



Team Results for Clean Snowmobile Challenge 2019 Team 104



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/05 11:06:50
Team Name : Buffalo
Team Number : 104
Model : Smart Car Diesel
Engine : Mercedes
Displacement[cc] : 799.00
100% Speed : 3878
100% Torque : 74.1
No of Strokes : 4
Fuel : Diesel H/C: 1.81 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	30.7	13.0	7.5	3.7	0.0	9.9
HC_m g/hr	:	2.44	0.00	0.00	0.55	0.08	0.11
CO_m g/hr	:	0.08	0.02	0.00	0.03	0.01	0.04
NOx_m g/hr	:	342.64	106.55	71.73	37.86	17.77	99.05
Soot_m mg/hr	:	1.88	1.50	1.26	0.90	0.60	-0.92
N2O_m mg/hr	:	0.15	0.03	0.02	0.04	0.02	0.05
CO2_m g/hr	:	25670.31	11208.85	7205.75	4752.46	1431.82	9870.24
CH4_m g/hr	:	0.29	0.08	0.08	0.18	0.10	0.13
W_HC g/hr	:	0.29	0.00	0.00	0.17	0.00	0.11
W_CO g/hr	:	0.01	0.01	0.00	0.01	0.00	0.04
W_NOx g/hr	:	41.12	28.77	17.93	11.74	0.89	99.05
W_HCNOx g/hr	:	41.41	28.77	17.93	11.91	0.89	99.16
W_Soot mg/hr	:	0.23	0.41	0.32	0.28	0.03	-0.92
W_N2O g/hr	:	0.02	0.01	0.01	0.01	0.00	0.05
W_CO2 g/hr	:	3080.44	3026.39	1801.44	1473.26	71.59	9870.24
W_CH4 g/hr	:	0.03	0.02	0.02	0.05	0.00	0.13

Total Weighted Power [kW] 10.222

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	0.47	0.02	100.44	100.91
Specific Mass [g/kW-hr]	0.05	0.00	9.83	9.87
BSFC [g/kW-hr]	305.0			

Total Soot [mg/hr] 1.26 Specific Soot [mg/kW-hr] 0.12

Not Used for Competition

Total N2O [mg/hr]	0.04	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	9453.12	Specific CO2 [g/kW-hr]	924.81
Total CH4 [g/hr]	0.14	Specific CH4 [g/kW-hr]	0.01
RMC BSFC [g/kW-hr]	314.90		

EMISSION TESTS:

	Value	Limit	Result
Power	30.08	<96.94 kW	PASS
Soot	0.12	<50 mg/kW-hr	PASS
CO	0.00	<275 g/kW-hr	PASS
HC + NOX	9.87	<90 g/kW-hr	PASS
E-Score	203.42	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



Team Results for Clean Snowmobile Challenge 2019 Team 104



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	3877.49	3296.47	2908.73	2518.91	900.28	2951.72
Torque	Nm	75.59	37.76	24.52	14.09	0.00	31.88
Power	kW	30.70	13.04	7.47	3.72	0.00	9.85
BSFC	g/kw-hr	262.95	270.29	303.29	402.22	**	314.90
Fuel	g/hr	8071.31	3523.24	2264.95	1494.39	450.14	3102.60
T_int	degC	46.50	32.11	31.05	30.99	24.14	32.33
RelHumid	%	18.96	17.88	14.57	20.21	14.96	17.37
Baro	in Hg	28.71	28.72	28.72	28.71	28.72	28.72
Baro	mmHg	729.29	729.50	729.53	729.35	729.57	729.44
Pvap_kPa	kPa	1.43	0.67	0.52	0.72	0.37	0.66
Pvap_inHg	inHg	0.42	0.20	0.15	0.21	0.11	0.20
AbsHumidity	grains/lb	64.99	30.31	23.36	32.39	16.71	29.77
SatPres	kPa	95.80	96.59	96.74	96.52	96.89	96.59
Hum Factor		0.96	0.83	0.80	0.83	0.78	0.82
F_fac		1.09	1.04	1.04	1.04	1.02	1.04
K_fac		1.07	1.05	1.05	1.05	1.03	1.05
Humidity	g/kg	9.28	4.33	3.34	4.63	2.39	4.25
H2		0.00	0.00	0.00	0.00	0.00	0.00
WetDry Factor		0.92	0.95	0.95	0.96	0.98	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 104



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	24.62	0.01	0.00	13.54	3.15	1.79
CO	%	0.00	0.00	0.00	0.00	0.00	0.00
N2O	ppm	4.84	1.37	1.38	3.02	2.64	2.30
CH4	ppm	2.54	1.14	1.37	3.73	3.40	1.88
CO2	%	8.14	5.46	4.60	3.66	1.78	5.00
O2	%	8.32	12.26	13.54	14.84	17.29	13.55
CNOx	ppm	1039.64	496.74	438.13	278.64	211.60	480.14
AHC	ppm	0.00	0.00	0.00	0.00	0.00	0.00
C2H2	ppm	0.13	0.02	0.01	0.07	0.01	0.03
C2H4	ppm	0.29	0.18	0.14	0.15	0.11	0.18
C3H6	ppm	0.31	0.36	0.27	0.20	0.35	0.30
C4H6	ppm	0.49	0.41	0.34	0.31	0.29	0.36
ETOH	ppm	2.32	1.87	1.59	1.77	1.41	1.88
H2O	%	7.72	5.29	4.51	3.71	2.24	0.00
HCHO	ppm	2.03	0.01	0.01	0.80	0.00	0.39
HCN	ppm	0.59	0.24	0.24	0.18	0.16	0.25
HNCO	ppm	2.46	1.67	1.37	1.83	1.12	1.82
MECHO	ppm	0.01	0.00	0.00	0.00	0.00	0.00
NC5	ppm	1.65	1.35	1.37	1.36	1.17	1.39
NH3	ppm	0.04	0.03	0.03	0.04	0.03	0.04
NO	ppm	963.84	327.34	277.23	232.32	67.29	371.15
NO2	ppm	125.10	273.66	267.22	102.15	202.32	211.07
Soot	mg/m3	0.01	0.01	0.01	0.01	0.01	-0.01
AFR	:1	24.77	36.99	43.97	55.05	111.43	41.64



Team Results for Clean Snowmobile Challenge 2019 Team 104



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.000	0.003	7.715	80.937	0.936	24.730	0.588
2	0.000	0.000	5.290	79.564	0.920	36.912	0.400
3	0.000	0.000	4.511	79.167	0.915	43.882	0.341
4	0.000	0.001	3.707	78.417	0.906	54.971	0.280
5	0.000	0.000	2.237	76.777	0.887	111.231	0.169

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	2.440	-3.636	-0.455	-4.091	95.740	4.260
2	0.001	-3.458	-0.432	-3.890	95.368	4.632
3	0.000	**	**	**	**	**
4	0.553	-2.732	-0.341	-3.073	95.493	4.507
5	0.079	-1.515	-0.189	-1.704	95.495	4.505

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	30.695	13.035	7.468	3.715	0.000	9.853
BSFC	g/kw-hr	262.95	270.29	303.29	402.22	**	314.90
Fuel_MassFlow	g/hr	8071.3	3523.2	2264.9	1494.4	450.1	3102.6
HC_m	g/hr	2.4402	0.0006	0.0000	0.5531	0.0794	0.1107
CO_m	g/hr	0.079021	0.020454	0.000000	0.030657	0.008984	0.043886
CO2_m	g/hr	25670	11209	7206	4752	1432	9870
TW_Power	kW	10.222					
TW_BSFC	g/kw-hr	305.04					
Fuel_MassFlow	g/hr	8071.3	3523.2	2264.9	1494.4	450.1	3102.6
FuelCalc	g/hr	8071.5	3523.2	2264.9	1494.4	450.1	3102.6
FuelCalcDev	%	-0.0027711	0.0018143	0.0018168	-0.0037993	-0.0008611	0.0012751

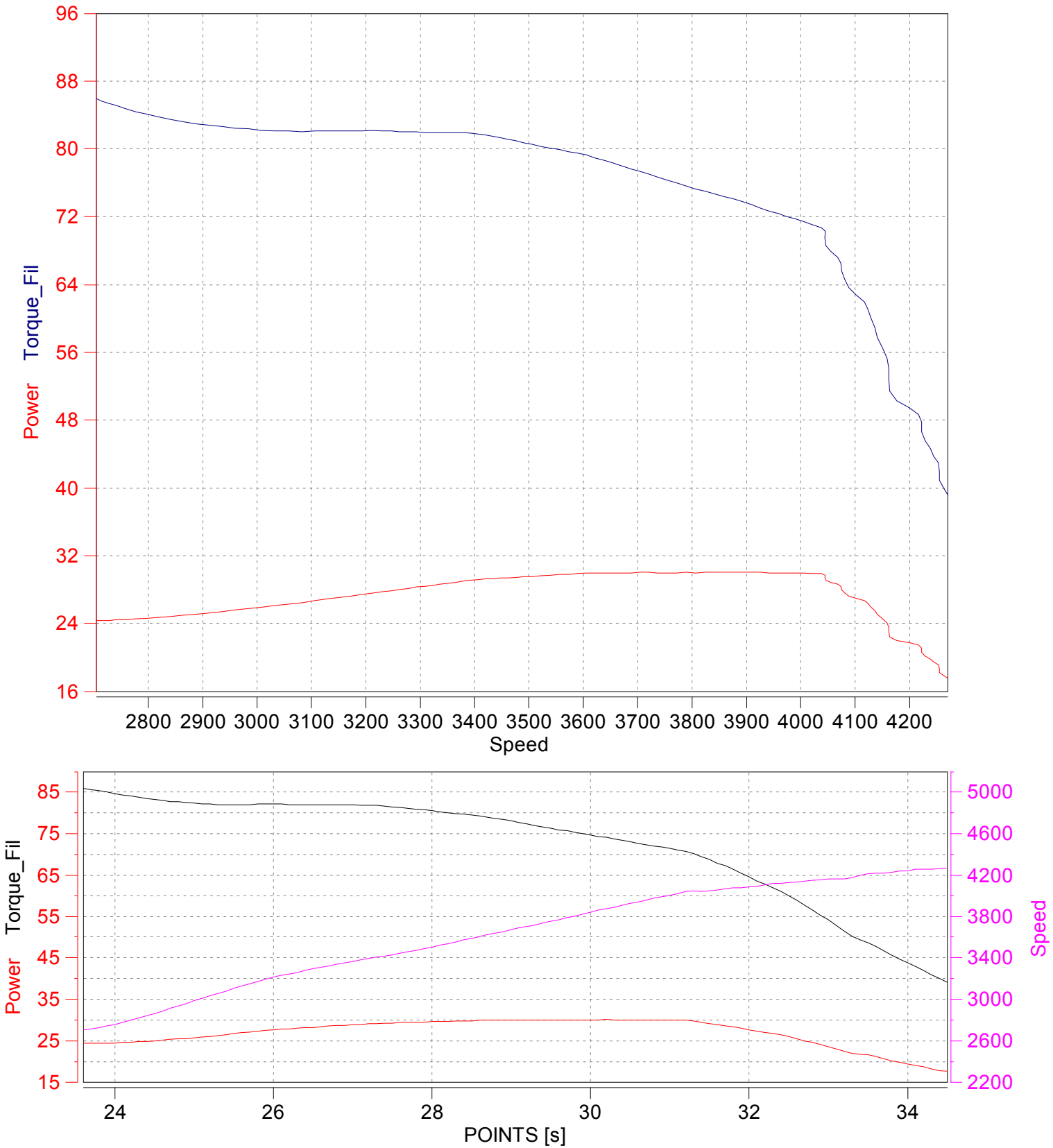
\$HCR_ENG	1.808
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.86826

Power Run

Team 104

TeamNumber	104
TeamName	Buffalo
Model	Smart Car Diesel
Engine	Mercedes

Displacement cc	799.00
RatedSpeed	3878
RatedTorque	74.1





Team Results for Clean Snowmobile Challenge 2019 Team 2



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/06 14:42:06
Team Name : UMD
Team Number : 2
Model : Ranger
Engine : Polaris
Displacement[cc] : 1000.00
100% Speed : 7803
100% Torque : 60.6
No of Strokes : 4
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	49.5	21.5	12.4	6.1	0.0	16.1
HC_m g/hr	:	20.31	14.96	7.83	4.69	0.39	3.67
CO_m g/hr	:	646.22	360.95	246.39	173.84	0.02	305.07
NOx_m g/hr	:	55.29	16.56	4.71	2.14	0.69	10.80
Soot_m mg/hr	:	182.92	17.82	2.52	1.19	0.72	13.88
N2O_m mg/hr	:	0.06	0.04	0.02	0.01	0.00	0.03
CO2_m g/hr	:	45239.28	23329.67	16605.83	11562.78	3062.85	20482.03
CH4_m g/hr	:	3.25	3.53	2.16	1.16	0.22	2.58
W_HC g/hr	:	2.44	4.04	1.96	1.45	0.02	3.67
W_CO g/hr	:	77.55	97.46	61.60	53.89	0.00	305.07
W_NOx g/hr	:	6.63	4.47	1.18	0.66	0.03	10.80
W_HCNOx g/hr	:	9.07	8.51	3.14	2.12	0.05	14.47
W_Soot mg/hr	:	21.95	4.81	0.63	0.37	0.04	13.88
W_N2O g/hr	:	0.01	0.01	0.00	0.00	0.00	0.03
W_CO2 g/hr	:	5428.71	6299.01	4151.46	3584.46	153.14	20482.03
W_CH4 g/hr	:	0.39	0.95	0.54	0.36	0.01	2.58

Total Weighted Power [kW] 16.692

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	9.91	290.49	12.98	22.89
Specific Mass [g/kW-hr]	0.59	17.40	0.78	1.37
BSFC [g/kW-hr]	433.5			

Total Soot [mg/hr] 27.79 Specific Soot [mg/kW-hr] 1.67

Not Used for Competition

Total N2O [mg/hr]	0.02	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	19616.79	Specific CO2 [g/kW-hr]	1175.22
Total CH4 [g/hr]	2.25	Specific CH4 [g/kW-hr]	0.14
RMC BSFC [g/kW-hr]	413.13		

EMISSION TESTS:

	Value	Limit	Result
Power	49.49	<96.94 kW	PASS
Soot	1.67	<50 mg/kW-hr	PASS
CO	17.40	<275 g/kW-hr	PASS
HC + NOX	1.37	<90 g/kW-hr	PASS
E-Score	204.74	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



Team Results for Clean Snowmobile Challenge 2019 Team 2



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	7803.73	6632.52	5853.61	5073.67	1510.17	5908.27
Torque	Nm	60.52	30.89	20.16	11.39	0.00	26.06
Power	kW	49.46	21.45	12.36	6.05	0.00	16.12
BSFC	g/kw-hr	297.41	354.43	437.34	621.85	**	413.13
Fuel	g/hr	14708.70	7603.50	5404.03	3763.25	973.02	6660.06
T_int	degC	26.99	22.27	22.29	24.39	21.91	23.29
RelHumid	%	13.91	16.53	18.70	14.81	17.98	16.16
Baro	in Hg	28.90	28.91	28.91	28.91	28.91	28.91
Baro	mmHg	734.18	734.25	734.24	734.22	734.21	734.22
Pvap_kPa	kPa	0.40	0.37	0.42	0.37	0.40	0.38
Pvap_inHg	inHg	0.12	0.11	0.12	0.11	0.12	0.11
AbsHumidity	grains/lb	17.95	16.58	18.79	16.65	17.70	17.14
SatPres	kPa	97.48	97.52	97.47	97.51	97.49	97.50
Hum Factor		0.79	0.78	0.79	0.78	0.79	0.79
F_fac		1.02	1.01	1.01	1.01	1.01	1.01
K_fac		1.03	1.02	1.02	1.03	1.02	1.03
Humidity	g/kg	2.56	2.37	2.68	2.38	2.53	2.45
H2		0.10	0.11	0.10	0.10	0.00	0.10
WetDry Factor		0.87	0.87	0.87	0.87	0.87	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 2



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	191.14	270.36	198.72	170.08	52.12	75.21
CO	%	0.30	0.33	0.31	0.31	0.00	0.31
N2O	ppm	1.81	2.22	1.32	1.07	1.56	1.77
CH4	ppm	26.73	55.74	47.90	36.65	26.25	46.22
CO2	%	13.52	13.39	13.38	13.32	13.05	13.32
O2	%	0.00	0.00	0.00	0.00	0.82	0.06
CNOx	ppm	158.03	90.91	36.31	23.63	28.21	67.21
AHC	ppm	5.18	0.00	0.00	0.00	0.00	0.45
C2H2	ppm	0.63	0.46	0.43	0.45	0.36	0.48
C2H4	ppm	2.64	4.24	2.62	2.88	0.24	3.23
C3H6	ppm	0.67	0.82	0.31	0.26	0.62	0.55
C4H6	ppm	3.33	3.99	5.13	4.92	0.70	4.52
ETOH	ppm	3.63	3.32	4.15	3.48	2.37	3.66
H2O	%	13.21	13.24	13.26	13.23	12.65	0.00
HCHO	ppm	0.00	0.00	0.00	0.00	0.00	0.00
HCN	ppm	1.48	1.38	1.12	1.02	0.15	1.34
HNCO	ppm	2.19	3.07	2.56	2.37	1.29	2.81
MECHO	ppm	0.01	0.01	0.01	0.00	0.00	0.01
NC5	ppm	10.40	2.20	1.72	2.43	1.18	3.11
NH3	ppm	69.25	102.99	129.92	124.28	5.32	111.44
NO	ppm	201.17	116.61	46.64	30.86	36.44	86.19
NO2	ppm	0.04	0.09	0.01	0.00	0.02	0.07
Soot	mg/m3	0.96	0.18	0.04	0.02	0.05	0.16
AFR	:1	14.52	14.48	14.51	14.52	15.32	14.59



Team Results for Clean Snowmobile Challenge 2019 Team 2



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.115	0.022	13.206	83.209	0.962	14.530	1.000
2	0.124	0.031	13.244	82.765	0.957	14.504	1.000
3	0.119	0.023	13.256	82.698	0.956	14.515	1.000
4	0.120	0.020	13.234	82.399	0.952	14.516	1.000
5	0.000	0.006	12.654	82.635	0.955	15.296	0.958

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	20.314	0.019	0.002	0.021	100.259	0.259
2	14.960	0.031	0.004	0.035	99.701	0.299
3	7.834	0.023	0.003	0.026	99.582	0.418
4	4.689	0.020	0.002	0.022	99.209	0.791
5	0.388	-0.617	-0.077	-0.694	98.784	1.216

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	49.455	21.453	12.357	6.052	0.000	16.121
BSFC	g/kw-hr	297.41	354.43	437.34	621.85	**	413.13
Fuel_MassFlow	g/hr	14709	7604	5404	3763	973	6660
HC_m	g/hr	20.314	14.960	7.834	4.689	0.388	3.672
CO_m	g/hr	646.22	360.95	246.39	173.84	0.02	305.07
CO2_m	g/hr	45239	23330	16606	11563	3063	20482
TW_Power	kW	16.692					
TW_BSFC	g/kw-hr	433.49					
Fuel_MassFlow	g/hr	14709	7604	5404	3763	973	6660
FuelCalc	g/hr	14712	7606	5405	3764	973	6661
FuelCalcDev	%	-0.020711	-0.030302	-0.021833	-0.018499	-0.004682	-0.007137

\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 2

TeamNumber	2
TeamName	UMD
Model	Ranger
Engine	Polaris

Displacement cc	1000.00
RatedSpeed	7803
RatedTorque	60.6





Team Results for Clean Snowmobile Challenge 2019 Team 103



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/08 14:23:27
Team Name : ETS
Team Number : 103
Model : Kohler
Engine : KDW
Displacement[cc] : 1003.00
100% Speed : 4152
100% Torque : 65.4
No of Strokes : 4
Fuel : Diesel H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	24.8	12.4	7.0	3.5	0.0	8.4
HC_m g/hr	:	0.03	0.00	0.04	0.00	0.00	-0.10
CO_m g/hr	:	0.71	0.12	0.23	0.02	0.13	0.60
NOx_m g/hr	:	134.19	81.94	56.89	42.10	25.94	70.55
Soot_m mg/hr	:	6854.87	3116.46	1008.39	243.22	101.22	1907.24
N2O_m mg/hr	:	0.04	0.02	0.02	0.01	0.00	0.02
CO2_m g/hr	:	23226.13	11759.89	7625.41	4743.40	1292.53	9438.81
CH4_m g/hr	:	0.07	0.05	0.05	0.04	0.02	0.06
W_HC g/hr	:	0.00	0.00	0.01	0.00	0.00	-0.10
W_CO g/hr	:	0.09	0.03	0.06	0.01	0.01	0.60
W_NOx g/hr	:	16.10	22.12	14.22	13.05	1.30	70.55
W_HCNOx g/hr	:	16.11	22.12	14.23	13.05	1.30	70.45
W_Soot mg/hr	:	822.58	841.44	252.10	75.40	5.06	1907.24
W_N2O g/hr	:	0.01	0.01	0.00	0.00	0.00	0.02
W_CO2 g/hr	:	2787.14	3175.17	1906.35	1470.45	64.63	9438.81
W_CH4 g/hr	:	0.01	0.01	0.01	0.01	0.00	0.06

Total Weighted Power [kW] 9.156

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	0.01	0.19	66.80	66.81
Specific Mass [g/kW-hr]	0.00	0.02	7.30	7.30
BSFC [g/kW-hr]	336.6			

Total Soot [mg/hr] 1996.59 Specific Soot [mg/kW-hr] 218.06

Not Used for Competition

Total N2O [mg/hr]	0.02	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	9403.74	Specific CO2 [g/kW-hr]	1027.07
Total CH4 [g/hr]	0.05	Specific CH4 [g/kW-hr]	0.01
RMC BSFC [g/kW-hr]	356.73		

EMISSION TESTS:

	Value	Limit	Result
Power	28.44	<96.94 kW	PASS
Soot	218.06	<50 mg/kW-hr	FAIL
CO	0.02	<275 g/kW-hr	PASS
HC + NOX	7.30	<90 g/kW-hr	PASS
E-Score	205.13	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			FAIL



Team Results for Clean Snowmobile Challenge 2019 Team 103



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	4150.09	3532.86	3114.07	2698.00	826.84	3159.50
Torque	Nm	56.98	33.41	21.61	12.39	0.00	25.40
Power	kW	24.76	12.36	7.05	3.50	0.00	8.40
BSFC	g/kw-hr	297.84	302.16	343.65	430.20	**	356.73
Fuel	g/hr	7375.95	3734.47	2421.65	1506.30	410.52	2997.54
T_int	degC	27.23	28.80	27.51	29.69	26.01	28.30
RelHumid	%	17.49	17.02	16.42	17.07	16.59	16.77
Baro	in Hg	28.91	28.91	28.91	28.91	28.91	28.91
Baro	mmHg	734.36	734.32	734.30	734.36	734.31	734.34
Pvap_kPa	kPa	0.51	0.54	0.49	0.57	0.45	0.52
Pvap_inHg	inHg	0.15	0.16	0.14	0.17	0.13	0.15
AbsHumidity	grains/lb	22.88	24.16	21.79	25.37	20.34	23.19
SatPres	kPa	97.39	97.36	97.41	97.34	97.44	97.38
Hum Factor		0.80	0.81	0.80	0.81	0.80	0.80
F_fac		1.02	1.03	1.02	1.03	1.02	1.02
K_fac		1.03	1.04	1.03	1.04	1.03	1.03
Humidity	g/kg	3.27	3.45	3.11	3.62	2.91	3.31
H2		0.00	0.00	0.00	0.00	0.00	0.00
WetDry Factor		0.92	0.94	0.95	0.96	0.97	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 103



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	0.30	0.00	0.94	0.05	0.00	-1.76
CO	%	0.00	0.00	0.00	0.00	0.00	0.00
N2O	ppm	1.48	1.27	1.30	1.08	0.65	1.21
CH4	ppm	0.70	0.77	0.98	1.07	1.07	0.91
CO2	%	8.10	6.16	5.08	4.16	2.64	5.13
O2	%	8.30	11.24	12.84	14.17	15.74	12.44
CNOx	ppm	447.73	410.35	362.67	353.37	507.61	366.46
AHC	ppm	0.59	0.60	0.52	0.57	0.44	0.56
C2H2	ppm	0.11	0.18	0.32	0.24	0.42	0.24
C2H4	ppm	0.68	0.55	1.62	1.02	1.00	0.99
C3H6	ppm	0.39	0.32	0.29	0.28	0.34	0.34
C4H6	ppm	0.46	0.22	0.11	0.10	0.09	0.15
ETOH	ppm	1.01	0.73	0.71	0.70	0.63	0.68
H2O	%	7.91	6.01	4.97	4.37	3.13	0.00
HCHO	ppm	1.33	0.91	1.79	1.29	1.32	1.28
HCN	ppm	0.21	0.13	0.04	0.04	0.02	0.07
HNCO	ppm	2.23	1.81	1.26	1.46	1.36	1.59
MECHO	ppm	0.00	0.00	0.00	0.00	0.00	0.00
NC5	ppm	1.15	0.95	1.28	0.84	0.93	1.03
NH3	ppm	0.03	0.00	0.00	0.02	0.00	0.01
NO	ppm	394.77	393.76	427.64	384.78	624.86	388.70
NO2	ppm	162.59	114.48	25.85	51.20	13.21	67.03
Soot	mg/m3	43.27	29.74	12.31	3.94	3.98	19.28
AFR	:1	24.87	32.80	39.74	48.43	73.67	38.76



Team Results for Clean Snowmobile Challenge 2019 Team 103



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.000	0.000	7.914	81.086	0.937	24.824	0.589
2	0.000	0.000	6.014	80.126	0.926	32.735	0.449
3	0.000	0.000	4.973	79.500	0.919	39.664	0.373
4	0.000	0.000	4.369	79.515	0.919	48.334	0.311
5	0.000	0.000	3.133	76.541	0.885	73.526	0.240

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	0.027	-3.617	-0.452	-4.069	95.825	4.175
2	0.000	**	**	**	**	**
3	0.045	-3.352	-0.419	-3.771	95.556	4.444
4	0.002	-2.997	-0.375	-3.371	96.275	3.725
5	0.000	**	**	**	**	**

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	24.765	12.359	7.047	3.501	0.000	8.403
BSFC	g/kw-hr	297.84	302.16	343.65	430.20	**	356.73
Fuel_MassFlow	g/hr	7376.0	3734.5	2421.6	1506.3	410.5	2997.5
HC_m	g/hr	0.02690	0.00000	0.04464	0.00188	0.00000	-0.10322
CO_m	g/hr	0.71329	0.12304	0.23433	0.02288	0.13311	0.59754
CO2_m	g/hr	23226	11760	7625	4743	1293	9439
TW_Power	kW	9.1559					
TW_BSFC	g/kw-hr	336.60					
Fuel_MassFlow	g/hr	7376.0	3734.5	2421.6	1506.3	410.5	2997.5
FuelCalc	g/hr	7375.8	3734.4	2421.6	1506.3	410.5	2997.5
FuelCalcDev	%	0.0017877	0.0018473	0.0015458	0.0018268	0.0018475	0.0024107

