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26 December 2024

~5x increase in engine lifespan (9-year test)

Aim

To quantify the long-term wear reduction from a single application of XcelPlus metal treatment in a real-world engine and to demonstrate that the treatment does not need to be reapplied at every oil change. The study also sought to evaluate the performance of a low-friction engine coating in the presence of adverse conditions such as dirt ingestion and fuel dilution.

Methodology

Vehicle: 2015 Toyota Yaris 1.3 L (2NZ-FE alloy engine), 5-door hatchback
Treatment: A single 100 mL dose of XcelPlus Engine Treatment added at 20,607 km after oil and filter change
Oil Change Interval: Every 10,000 km
Sample Collection: 50 mL oil samples were extracted via dipstick hole using a clean syringe within 5 minutes of shutdown to minimise sedimentation
Analysis:

- Wear Metals: Techenomics using ICP mass spectrometry
- Microscopy: Mainlube at 120,526 km

Summary

After a single XcelPlus treatment, 190,816 km total (170,209 km while treated), and 9 years later, engine wear remained reduced by ~79 % (45 v's 9 ppm): If wear is ~1/5 expected, engine lifespan will increase by ~5x. Wear in the engine remained low even when dirt (aka silicon) ingestion and fuel dilution increased. XcelPlus is responsible for this reduced wear. N.B. Engines become noticeably quieter when the number of particles in the oil decreases.

Experimental

A 50 mL engine oil sample of used oil was taken from the dipstick hole using a clean syringe and tubing. Sampling was carried out within 5 minutes of stopping the car to minimise sedimentation. Techenomics, which uses mass spectroscopy to identify the constituents of oil contamination, carried out the testing. Mainlube carried out microscopy of the oil at 120,526 km.

Discussion: Oil analysis is a simple, cheap, accurate and objective method of quantifying engine wear changes by measuring the contaminants in engine oil. Undertaking a longitudinal study with 18 samples over nine years minimises error and confirms long term efficacy.

XcelPlus is a metal treatment that is applied once every 160,000 km and reduces wear and friction in an engine.

Before treatment with XcelPlus, the engine's wear metals were 45 ppm (20,607 km). After treatment, they were 7 ppm (-84 %) at 190,816 km. Wear metals (45 ppm) and silicon (52 ppm, aka dirt) were the primary contaminants in engine oil before treatment. They occurred in a roughly 50/50 ratio N.B. After treatment, silicon was the primary engine oil contaminant.

During the test, metal wear fluctuated between 5 ~ 16 ppm (11 ppm variation 9 ppm average). Wear correlated to silicon (dirt) levels and fuel dilution. Engine wear remained low despite the ingestion of dirt (abrasive particles) and fuel dilution N.B. Normally dirt and fuel dilution would cause substantial increases in wear e.g. If Si doubles wear would normally double (it would halve lifespan).

Microscopy was carried out at 120,328 km. It shows that the wear metals and dirt (silicon) particles are mainly in the sub-micron range and that "The machine is running very well."

N.B. Engine noise/vibration is reduced when the number and size of circulating particles decreases.

The engine used zero oil between oil changes for the entire test period. Zero oil use indicates that the oil rings have experienced minor wear, compression remains normal, and the oil change intervals are sufficient to protect the engine.

Oil dilution by E10 fuel (10 % ethanol) reduced oil viscosity and lubrication. However, the engine's wear did not change even when the fuel dilution rose to 5 %.

XcelPlus prevented the formation of significant wear particles (-79 % Table 1) and protected against particulate contamination: Demonstrating that a low-friction coating exists.

Other expected benefits of the XcelPlus low-friction coating include improved fuel economy and emissions, temperature reduction, protection against accidental loss of lubrication and longer oil life.

Conclusion

XcelPlus Engine Treatment demonstrated a consistent and substantial reduction in engine wear over 9 years and 170,209 km after a single application. Wear metals were reduced by an average of 79 % with wear reduction remaining low despite the presence of fuel dilution and abrasive particles. After XcelPlus treatment, the engine became noticeably quieter, and the number of circulating particles decreased. Estimated benefits: If wear is reduced to ~1/5 of baseline levels engine lifespan can be reasonably expected to increase by ~5x.

Table 1 Reduction in wear

Sample date	km	Iron	Chromium	Nickel	Aluminium	Copper	Tin	Lead	Total (ppm)	Reduction
22/10/2016	20,607	22	0	2	7	11	2	1	45	Untreated
24/03/2017	30,622	7	0	0	4	3	0	0	14	-69%
5/08/2017	40,988	6	1	0	4	1	1	0	13	-71%
8/01/2018	50,865	4	0	0	3	1	0	0	8	-82%
18/05/2018	60,644	8	0	0	3	1	0	0	12	-73%
30/09/2018	70,960	7	0	0	3	0	0	0	10	-78%
5/02/2019	80,707	4	0	0	5	0	1	0	10	-78%
10/06/2019	90,700	6	0	0	5	0	0	0	11	-76%
24/10/2019	100,593	4	1	0	5	1	4	1	16	-64%
5/02/2020	110,325	2	0	0	3	0	0	0	5	-89%
28/08/2020	120,528	4	0	0	3	0	0	1	8	-82%
7/01/2021	130,383	3	0	0	2	0	1	2	8	-82%
20/05/2021	140,515	6	0	0	1	0	1	0	8	-82%
17/11/2021	150,599	6	0	0	2	0	0	1	9	-80%
2/05/2022	160,401	5	0	0	0	1	0	1	7	-84%
28/09/2022	170,518	5	0	0	0	0	0	0	5	-89%
16/03/2023	180,398	6	0	0	1	0	0	1	8	-82%
12/09/2023	190,816	7	0	0	0	0	0	0	7	-84%
Average treated		5.3	0.1	0	2.6	0.5	0.5	0.4	9.4	-79%

