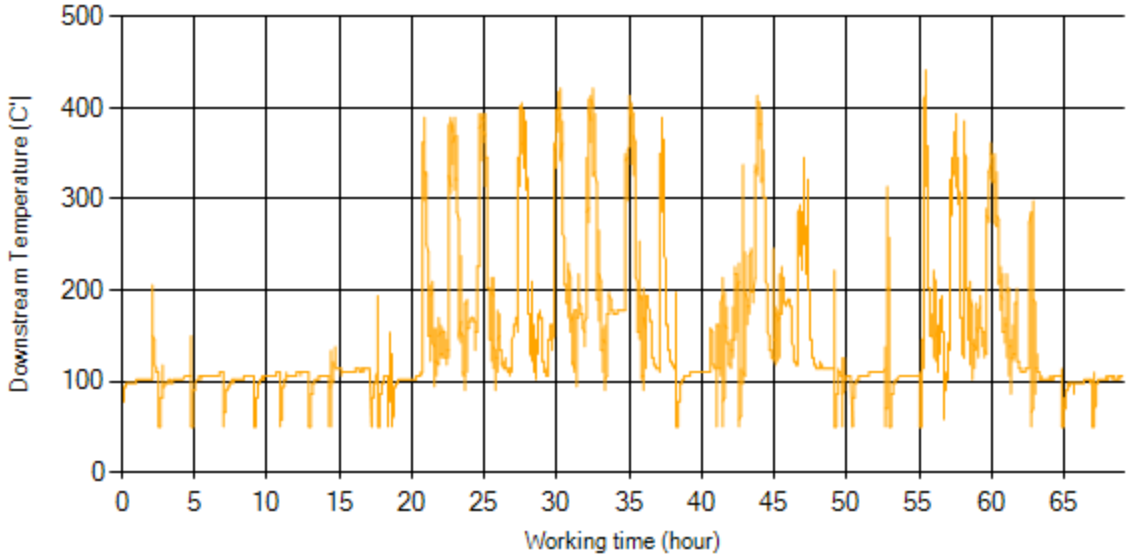



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

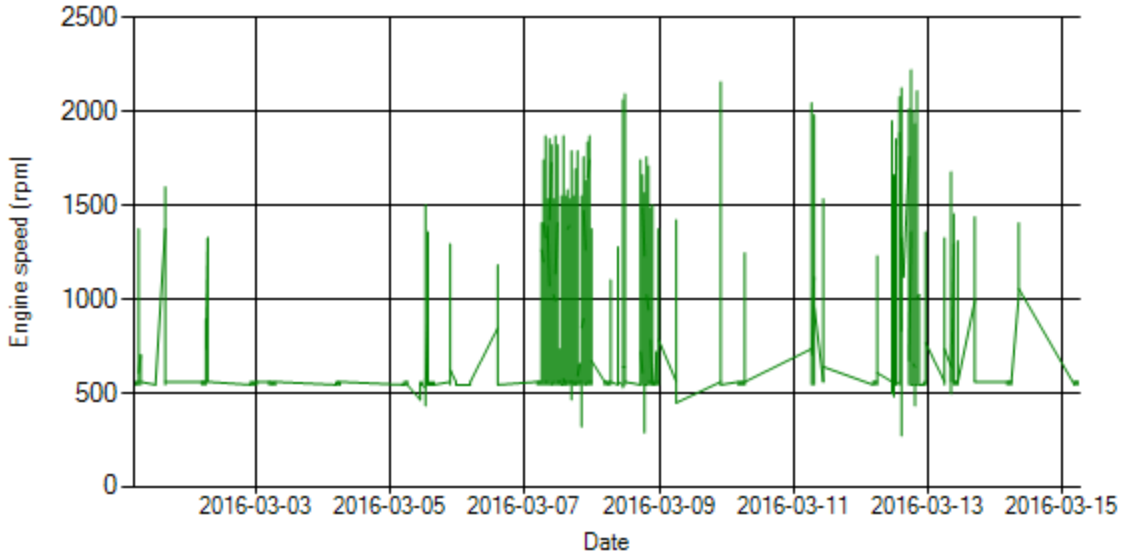



*Figure 10- Engine speed distribution over the period*

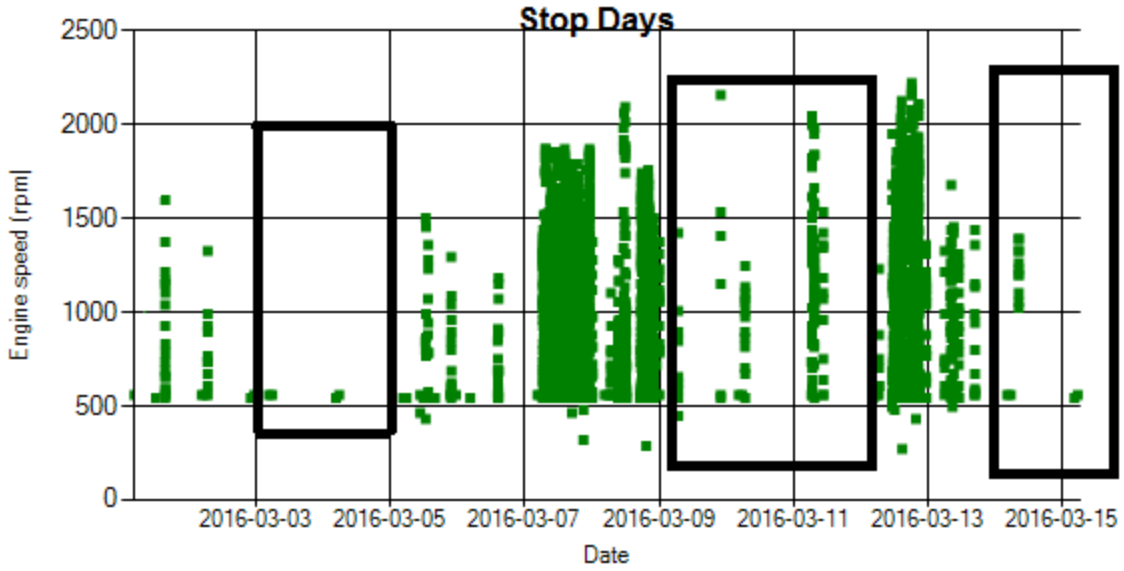



*Figure 11- Engine speed diagram for calculating CPK's working days*

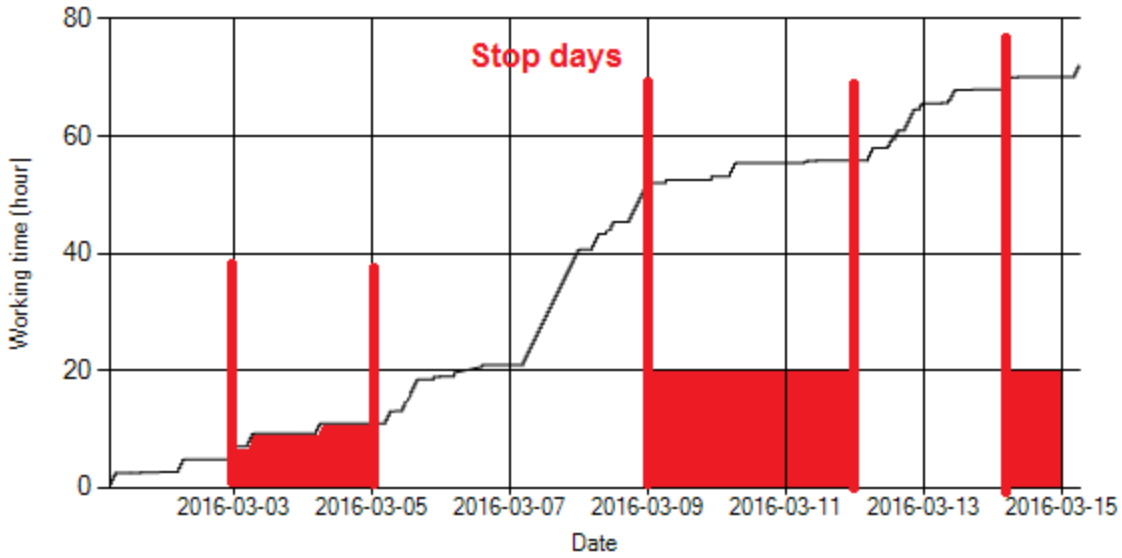



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data. As depicted in Figure 12, bus was stationary for 7 days during this period.