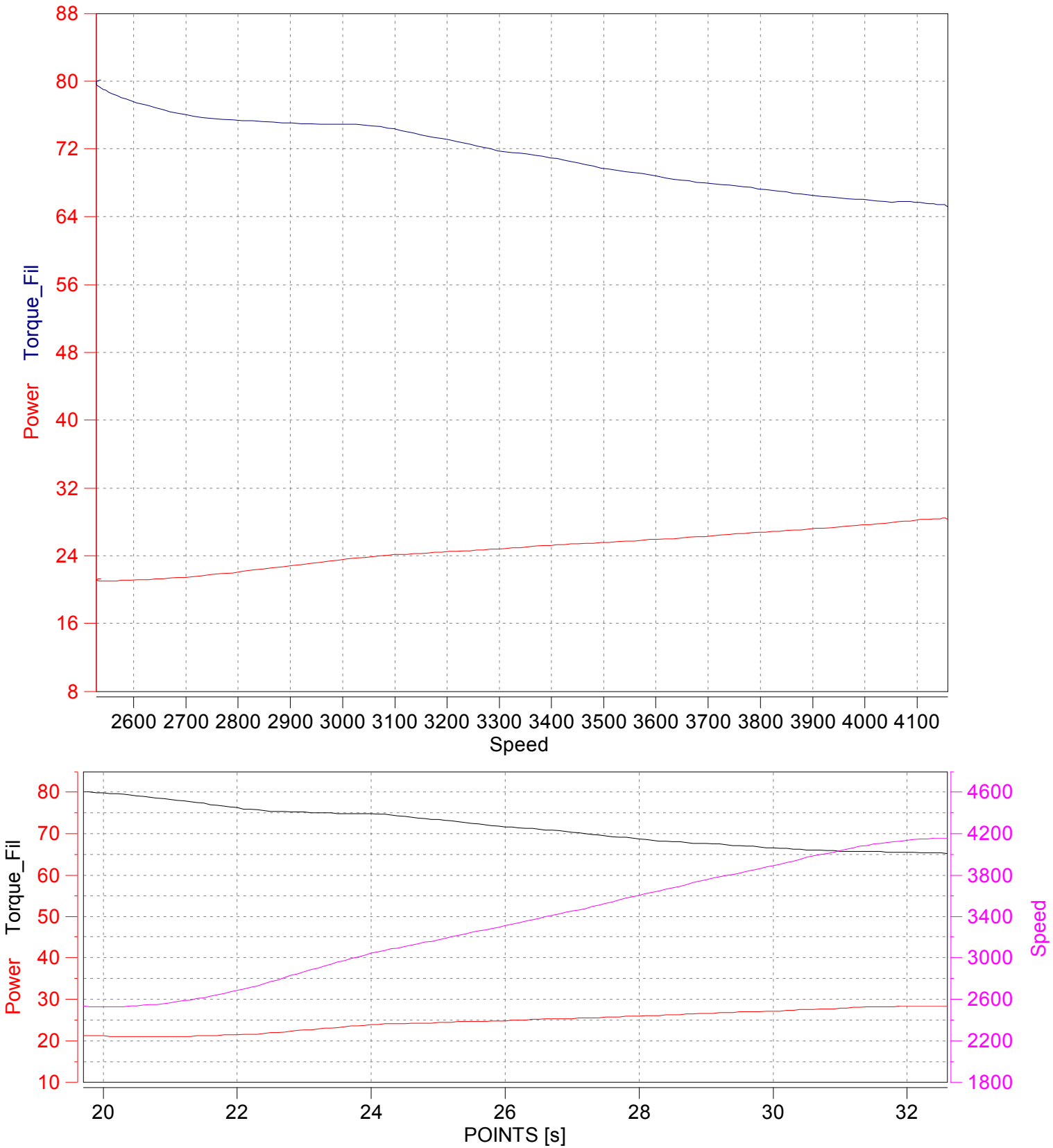
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 103

TeamNumber	103
TeamName	ETS
Model	Kohler
Engine	KDW

Displacement cc	1003.00
RatedSpeed	4152
RatedTorque	65.4





Team Results for Clean Snowmobile Challenge 2019 Team 4



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/07 12:53:32
Team Name : ETS
Team Number : 4
Model : 600 ACE
Engine : 600 ACE
Displacement[cc] : 600.00
100% Speed : 7217
100% Torque : 59.2
No of Strokes : 4
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5
Weighting	:	0.12	0.27	0.25	0.31	0.05
Power	kW :	28.8	0.0	0.0	0.0	0.0
HC_m	g/hr :	24.73	**	**	**	**
CO_m	g/hr :	5817.86	**	**	**	**
NOx_m	g/hr :	10.56	**	**	**	**
Soot_m	mg/hr:	215.21	**	**	**	**
N2O_m	mg/hr:	0.19	**	**	**	**
CO2_m	g/hr :	41624.98	**	**	**	**
CH4_m	g/hr :	6.74	**	**	**	**
W_HC	g/hr :	2.97	**	**	**	**
W_CO	g/hr :	698.14	**	**	**	**
W_NOx	g/hr :	1.27	**	**	**	**
W_HCNOx	g/hr :	4.24	**	**	**	**
W_Soot	mg/hr:	25.83	**	**	**	**
W_N2O	g/hr :	0.02	**	**	**	**
W_CO2	g/hr :	4995.00	**	**	**	**
W_CH4	g/hr :	0.81	**	**	**	**

Total Weighted Power [kW] 3.454

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	2.97	698.14	1.27	4.24
Specific Mass [g/kW-hr]	0.86	202.11	0.37	1.23
BSFC [g/kW-hr]	****			

Total Soot [mg/hr] 25.83 Specific Soot [mg/kW-hr] 7.48

Not Used for Competition

Total N2O [mg/hr]	0.02	Specific N2O [mg/kW-hr]	0.01
Total CO2 [g/hr]	4995.00	Specific CO2 [g/kW-hr]	1446.01
Total CH4 [g/hr]	0.81	Specific CH4 [g/kW-hr]	0.23
RMC BSFC [g/kW-hr]	0		

EMISSION TESTS:

	Value	Limit	Result
Power	44.74	<96.94 kW	PASS
Soot	7.48	<50 mg/kW-hr	PASS
CO	202.11	<275 g/kW-hr	FAIL
HC + NOX	1.23	<90 g/kW-hr	FAIL
E-Score	158.66	>175	FAIL
Valid Data for All 5 Modes			FAIL
RMC			FAIL (-50 Points)
LAB EMISSION TEST			FAIL



Team Results for Clean Snowmobile Challenge 2019 Team 4



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5
Total Points	points	373	1	1	1	1
PtsInMode	points	983	1	1	1	1
Speed	rpm	7082.31	0.00	0.00	0.00	0.00
Torque	Nm	38.81	0.00	0.00	0.00	0.00
Power	kW	28.79	0.00	0.00	0.00	0.00
BSFC	g/kw-hr	560.89	**	**	**	**
Fuel	g/hr	16145.77	#####	#####	#####	#####
T_int	degC	19.17	0.00	0.00	0.00	0.00
RelHumid	%	17.57	0.00	0.00	0.00	0.00
Baro	in Hg	29.16	0.00	0.00	0.00	0.00
Baro	mmHg	740.54	0.00	0.00	0.00	0.00
Pvap_kPa	kPa	0.33	0.00	0.00	0.00	0.00
Pvap_inHg	inHg	0.10	0.00	0.00	0.00	0.00
AbsHumidity	grains/lb	14.75	**	**	**	**
SatPres	kPa	98.40	0.00	0.00	0.00	0.00
Hum Factor		0.78	**	**	**	**
F_fac		0.99	**	**	**	**
K_fac		1.01	**	**	**	**
Humidity	g/kg	2.11	**	**	**	**
H2		0.92	**	**	**	**
WetDry Factor		0.87	1.00	1.00	1.00	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 4



Modal Emissions Concentrations

ModeNum		1	2	3	4	5
THC	ppmC1	213.11	0.00	0.00	0.00	0.00
CO	%	2.50	0.00	0.00	0.00	0.00
N2O	ppm	5.16	0.00	0.00	0.00	0.00
CH4	ppm	50.73	0.00	0.00	0.00	0.00
CO2	%	11.39	0.00	0.00	0.00	0.00
O2	%	0.01	0.00	0.00	0.00	0.00
CNOx	ppm	27.65	**	**	**	**
AHC	ppm	2.00	0.00	0.00	0.00	0.00
C2H2	ppm	1.56	0.00	0.00	0.00	0.00
C2H4	ppm	0.71	0.00	0.00	0.00	0.00
C3H6	ppm	0.07	0.00	0.00	0.00	0.00
C4H6	ppm	8.29	0.00	0.00	0.00	0.00
ETOH	ppm	5.27	0.00	0.00	0.00	0.00
H2O	%	12.65	0.00	0.00	0.00	0.00
HCHO	ppm	0.15	0.00	0.00	0.00	0.00
HCN	ppm	1.19	0.00	0.00	0.00	0.00
HNCO	ppm	4.22	0.00	0.00	0.00	0.00
MECHO	ppm	0.16	0.00	0.00	0.00	0.00
NC5	ppm	2.10	0.00	0.00	0.00	0.00
NH3	ppm	223.04	0.00	0.00	0.00	0.00
NO	ppm	35.67	0.00	0.00	0.00	0.00
NO2	ppm	0.18	0.00	0.00	0.00	0.00
Soot	mg/m3	1.10	0.00	0.00	0.00	0.00
AFR	:1	13.50	**	**	**	**



Team Results for Clean Snowmobile Challenge 2019 Team 4



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	1.057	0.024	12.648	77.398	0.895	13.492	1.000
2	**	0.000	0.000	0.000	0.000	**	**
3	**	0.000	0.000	0.000	0.000	**	**
4	**	0.000	0.000	0.000	0.000	**	**
5	**	0.000	0.000	0.000	0.000	**	**

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	24.730	0.019	0.002	0.021	95.287	4.713
2	**	**	**	**	**	**
3	**	**	**	**	**	**
4	**	**	**	**	**	**
5	**	**	**	**	**	**

Carbon Balance Verification

		1	2	3	4	5
Power	kW	28.786	0.000	0.000	0.000	0.000
BSFC	g/kw-hr	560.89	**	**	**	**
Fuel_MassFlow	g/hr	16146	9999999	9999999	9999999	9999999
HC_m	g/hr	24.730	**	**	**	**
CO_m	g/hr	5817.9	**	**	**	**
CO2_m	g/hr	41625	**	**	**	**
TW_Power	kW	3.4543				
TW_BSFC	g/kw-hr	**				
Fuel_MassFlow	g/hr	16146	9999999	9999999	9999999	9999999
FuelCalc	g/hr	16149	**	**	**	**
FuelCalcDev	%	-0.022939	**	**	**	**

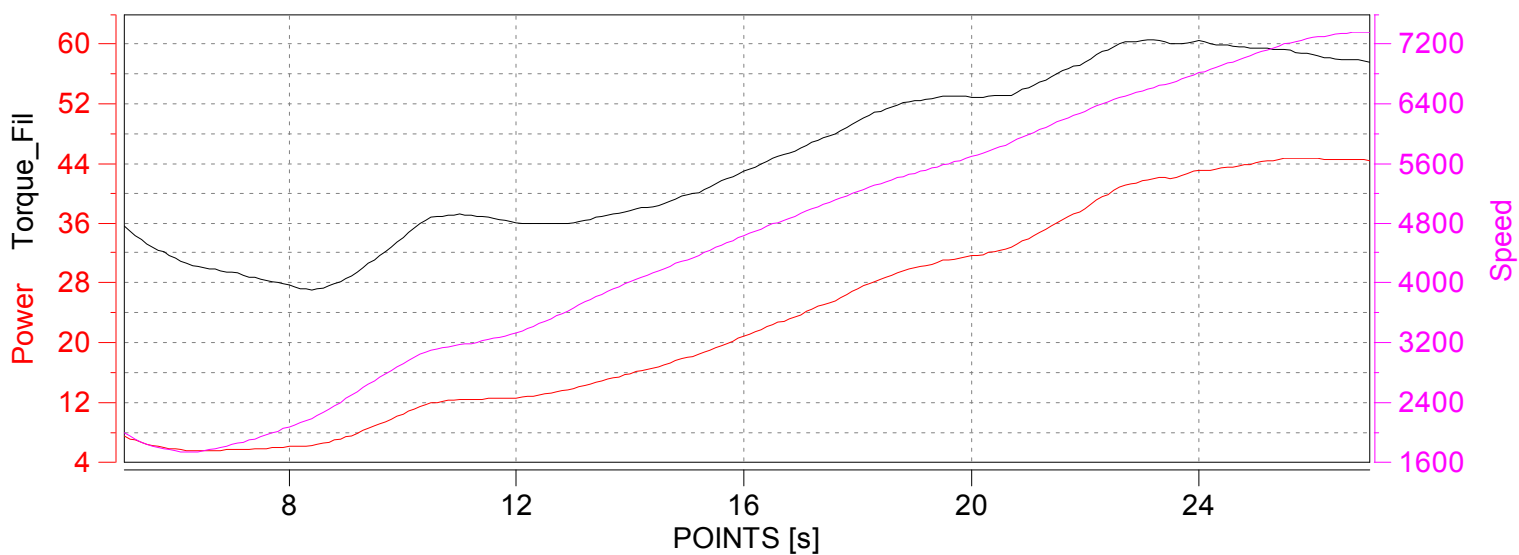
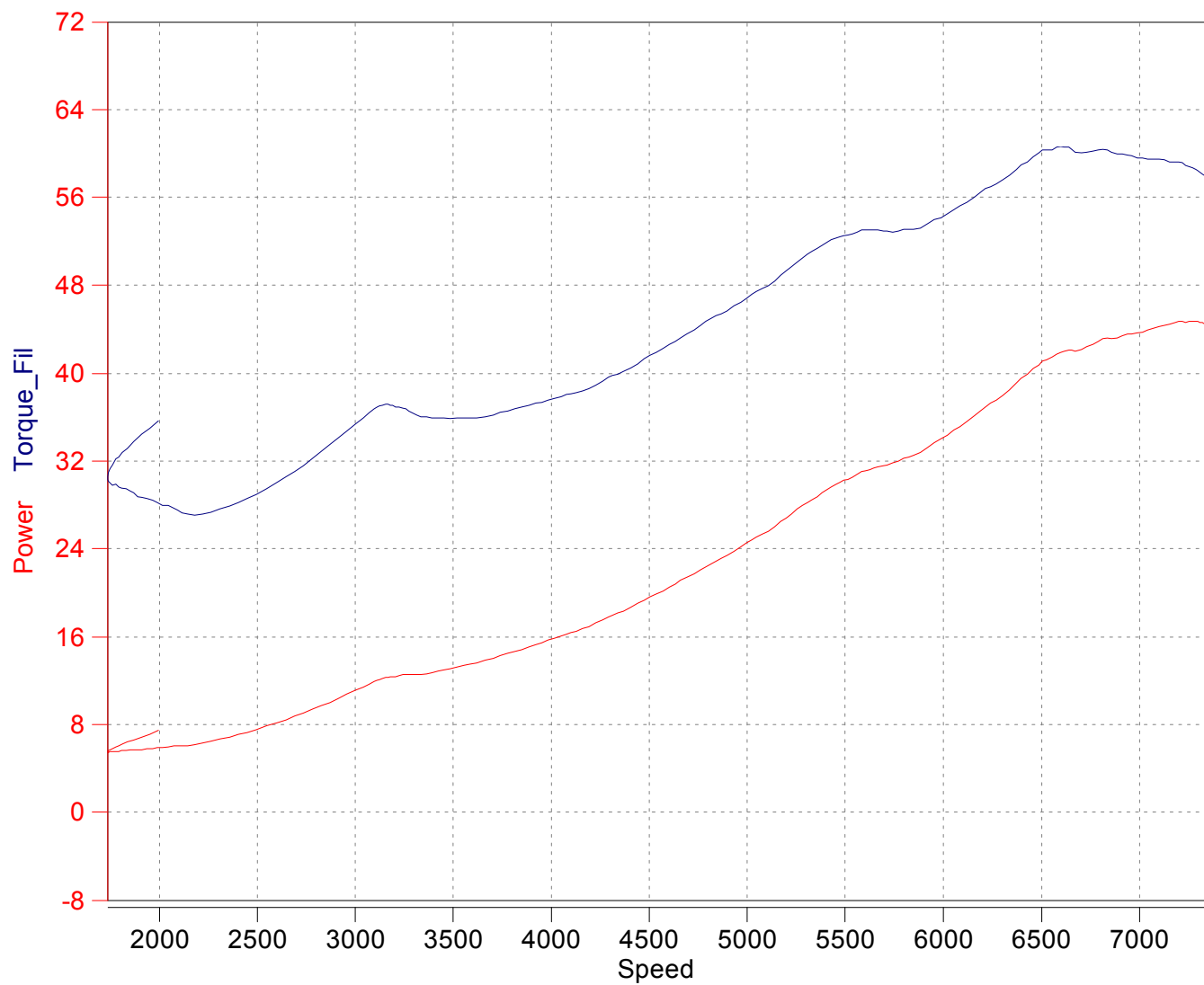
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 4

TeamNumber	4
TeamName	ETS
Model	600 ACE
Engine	600 ACE

Displacement cc	600.00
RatedSpeed	7217
RatedTorque	59.2





Team Results for Clean Snowmobile Challenge 2019 Team 10



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/07 10:42:40
Team Name : Ferris State
Team Number : 10
Model : Polaris
Engine : Polaris
Displacement[cc] : 798.00
100% Speed : 5861
100% Torque : 68.8
No of Strokes : 2
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5
Weighting	:	0.12	0.27	0.25	0.31	0.05
Power	kW	0.0	0.0	0.0	0.0	0.0
HC_m	g/hr	**	**	**	**	**
CO_m	g/hr	**	**	**	**	**
NOx_m	g/hr	**	**	**	**	**
Soot_m	mg/hr	**	**	**	**	**
N2O_m	mg/hr	**	**	**	**	**
CO2_m	g/hr	**	**	**	**	**
CH4_m	g/hr	**	**	**	**	**
W_HC	g/hr	**	**	**	**	**
W_CO	g/hr	**	**	**	**	**
W_NOx	g/hr	**	**	**	**	**
W_HCNOx	g/hr	**	**	**	**	**
W_Soot	mg/hr	**	**	**	**	**
W_N2O	g/hr	**	**	**	**	**
W_CO2	g/hr	**	**	**	**	**
W_CH4	g/hr	**	**	**	**	**

Total Weighted Power [kW] 0.000

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	****	****	****	****
Specific Mass [g/kW-hr]	****	****	****	****
BSFC [g/kW-hr]	****			

Total Soot [mg/hr] **** Specific Soot [mg/kW-hr] ****

Not Used for Competition

Total N2O [mg/hr]	****	Specific N2O [mg/kW-hr]	****
Total CO2 [g/hr]	****	Specific CO2 [g/kW-hr]	****
Total CH4 [g/hr]	****	Specific CH4 [g/kW-hr]	****
RMC BSFC [g/kW-hr]	0		

EMISSION TESTS:

	Value	Limit	Result
Power	42.26	<96.94 kW	PASS
Soot	****	<50 mg/kW-hr	FAIL
CO	****	<275 g/kW-hr	FAIL
HC + NOX	****	<90 g/kW-hr	FAIL
E-Score	0.00	>175	FAIL
Valid Data for All 5 Modes			FAIL
RMC			FAIL (-50 Points)
LAB EMISSION TEST			FAIL



Team Results for
Clean Snowmobile Challenge 2019
Team 10



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5
Total Points	points	1	1	1	1	1
PtsInMode	points	1	1	1	1	1
Speed	rpm	0.00	0.00	0.00	0.00	0.00
Torque	Nm	0.00	0.00	0.00	0.00	0.00
Power	kW	0.00	0.00	0.00	0.00	0.00
BSFC	g/kw-hr	**	**	**	**	**
Fuel	g/hr	#####	#####	#####	#####	#####
T_int	degC	0.00	0.00	0.00	0.00	0.00
RelHumid	%	0.00	0.00	0.00	0.00	0.00
Baro	in Hg	0.00	0.00	0.00	0.00	0.00
Baro	mmHg	0.00	0.00	0.00	0.00	0.00
Pvap_kPa	kPa	0.00	0.00	0.00	0.00	0.00
Pvap_inHg	inHg	0.00	0.00	0.00	0.00	0.00
AbsHumidity	grains/lb	**	**	**	**	**
SatPres	kPa	0.00	0.00	0.00	0.00	0.00
Hum Factor		1.00	1.00	1.00	1.00	1.00
F_fac		**	**	**	**	**
K_fac		**	**	**	**	**
Humidity	g/kg	**	**	**	**	**
H2		**	**	**	**	**
WetDry Factor		1.00	1.00	1.00	1.00	1.00



Team Results for
Clean Snowmobile Challenge 2019
Team 10



Modal Emissions Concentrations

ModeNum		1	2	3	4	5
THC	ppmC1	0.00	0.00	0.00	0.00	0.00
CO	%	0.00	0.00	0.00	0.00	0.00
N2O	ppm	0.00	0.00	0.00	0.00	0.00
CH4	ppm	0.00	0.00	0.00	0.00	0.00
CO2	%	0.00	0.00	0.00	0.00	0.00
O2	%	0.00	0.00	0.00	0.00	0.00
CNOx	ppm	0.00	0.00	0.00	0.00	0.00
AHC	ppm	0.00	0.00	0.00	0.00	0.00
C2H2	ppm	0.00	0.00	0.00	0.00	0.00
C2H4	ppm	0.00	0.00	0.00	0.00	0.00
C3H6	ppm	0.00	0.00	0.00	0.00	0.00
C4H6	ppm	0.00	0.00	0.00	0.00	0.00
ETOH	ppm	0.00	0.00	0.00	0.00	0.00
H2O	%	0.00	0.00	0.00	0.00	0.00
HCHO	ppm	0.00	0.00	0.00	0.00	0.00
HCN	ppm	0.00	0.00	0.00	0.00	0.00
HNCO	ppm	0.00	0.00	0.00	0.00	0.00
MECHO	ppm	0.00	0.00	0.00	0.00	0.00
NC5	ppm	0.00	0.00	0.00	0.00	0.00
NH3	ppm	0.00	0.00	0.00	0.00	0.00
NO	ppm	0.00	0.00	0.00	0.00	0.00
NO2	ppm	0.00	0.00	0.00	0.00	0.00
Soot	mg/m3	0.00	0.00	0.00	0.00	0.00
AFR	:1	**	**	**	**	**



Team Results for Clean Snowmobile Challenge 2019 Team 10



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	**	0.000	0.000	0.000	0.000	**	**
2	**	0.000	0.000	0.000	0.000	**	**
3	**	0.000	0.000	0.000	0.000	**	**
4	**	0.000	0.000	0.000	0.000	**	**
5	**	0.000	0.000	0.000	0.000	**	**

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	**	**	**	**	**	**
2	**	**	**	**	**	**
3	**	**	**	**	**	**
4	**	**	**	**	**	**
5	**	**	**	**	**	**

Carbon Balance Verification

		1	2	3	4	5
Power	kW	0	0	0	0	0
BSFC	g/kw-hr	**	**	**	**	**
Fuel_MassFlow	g/hr	9999999	9999999	9999999	9999999	9999999
HC_m	g/hr	**	**	**	**	**
CO_m	g/hr	**	**	**	**	**
CO2_m	g/hr	**	**	**	**	**
TW_Power	kW	0				
TW_BSFC	g/kw-hr	**				
Fuel_MassFlow	g/hr	9999999	9999999	9999999	9999999	9999999
FuelCalc	g/hr	**	**	**	**	**
FuelCalcDev	%	**	**	**	**	**

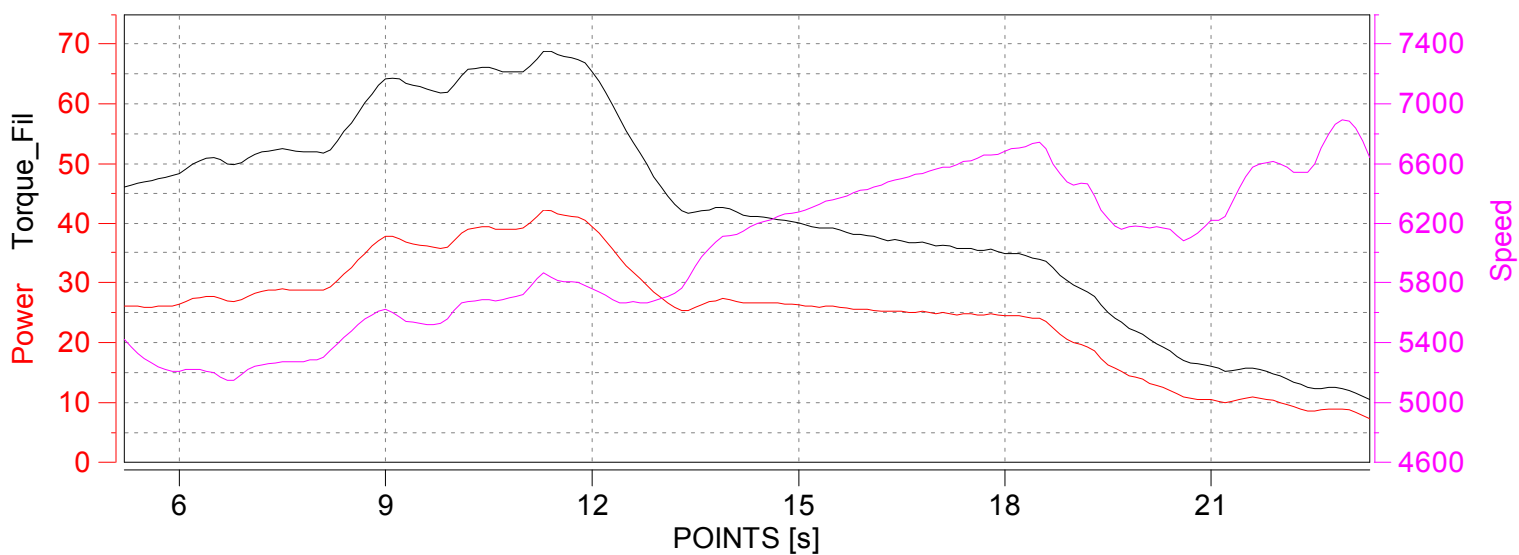
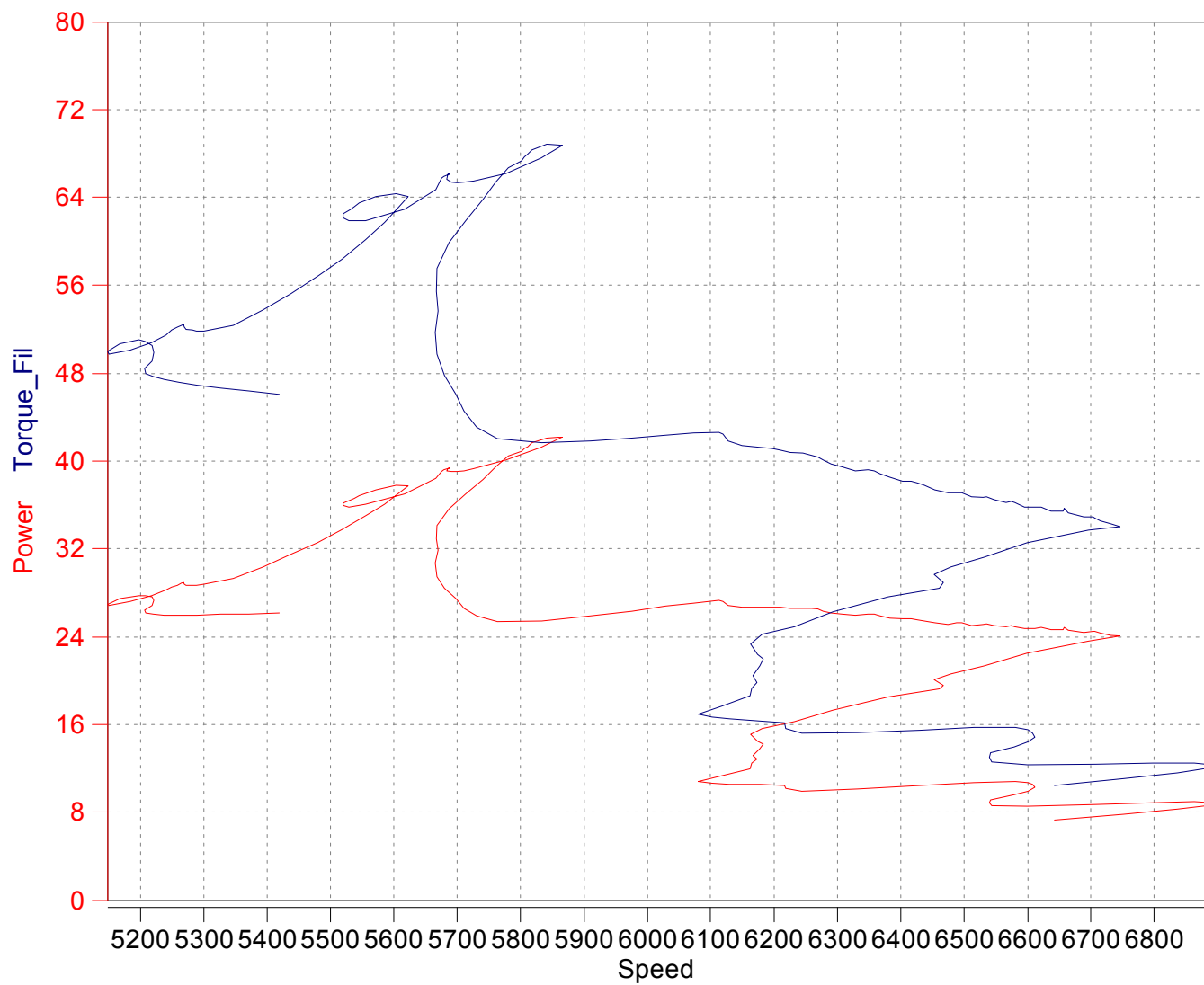
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 10