Figure 1 Yaris 2015 white 1.3 L 5-door hatch

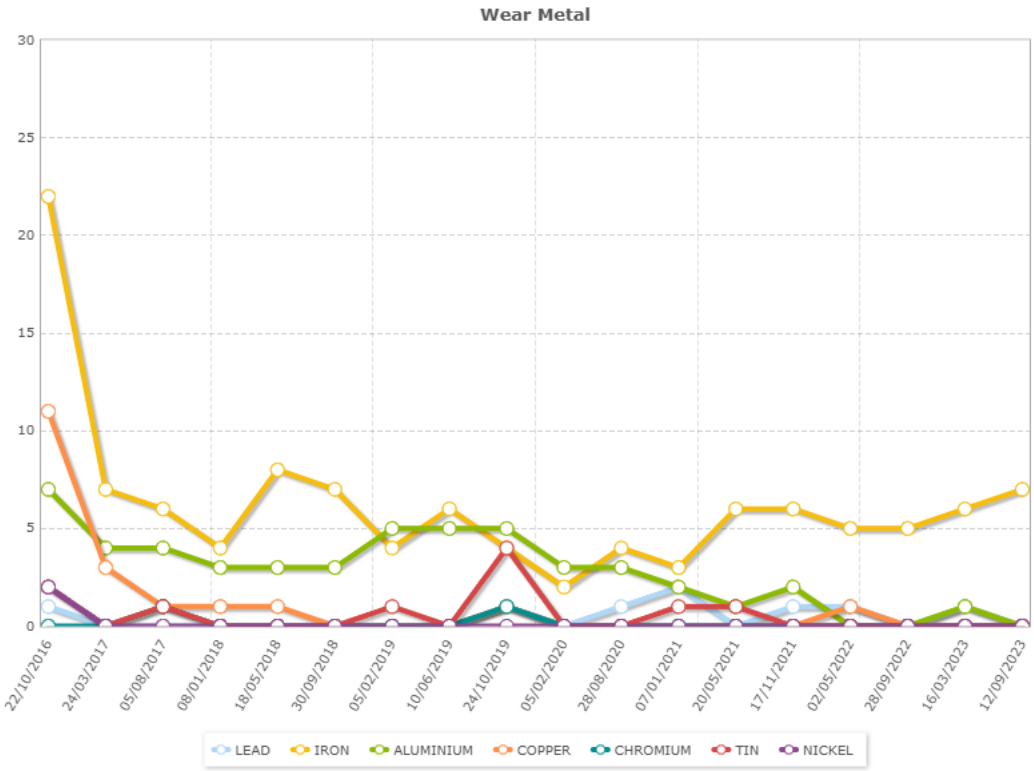


Figure 2 Wear analysis between 2016 (20,607 km) - 2023 (190,816 km) = 170,209 km treated

TECHENOMICS

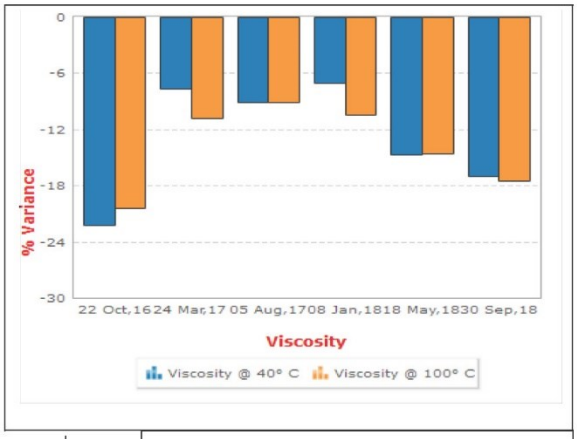
CONDITION MONITORING

DANGER

TECHNICAL ADVANCE FOR ECONOMIC GAIN

Wear Metal Report: 00365042
Client: MICHAEL CZAJKA
Attention:
Machine: TOYOTA YARIS **ID No:** 1FD1FN
Oil Name: SEMI SYN
Visc@40°C: 95 **Visc@100°C:** 14.6 **TBN:** 1.6
Compartm't: TOYOTA YARIS

