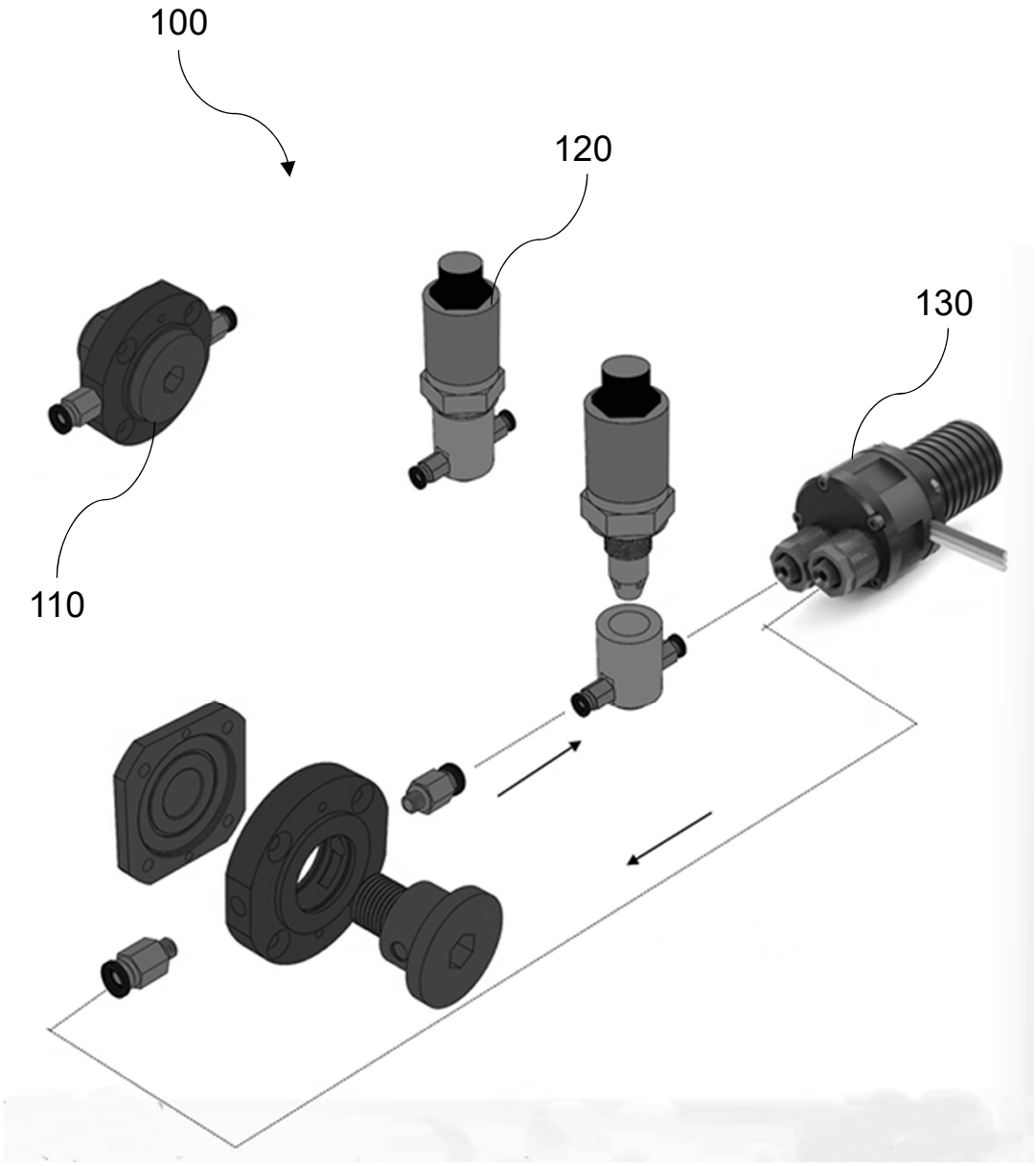


FIG. 1

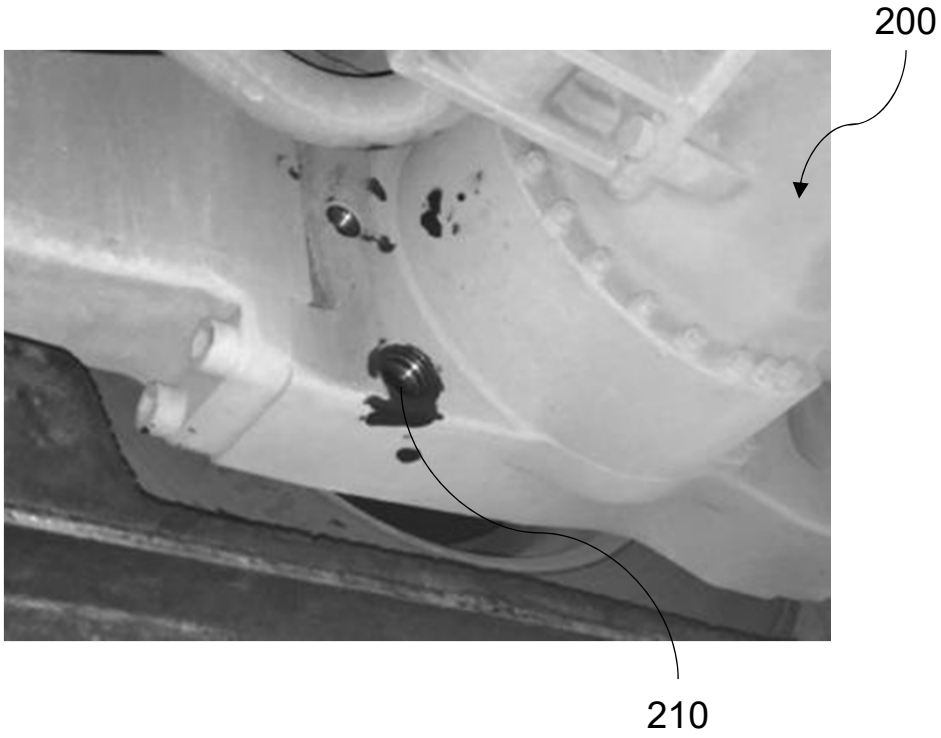


FIG. 2A

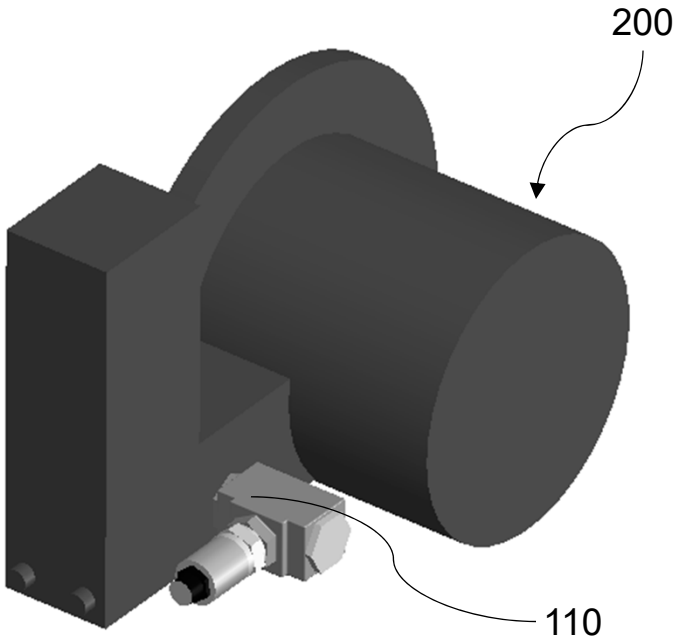


FIG. 2B



FIG. 2C

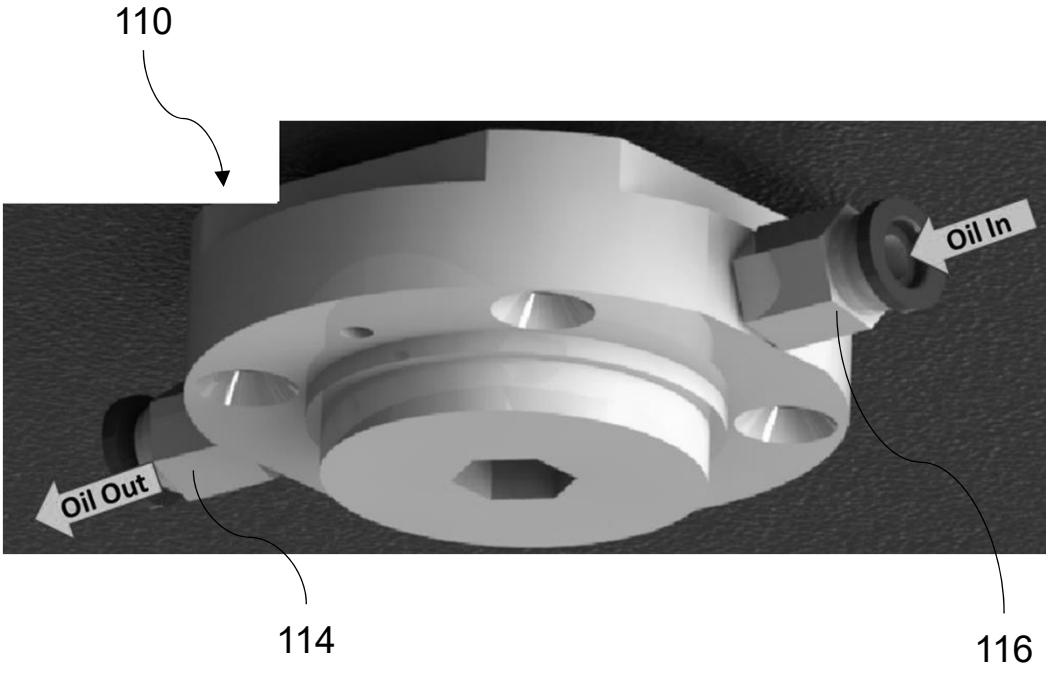


FIG. 3A

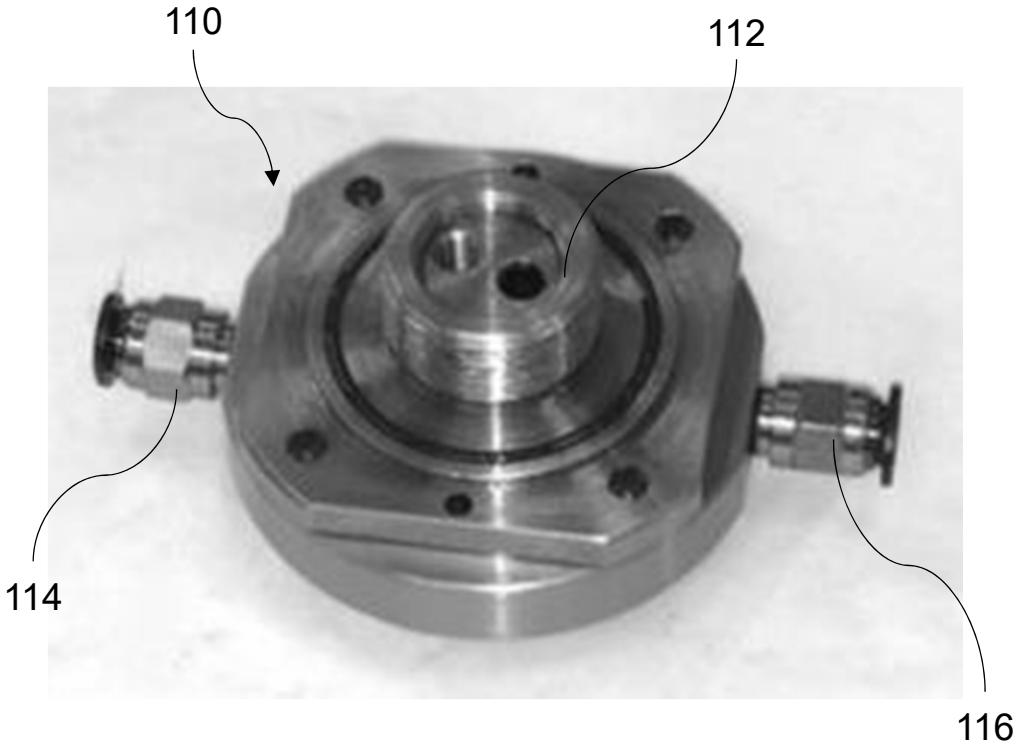


FIG. 3B

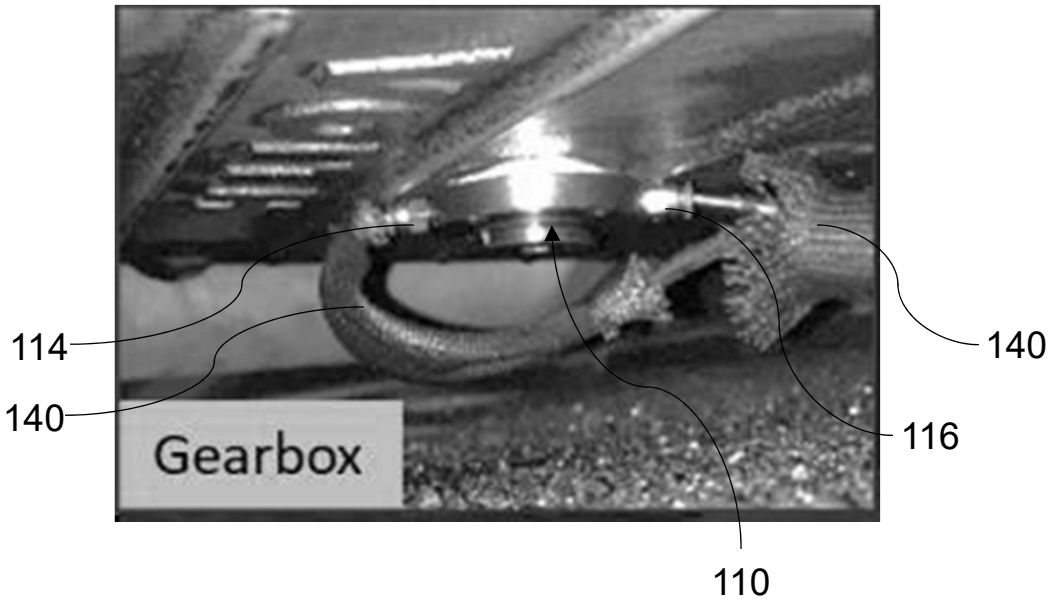


FIG. 4A

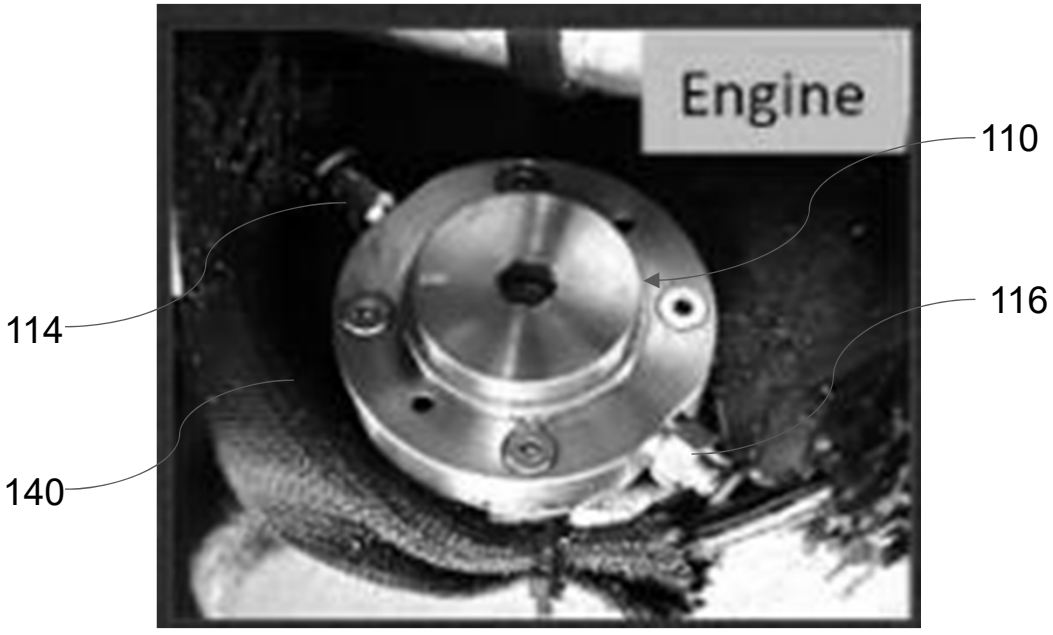


FIG. 4B

Sample No.	Bus No.	Oil Type	Bus Model
1	3133	Fresh gear oil	Volvo
2	3133	Used gear oil	Volvo
3	3063	Used gear oil	MAN
4	3121	Used gear oil	MAN
5	3133	Used gear oil	Volvo
6	5463	Used gear oil	MAN
7	3134	Used gear oil	Volvo
8	3924	Used gear oil	Volvo

FIG. 5A

Sample No.	Bus No.	Oil Type	Bus Model
1	3133	Fresh engine oil	Volvo
2	3133	Used engine oil	Volvo
3	3133	Used engine oil	Volvo
4	3063	Used engine oil	MAN
5	3121	Used engine oil	MAN
6	6692	Used engine oil	Scania
7	3135	Used engine oil	Volvo
8	3668	Used engine oil	MAN
9	3670	Used engine oil	Volvo
10	3782	Used engine oil	Citaro
11	3134	Used engine oil	Volvo
12	3924	Used engine oil	Volvo

FIG. 5B

Load	10 N
RPM	300
Distance	1 km
Oil volume for each test	20 ml
Radius of wear track	7 mm

