



Team Results for Clean Snowmobile Challenge 2014 Team 11



2014 Clean Snowmobile Competition - Lab Emission Event Emission Data Sheet

Test Date : 2014/03/07 19:09:20
 Team Name : NDSU
 Team Number : 11
 Model : Polaris Pro-R Rush
 Engine : Yanmar
 Displacement[cc] : 952.00
 100% Speed : 3791
 100% Torque : 76.4
 No of Strokes : 4
 Fuel : diesel H/C: 1.80 O/C: 0.00

| ModeNum | : | 1 | 2 | 3 | 4 | 5 |
|--------------|---|----------|----------|---------|---------|---------|
| Weighting | : | 0.12 | 0.27 | 0.25 | 0.31 | 0.05 |
| Power kW | : | 29.8 | 13.1 | 7.1 | 4.0 | 0.0 |
| HC_m g/hr | : | 53.79 | 0.00 | 0.00 | 0.08 | 0.00 |
| CO_m g/hr | : | 4082.93 | 0.10 | 0.03 | 0.00 | 0.01 |
| NOx_m g/hr | : | 3.57 | 72.82 | 57.98 | 35.62 | 19.26 |
| Soot_m mg/hr | : | 9132.50 | 667.77 | 391.09 | 210.33 | 14.62 |
| N2O_m mg/hr | : | 0.00 | 0.02 | 0.02 | 0.01 | 0.01 |
| CO2_m g/hr | : | 28048.50 | 11625.66 | 7434.44 | 4775.70 | 1533.79 |
| CH4_m g/hr | : | 40.99 | 0.03 | 0.04 | 0.05 | 0.02 |
| W_HC g/hr | : | 6.45 | 0.00 | 0.00 | 0.02 | 0.00 |
| W_CO g/hr | : | 489.95 | 0.03 | 0.01 | 0.00 | 0.00 |
| W_NOx g/hr | : | 0.43 | 19.66 | 14.49 | 11.04 | 0.96 |
| W_HCNOx g/hr | : | 6.88 | 19.66 | 14.49 | 11.07 | 0.96 |
| W_Soot mg/hr | : | 1095.90 | 180.30 | 97.77 | 65.20 | 0.73 |
| W_N2O g/hr | : | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| W_CO2 g/hr | : | 3365.82 | 3138.93 | 1858.61 | 1480.47 | 76.69 |
| W_CH4 g/hr | : | 4.92 | 0.01 | 0.01 | 0.01 | 0.00 |

Total Weighted Power [kW] 10.131

Weighted Emissions

| | HC | CO | NOx | HC+NOx |
|-------------------------|-------|--------|-------|--------|
| Total Mass [g/hr] | 6.48 | 489.99 | 46.59 | 53.07 |
| Specific Mass [g/kW-hr] | 0.64 | 48.37 | 4.60 | 5.24 |
| BSFC [g/kW-hr] | 317.7 | | | |

Total Soot [mg/hr] 1439.90 Specific Soot [mg/kW-hr] 142.13

Not Used for Competition

| | | | |
|--------------------|---------|-------------------------|--------|
| Total N2O [mg/hr] | 0.02 | Specific N2O [mg/kW-hr] | 0.00 |
| Total CO2 [g/hr] | 9920.51 | Specific CO2 [g/kW-hr] | 979.23 |
| Total CH4 [g/hr] | 4.95 | Specific CH4 [g/kW-hr] | 0.49 |
| RMC BSFC [g/kW-hr] | | | |

EMISSION TESTS:

| | Value | Limit | Result |
|----------------------------|--------|---------------|--------|
| Power | 30.35 | <96.94 kW | PASS |
| Soot | 142.13 | <100 mg/kW-hr | FAIL |
| CO | 48.37 | <275 g/kW-hr | PASS |
| HC + NOX | 5.24 | <90 g/kW-hr | PASS |
| E-Score | 194.42 | >100 | PASS |
| Valid Data for All 5 Modes | | | PASS |

LAB EMISSION TEST FAIL



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Modal Raw Data : Engine / Environmental

| ModeNum | | 1 | 2 | 3 | 4 | 5 |
|---------------|-----------|----------|---------|---------|---------|---------|
| Total Points | points | 591 | 1208 | 1200 | 1200 | 1200 |
| PtsInMode | points | 1210 | 1500 | 1500 | 1500 | 1800 |
| Speed | rpm | 3790.42 | 3216.00 | 2862.59 | 2472.72 | 1281.32 |
| Torque | Nm | 75.12 | 38.86 | 23.83 | 15.37 | 0.00 |
| Power | kW | 29.82 | 13.09 | 7.14 | 3.98 | 0.00 |
| BSFC | g/kw-hr | 364.85 | 279.05 | 326.90 | 376.90 | ** |
| Fuel | g/hr | 10878.72 | 3651.63 | 2335.14 | 1500.11 | 481.76 |
| T_int | degC | 26.19 | 6.58 | 5.22 | 2.09 | 1.68 |
| RelHumid | % | 25.35 | 28.72 | 28.44 | 28.40 | 28.60 |
| Baro | in Hg | 28.82 | 28.83 | 28.83 | 28.83 | 28.83 |
| Baro | mmHg | 732.05 | 732.31 | 732.41 | 732.23 | 732.41 |
| Pvap_kPa | kPa | 0.70 | 0.26 | 0.24 | 0.20 | 0.19 |
| Pvap_inHg | inHg | 0.21 | 0.08 | 0.07 | 0.06 | 0.06 |
| AbsHumidity | grains/lb | 31.55 | 11.79 | 10.74 | 8.85 | 8.68 |
| SatPres | kPa | 96.90 | 97.37 | 97.41 | 97.42 | 97.45 |
| Hum Factor | | 0.83 | 0.77 | 0.77 | 0.76 | 0.76 |
| F_fac | | 1.02 | 0.97 | 0.97 | 0.96 | 0.96 |
| K_fac | | 1.03 | 1.00 | 1.00 | 0.99 | 0.99 |
| Humidity | g/kg | 4.51 | 1.68 | 1.53 | 1.26 | 1.24 |
| H2 | | 0.74 | 0.00 | 0.00 | 0.00 | 0.00 |
| WetDry Factor | | 0.89 | 0.93 | 0.95 | 0.96 | 0.98 |