Sample Date:	22/10/2016	24/03/2017	05/08/2017	08/01/2018	18/05/2018	30/09/2018
Analysis Date:	01/11/2016	29/03/2017	08/09/2017	12/01/2018	25/05/2018	04/10/2018
Sample no:	00343502	00347771	00352928	00356546	00360916	00365042
SMU:	20607 km	30622 km	40988 km	50865 km	60644 km	70960 km
Oil km:	10275	10015	10366	9877	9779	10316
Oil Changed:	Yes	Yes	Yes	Yes	Yes	Yes



Wear Metals	PPM	PPM	PPM	PPM	PPM	PPM	Caut	High
lead	1	0	0	0	0	0	60	80
iron	22	7	6	4	8	7	75	95
aluminium	7	4	4	3	3	3	10	16
copper	11	3	1	1	1	0	20	30
chromium	0	0	1	0	0	0	10	15
tin	2	0	1	0	0	0	10	15
nickel	2	0	0	0	0	0	10	15
Contaminants								
silicon	52	40	42	30	26	30	20	35
sodium	4	5	4	3	5	5	20	30
Oil Additives								
magnesium	3	2	2	1	3	3	0	0
zinc	954	749	702	578	512	609	0	0
molybdenum	6	4	1	0	24	32	0	0
calcium	1767	1732	1731	1519	1187	1383	0	0
phosphorus	n/a	620	629	554	452	538	0	0
boron	n/a	0	0	2	2	3	0	0
Infra Red								
TBN	n/a	n/a	n/a	n/a	n/a	0.3	0	0
soot	1	3	0	0	0	1	50	70
glycol	0	0	0	0	0	0	1	2
water (ppm)	0.1	0.0	0.0	0.0	0.0	n/a	0	0
fuel dilution	1	0	0	0	3	3	1	2
oxidation	15	14	17	16	15	14	30	40
nitration	11	10	11	22	21	20	30	40
sulphation	n/a	n/a	n/a	n/a	n/a	22	0	0
TAN	n/a	n/a	n/a	n/a	n/a	6.1	0	0
zinc dtp	n/a	0	n/a	0	n/a	n/a	0	0

Comments on elevated results

Approved by : Sahar Nazari

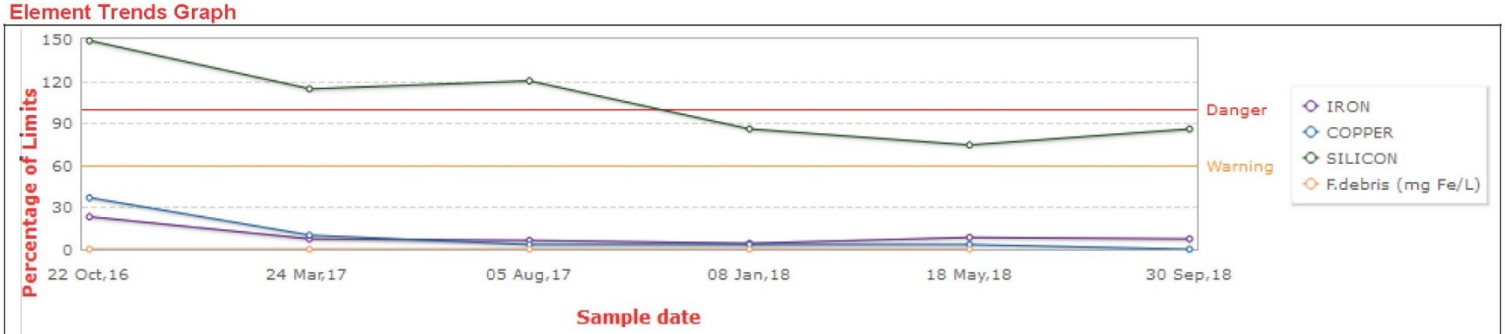
Physical Tests

water %	n/a	n/a	n/a	n/a	n/a	n/a	0	0	
f.debris (mg fe/l)	1	10	n/a	2	1	1	0	0	
viscosity @ 100 oc	14	16	17	16	12	12	+-10	+-30	
viscosity @ 40 oc	112	133	131	134	81	78	+-10	+-30	

Particle Cleanliness Analysis - ISO CODE 4406

4 m	-
6 µm	-
14 µm	-
SAE AS 4059 NAS CODE	-

Element Trends Graph



TECHENOMICS

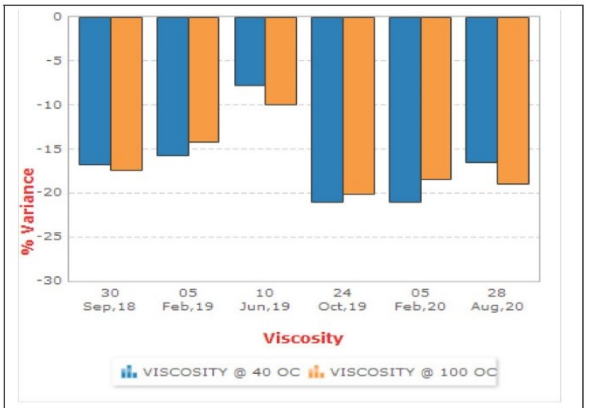
CONDITION MONITORING

WATCH

TECHNICAL ADVANCE FOR ECONOMIC GAIN

Wear Metal Report: 00386805
Client: MICHAEL CZAJKA
Attention:
Machine: TOYOTA YARIS **ID No:** 1FD1FN
Oil Name: SEMI SYN
Visc@40°C: 95 **Visc@100°C:** 14.6 **TBN:** 1.6
Compartm't: TOYOTA YARIS