## Pressure-Engine Speed diagrams

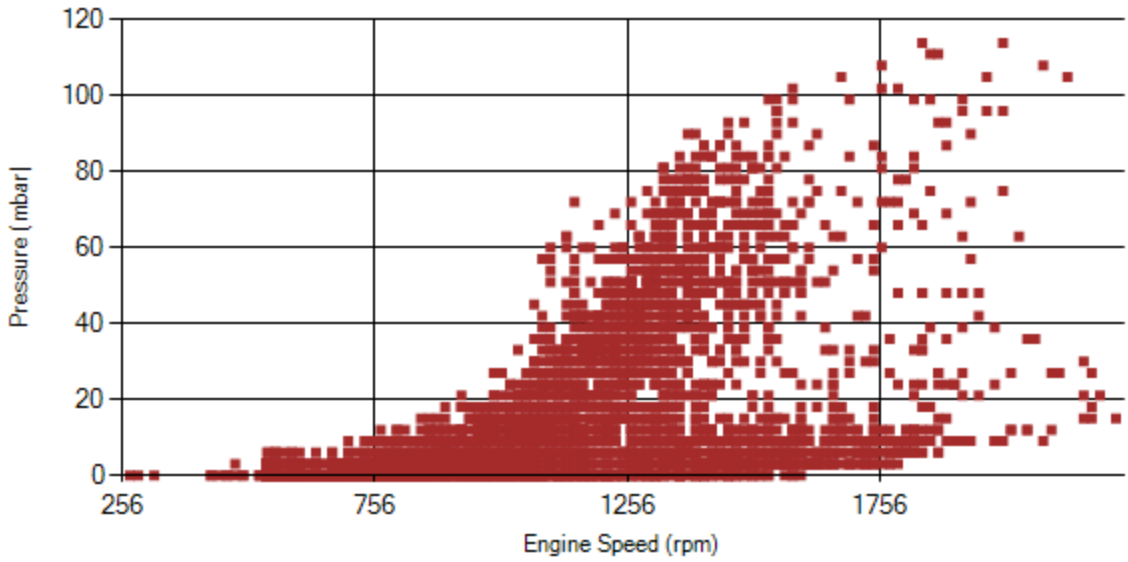



*Figure 13- Pressure against engine speed*

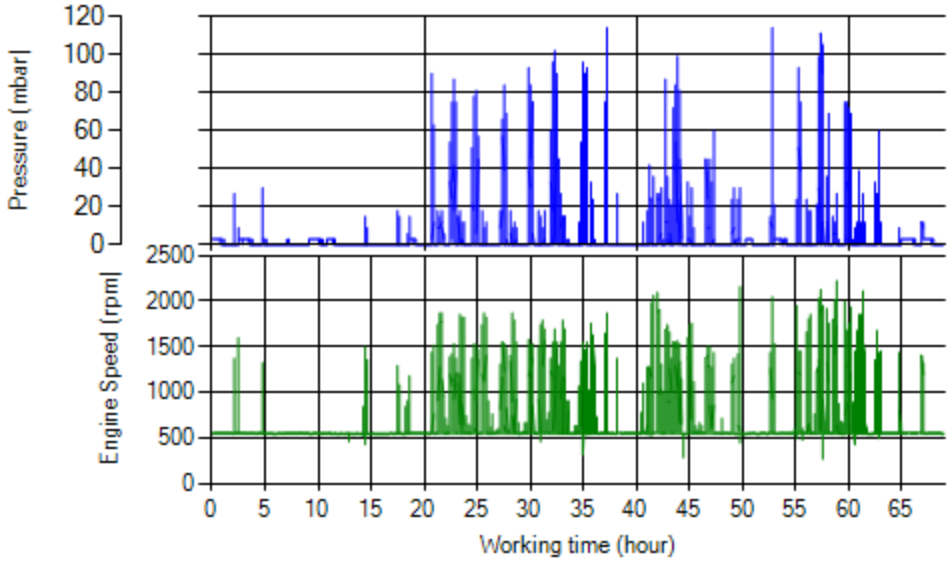



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

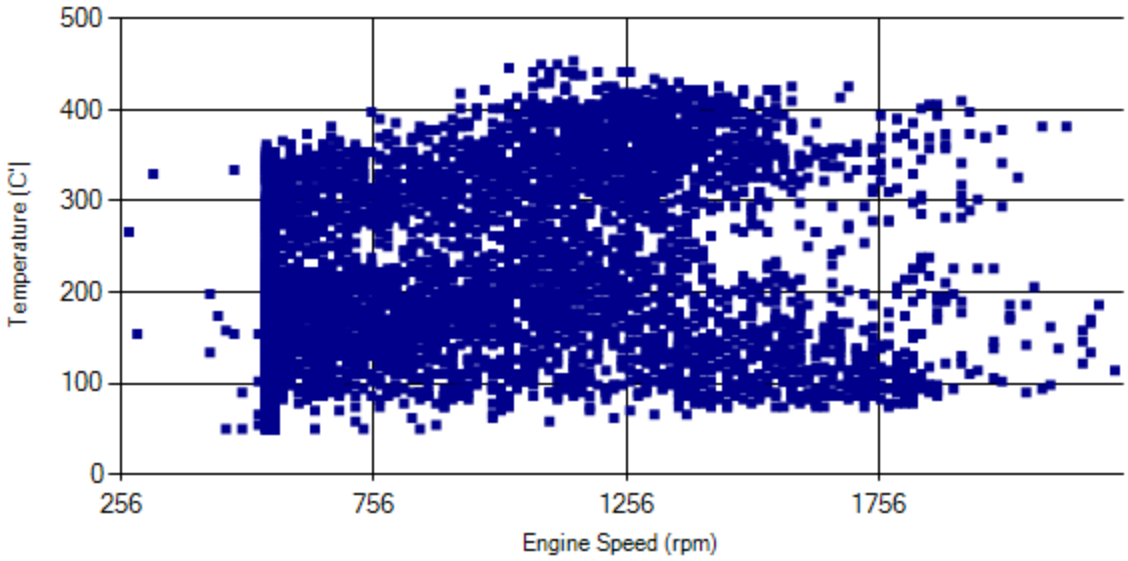



*Figure 15- Temperature against engine speed*

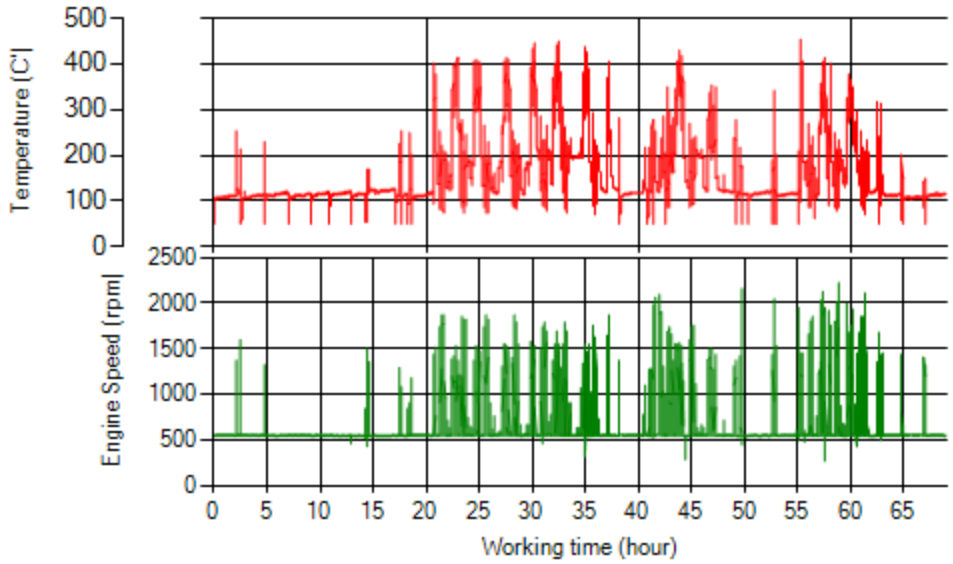



*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

- As depicted in figure 1, only 0.05% of working time pressure was above 100 mbar during this period.
- Figure 2 display flow temperature distribution for DPF's upstream. It can be obviously observed that 3.6% of total working-time temperature is above 350 ℃ and 10.6% above 250℃. This low temperature distribution was because of high idle ratio (81%).

| | | |
|---|---|---|
| Filter operation status | Excellent ■ | Good ☐ |
| | Maintenance required ☐ | Failed☐ |

| | |
|---|---|
| ASA Azmoon Sanat Arvin | Document Number: DPF2016031/1<br>Date: 10/Apr/2016 |

## Overall Information

*Table1- Overall Information*

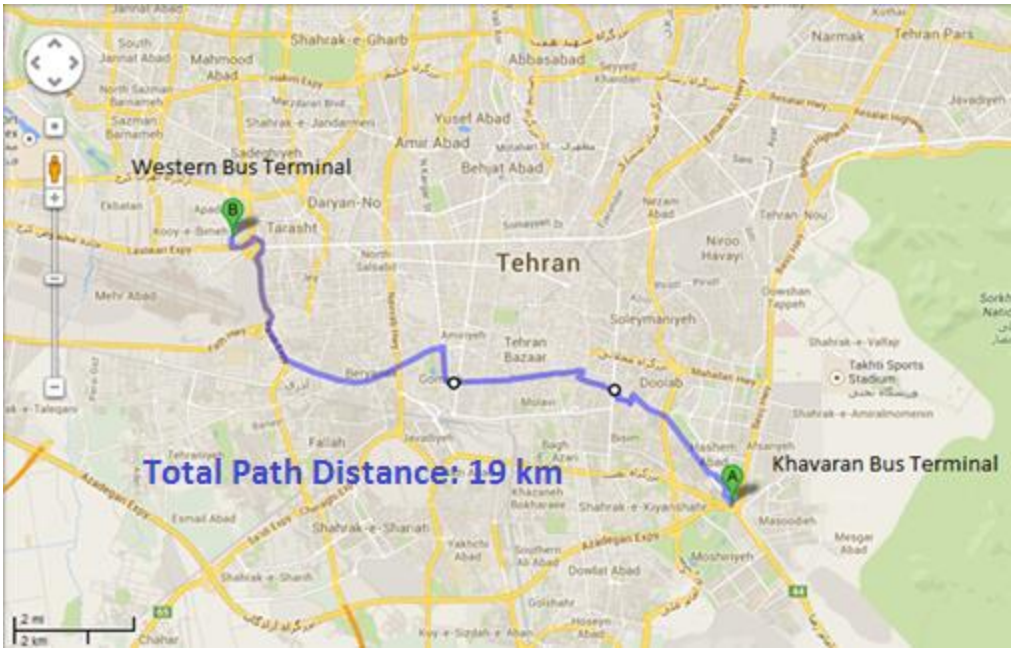
| | |
|---|---|
| Vehicle plate number | 85182 |
| CPK data logger number | LN: 001502, DN: 1999 |
| Bus line | Number 10 (south to north Bus line) |
| Bus Terminals | Azadi square - Daneshgah square |
| Total path distance | 10.7 km |
| DPF producer company | Tehag_01 (Catalyzed DPF) |
| Installation date | 24/Sep/2015 |
| Report period | 16/Mar/2016 – 31/Mar/2016 (sixteen days) |
| K value - DPF upstream | 1.80 [1/m] |
| K value – DPF downstream | 0.04 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | Filter have been working from installation date without any cleaning. |
| Dosing status | This system doesn't use additive. |

**Notice: Bus was stationary during this period due to technical problem.**

| | |
|---|---|
| Vehicle plate number | 33592 (32441) |
| Bus line | Number 2 (west to east bus line) |
| DPF producer company | Tehag_02 (CDPF) |

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 33592 (32441) |
| CPK data logger number | LN: 001506, DN: 1927 |
| Bus line | Number 2 (west to east bus line) |
| Bus Terminals | Khavaran Bus Terminal - Western Bus Terminal |
| Total path distance | 19 km |
| DPF producer company | Tehag_02 (Catalyzed DPF) |
| Installation date | 25/Jan/2016 |
| Report period | 01/Mar/2016-15/Mar/2016 (fifteen days) |
| K value - DPF upstream | 1.65 [1/m] |
| K value – DPF downstream | 0 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | System have been working without any cleaning from installation date. |
| Dosing status | This type do not use FBC. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 3542 km |
| Bus mileage over the period | 500 km |
| Working days over the period | 9 days |
| Stop days | 6 days |
| Data logger working days | 9 days |
| Working hours over the period | 45 hours 9 minutes |
| Average working hours per day (including stop days) | 3 hours 0 minutes |
| Bus average speed | 11.1 km/hr |
| idle speed time to all working time ration | 62.23 % |
| Total Bus fuel consumption over the period | 305 lit |
| Fuel consumption per hour | 6.75 lit/hr |
| Average fuel consumption | 0.62 lit/km |

