As the flow rate, sample concentration and sample temperature increase the peak height for each sensor increases and also the number of sensors that respond (Table 5.2.2.3.3). The greater the combination of variables the more sensors respond. The RH values are comparable for each temperature group. The data illustrated in Figures 5.2.2.3.1, 5.2.2.3.2 and 5.2.2.3.3 all show spiking episodes using 2-chlorophenol at 20, 10 and 5 ppm respectively for sensor 501 in each case. It is clear that the intensity of the peak decreases with the decreasing level of concentration introduced.

Table 5.2.2.3.3. Parameter comparisons and their effect on sensor and RH response. 2-chlorophenol at flows of 200 ml/min. Sample temperatures of 15°C and 30°C Vs sample concentrations of 5, 10 and 20 ppm

	200 ml/min 2-chlorophenol					
Sample Temp	15 °C			30 °C		
Sample Conc.	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm
Sensor 501	0.05	0.07	0.12	0.06	0.12	0.22
Sensor 502	0	0.08	0.09	0	0.04	0.15
Sensor 503	0	0.06	0	0	0	0.06
Sensor 504	0	0	0.12	0	0.1	0.17
RH	36	33	32	45	44	41

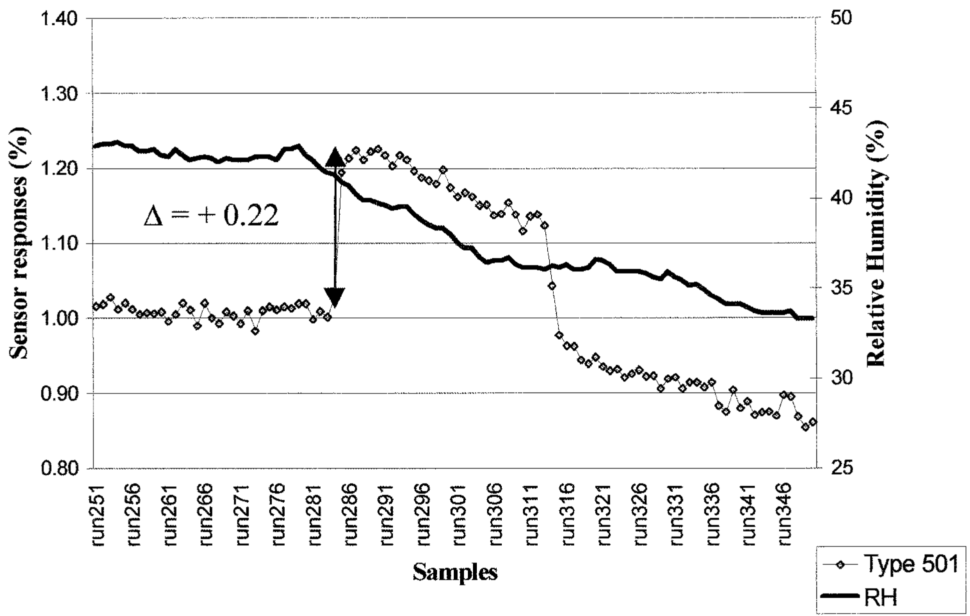

Figure 5.2.2.3.1 Sensor 501 between runs 250-350. 200ml/min sparge flow rate. 20 ppm 2-chorophenol spike between sample numbers 284-312. Liquid samples at 30 °C.