Sample Date:	30/09/2018	05/02/2019	10/06/2019	24/10/2019	05/02/2020	28/08/2020
Analysis Date:	04/10/2018	12/02/2019	17/06/2019	29/10/2019	10/02/2020	07/09/2020
Sample no:	00365042	00368643	00372626	00376734	00379900	00386805
SMU:	70960 km	80707 km	90700 km	100593 km	110325 km	120528 km
Oil km:	10316	9747	9993	9887	9732	10203
Oil Changed:	Yes	Yes	Yes	Yes	Yes	Yes



Wear Metals	PPM	PPM	PPM	PPM	PPM	PPM	Caut	High
lead	0.0	0.0	0.0	1.0	0.0	1.0	60	80
iron	7.0	4.0	6.0	4.0	2.0	4.0	75	95
aluminium	3.0	5.0	5.0	5.0	3.0	3.0	10	16
copper	0.0	0.0	0.0	1.0	0.0	0.0	20	30
chromium	0.0	0.0	0.0	1.0	0.0	0.0	10	15
tin	0.0	1.0	0.0	4.0	0.0	0.0	10	15
nickel	0.0	0.0	0.0	0.0	0.0	0.0	10	15
Contaminants								
silicon	30.0	27.0	29.0	42.0	32.0	11.0	20	35
sodium	5.0	4.0	2.0	3.0	1.0	2.0	20	30
Oil Additives								
magnesium	3.0	3.0	7.0	6.0	4.0	5.0	0	0
zinc	609.0	550.0	649.0	764.0	572.0	551.0	0	0
molybdenum	32.0	31.0	34.0	9.0	2.0	2.0	0	0
calcium	1383.0	1332.0	1403.0	1794.0	1437.0	1346.0	0	0
phosphorus	538.0	503.0	493.0	620.0	511.0	503.0	0	0
boron	3.0	2.0	3.0	4.0	2.0	4.0	0	0
Infra Red								
TBN	0.3	0.0	0.0	0.2	0.0	0.0	+-25	+-50
soot	1.0	6.0	0.0	0.0	0.0	0.0	50	70
glycol	0.0	0.0	0.0	0.0	0.0	n/a	1	2
water ppm	n/a	n/a	0.0	0.0	0.0	n/a	0	0
fuel dilution	3.0	5.0	2.0	3.0	2.0	2.0	1	2
oxidation	14.0	16.0	16.0	16.0	18.0	19.0	30	40
nitration	20.0	22.0	25.0	31.0	32.0	34.0	30	40
sulphation	22.0	27.0	25.0	23.0	24.0	25.0	30	40
TAN	6.1	n/a	0.0	0.0	0.0	n/a	0	0

Comments on elevated results

All wear rate normal, 2% of fuel dilution detected. Viscosity low, indicating fuel dilution. Please check all injectors, fuel pumps and internal fuel liners for the possible fuel leak. Re-sample at the reduced service interval to further monitor

Analyzed by : Sahar Nazari

Approved by : Sahar Nazari

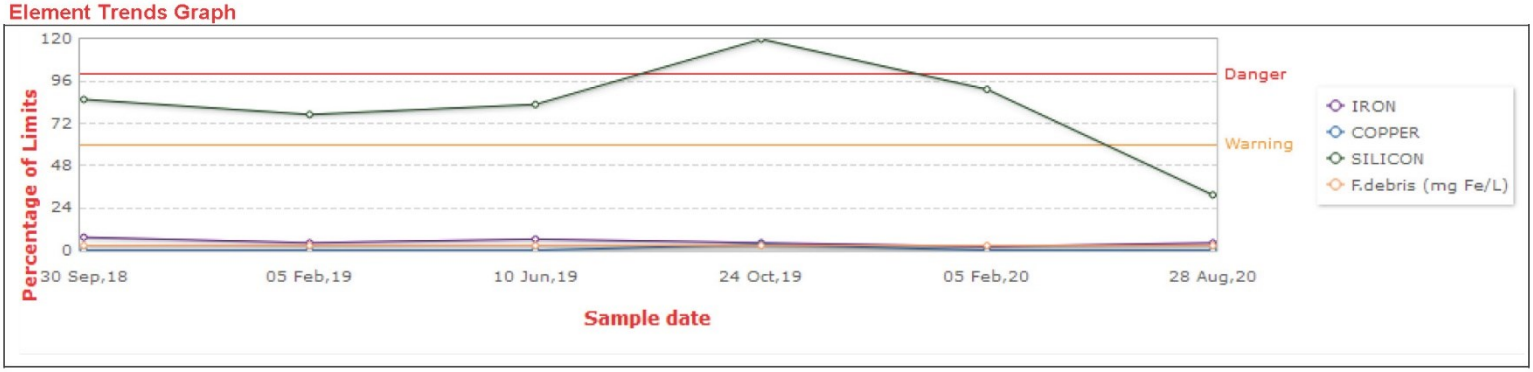
Physical Tests

water %	n/a	n/a	0.0	0.0	0.0	0.0	0	0
f.debris (mg fe/l)	1.0	1.0	1.0	1.0	1.0	1.0	20	38
viscosity @ 100 oc	12.1	12.5	13.1	11.7	11.9	11.8	+-10	+-30
viscosity @ 40 oc	78.9	80.0	87.6	75.0	75.0	79.2	+-10	+-30