## Temperature, Pressure and Engine Speed Overview

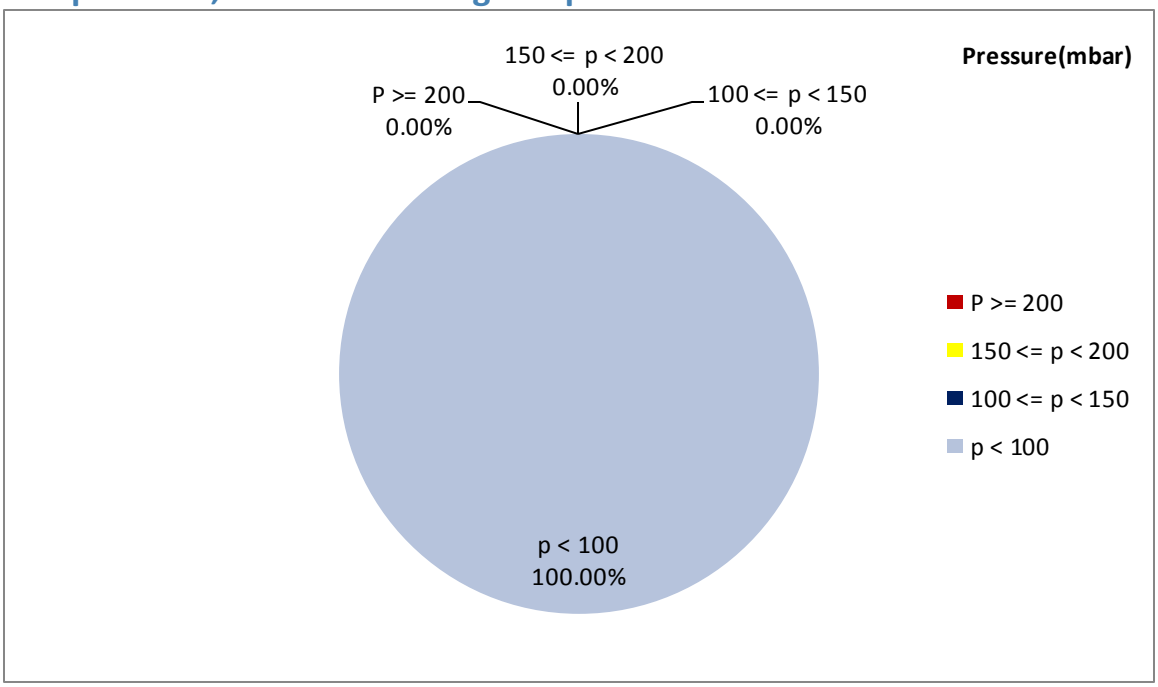



*Figure 1- Pressure distribution over the working hours*

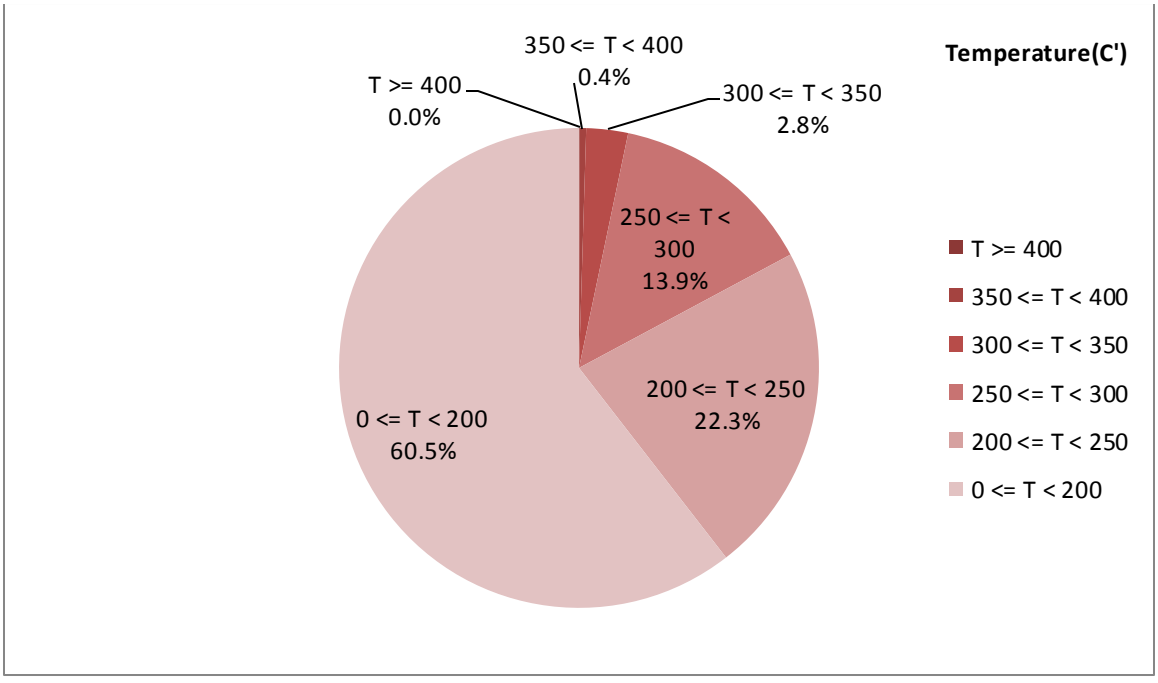



*Figure 2-Temperature distribution over the working hours*

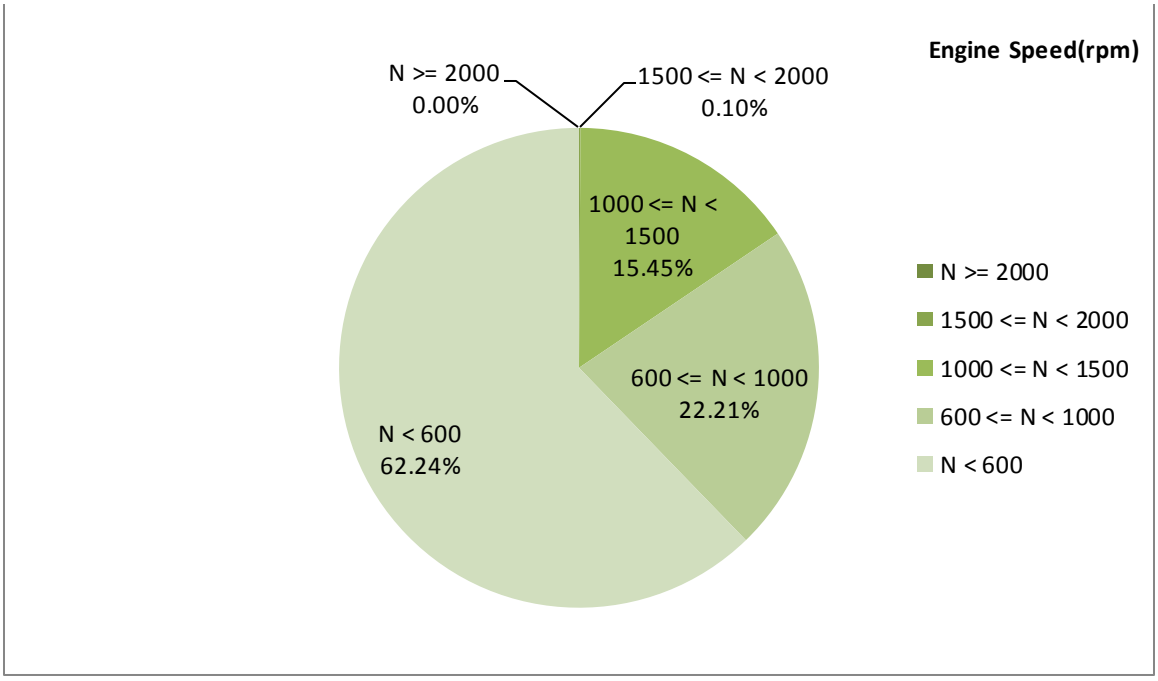



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 181.35 | 4.37 | 686 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 238.65 | 9.95 | 942 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 442-50 | 87-0 | 1984-368 |