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Modal Emissions Concentrations

| ModeNum | | 1 | 2 | 3 | 4 | 5 |
|---------|-------|--------|--------|--------|--------|--------|
| THC | ppmC1 | 577.16 | 0.00 | 0.00 | 2.26 | 0.00 |
| CO | % | 2.16 | 0.00 | 0.00 | 0.00 | 0.00 |
| N2O | ppm | 0.00 | 1.50 | 1.32 | 1.19 | 0.89 |
| CH4 | ppm | 379.95 | 0.57 | 0.84 | 1.18 | 0.99 |
| CO2 | % | 9.45 | 7.35 | 5.05 | 4.24 | 2.66 |
| O2 | % | 3.38 | 9.38 | 13.18 | 14.36 | 16.68 |
| CNOx | ppm | 11.52 | 440.37 | 377.07 | 302.82 | 320.06 |
| AHC | ppm | 6.22 | 0.00 | 0.00 | 0.00 | 0.01 |
| C2H2 | ppm | 2.52 | 1.09 | 0.96 | 1.33 | 1.08 |
| C2H4 | ppm | 29.19 | 0.09 | 0.20 | 1.68 | 0.24 |
| C3H6 | ppm | 3.00 | 0.14 | 0.15 | 0.23 | 0.28 |
| C4H6 | ppm | 8.41 | 0.05 | 0.04 | 0.10 | 0.29 |
| ETOH | ppm | 2.60 | 0.32 | 0.27 | 0.25 | 0.39 |
| H2O | % | 11.32 | 6.89 | 4.71 | 4.08 | 2.46 |
| HCHO | ppm | 1.04 | 0.32 | 0.33 | 0.59 | 0.24 |
| HCN | ppm | 2.41 | 0.30 | 0.23 | 0.10 | 0.16 |
| HNCO | ppm | 5.63 | 3.48 | 2.27 | 1.49 | 1.88 |
| MECHO | ppm | 1.24 | 0.00 | 0.01 | 0.64 | 0.14 |
| NC5 | ppm | 0.00 | 0.46 | 0.30 | 0.28 | 0.19 |
| NH3 | ppm | 269.21 | 0.17 | 0.08 | 0.41 | 0.08 |
| NO | ppm | 13.79 | 248.98 | 328.90 | 381.89 | 267.75 |
| NO2 | ppm | 0.13 | 322.21 | 162.04 | 15.03 | 152.10 |
| Soot | mg/m3 | 59.00 | 7.79 | 4.85 | 3.42 | 0.47 |
| AFR | :1 | 15.99 | 27.29 | 40.61 | 48.35 | 77.16 |



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Measurement Accuracy (SAE paper 961804)

| ModeNum | H2_XLS % | ModalHC_Dry % | ModalFTIR_H2O % | N2 % | Ar % | AFR :1 | Tr_Eff - |
|---------|-------------|------------------|--------------------|---------|---------|-----------|-------------|
| 1 | 0.834 | 0.065 | 11.318 | 79.427 | 0.918 | 16.086 | 0.829 |
| 2 | 0.000 | 0.000 | 6.891 | 79.760 | 0.922 | 27.234 | 0.537 |
| 3 | 0.000 | 0.000 | 4.709 | 80.027 | 0.925 | 40.526 | 0.357 |
| 4 | 0.000 | 0.000 | 4.084 | 79.811 | 0.923 | 48.260 | 0.302 |
| 5 | 0.000 | 0.000 | 2.463 | 78.445 | 0.907 | 77.004 | 0.195 |

| ModeNum | ModalWHC % | ModalC1 % | ModalC8 % | ModalSUM_HC % | ModalT_Emiss % | ModalError % |
|---------|---------------|--------------|--------------|------------------|-------------------|-----------------|
| 1 | 53.791 | -2.186 | -0.273 | -2.459 | 95.632 | 4.368 |
| 2 | 0.000 | ** | ** | ** | ** | ** |
| 3 | 0.000 | ** | ** | ** | ** | ** |
| 4 | 0.080 | -3.087 | -0.386 | -3.473 | 96.693 | 3.307 |
| 5 | 0.000 | ** | ** | ** | ** | ** |

Power Run

Team 11

| | |
|------------|--------------------|
| TeamNumber | 11 |
| TeamName | NDSU |
| Model | Polaris Pro-R Rush |
| Engine | Yanmar |

| | |
|-----------------|--------|
| Displacement cc | 952.00 |
| RatedSpeed | 3791 |
| RatedTorque | 76.4 |