Particle Cleanliness Analysis - ISO CODE 4406

4 m	0.00
6 µm	0.00
14 µm	0.00
SAE AS 4059 NAS CODE	-

Element Trends Graph



Techenomics Australia Pty Ltd

Address : 72 BARBER STREET, GUNNEDAH, NSW, 2380

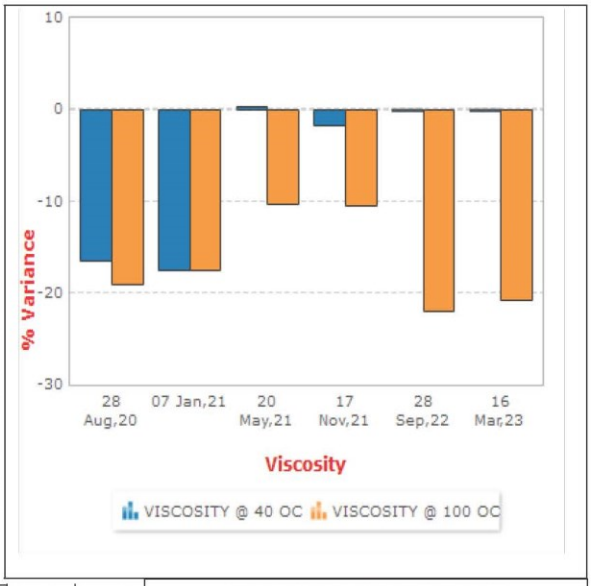
Accreditation No. 20564

WATCH

TECHNICAL ADVANCE FOR ECONOMIC GAIN

Wear Metal Report: 00419528
Client: MICHAEL CZAJKA
Attention: -
Machine: TOYOTA YARIS — **ID No:** 1FD1FN.
Oil Name: LUBRIMAXX POWER SYN ENGINE OIL
Visc@40°C: 105 **Visc@100°C:** 15 **TBN:** 8
Compartm't: TOYOTA YARIS

Sample Date:	07/01/2021	20/05/2021	17/11/2021	02/05/2022	28/09/2022	16/03/2023
Received Date	19/01/2021	27/05/2021	24/11/2021	13/05/2022	10/10/2022	28/03/2023
Analysis Date:	19/01/2021	27/05/2021	24/11/2021	13/05/2022	10/10/2022	28/03/2023
Reported Date	21/01/2021	02/06/2021	24/11/2021	16/05/2022	10/10/2022	29/03/2023
Sample no:	00391402	00395714	00401940	00407998	00413424	00419528
SMU:(hrs)	130383	140515	150599	160401	170518	180398
Oil Hrs:	9855	10132	10429	9802	10117	9880
Oil Changed:	Yes	Yes	Yes	Yes	No	Yes
Component Hours	-	-	-	-	-	-
Wear Metal Rate	0.00	0.00	0.00	0.00	0.00	0.00
Serial Number	-	-	-	-	-	-
Work Order Number	-	-	-	-	-	-



