



Team Results for Clean Snowmobile Challenge 2019 Team 8



2019 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

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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
  
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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



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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



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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



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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