TeamNumber	10
TeamName	Ferris State
Model	Polaris
Engine	Polaris

Displacement cc	798.00
RatedSpeed	5861
RatedTorque	68.8





Team Results for Clean Snowmobile Challenge 2019 Team 7



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/06 16:34:55
Team Name : Idaho
Team Number : 7
Model : ETec
Engine : ETec
Displacement[cc] : 850.00
100% Speed : 6843
100% Torque : 109.5
No of Strokes : 2
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	69.7	34.1	19.4	9.7	0.0	24.9
HC_m g/hr	:	2768.41	379.05	132.58	77.96	39.17	142.64
CO_m g/hr	:	16285.20	1626.48	101.66	12.14	6.04	1292.28
NOx_m g/hr	:	101.99	31.53	54.45	6.00	0.98	56.03
Soot_m mg/hr	:	1898.04	347.00	238.59	6.96	86.81	365.28
N2O_m mg/hr	:	0.49	0.04	0.01	0.01	0.00	0.05
CO2_m g/hr	:	49291.69	30137.04	17818.61	10619.12	3281.74	26523.22
CH4_m g/hr	:	119.36	13.26	5.99	1.59	0.28	14.11
W_HC g/hr	:	332.21	102.34	33.15	24.17	1.96	142.64
W_CO g/hr	:	1954.22	439.15	25.42	3.76	0.30	1292.28
W_NOx g/hr	:	12.24	8.51	13.61	1.86	0.05	56.03
W_HCNOx g/hr	:	344.45	110.85	46.76	26.03	2.01	198.67
W_Soot mg/hr	:	227.76	93.69	59.65	2.16	4.34	365.28
W_N2O g/hr	:	0.06	0.01	0.00	0.00	0.00	0.05
W_CO2 g/hr	:	5915.00	8137.00	4454.65	3291.93	164.09	26523.22
W_CH4 g/hr	:	14.32	3.58	1.50	0.49	0.01	14.11

Total Weighted Power [kW] 25.410

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	493.83	2422.86	36.27	530.10
Specific Mass [g/kW-hr]	19.43	95.35	1.43	20.86
BSFC [g/kW-hr]	317.1			

Total Soot [mg/hr] 387.60 Specific Soot [mg/kW-hr] 15.25

Not Used for Competition

Total N2O [mg/hr]	0.08	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	21962.67	Specific CO2 [g/kW-hr]	864.34
Total CH4 [g/hr]	19.91	Specific CH4 [g/kW-hr]	0.78
RMC BSFC [g/kW-hr]	370.15		

EMISSION TESTS:

	Value	Limit	Result
Power	78.50	<96.94 kW	PASS
Soot	15.25	<50 mg/kW-hr	PASS
CO	95.35	<275 g/kW-hr	PASS
HC + NOX	20.86	<90 g/kW-hr	PASS
E-Score	172.25	>175	FAIL
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			FAIL



Team Results for Clean Snowmobile Challenge 2019 Team 7



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	6843.92	5816.40	5132.37	4448.85	1198.36	5178.75
Torque	Nm	97.19	55.93	36.15	20.74	0.00	45.88
Power	kW	69.66	34.07	19.43	9.66	0.00	24.88
BSFC	g/kw-hr	381.11	315.85	300.65	357.74	**	370.15
Fuel	g/hr	26546.73	10760.75	5841.70	3456.18	1084.31	9210.00
T_int	degC	32.67	24.59	20.49	22.07	18.83	23.72
RelHumid	%	12.98	19.85	20.47	16.59	20.37	17.89
Baro	in Hg	28.91	28.92	28.92	28.91	28.92	28.91
Baro	mmHg	734.26	734.53	734.53	734.36	734.56	734.44
Pvap_kPa	kPa	0.50	0.50	0.42	0.37	0.38	0.43
Pvap_inHg	inHg	0.15	0.15	0.12	0.11	0.11	0.13
AbsHumidity	grains/lb	22.46	22.58	18.65	16.46	16.92	19.41
SatPres	kPa	97.39	97.42	97.51	97.54	97.55	97.48
Hum Factor		1.00	1.00	1.00	1.00	1.00	1.00
F_fac		1.04	1.02	1.00	1.01	1.00	1.01
K_fac		1.04	1.03	1.02	1.02	1.02	1.03
Humidity	g/kg	3.21	3.23	2.66	2.35	2.42	2.77
H2		1.98	0.36	0.03	0.01	0.01	0.29
WetDry Factor		0.86	0.87	0.89	0.90	0.93	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 7



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	16016.25	4950.37	2654.08	2412.59	2634.63	1877.89
CO	%	4.70	1.06	0.10	0.02	0.02	0.85
N2O	ppm	8.93	1.81	0.88	0.85	0.67	2.13
CH4	ppm	603.16	151.29	104.68	43.05	16.65	162.30
CO2	%	9.06	12.50	11.33	10.44	7.01	11.09
O2	%	0.33	0.15	3.23	4.65	9.86	2.82
CNOx	ppm	179.25	125.08	331.15	56.43	20.09	224.07
AHC	ppm	197.51	51.60	8.41	5.40	20.54	52.73
C2H2	ppm	51.38	11.25	3.96	1.38	1.94	11.75
C2H4	ppm	376.75	93.31	28.03	15.10	7.05	86.64
C3H6	ppm	224.06	72.77	11.63	9.62	4.93	56.62
C4H6	ppm	20.64	8.43	0.08	0.07	0.16	4.29
ETOH	ppm	4.85	3.79	2.44	2.31	1.73	5.66
H2O	%	13.93	13.22	11.04	10.19	6.80	0.00
HCHO	ppm	76.55	19.17	22.89	17.96	10.12	29.76
HCN	ppm	6.73	2.93	0.29	0.27	0.10	1.91
HNCO	ppm	16.91	3.92	1.95	1.38	0.49	4.62
MECHO	ppm	28.72	6.15	4.40	4.63	2.67	10.19
NC5	ppm	46.08	29.39	72.12	88.09	102.55	83.39
NH3	ppm	36.50	21.48	1.02	3.57	0.55	11.01
NO	ppm	179.30	125.65	320.28	53.73	16.48	219.46
NO2	ppm	0.20	0.02	10.87	2.70	3.62	4.81
Soot	mg/m3	6.98	2.62	2.72	0.12	3.38	2.75
AFR	:1	9.40	12.92	16.33	17.87	25.69	15.86



Team Results for Clean Snowmobile Challenge 2019 Team 7



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	2.298	1.861	13.935	76.675	0.886	11.298	0.983
2	0.419	0.570	13.219	81.123	0.938	13.792	0.992
3	0.037	0.298	11.040	81.708	0.944	17.035	0.837
4	0.007	0.269	10.186	81.475	0.942	18.630	0.767
5	0.007	0.283	6.801	80.050	0.925	27.481	0.513

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	2768.414	1.558	0.195	1.752	97.997	2.003
2	379.047	0.443	0.055	0.499	98.794	1.206
3	132.584	-1.845	-0.231	-2.076	97.134	2.866
4	77.964	-2.509	-0.314	-2.823	96.423	3.577
5	39.166	-3.527	-0.441	-3.968	95.144	4.856

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	69.656	34.069	19.430	9.661	0.000	24.882
BSFC	g/kw-hr	381.11	315.85	300.65	357.74	**	370.15
Fuel_MassFlow	g/hr	26547	10761	5842	3456	1084	9210
HC_m	g/hr	2768.4	379.0	132.6	78.0	39.2	142.6
CO_m	g/hr	16285	1626	102	12	6	1292
CO2_m	g/hr	49292	30137	17819	10619	3282	26523
TW_Power	kW	25.410					
TW_BSFC	g/kw-hr	317.08					
Fuel_MassFlow	g/hr	26547	10761	5842	3456	1084	9210
FuelCalc	g/hr	26999	10823	5863	3469	1091	9233
FuelCalcDev	%	-1.7036	-0.5742	-0.3694	-0.3671	-0.5890	-0.2514

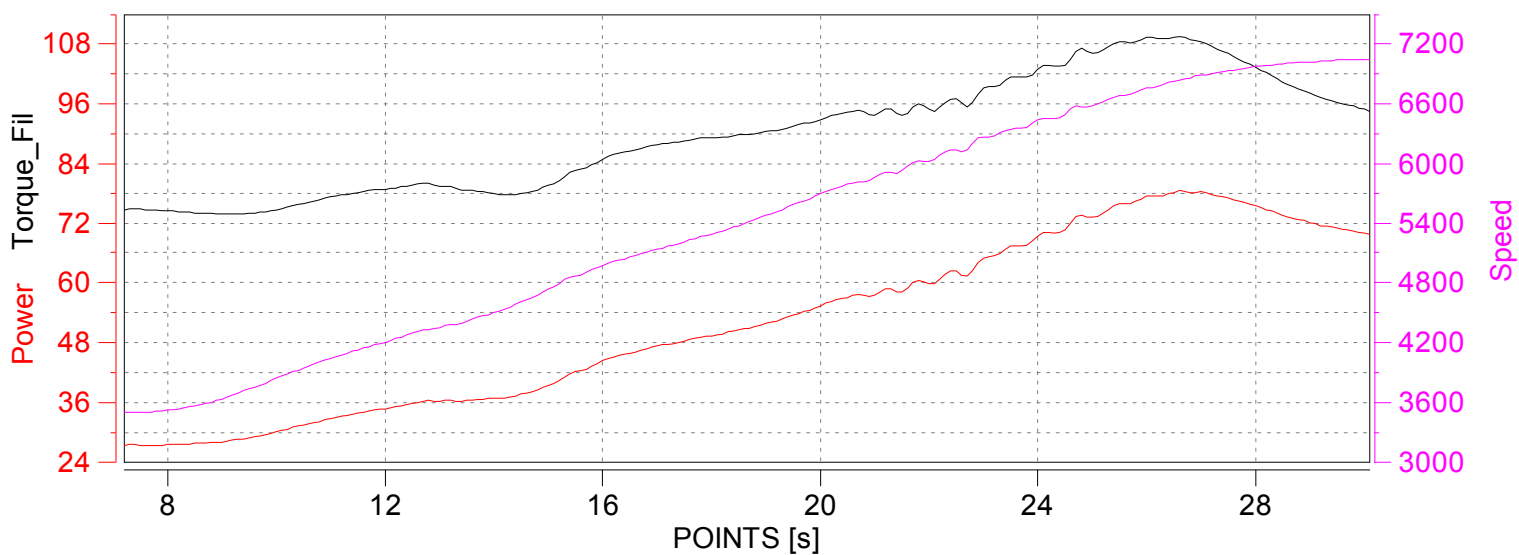
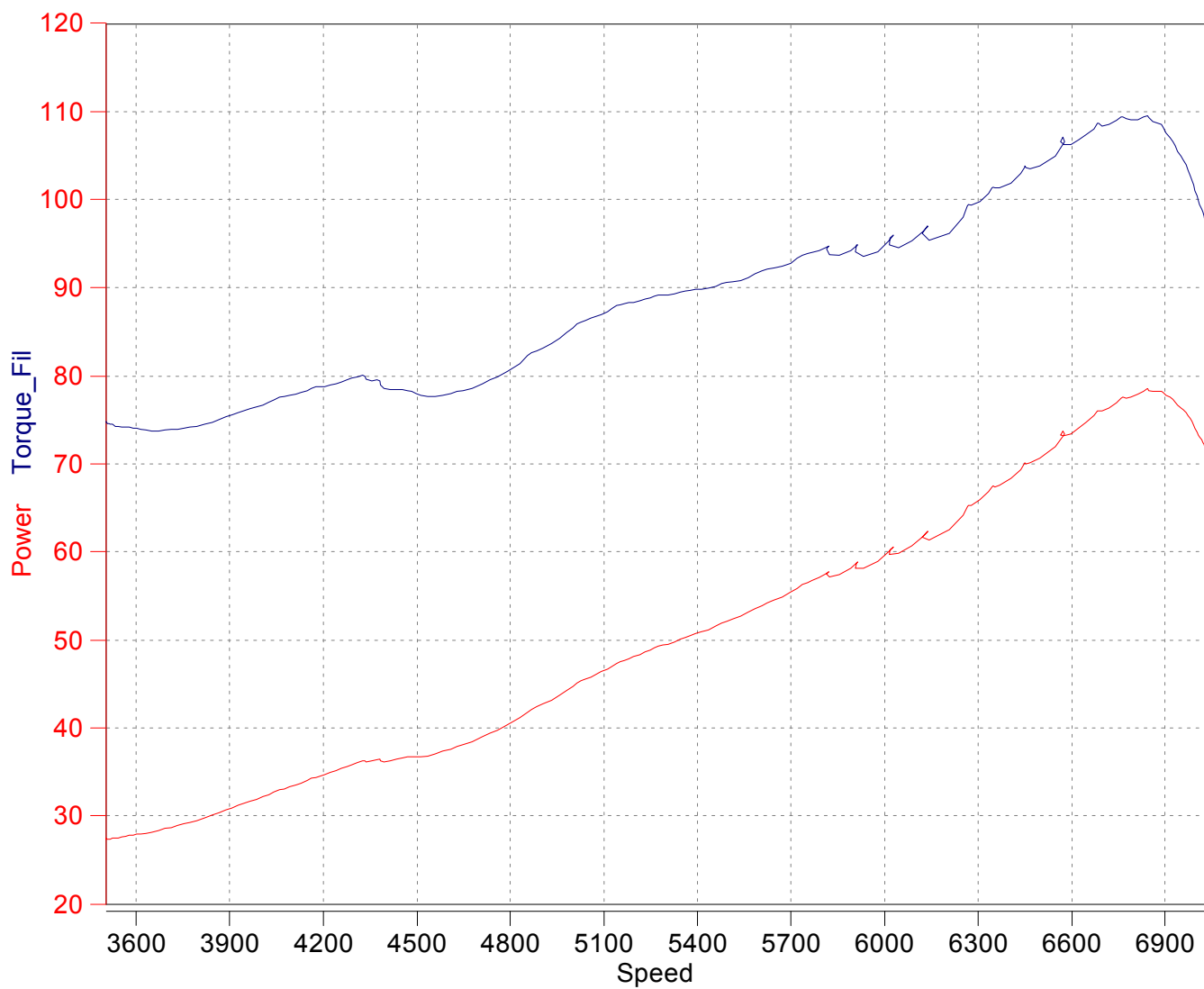
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 7

TeamNumber	7
TeamName	Idaho
Model	ETec
Engine	ETec

Displacement cc	850.00
RatedSpeed	6843
RatedTorque	109.5





Team Results for Clean Snowmobile Challenge 2019 Team 11



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/08 08:59:09
Team Name : Iowa State
Team Number : 11
Model : R1X
Engine : Yamaha
Displacement[cc] : 1049.00
100% Speed : 8650
100% Torque : 100.1
No of Strokes : 4
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5
Weighting	:	0.12	0.27	0.25	0.31	0.05
Power	kW	90.6	39.3	22.4	11.2	0.0
HC_m	g/hr	1303.54	814.41	635.07	89.46	**
CO_m	g/hr	22158.68	5863.59	1797.81	1956.93	**
NOx_m	g/hr	82.34	37.50	12.25	0.72	**
Soot_m	mg/hr	60.67	2.40	1.73	3.15	**
N2O_m	mg/hr	0.78	0.18	0.06	0.06	**
CO2_m	g/hr	41811.43	21691.04	16360.57	11366.53	**
CH4_m	g/hr	58.54	21.04	19.82	12.60	**
W_HC	g/hr	156.42	219.89	158.77	27.73	**
W_CO	g/hr	2659.04	1583.17	449.45	606.65	**
W_NOx	g/hr	9.88	10.13	3.06	0.22	**
W_HCNOx	g/hr	166.31	230.02	161.83	27.95	**
W_Soot	mg/hr	7.28	0.65	0.43	0.98	**
W_N2O	g/hr	0.09	0.05	0.01	0.02	**
W_CO2	g/hr	5017.37	5856.58	4090.14	3523.62	**
W_CH4	g/hr	7.03	5.68	4.95	3.91	**

Total Weighted Power [kW] 30.566

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	562.81	5298.31	23.29	586.10
Specific Mass [g/kW-hr]	18.41	173.34	0.76	19.17
BSFC [g/kW-hr]	311.2			

Total Soot [mg/hr] 9.34 Specific Soot [mg/kW-hr] 0.31

Not Used for Competition

Total N2O [mg/hr]	0.17	Specific N2O [mg/kW-hr]	0.01
Total CO2 [g/hr]	18487.72	Specific CO2 [g/kW-hr]	604.84
Total CH4 [g/hr]	21.56	Specific CH4 [g/kW-hr]	0.71
RMC BSFC [g/kW-hr]	0		

EMISSION TESTS:

	Value	Limit	Result
Power	90.69	<96.94 kW	PASS
Soot	0.31	<50 mg/kW-hr	PASS
CO	173.34	<275 g/kW-hr	FAIL
HC + NOX	19.17	<90 g/kW-hr	FAIL
E-Score	153.88	>175	FAIL
Valid Data for All 5 Modes			FAIL
RMC			FAIL (-50 Points)
LAB EMISSION TEST			FAIL



Team Results for Clean Snowmobile Challenge 2019 Team 11



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5
Total Points	points	600	1520	1099	1200	1
PtsInMode	points	1210	3370	3369	1800	1
Speed	rpm	8650.77	7352.03	6484.06	5622.21	0.00
Torque	Nm	100.01	51.08	32.97	19.06	0.00
Power	kW	90.60	39.33	22.38	11.22	0.00
BSFC	g/kw-hr	282.96	270.23	300.55	416.59	**
Fuel	g/hr	25637.04	10628.14	6727.47	4675.37	#####
T_int	degC	20.06	21.79	20.80	22.23	0.00
RelHumid	%	17.29	23.54	20.77	17.67	0.00
Baro	in Hg	28.96	28.97	28.97	28.96	0.00
Baro	mmHg	735.57	735.83	735.81	735.66	0.00
Pvap_kPa	kPa	0.34	0.51	0.43	0.40	0.00
Pvap_inHg	inHg	0.10	0.15	0.13	0.12	0.00
AbsHumidity	grains/lb	15.36	22.99	19.21	17.67	**
SatPres	kPa	97.72	97.59	97.67	97.68	0.00
Hum Factor		0.78	0.80	0.79	0.79	**
F_fac		1.00	1.01	1.00	1.01	**
K_fac		1.02	1.02	1.02	1.02	**
Humidity	g/kg	2.19	3.28	2.74	2.52	**
H2		3.14	1.71	0.72	1.07	**
WetDry Factor		0.87	0.87	0.87	0.87	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 11



Modal Emissions Concentrations

ModeNum		1	2	3	4	5
THC	ppmC1	7943.00	11719.03	14178.87	2599.76	0.00
CO	%	6.74	4.21	2.00	2.84	0.00
N2O	ppm	15.06	8.20	3.92	5.15	0.00
CH4	ppm	311.60	264.40	386.45	319.77	0.00
CO2	%	8.09	9.91	11.60	10.49	0.00
O2	%	0.03	0.08	0.28	0.82	0.00
CNOx	ppm	152.42	163.93	83.07	6.32	**
AHC	ppm	112.89	121.68	108.27	19.63	0.00
C2H2	ppm	28.45	8.43	6.93	3.98	0.00
C2H4	ppm	140.25	145.68	265.29	95.15	0.00
C3H6	ppm	69.95	108.71	181.98	5.93	0.00
C4H6	ppm	10.17	10.56	6.93	3.14	0.00
ETOH	ppm	5.83	5.88	4.92	4.81	0.00
H2O	%	12.52	13.23	13.28	12.89	0.00
HCHO	ppm	8.37	17.03	27.10	25.26	0.00
HCN	ppm	32.79	26.04	9.91	4.00	0.00
HNCO	ppm	6.44	17.44	16.56	7.25	0.00
MECHO	ppm	2.42	0.39	1.35	0.69	0.00
NC5	ppm	85.54	212.51	202.21	2.59	0.00
NH3	ppm	195.87	367.29	256.42	82.98	0.00
NO	ppm	196.02	205.66	106.30	3.43	0.00
NO2	ppm	0.00	0.00	0.00	4.58	0.00
Soot	mg/m3	0.24	0.02	0.02	0.06	0.00
AFR	:1	10.01	10.26	10.65	13.18	**



Team Results for Clean Snowmobile Challenge 2019 Team 11



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	3.589	0.908	12.521	72.167	0.834	10.950	0.999
2	1.967	1.351	13.233	76.502	0.884	11.771	0.996
3	0.832	1.635	13.276	79.964	0.924	12.617	0.986
4	1.233	0.298	12.889	78.323	0.905	13.624	0.958
5	**	0.000	0.000	0.000	0.000	**	**

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	1303.539	0.884	0.111	0.995	94.586	5.414
2	814.407	1.281	0.160	1.441	97.182	2.818
3	635.069	1.386	0.173	1.560	99.298	0.702
4	89.460	-0.354	-0.044	-0.398	96.303	3.697
5	**	**	**	**	**	**

Carbon Balance Verification

		1	2	3	4	5
Power	kW	90.602	39.329	22.384	11.223	0.000
BSFC	g/kw-hr	282.96	270.23	300.55	416.59	**
Fuel_MassFlow	g/hr	25637	10628	6727	4675	9999999
HC_m	g/hr	1303.5	814.4	635.1	89.5	**
CO_m	g/hr	22159	5864	1798	1957	**
CO2_m	g/hr	41811	21691	16361	11367	**
TW_Power	kW	30.566				
TW_BSFC	g/kw-hr	311.20				
Fuel_MassFlow	g/hr	25637	10628	6727	4675	9999999
FuelCalc	g/hr	25850	10761	6831	4690	**
FuelCalcDev	%	-0.8292	-1.2512	-1.5421	-0.3108	**

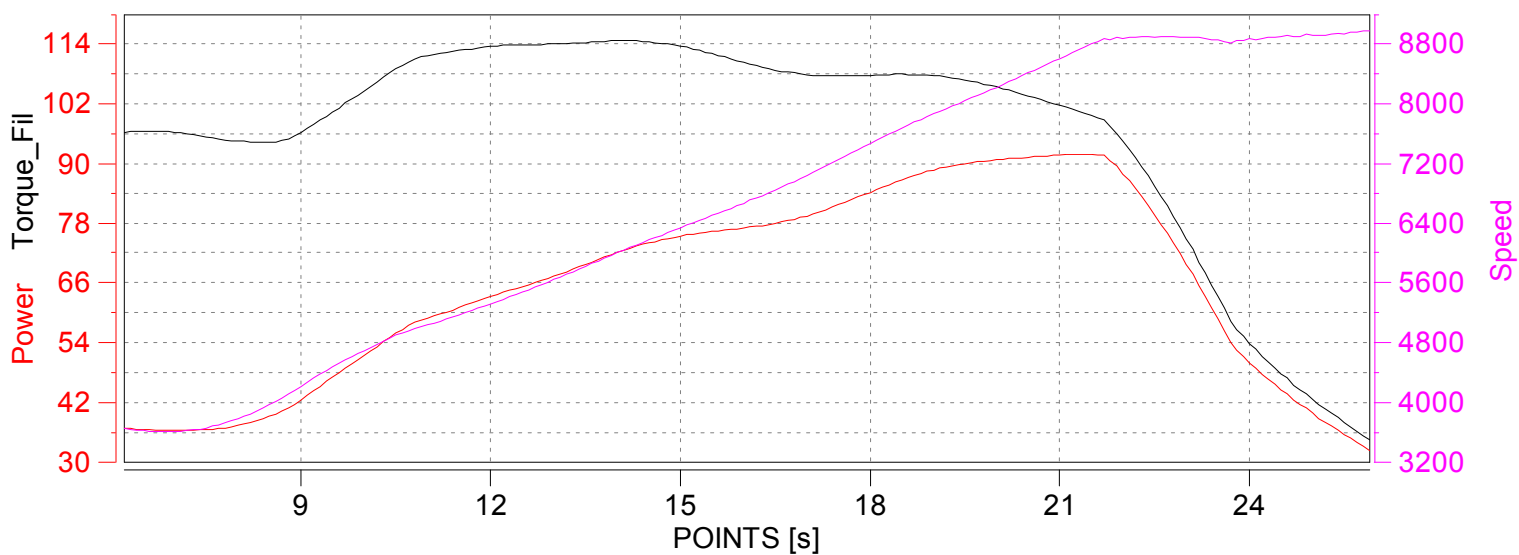
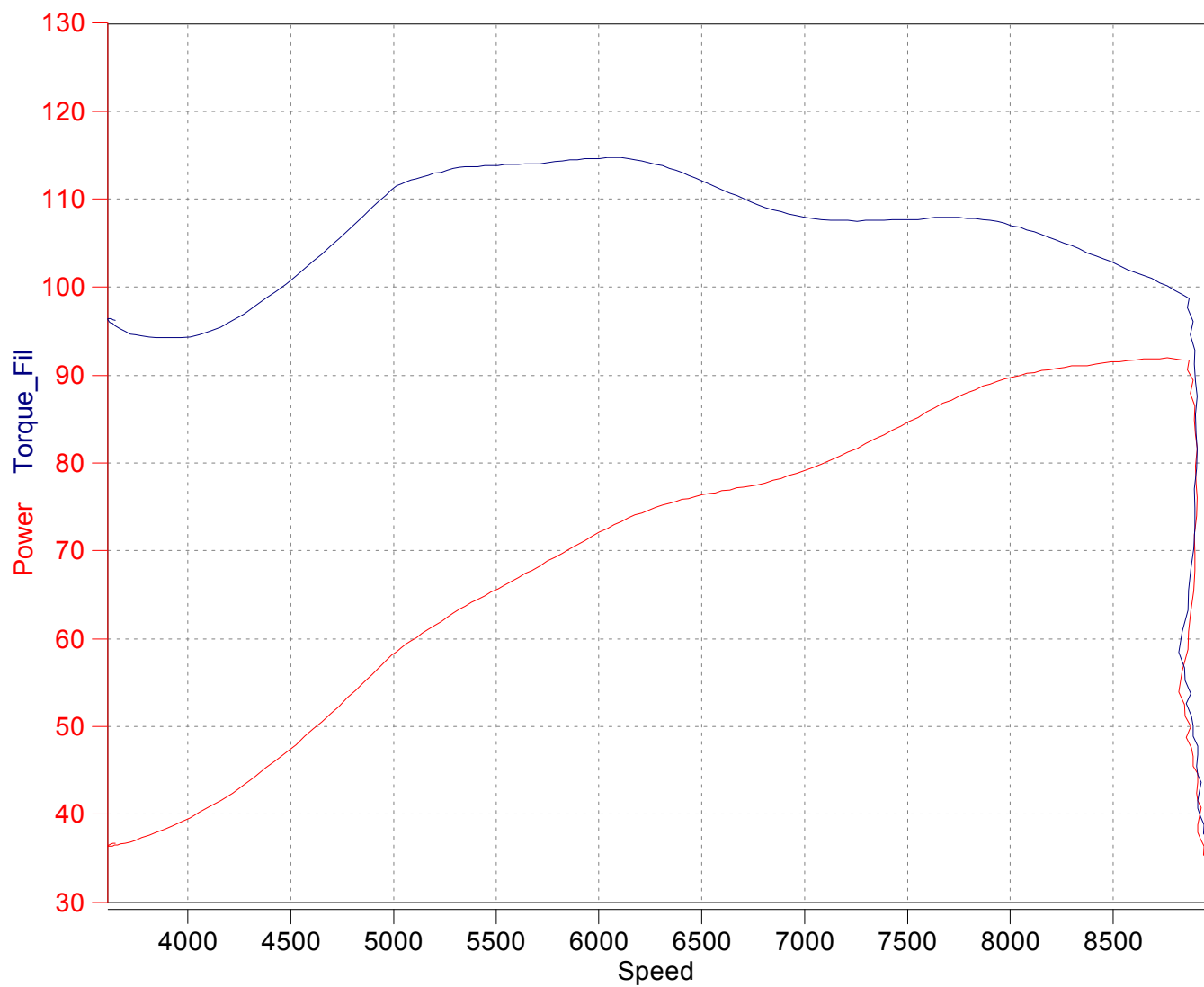
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 11

TeamNumber	11
TeamName	Iowa State
Model	R1X
Engine	Yamaha

Displacement cc	1049.00
RatedSpeed	8650
RatedTorque	100.1





Team Results for Clean Snowmobile Challenge 2019 Team 9



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/06 12:59:50
Team Name : IUPUI
Team Number : 9
Model : Polaris
Engine : Polaris
Displacement[cc] : 800.00
100% Speed : 8182
100% Torque : 92.9
No of Strokes : 2
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5
Weighting	:	0.12	0.27	0.25	0.31	0.05
Power	kW :	34.7	0.0	0.0	0.0	0.0
HC_m	g/hr :	1368.12	**	**	**	**
CO_m	g/hr :	32212.18	**	**	**	**
NOx_m	g/hr :	0.88	**	**	**	**
Soot_m	mg/hr:	421.15	**	**	**	**
N2O_m	mg/hr:	1.06	**	**	**	**
CO2_m	g/hr :	35973.52	**	**	**	**
CH4_m	g/hr :	310.93	**	**	**	**
W_HC	g/hr :	164.17	**	**	**	**
W_CO	g/hr :	3865.46	**	**	**	**
W_NOx	g/hr :	0.11	**	**	**	**
W_HCNOx	g/hr :	164.28	**	**	**	**
W_Soot	mg/hr:	50.54	**	**	**	**
W_N2O	g/hr :	0.13	**	**	**	**
W_CO2	g/hr :	4316.82	**	**	**	**
W_CH4	g/hr :	37.31	**	**	**	**