FIG. 6A

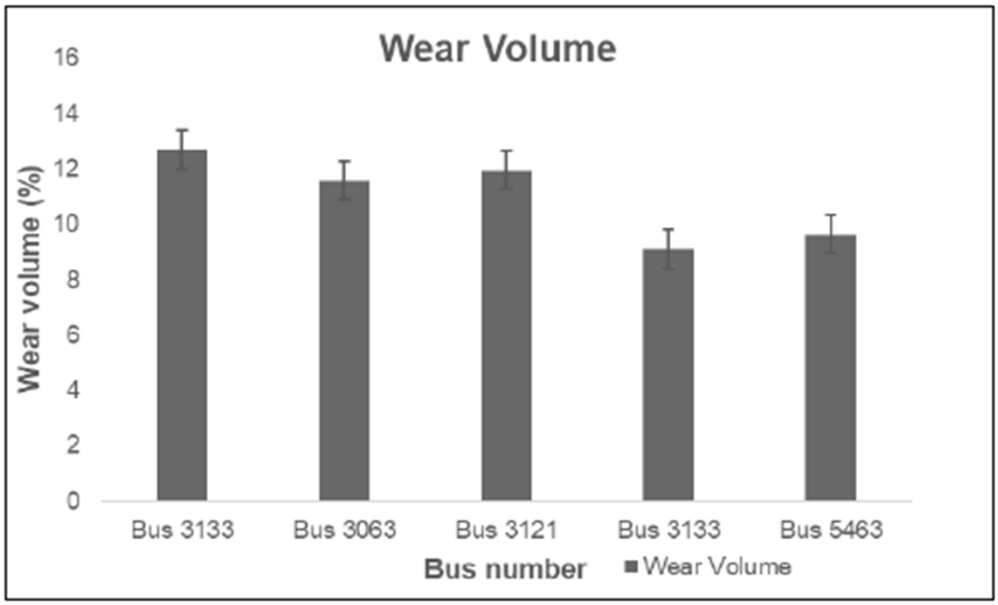


FIG. 6B

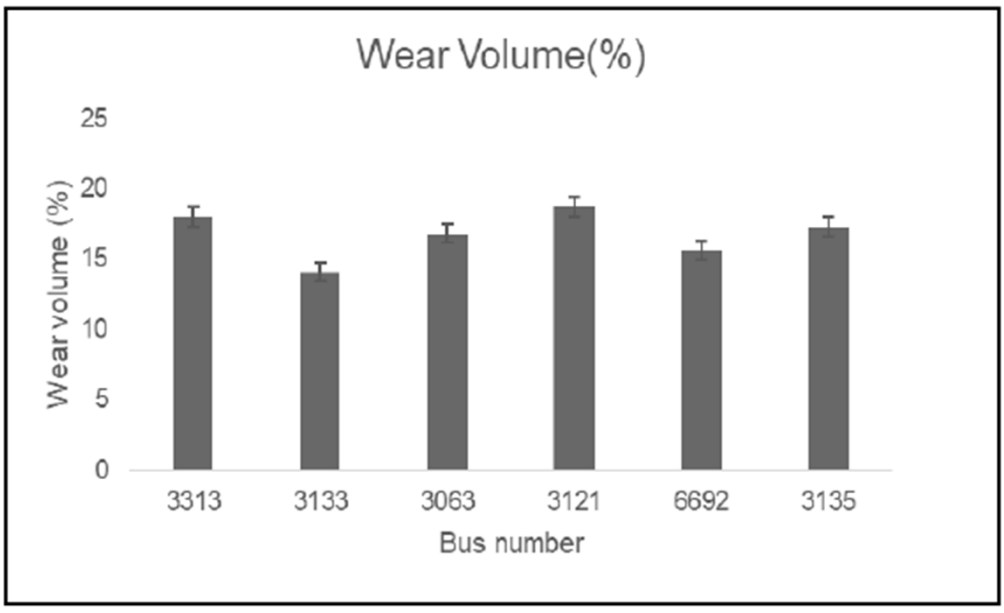


FIG. 6C

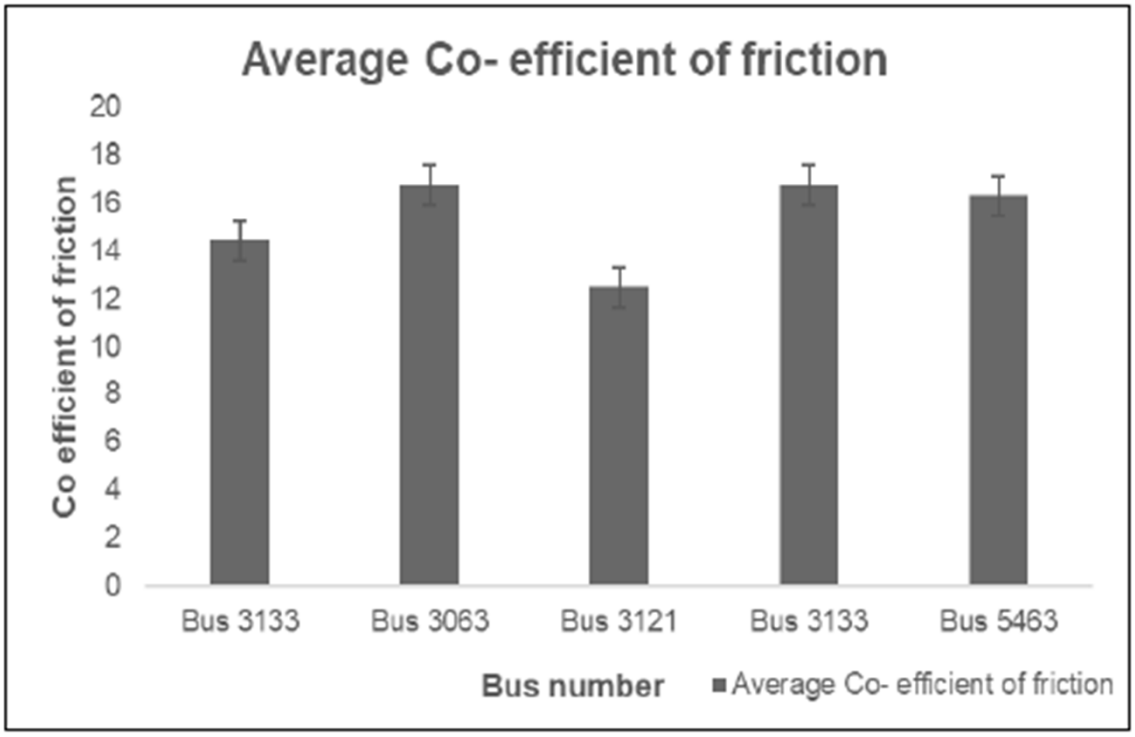

Average Co- efficient of friction
Co efficient of friction
20
18
16
14
12
10
8
6
4
2
0
Bus 3133
Bus 3063
Bus 3121
Bus 3133
Bus 5463
Bus number
Average Co- efficient of friction

FIG. 6D

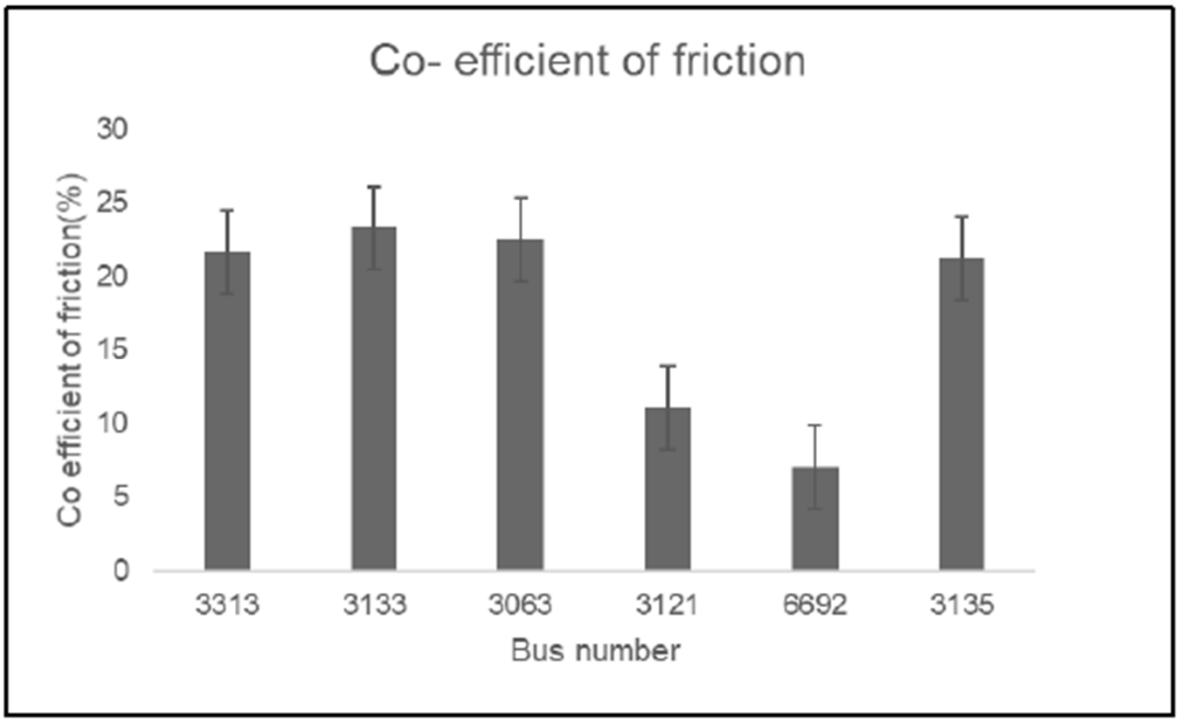

Co- efficient of friction
Co efficient of friction(%)
30
25
20
15
10
5
0
3313
3133
3063
3121
6692
3135
Bus number