## Detailed Pressure Analysis

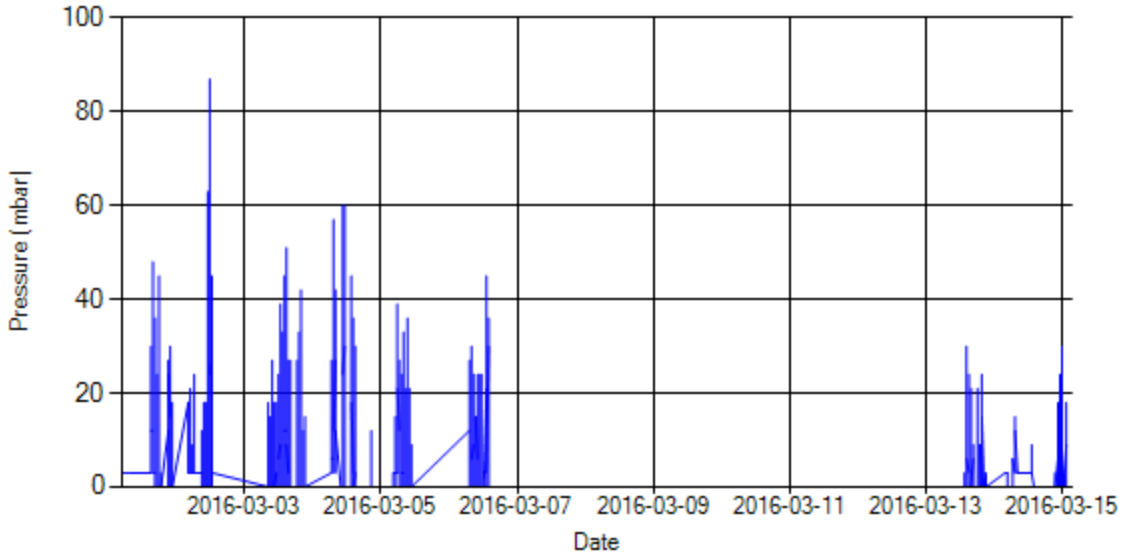



*Figure 4- Pressure distribution over the period*

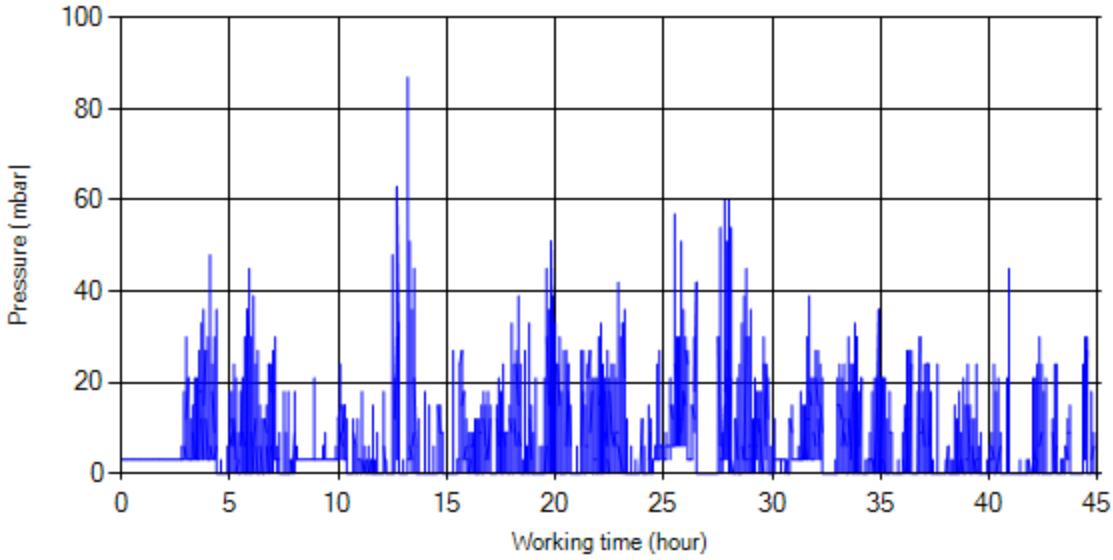



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

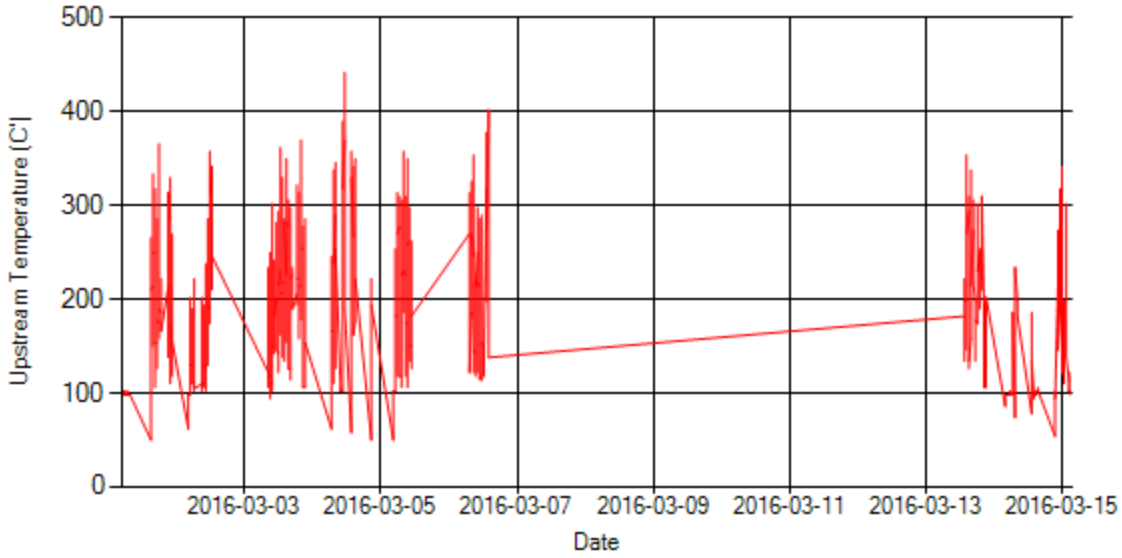



*Figure 6- Temperature distribution over the period*

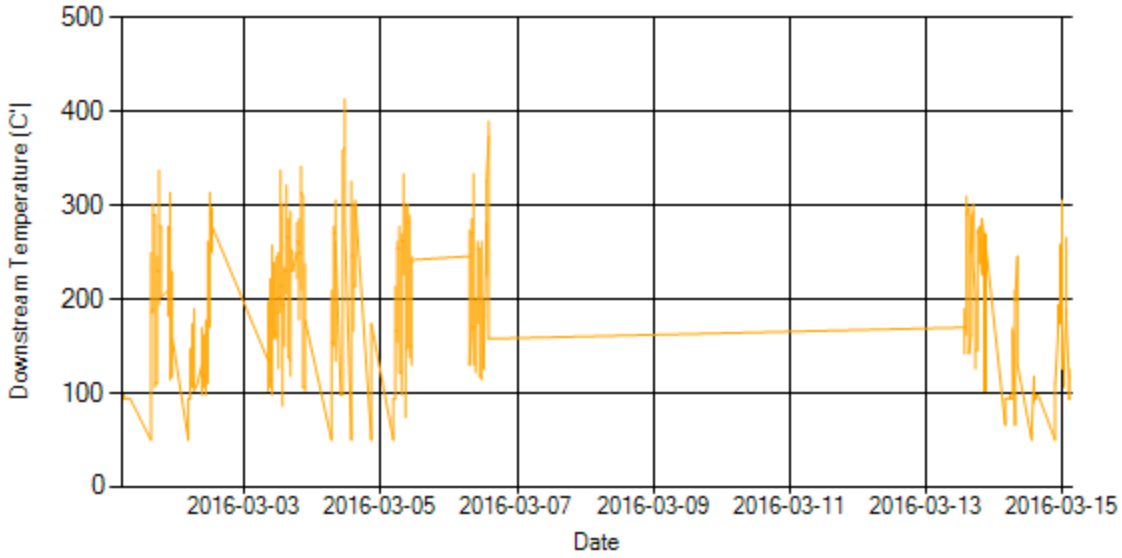



*Figure 7- Temperature distribution over the period*

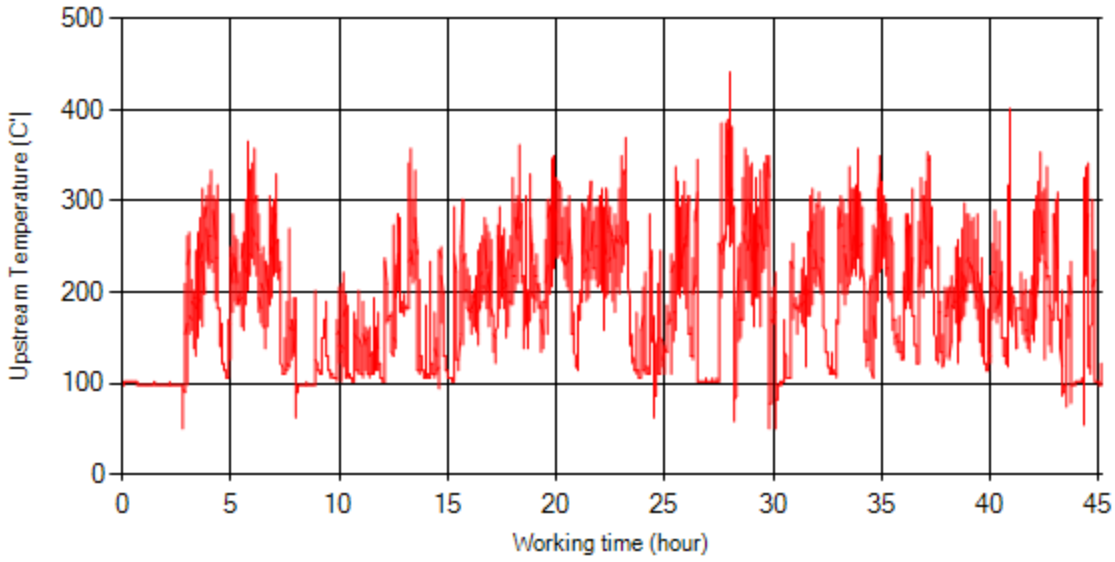



*Figure 8- Temperature vs. working hours*

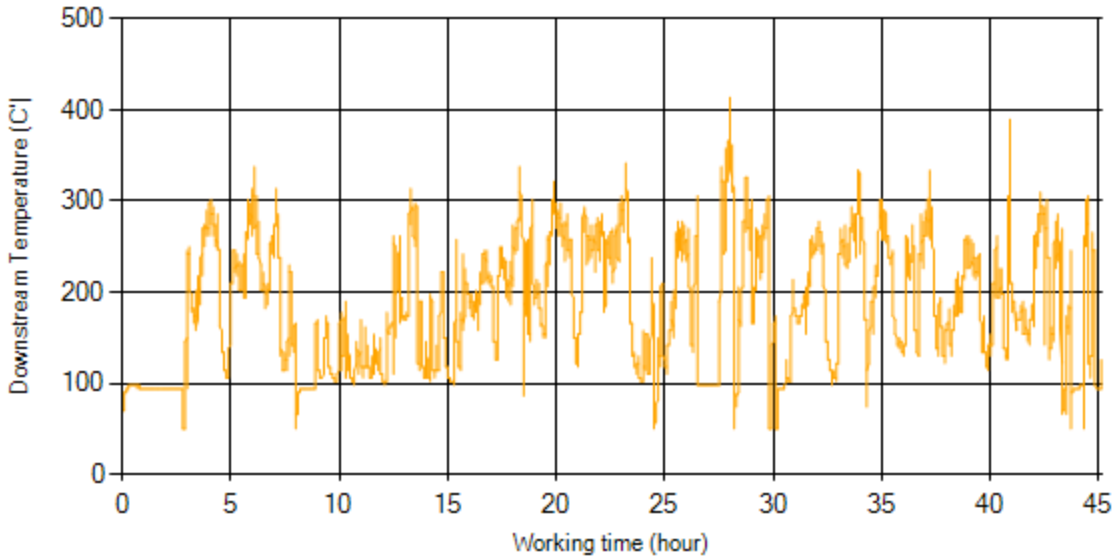



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

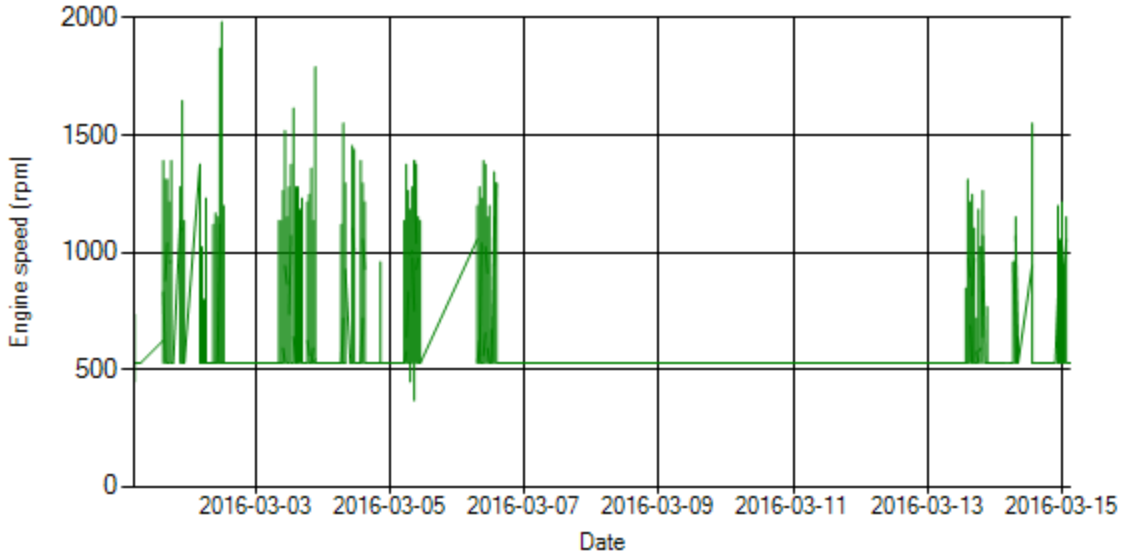



*Figure 10- Engine speed distribution over the period*

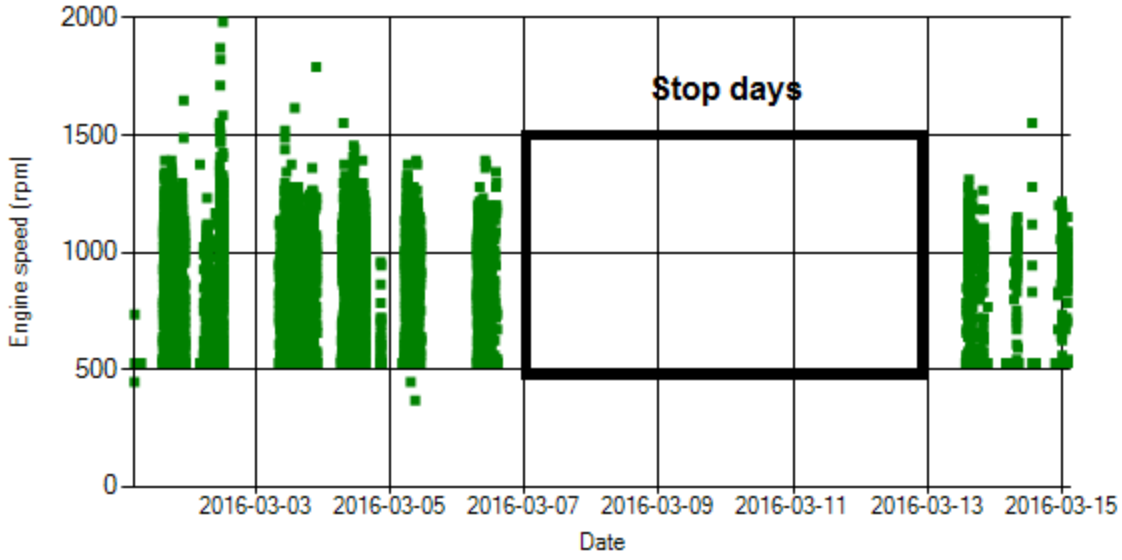



*Figure 11- Engine speed diagram for calculating CPK's working days*

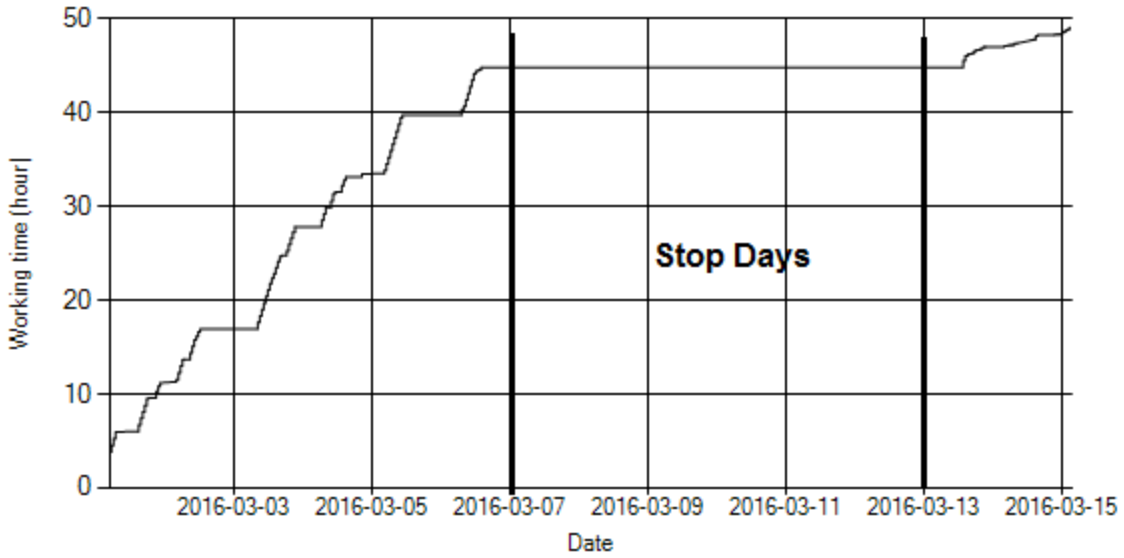



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data.

