



Team Results for Clean Snowmobile Challenge 2018 Team 1



2018 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

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Test Date       : 2018/03/07 15:23:53
Team Name      : ETS
Team Number    : 1
Model          : Rotax
Engine         : Ace
Displacement[cc] : 600.00
100% Speed    : 6929
100% Torque    : 68.8
No of Strokes  : 4
Fuel           : GAS
                H/C: 2.04      O/C: 0.07
  
```

| ModeNum | : | 1 | 2 | 3 | 4 | 5 | RMC |
|-----------|--------|----------|----------|----------|---------|---------|----------|
| Weighting | : | 0.12 | 0.27 | 0.25 | 0.31 | 0.05 | 1.00 |
| Power | kW : | 49.6 | 25.3 | 11.4 | 6.1 | 0.0 | 16.9 |
| HC_m | g/hr : | 405.43 | 8.20 | 13.32 | 1.61 | 9.84 | 10.03 |
| CO_m | g/hr : | 19341.56 | 1.37 | 1.94 | 0.63 | 127.99 | 908.10 |
| NOx_m | g/hr : | 7.69 | 377.33 | 156.45 | 42.32 | 0.02 | 200.44 |
| Soot_m | mg/hr: | 100.68 | 5.96 | 0.52 | 0.04 | 0.02 | 10.05 |
| N2O_m | mg/hr: | 0.62 | 0.04 | 0.03 | 0.01 | 0.00 | 0.06 |
| CO2_m | g/hr : | 37326.44 | 25875.87 | 13570.71 | 8836.48 | 4568.24 | 21195.48 |
| CH4_m | g/hr : | 50.19 | 0.13 | 0.59 | 0.28 | 0.44 | 2.86 |
| W_HC | g/hr : | 48.65 | 2.21 | 3.33 | 0.50 | 0.49 | 10.03 |
| W_CO | g/hr : | 2320.99 | 0.37 | 0.49 | 0.20 | 6.40 | 908.10 |
| W_NOx | g/hr : | 0.92 | 101.88 | 39.11 | 13.12 | 0.00 | 200.44 |
| W_HCNOx | g/hr : | 49.57 | 104.09 | 42.44 | 13.62 | 0.49 | 210.47 |
| W_Soot | mg/hr: | 12.08 | 1.61 | 0.13 | 0.01 | 0.00 | 10.05 |
| W_N2O | g/hr : | 0.07 | 0.01 | 0.01 | 0.00 | 0.00 | 0.06 |
| W_CO2 | g/hr : | 4479.17 | 6986.49 | 3392.68 | 2739.31 | 228.41 | 21195.48 |
| W_CH4 | g/hr : | 6.02 | 0.04 | 0.15 | 0.09 | 0.02 | 2.86 |

Total Weighted Power [kW] 17.543

Weighted Emissions

| | HC | CO | NOx | HC+NOx |
|-------------------------|-------|---------|--------|--------|
| Total Mass [g/hr] | 55.19 | 2328.44 | 155.03 | 210.22 |
| Specific Mass [g/kW-hr] | 3.15 | 132.73 | 8.84 | 11.98 |
| BSFC [g/kW-hr] | 379.7 | | | |

Total Soot [mg/hr] 13.83 Specific Soot [mg/kW-hr] 0.79

Not Used for Competition

| | | | |
|--------------------|----------|-------------------------|---------|
| Total N2O [mg/hr] | 0.10 | Specific N2O [mg/kW-hr] | 0.01 |
| Total CO2 [g/hr] | 17826.06 | Specific CO2 [g/kW-hr] | 1016.14 |
| Total CH4 [g/hr] | 6.31 | Specific CH4 [g/kW-hr] | 0.36 |
| RMC BSFC [g/kW-hr] | 429.45 | | |

EMISSION TESTS:

| | Value | Limit | Result |
|----------------------------|--------|--------------|--------|
| Power | 49.94 | <96.94 kW | PASS |
| Soot | 0.79 | <50 mg/kW-hr | PASS |
| CO | 132.73 | <275 g/kW-hr | PASS |
