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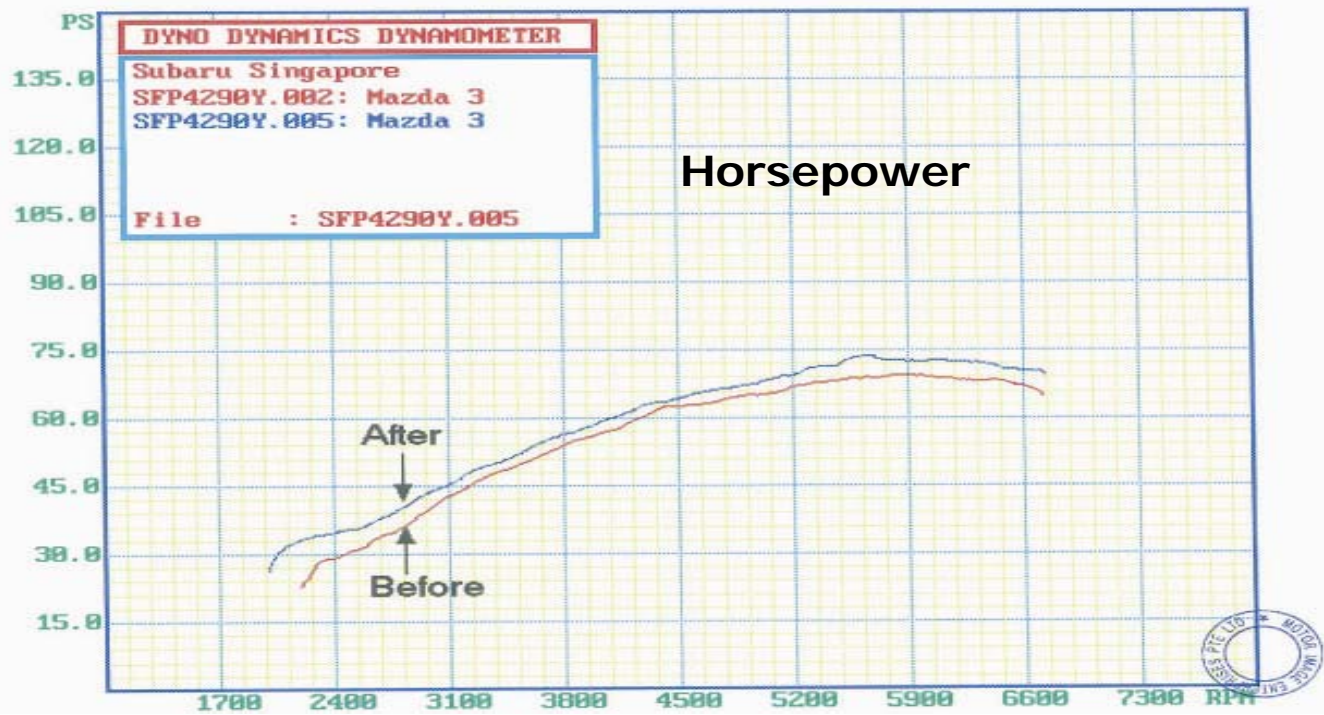
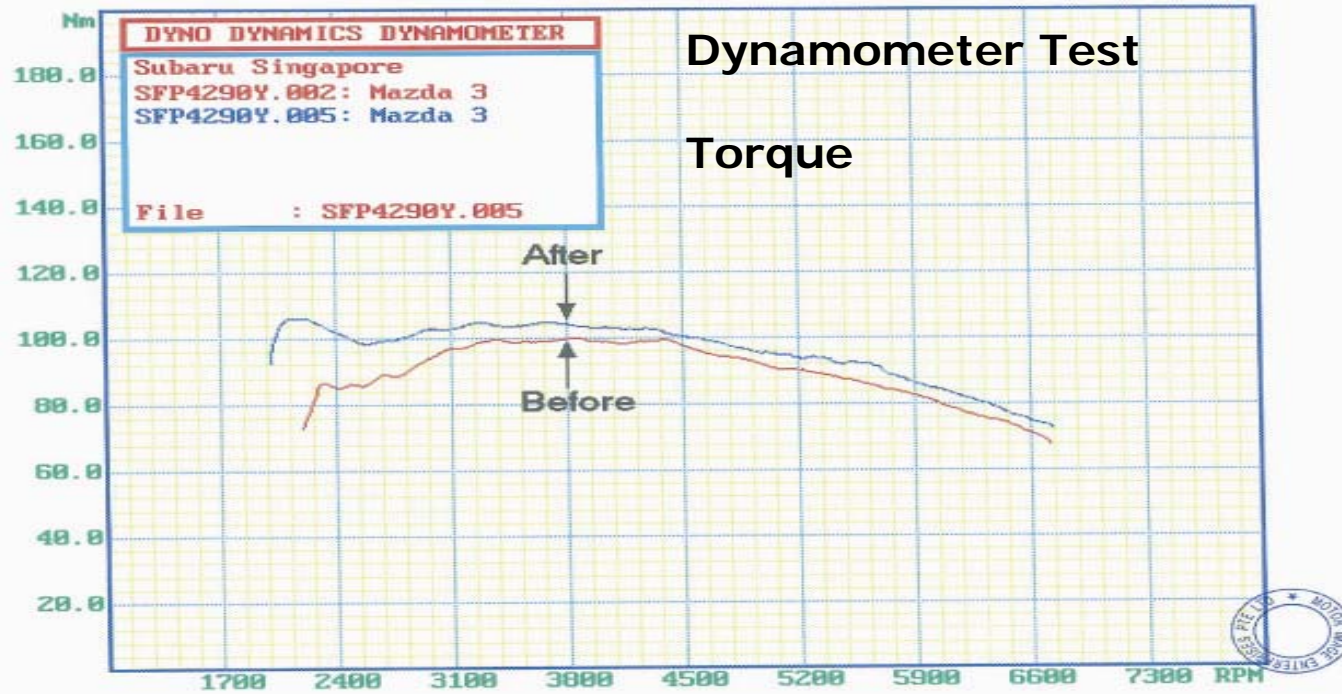
## Dyno & Engine Pressure Analysis