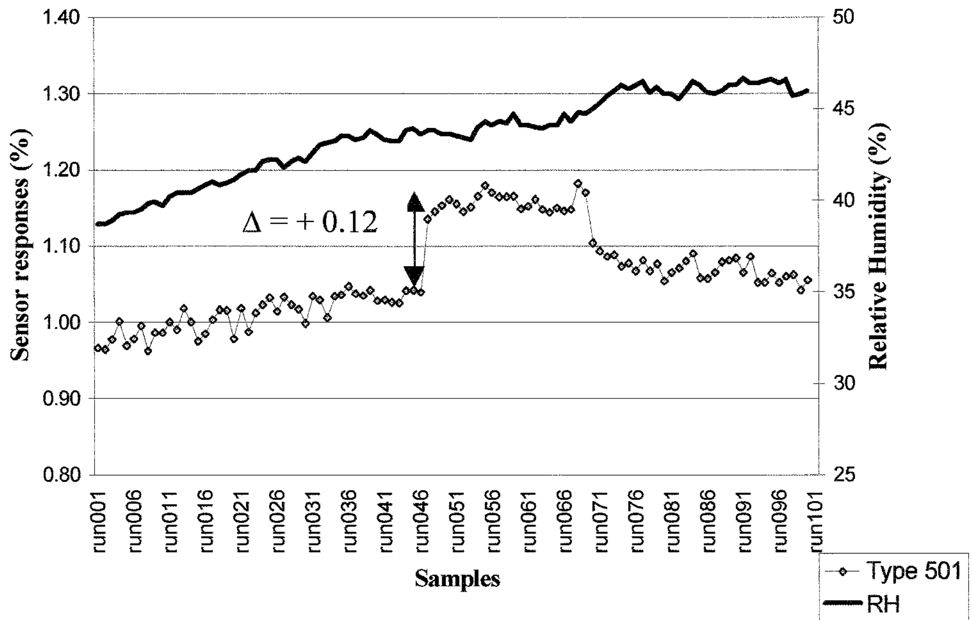

Figure 5.2.2.3.2 Sensor 501 between runs 1-101. 200ml/min sparge flow rate. 10 ppm 2-chorophenol spike between sample numbers 47-69. Liquid samples at 30 °C.

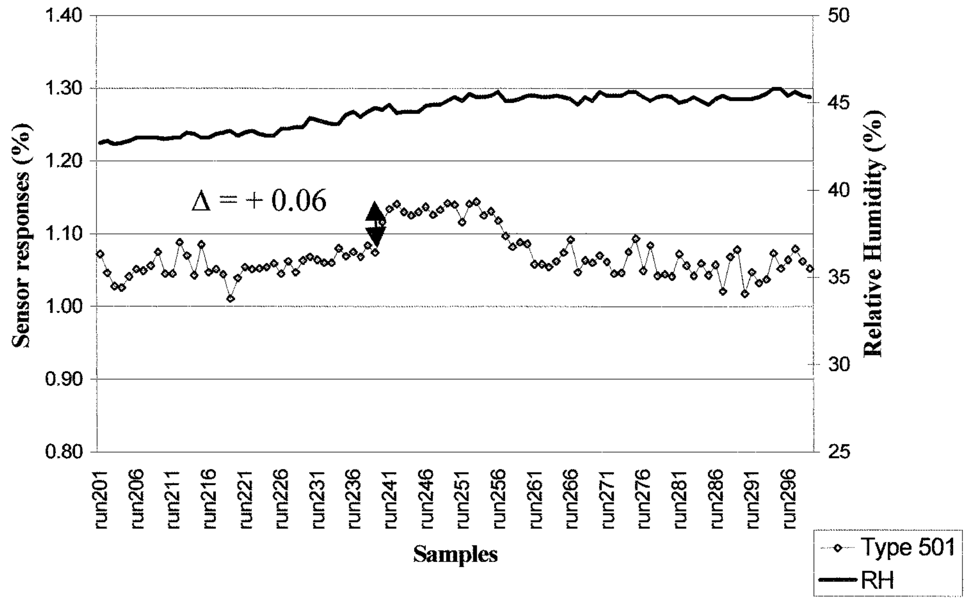

Figure 5.2.2.3.3 Sensor 501 between runs 201-399. 200ml/min sparge gas flow rate. 5 ppm 2-chorophenol spike between sample numbers 238-256. Liquid samples at 30°C

At 30°C sensor 502 registers the same response change for 5, 10 and 20 ppm diesel solutions (Table 5.2.2.3.4). The RH recorded is comparable across the group suggesting that the low flow of 50 ml/min is having little effect on sample volatilisation and the profile observed is due to natural dynamic headspace formation connected to the sample temperature and corresponding vapour pressure of the pollutant mixture.