FIG. 6E

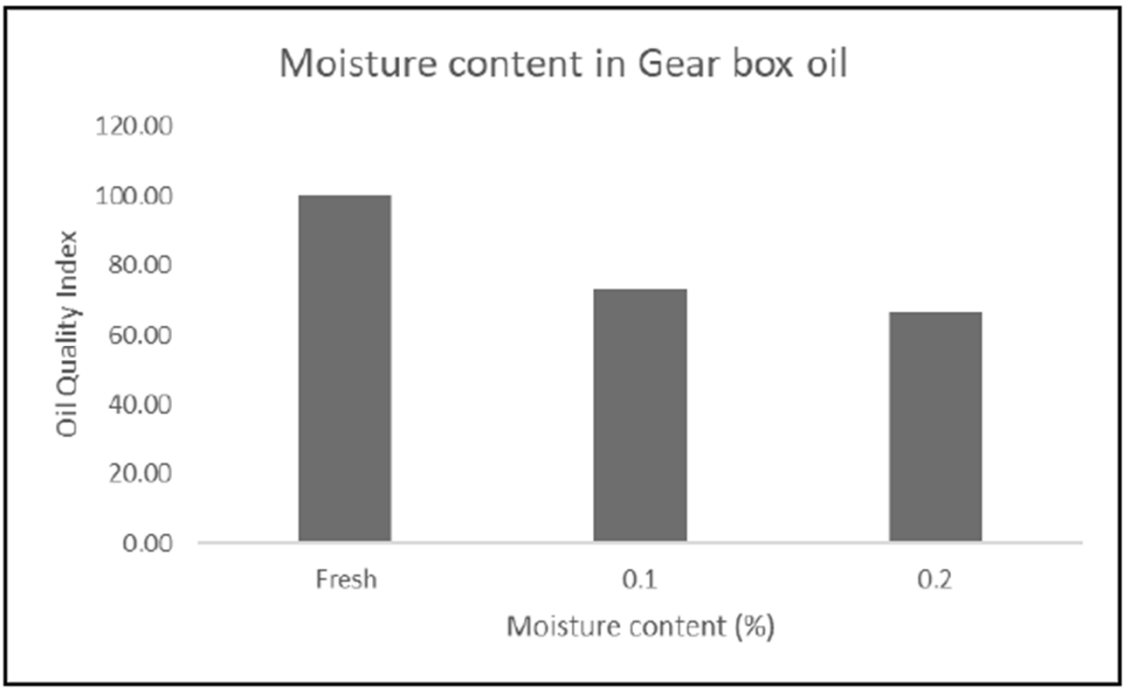

Moisture content in Gear box oil
120.00
100.00
80.00
60.00
40.00
20.00
0.00
Oil Quality Index
Fresh
0.1
0.2
Moisture content (%)

FIG. 7A

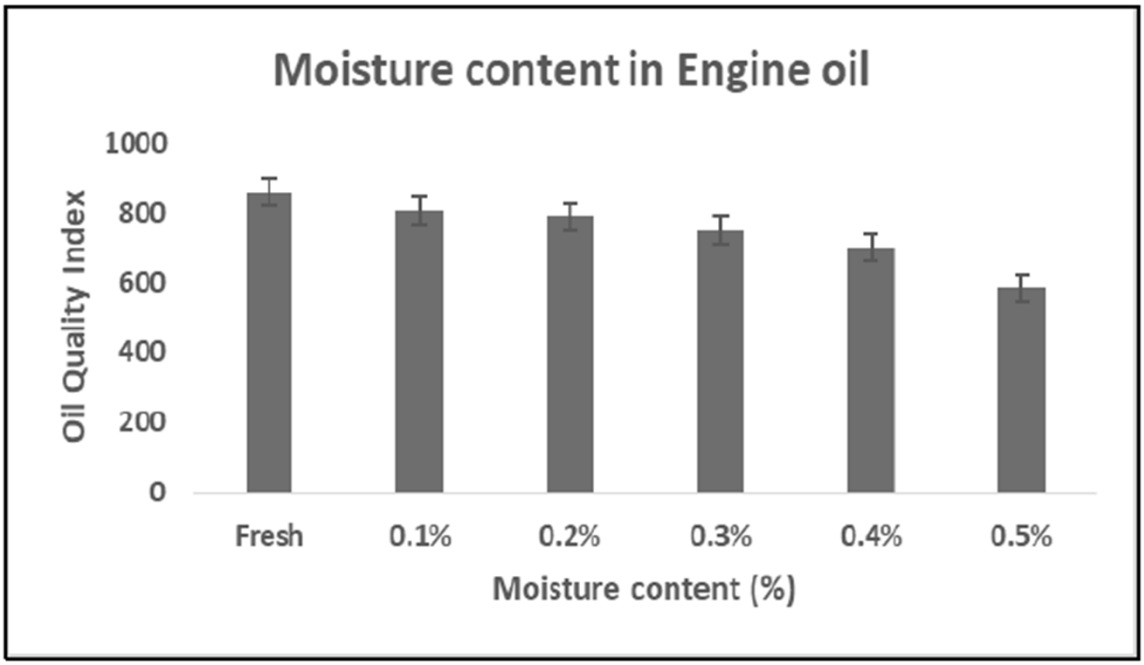

Moisture content in Engine oil
1000
800
600
400
200
0
Oil Quality Index
Fresh
0.1%
0.2%
0.3%
0.4%
0.5%
Moisture content (%)

FIG. 7B

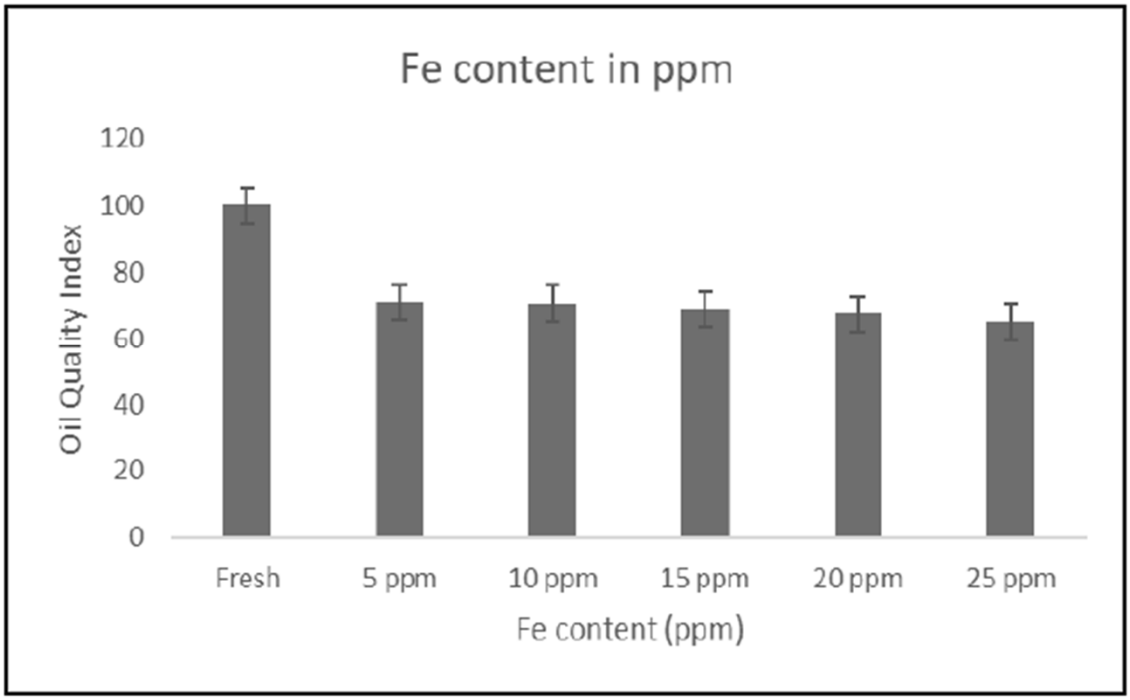

Fe content in ppm
Oil Quality Index
120
100
80
60
40
20
0
Fresh
5 ppm
10 ppm
15 ppm
20 ppm
25 ppm
Fe content (ppm)