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- Dynamometer Test
  - Subaru – Motor Image Enterprises
  - Dyno Used – Dyno Dynamics
  - Car Tested – Mazda 3
  
- Engine Pressure Analysis
  - UM2 Performance Tuning
  - Car Tested – Toyota Wish





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# Engine Pressure Analysis

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Used by major OEM manufacturers and F1 Racing teams to study the in cylinder combustion process.

Utilising pressure sensors located in the combustion chamber to record pressure data. It is akin to having a window to the combustion chamber.

Engine Pressure Analysis provides insights of what the activities in the combustion chamber during combustion which no other equipment can do.

The various graphs and data will assist the user in understanding and explaining what is/are the exact causes of higher or lower horsepower and torque.



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# Equipment

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- A spark plug with a fibre optic pressure sensor inserted
- A crank sensor
- A crank trigger wheel
- Data Logger
- Software to interpret the data



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## Procedure

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- Conduct a before and after treatment data logging runs
- 2 types of run will be recorded; Steady State Load and Wide Open Throttle (WOT)
- Each log will consist of about 5 to 8 seconds worth of data

## Maximum Cylinder Pressure and Location



## Maximum Cylinder Pressure and Location







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## Maximum Cylinder Pressure and Location

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- Graph shows maximum pressure and location of maximum pressure relative to TDC (Top Dead Center)
- White line is RPM (Revolution Per Minute)
- Blue line is the value for each cycle
- Pink line is the average value