| HC + NOX | 11.98 | <90 g/kW-hr | PASS |
| E-Score | 168.83 | >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 | 6928.99 | 5889.25 | 5092.67 | 4500.17 | 1914.62 | 5249.96 |
| Torque | Nm | 68.42 | 41.02 | 21.38 | 13.04 | 0.00 | 30.67 |
| Power | kW | 49.65 | 25.30 | 11.40 | 6.15 | 0.00 | 16.86 |
| BSFC | g/kw-hr | 444.14 | 327.33 | 381.70 | 459.91 | ** | 429.45 |
| Fuel | g/hr | 22050.24 | 8279.83 | 4352.03 | 2826.41 | 1534.31 | 7241.01 |
| T_int | degC | -3.79 | -3.74 | -3.97 | -4.11 | -3.88 | -3.93 |
| RelHumid | % | 22.25 | 23.80 | 17.03 | 21.05 | 16.90 | 20.93 |
| Baro | in Hg | 28.81 | 28.81 | 28.81 | 28.81 | 28.81 | 28.81 |
| Baro | mmHg | 731.73 | 731.74 | 731.68 | 731.70 | 731.65 | 731.71 |
| Pvap_kPa | kPa | 0.11 | 0.11 | 0.08 | 0.10 | 0.08 | 0.10 |
| Pvap_inHg | inHg | 0.03 | 0.03 | 0.02 | 0.03 | 0.02 | 0.03 |
| AbsHumidity | grains/lb | 4.77 | 5.12 | 3.60 | 4.42 | 3.60 | 4.44 |
| SatPres | kPa | 97.45 | 97.44 | 97.47 | 97.45 | 97.46 | 97.45 |
| Hum Factor | | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| F_fac | | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| K_fac | | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |
| Humidity | g/kg | 0.68 | 0.73 | 0.51 | 0.63 | 0.51 | 0.63 |
| H2 | | 3.13 | 0.00 | 0.00 | 0.00 | 0.20 | 0.29 |
| WetDry Factor | | 0.87 | 0.87 | 0.87 | 0.87 | 0.87 | 1.00 |



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Modal Emissions Concentrations

| ModeNum | | 1 | 2 | 3 | 4 | 5 | RMC |
|---------|-------|---------|---------|---------|--------|--------|---------|
| THC | ppmC1 | 2693.69 | 124.88 | 383.36 | 70.01 | 860.54 | 177.02 |
| CO | % | 6.45 | 0.00 | 0.00 | 0.00 | 0.56 | 0.80 |
| N2O | ppm | 13.19 | 2.13 | 2.94 | 1.27 | 0.86 | 3.45 |
| CH4 | ppm | 293.20 | 1.75 | 14.81 | 10.56 | 34.06 | 44.36 |
| CO2 | % | 7.93 | 12.60 | 12.48 | 12.29 | 12.77 | 11.95 |
| O2 | % | 0.00 | 0.86 | 0.97 | 1.33 | 0.26 | 0.97 |
| CNOx | ppm | 15.62 | 1757.34 | 1376.61 | 562.97 | 0.50 | 1081.39 |
| AHC | ppm | 31.40 | 0.05 | 0.01 | 0.01 | 0.00 | 4.12 |
| C2H2 | ppm | 1.54 | 0.44 | 0.43 | 0.42 | 0.85 | 0.62 |
| C2H4 | ppm | 58.42 | 0.61 | 1.53 | 0.69 | 4.05 | 7.89 |
| C3H6 | ppm | 7.56 | 1.89 | 6.54 | 1.22 | 9.07 | 3.88 |
| C4H6 | ppm | 5.45 | 1.03 | 2.83 | 0.93 | 6.37 | 2.32 |
| ETOH | ppm | 0.57 | 0.00 | 0.46 | 0.46 | 0.00 | 0.57 |
| H2O | % | 12.99 | 13.40 | 13.25 | 13.01 | 12.72 | 0.00 |
| HCHO | ppm | 0.60 | 1.46 | 5.37 | 1.73 | 65.04 | 4.03 |
| HCN | ppm | 1.18 | 0.47 | 0.41 | 0.28 | 0.44 | 0.61 |
| HNCO | ppm | 1.88 | 2.06 | 3.51 | 1.10 | 0.00 | 2.42 |
| MECHO | ppm | 0.07 | 0.96 | 4.81 | 0.11 | 38.62 | 4.72 |
| NC5 | ppm | 2.23 | 0.83 | 9.34 | 0.92 | 14.71 | 3.60 |