FIG. 8A

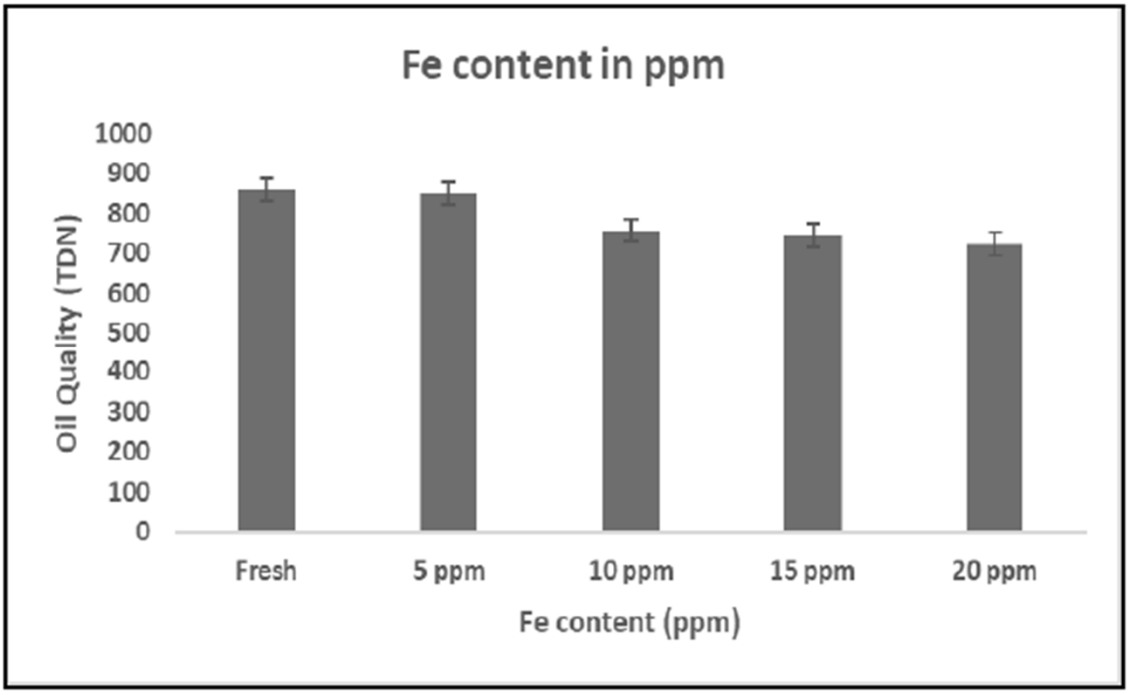
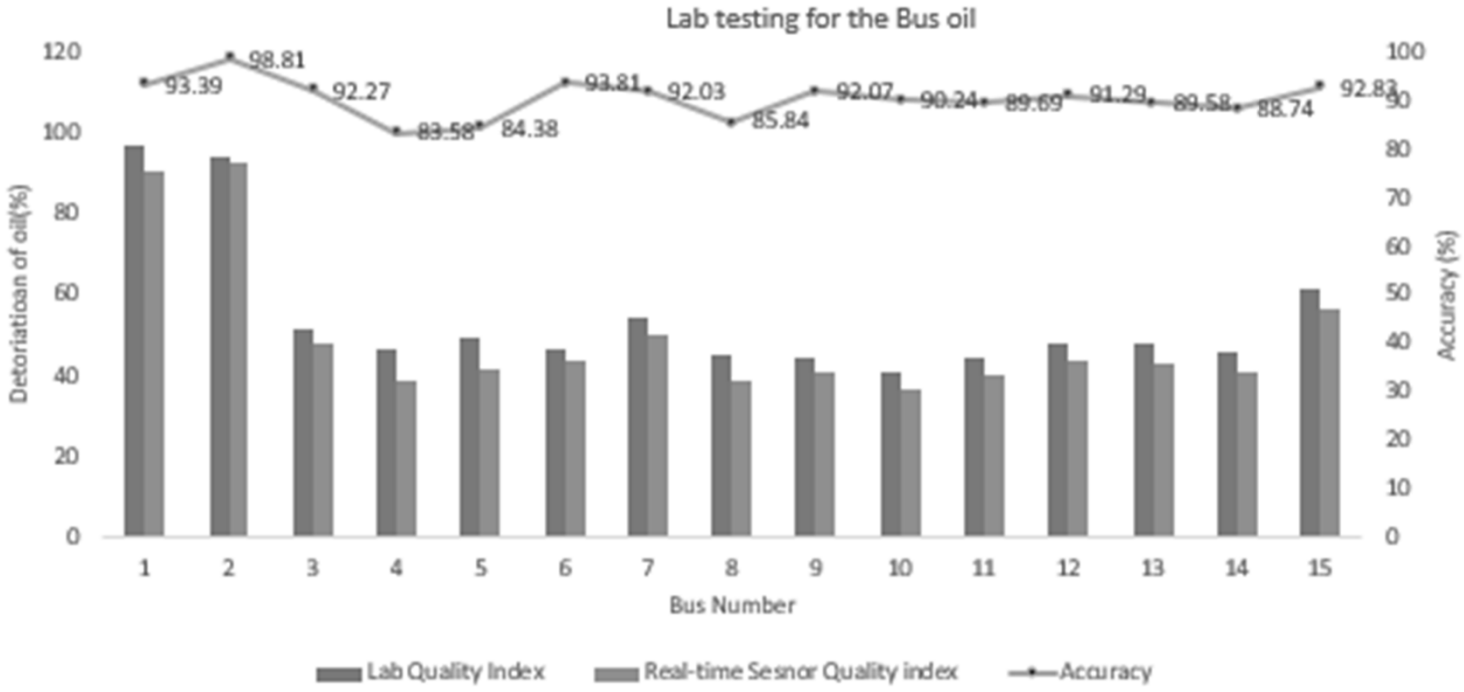

Fe content in ppm
Oil Quality (TDN)
1000
900
800
700
600
500
400
300
200
100
0
Fresh
5 ppm
10 ppm
15 ppm
20 ppm
Fe content (ppm)

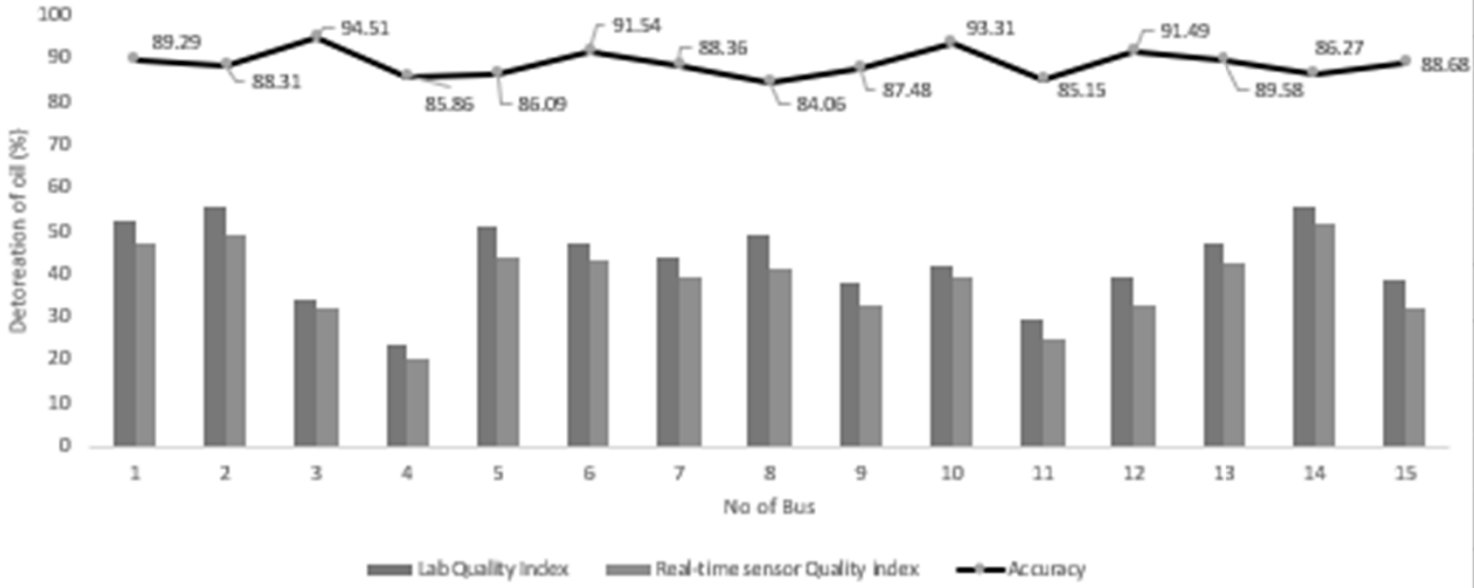
FIG. 8B



Deterioration of the oil based on Sensor

Oil sample	Oil Health
Fresh oil	100%
Bus 1	97.43%
Bus 2	94.11%
Bus 15	61.40%
Bus 7	54.32%
Bus 3	52.02%
Bus 5	49.77%
Bus 12	48.20%
Bus 13	48.00%
Bus 6	46.90%
Bus 4	46.66%
Bus 14	46.20%
Bus 8	45.43%
Bus 11	44.60%
Bus 9	44.53%
Bus 10	41.00%