Total Weighted Power [kW] 4.164

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	164.17	3865.46	0.11	164.28
Specific Mass [g/kW-hr]	39.43	928.29	0.03	39.45
BSFC [g/kW-hr]	****			

Total Soot [mg/hr] 50.54 Specific Soot [mg/kW-hr] 12.14

Not Used for Competition

Total N2O [mg/hr]	0.13	Specific N2O [mg/kW-hr]	0.03
Total CO2 [g/hr]	4316.82	Specific CO2 [g/kW-hr]	1036.68
Total CH4 [g/hr]	37.31	Specific CH4 [g/kW-hr]	8.96
RMC BSFC [g/kW-hr]	0		

EMISSION TESTS:

	Value	Limit	Result
Power	79.57	<96.94 kW	PASS
Soot	12.14	<50 mg/kW-hr	PASS
CO	928.29	<275 g/kW-hr	FAIL
HC + NOX	39.45	<90 g/kW-hr	FAIL
E-Score	0.00	>175	FAIL
Valid Data for All 5 Modes			FAIL
RMC			FAIL (-50 Points)
LAB EMISSION TEST			FAIL



Team Results for
Clean Snowmobile Challenge 2019
Team 9



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5
Total Points	points	530	1	1	1	1
PtsInMode	points	1140	1	1	1	1
Speed	rpm	8018.74	0.00	0.00	0.00	0.00
Torque	Nm	41.32	0.00	0.00	0.00	0.00
Power	kW	34.70	0.00	0.00	0.00	0.00
BSFC	g/kw-hr	831.80	**	**	**	**
Fuel	g/hr	28863.96	#####	#####	#####	#####
T_int	degC	23.36	0.00	0.00	0.00	0.00
RelHumid	%	16.74	0.00	0.00	0.00	0.00
Baro	in Hg	28.91	0.00	0.00	0.00	0.00
Baro	mmHg	734.42	0.00	0.00	0.00	0.00
Pvap_kPa	kPa	0.40	0.00	0.00	0.00	0.00
Pvap_inHg	inHg	0.12	0.00	0.00	0.00	0.00
AbsHumidity	grains/lb	17.81	**	**	**	**
SatPres	kPa	97.51	0.00	0.00	0.00	0.00
Hum Factor		1.00	1.00	1.00	1.00	1.00
F_fac		1.01	**	**	**	**
K_fac		1.03	**	**	**	**
Humidity	g/kg	2.54	**	**	**	**
H2		5.06	**	**	**	**
WetDry Factor		0.90	1.00	1.00	1.00	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 9



Modal Emissions Concentrations

ModeNum		1	2	3	4	5
THC	ppmC1	8092.03	0.00	0.00	0.00	0.00
CO	%	9.51	0.00	0.00	0.00	0.00
N2O	ppm	19.87	0.00	0.00	0.00	0.00
CH4	ppm	1606.39	0.00	0.00	0.00	0.00
CO2	%	6.76	0.00	0.00	0.00	0.00
O2	%	0.08	0.00	0.00	0.00	0.00
CNOx	ppm	1.58	0.00	0.00	0.00	0.00
AHC	ppm	68.87	0.00	0.00	0.00	0.00
C2H2	ppm	10.10	0.00	0.00	0.00	0.00
C2H4	ppm	84.82	0.00	0.00	0.00	0.00
C3H6	ppm	16.22	0.00	0.00	0.00	0.00
C4H6	ppm	4.69	0.00	0.00	0.00	0.00
ETOH	ppm	0.00	0.00	0.00	0.00	0.00
H2O	%	10.18	0.00	0.00	0.00	0.00
HCHO	ppm	0.32	0.00	0.00	0.00	0.00
HCN	ppm	2.20	0.00	0.00	0.00	0.00
HNCO	ppm	2.51	0.00	0.00	0.00	0.00
MECHO	ppm	1.47	0.00	0.00	0.00	0.00
NC5	ppm	6.16	0.00	0.00	0.00	0.00
NH3	ppm	25.40	0.00	0.00	0.00	0.00
NO	ppm	0.80	0.00	0.00	0.00	0.00
NO2	ppm	0.84	0.00	0.00	0.00	0.00
Soot	mg/m3	1.60	0.00	0.00	0.00	0.00
AFR	:1	9.19	**	**	**	**



Team Results for Clean Snowmobile Challenge 2019 Team 9



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	5.633	0.901	10.181	66.933	0.774	9.967	0.996
2	**	0.000	0.000	0.000	0.000	**	**
3	**	0.000	0.000	0.000	0.000	**	**
4	**	0.000	0.000	0.000	0.000	**	**
5	**	0.000	0.000	0.000	0.000	**	**

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	1368.121	0.822	0.103	0.925	92.459	7.541
2	**	**	**	**	**	**
3	**	**	**	**	**	**
4	**	**	**	**	**	**
5	**	**	**	**	**	**

Carbon Balance Verification

		1	2	3	4	5
Power	kW	34.701	0.000	0.000	0.000	0.000
BSFC	g/kw-hr	831.80	**	**	**	**
Fuel_MassFlow	g/hr	28864	9999999	9999999	9999999	9999999
HC_m	g/hr	1368.1	**	**	**	**
CO_m	g/hr	32212	**	**	**	**
CO2_m	g/hr	35974	**	**	**	**
TW_Power	kW	4.1641				
TW_BSFC	g/kw-hr	**				
Fuel_MassFlow	g/hr	28864	9999999	9999999	9999999	9999999
FuelCalc	g/hr	29087	**	**	**	**
FuelCalcDev	%	-0.77267	**	**	**	**

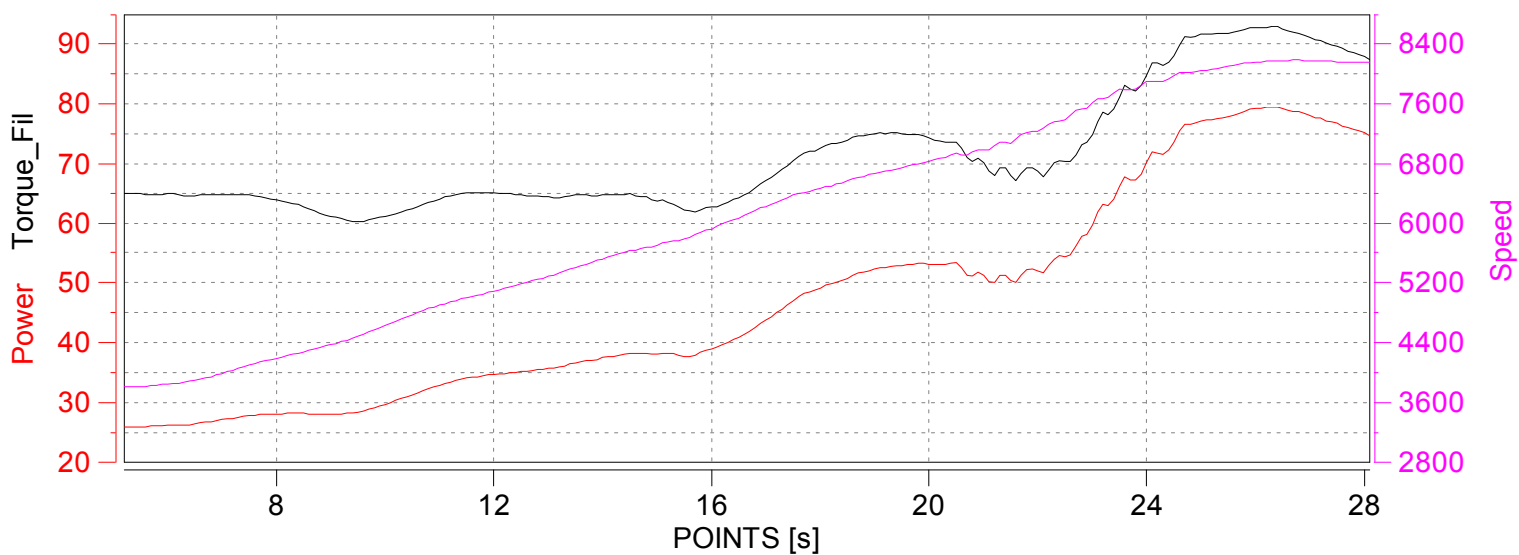
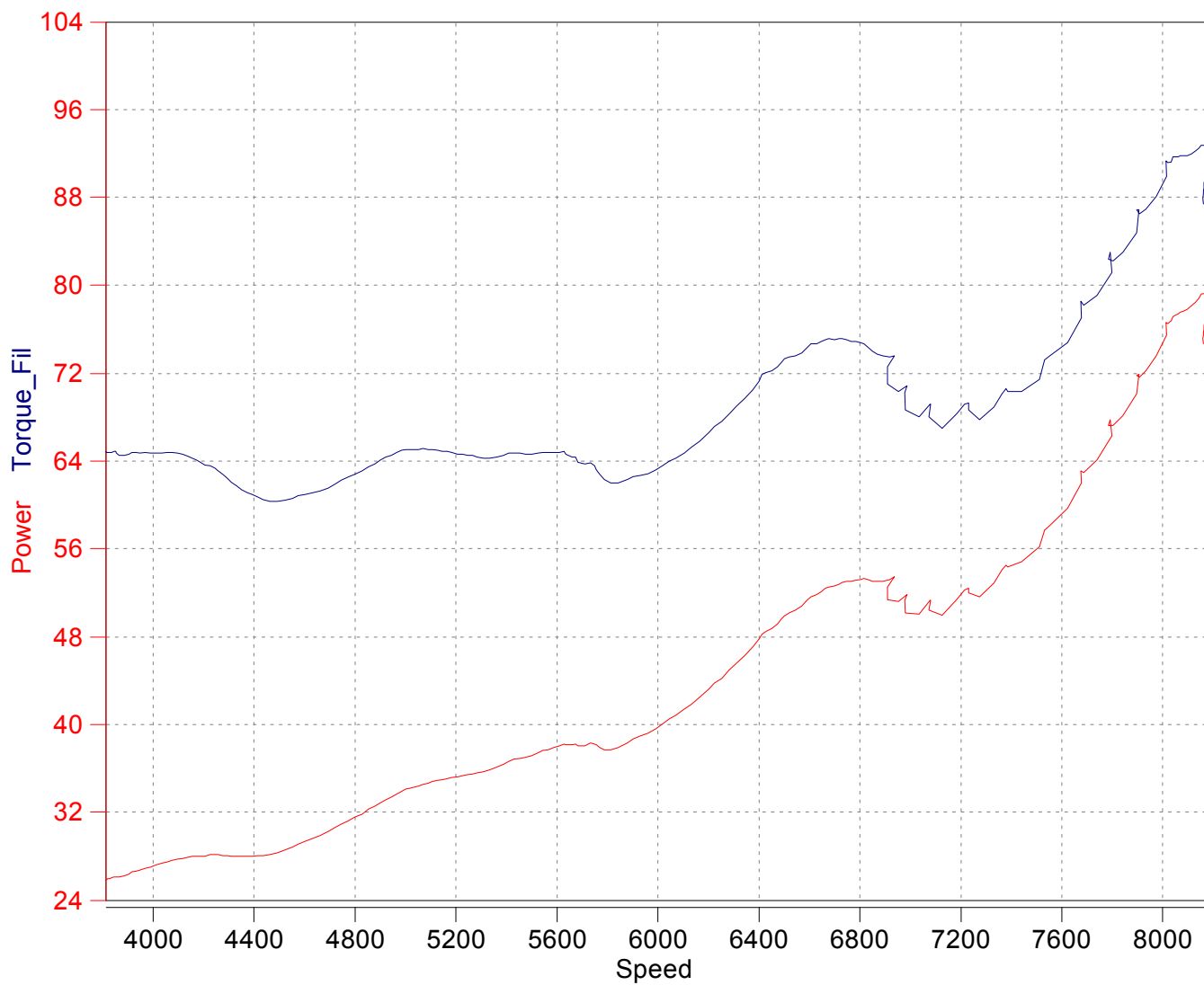
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 9

TeamNumber	9
TeamName	IUPUI
Model	Polaris
Engine	Polaris

Displacement cc	800.00
RatedSpeed	8182
RatedTorque	92.9





Team Results for Clean Snowmobile Challenge 2019 Team 102



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/05 09:30:13
Team Name : Kettering
Team Number : 102
Model : Smart Car Diesel
Engine : Mercedes
Displacement[cc] : 799.00
100% Speed : 3778
100% Torque : 54.0
No of Strokes : 4
Fuel : Diesel H/C: 1.81 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	22.8	9.3	5.3	2.6	0.0	7.1
HC_m g/hr	:	7.37	2.02	1.11	2.71	0.45	0.89
CO_m g/hr	:	0.33	0.06	0.03	0.62	0.04	0.28
NOx_m g/hr	:	270.03	177.15	106.39	2.46	9.48	113.88
Soot_m mg/hr	:	2.99	3.99	2.30	1.06	0.76	1.78
N2O_m mg/hr	:	0.05	0.03	0.04	0.02	0.03	0.04
CO2_m g/hr	:	24184.48	10611.75	7036.41	4825.63	1630.81	9463.04
CH4_m g/hr	:	0.14	0.05	0.05	0.07	0.08	0.07
W_HC g/hr	:	0.88	0.55	0.28	0.84	0.02	0.89
W_CO g/hr	:	0.04	0.02	0.01	0.19	0.00	0.28
W_NOx g/hr	:	32.40	47.83	26.60	0.76	0.47	113.88
W_HCNOx g/hr	:	33.29	48.38	26.87	1.60	0.50	114.77
W_Soot mg/hr	:	0.36	1.08	0.57	0.33	0.04	1.78
W_N2O g/hr	:	0.01	0.01	0.01	0.01	0.00	0.04
W_CO2 g/hr	:	2902.14	2865.17	1759.10	1495.94	81.54	9463.04
W_CH4 g/hr	:	0.02	0.01	0.01	0.02	0.00	0.07

Total Weighted Power [kW] 7.386

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	2.57	0.26	108.07	110.64
Specific Mass [g/kW-hr]	0.35	0.03	14.63	14.98
BSFC [g/kW-hr]	420.7			

Total Soot [mg/hr] 2.38 Specific Soot [mg/kW-hr] 0.32

Not Used for Competition

Total N2O [mg/hr]	0.03	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	9103.90	Specific CO2 [g/kW-hr]	1232.64
Total CH4 [g/hr]	0.07	Specific CH4 [g/kW-hr]	0.01
RMC BSFC [g/kW-hr]	417.80		

EMISSION TESTS:

	Value	Limit	Result
Power	21.37	<96.94 kW	PASS
Soot	0.32	<50 mg/kW-hr	PASS
CO	0.03	<275 g/kW-hr	PASS
HC + NOX	14.98	<90 g/kW-hr	PASS
E-Score	200.00	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



Team Results for Clean Snowmobile Challenge 2019 Team 102



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	3778.73	3211.29	2833.63	2456.40	1001.02	2877.32
Torque	Nm	57.73	27.62	17.81	10.23	0.00	23.64
Power	kW	22.84	9.29	5.28	2.63	0.00	7.12
BSFC	g/kw-hr	333.11	359.40	418.78	577.29	**	417.80
Fuel	g/hr	7609.33	3337.59	2212.85	1519.84	513.07	2975.50
T_int	degC	52.13	49.79	51.05	58.74	57.08	52.13
RelHumid	%	17.52	16.50	15.25	16.67	14.31	16.45
Baro	in Hg	28.67	28.67	28.67	28.67	28.67	28.67
Baro	mmHg	728.25	728.31	728.34	728.26	728.34	728.30
Pvap_kPa	kPa	1.70	1.44	1.41	2.16	1.73	1.60
Pvap_inHg	inHg	0.50	0.43	0.42	0.64	0.51	0.47
AbsHumidity	grains/lb	77.84	65.84	64.33	99.34	79.01	73.01
SatPres	kPa	95.38	95.65	95.69	94.92	95.37	95.49
Hum Factor		1.01	0.96	0.95	1.13	1.02	0.99
F_fac		1.10	1.09	1.10	1.12	1.12	1.10
K_fac		1.08	1.08	1.08	1.10	1.09	1.08
Humidity	g/kg	11.12	9.41	9.19	14.19	11.29	10.43
H2		0.00	0.00	0.00	0.00	0.00	0.00
WetDry Factor		0.92	0.94	0.95	0.96	0.97	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 102



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	80.43	36.53	25.44	79.05	20.76	16.57
CO	%	0.00	0.00	0.00	0.00	0.00	0.00
N2O	ppm	1.87	1.80	2.78	1.70	4.26	2.17
CH4	ppm	1.30	0.77	1.03	1.69	3.09	1.19
CO2	%	8.30	6.03	5.07	4.42	2.36	5.52
O2	%	8.07	11.36	12.80	13.81	16.27	12.77
CNOx	ppm	886.75	963.04	733.75	21.53	131.25	635.72
AHC	ppm	4.47	0.00	0.00	2.07	0.01	1.05
C2H2	ppm	0.02	0.01	0.01	0.33	0.07	0.07
C2H4	ppm	0.31	0.18	0.14	1.53	0.13	0.45
C3H6	ppm	0.43	0.43	0.46	0.25	0.33	0.36
C4H6	ppm	0.65	1.01	0.53	0.14	0.23	0.59
ETOH	ppm	2.56	2.22	1.92	3.86	1.56	2.46
H2O	%	7.84	5.77	5.02	4.23	2.55	0.00
HCHO	ppm	0.00	0.03	0.01	0.01	0.00	0.02
HCN	ppm	0.21	0.25	0.24	0.03	0.09	0.20
HNCO	ppm	3.36	4.88	3.23	1.48	1.33	3.23
MECHO	ppm	0.00	0.00	0.00	0.00	0.00	0.00
NC5	ppm	9.54	2.85	2.28	6.08	1.71	4.34
NH3	ppm	0.12	0.03	0.03	0.08	0.03	0.06
NO	ppm	604.05	395.02	316.86	14.26	22.26	298.32
NO2	ppm	270.87	609.47	453.69	4.81	106.52	343.36
Soot	mg/m3	0.02	0.04	0.03	0.02	0.02	0.02
AFR	:1	24.21	33.36	39.74	45.52	83.21	37.65



Team Results for Clean Snowmobile Challenge 2019 Team 102



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.000	0.009	7.842	80.851	0.935	24.200	0.600
2	0.000	0.004	5.772	79.581	0.920	33.322	0.443
3	0.000	0.003	5.019	79.482	0.919	39.692	0.375
4	0.000	0.008	4.226	78.672	0.909	45.573	0.328
5	0.000	0.002	2.548	75.879	0.877	83.167	0.216

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	7.365	-3.600	-0.450	-4.050	95.596	4.404
2	2.020	-3.564	-0.445	-4.009	95.052	4.948
3	1.109	-3.336	-0.417	-3.753	95.545	4.455
4	2.715	-3.098	-0.387	-3.485	95.134	4.866
5	0.451	-1.899	-0.237	-2.136	93.751	6.249

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	22.843	9.287	5.284	2.633	0.000	7.122
BSFC	g/kw-hr	333.11	359.40	418.78	577.29	**	417.80
Fuel_MassFlow	g/hr	7609.3	3337.6	2212.8	1519.8	513.1	2975.5
HC_m	g/hr	7.3652	2.0204	1.1090	2.7146	0.4510	0.8924
CO_m	g/hr	0.33015	0.05981	0.02871	0.62214	0.03768	0.28184
CO2_m	g/hr	24184	10612	7036	4826	1631	9463
TW_Power	kW	7.3857					
TW_BSFC	g/kw-hr	420.67					
Fuel_MassFlow	g/hr	7609.3	3337.6	2212.8	1519.8	513.1	2975.5
FuelCalc	g/hr	7610.3	3337.8	2213.0	1520.2	513.1	2975.6
FuelCalcDev	%	-0.012871	-0.007369	-0.005788	-0.025286	-0.011521	-0.002734

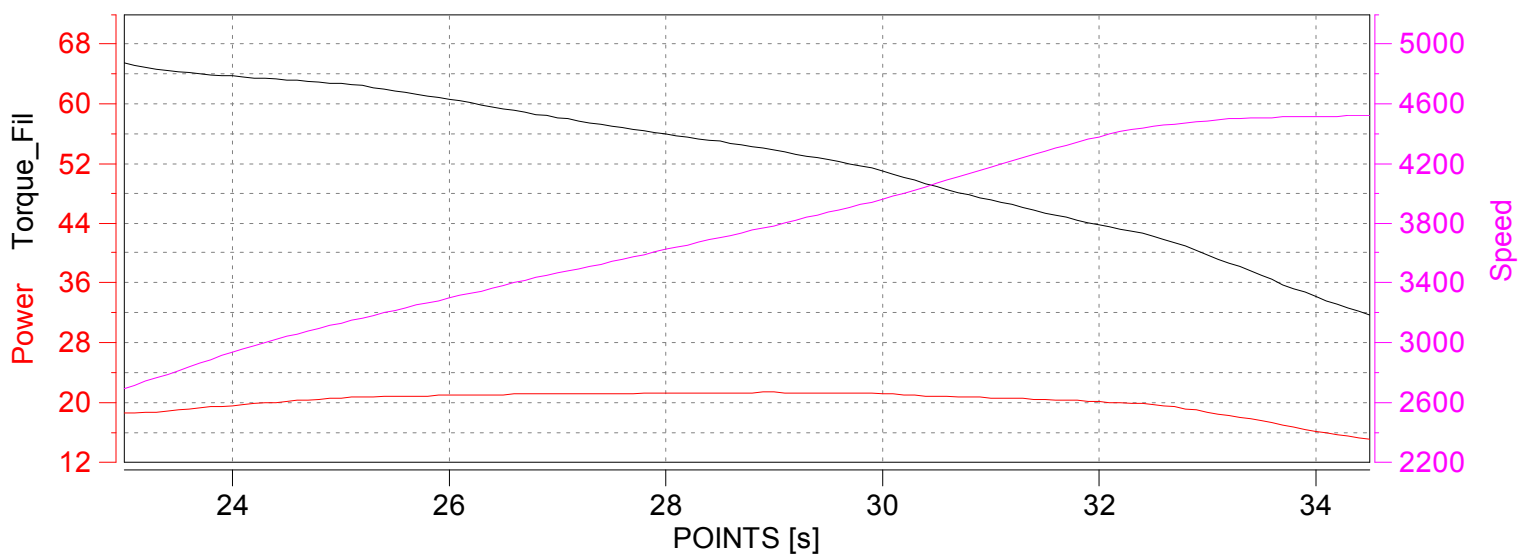
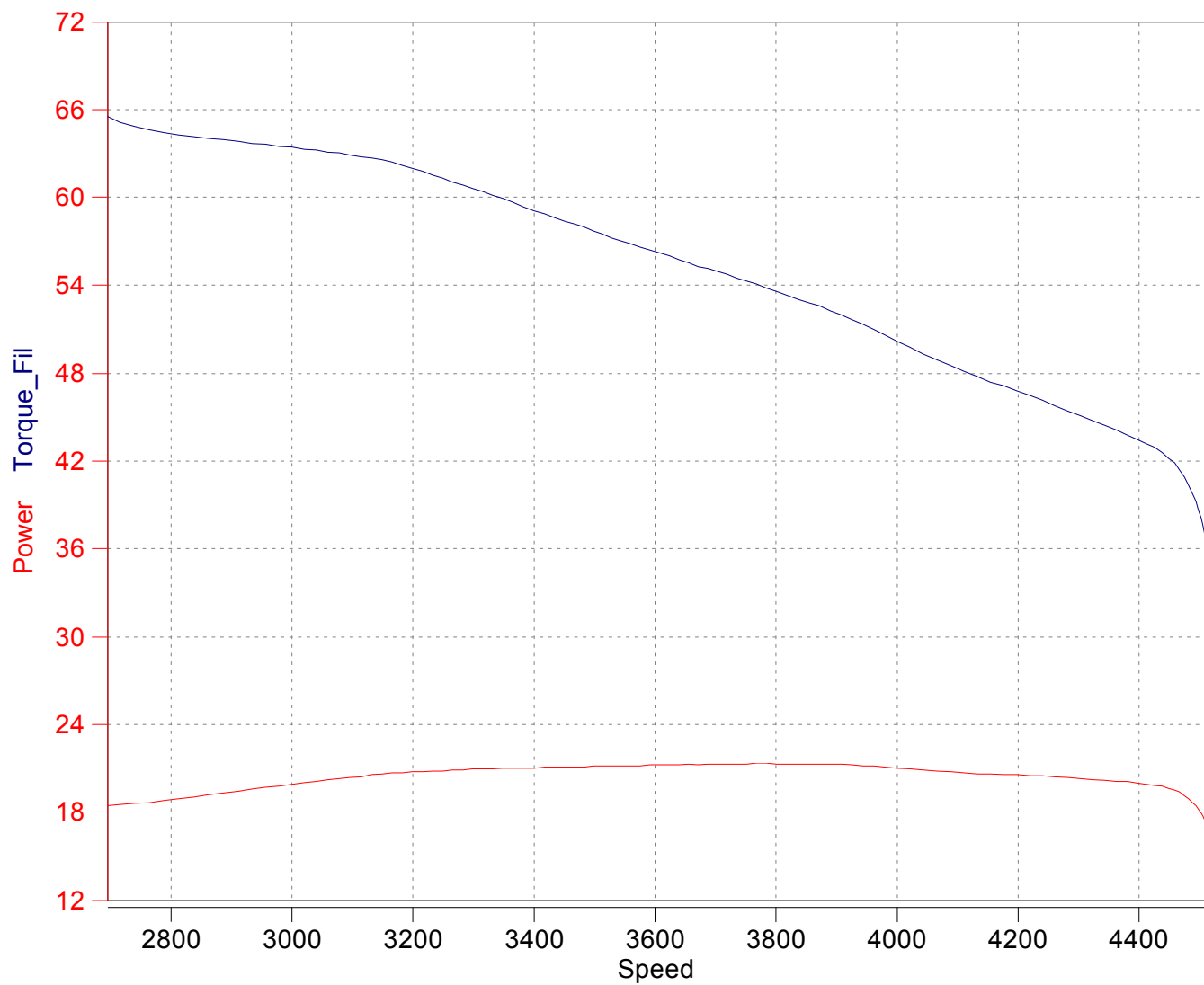
\$HCR_ENG	1.808
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.86826

Power Run

Team 102

TeamNumber	102
TeamName	Kettering
Model	Smart Car Diesel
Engine	Mercedes

Displacement cc	799.00
RatedSpeed	3778
RatedTorque	54.0





Team Results for Clean Snowmobile Challenge 2019 Team 3



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/07 09:33:47
Team Name : University of Madison
Team Number : 3
Model : Skidoo
Engine : Skidoo
Displacement[cc] : 674.00
100% Speed : 6029
100% Torque : 55.6
No of Strokes : 4
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	34.0	15.3	8.7	4.2	0.0	11.6
HC_m g/hr	:	9.13	5.40	7.11	5.68	2.36	2.49
CO_m g/hr	:	6.14	0.94	0.51	0.15	0.08	1.25
NOx_m g/hr	:	413.32	72.28	17.29	5.57	1.93	53.91
Soot_m mg/hr	:	45.19	14.56	1.66	0.82	0.50	7.86
N2O_m mg/hr	:	0.08	0.01	0.01	0.00	0.00	0.01
CO2_m g/hr	:	26445.57	13925.27	10175.54	7070.18	4152.70	12494.57
CH4_m g/hr	:	1.61	1.31	1.68	1.45	0.53	1.68
W_HC g/hr	:	1.10	1.46	1.78	1.76	0.12	2.49
W_CO g/hr	:	0.74	0.25	0.13	0.05	0.00	1.25
W_NOx g/hr	:	49.60	19.51	4.32	1.73	0.10	53.91
W_HCNOx g/hr	:	50.69	20.97	6.10	3.49	0.21	56.40
W_Soot mg/hr	:	5.42	3.93	0.42	0.25	0.02	7.86
W_N2O g/hr	:	0.01	0.00	0.00	0.00	0.00	0.01
W_CO2 g/hr	:	3173.47	3759.82	2543.89	2191.76	207.63	12494.57
W_CH4 g/hr	:	0.19	0.35	0.42	0.45	0.03	1.68

Total Weighted Power [kW] 11.670

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	6.21	1.17	75.26	81.47
Specific Mass [g/kW-hr]	0.53	0.10	6.45	6.98
BSFC [g/kW-hr]	368.3			

Total Soot [mg/hr] 10.05 Specific Soot [mg/kW-hr] 0.86

Not Used for Competition

Total N2O [mg/hr]	0.02	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	11876.57	Specific CO2 [g/kW-hr]	1017.72
Total CH4 [g/hr]	1.44	Specific CH4 [g/kW-hr]	0.12
RMC BSFC [g/kW-hr]	343.79		

EMISSION TESTS:

	Value	Limit	Result
Power	35.09	<96.94 kW	PASS
Soot	0.86	<50 mg/kW-hr	PASS
CO	0.10	<275 g/kW-hr	PASS
HC + NOX	6.98	<90 g/kW-hr	PASS
E-Score	205.32	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