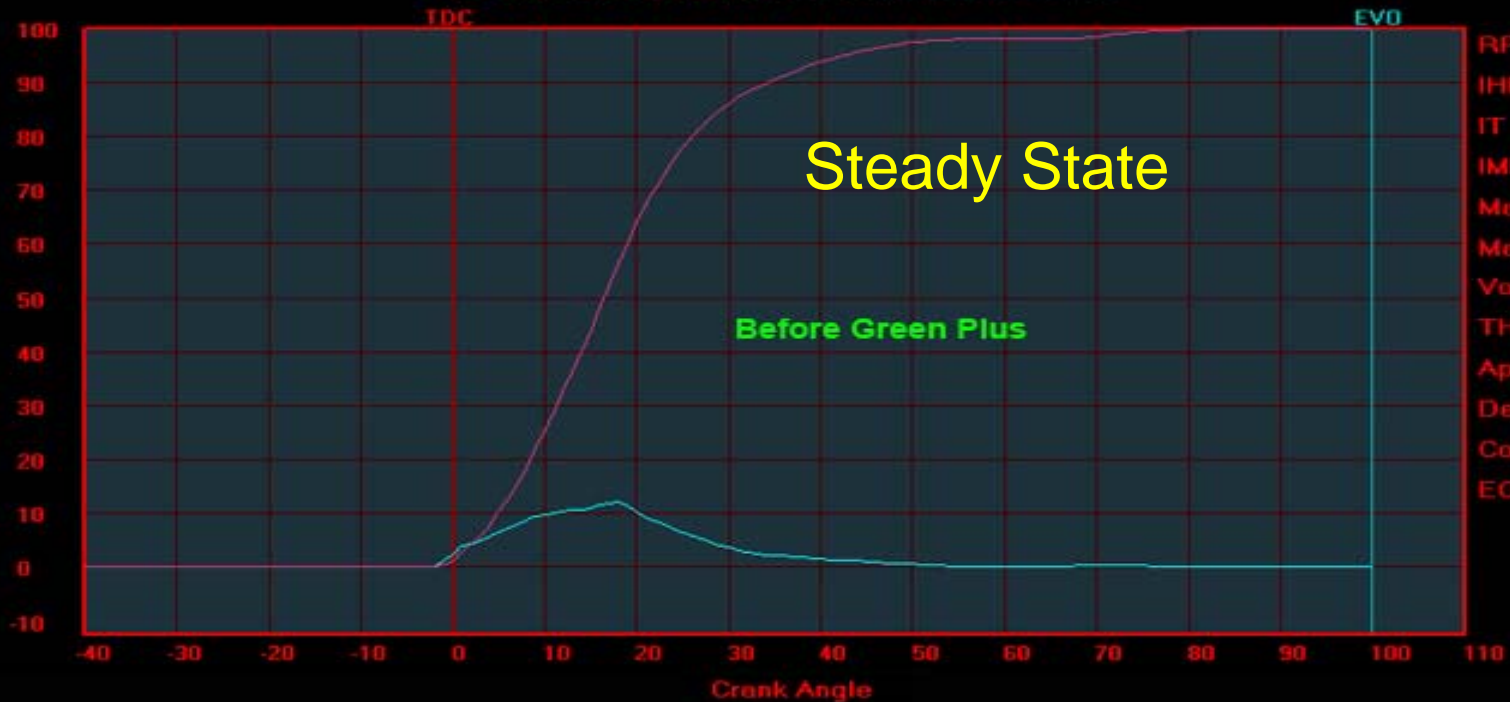
### **Differences between before and after:**

- Less variation between each cycle
- Higher average value
- Ascending average value at higher RPM
- Maximum pressure occurring earlier for fuel with catalyst particularly at higher RPM
- Maximum pressure occurring later for non treated fuel particularly at higher RPM