FIG. 9A



Deterioration of the oil based on sensor

Oil sample	Oil Health
Fresh oil	100%
Bus 2	55.49%
Bus 14	55.43%
Bus 1	52.64%
Bus 5	51.11%
Bus 8	48.77%
Bus 6	46.98%
Bus 13	46.90%
Bus 7	44.14%
Bus 10	41.80%
Bus 12	39.00%
Bus 15	38.70%
Bus 9	37.72%
Bus 3	33.86%
Bus 11	29.36%
Bus 4	23.29%

FIG. 9B

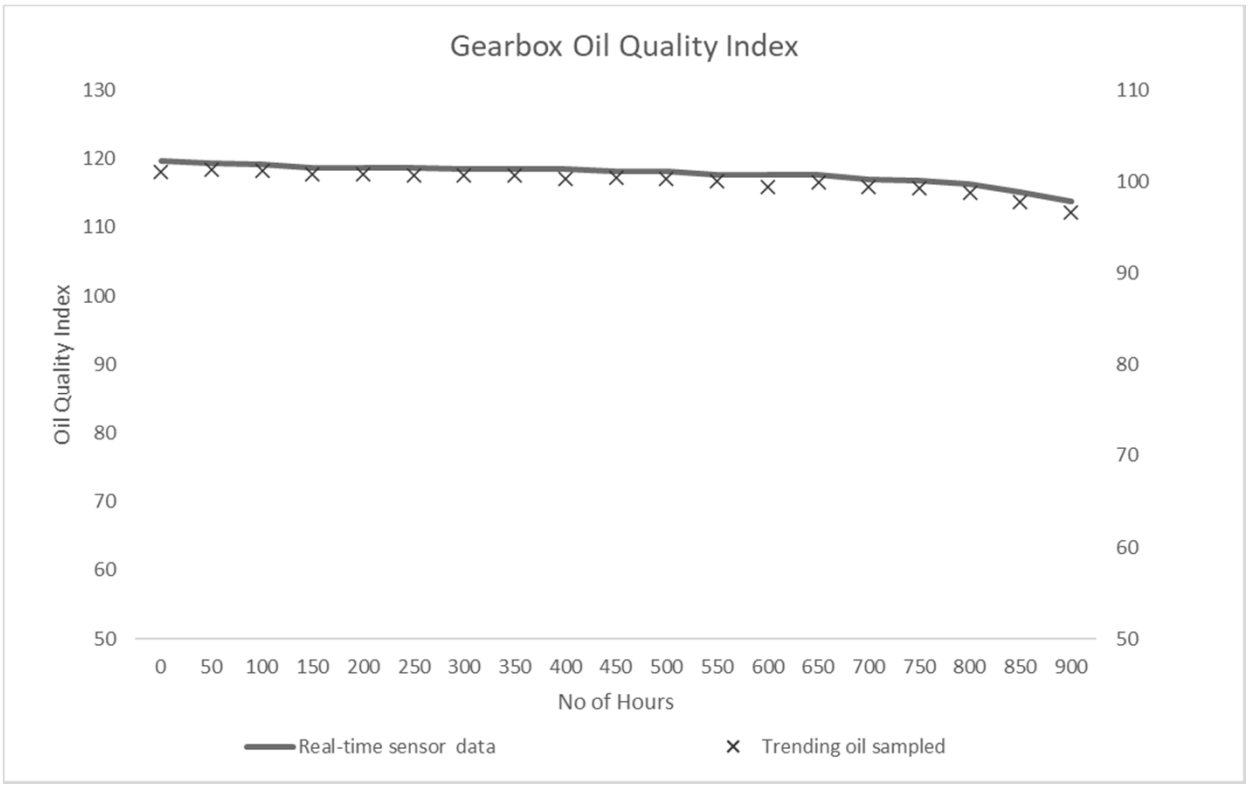

Gearbox Oil Quality Index
Oil Quality Index
130
120
110
100
90
80
70
60
50
110
100
90
80
70
60
50
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900
No of Hours
Real-time sensor data
Trending oil sampled

FIG. 9C

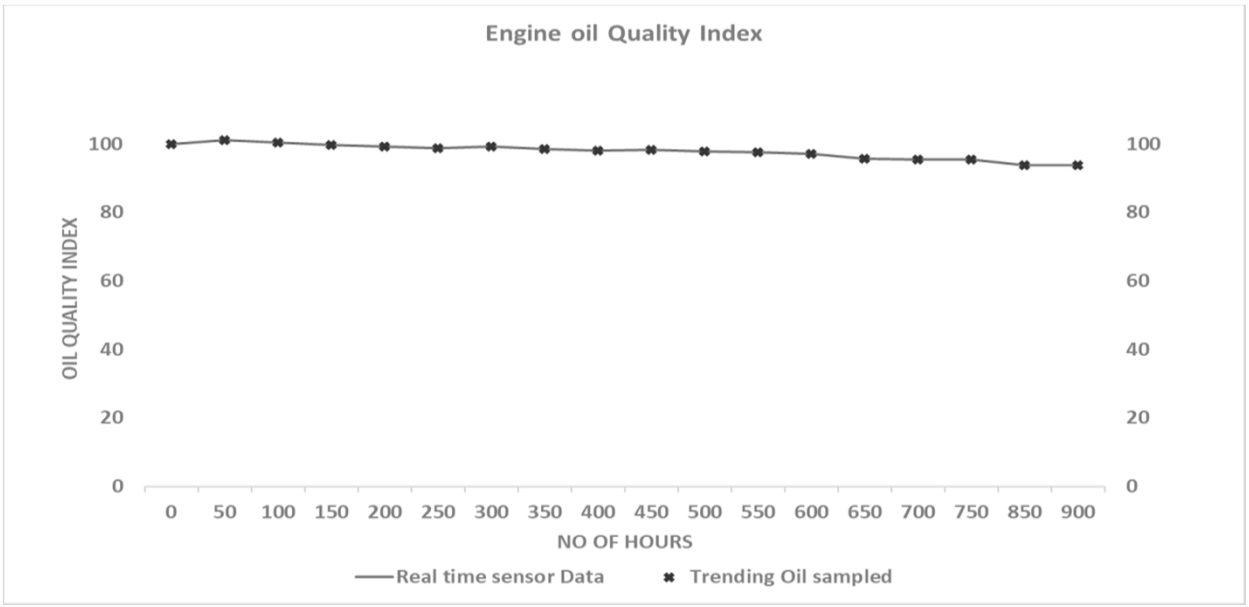

Engine oil Quality Index
OIL QUALITY INDEX
100
80
60
40
20
0
100
80
60
40
20
0
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 850 900
NO OF HOURS
Real time sensor Data
Trending Oil sampled

FIG. 9D

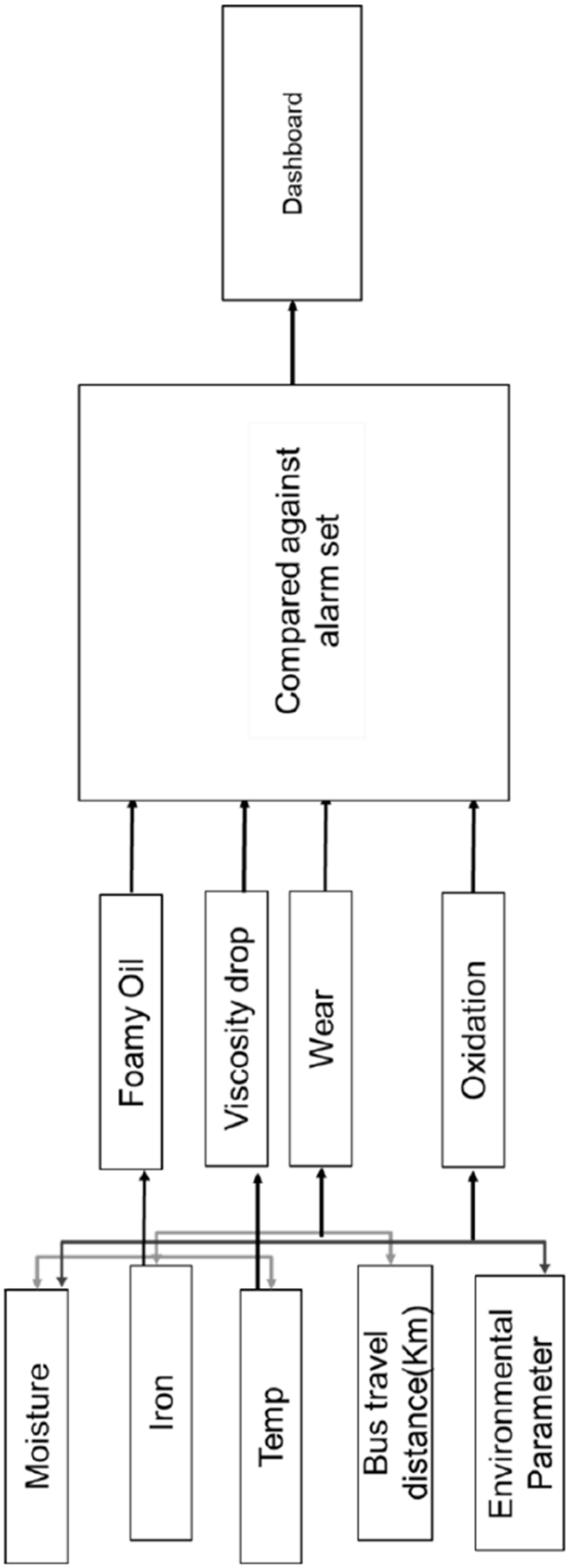

Dashboard
Compared against alarm set
Foamy Oil
Viscosity drop
Wear
Oxidation
Moisture
Iron
Temp
Bus travel distance(Km)
Environmental Parameter