## Pressure-Engine Speed diagrams

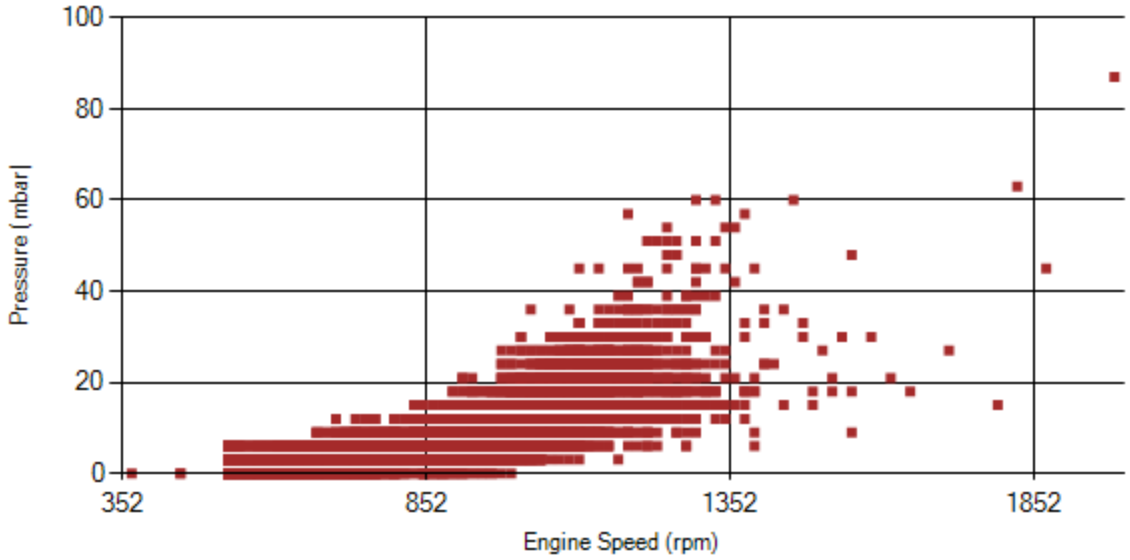



*Figure 13- Pressure against engine speed*

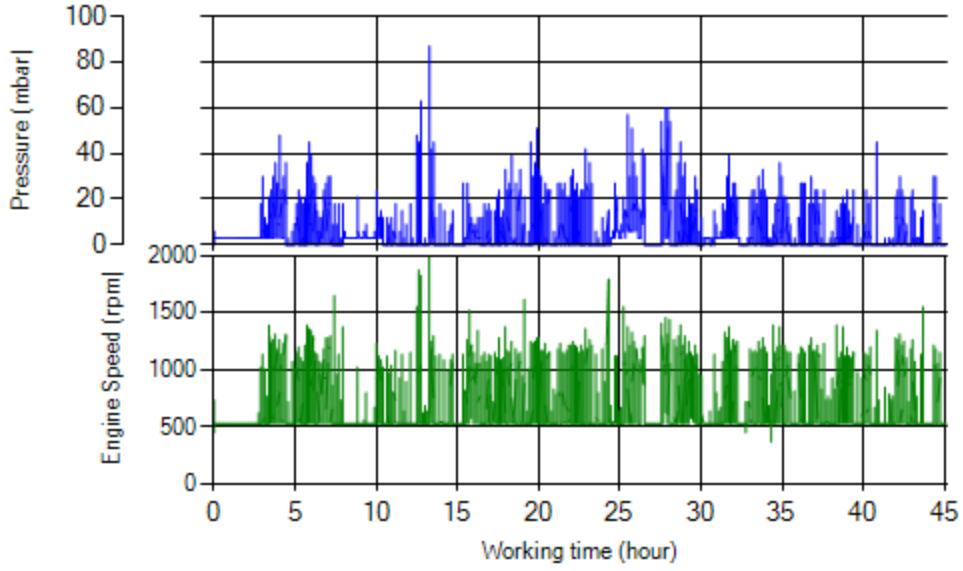



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

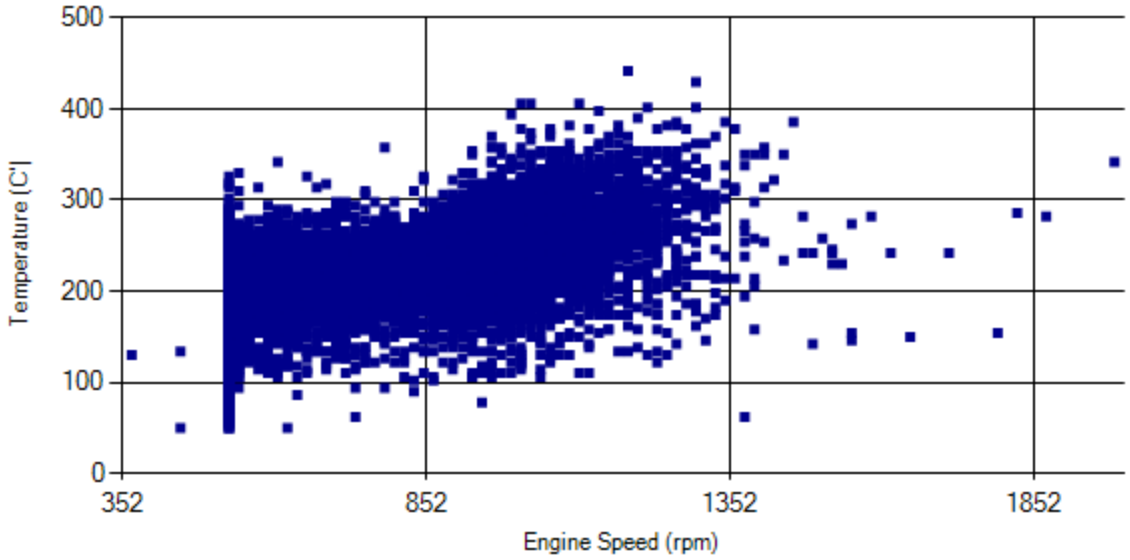



*Figure 15- Temperature against engine speed*

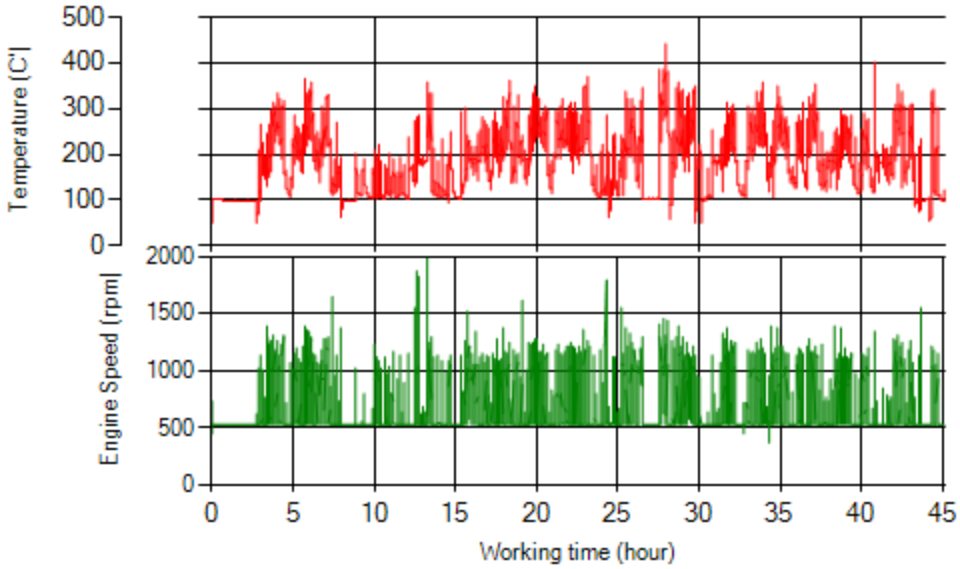



*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

- As depicted in figure 1, pressure above 100 mbar was not observed during this period.
- Figure 2 display flow temperature distribution for DPF's upstream. It can be obviously observed that 0.4% of total working-time temperature is above 350 ℃ and 17.1 % above 250℃.

| | | |
|---|---|---|
| Filter operation status | Excellent ■ | Good ☐ |
| | Maintenance required ☐ | Failed☐ |

## Overall Information

*Table1- Overall Information*

| | |
|---|---|
| Vehicle plate number | 33592 (32441) |
| CPK data logger number | LN: 001506, DN: 1927 |
| Bus line | Number 2 (west to east bus line) |
| Bus Terminals | Khavaran Bus Terminal - Western Bus Terminal |
| Total path distance | 19 km |
| DPF producer company | Tehag_02 (Catalyzed DPF) |
| Installation date | 25/Jan/2016 |
| Report period | 16/Mar/2016- 31/Mar/2016 (sixteen days) |
| K value - DPF upstream | 1.65 [1/m] |
| K value – DPF downstream | 0 [1/m] |

*Table 2- DPF Maintenance History*

| | |
|---|---|
| Filter maintenance date | System have been working without any cleaning from installation date. |
| Dosing status | This type do not use FBC. |

*Table 3- Fuel and Additive Consumption Information*

| | |
|---|---|
| Bus mileage (from DPF installation date) | 3841 km |
| Bus mileage over the period | 299 km |
| Working days over the period | 8 days |
| Stop days | 8 days |
| Data logger working days | 8 days |
| Working hours over the period | 31 hours 23 minutes |
| Average working hours per day (including stop days) | 2 hours 5 minutes |
| Bus average speed | 9.5 km/hr |
| idle speed time to all working time ration | 68.87 % |
| Total Bus fuel consumption over the period | 195 lit |
| Fuel consumption per hour | 6 lit/hr |
| Average fuel consumption | 0.65 lit/km |