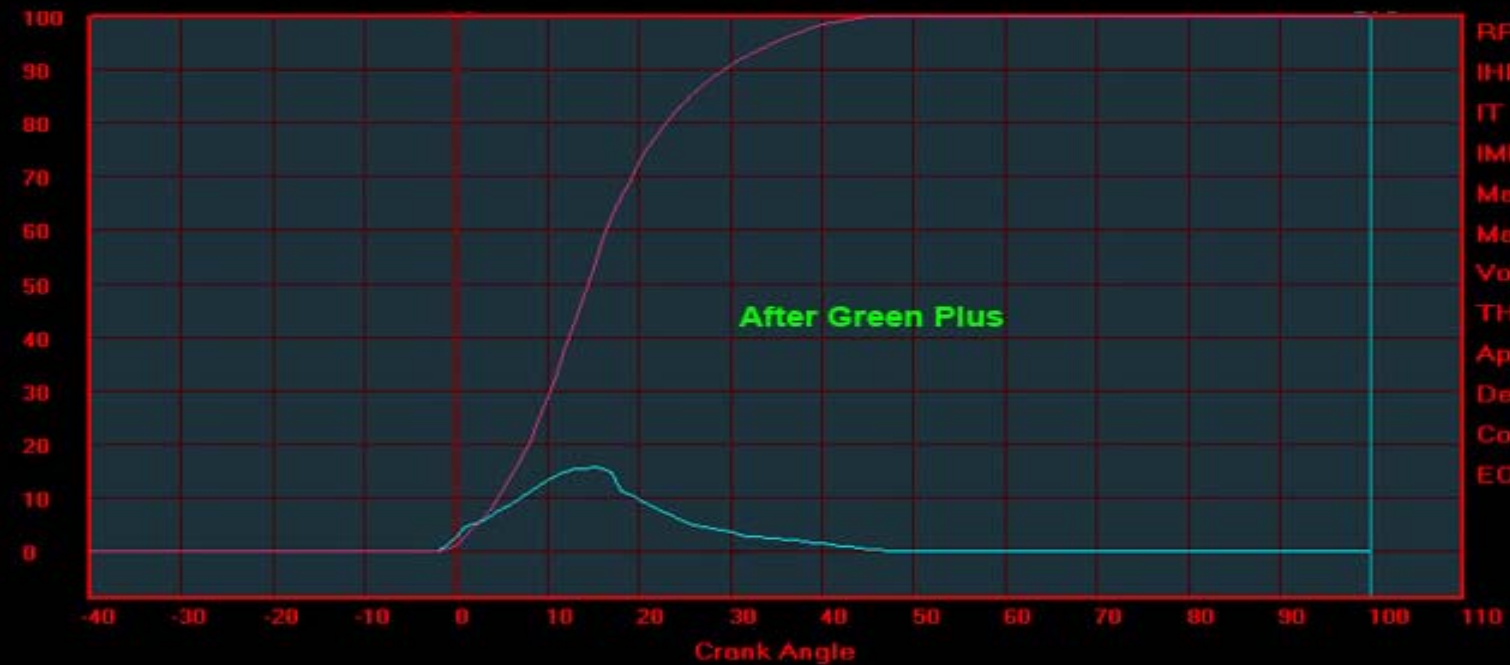


## Individual Graphs at Particular RPM

### Combustion Rate / Fraction Burned %



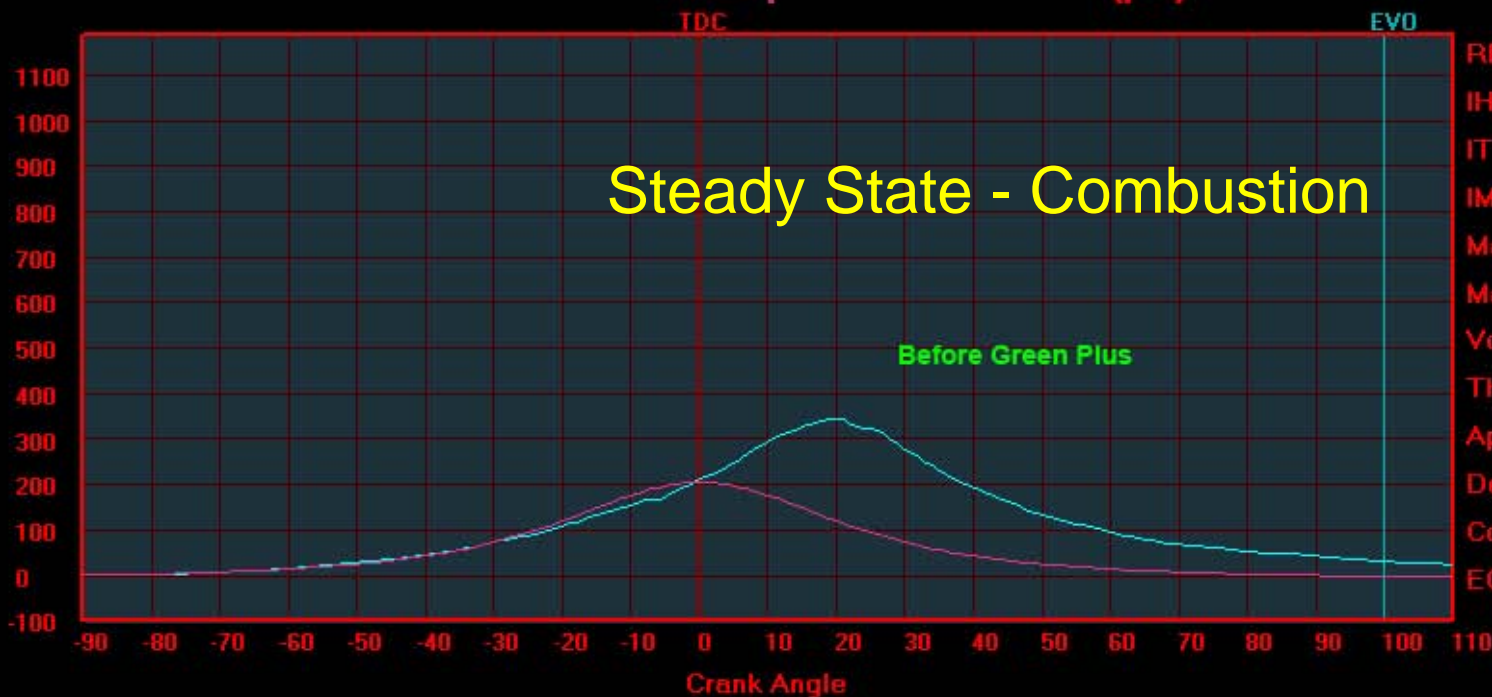
RPM	2080
IHP	8.3 [ 33.2 ]
IT	21 [ 84 ]
IMEP	80
Max CP	345 @ 20 ATDC
Max CPR	11 @ 9 ATDC
Vol. Eff.	69
THR	0.0143
App. Eff.	54.3
Det. Rating	0
Comb. Dur.	36
EOP	31