FIG. 10

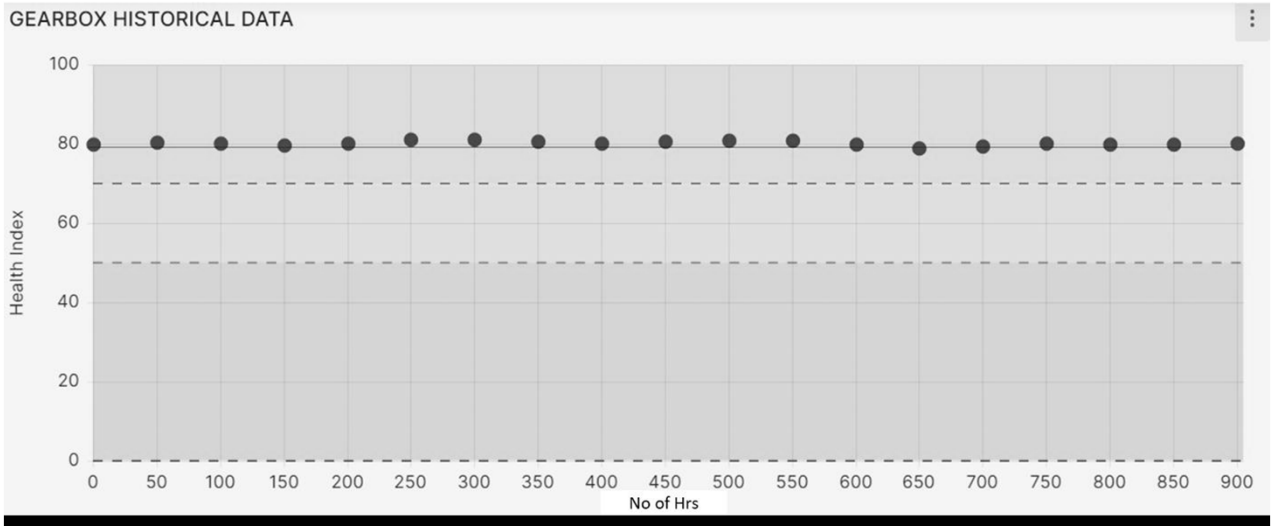


FIG. 11A

Parameters	**At start**	**After 900 hours**
Mean oil quality index	79.9	80.2
Crest factor	1.03	1.37
True positive	844	
False negative	186	
Sensitivity to detect gearbox failures	81.9	

FIG. 11B

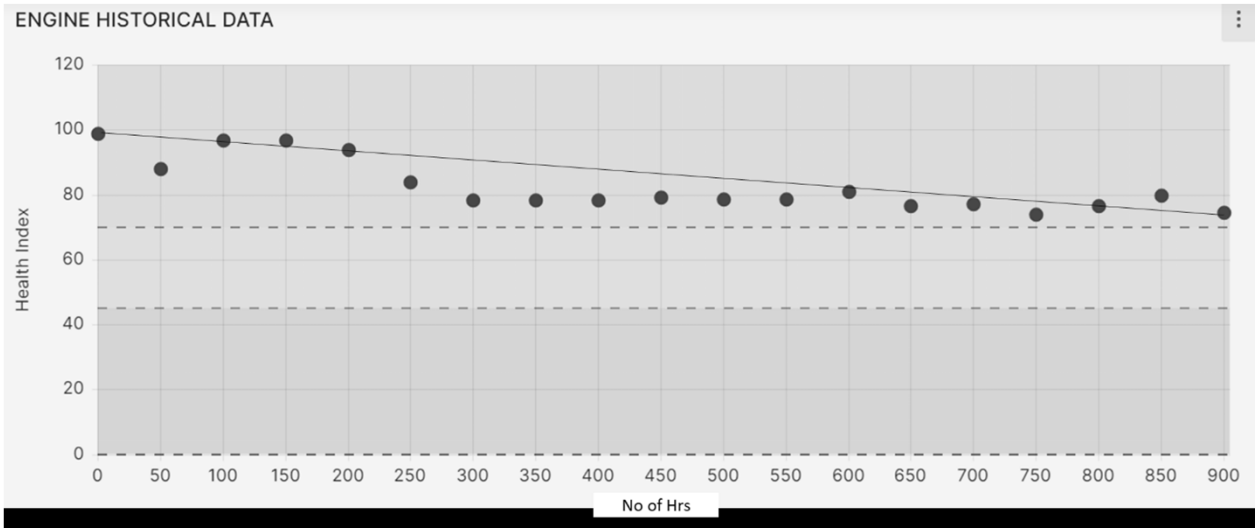


FIG. 11C

Parameters	**At start**	**After 900 hours**
Mean oil quality index	99	74.5
Crest factor	1.01	1.06
True positive	5880	
False negative	2	
Sensitivity to detect engine failures	99.9	

FIG. 11D

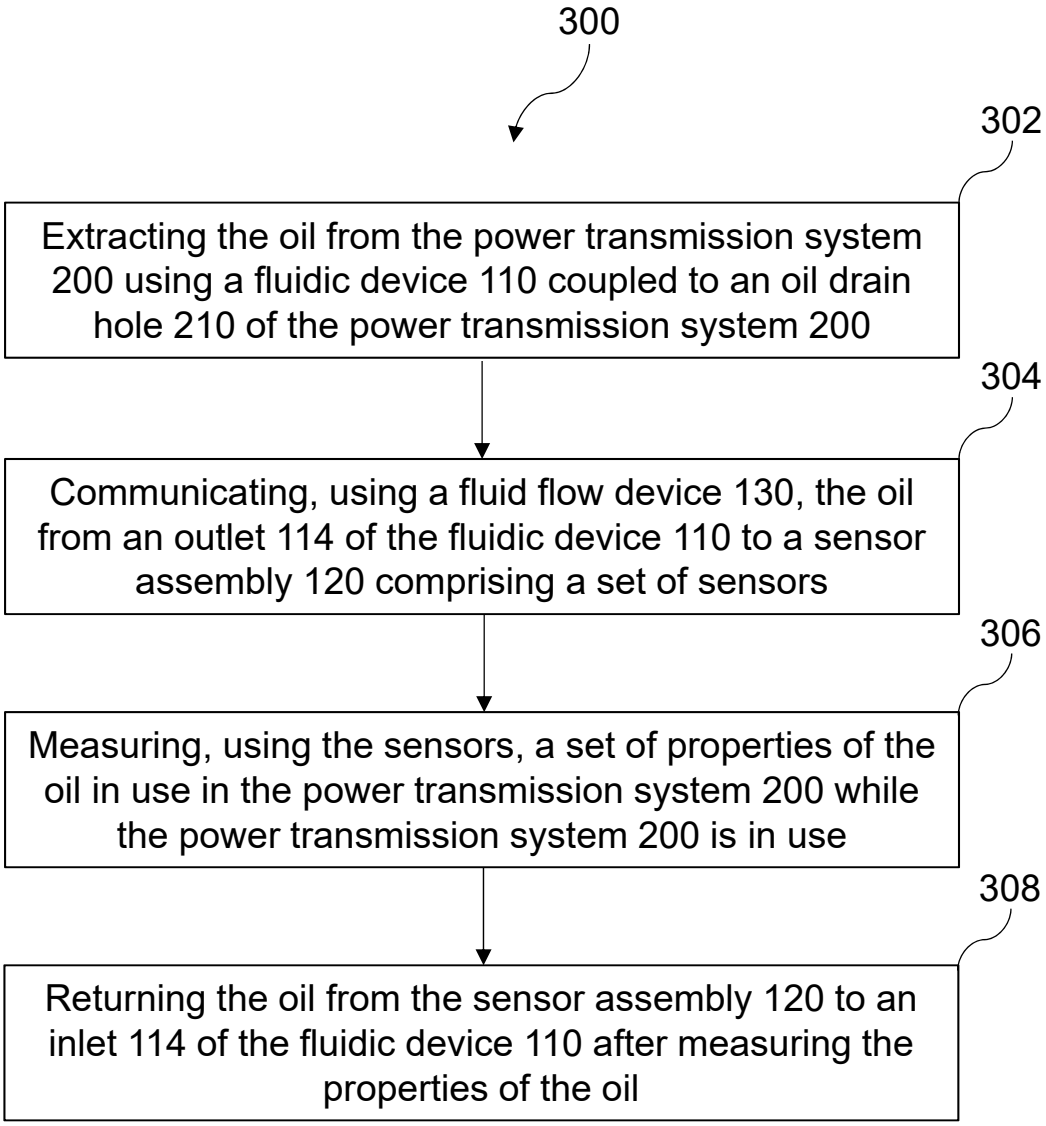

300
302
Extracting the oil from the power transmission system 200 using a fluidic device 110 coupled to an oil drain hole 210 of the power transmission system 200
304
Communicating, using a fluid flow device 130, the oil from an outlet 114 of the fluidic device 110 to a sensor assembly 120 comprising a set of sensors
306
Measuring, using the sensors, a set of properties of the oil in use in the power transmission system 200 while the power transmission system 200 is in use
308
Returning the oil from the sensor assembly 120 to an inlet 114 of the fluidic device 110 after measuring the properties of the oil

