Rio Tinto Alcan

KMP SO_2 EEM Program – Technical Memo P02

Atmospheric Sulphur Dioxide
Passive Diffusive Sampler Network: Pilot Study

March 2015

Prepared for:

Rio Tinto Alcan
1 Smeltersite Road, P.O. Box 1800,
Kitimat, BC, Canada V8C 2H2

Prepared by:

Trent University
ERS, 1600 West Bank Drive
Peterborough, ON, Canada K9J 7B8

1 Overview

Passive samplers can be used to provide empirical observations of atmospheric SO_2 concentrations to (a) assess spatial and temporal changes, (b) evaluate modelled concentration fields, and (c) estimate dry deposition of SO_2. They provide time-integrated air concentrations which support the assessment of ecosystems impacts under the EEM program.

Ideally a passive sampler network should be cost-effective, low maintenance and provide reliable, scientifically defensible data. However, the 2011–2012 RTA Passive Monitoring Program, which used Radiello triethanolamine (TEA) coated samplers, did not produce consistent reliable data (see Technical Memo: Passive Diffusive Sampler Network 2011–2012, March 2015).

The EEM program proposed a pilot study to evaluate the performance of SO_2 passive samplers prior to re-establishment of a network. Future network deployments depended upon the performance of samplers during the pilot study.

2 Passive Sampler Pilot Study

The goal of the pilot study is to evaluate the performance of passive SO_2 samplers against continuous SO_2 monitors across a gradient in air concentrations. It is proposed that passive samplers are deployed across three active monitoring stations during summer 2015 (May to September).

Passive samplers will be deemed effective, i.e., reliable for network deployment, if they exhibit: (a) a high correlation with continuous SO_2 monitors (e.g., $r \geq 0.8$), and (b) low variability between replicate exposures.

3 Passive Samplers

Passive samplers: SO_2 passive samplers with a carbonate-based coating have been shown to have a high degree of reliability (Cruz et al. 2005, Swaans et al. 2007) compared to TEA coated samplers. The 2011–2012 network employed TEA coated samplers which showed high variability between replicates, limited correlation with continuous observations, and poor levels of detection.

It is proposed that two carbonate-based samplers are evaluated in the pilot study: IVL diffusive sampler and AGAT Laboratories Passive Air Quality Sampler (PAQS).

The IVL samplers may be viewed as the 'industry standard'; IVL have > 25 years experience with diffusive samplers, their SO_2 samplers have been widely used around the globe (Carmichael et al. 2003, Ferm and Rodhe 1997), they are well represented in the peer-review

literature and shown to have good correspondence with continuous samplers (Ferm and Rodhe 1997, Swaans et al. 2007).

The PAQS provide a potential 'local' option for a carbonate-based sampler; though notably their reported lower detection limit is 2.5 times higher than the IVL samplers. However, AGAT Laboratories have agreed to provide discounted sampler pricing during the pilot study.

Lower detection limit (30 day exposure): 0.04 ppb IVL samplers compared with 0.1 ppb for PAQS

4 Monitoring Stations

It is proposed that three continuous monitoring stations (KMP, Haul Road and Riverlodge: Figure 1) are included in the pilot study to capture a range in atmospheric SO_2 concentrations (Table 1).

Passive samplers should be similarly deployed (consistent sampler housing, setting, exposure period) across all three stations during the pilot study. It is essential that continuous SO_2 monitors are in operation during the study to allow evaluation of the samplers.

Table 1. Average monthly atmospheric concentration (ppb) of sulphur dioxide (SO_2) during summer 2014 at KMP, Haul Road and Riverlodge continuous monitoring stations (see Figure 1 for station location).

Month	Average Atmospheric Concentration of Sulphur Dioxide (ppb)		
	KMP	Haul Road	Riverlodge
May 2014	4.54	2.67	0.65
June 2014	4.64	3.08	0.17
July 2014	5.34	2.93	0.30
August 2014	4.71	3.14	0.56

Figure 1. Location of continuous sulphur dioxide monitoring stations for co-deployment of passive samplers during the 2015 pilot study.

5 Sampler Deployment

Pilot study duration: A four month period between May and August is proposed to allow adequate capture of data for the statistical evaluation of sampler performance against continuous SO_2 observations.

Sampler deployment: A combination of two and four week deployments is proposed, with rotating replicate exposures to evaluate variability between samplers.

While both IVL and AGAT Laboratories recommend one month exposures, two weeks deployments provide greater resolution in temporal concentrations. Further, passive sampler performance may be reduced under long(er) exposure periods.

Similarly both IVL and AGAT Laboratories indicate that one sampler per exposures is adequate but note that replicate exposures provide greater confidence in sampler results.

Passive sampler numbers: A total of 60 passive samplers are required from both IVL and AGAT Laboratories. In addition, sampler-specific housing will need to be obtained from each supplier.

Sampler analysis: Individual sampler pricing includes the cost of analysis carried out by the supplier; IVL 50.00 US$ (420 SEK) per sampler, and PQAS 52.50 C$ per sampler (note AGAT will provide discounted pricing of 26.25 C$ during the pilot study).

IVL: www.diffusivesampling.ivl.se
AGAT Laboratories: www.agatlabs.com/energy/air-quality-monitoring/passive-monitoring.cfm

6 Literature Cited

Carmichael, G.R., Ferm, M. and 28 others. 2003. Measurements of sulfur dioxide, ozone and ammonia concentrations in Asia, Africa, and South America using passive samplers. Atmospheric Environment 37, 1293–1308.

Cruz, L.P.S., Campos, V.P., Novaes, J.A.P. and Tavares, T.M. 2005. Laboratory validation of a passive sampler for SO2 atmospheric monitoring. Journal of the Brazilian Chemical Society, 16:1, 50–57.

Ferm, M. and Rodhe, H. 1997. Measurements of air concentrations of SO2, NO2 and NH3 at rural and remote sites in Asia. Journal of Atmospheric Chemistry 27, 17–29.

Swaans, W., Goelen, E., De Fré, R., Damen, E., Van Avermaet, P., Roekens, E. and Keppens, V. 2007. Laboratory and field validation of a combined NO2–SO2 Radiello passive sampler. Journal of Environmental Monitoring 9, 1231–1240.

Technical Memo: Passive Diffusive Sampler Network 2011–2012, March 2015. In, Sulphur Dioxide Environmental Effects Monitoring for the Kitimat Modernization Project, 2013 and 2014 Annual Reports. ESSA Technologies Ltd, Vancouver, Canada.