Team Results for Clean Snowmobile Challenge 2019 Team 3



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	6028.36	5125.10	4522.16	3919.25	2137.21	4636.48
Torque	Nm	53.80	28.45	18.42	10.15	0.00	23.79
Power	kW	33.96	15.27	8.72	4.17	0.00	11.55
BSFC	g/kw-hr	247.63	290.01	371.35	540.27	**	343.79
Fuel	g/hr	8410.11	4427.91	3238.66	2250.92	1321.11	3970.83
T_int	degC	22.36	42.24	24.73	25.11	25.72	29.85
RelHumid	%	11.80	10.20	13.15	11.39	14.24	11.51
Baro	in Hg	29.17	29.16	29.17	29.17	29.17	29.17
Baro	mmHg	740.84	740.78	740.86	740.86	740.97	740.82
Pvap_kPa	kPa	0.27	0.63	0.34	0.30	0.38	0.38
Pvap_inHg	inHg	0.08	0.19	0.10	0.09	0.11	0.11
AbsHumidity	grains/lb	11.78	27.95	14.91	13.18	17.03	17.06
SatPres	kPa	98.50	98.13	98.44	98.48	98.40	98.38
Hum Factor		0.77	0.82	0.78	0.77	0.79	0.79
F_fac		1.00	1.05	1.01	1.01	1.01	1.02
K_fac		1.02	1.05	1.02	1.02	1.02	1.03
Humidity	g/kg	1.68	3.99	2.13	1.88	2.43	2.44
H2		0.00	0.00	0.00	0.00	0.00	0.00
WetDry Factor		0.88	0.87	0.88	0.88	0.88	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 3



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	139.77	158.28	282.82	318.48	231.95	80.59
CO	%	0.00	0.00	0.00	0.00	0.00	0.00
N2O	ppm	4.07	1.12	0.74	0.55	0.47	1.27
CH4	ppm	21.56	33.44	58.33	70.92	45.25	47.48
CO2	%	12.86	12.96	12.85	12.60	12.98	12.82
O2	%	1.13	0.92	1.17	1.49	1.08	1.34
CNOx	ppm	1923.00	643.32	208.94	94.95	57.77	529.08
AHC	ppm	0.00	0.00	0.00	0.00	0.00	0.00
C2H2	ppm	0.60	0.43	0.53	0.59	0.53	0.53
C2H4	ppm	5.18	3.57	3.70	1.66	0.83	3.41
C3H6	ppm	0.41	0.27	0.25	0.13	0.18	0.28
C4H6	ppm	0.84	0.42	0.33	0.42	0.27	0.45
ETOH	ppm	3.05	3.14	3.23	2.76	3.08	3.02
H2O	%	12.43	12.55	12.38	12.26	12.02	0.00
HCHO	ppm	1.01	0.61	0.34	0.28	0.22	0.55
HCN	ppm	0.18	0.09	0.04	0.09	0.09	0.11
HNCO	ppm	1.61	1.68	1.91	1.08	1.47	1.61
MECHO	ppm	0.00	0.00	0.00	0.00	0.00	0.00
NC5	ppm	1.39	2.40	3.81	5.03	6.89	3.77
NH3	ppm	2.10	0.29	0.01	0.90	0.01	0.87
NO	ppm	2478.95	783.22	267.02	122.03	73.98	669.52
NO2	ppm	15.42	2.77	0.54	0.51	0.04	3.60
Soot	mg/m3	0.39	0.24	0.04	0.03	0.03	0.14
AFR	:1	15.60	15.39	15.52	15.77	15.46	15.73



Team Results for Clean Snowmobile Challenge 2019 Team 3



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.002	0.016	12.425	83.076	0.960	15.621	0.943
2	0.001	0.018	12.554	82.568	0.954	15.393	0.953
3	0.000	0.032	12.381	82.637	0.955	15.557	0.940
4	0.000	0.036	12.260	82.567	0.954	15.813	0.924
5	0.000	0.026	12.025	81.813	0.946	15.475	0.945

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	9.126	-0.825	-0.103	-0.928	99.375	0.625
2	5.402	-0.677	-0.085	-0.762	98.726	1.274
3	7.111	-0.843	-0.105	-0.948	98.684	1.316
4	5.676	-1.051	-0.131	-1.182	98.412	1.588
5	2.357	-0.782	-0.098	-0.880	97.864	2.136

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	33.963	15.268	8.721	4.166	0.000	11.550
BSFC	g/kw-hr	247.63	290.01	371.35	540.27	**	343.79
Fuel_MassFlow	g/hr	8410.1	4427.9	3238.7	2250.9	1321.1	3970.8
HC_m	g/hr	9.1261	5.4020	7.1113	5.6762	2.3573	2.4943
CO_m	g/hr	6.1422	0.9396	0.5121	0.1460	0.0823	1.2508
CO2_m	g/hr	26446	13925	10176	7070	4153	12495
TW_Power	kW	11.670					
TW_BSFC	g/kw-hr	368.34					
Fuel_MassFlow	g/hr	8410.1	4427.9	3238.7	2250.9	1321.1	3970.8
FuelCalc	g/hr	8411.4	4428.7	3239.8	2251.8	1321.5	3971.2
FuelCalcDev	%	-0.015903	-0.018109	-0.034070	-0.039402	-0.027341	-0.008428

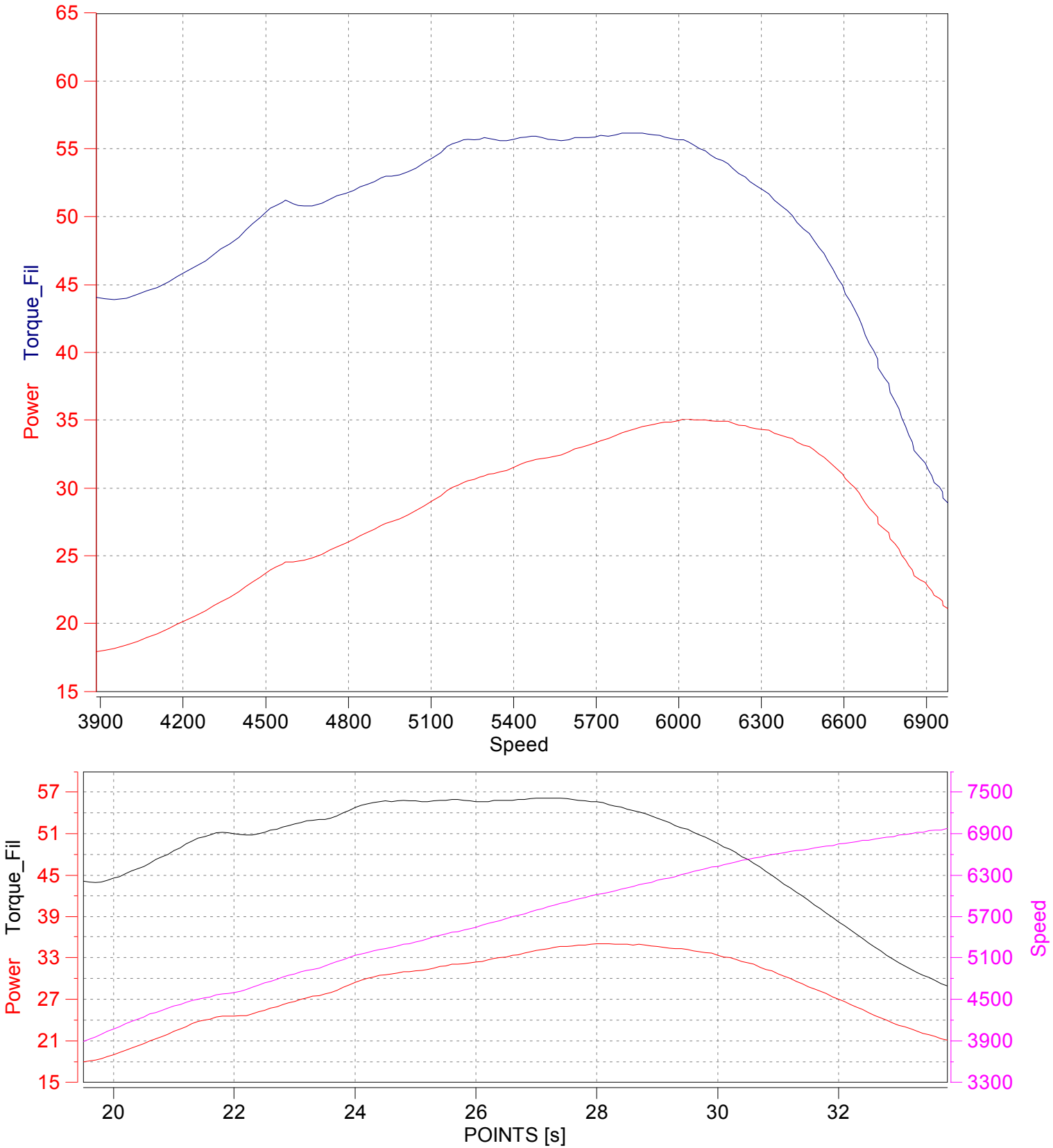
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 3

TeamNumber	3
TeamName	University of Madison
Model	Skidoo
Engine	Skidoo

Displacement cc	674.00
RatedSpeed	6029
RatedTorque	55.6





Team Results for Clean Snowmobile Challenge 2019 Team 13



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5
Total Points	points	1	100	1	1	1
PtsInMode	points	1	150	1	1	1
Speed	rpm	0.00	6290.44	0.00	0.00	0.00
Torque	Nm	0.00	23.72	0.00	0.00	0.00
Power	kW	0.00	15.63	0.00	0.00	0.00
BSFC	g/kw-hr	**	597.78	**	**	**
Fuel	g/hr	#####	9341.84	#####	#####	#####
T_int	degC	0.00	16.18	0.00	0.00	0.00
RelHumid	%	0.00	17.55	0.00	0.00	0.00
Baro	in Hg	0.00	28.96	0.00	0.00	0.00
Baro	mmHg	0.00	735.71	0.00	0.00	0.00
Pvap_kPa	kPa	0.00	0.28	0.00	0.00	0.00
Pvap_inHg	inHg	0.00	0.08	0.00	0.00	0.00
AbsHumidity	grains/lb	**	12.55	**	**	**
SatPres	kPa	0.00	97.80	0.00	0.00	0.00
Hum Factor		1.00	1.00	1.00	1.00	1.00
F_fac		**	0.99	**	**	**
K_fac		**	1.01	**	**	**
Humidity	g/kg	**	1.79	**	**	**
H2		**	4.45	**	**	**
WetDry Factor		1.00	0.88	1.00	1.00	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 13



Modal Emissions Concentrations

ModeNum		1	2	3	4	5
THC	ppmC1	0.00	12542.40	0.00	0.00	0.00
CO	%	0.00	8.58	0.00	0.00	0.00
N2O	ppm	0.00	19.21	0.00	0.00	0.00
CH4	ppm	0.00	1368.50	0.00	0.00	0.00
CO2	%	0.00	6.74	0.00	0.00	0.00
O2	%	0.00	0.00	0.00	0.00	0.00
CNOx	ppm	0.00	4.02	0.00	0.00	0.00
AHC	ppm	0.00	123.88	0.00	0.00	0.00
C2H2	ppm	0.00	55.33	0.00	0.00	0.00
C2H4	ppm	0.00	314.00	0.00	0.00	0.00
C3H6	ppm	0.00	94.41	0.00	0.00	0.00
C4H6	ppm	0.00	12.82	0.00	0.00	0.00
ETOH	ppm	0.00	0.54	0.00	0.00	0.00
H2O	%	0.00	12.34	0.00	0.00	0.00
HCHO	ppm	0.00	3.77	0.00	0.00	0.00
HCN	ppm	0.00	7.04	0.00	0.00	0.00
HNCO	ppm	0.00	2.24	0.00	0.00	0.00
MECHO	ppm	0.00	0.32	0.00	0.00	0.00
NC5	ppm	0.00	9.31	0.00	0.00	0.00
NH3	ppm	0.00	54.96	0.00	0.00	0.00
NO	ppm	0.00	4.22	0.00	0.00	0.00
NO2	ppm	0.00	0.09	0.00	0.00	0.00
Soot	mg/m3	0.00	7.53	0.00	0.00	0.00
AFR	:1	**	8.62	**	**	**



Team Results for Clean Snowmobile Challenge 2019 Team 13



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	**	0.000	0.000	0.000	0.000	**	**
2	5.073	1.431	12.336	69.750	0.806	9.828	1.000
3	**	0.000	0.000	0.000	0.000	**	**
4	**	0.000	0.000	0.000	0.000	**	**
5	**	0.000	0.000	0.000	0.000	**	**

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	**	**	**	**	**	**
2	706.981	1.431	0.179	1.610	94.714	5.286
3	**	**	**	**	**	**
4	**	**	**	**	**	**
5	**	**	**	**	**	**

Carbon Balance Verification

		1	2	3	4	5
Power	kW	0.000	15.628	0.000	0.000	0.000
BSFC	g/kw-hr	**	597.78	**	**	**
Fuel_MassFlow	g/hr	9999999	9342	9999999	9999999	9999999
HC_m	g/hr	**	706.98	**	**	**
CO_m	g/hr	**	9691.9	**	**	**
CO2_m	g/hr	**	11963	**	**	**
TW_Power	kW	4.2194				
TW_BSFC	g/kw-hr	**				
Fuel_MassFlow	g/hr	9999999	9342	9999999	9999999	9999999
FuelCalc	g/hr	**	9457.2	**	**	**
FuelCalcDev	%	**	-1.2353	**	**	**

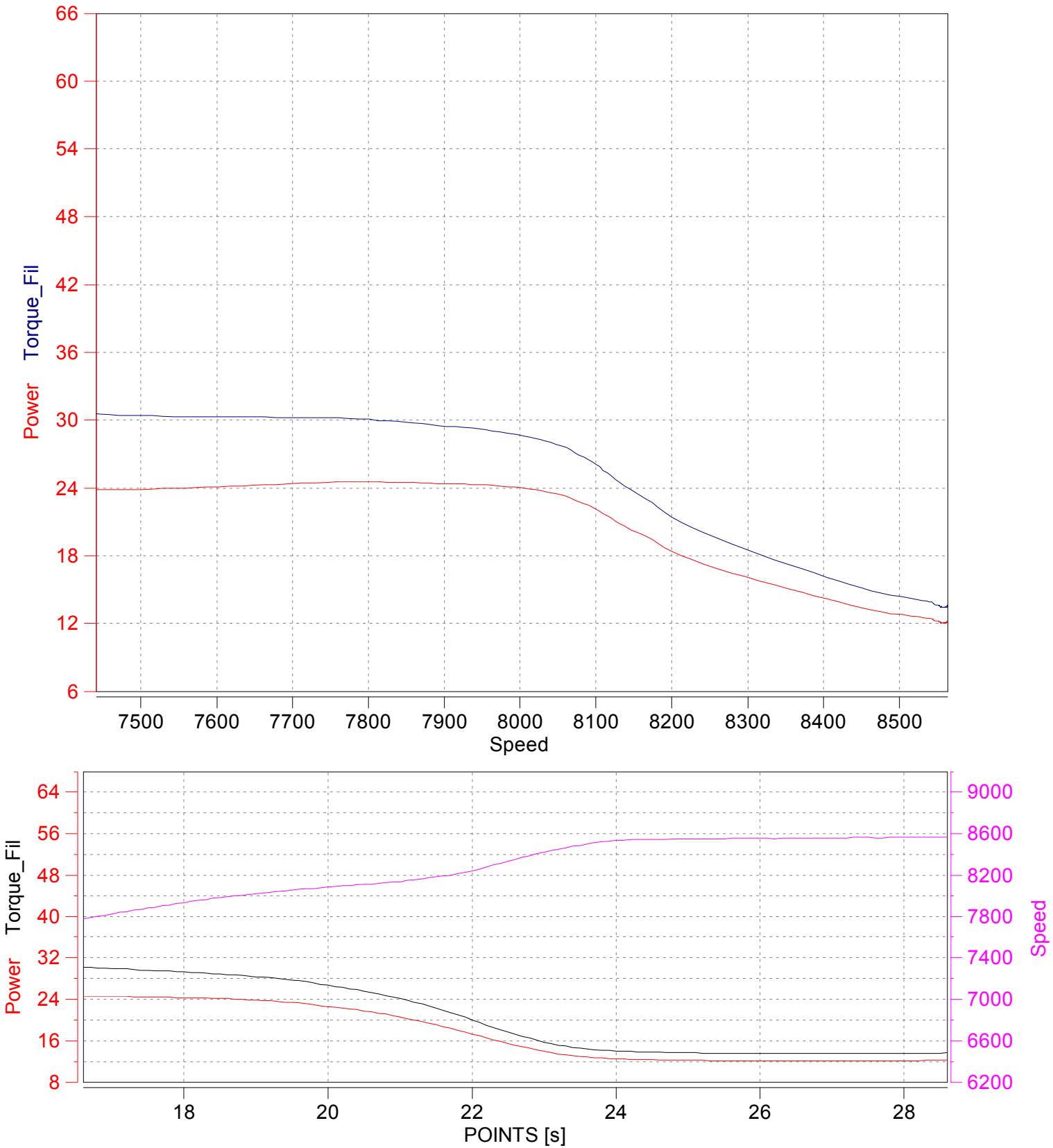
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 13

TeamNumber	13
TeamName	Montana State
Model	Polaris
Engine	Polaris

Displacement cc	600.00
RatedSpeed	7063
RatedTorque	33.6





Team Results for Clean Snowmobile Challenge 2019 Team 111



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/05 12:21:41
Team Name : Michigan Tech
Team Number : 111
Model : KDW
Engine : Kohler
Displacement[cc] : 993.00
100% Speed : 3832
100% Torque : 49.4
No of Strokes : 4
Fuel : Diesel H/C: 1.81 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	20.7	8.6	4.9	2.5	0.0	6.4
HC_m g/hr	:	93.53	2.61	4.49	8.47	0.54	3.91
CO_m g/hr	:	16.08	0.04	5.38	1.16	2.15	3.65
NOx_m g/hr	:	82.52	63.04	52.09	44.51	27.71	58.68
Soot_m mg/hr	:	1.48	1.16	1.09	0.86	0.36	-1.02
N2O_m mg/hr	:	0.06	0.02	0.02	0.02	0.01	0.03
CO2_m g/hr	:	18679.43	9785.23	6445.17	4321.43	1717.54	8247.49
CH4_m g/hr	:	0.89	0.10	0.07	0.11	0.03	0.18
W_HC g/hr	:	11.22	0.70	1.12	2.62	0.03	3.91
W_CO g/hr	:	1.93	0.01	1.35	0.36	0.11	3.65
W_NOx g/hr	:	9.90	17.02	13.02	13.80	1.39	58.68
W_HCNOx g/hr	:	21.13	17.73	14.14	16.42	1.41	62.59
W_Soot mg/hr	:	0.18	0.31	0.27	0.27	0.02	-1.02
W_N2O g/hr	:	0.01	0.01	0.01	0.01	0.00	0.03
W_CO2 g/hr	:	2241.53	2642.01	1611.29	1339.64	85.88	8247.49
W_CH4 g/hr	:	0.11	0.03	0.02	0.03	0.00	0.18

Total Weighted Power [kW] 6.797

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	15.70	3.75	55.13	70.83
Specific Mass [g/kW-hr]	2.31	0.55	8.11	10.42
BSFC [g/kW-hr]	407.5			

Total Soot [mg/hr] 1.05 Specific Soot [mg/kW-hr] 0.15

Not Used for Competition

Total N2O [mg/hr]	0.03	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	7920.36	Specific CO2 [g/kW-hr]	1165.25
Total CH4 [g/hr]	0.19	Specific CH4 [g/kW-hr]	0.03
RMC BSFC [g/kW-hr]	408.43		

EMISSION TESTS:

	Value	Limit	Result
Power	19.81	<96.94 kW	PASS
Soot	0.15	<50 mg/kW-hr	PASS
CO	0.55	<275 g/kW-hr	PASS
HC + NOX	10.42	<90 g/kW-hr	PASS
E-Score	202.91	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



Team Results for Clean Snowmobile Challenge 2019 Team 111



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1411	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	3831.64	3266.13	2874.37	2490.48	1190.57	2940.94
Torque	Nm	51.69	25.12	16.32	9.41	0.00	20.66
Power	kW	20.74	8.59	4.91	2.45	0.00	6.36
BSFC	g/kw-hr	288.00	358.34	413.75	557.30	**	408.43
Fuel	g/hr	5972.89	3078.38	2033.02	1367.37	541.47	2598.11
T_int	degC	21.42	39.80	37.28	40.74	24.49	35.49
RelHumid	%	17.07	15.01	14.79	17.42	13.55	15.53
Baro	in Hg	28.76	28.76	28.77	28.76	28.77	28.76
Baro	mmHg	730.42	730.56	730.71	730.44	730.72	730.54
Pvap_kPa	kPa	0.37	0.82	0.72	1.00	0.34	0.69
Pvap_inHg	inHg	0.11	0.24	0.21	0.30	0.10	0.20
AbsHumidity	grains/lb	16.44	37.20	32.37	45.26	15.38	31.14
SatPres	kPa	97.01	96.57	96.70	96.38	97.08	96.70
Hum Factor		0.78	0.85	0.83	0.88	0.78	0.83
F_fac		1.01	1.06	1.05	1.07	1.02	1.05
K_fac		1.03	1.06	1.06	1.06	1.03	1.05
Humidity	g/kg	2.35	5.31	4.62	6.47	2.20	4.45
H2		0.00	0.00	0.00	0.00	0.00	0.00
WetDry Factor		0.92	0.95	0.96	0.96	0.97	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 111



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	1320.00	46.10	99.19	233.89	25.09	74.76
CO	%	0.01	0.00	0.01	0.00	0.00	0.00
N2O	ppm	2.71	1.34	1.51	2.04	0.91	1.88
CH4	ppm	10.91	1.52	1.36	2.55	1.14	3.01
CO2	%	8.29	5.44	4.48	3.75	2.51	4.95
O2	%	8.06	12.32	13.76	14.83	16.06	13.64
CNOx	ppm	350.22	335.08	346.39	369.77	387.72	336.92
AHC	ppm	68.62	0.39	0.08	11.03	0.00	10.09
C2H2	ppm	0.55	0.37	0.36	0.37	0.26	0.40
C2H4	ppm	2.09	2.33	6.75	7.37	1.38	4.60
C3H6	ppm	3.94	0.32	1.28	0.44	0.35	0.89
C4H6	ppm	0.01	0.23	0.27	0.16	0.15	0.20
ETOH	ppm	4.78	1.37	1.23	2.03	0.96	1.78
H2O	%	7.90	5.21	4.36	3.69	2.83	0.00
HCHO	ppm	7.55	0.00	0.00	0.36	0.00	1.33
HCN	ppm	2.52	0.03	0.02	0.04	0.02	0.25
HNCO	ppm	5.21	1.52	1.35	1.37	1.26	1.72
MECHO	ppm	11.54	0.00	0.03	0.38	0.00	1.78
NC5	ppm	88.25	3.34	2.68	14.06	1.84	14.14
NH3	ppm	2.42	0.02	0.25	0.09	0.08	0.36
NO	ppm	445.75	393.68	415.44	421.01	495.69	405.52
NO2	ppm	0.87	0.97	0.35	0.46	0.50	0.85
Soot	mg/m3	0.01	0.01	0.01	0.01	0.01	-0.01
AFR	:1	23.13	37.10	44.89	53.04	78.10	41.87



Team Results for Clean Snowmobile Challenge 2019 Team 111



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.004	0.143	7.895	80.834	0.934	23.808	0.600
2	0.000	0.005	5.213	79.476	0.919	37.086	0.397
3	0.002	0.010	4.363	79.142	0.915	44.995	0.330
4	0.000	0.024	3.690	78.710	0.910	53.580	0.281
5	0.002	0.003	2.826	76.452	0.884	78.093	0.226

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	93.526	-3.519	-0.440	-3.958	95.626	4.374
2	2.608	-3.455	-0.432	-3.887	95.287	4.713
3	4.485	-3.138	-0.392	-3.530	95.647	4.353
4	8.467	-2.797	-0.350	-3.146	95.811	4.189
5	0.539	-2.006	-0.251	-2.256	94.247	5.753

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	20.739	8.591	4.914	2.454	0.000	6.361
BSFC	g/kw-hr	288.00	358.34	413.75	557.30	**	408.43
Fuel_MassFlow	g/hr	5972.9	3078.4	2033.0	1367.4	541.5	2598.1
HC_m	g/hr	93.526	2.608	4.485	8.467	0.539	3.915
CO_m	g/hr	16.083	0.040	5.384	1.157	2.149	3.649
CO2_m	g/hr	18679	9785	6445	4321	1718	8247
TW_Power	kW	6.7971					
TW_BSFC	g/kw-hr	407.52					
Fuel_MassFlow	g/hr	5972.9	3078.4	2033.0	1367.4	541.5	2598.1
FuelCalc	g/hr	5987.0	3078.7	2033.7	1368.6	541.5	2598.7
FuelCalcDev	%	-0.23579	-0.01104	-0.03166	-0.09214	-0.01329	-0.02105

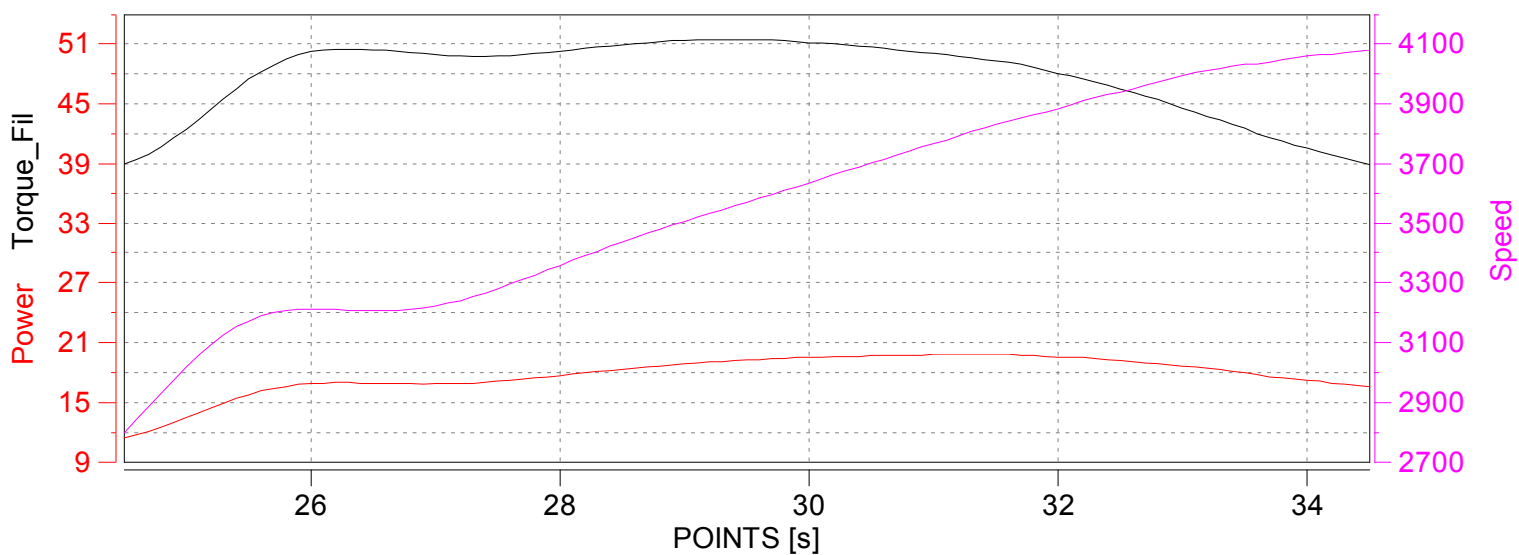
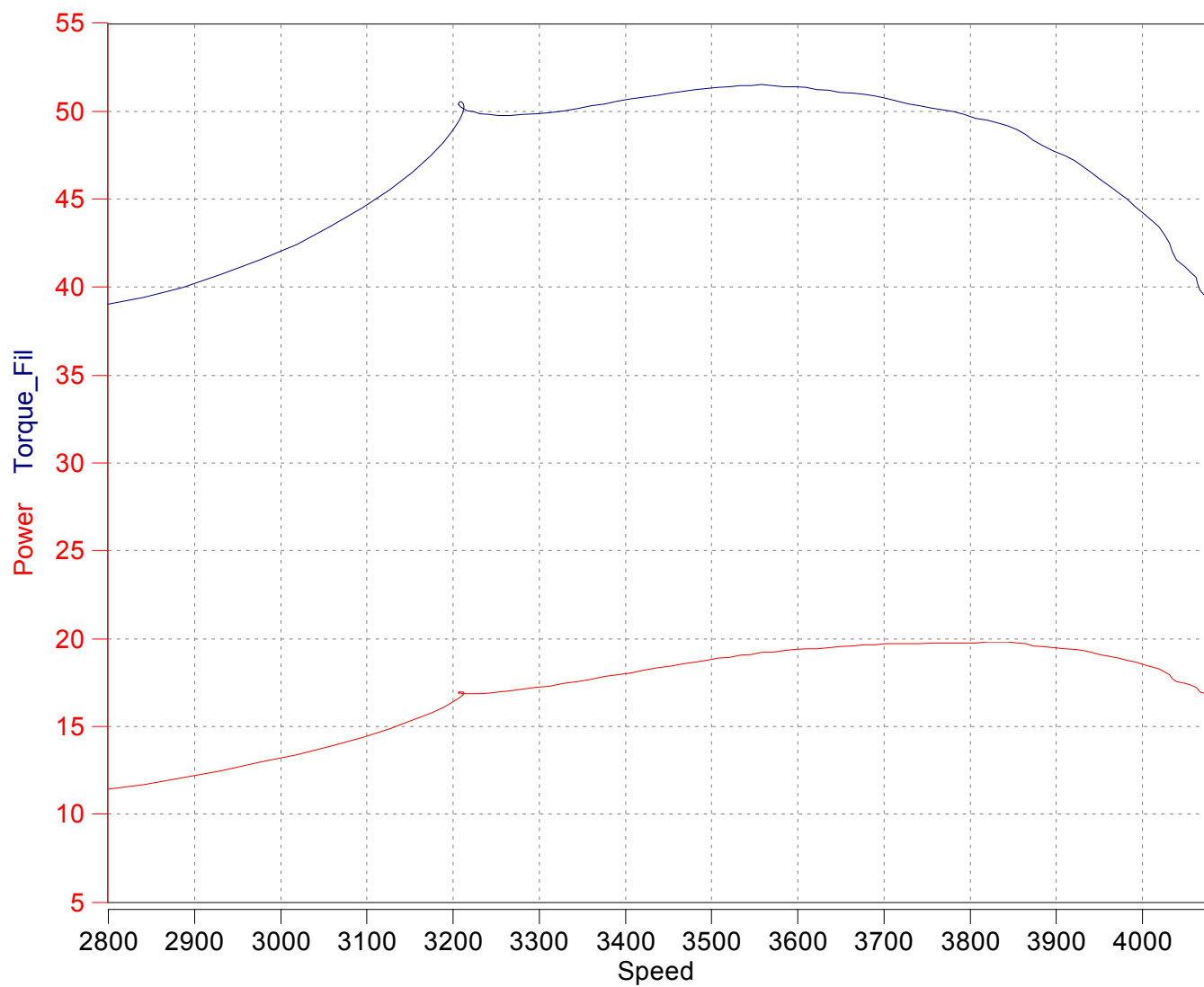
\$HCR_ENG	1.808
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.86826