FIG. 12

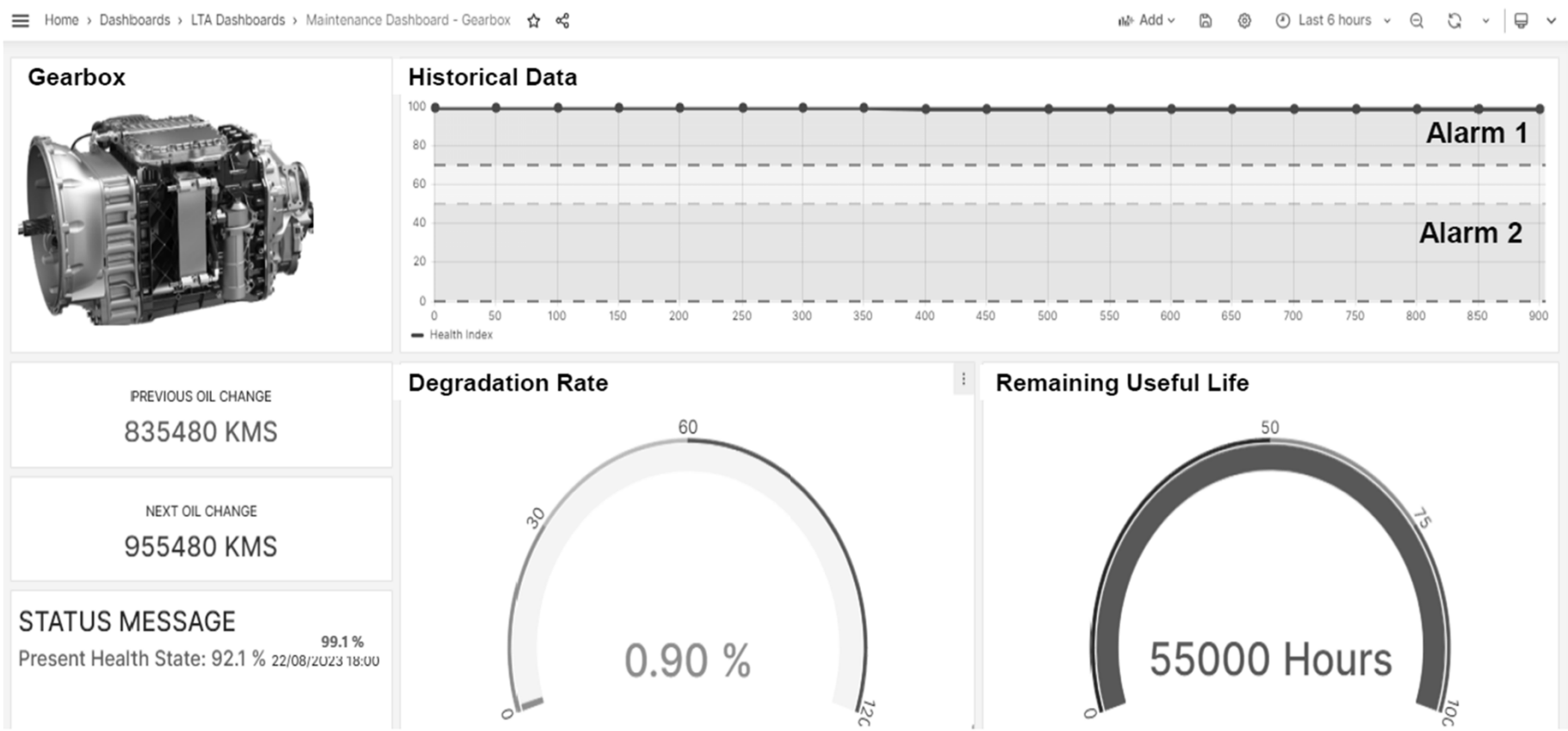

Home › Dashboards › LTA Dashboards › Maintenance Dashboard - Gearbox
Add
Last 6 hours
Gearbox
Historical Data
Alarm 1
Alarm 2
Health Index
PREVIOUS OIL CHANGE
835480 KMS
NEXT OIL CHANGE
955480 KMS
STATUS MESSAGE
Present Health State: 92.1 %
99.1 %
Degradation Rate
0.90 %
Remaining Useful Life
55000 Hours

FIG. 13A

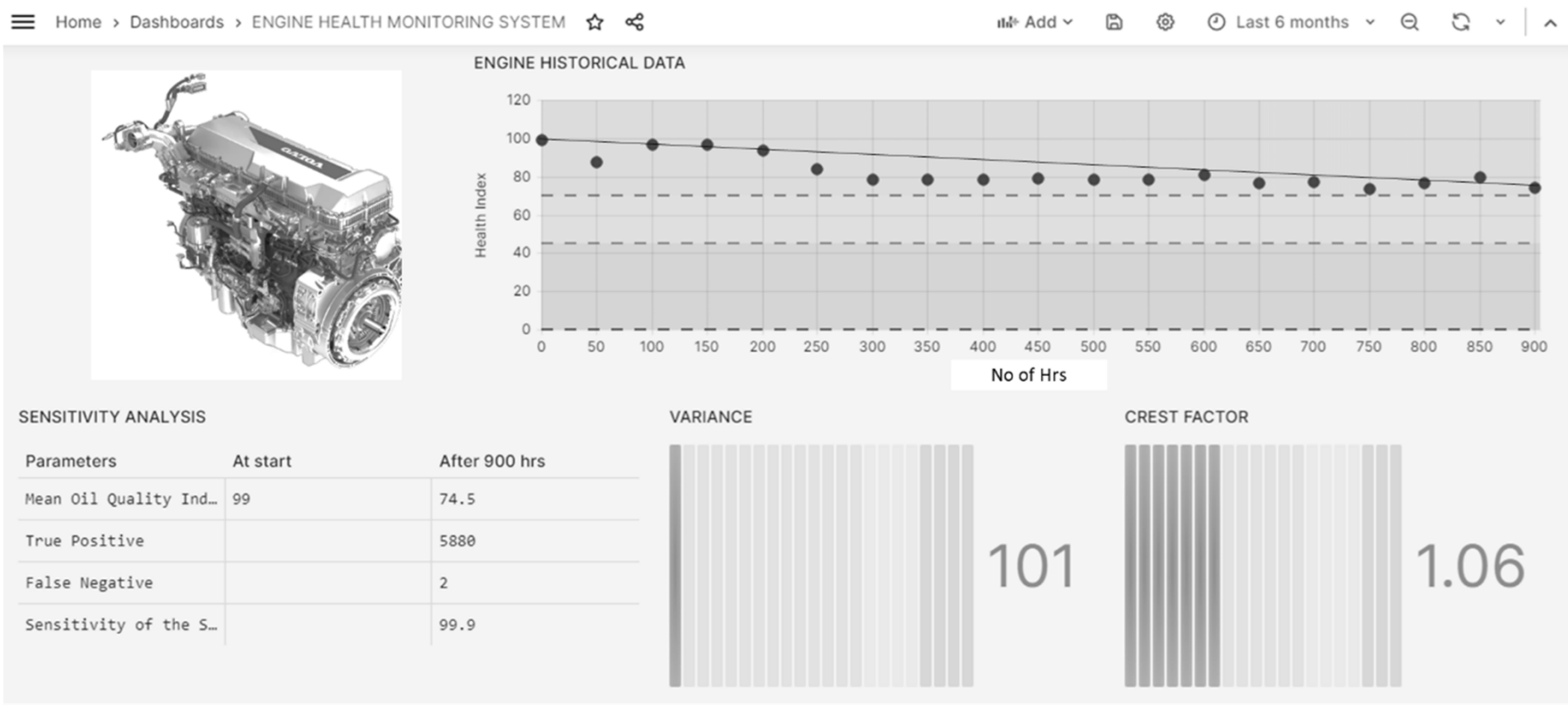

Home › Dashboards › ENGINE HEALTH MONITORING SYSTEM
Add
Last 6 months
ENGINE HISTORICAL DATA
Health Index
120
100
80
60
40
20
0
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900
No of Hrs
SENSITIVITY ANALYSIS
Parameters
At start
After 900 hrs
Mean Oil Quality Ind…
99
74.5
True Positive
5880
False Negative
2
Sensitivity of the S…
99.9
VARIANCE
101
CREST FACTOR
1.06

FIG. 13B