

S5P2-1

AGENDA

History of Gas monitoring

Challenges

Test Project

- Equipment
- System Components

Communication – Real Time

Preliminary Results

Conclusion

Acknowledgements

Underground Real Time Diesel Exhaust Gas Monitoring Project

Introduction

- Vale Canada operates 6 base metal mines in the Sudbury, Ontario region; which vary in depth from 1200 meters (3900 ft) to 2400 meters (7900 ft) with plans to going to 3050 meters (10,020 ft)
- Committed to Safe Production.
- Research & Project initiatives are used to continually improve how we attain Safe Production



Underground Real Time Diesel Exhaust Gas Monitoring Project

History of Gas monitoring

- 1973 First U/G Diesel Code issued in Ontario (CO, NO₂, HCHO)
- 1994 Testing frequency changes for CO and other gases on request
- 2003 Audit of Ontario Mines, inconsistent testing and not reliable to assess condition of engines
- 2008 Proposed changes to OHSA, Mining Regulations – lower CO exhaust levels to 600 ppm and TC limits to 400 µg/m³. Procedures developed by mines to sample undiluted exhaust to ensure reproducible testing of engines. (MLRC Diesel subcommittee, 2008)



Underground Real Time Diesel Exhaust Gas Monitoring Project

Challenges

- Accurate Instrumentation Designed For Purpose
- Testing Equipment Cost
- Commitment of time for testing
- Engine Health Indicator
- Emission Control Testing



Underground Real Time Diesel Exhaust Gas Monitoring Project

This project in partnership with Draeger Canada has two objectives

- Development of a cost effective, hand-held, portable device that has the ability to provide accurate and reproducible engine exhaust tests; and
- Unit to sample, store and transmit real-time exhaust emission data.



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Initial Testing

- Demonstration test of communication system at Dynamic Earth Underground Tour Facility
- Demonstration of test unit on an MTI – LT1050 LHD unit equipped with a Deutz engine at 206 kW. This unit is located at the MTI surface facility.

Site Test

- The site selected for this test is the Totten Mine located in Sudbury, Ontario
- The selected equipment is an MTI - LT350 LHD unit equipped with a Mercedes 904 engine @ 86 kW. This unit is located on the 1250 level in an isolated ore body.
- A second test unit will be an Elphinstone R1600G LHD unit equipped with a Caterpillar 3176 ATTAC engine @ 231 kW. This unit is located on the 1850 level of the mine.



Underground Real Time Diesel Exhaust Gas Monitoring Project

Hand-held Portable Monitor

- Designed for purpose
- Repeatable sampling of diesel exhaust for (CO, NO_x, NO, NO₂)
- Portable unit designed for shop or field application



Underground Real Time Diesel Exhaust Gas Monitoring Project

Hand-held Portable Monitor



Underground Real Time Diesel Exhaust Gas Monitoring Project



Underground Real Time Diesel Exhaust Gas Monitoring Project

Preliminary Results

Hand Held Gas Monitor

- Testing of the unit at MTI surface facility confirmed the operation of the unit

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-----
MSI EM200 E
KRBK-0064
DIESEL EXHAUST
GAS ANALYSER
ENG.No.-----
30.09.10 15:16
Condition : IDLE
-----
CO                7 ppm
NOx               352 ppm
NO                344 ppm
NO2               8 ppm
Speed            600 rpm
-----
Condition : HIGH IDLE
-----
CO                55 ppm
NOx               245 ppm
NO                239 ppm
NO2               6 ppm
Speed            3000 rpm
-----
Condition : LOAD
-----
CO                50 ppm
NOx               368 ppm
NO                362 ppm
NO2               6 ppm
Speed            3100 rpm
-----

```



Underground Real Time Diesel Exhaust Gas Monitoring Project

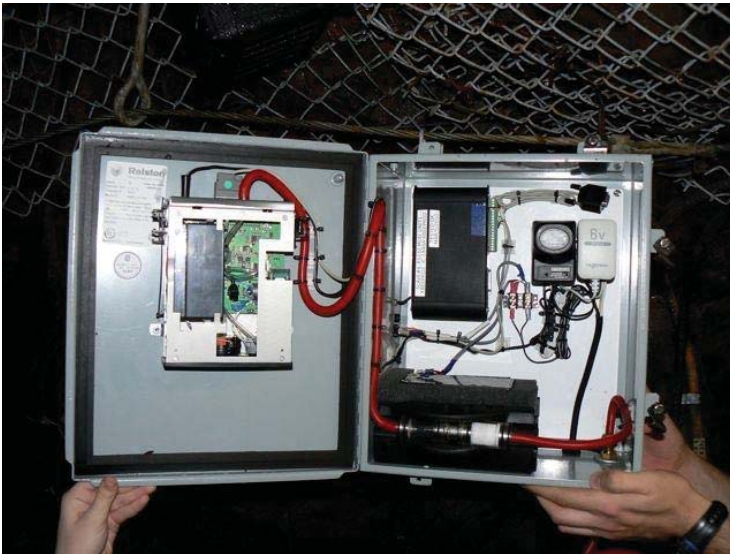
Real-Time Onboard Gas Monitor Objectives

- exhaust (pre & post treatment devices) measurements during operation
- function without compromising the safe operation of the diesel unit or the engine and associated exhaust treatment devices
- operate without operator intervention or dependency
- have programming capability (sampling time/duration)
- include data storage capacity and is downloadable for data management and analysis
- The system must be able to wirelessly transfer data to the existing communication network and/or have the ability for manual download if required.



Underground Real Time Diesel Exhaust Gas Monitoring Project

Real-Time Onboard Gas Monitor



Underground Real Time Diesel Exhaust Gas Monitoring Project

Real-Time Onboard Gas Monitor Protocol

Operation

- Interface Control Module unit integrates the components of the Dräger EM200-E (EM500-X)
- Acquires info from the Engine Control Module (for engine data such as engine temp, rpm, etc.)
- Exhaust sampling system, power supply and data storage components
- ICM controls the EM500-X, switching between manifold, and tailpipe monitoring points.

Potential Uses of Onboard System

- Meet OSHA Reg. 183.2(1)2 – emission testing
- Application for Occupational Health Monitoring Programs – operator personal exposure
- Ventilation On Demand Systems – compliance to OEL's
- Engine Health Indicator – pre exhaust treatment devices and repeatable sampling
- Performance Evaluation of Exhaust After-Treatment Devices – pre & post exhaust treatment device samples



Underground Real Time Diesel Exhaust Gas Monitoring Project

Communication

Onboard monitoring samples data points in real-time while the equipment is operating

- The CO ambient conditions, vehicle data and exhaust emissions are simultaneously sampled once per second (which is adjustable) and toggles between manifold and tailpipe probes on a 15 minute cycle.
- Data is stored in RAM, where it is compressed and encrypted
- Data is transmitted from the unit via a wireless network to the master controller either local or remote.



Underground Real Time Diesel Exhaust Gas Monitoring Project

Prototype unit on Surface LHD



Underground Real Time Diesel Exhaust Gas Monitoring Project

Preliminary Results

Real-Time Onboard Gas Monitor

- Testing of the unit at Dynamic Earth provided confirmation with respect to the WI-FI data transfer from a remote underground site to the surface computer station
- Lab testing of control sequence and data collection in the lab with calibration gas
- Testing of the unit at MTI surface facility will confirm the interface and operation of the equipment



Underground Real Time Diesel Exhaust Gas Monitoring Project

Real-Time Onboard Gas Monitor Sample Data

- Streamed data from Onboard unit to computer (lab data)