Power Run

Team 111

TeamNumber	111
TeamName	Michigan Tech
Model	KDW
Engine	Kohler

Displacement cc	993.00
RatedSpeed	3832
RatedTorque	49.4





Team Results for Clean Snowmobile Challenge 2019 Team 6



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/06 15:45:20
Team Name : Michigan Tech
Team Number : 6
Model : R1
Engine : Yamaha
Displacement[cc] : 1049.00
100% Speed : 8186
100% Torque : 55.8
No of Strokes : 4
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	48.6	20.8	12.3	6.2	0.0	15.7
HC_m g/hr	:	155.84	12.18	16.20	40.99	16.63	14.30
CO_m g/hr	:	608.36	275.26	329.41	506.98	136.95	412.87
NOx_m g/hr	:	154.32	12.73	3.65	1.39	0.01	16.15
Soot_m mg/hr	:	5.46	2.68	5.53	20.36	0.38	8.40
N2O_m mg/hr	:	0.15	0.02	0.01	0.01	0.00	0.03
CO2_m g/hr	:	42141.21	21308.09	16249.59	10959.06	2671.37	19117.80
CH4_m g/hr	:	5.40	2.45	2.22	3.89	1.09	3.22
W_HC g/hr	:	18.70	3.29	4.05	12.71	0.83	14.30
W_CO g/hr	:	73.00	74.32	82.35	157.16	6.85	412.87
W_NOx g/hr	:	18.52	3.44	0.91	0.43	0.00	16.15
W_HCNOx g/hr	:	37.22	6.73	4.96	13.14	0.83	30.45
W_Soot mg/hr	:	0.66	0.72	1.38	6.31	0.02	8.40
W_N2O g/hr	:	0.02	0.00	0.00	0.00	0.00	0.03
W_CO2 g/hr	:	5056.95	5753.18	4062.40	3397.31	133.57	19117.80
W_CH4 g/hr	:	0.65	0.66	0.56	1.20	0.05	3.22

Total Weighted Power [kW] 16.462

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	39.58	393.69	23.30	62.88
Specific Mass [g/kW-hr]	2.40	23.92	1.42	3.82
BSFC [g/kW-hr]	420.2			

Total Soot [mg/hr] 9.09 Specific Soot [mg/kW-hr] 0.55

Not Used for Competition

Total N2O [mg/hr]	0.03	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	18403.40	Specific CO2 [g/kW-hr]	1117.95
Total CH4 [g/hr]	3.12	Specific CH4 [g/kW-hr]	0.19
RMC BSFC [g/kW-hr]	399.92		

EMISSION TESTS:

	Value	Limit	Result
Power	47.87	<96.94 kW	PASS
Soot	0.55	<50 mg/kW-hr	PASS
CO	23.92	<275 g/kW-hr	PASS
HC + NOX	3.82	<90 g/kW-hr	PASS
E-Score	201.47	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



Team Results for Clean Snowmobile Challenge 2019 Team 6



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11431
PtsInMode	points	1210	3370	3470	1800	1480	11431
Speed	rpm	8185.73	6957.23	6139.28	5111.92	1631.07	6167.66
Torque	Nm	56.68	28.57	19.17	11.62	0.00	24.36
Power	kW	48.59	20.82	12.33	6.22	0.00	15.73
BSFC	g/kw-hr	284.86	332.23	433.28	606.59	**	399.92
Fuel	g/hr	13841.54	6916.01	5340.70	3774.04	933.26	6291.25
T_int	degC	27.57	34.67	36.32	33.37	38.24	33.73
RelHumid	%	17.37	13.46	13.66	14.53	12.80	14.45
Baro	in Hg	28.91	28.91	28.91	28.91	28.91	28.91
Baro	mmHg	734.34	734.28	734.34	734.34	734.28	734.31
Pvap_kPa	kPa	0.52	0.57	0.63	0.58	0.65	0.59
Pvap_inHg	inHg	0.15	0.17	0.19	0.17	0.19	0.17
AbsHumidity	grains/lb	23.12	25.74	28.38	26.05	29.21	26.38
SatPres	kPa	97.39	97.32	97.27	97.32	97.24	97.31
Hum Factor		0.80	0.81	0.82	0.81	0.82	0.81
F_fac		1.02	1.04	1.05	1.04	1.05	1.04
K_fac		1.03	1.05	1.05	1.04	1.05	1.04
Humidity	g/kg	3.30	3.68	4.05	3.72	4.17	3.77
H2		0.10	0.09	0.14	0.32	0.35	0.15
WetDry Factor		0.86	0.87	0.87	0.87	0.87	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 6



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	1538.33	239.63	414.08	1510.39	2496.84	310.44
CO	%	0.30	0.27	0.42	0.93	1.03	0.45
N2O	ppm	4.86	1.02	0.69	1.42	1.59	2.35
CH4	ppm	46.59	42.04	49.62	125.10	142.55	61.11
CO2	%	13.21	13.31	13.19	12.82	12.74	13.18
O2	%	0.02	0.00	0.00	0.00	0.00	-0.01
CNOx	ppm	462.77	76.10	28.35	15.58	0.26	106.56
AHC	ppm	19.95	0.00	0.00	3.67	12.50	3.01
C2H2	ppm	2.21	0.55	0.71	2.24	0.58	0.99
C2H4	ppm	16.91	2.27	5.47	35.84	5.54	10.20
C3H6	ppm	15.37	0.70	3.32	17.14	1.52	5.70
C4H6	ppm	5.38	5.02	5.88	8.13	3.60	5.70
ETOH	ppm	2.99	3.82	5.12	5.17	3.45	4.11
H2O	%	14.18	13.14	13.04	12.81	12.72	0.00
HCHO	ppm	0.36	0.00	0.00	0.07	1.72	0.51
HCN	ppm	1.74	0.66	0.60	0.60	0.57	0.75
HNCO	ppm	4.56	2.45	2.68	3.11	1.55	2.71
MECHO	ppm	0.93	0.00	0.00	0.00	0.00	0.26
NC5	ppm	14.58	3.62	5.82	14.09	44.36	18.57
NH3	ppm	90.06	127.26	149.82	179.02	100.11	135.92
NO	ppm	575.95	94.23	34.98	19.47	0.42	131.19
NO2	ppm	0.09	0.02	0.05	0.06	0.06	0.05
Soot	mg/m3	0.03	0.03	0.08	0.43	0.03	0.10
AFR	:1	14.12	14.51	14.39	13.83	13.51	14.41



Team Results for Clean Snowmobile Challenge 2019 Team 6



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.115	0.179	14.177	84.466	0.976	14.407	0.999
2	0.102	0.028	13.145	82.062	0.949	14.531	1.000
3	0.160	0.048	13.044	81.589	0.943	14.441	1.000
4	0.364	0.173	12.805	80.525	0.931	14.093	1.000
5	0.402	0.286	12.721	80.144	0.926	13.950	1.000

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	155.842	0.167	0.021	0.188	101.571	1.571
2	12.181	0.028	0.003	0.031	98.792	1.208
3	16.201	0.048	0.006	0.054	98.400	1.600
4	40.985	0.173	0.022	0.195	97.794	2.206
5	16.627	0.286	0.036	0.322	97.565	2.435

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	48.590	20.817	12.326	6.222	0.000	15.731
BSFC	g/kw-hr	284.86	332.23	433.28	606.59	**	399.92
Fuel_MassFlow	g/hr	13842	6916	5341	3774	933	6291
HC_m	g/hr	155.84	12.18	16.20	40.99	16.63	14.30
CO_m	g/hr	608.36	275.26	329.41	506.98	136.95	412.87
CO2_m	g/hr	42141	21308	16250	10959	2671	19118
TW_Power	kW	16.462					
TW_BSFC	g/kw-hr	420.25					
Fuel_MassFlow	g/hr	13842	6916	5341	3774	933	6291
FuelCalc	g/hr	13867	6918	5343	3781	936	6293
FuelCalcDev	%	-0.18229	-0.02693	-0.04773	-0.17570	-0.28947	-0.03527

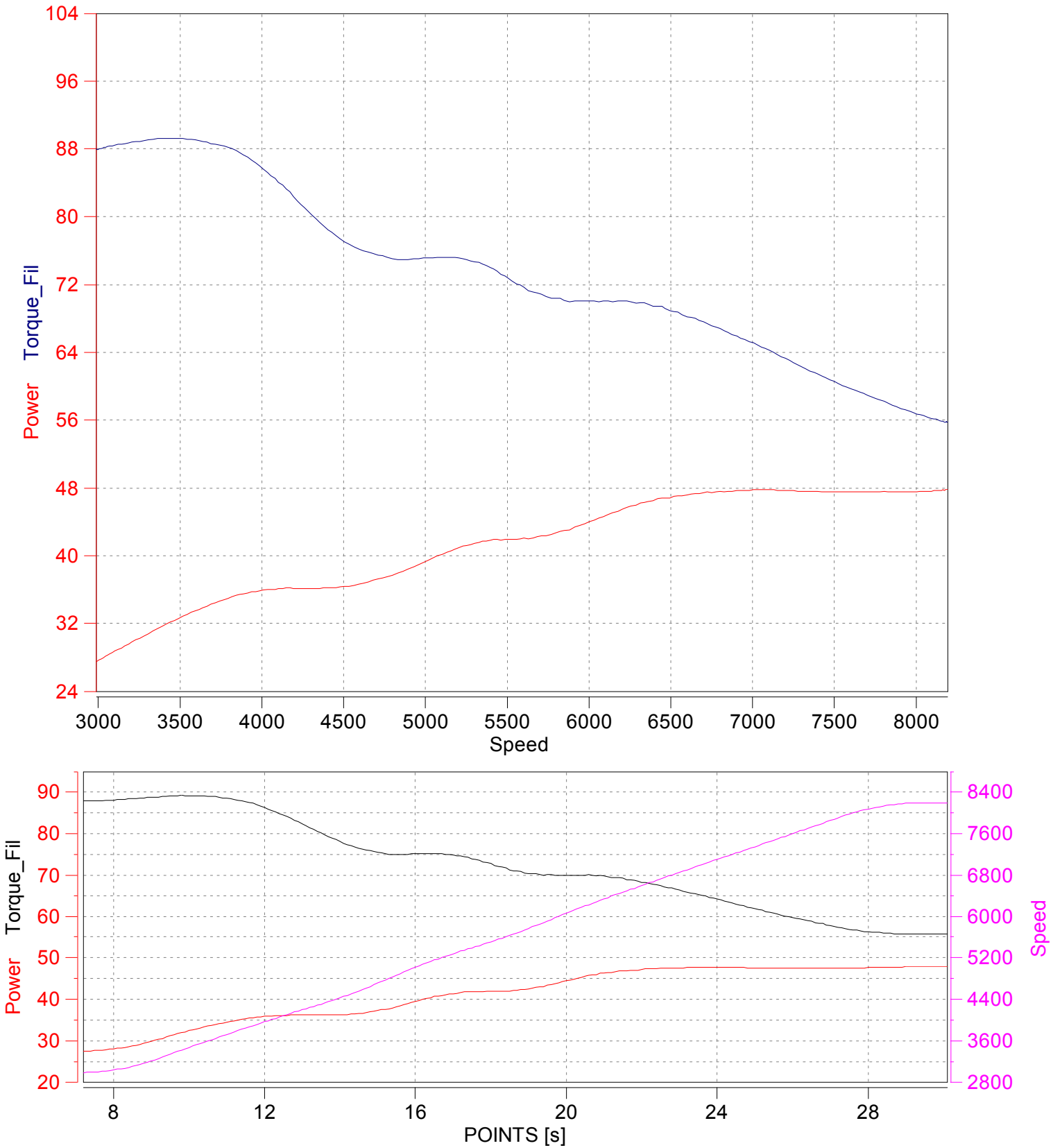
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 6

TeamNumber	6
TeamName	Michigan Tech
Model	R1
Engine	Yamaha

Displacement cc	1049.00
RatedSpeed	8186
RatedTorque	55.8





Team Results for Clean Snowmobile Challenge 2019 Team 108



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/05 13:37:12
Team Name : Bison Motorsports
Team Number : 108
Model : Mercedes
Engine : Mercedes
Displacement[cc] : 800.00
100% Speed : 4001
100% Torque : 58.7
No of Strokes : 4
Fuel : Diesel H/C: 1.81 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	22.9	10.6	6.1	3.2	0.0	7.6
HC_m g/hr	:	82.74	0.15	0.06	0.95	0.45	15.61
CO_m g/hr	:	2120.79	0.10	0.01	2.31	0.01	295.03
NOx_m g/hr	:	53.97	134.45	108.88	63.42	10.18	103.39
Soot_m mg/hr	:	56565.66	4048.84	269.09	154.68	69.83	**
N2O_m mg/hr	:	0.15	0.03	0.03	0.02	0.03	0.05
CO2_m g/hr	:	25126.02	12946.98	8448.61	5846.62	1773.74	10903.33
CH4_m g/hr	:	14.61	0.09	0.08	0.07	0.21	5.43
W_HC g/hr	:	9.93	0.04	0.02	0.29	0.02	15.61
W_CO g/hr	:	254.49	0.03	0.00	0.72	0.00	295.03
W_NOx g/hr	:	6.48	36.30	27.22	19.66	0.51	103.39
W_HCNOx g/hr	:	16.41	36.34	27.23	19.95	0.53	118.99
W_Soot mg/hr	:	6787.88	1093.19	67.27	47.95	3.49	**
W_N2O g/hr	:	0.02	0.01	0.01	0.01	0.00	0.05
W_CO2 g/hr	:	3015.12	3495.68	2112.15	1812.45	88.69	10903.33
W_CH4 g/hr	:	1.75	0.02	0.02	0.02	0.01	5.43

Total Weighted Power [kW] 8.124

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	10.30	255.24	90.17	100.47
Specific Mass [g/kW-hr]	1.27	31.42	11.10	12.37
BSFC [g/kW-hr]	440.3			

Total Soot [mg/hr] 7999.78 Specific Soot [mg/kW-hr] 984.75

Not Used for Competition

Total N2O [mg/hr]	0.04	Specific N2O [mg/kW-hr]	0.01
Total CO2 [g/hr]	10524.10	Specific CO2 [g/kW-hr]	1295.48
Total CH4 [g/hr]	1.83	Specific CH4 [g/kW-hr]	0.23
RMC BSFC [g/kW-hr]	470.42		

EMISSION TESTS:

	Value	Limit	Result
Power	24.58	<96.94 kW	PASS
Soot	984.75	<50 mg/kW-hr	FAIL
CO	31.42	<275 g/kW-hr	PASS
HC + NOX	12.37	<90 g/kW-hr	PASS
E-Score	193.90	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			FAIL



Team Results for Clean Snowmobile Challenge 2019 Team 108



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	3919.85	3401.24	3000.97	2603.46	1016.03	3036.92
Torque	Nm	55.90	29.89	19.29	11.60	0.00	23.99
Power	kW	22.95	10.65	6.06	3.16	0.00	7.63
BSFC	g/kw-hr	393.44	382.25	438.19	581.76	**	470.42
Fuel	g/hr	9027.90	4069.76	2655.68	1839.83	557.99	3588.51
T_int	degC	20.91	24.19	25.21	19.80	24.86	23.24
RelHumid	%	11.21	13.92	12.08	14.89	11.38	13.62
Baro	in Hg	28.81	28.80	28.80	28.80	28.80	28.80
Baro	mmHg	731.68	731.54	731.50	731.55	731.53	731.55
Pvap_kPa	kPa	0.23	0.35	0.32	0.29	0.29	0.32
Pvap_inHg	inHg	0.07	0.10	0.09	0.09	0.09	0.10
AbsHumidity	grains/lb	10.47	15.54	14.24	13.10	13.16	14.45
SatPres	kPa	97.31	97.18	97.21	97.24	97.23	97.21
Hum Factor		0.77	0.78	0.78	0.77	0.77	0.78
F_fac		1.01	1.02	1.02	1.01	1.02	1.01
K_fac		1.03	1.03	1.03	1.02	1.03	1.03
Humidity	g/kg	1.50	2.22	2.03	1.87	1.88	2.06
H2		0.46	0.00	0.00	0.00	0.00	0.09
WetDry Factor		0.88	0.92	0.94	0.95	0.97	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 108



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	1109.53	2.99	1.46	27.82	19.91	324.47
CO	%	1.40	0.00	0.00	0.00	0.00	0.30
N2O	ppm	6.47	1.88	2.03	2.06	4.47	3.25
CH4	ppm	169.44	1.48	1.67	1.77	8.07	97.66
CO2	%	10.59	8.06	6.39	5.41	2.45	7.13
O2	%	2.61	8.32	10.83	12.40	16.14	10.00
CNOx	ppm	217.60	800.84	788.09	560.94	134.33	646.37
AHC	ppm	3.39	0.00	0.00	0.00	0.00	5.00
C2H2	ppm	1.36	0.07	0.07	0.32	0.14	5.39
C2H4	ppm	26.80	0.23	0.47	0.24	0.36	41.11
C3H6	ppm	1.91	0.35	0.29	0.41	0.33	6.43
C4H6	ppm	6.08	0.64	0.37	0.62	0.24	2.96
ETOH	ppm	2.27	1.19	1.09	0.47	0.83	1.09
H2O	%	11.70	7.51	6.01	5.02	2.82	0.00
HCHO	ppm	2.20	0.00	0.00	0.02	0.00	1.20
HCN	ppm	5.42	0.15	0.14	0.11	0.03	3.21
HNCO	ppm	3.16	3.28	2.69	4.40	1.90	3.43
MECHO	ppm	0.37	0.00	0.00	0.02	0.00	0.62
NC5	ppm	3.01	1.07	1.05	1.45	1.02	3.18
NH3	ppm	183.89	0.08	0.03	1.68	0.03	26.65
NO	ppm	283.89	875.78	869.29	686.66	138.15	727.00
NO2	ppm	0.05	148.86	143.88	37.25	35.22	103.33
Soot	mg/m3	449.13	46.36	3.76	2.64	1.85	#####
AFR	:1	15.52	24.88	31.50	37.41	80.28	27.39



Team Results for Clean Snowmobile Challenge 2019 Team 108



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.520	0.126	11.696	80.370	0.929	15.763	0.868
2	0.000	0.000	7.509	80.068	0.926	24.835	0.588
3	0.000	0.000	6.007	79.527	0.919	31.446	0.468
4	0.001	0.003	5.019	79.220	0.916	37.382	0.394
5	0.000	0.002	2.817	76.410	0.883	80.233	0.222

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	82.744	-1.684	-0.211	-1.895	96.492	3.508
2	0.151	-3.593	-0.449	-4.042	94.776	5.224
3	0.061	-3.618	-0.452	-4.070	94.805	5.195
4	0.946	-3.451	-0.431	-3.883	95.079	4.921
5	0.454	-1.958	-0.245	-2.203	94.232	5.768

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	22.946	10.647	6.061	3.163	0.000	7.628
BSFC	g/kw-hr	393.44	382.25	438.19	581.76	**	470.42
Fuel_MassFlow	g/hr	9027.9	4069.8	2655.7	1839.8	558.0	3588.5
HC_m	g/hr	82.744	0.151	0.061	0.946	0.454	15.606
CO_m	g/hr	2120.8	0.1	0.0	2.3	0.0	295.0
CO2_m	g/hr	25126	12947	8449	5847	1774	10903
TW_Power	kW	8.1237					
TW_BSFC	g/kw-hr	440.31					
Fuel_MassFlow	g/hr	9027.9	4069.8	2655.7	1839.8	558.0	3588.5
FuelCalc	g/hr	9040.3	4069.7	2655.6	1839.9	558.0	3590.8
FuelCalcDev	%	-0.13709	0.00125	0.00147	-0.00598	-0.01053	-0.06411

\$HCR_ENG	1.808
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.86826

Power Run

Team 108

TeamNumber	108
TeamName	Bison Motorsports
Model	Mercedes
Engine	Mercedes

Displacement cc	800.00
RatedSpeed	4001
RatedTorque	58.7





Team Results for Clean Snowmobile Challenge 2019 Team 101



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/04 15:51:22
Team Name : UW Plattville
Team Number : 101
Model : D902
Engine : Kubota
Displacement[cc] : 898.00
100% Speed : 3725
100% Torque : 64.4
No of Strokes : 4
Fuel : Diesel H/C: 1.81 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	23.7	10.9	6.2	3.1	0.0	8.1
HC_m g/hr	:	9.47	0.00	0.00	0.37	0.00	0.01
CO_m g/hr	:	8.68	2.22	1.64	3.08	1.61	3.47
NOx_m g/hr	:	91.85	63.45	45.73	30.92	19.22	55.71
Soot_m mg/hr	:	2093.57	507.83	319.72	187.09	149.01	606.65
N2O_m mg/hr	:	0.02	0.02	0.01	0.01	0.00	0.02
CO2_m g/hr	:	22731.41	10109.22	6340.62	4208.76	1427.97	8826.01
CH4_m g/hr	:	0.28	0.03	0.04	0.07	0.03	0.08
W_HC g/hr	:	1.14	0.00	0.00	0.12	0.00	0.01
W_CO g/hr	:	1.04	0.60	0.41	0.95	0.08	3.47
W_NOx g/hr	:	11.02	17.13	11.43	9.58	0.96	55.71
W_HCNOx g/hr	:	12.16	17.13	11.43	9.70	0.96	55.72
W_Soot mg/hr	:	251.23	137.11	79.93	58.00	7.45	606.65
W_N2O g/hr	:	0.00	0.00	0.00	0.00	0.00	0.02
W_CO2 g/hr	:	2727.77	2729.49	1585.15	1304.72	71.40	8826.01
W_CH4 g/hr	:	0.03	0.01	0.01	0.02	0.00	0.08

Total Weighted Power [kW] 8.303

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	1.25	3.09	50.13	51.38
Specific Mass [g/kW-hr]	0.15	0.37	6.04	6.19
BSFC [g/kW-hr]	327.6			

Total Soot [mg/hr] 533.72 Specific Soot [mg/kW-hr] 64.28

Not Used for Competition

Total N2O [mg/hr]	0.01	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	8418.53	Specific CO2 [g/kW-hr]	1013.91
Total CH4 [g/hr]	0.07	Specific CH4 [g/kW-hr]	0.01
RMC BSFC [g/kW-hr]	341.64		

EMISSION TESTS:

	Value	Limit	Result
Power	25.11	<96.94 kW	PASS
Soot	64.28	<50 mg/kW-hr	FAIL
CO	0.37	<275 g/kW-hr	PASS
HC + NOX	6.19	<90 g/kW-hr	PASS
E-Score	205.78	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			FAIL



Team Results for Clean Snowmobile Challenge 2019 Team 101



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	3725.47	3166.50	2793.86	2420.45	1393.54	2875.60
Torque	Nm	60.85	32.86	21.18	12.26	0.00	26.98
Power	kW	23.74	10.90	6.20	3.11	0.00	8.13
BSFC	g/kw-hr	301.55	291.71	321.78	426.47	**	341.64
Fuel	g/hr	7158.82	3178.68	1993.83	1324.82	449.64	2775.97
T_int	degC	28.73	17.04	19.89	17.73	23.79	19.99
RelHumid	%	13.18	18.89	27.22	12.02	21.10	18.19
Baro	in Hg	28.67	28.67	28.68	28.67	28.68	28.67
Baro	mmHg	728.15	728.31	728.42	728.19	728.41	728.30
Pvap_kPa	kPa	0.42	0.32	0.54	0.21	0.51	0.36
Pvap_inHg	inHg	0.12	0.09	0.16	0.06	0.15	0.11
AbsHumidity	grains/lb	18.77	14.32	24.22	9.47	23.20	16.25
SatPres	kPa	96.66	96.78	96.58	96.87	96.60	96.74
Hum Factor		0.79	0.78	0.81	0.76	0.80	0.78
F_fac		1.03	1.00	1.01	1.00	1.02	1.01
K_fac		1.04	1.02	1.03	1.02	1.04	1.03
Humidity	g/kg	2.68	2.05	3.46	1.35	3.31	2.32
H2		0.00	0.00	0.00	0.00	0.00	0.00
WetDry Factor		0.91	0.95	0.96	0.96	0.98	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 101



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	132.05	0.00	0.00	10.51	0.00	0.22
CO	%	0.01	0.00	0.00	0.00	0.00	0.00
N2O	ppm	0.84	0.89	0.93	0.90	0.71	0.92
CH4	ppm	3.34	0.54	0.73	1.58	1.21	1.30
CO2	%	9.96	5.74	4.70	3.71	2.04	5.33
O2	%	5.58	11.91	13.51	14.86	16.93	13.11
CNOx	ppm	385.06	344.83	324.18	260.89	263.24	321.90
AHC	ppm	0.00	0.79	1.12	0.17	0.50	0.66
C2H2	ppm	0.91	0.20	0.17	0.16	0.13	0.26
C2H4	ppm	1.52	1.00	0.96	0.98	1.28	1.08
C3H6	ppm	2.21	0.60	0.28	0.68	0.47	0.69
C4H6	ppm	1.17	0.61	0.30	0.46	0.35	0.55
ETOH	ppm	0.00	1.72	2.57	0.00	1.92	1.48
H2O	%	9.45	5.41	4.45	3.67	2.38	0.00
HCHO	ppm	5.98	1.05	0.79	2.51	1.31	2.91
HCN	ppm	1.01	0.15	0.07	0.21	0.04	0.28
HNCO	ppm	38.90	1.30	0.72	5.50	0.59	8.41
MECHO	ppm	0.00	0.00	0.00	0.00	0.00	0.00
NC5	ppm	7.42	2.79	2.54	3.29	1.40	3.58
NH3	ppm	4.30	0.05	0.01	0.64	0.01	0.75
NO	ppm	474.74	371.17	360.68	276.81	311.59	355.90
NO2	ppm	12.09	72.05	40.91	64.43	15.78	54.91
Soot	mg/m3	16.70	5.31	4.36	3.07	4.07	6.57
AFR	:1	20.05	35.25	43.27	54.44	97.18	39.10



Team Results for Clean Snowmobile Challenge 2019 Team 101



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.002	0.015	9.447	81.544	0.943	20.058	0.721
2	0.001	0.000	5.415	79.578	0.920	35.180	0.417
3	0.001	0.000	4.452	79.268	0.916	43.184	0.342
4	0.001	0.001	3.665	78.592	0.908	54.354	0.280
5	0.001	0.000	2.378	76.811	0.888	96.976	0.185