Wear Metals	METHOD	PPM	PPM	PPM	PPM	PPM	PPM	Caut	High
lead (Pb)(mg/kg)	ASTM D5185	2.0	0.0	1.0	1.0	0.0	1.0	9	15
iron (Fe)(mg/kg)	ASTM D5185	3.0	6.0	6.0	5.0	5.0	6.0	60	95
aluminium (Al)(mg/kg)	ASTM D5185	2.0	1.0	2.0	0.0	0.0	1.0	9	15
copper (Cu)(mg/kg)	ASTM D5185	0.0	0.0	0.0	1.0	0.0	0.0	18	30
chromium (Cr)(mg/kg)	ASTM D5185	0.0	0.0	0.0	0.0	0.0	0.0	9	15
tin (Sn)(mg/kg)	ASTM D5185	1.0	1.0	0.0	0.0	0.0	0.0	9	15
nickel (Ni)(mg/kg)	ASTM D5185	0.0	0.0	0.0	0.0	0.0	0.0	9	15
Contaminants									
silicon (Si)(mg/kg)	ASTM D5185	14.0	13.0	13.0	5.0	4.0	8.0	25	35
sodium (Na)(mg/kg)	ASTM D5185	3.0	8.0	7.0	13.0	8.0	4.0	20	30
Oil Additives									
magnesium (Mg)(mg/kg)	ASTM D5185	4.0	298.0	323.0	119.0	72.0	53.0		
zinc (Zn)(mg/kg)	ASTM D5185	555.0	546.0	495.0	840.0	682.0	689.0	0	0
molybdenum (Mo)(mg/kg)	ASTM D5185	2.0	1.0	0.0	2.0	1.0	2.0	0	0
calcium (Ca)(mg/kg)	ASTM D5185	1319.0	806.0	586.0	1353.0	1241.0	1368.0	0	0
phosphorous (P)(mg/kg)	ASTM D5185	475.0	470.0	438.0	665.0	576.0	596.0	0	0
boron (B)(mg/kg)	ASTM D5185	6.0	2.0	3.0	37.0	39.0	35.0	0	0
Infra Red									
TBN(mg KOH/gr)	ASTM E2412	0.1	0.0	0.0	1.5	1.1	1.5	+-25	+-50
TAN(mg KOH/gr)	ASTM D974*	n/a	n/a	n/a	2.4	0.0	0.0	1.5	3
soot(Abs/cm)	ASTM E2412	0.0	0.0	1.0	20.0	18.0	18.0	40	70
glycol(% vol)	ASTM E2412	n/a	n/a	n/a	n/a	n/a	n/a	0	0
water(ppm)	ASTM D6304*	n/a	n/a	n/a	n/a	0.0	0.0	0	0
fuel dilution(% vol)	ASTM D7593	3.0	0.0	1.0	0.0	1.0	1.0	1	3
oxidation((x.100)abs/0.1mm)	ASTM E2412	18.0	21.0	20.0	24.0	23.0	20.0	24	40
nitration((x.100)abs/0.1mm)	ASTM E2412	35.0	35.0	37.0	13.0	13.0	12.0	24	40
sulphation((x.100)abs/0.1mm)	ASTM E2412	24.0	0.0	26.0	30.0	31.0	25.0	24	40
Physical Tests									
water(% vol)	ASTM E2412	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5
F.debris(mg Fe/L)	ASTM D8120*	1.0	12.0	1.0	0.0	2.0	0.0	23	38
visc @ 100oC(cSt)	ASTM D7279	12.0	13.1	13.1	0.0	11.7	11.9	+-10	+-30
visc @ 40oC(cSt)	ASTM D7279	78.3	95.3	93.2	0.0	n/a	n/a	0	0
Iso Code Part/ml(Part/mL)	ISO 4406*	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	0/0/0	-/-/-	-/-/-

Comments on elevated results

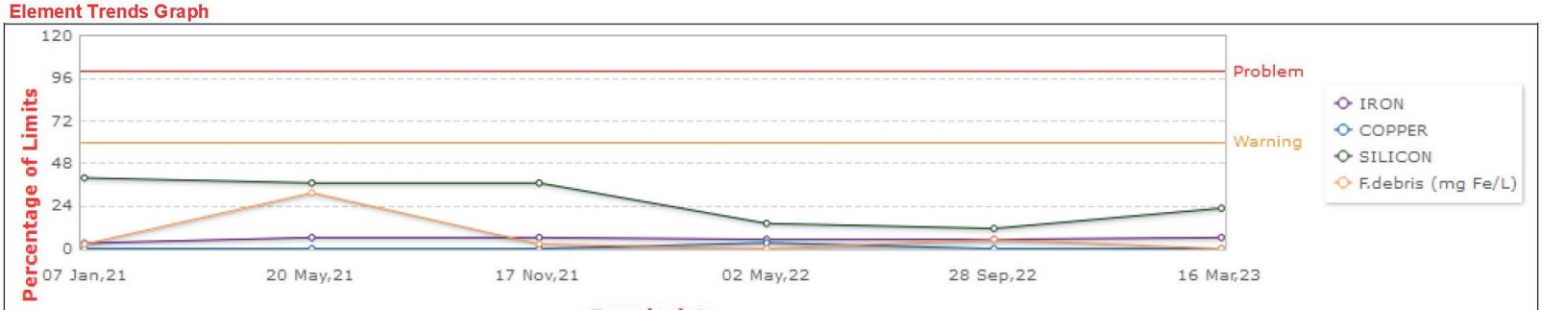
All wear rate normal, 1% of fuel dilution detected. Please check all injectors, fuel pumps, and internal fuel liners for possible fuel leaks. Re-sample at the reduced service interval to further monitor.