```
[10:07:54-F] Purge - 2 min for Standby\r
[10:09:54-F] Standby for 5 minutes\r
[10:14:54-F] Wake up from sleep\r
[10:16:54-F] Stabilizing for 2 min\r
[10:18:54-F] Channel 1 selected\r
[10:59:32-F] 01 17 51 0 0 0 0 0\r01 18 51 0 0 0 0 0
[10:59:34-F] 01 22 51 0 0 0 0 0\r01 24 51 0 0 0 0 0
[10:59:37-F] 01 25 51 0 0 0 0 0\r01 26 51 0 0 0 0 0
[10:59:43-F] 01 28 51 0 0 0 0 0\r01 29 51 0 0 0 0 0
[10:59:51-F] 01 34 51 0 0 0 0 0\r01 35 51 0 0 0 0 0
[10:59:53-F] 01 41 51 0 64 0 0 0\r01 42 51 0 72 0 0 0
[10:59:55-F] 01 43 51 0 78 0 0 0\r01 45 51 0 85 0 0 0
[10:59:58-F] 01 46 51 0 89 0 0 0\r01 47 51 0 92 0 0 0
[11:00:02-F] 01 49 51 0 95 0 0 0\r01 50 51 0 95 0 0 0
[11:00:04-F] 01 53 51 0 96 0 0 0\r01 54 51 0 96 0 0 0
[11:00:12-F] 01 55 51 0 96 0 0 0\r01 56 51 0 96 0 0 0
[11:00:14-F] 01 62 51 0 96 0 0 0\r01 63 51 0 96 0 0 0
[11:00:16-F] 01 65 51 0 96 0 0 0\r01 66 51 0 96 0 0 0
[11:00:18-F] 01 67 51 0 96 0 0 0\r01 68 51 0 96 0 0 0
[11:00:21-F] 01 69 51 0 96 1 0 0\r01 70 51 0 96 1 0 0
[11:00:23-F] 01 72 51 0 96 1 0 0\r01 73 51 0 96 1 0 0
[11:00:28-F] 01 74 51 0 96 1 0 0\r01 75 51 0 96 1 0 0
[11:00:37-F] 01 78 51 0 78 1 0 0\r01 79 51 0 62 1 0 0
[11:00:39-F] 01 88 51 0 4 1 0 0\r01 89 51 0 2 1 0 0
[11:00:41-F] 01 90 51 0 0 1 0 0\r01 91 51 0 0 0 0 0
```

CO
Readings
from
Calibration
gas



Conclusion

- Working with Dräger over the past two years has proven to be very successful in developing a hand-held portable instrument for obtaining reproducible gas measurements from undiluted diesel exhaust.
- This instrument will be a sampling option available to industry for compliance to Occupational Health and Safety Regulations.
- Building on the success of the hand held EM200-E unit, a method has been developed by WSN in collaboration with Dräger and KPI to employ the hand-held unit components into a mobile on-board application (EM500-X version) which potentially could facilitate non-intrusive real time data that can be used for preventative maintenance and new technologies applications such as Ventilation on Demand (VOD).



Underground Real Time Diesel Exhaust Gas Monitoring Project

Acknowledgements

- The authors would like to acknowledge the assistance of the following companies for their assistance with this project & presentation.
- Vale - Totten Mine Management & Team
- Vale - Central Maintenance and Information Technology Groups
- Dräger - Germany & Canada;
- Wireless Sensor Networks - Brazil & Canada;
- KPI Industrial Controls Inc.;
- Toromont/Caterpillar
- Mining Technology Industries (MTI)/Mercedes



Thank you!

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