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	9.472	-3.062	-0.383	-3.445	96.271	3.729
2	0.000	**	**	**	**	**
3	0.000	**	**	**	**	**
4	0.374	-2.779	-0.347	-3.127	95.689	4.311
5	0.000	**	**	**	**	**

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	23.740	10.897	6.196	3.106	0.000	8.125
BSFC	g/kw-hr	301.55	291.71	321.78	426.47	**	341.64
Fuel_MassFlow	g/hr	7158.8	3178.7	1993.8	1324.8	449.6	2776.0
HC_m	g/hr	9.4720	0.0000	0.0000	0.3743	0.0000	0.0113
CO_m	g/hr	8.6759	2.2227	1.6425	3.0785	1.6083	3.4742
CO2_m	g/hr	22731	10109	6341	4209	1428	8826
TW_Power	kW	8.3031					
TW_BSFC	g/kw-hr	327.60					
Fuel_MassFlow	g/hr	7158.8	3178.7	1993.8	1324.8	449.6	2776.0
FuelCalc	g/hr	7160.1	3178.6	1993.8	1324.8	449.6	2775.9
FuelCalcDev	%	-0.018260	0.001817	0.001817	-0.002469	0.001819	0.001756

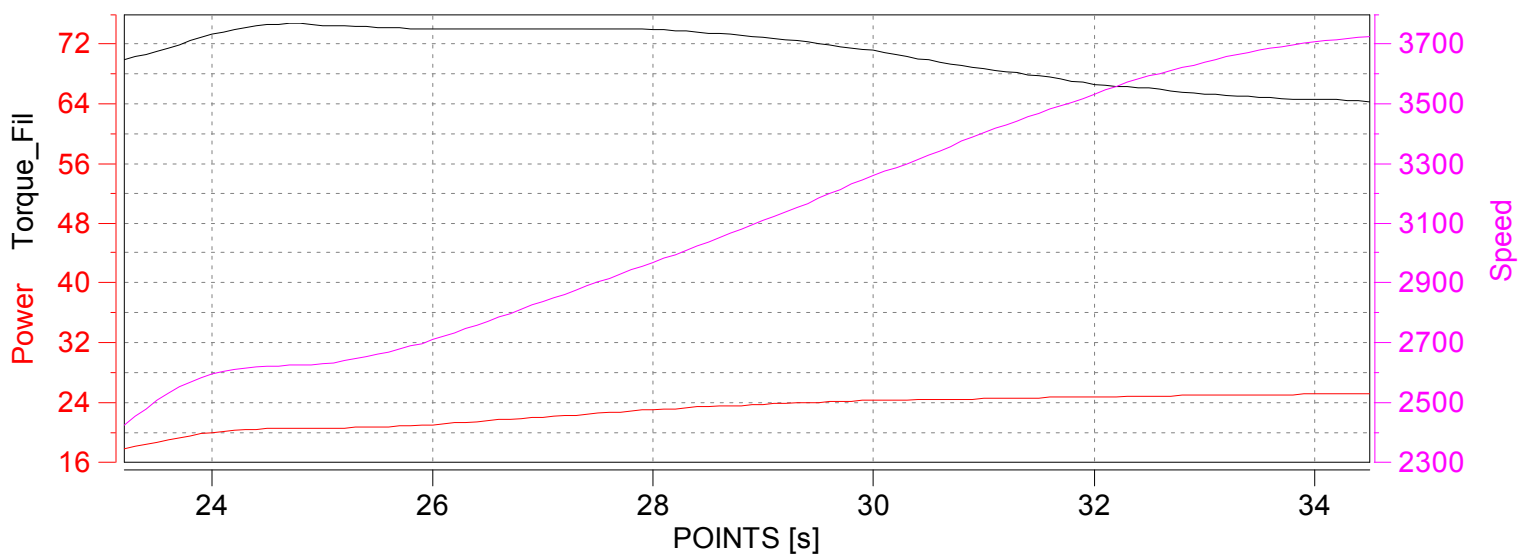
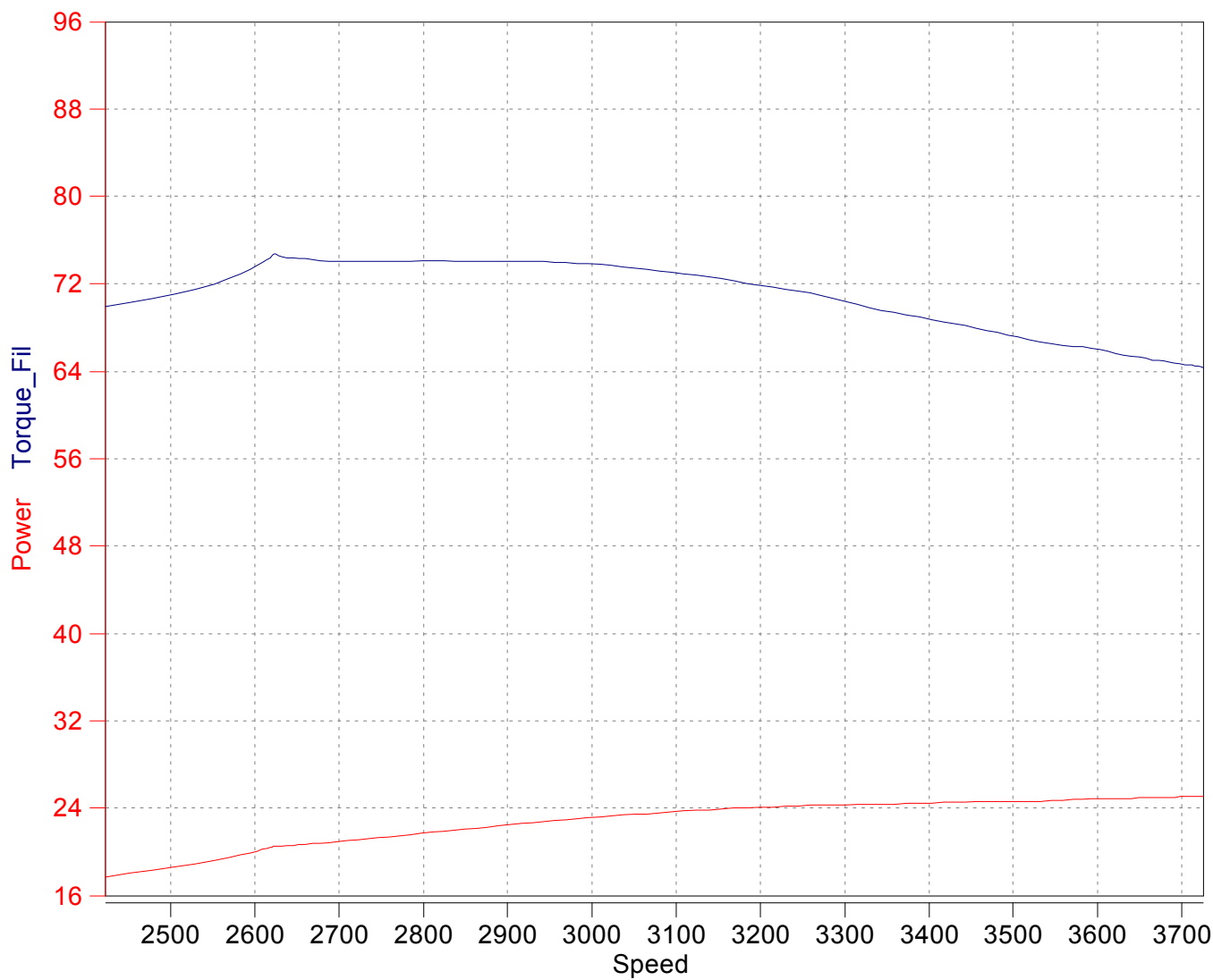
\$HCR_ENG	1.808
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.86826

Power Run

Team 101

TeamNumber	101
TeamName	UW Plattville
Model	D902
Engine	Kubota

Displacement cc	898.00
RatedSpeed	3725
RatedTorque	64.4





Team Results for Clean Snowmobile Challenge 2019 Team 5



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/06 11:15:21
Team Name : Plattville
Team Number : 5
Model : EcoBoost
Engine : Ford
Displacement[cc] : 1000.00
100% Speed : 4828
100% Torque : 132.4
No of Strokes : 4
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	61.4	29.0	16.5	8.3	0.0	23.7
HC_m g/hr	:	303.91	154.28	74.74	33.40	27.48	45.29
CO_m g/hr	:	8408.47	2506.52	944.25	299.24	93.70	1887.27
NOx_m g/hr	:	94.44	33.42	11.53	1.12	0.01	23.66
Soot_m mg/hr	:	98.21	**	**	**	**	**
N2O_m mg/hr	:	0.26	0.09	0.04	0.02	0.00	0.07
CO2_m g/hr	:	42391.65	22163.74	14775.69	9232.92	2605.97	21623.23
CH4_m g/hr	:	22.49	7.30	3.91	1.99	0.77	6.66
W_HC g/hr	:	36.47	41.66	18.68	10.35	1.37	45.29
W_CO g/hr	:	1009.02	676.76	236.06	92.76	4.68	1887.27
W_NOx g/hr	:	11.33	9.02	2.88	0.35	0.00	23.66
W_HCNOx g/hr	:	47.80	50.68	21.57	10.70	1.37	68.95
W_Soot mg/hr	:	11.79	**	**	**	**	**
W_N2O g/hr	:	0.03	0.02	0.01	0.01	0.00	0.07
W_CO2 g/hr	:	5087.00	5984.21	3693.92	2862.21	130.30	21623.23
W_CH4 g/hr	:	2.70	1.97	0.98	0.62	0.04	6.66

Total Weighted Power [kW] 21.874

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	108.54	2019.29	23.58	132.12
Specific Mass [g/kW-hr]	4.96	92.31	1.08	6.04
BSFC [g/kW-hr]	309.9			

Total Soot [mg/hr] 11.79 Specific Soot [mg/kW-hr] 0.54

Not Used for Competition

Total N2O [mg/hr]	0.07	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	17757.63	Specific CO2 [g/kW-hr]	811.80
Total CH4 [g/hr]	6.30	Specific CH4 [g/kW-hr]	0.29
RMC BSFC [g/kW-hr]	330.80		

EMISSION TESTS:

	Value	Limit	Result
Power	66.91	<96.94 kW	PASS
Soot	0.54	<50 mg/kW-hr	PASS
CO	92.31	<275 g/kW-hr	PASS
HC + NOX	6.04	<90 g/kW-hr	PASS
E-Score	182.90	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



Team Results for Clean Snowmobile Challenge 2019 Team 5



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	371	1200	1009	8591
PtsInMode	points	1210	3370	629	1800	1480	8591
Speed	rpm	4827.36	4103.38	3621.42	3138.53	1154.01	3745.47
Torque	Nm	121.37	67.44	43.48	25.18	0.00	60.53
Power	kW	61.36	28.98	16.49	8.28	0.00	23.74
BSFC	g/kw-hr	292.74	291.37	317.66	376.37	**	330.80
Fuel	g/hr	17960.99	8443.11	5237.96	3114.66	901.76	7853.51
T_int	degC	19.82	22.17	22.42	21.64	23.17	21.74
RelHumid	%	17.55	19.33	19.47	18.86	19.97	19.06
Baro	in Hg	28.94	28.94	28.94	28.94	28.94	28.94
Baro	mmHg	735.01	735.08	735.10	735.02	735.03	735.06
Pvap_kPa	kPa	0.34	0.43	0.44	0.41	0.47	0.42
Pvap_inHg	inHg	0.10	0.13	0.13	0.12	0.14	0.12
AbsHumidity	grains/lb	15.38	19.28	19.69	18.28	21.03	18.57
SatPres	kPa	97.65	97.57	97.56	97.58	97.52	97.58
Hum Factor		0.78	0.79	0.79	0.79	0.80	0.79
F_fac		1.00	1.01	1.01	1.01	1.01	1.01
K_fac		1.02	1.02	1.02	1.02	1.02	1.02
Humidity	g/kg	2.20	2.75	2.81	2.61	3.00	2.65
H2		1.27	0.66	0.34	0.17	0.19	0.49
WetDry Factor		0.87	0.88	0.90	0.90	0.90	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 5



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	2390.61	2264.40	1570.72	1161.96	3388.78	666.99
CO	%	3.30	1.84	0.99	0.52	0.58	1.39
N2O	ppm	6.39	4.04	2.42	2.21	1.25	3.49
CH4	ppm	154.54	93.58	71.69	60.39	82.67	85.62
CO2	%	10.59	10.33	9.86	10.20	10.21	10.11
O2	%	0.07	2.29	4.19	4.25	4.26	3.64
CNOx	ppm	225.67	149.00	73.61	11.81	0.19	105.83
AHC	ppm	21.91	20.70	9.71	0.00	35.62	15.41
C2H2	ppm	1.54	0.58	0.56	0.69	0.68	0.75
C2H4	ppm	53.55	44.04	35.56	16.44	48.92	38.34
C3H6	ppm	14.21	18.48	12.38	4.02	16.53	14.11
C4H6	ppm	19.38	12.83	7.35	3.34	2.82	8.90
ETOH	ppm	9.60	7.91	6.99	5.38	3.07	6.75
H2O	%	13.03	11.60	10.44	10.48	10.18	0.00
HCHO	ppm	0.37	1.35	1.67	0.74	4.30	1.49
HCN	ppm	24.65	30.59	11.70	0.69	0.15	19.48
HNCO	ppm	8.36	4.54	1.46	0.56	0.35	2.98
MECHO	ppm	0.00	0.00	0.00	0.00	0.04	0.01
NC5	ppm	19.19	29.86	23.95	35.57	73.24	32.71
NH3	ppm	529.27	409.07	286.58	142.22	93.75	303.13
NO	ppm	289.81	188.63	92.99	15.21	0.32	134.36
NO2	ppm	0.00	0.01	0.04	0.02	0.06	0.03
Soot	mg/m3	0.47	#####	#####	#####	#####	#####
AFR	:1	12.58	14.80	17.22	17.75	16.71	16.79



Team Results for Clean Snowmobile Challenge 2019 Team 5



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	1.465	0.275	13.033	76.961	0.890	12.951	0.996
2	0.750	0.256	11.601	78.603	0.909	15.286	0.884
3	0.382	0.175	10.444	79.882	0.923	17.657	0.789
4	0.195	0.130	10.482	80.635	0.932	18.089	0.786
5	0.216	0.377	10.177	80.024	0.925	17.679	0.786

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	303.912	0.215	0.027	0.242	95.644	4.356
2	154.280	-1.375	-0.172	-1.547	95.093	4.907
3	74.735	-2.418	-0.302	-2.720	95.277	4.723
4	33.396	-2.456	-0.307	-2.763	95.725	4.275
5	27.476	-2.275	-0.284	-2.559	95.351	4.649

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	61.355	28.978	16.489	8.276	0.000	23.741
BSFC	g/kw-hr	292.74	291.37	317.66	376.37	**	330.80
Fuel_MassFlow	g/hr	17961	8443	5238	3115	902	7854
HC_m	g/hr	303.91	154.28	74.74	33.40	27.48	45.29
CO_m	g/hr	8408.5	2506.5	944.2	299.2	93.7	1887.3
CO2_m	g/hr	42392	22164	14776	9233	2606	21623
TW_Power	kW	21.874					
TW_BSFC	g/kw-hr	309.89					
Fuel_MassFlow	g/hr	17961	8443	5238	3115	902	7854
FuelCalc	g/hr	18010	8468	5250	3120	906	7861
FuelCalcDev	%	-0.27459	-0.29684	-0.23141	-0.17347	-0.49648	-0.09231

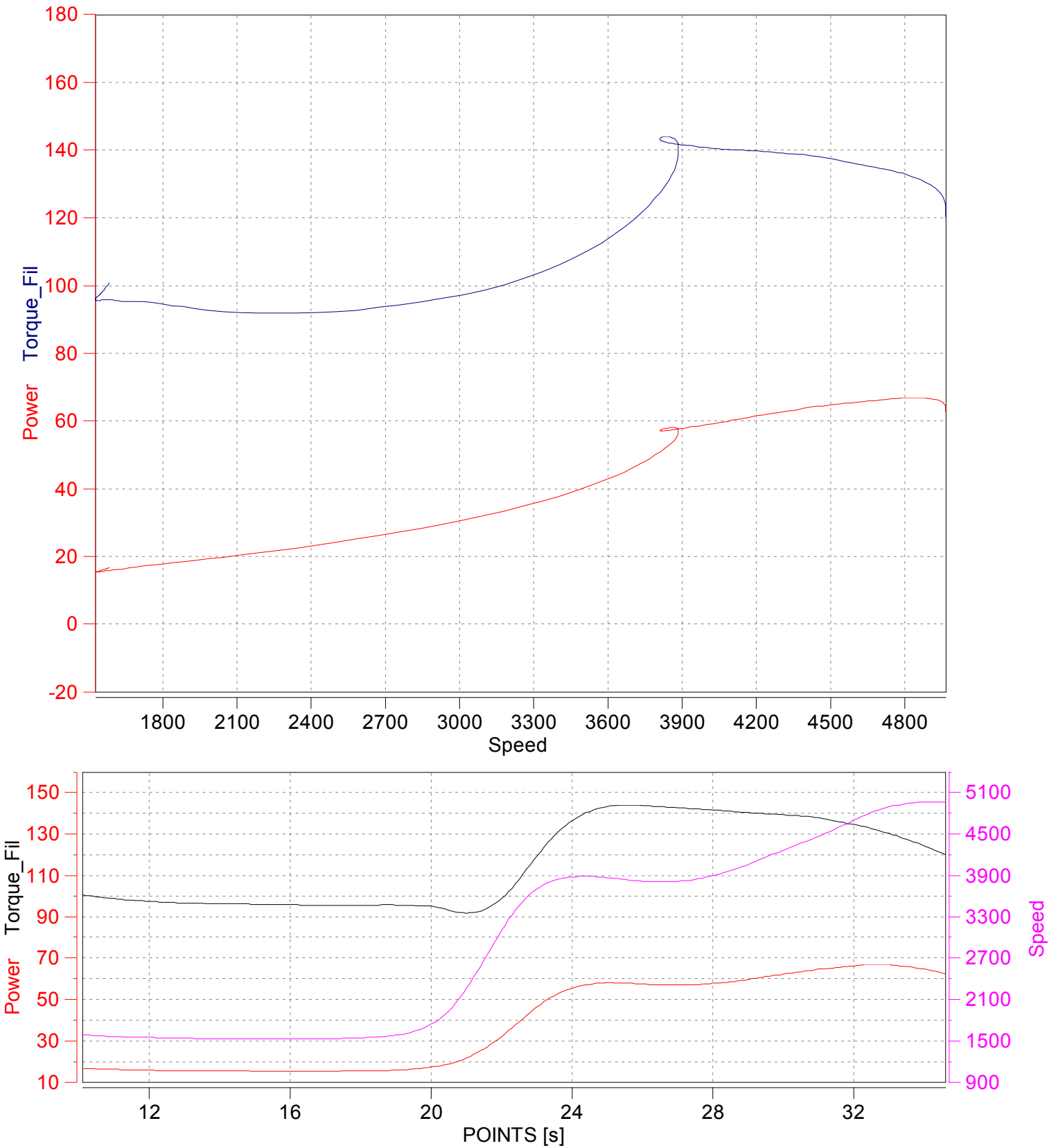
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 5

TeamNumber	5
TeamName	Plattville
Model	EcoBoost
Engine	Ford

Displacement cc	1000.00
RatedSpeed	4828
RatedTorque	132.4





Team Results for Clean Snowmobile Challenge 2019 Team 14



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/06 17:22:47
Team Name : Rochester
Team Number : 14
Model : Weber 750
Engine : Weber 750
Displacement[cc] : 750.00
100% Speed : 6943
100% Torque : 45.3
No of Strokes : 4
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	35.0	14.2	8.1	4.1	0.0	11.1
HC_m g/hr	:	822.19	408.38	356.88	277.56	157.92	151.45
CO_m g/hr	:	17979.13	8134.63	6376.08	4790.58	1151.22	7793.04
NOx_m g/hr	:	8.72	4.46	2.33	0.87	0.28	3.28
Soot_m mg/hr	:	48.46	42.99	76.73	24.62	7.11	103.50
N2O_m mg/hr	:	0.66	0.30	0.25	0.18	0.04	0.29
CO2_m g/hr	:	19691.77	13060.58	10172.78	7574.37	3160.62	12102.74
CH4_m g/hr	:	33.73	20.60	25.59	25.91	14.75	31.15
W_HC g/hr	:	98.66	110.26	89.22	86.04	7.90	151.45
W_CO g/hr	:	2157.50	2196.35	1594.02	1485.08	57.56	7793.04
W_NOx g/hr	:	1.05	1.20	0.58	0.27	0.01	3.28
W_HCNOx g/hr	:	99.71	111.47	89.80	86.31	7.91	154.74
W_Soot mg/hr	:	5.82	11.61	19.18	7.63	0.36	103.50
W_N2O g/hr	:	0.08	0.08	0.06	0.06	0.00	0.29
W_CO2 g/hr	:	2363.01	3526.36	2543.20	2348.06	158.03	12102.74
W_CH4 g/hr	:	4.05	5.56	6.40	8.03	0.74	31.15

Total Weighted Power [kW] 11.319

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	392.09	7490.51	3.11	395.20
Specific Mass [g/kW-hr]	34.64	661.78	0.28	34.92
BSFC [g/kW-hr]	814.7			

Total Soot [mg/hr] 44.59 Specific Soot [mg/kW-hr] 3.94

Not Used for Competition

Total N2O [mg/hr]	0.28	Specific N2O [mg/kW-hr]	0.02
Total CO2 [g/hr]	10938.65	Specific CO2 [g/kW-hr]	966.42
Total CH4 [g/hr]	24.78	Specific CH4 [g/kW-hr]	2.19
RMC BSFC [g/kW-hr]	711.36		

EMISSION TESTS:

	Value	Limit	Result
Power	32.97	<96.94 kW	PASS
Soot	3.94	<50 mg/kW-hr	PASS
CO	661.78	<275 g/kW-hr	FAIL
HC + NOX	34.92	<90 g/kW-hr	PASS
E-Score	21.28	>175	FAIL
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			FAIL



Team Results for Clean Snowmobile Challenge 2019 Team 14



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11431
PtsInMode	points	1210	3370	3470	1800	1480	11431
Speed	rpm	6943.67	5842.90	5207.38	4511.02	1811.70	5268.36
Torque	Nm	48.17	23.17	14.88	8.60	0.00	20.09
Power	kW	35.02	14.18	8.11	4.06	0.00	11.08
BSFC	g/kw-hr	458.14	607.63	834.13	1248.80	**	711.36
Fuel	g/hr	16046.10	8614.61	6768.64	5073.10	1735.99	7883.08
T_int	degC	19.56	18.68	19.42	18.20	19.33	19.21
RelHumid	%	14.11	18.31	18.42	16.56	18.34	17.27
Baro	in Hg	28.92	28.93	28.93	28.93	28.93	28.93
Baro	mmHg	734.67	734.77	734.77	734.70	734.76	734.73
Pvap_kPa	kPa	0.27	0.34	0.35	0.30	0.35	0.33
Pvap_inHg	inHg	0.08	0.10	0.10	0.09	0.10	0.10
AbsHumidity	grains/lb	12.20	15.08	15.81	13.28	15.66	14.65
SatPres	kPa	97.67	97.62	97.61	97.65	97.61	97.63
Hum Factor		0.77	0.78	0.78	0.78	0.78	0.78
F_fac		1.00	1.00	1.00	1.00	1.00	1.00
K_fac		1.02	1.02	1.02	1.02	1.02	1.02
Humidity	g/kg	1.74	2.15	2.26	1.90	2.24	2.09
H2		4.88	3.66	3.67	3.67	2.25	3.73
WetDry Factor		0.88	0.88	0.88	0.88	0.87	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 14



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	8361.04	7589.43	8478.00	8769.26	14418.91	2971.54
CO	%	9.12	7.54	7.56	7.55	5.24	7.63
N2O	ppm	21.26	17.81	18.52	17.81	10.79	17.77
CH4	ppm	299.59	334.47	530.90	715.06	1176.25	533.81
CO2	%	6.36	7.71	7.67	7.60	9.16	7.54
O2	%	0.05	0.01	0.00	0.00	0.05	0.02
CNOx	ppm	26.94	25.15	16.80	8.32	7.84	19.56
AHC	ppm	124.09	113.89	128.13	121.02	140.70	127.38
C2H2	ppm	23.92	23.52	43.59	54.49	71.62	39.11
C2H4	ppm	99.12	127.69	182.28	247.45	463.70	186.56
C3H6	ppm	52.58	65.77	69.05	52.26	74.94	64.78
C4H6	ppm	3.76	5.39	5.99	6.36	6.88	5.73
ETOH	ppm	1.56	2.70	2.17	1.92	0.19	2.17
H2O	%	12.11	12.48	12.42	12.44	13.05	0.00
HCHO	ppm	7.09	4.11	3.28	2.81	18.88	4.75
HCN	ppm	14.89	18.70	17.97	14.32	10.36	16.69
HNCO	ppm	1.69	1.93	1.61	1.80	4.19	1.67
MECHO	ppm	6.65	4.29	2.86	0.84	3.80	3.67
NC5	ppm	141.78	78.50	42.46	16.95	82.73	69.24
NH3	ppm	103.41	112.79	94.24	81.30	53.56	95.63
NO	ppm	35.73	33.23	22.39	11.33	10.47	25.91
NO2	ppm	0.00	0.00	0.00	0.01	0.03	0.01
Soot	mg/m3	0.33	0.51	1.17	0.50	0.41	1.32
AFR	:1	9.04	9.82	9.65	9.59	9.47	10.60



Team Results for Clean Snowmobile Challenge 2019 Team 14



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	5.553	0.951	12.106	68.934	0.797	9.870	0.998
2	4.177	0.867	12.481	72.041	0.833	10.662	1.000
3	4.189	0.968	12.421	71.755	0.829	10.586	1.000
4	4.196	1.002	12.440	71.475	0.826	10.547	1.000
5	2.587	1.658	13.051	74.906	0.866	11.126	0.998

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	822.194	0.907	0.113	1.021	93.974	6.026
2	408.380	0.861	0.108	0.969	95.456	4.544
3	356.879	0.968	0.121	1.089	95.257	4.743
4	277.559	1.000	0.125	1.125	94.929	5.071
5	157.919	1.614	0.202	1.815	96.801	3.199

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	35.024	14.177	8.115	4.062	0.000	11.082
BSFC	g/kw-hr	458.1	607.6	834.1	1248.8	**	711.4
Fuel_MassFlow	g/hr	16046	8615	6769	5073	1736	7883
HC_m	g/hr	822.19	408.38	356.88	277.56	157.92	151.45
CO_m	g/hr	17979	8135	6376	4791	1151	7793
CO2_m	g/hr	19692	13061	10173	7574	3161	12103
TW_Power	kW	11.319					
TW_BSFC	g/kw-hr	814.70					
Fuel_MassFlow	g/hr	16046	8615	6769	5073	1736	7883
FuelCalc	g/hr	16180	8681	6827	5118	1762	7908
FuelCalcDev	%	-0.8355	-0.7729	-0.8599	-0.8924	-1.4857	-0.3117