## Temperature, Pressure and Engine Speed Overview

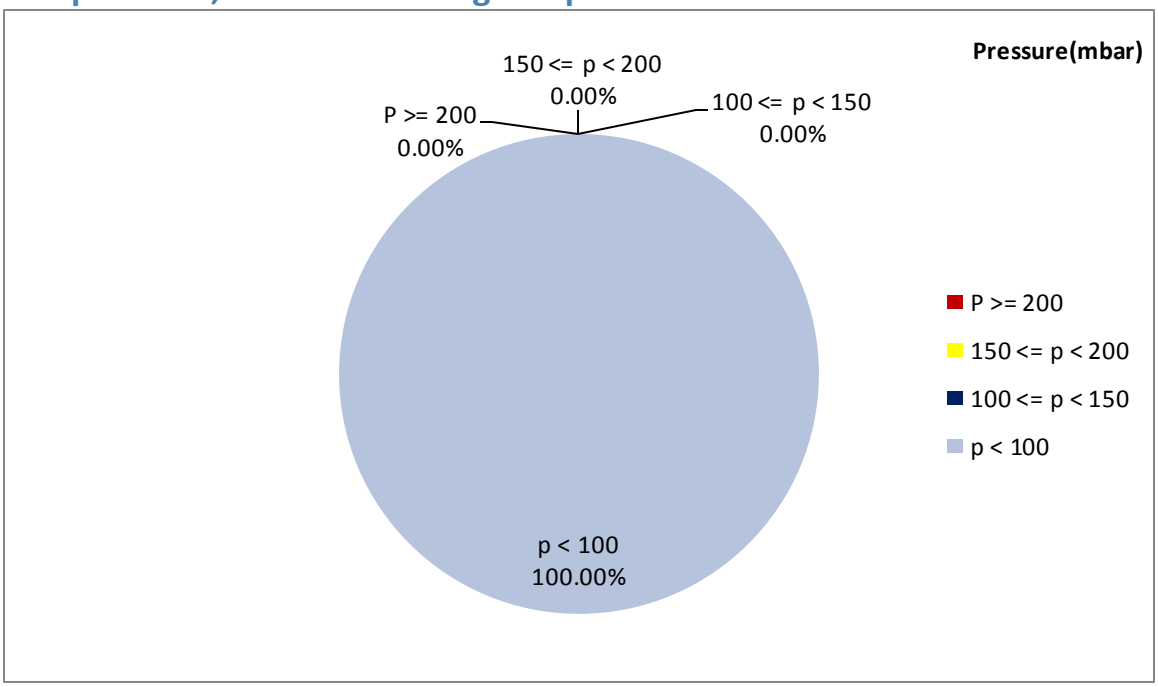



*Figure 1- Pressure distribution over the working hours*

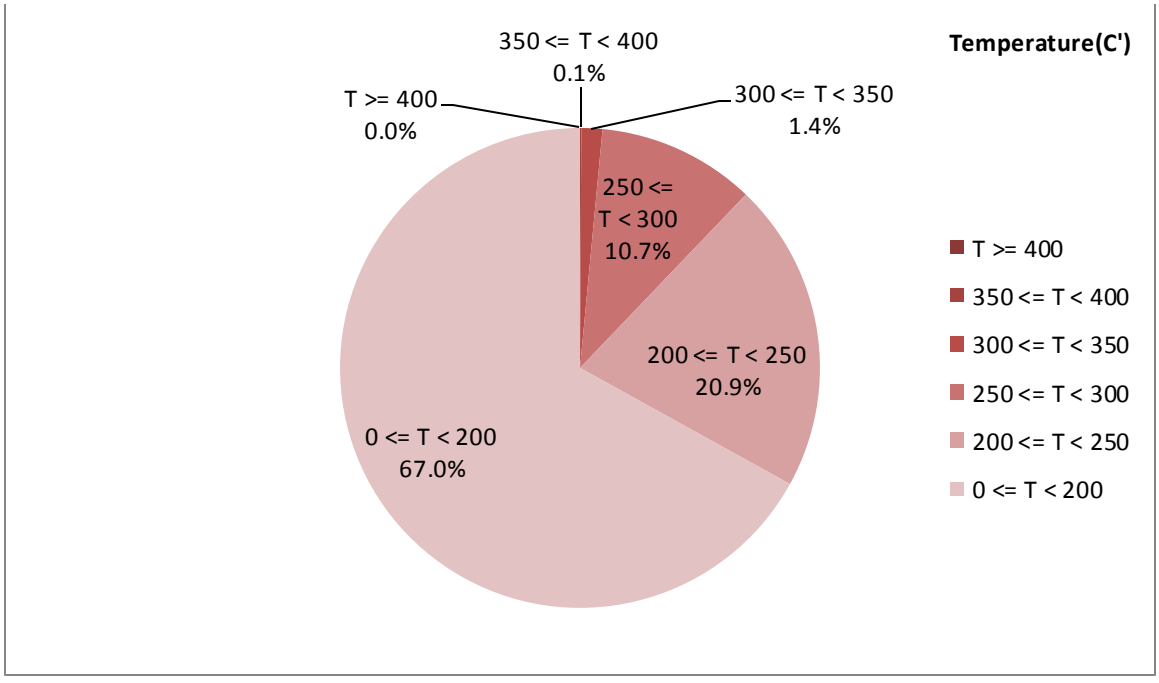



*Figure 2-Temperature distribution over the working hours*

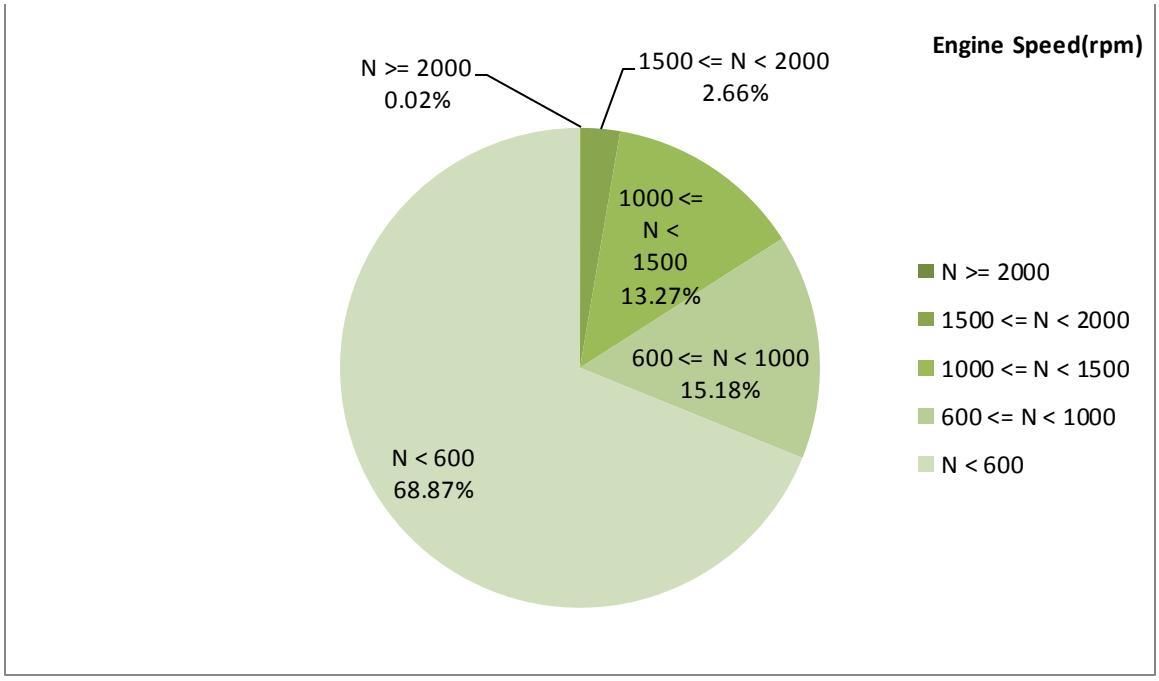



*Figure 3- Engine speed distribution over the working hours*

*Table 4- Mean values*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 165.72 | 5.56 | 691 |

*Table 5- Mean values without idling*

| Mean temperature (C) | Mean pressure(mbar) | Mean engine speed(rpm) |
|---|---|---|
| 236.77 | 15.32 | 1048 |

*Table 6- Max-min values*

| Max-min temperature(C) | Max-min pressure(mbar) | Max-min engine speed(rpm) |
|---|---|---|
| 366-50 | 72-0 | 2048-528 |

## Detailed Pressure Analysis

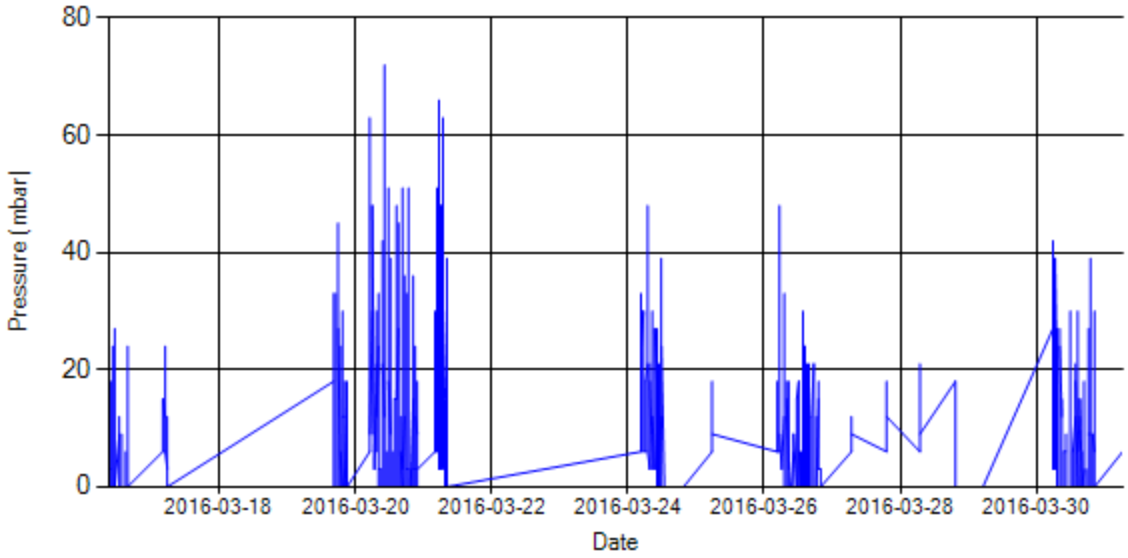



*Figure 4- Pressure distribution over the period*

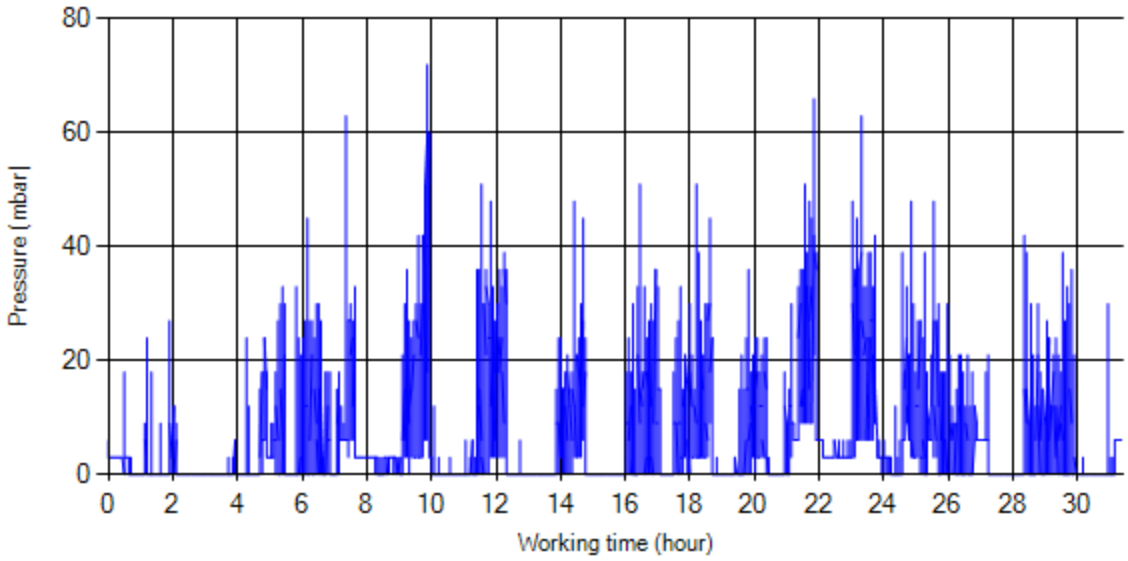



*Figure 5- Pressure vs. working hours*

Notice: backpressure distribution was shown into two diagrams. As obvious in figure 5, stop-working periods were eliminated and pressure was displayed along working hours.