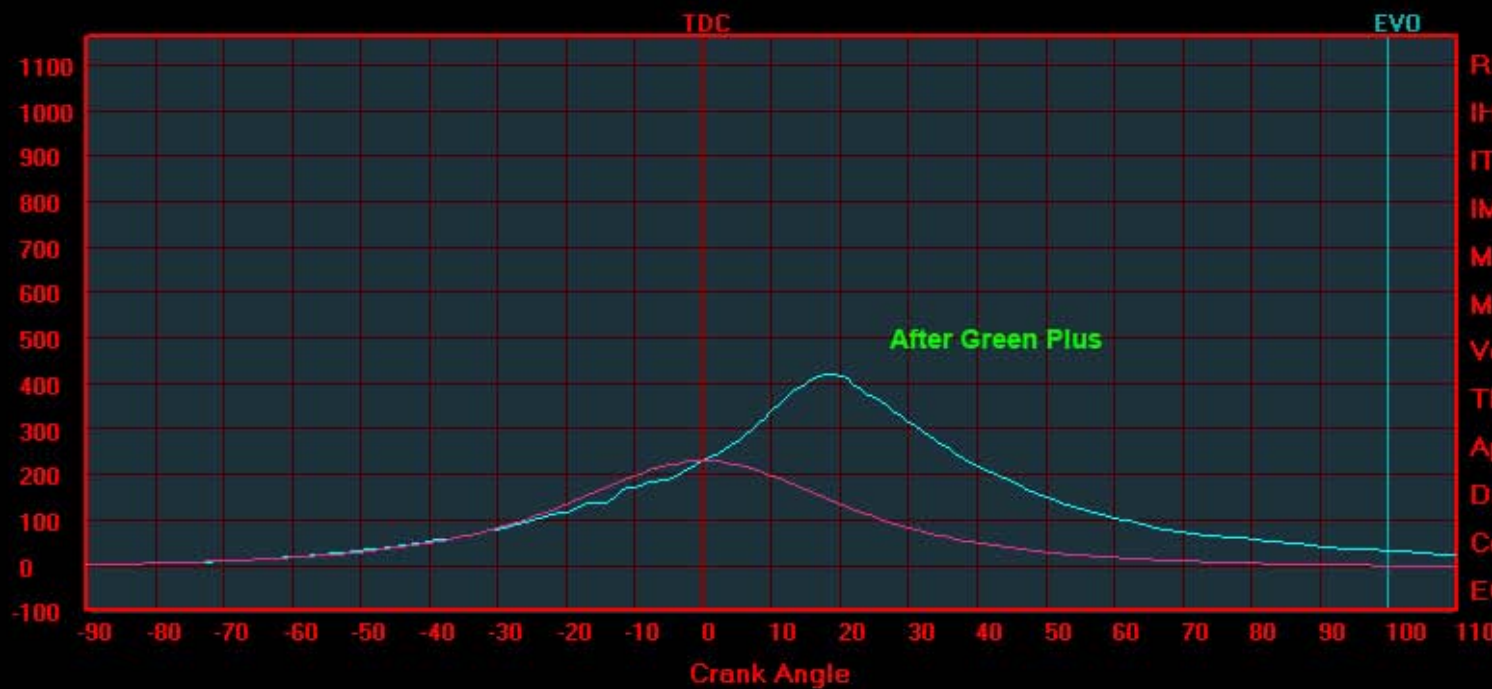
RPM	2080
IHP	9.2 [ 36.8 ]
IT	23.2 [ 92.8 ]
IMEP	88
Max CP	421 @ 19 ATDC
Max CPR	15 @ 10 ATDC
Vol. Eff.	74
THR	0.0157
App. Eff.	54.3
Det. Rating	0
Comb. Dur.	31
EOP	34