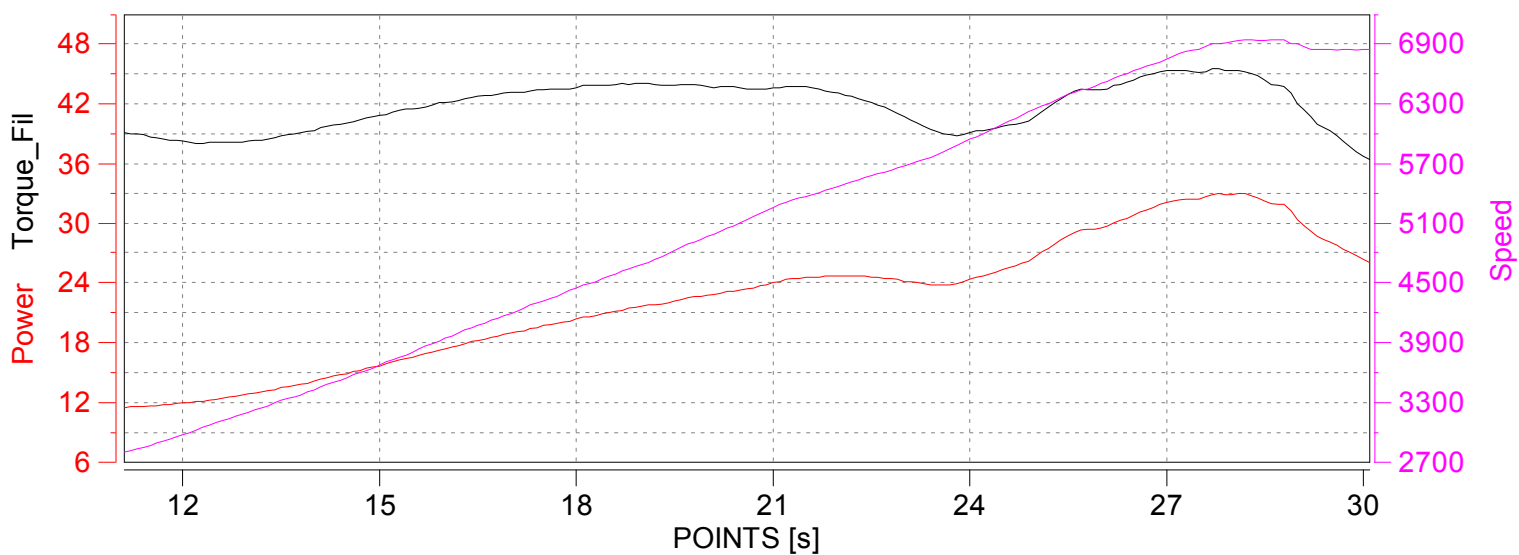
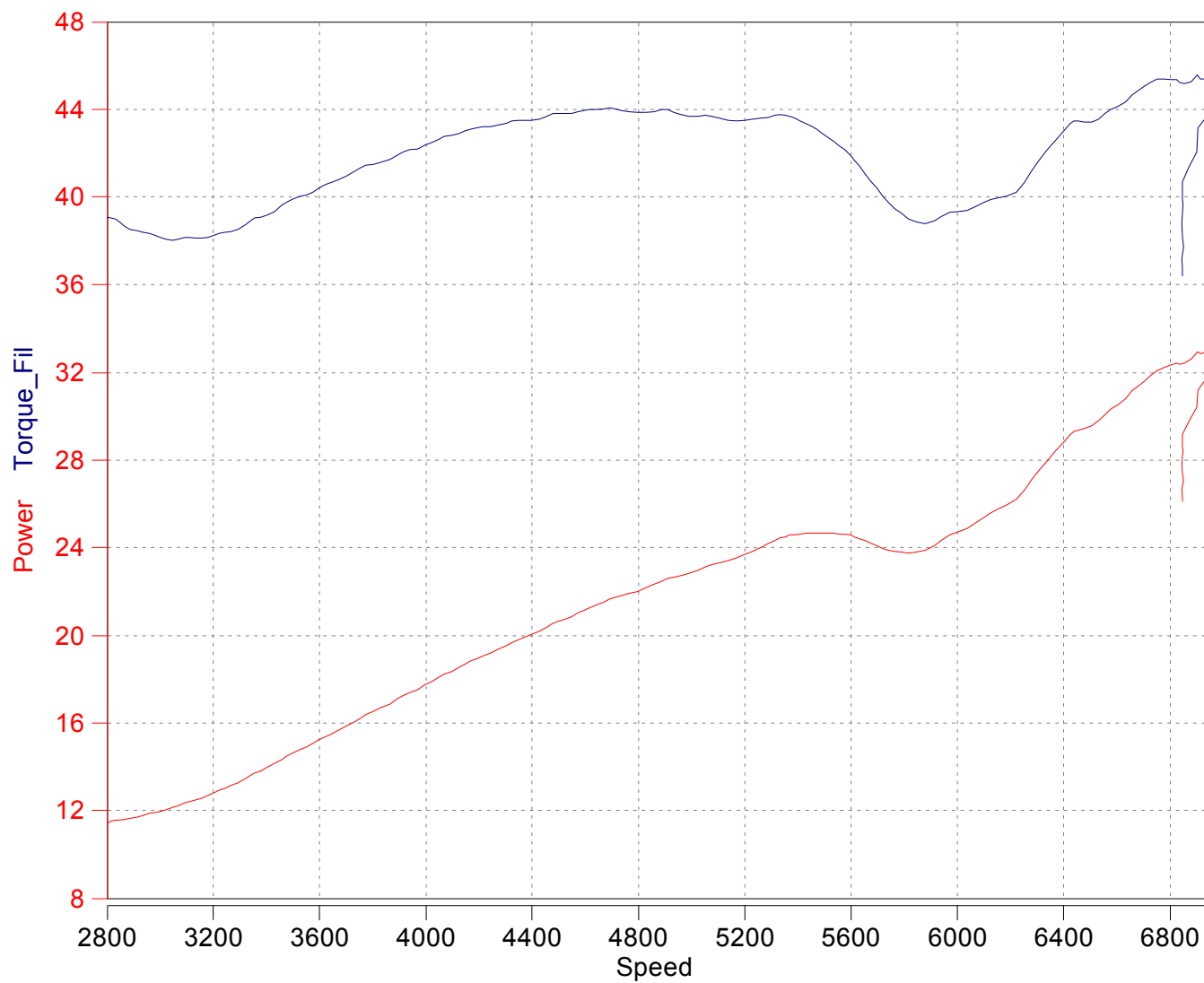
\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 14

TeamNumber	14
TeamName	Rochester
Model	Weber 750
Engine	Weber 750

Displacement cc	750.00
RatedSpeed	6943
RatedTorque	45.3





Team Results for Clean Snowmobile Challenge 2019 Team 107



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/04 19:46:08
Team Name : South Dakota
Team Number : 107
Model : D902
Engine : Kubota
Displacement[cc] : 898.00
100% Speed : 3520
100% Torque : 43.0
No of Strokes : 4
Fuel : Diesel H/C: 1.81 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	15.6	6.9	3.9	2.0	0.0	5.0
HC_m g/hr	:	1.06	0.19	0.27	0.33	0.16	0.15
CO_m g/hr	:	0.84	0.02	0.00	0.04	0.00	1.20
NOx_m g/hr	:	36.73	37.45	31.54	25.06	17.41	33.49
Soot_m mg/hr	:	104.14	18.41	7.67	16.87	1.66	26.73
N2O_m mg/hr	:	0.02	0.02	0.02	0.02	0.01	0.02
CO2_m g/hr	:	17739.67	7496.17	5286.26	3686.34	1323.73	6788.92
CH4_m g/hr	:	0.05	0.03	0.04	0.04	0.03	0.04
W_HC g/hr	:	0.13	0.05	0.07	0.10	0.01	0.15
W_CO g/hr	:	0.10	0.00	0.00	0.01	0.00	1.20
W_NOx g/hr	:	4.41	10.11	7.88	7.77	0.87	33.49
W_HCNOx g/hr	:	4.53	10.16	7.95	7.87	0.88	33.64
W_Soot mg/hr	:	12.50	4.97	1.92	5.23	0.08	26.73
W_N2O g/hr	:	0.00	0.01	0.00	0.01	0.00	0.02
W_CO2 g/hr	:	2128.76	2023.97	1321.57	1142.77	66.19	6788.92
W_CH4 g/hr	:	0.01	0.01	0.01	0.01	0.00	0.04

Total Weighted Power [kW] 5.310

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	0.36	0.12	31.04	31.40
Specific Mass [g/kW-hr]	0.07	0.02	5.85	5.91
BSFC [g/kW-hr]	425.2			

Total Soot [mg/hr] 24.70 Specific Soot [mg/kW-hr] 4.65

Not Used for Competition

Total N2O [mg/hr]	0.02	Specific N2O [mg/kW-hr]	0.00
Total CO2 [g/hr]	6683.24	Specific CO2 [g/kW-hr]	1258.70
Total CH4 [g/hr]	0.04	Specific CH4 [g/kW-hr]	0.01
RMC BSFC [g/kW-hr]	427.66		

EMISSION TESTS:

	Value	Limit	Result
Power	15.84	<96.94 kW	PASS
Soot	4.65	<50 mg/kW-hr	PASS
CO	0.02	<275 g/kW-hr	PASS
HC + NOX	5.91	<90 g/kW-hr	PASS
E-Score	206.05	>175	PASS
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			PASS



Team Results for Clean Snowmobile Challenge 2019 Team 107



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11431
PtsInMode	points	1210	3370	3470	1800	1480	11431
Speed	rpm	3519.88	2992.83	2639.65	2289.07	1176.03	2710.16
Torque	Nm	42.34	21.88	14.15	8.18	0.00	17.59
Power	kW	15.61	6.86	3.91	1.96	0.00	4.99
BSFC	g/kw-hr	357.38	343.63	424.94	591.33	**	427.66
Fuel	g/hr	5577.50	2356.44	1661.88	1159.06	416.24	2134.67
T_int	degC	13.49	17.81	15.74	17.55	14.29	15.88
RelHumid	%	13.48	10.84	11.17	12.89	11.47	11.74
Baro	in Hg	28.66	28.66	28.66	28.66	28.66	28.66
Baro	mmHg	728.01	727.95	727.89	728.02	727.90	727.96
Pvap_kPa	kPa	0.19	0.19	0.17	0.22	0.17	0.19
Pvap_inHg	inHg	0.05	0.06	0.05	0.07	0.05	0.05
AbsHumidity	grains/lb	8.35	8.57	7.86	10.05	7.44	8.33
SatPres	kPa	96.87	96.86	96.87	96.84	96.88	96.87
Hum Factor		0.76	0.76	0.76	0.77	0.76	0.76
F_fac		0.99	1.01	1.00	1.00	1.00	1.00
K_fac		1.02	1.03	1.02	1.02	1.02	1.02
Humidity	g/kg	1.19	1.22	1.12	1.44	1.06	1.19
H2		0.00	0.00	0.00	0.00	0.00	0.00
WetDry Factor		0.88	0.94	0.95	0.96	0.98	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 107



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	24.61	5.17	7.95	11.16	7.96	4.16
CO	%	0.00	0.00	0.00	0.00	0.00	0.00
N2O	ppm	1.80	1.62	1.48	1.87	0.96	1.68
CH4	ppm	1.04	0.71	1.06	1.23	1.34	0.99
CO2	%	12.95	6.33	4.82	3.90	2.05	5.89
O2	%	1.20	11.01	13.24	14.55	16.83	12.26
CNOx	ppm	256.52	302.52	275.25	253.86	258.17	277.73
AHC	ppm	0.22	0.71	0.85	0.81	1.31	0.72
C2H2	ppm	0.39	0.08	0.04	0.05	0.03	0.09
C2H4	ppm	0.24	0.24	0.28	0.17	0.24	0.30
C3H6	ppm	0.22	0.31	0.23	0.18	0.20	0.22
C4H6	ppm	0.88	0.44	0.30	0.35	0.46	0.43
ETOH	ppm	2.79	1.30	1.49	1.08	1.34	1.56
H2O	%	12.15	5.97	4.62	3.93	2.43	0.00
HCHO	ppm	0.65	0.37	0.32	0.37	0.15	0.41
HCN	ppm	0.32	0.38	0.31	0.28	0.23	0.33
HNCO	ppm	1.86	1.41	1.32	1.08	1.01	1.33
MECHO	ppm	0.00	0.00	0.00	0.00	0.00	0.00
NC5	ppm	1.01	1.07	1.23	0.80	1.02	1.08
NH3	ppm	0.10	0.03	0.02	0.31	0.02	0.10
NO	ppm	239.98	124.31	140.49	170.01	163.20	158.11
NO2	ppm	96.89	272.59	221.61	161.26	176.95	206.66
Soot	mg/m3	1.37	0.29	0.13	0.33	0.05	0.41
AFR	:1	15.44	31.91	41.96	51.74	96.46	35.33



Team Results for Clean Snowmobile Challenge 2019 Team 107



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	0.000	0.003	12.152	82.613	0.955	15.413	0.939
2	0.000	0.001	5.967	79.782	0.922	31.851	0.459
3	0.000	0.001	4.621	79.131	0.915	41.892	0.354
4	0.000	0.001	3.930	78.813	0.911	51.661	0.294
5	0.000	0.001	2.430	76.581	0.885	96.333	0.190

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	1.059	-0.896	-0.112	-1.008	98.712	1.288
2	0.193	-3.641	-0.455	-4.096	95.093	4.907
3	0.274	-3.265	-0.408	-3.673	95.352	4.648
4	0.331	-2.869	-0.359	-3.227	95.735	4.265
5	0.161	-1.703	-0.213	-1.916	94.940	5.060

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	15.607	6.857	3.911	1.960	0.000	4.992
BSFC	g/kw-hr	357.38	343.63	424.94	591.33	**	427.66
Fuel_MassFlow	g/hr	5577.5	2356.4	1661.9	1159.1	416.2	2134.7
HC_m	g/hr	1.0593	0.1925	0.2739	0.3312	0.1614	0.1509
CO_m	g/hr	0.8393	0.0178	0.0000	0.0362	0.0019	1.2013
CO2_m	g/hr	17740	7496	5286	3686	1324	6789
TW_Power	kW	5.3096					
TW_BSFC	g/kw-hr	425.21					
Fuel_MassFlow	g/hr	5577.5	2356.4	1661.9	1159.1	416.2	2134.7
FuelCalc	g/hr	5577.6	2356.4	1661.9	1159.1	416.3	2134.7
FuelCalcDev	%	-0.0010652	0.0005769	-0.0006838	-0.0025198	-0.0040656	0.0007446

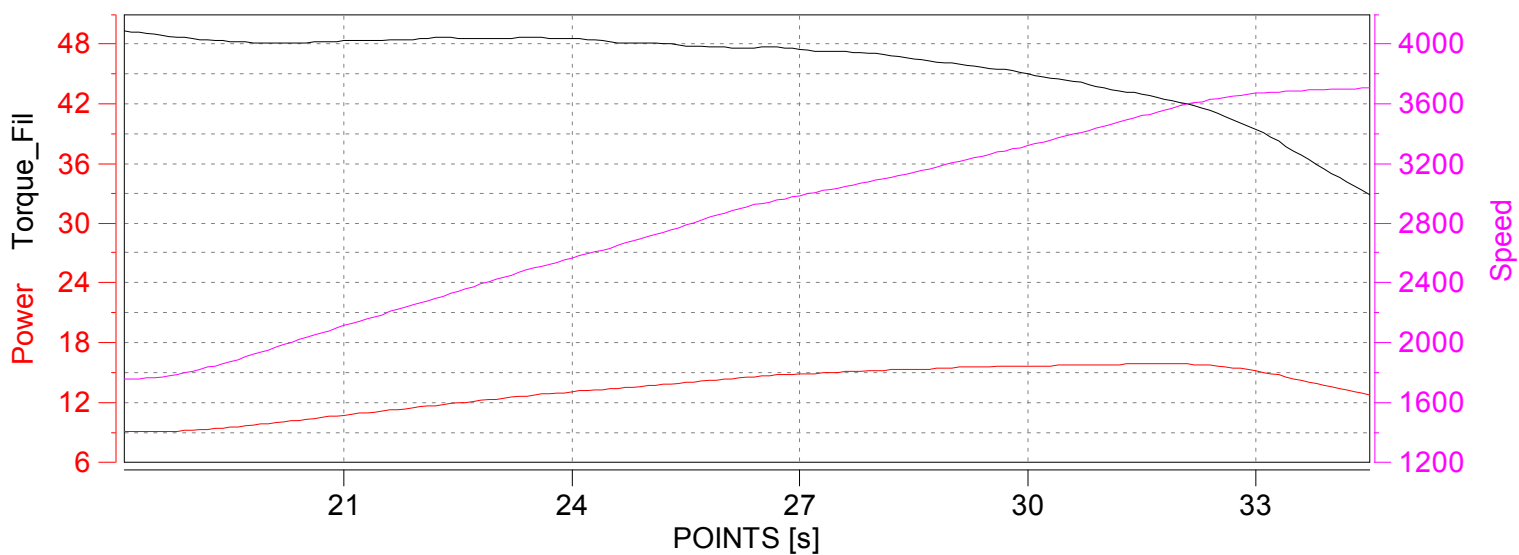
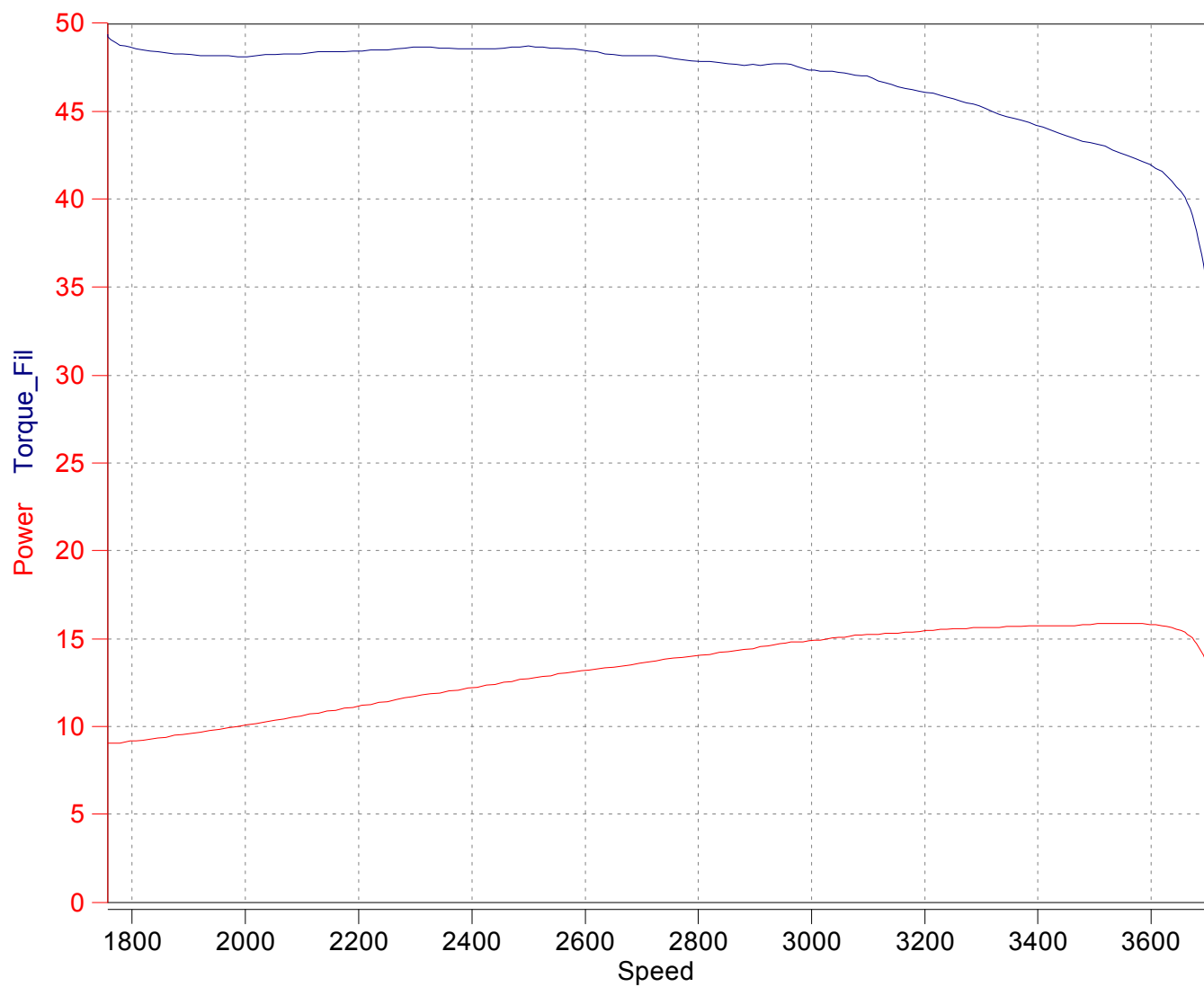
\$HCR_ENG	1.808
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.86826

Power Run

Team 107

TeamNumber	107
TeamName	South Dakota
Model	D902
Engine	Kubota

Displacement cc	898.00
RatedSpeed	3520
RatedTorque	43.0





Team Results for Clean Snowmobile Challenge 2019 Team 8



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2019/03/07 11:47:10
Team Name : University of Minnesota
Team Number : 8
Model : ProStar
Engine : ProStar
Displacement[cc] : 570.00
100% Speed : 5964
100% Torque : 36.2
No of Strokes : 4
Fuel : Gas H/C: 1.95 O/C: 0.00

ModeNum	:	1	2	3	4	5	RMC
Weighting	:	0.12	0.27	0.25	0.31	0.05	1.00
Power kW	:	22.4	9.8	5.6	2.7	0.0	7.7
HC_m g/hr	:	352.46	16.01	13.14	36.60	1.58	15.55
CO_m g/hr	:	7018.20	56.81	4.62	392.64	0.07	574.52
NOx_m g/hr	:	8.85	3.33	47.83	0.45	1.29	21.18
Soot_m mg/hr	:	255.48	7.85	101.79	4.27	0.53	50.90
N2O_m mg/hr	:	0.26	0.01	0.01	0.01	0.00	0.03
CO2_m g/hr	:	14126.74	10419.42	6757.51	4334.75	3179.81	8931.66
CH4_m g/hr	:	15.86	2.01	2.44	2.20	0.59	3.22
W_HC g/hr	:	42.30	4.32	3.28	11.35	0.08	15.55
W_CO g/hr	:	842.18	15.34	1.15	121.72	0.00	574.52
W_NOx g/hr	:	1.06	0.90	11.96	0.14	0.06	21.18
W_HCNOx g/hr	:	43.36	5.22	15.24	11.49	0.14	36.74
W_Soot mg/hr	:	30.66	2.12	25.45	1.32	0.03	50.90
W_N2O g/hr	:	0.03	0.00	0.00	0.00	0.00	0.03
W_CO2 g/hr	:	1695.21	2813.24	1689.38	1343.77	158.99	8931.66
W_CH4 g/hr	:	1.90	0.54	0.61	0.68	0.03	3.22

Total Weighted Power [kW] 7.604

Weighted Emissions

	HC	CO	NOx	HC+NOx
Total Mass [g/hr]	61.33	980.40	14.12	75.45
Specific Mass [g/kW-hr]	8.07	128.94	1.86	9.92
BSFC [g/kW-hr]	415.8			

Total Soot [mg/hr] 59.57 Specific Soot [mg/kW-hr] 7.83

Not Used for Competition

Total N2O [mg/hr]	0.04	Specific N2O [mg/kW-hr]	0.01
Total CO2 [g/hr]	7700.59	Specific CO2 [g/kW-hr]	1012.73
Total CH4 [g/hr]	3.77	Specific CH4 [g/kW-hr]	0.50
RMC BSFC [g/kW-hr]	406.27		

EMISSION TESTS:

	Value	Limit	Result
Power	22.61	<96.94 kW	PASS
Soot	7.83	<50 mg/kW-hr	PASS
CO	128.94	<275 g/kW-hr	PASS
HC + NOX	9.92	<90 g/kW-hr	PASS
E-Score	171.15	>175	FAIL
Valid Data for All 5 Modes			PASS
RMC			PASS
LAB EMISSION TEST			FAIL



Team Results for Clean Snowmobile Challenge 2019 Team 8



Modal Raw Data : Engine / Environmental

ModeNum		1	2	3	4	5	RMC
Total Points	points	600	1520	1200	1200	1200	11432
PtsInMode	points	1210	3370	3470	1800	1480	11432
Speed	rpm	5964.47	5069.20	4473.07	3872.03	1251.89	4554.68
Torque	Nm	35.91	18.56	12.04	6.71	0.00	16.20
Power	kW	22.43	9.85	5.64	2.72	0.00	7.73
BSFC	g/kw-hr	371.86	340.42	383.24	591.70	**	406.27
Fuel	g/hr	8340.21	3353.09	2161.32	1609.03	1011.38	3138.50
T_int	degC	21.19	22.25	22.83	21.30	21.47	22.47
RelHumid	%	14.39	13.60	13.14	14.41	13.86	13.88
Baro	in Hg	29.17	29.17	29.16	29.17	29.17	29.17
Baro	mmHg	740.97	740.92	740.75	740.89	740.85	740.88
Pvap_kPa	kPa	0.30	0.30	0.30	0.31	0.30	0.31
Pvap_inHg	inHg	0.09	0.09	0.09	0.09	0.09	0.09
AbsHumidity	grains/lb	13.48	13.50	13.46	13.59	13.20	13.94
SatPres	kPa	98.48	98.48	98.45	98.47	98.47	98.46
Hum Factor		0.78	0.78	0.78	0.78	0.77	0.78
F_fac		1.00	1.00	1.00	1.00	1.00	1.00
K_fac		1.01	1.02	1.02	1.01	1.01	1.02
Humidity	g/kg	1.93	1.93	1.92	1.94	1.89	1.99
H2		3.07	0.04	0.00	0.61	0.00	0.43
WetDry Factor		0.88	0.87	0.87	0.87	0.88	1.00



Team Results for Clean Snowmobile Challenge 2019 Team 8



Modal Emissions Concentrations

ModeNum		1	2	3	4	5	RMC
THC	ppmC1	6730.56	650.85	801.10	3234.88	188.16	679.73
CO	%	6.69	0.12	0.01	1.73	0.00	1.25
N2O	ppm	15.48	1.45	2.78	2.79	1.19	4.21
CH4	ppm	264.57	71.36	130.17	169.54	61.57	122.79
CO2	%	8.57	13.45	13.09	12.17	12.01	12.40
O2	%	0.00	0.08	0.77	0.13	2.39	0.44
CNOx	ppm	51.34	41.14	886.08	12.07	46.69	281.29
AHC	ppm	108.97	4.02	4.33	50.22	0.07	28.41
C2H2	ppm	15.63	1.24	0.75	1.78	0.57	3.28
C2H4	ppm	77.85	9.70	14.39	82.41	0.63	31.63
C3H6	ppm	37.08	3.80	1.78	19.14	0.17	11.26
C4H6	ppm	9.39	2.17	0.73	14.82	0.51	5.46
ETOH	ppm	2.72	2.69	2.29	7.87	2.39	3.38
H2O	%	11.80	13.18	12.70	12.83	11.56	0.00
HCHO	ppm	4.77	1.58	3.27	1.22	0.30	2.31
HCN	ppm	5.95	1.50	0.13	2.71	0.07	1.84
HNCO	ppm	1.46	2.00	0.82	4.23	0.49	2.17
MECHO	ppm	0.20	0.00	0.01	0.00	0.01	0.08
NC5	ppm	109.20	7.12	3.46	21.04	0.81	24.95
NH3	ppm	282.40	28.95	1.01	367.84	1.30	137.21
NO	ppm	66.89	53.57	1142.42	16.22	60.52	362.52
NO2	ppm	0.00	0.02	0.17	0.01	0.02	0.04
Soot	mg/m3	3.03	0.18	3.50	0.22	0.04	1.27
AFR	:1	10.35	14.51	15.05	13.10	16.60	14.25



Team Results for Clean Snowmobile Challenge 2019 Team 8



Measurement Accuracy (SAE paper 961804)

ModeNum	H2_XLS %	ModalHC_Dry %	ModalFTIR_H2O %	N2 %	Ar %	AFR :1	Tr_Eff -
1	3.480	0.763	11.801	72.196	0.835	11.149	1.000
2	0.043	0.075	13.176	82.758	0.957	14.616	0.996
3	0.005	0.092	12.702	82.947	0.959	15.204	0.961
4	0.704	0.371	12.831	80.020	0.925	13.648	0.994
5	0.000	0.021	11.559	82.098	0.949	16.618	0.879

ModeNum	ModalWHC %	ModalC1 %	ModalC8 %	ModalSUM_HC %	ModalT_Emiss %	ModalError %
1	352.464	0.763	0.095	0.858	94.670	5.330
2	16.006	0.010	0.001	0.011	99.498	0.502
3	13.137	-0.499	-0.062	-0.562	99.369	0.631
4	36.600	0.266	0.033	0.300	98.038	1.962
5	1.581	-1.620	-0.202	-1.822	97.519	2.481

Carbon Balance Verification

		1	2	3	4	5	6
Power	kW	22.428	9.850	5.640	2.719	0.000	7.725
BSFC	g/kw-hr	371.86	340.42	383.24	591.70	**	406.27
Fuel_MassFlow	g/hr	8340.2	3353.1	2161.3	1609.0	1011.4	3138.5
HC_m	g/hr	352.46	16.01	13.14	36.60	1.58	15.55
CO_m	g/hr	7018.2	56.8	4.6	392.6	0.1	574.5
CO2_m	g/hr	14127	10419	6758	4335	3180	8932
TW_Power	kW	7.6038					
TW_BSFC	g/kw-hr	415.77					
Fuel_MassFlow	g/hr	8340.2	3353.1	2161.3	1609.0	1011.4	3138.5
FuelCalc	g/hr	8397.7	3355.6	2163.4	1615.0	1011.6	3141.0
FuelCalcDev	%	-0.68882	-0.07622	-0.09758	-0.37006	-0.02373	-0.07907

\$HCR_ENG	1.949
\$OCR_ENG	0
MassFracCFuel H/C ratio	0.85943

Power Run

Team 8

TeamNumber	8
TeamName	University of Minnesota
Model	ProStar
Engine	ProStar

Displacement cc	570.00
RatedSpeed	5964
RatedTorque	36.2