## Detailed Temperature Analysis

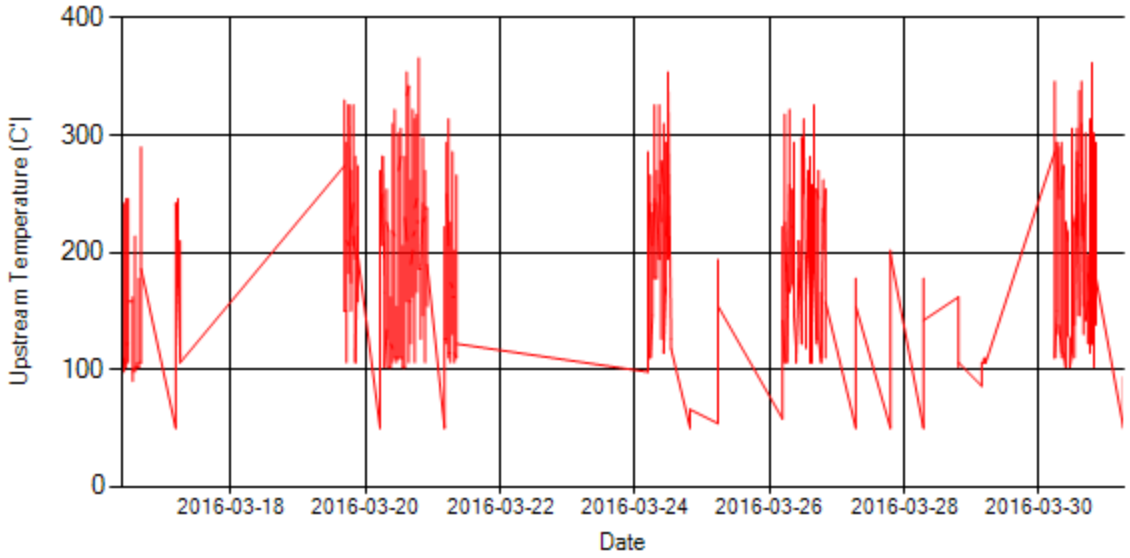



*Figure 6- Temperature distribution over the period*

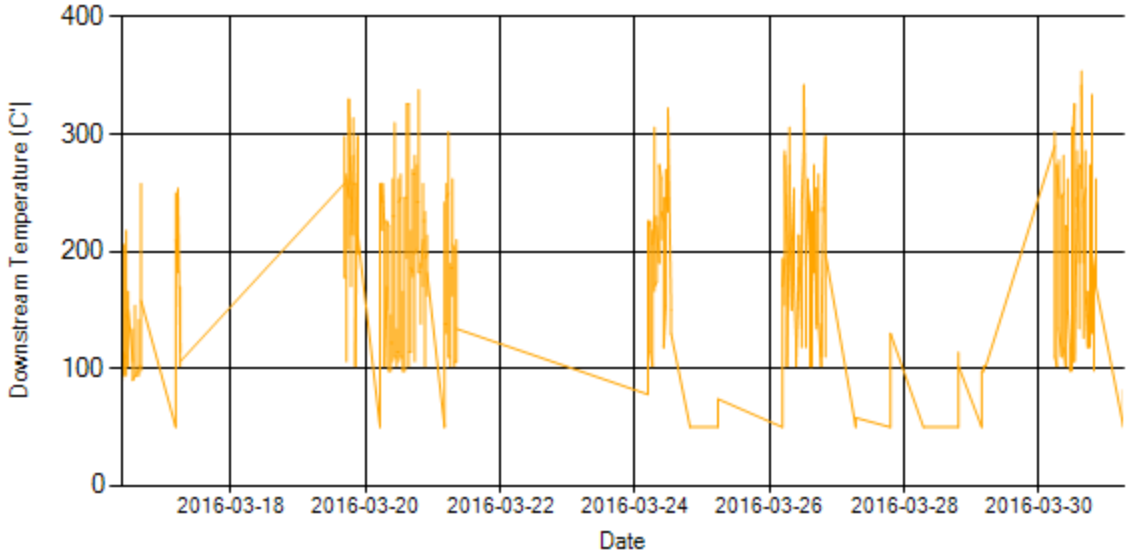



*Figure 7- Temperature distribution over the period*

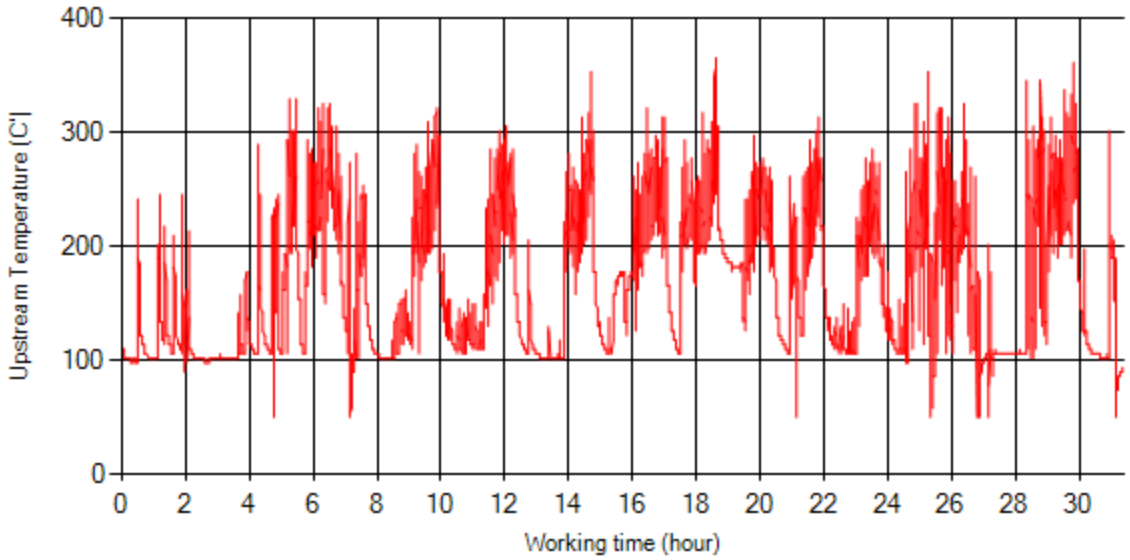



*Figure 8- Temperature vs. working hours*

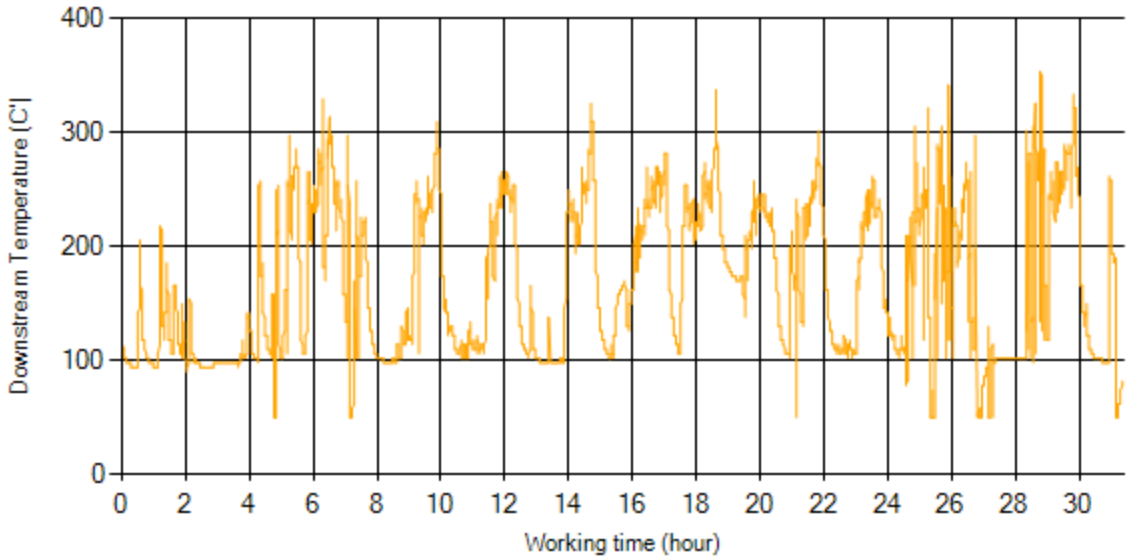



*Figure 9- Temperature vs. working hours*

## Engine Speed Diagrams

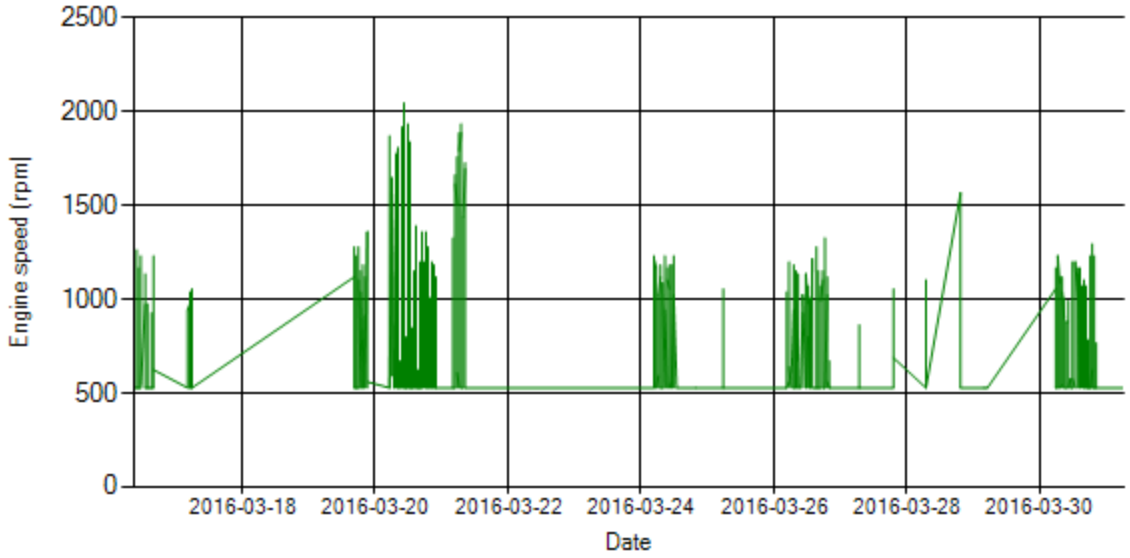



*Figure 10- Engine speed distribution over the period*

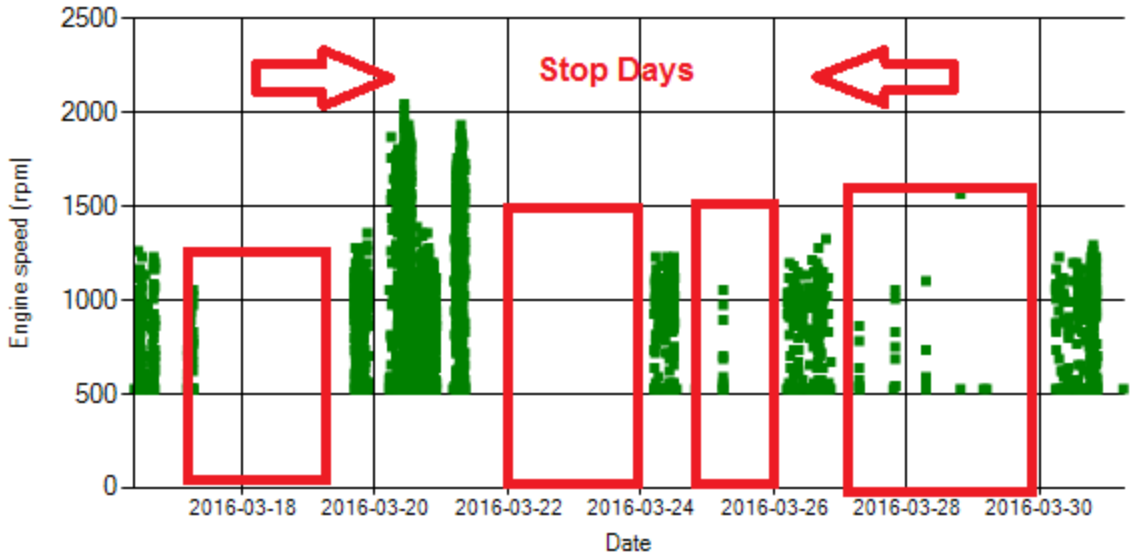



*Figure 11- Engine speed diagram for calculating CPK's working days*

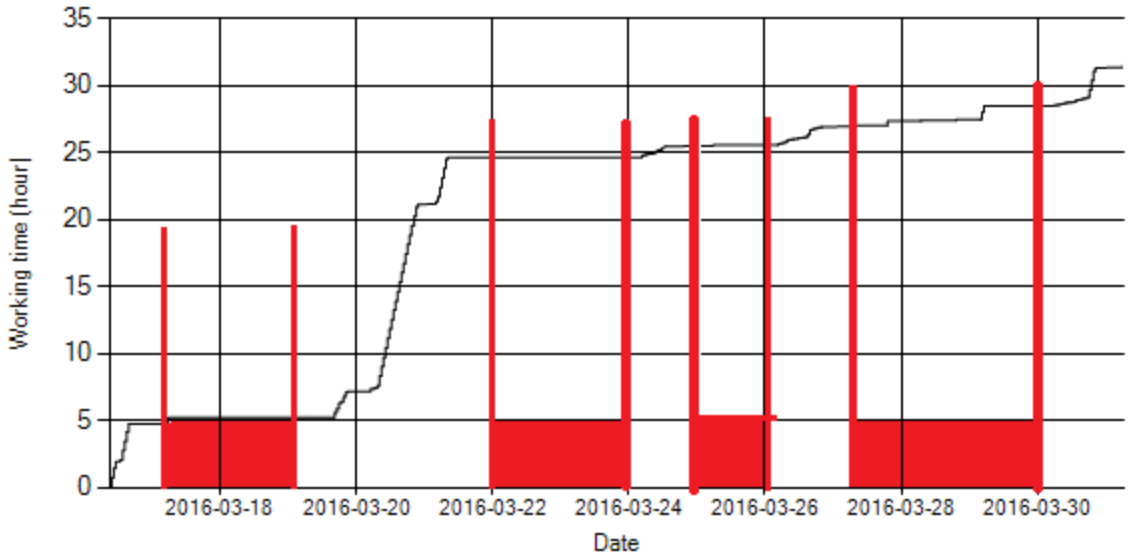



*Figure 12- Time diagram for calculating CPK's working days*

Notice: Data logger sampling time can be calculated from Figure 12. The lines parallel with Date axis show days without data logger data. As depicted in Figure 12, bus was stationary for 8 days.

## Pressure-Engine Speed diagrams

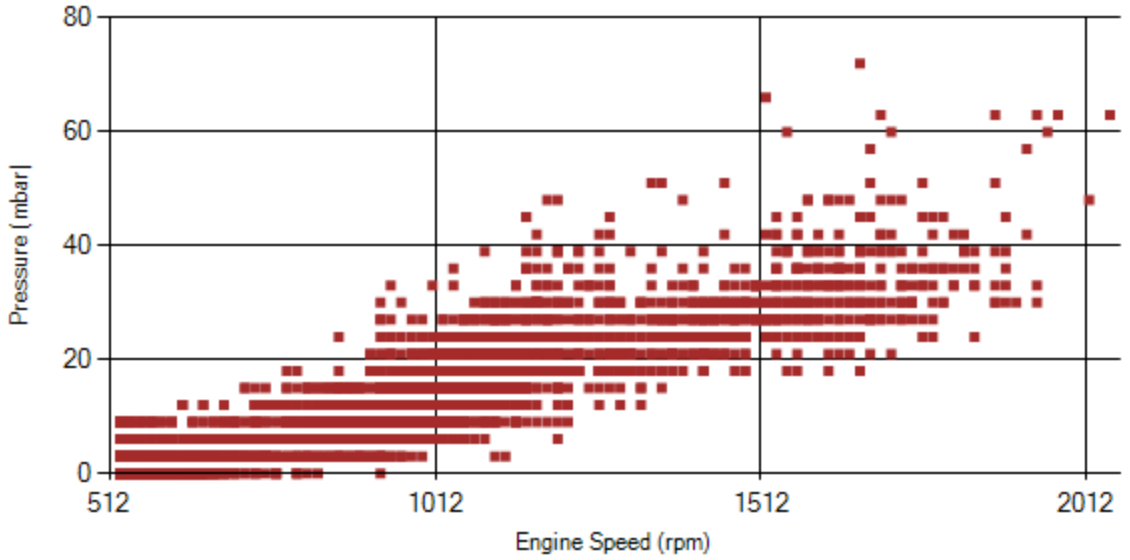