Approved by : Keshini Lokhun

Particle Cleanliness Analysis - ISO CODE 4406

4 m	|	0.00
6 µm	|	0.00
14 µm	|	0.00
SAE AS 4059 NAS CODE	|	-

Element Trends Graph



Techenomics Australia Pty Ltd

Address : 72 BARBER STREET, GUNNEDAH, NSW, 2380

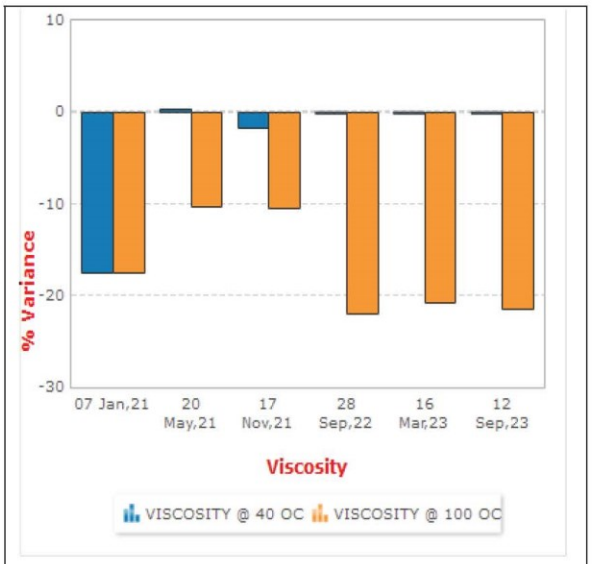
Accreditation No. 20564

WATCH

TECHNICAL ADVANCE FOR ECONOMIC GAIN

Wear Metal Report: 00425745
Client: MICHAEL CZAJKA
Attention: -
Machine: TOYOTA YARIS — **ID No:** 1FD1FN.
Oil Name: LUBRIMAXX POWER SYN ENGINE OIL
Visc@40°C: 105 **Visc@100°C:** 15 **TBN:** 8
Compartm't: TOYOTA YARIS

Sample Date:	12/09/2023
Received Date	19/09/2023
Analysis Date:	19/09/2023
Reported Date	20/09/2023
Sample no:	00425745
SMU:(hrs)	190816
Oil Hrs:	10418
Oil Changed:	Yes
Component Hours	-
Wear Metal Rate	0.00
Serial Number	-
Work Order Number	-



Wear Metals	METHOD	PPM	PPM	PPM	PPM	PPM	PPM	Caut	High
lead (Pb)(mg/kg)	ASTM D5185						0.0	9	15
iron (Fe)(mg/kg)	ASTM D5185						7.0	65	75
aluminium (Al)(mg/kg)	ASTM D5185						0.0	15	22
copper (Cu)(mg/kg)	ASTM D5185						0.0	10	15
chromium (Cr)(mg/kg)	ASTM D5185						0.0	9	15
tin (Sn)(mg/kg)	ASTM D5185						0.0	9	15
nickel (Ni)(mg/kg)	ASTM D5185						0.0	9	15
Contaminants									
silicon (Si)(mg/kg)	ASTM D5185						6.0	18	25
sodium (Na)(mg/kg)	ASTM D5185						2.0	10	18
Oil Additives									
magnesium (Mg)(mg/kg)	ASTM D5185						40.0		
zinc (Zn)(mg/kg)	ASTM D5185						666.0	0	0
molybdenum (Mo)(mg/kg)	ASTM D5185						2.0	0	0
calcium (Ca)(mg/kg)	ASTM D5185						1332.0	0	0
phosphorous (P)(mg/kg)	ASTM D5185						566.0	0	0
boron (B)(mg/kg)	ASTM D5185						39.0	0	0
Infra Red									
TBN(mg KOH/gr)	ASTM E2412						3.6	+-25	+-50
TAN(mg KOH/gr)	ASTM D974*						0.0	1.5	3
soot(Abs/cm)	ASTM E2412						1.0	40	70
glycol(% vol)	ASTM E2412						n/a	0	0
water(ppm)	ASTM D6304						0.0	0	0
fuel dilution(% vol)	ASTM D7593						2.00	1	3
oxidation((x.100)abs/0.1mm)	ASTM E2412						20.0	24	40
nitration((x.100)abs/0.1mm)	ASTM E2412						15.0	24	40
sulphation((x.100)abs/0.1mm)	ASTM E2412						30.0	24	40

Comments on elevated results

All wear rate normal, 2% of fuel dilution detected. This is common in a petrol vehicle. Viscosity is slightly reduced due to fuel dilution. Continue to sample at regular service interval.