## Combustion/Compression Pressure (psi)

# Steady State - Combustion



RPM	2080
IHP	8.3 [ 33.2 ]
IT	21 [ 84 ]
IMEP	80
Max CP	345 @ 20 ATDC
Max CPR	11 @ 9 ATDC
Vol. Eff.	69
THR	0.0143
App. Eff.	54.3
Det. Rating	0
Comb. Dur.	36
EOP	31



RPM	2080
IHP	9.2 [ 36.8 ]
IT	23.2 [ 92.8 ]
IMEP	88
Max CP	421 @ 19 ATDC
Max CPR	15 @ 10 ATDC
Vol. Eff.	74
THR	0.0157
App. Eff.	54.3
Det. Rating	0
Comb. Dur.	31
EOP	34



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## Steady Load Before Treatment vs After Treatment

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	<b>Before Green Plus</b>	<b>After Green Plus</b>
<b>RPM</b>	2080	2080
<b>IHP</b>	8.3 (33.2)	9.2 (36.8)
<b>IT</b>	21 (84)	23.2 (92.8)
<b>IMEP</b>	80	88
<b>Max CP</b>	345 at 20 ATDC	421 at 19 ATDC
<b>Vol Eff</b>	69	74
<b>THR</b>	0.0143	0.0157
<b>App Eff</b>	54.3	54.3

### **Summary:**

- Indicated Horsepower, Torque and Max Compression Pressure are higher after treatment.
- Maximum Compression Pressure occurring earlier – faster burn rate
- Increased in volumetric efficiency
- More heat is produced as indicated by higher THR