*Figure 13- Pressure against engine speed*

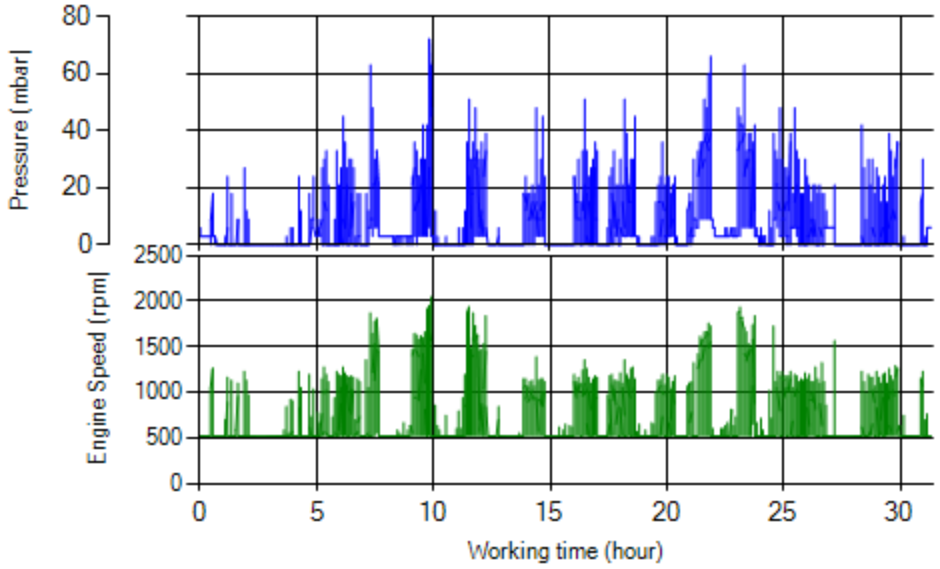



*Figure 14- P, N distribution vs. working hours*

## Temperature-Engine Speed diagrams

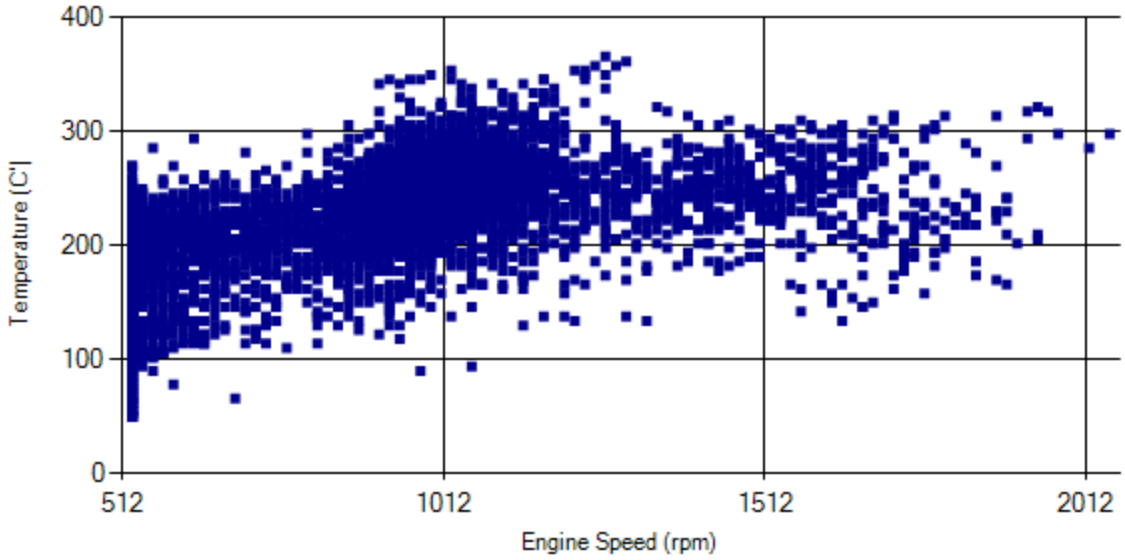



*Figure 15- Temperature against engine speed*

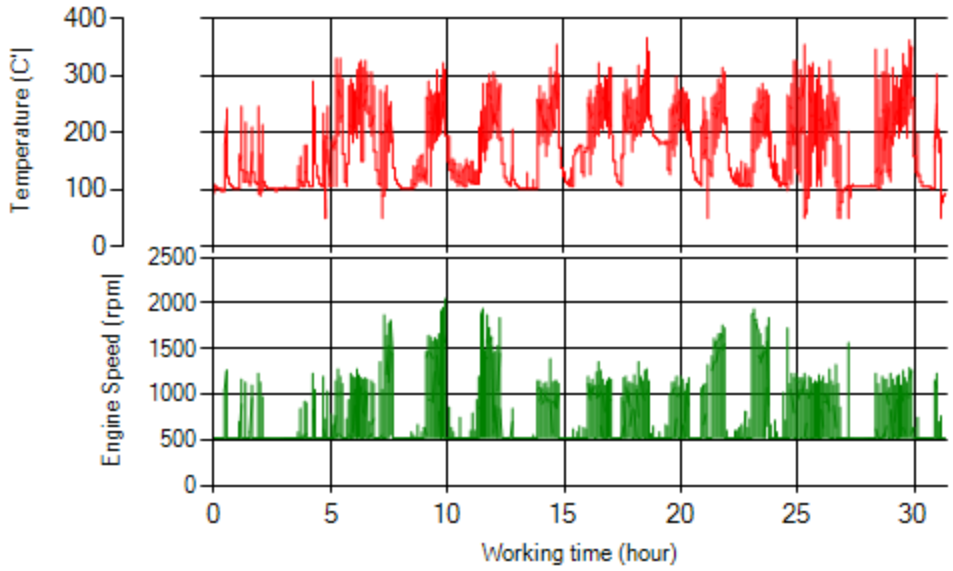



*Figure 16- T, N distribution vs. working hours*

## Filter Operation Analysis

- As depicted in figure 1, pressure above 100 mbar was not observed during this period.
- Figure 2 display flow temperature distribution for DPF's upstream. It can be obviously observed that 0.1% of total working-time temperature is above 350 ℃ and 12.2 % above 250℃. It is worth to mention despite this low temperature distribution the DPF operation was excellent.

| | | |
|---|---|---|
| Filter operation status | Excellent ■ | Good ☐ |
| | Maintenance required ☐ | Failed☐ |

# Diesel Particulate Filter

## an effective way to control solid particulate

ASA
AZMOON SANAT ARVIN

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