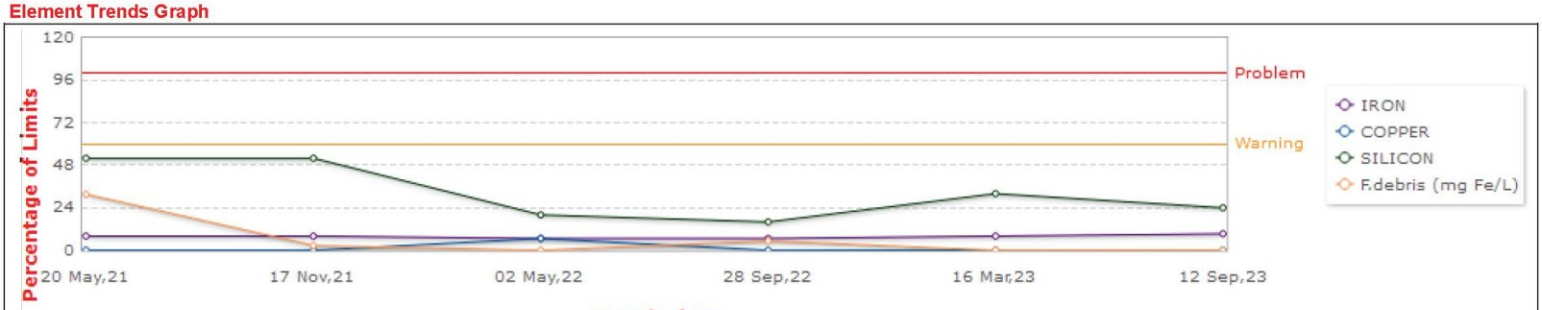
Approved by : Abu Bakkar Siddique

Physical Tests									
water(% vol)	ASTM E2412						0.0	0.2	0.5
F.debris(mg Fe/L)	ASTM D8120						0.0	23	38
visc @ 100oC(cSt)	ASTM D7279						11.8	+-10	+-30
visc @ 40oC(cSt)	ASTM D7279						n/a	0	0
Iso Code Part/ml(Part/mL)	ISO 4406*						0/0/0	-/-/-	-/-/-

Particle Cleanliness Analysis - ISO CODE 4406

4 m	|	0.00
6 µm	|	0.00
14 µm	|	0.00
SAE AS 4059 NAS CODE	|	-

Element Trends Graph



Mainlube Superior Maintenance Lubricants Pty Ltd

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A.C.N. 003-602-195

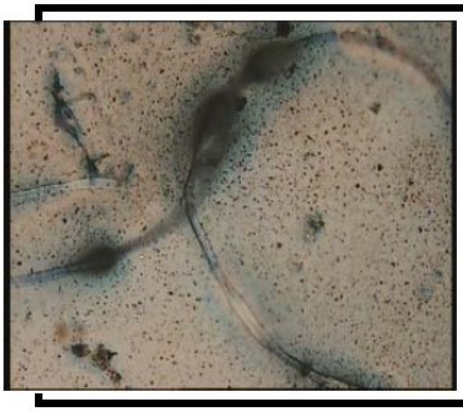
DATE 01/09/20

Wear Metal Analysis No 20060 Michael Czajka- Toyota - Motor

Attention; Michael

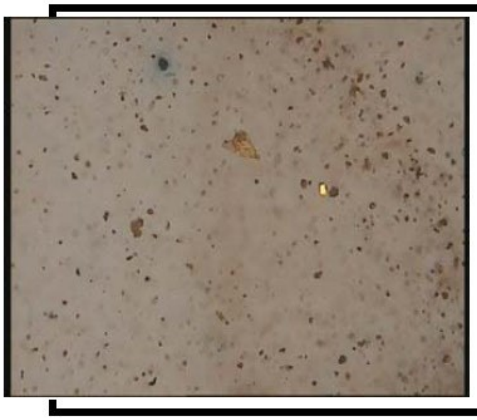
Objective. Check oil for Wear Metal Particles and any possible contamination, Information found used to establish machine condition and future maintenance requirements.

Method. Sample of approx 100 mL received from **Toyota Yaris motor @ 120,528 km, 10,203 km on Tritech Lubricants Semi Synthetic 10W40.** Sample preparation in accordance with Mainlube standard laboratory practices. One sample processed 1 mL in volume; therefore the amount seen in the pictures is the actual debris concentration per ml of oil.

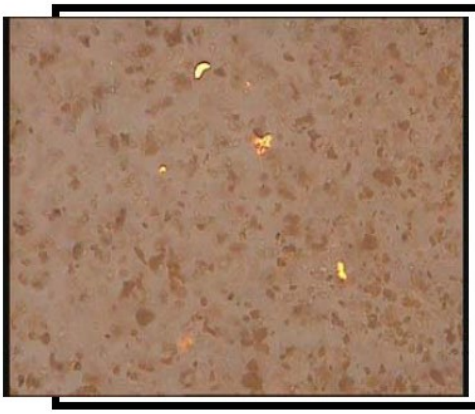


One mL of the sample oil has been forced through a 13 mm diameter **1 micron membrane filter** @ 150 P.S.I. The membrane filter has caught any contaminates present, filters are glass slide mounted for examination.
This image represents a 1-mm diameter circle focused on the top layer of the filter @ **100X**. The coloured background is the microscopes bottom light shining up through the glass slide illustrating density level of dirt, metal chunks and debris particles.

This image demonstrates the average debris level for sample No. 20060
To achieve an acceptable life from this application,
this image should be clear, no particles



Overview density of dirt,
Wear Metal Chunks and debris particles @ 200X.



Overview density of dirt,
Wear Metal Chunks and debris particles @ 500X.

Recommendations

This machine is running very well.

The only metal showing is normal rubbing wear, which cannot even be classed as an abnormal wear mode.

Recheck again next oil change

This analysis is intended as an aid in predicting mechanical wear, and should be used in conjunction with (and not as a replacement for) your normal maintenance routine for the care of your machinery. The user will take all care in the processing of samples but no guarantee, express or implied, is made against failure of this piece of equipment or a component part hereof.

Steve Simmonds ATCAE
Managing Director