| NH3 | ppm | 126.68 | 0.40 | 1.12 | 0.87 | 62.52 | 23.09 |
| NO | ppm | 20.90 | 2311.94 | 1798.46 | 736.99 | 0.98 | 1417.83 |
| NO2 | ppm | 0.16 | 22.59 | 45.22 | 12.74 | 0.05 | 22.30 |
| Soot | mg/m3 | 0.44 | 0.05 | 0.01 | 0.00 | 0.00 | 0.10 |
| AFR | :1 | 9.99 | 14.07 | 14.05 | 14.40 | 13.10 | 13.73 |



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Measurement Accuracy (SAE paper 961804)

| ModeNum | H2_XLS % | ModalHC_Dry % | ModalFTIR_H2O % | N2 % | Ar % | AFR :1 | Tr_Eff - |
|---------|-------------|------------------|--------------------|---------|---------|-----------|-------------|
| 1 | 3.599 | 0.310 | 12.991 | 71.858 | 0.831 | 11.449 | 1.000 |
| 2 | 0.000 | 0.014 | 13.398 | 83.229 | 0.962 | 15.550 | 0.956 |
| 3 | 0.001 | 0.044 | 13.253 | 82.750 | 0.957 | 15.593 | 0.951 |
| 4 | 0.001 | 0.008 | 13.011 | 82.579 | 0.955 | 15.884 | 0.933 |
| 5 | 0.225 | 0.099 | 12.724 | 80.370 | 0.929 | 14.631 | 0.987 |

| ModeNum | ModalWHC % | ModalC1 % | ModalC8 % | ModalSUM_HC % | ModalT_Emiss % | ModalError % |
|---------|---------------|--------------|--------------|------------------|-------------------|-----------------|
| 1 | 405.431 | 0.309 | 0.039 | 0.347 | 93.167 | 6.833 |
| 2 | 8.199 | -0.620 | -0.077 | -0.697 | 99.303 | 0.697 |
| 3 | 13.322 | -0.667 | -0.083 | -0.751 | 98.682 | 1.318 |
| 4 | 1.609 | -0.940 | -0.118 | -1.058 | 98.214 | 1.786 |
| 5 | 9.842 | -0.101 | -0.013 | -0.114 | 96.976 | 3.024 |

Carbon Balance Verification

| | | 1 | 2 | 3 | 4 | 5 | 6 |
|---------------|---------|---------|---------|---------|---------|---------|---------|
| Power | kW | 49.647 | 25.295 | 11.402 | 6.146 | 0.000 | 16.861 |
| BSFC | g/kw-hr | 444.14 | 327.33 | 381.70 | 459.91 | ** | 429.45 |
| Fuel_MassFlow | g/hr | 22050 | 8280 | 4352 | 2826 | 1534 | 7241 |
| HC_m | g/hr | 405.43 | 8.20 | 13.32 | 1.61 | 9.84 | 10.03 |
| CO_m | g/hr | 19342 | 1 | 2 | 1 | 128 | 908 |
| CO2_m | g/hr | 37326 | 25876 | 13571 | 8836 | 4568 | 21195 |
| TW_Power | kW | 17.543 | | | | | |
| TW_BSFC | g/kw-hr | 379.67 | | | | | |
| Fuel_MassFlow | g/hr | 22050 | 8280 | 4352 | 2826 | 1534 | 7241 |
| FuelCalc | g/hr | 23880 | 8940 | 4701 | 3052 | 1658 | 7819 |
| FuelCalcDev | % | -8.2988 | -7.9779 | -8.0162 | -7.9702 | -8.0781 | -7.9852 |

| | |
|-------------------------|---------|
| \$HCR_ENG | 2.04 |
| \$OCR_ENG | 0.07 |
| MassFracCFuel H/C ratio | 0.79086 |

Power Run

Team 1

| | |
|------------|-------|
| TeamNumber | 1 |
| TeamName | ETS |
| Model | Rotax |
| Engine | Ace |

| | |
|-----------------|--------|
| Displacement cc | 600.00 |
| RatedSpeed | 6929 |
| RatedTorque | 68.8 |