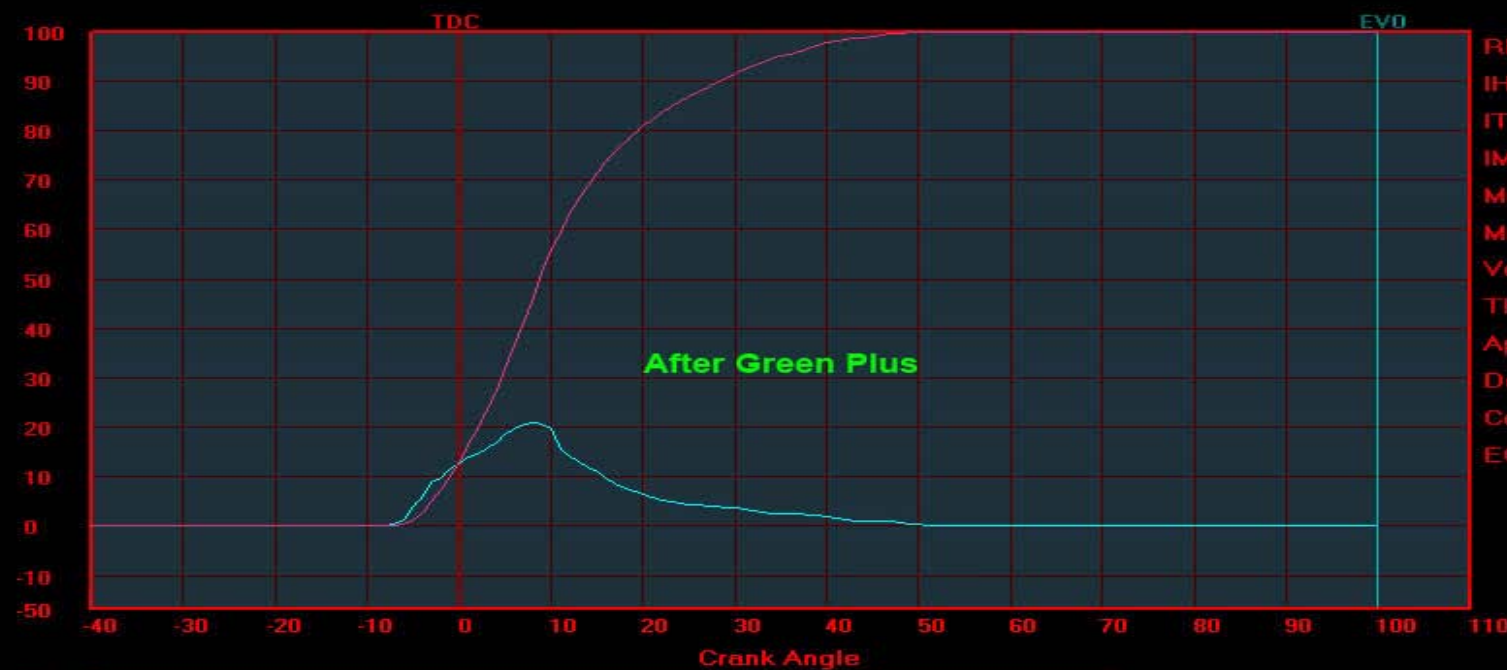
### Combustion Rate / Fraction Burned %



Wide Open Throttle (WOT)

Before Green Plus

RPM	3306
IHP	19.5 [ 78 ]
IT	31 [ 124 ]
IMEP	118
Max CP	530 @ 18 ATDC
Max CPR	20 @ 8 ATDC
Vol. Eff.	85
THR	0.0207
App. Eff.	55.2
Det. Rating	0
Comb. Dur.	36
EOP	51



After Green Plus

RPM	3304
IHP	20.5 [ 82 ]
IT	32.5 [ 130 ]
IMEP	124
Max CP	651 @ 12 ATDC
Max CPR	45 @ -11 ATDC
Vol. Eff.	86
THR	0.0211
App. Eff.	56.7
Det. Rating	0
Comb. Dur.	36
EOP	48



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## Wide Open Throttle Before Treatment vs After Treatment

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	<b>Before Green Plus</b>	<b>After Green Plus</b>
<b>RPM</b>	3306	3304
<b>IHP</b>	19.5 (78)	20.5 (82)
<b>IT</b>	31(124)	32.5(130)
<b>IMEP</b>	118	124
<b>Max CP</b>	530 at 18 ATDC	651 at 12 ATDC
<b>Vol Eff</b>	85	86
<b>THR</b>	0.0207	0.0211
<b>App Eff</b>	55.2	56.7

### **Summary:**

- Indicated Horsepower, Torque and Max Compression Pressure are higher after treatment.
- Maximum Compression Pressure occurring earlier – faster burn rate
- More heat is produced as indicated by higher THR



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## Conclusion

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The catalyst clearly does make a difference to the max pressure. Maximum pressure is higher and occurs earlier. This is particularly true at higher engine speed where the non-treated fuel max pressure location starts to occur later and later. The burn rate is faster with the additive and the amount of energy release is greater.

Due to the more stable peak to peak combustion cycles, it also indicates that the treated fuel will result in a smoother running engine.

Further the spark plugs from the tested engine have lesser carbon deposit versus plugs from a non fuel-treated engine.

In conclusion, using the treated fuel, one would expect a cleaner and smoother running engine with an increase of about 5% in horsepower and torque.

A decorative graphic at the bottom of the slide, consisting of a solid green shape that forms a wave-like pattern across the width of the page.