



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



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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	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



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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



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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

