Scaling AQMesh against data from diffusion tubes

For improved accuracy, AQMesh must be scaled locally. However, a calibrated local reference station is not always available in the locations where AQMesh is to be used to monitor air quality, so a test was carried out to see if local scaling of NO2 could be performed using diffusion tubes.

Diffusion tubes can be used to measure at an indicative level for all major ambient pollutants with one or a series of diffusion tubes providing a known level of accuracy over a weekly, fortnightly or monthly period. Typically, they provide a single interpolated result over a month long period of exposure, however recent advances in the technology can provide results from one week of exposure, with an acceptable level of error.

In order to limit the amount of time required for this test, Rapid Air Monitoring diffusion tubes from Gradko Environmental were used. Analysis was also completed by Gradko using their accredited labs. Diffusion tubes were set out in groups of four for each target gas, two open in the test area, one closed in the test area and a fourth closed in a refrigerated area. There were then four groups of tubes for the target gas (NO2), totalling 16 used throughout the whole test.

Three AQMesh pods set up and allowed to stabilise, as described in the AQMesh standard operating procedure. The pods were co-located (within one metre of each other) with calibrated reference equipment and also with the diffusion tubes, as described above. This test was repeated four times. All best practice procedures provided by Gradko were followed and tubes were returned to Gradko for analysis at the end of each test period.

15 minute results from all three AQMesh pods and the reference instrument were averaged over each of the separate four test periods. To give a general comparison, the three AQMesh pods averaged NO2 pre-scaled readings of 9.1, 9.2 and 11.3ppb. The diffusion tube averages were both 5.7ppb and the reference 5.7ppb. Individual test results for NO2 (ppb) are given below:

Test	AQMesh1	AQMesh2	AQMesh3	AQMeshAVE	Tube1	Tube2	TubeAVE	Reference
1	9.30	10.18	11.63	10.37	5.57	5.61	5.59	5.77
2	8.44	9.36	10.72	9.51	4.84	4.78	4.81	4.89
3	9.21	8.85	11.42	9.82	6.19	6.29	6.24	5.93
4	9.29	8.23	11.50	9.67	6.29	6.13	6.21	6.05

Based on these results a slope adjustment can be derived for each AQMesh pod over the test periods, alongside the slope and offset against reference equipment, using the 15-minute reference data.

After scaling mean variances were calculated for each pod, versus reference: The average of the three pods was ±4.7ppb for the unscaled pods, ±1.7ppb for the pods scaled against reference and ±1.7ppb scaled against diffusion tubes.

We are able to conclude from this test that calibration (scaling) of AQMesh against one or ideally several, diffusion tubes, is a viable option when no local reference station is available. With only a single data point, the limitations of scaling using diffusion tube data must be understood, eg: significant offset calculation. Increasing the number of diffusion tubes used helps to offset this challenge, alongside the fact that the latest electrochemical gas sensors require less offset adjustment than previous versions.

As with any scaling exercise, very low levels of the target gas make this impossible, and was the case when SO2 scaling was attempted using the same process here.