Table 5.2.2.3.4. Parameter comparisons and their effect on sensor and RH response. diesel at flows of 50 ml/min. Sample temperatures of 15°C and 30°C Vs sample concentrations of 5, 10 and 20 ppm

	50 ml/min Diesel					
Sample Temp	15 °C			30 °C		
Sample Conc.	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm
Sensor 501	0	0	0.05	0.04	0.04	0.04
Sensor 502	0.06	0.03	0.19	0.14	0.08	0.18
Sensor 503	0	0	0	0	0	0
Sensor 504	0	0	0	0	0	0
RH	31	38	32	34	33	32

The data in Table 5.2.2.3.5 shows the trends observed at a flow of 100 ml/min. As the sample concentration increases across each temperature bracket a corresponding increase is reflected in the magnitude of the sensor response indicating the combined effect of sparge flow and sample concentration.

Table 5.2.2.3.5. Parameter comparisons and their effect on sensor and RH response. Diesel at flows of 100 ml/min. Sample temperatures of 15°C and 30°C Vs sample concentrations of 5, 10 and 20 ppm

	100 ml/min Diesel					
Sample Temp	15 °C			30 °C		
Sample Conc.	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm
Sensor 501	0.04	0.07	0.19	0.14	0.3	1.45
Sensor 502	0.15	0.19	0.5	0.2	0.8	2.10
Sensor 503	0	0	0	0	0	0.9
Sensor 504	0	0	0.2	0.12	0.3	0.78
RH	28	28	29	47	39	44

The data in Table 5.2.2.3.6 shows a similar to the trend that seen in Table 5.2.2.3.5; as the sample concentration increases and temperature increases so does the response magnitude with one exception, sensor 502 at 10 ppm and 30°C. This result is higher that the 20ppm spike collected under identical conditions. The RH values are comparable for each set of temperatures. There is no reason to suspect ambient conditions have caused the increased peak height. Time constraints allowed the data for these matrices to be collected once so observed results could not be compared over several runs.

Table 5.2.2.3.6. Parameter comparisons and their effect on sensor and RH response. Diesel at flows of 200 ml/min. Sample temperatures of 15°C and 30°C Vs sample concentrations of 5, 10 and 20 ppm

	200 ml/min Diesel					
Sample Temp	15 °C			30 °C		
Sample Conc.	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm
Sensor 501	0	0.11	0.12	0.12	0.62	0.68
Sensor 502	0.14	0.49	0.55	0.25	1.24	0.92
Sensor 503	0	0.08	0.07	0.1	0.44	0.55
Sensor 504	0	0.14	0.2	0.1	0.54	0.44
RH	32	33	33	46	42	48

5.2.2.4. Sparge gas flow rate - concentration by temperature:

At 50 ml/min sparge gas flow rate the number of sensors responding is minimal (Table 5.2.2.4.1). Only sensor 501 responds to the highest combination of sample concentration and temperature with the response from the 30°C run being double that of the 15°C run.

Table 5.2.2.4.1 Parameter comparisons and their effect on sensor and RH response. 2-chlorophenol at flows of 50 ml/min. Sample concentrations of 5, 10 and 20 ppm Vs sample temperatures of 15°C and 30°C

	50 ml/min 2-chlorophenol					
Sample Conc.	5 ppm		10 ppm		20 ppm	
Sample Temp	15 °C	30 °C	15 °C	30 °C	15 °C	30 °C
Sensor 501	0	0	0	0	0.09	0.16
Sensor 502	0	0	0	0	0	0
Sensor 503	0	0	0	0	0	0
Sensor 504	0	0	0	0	0	0
RH	29	30	31	33	29	39

The plots in Figures 5.2.2.4.1 and 5.2.2.4.2 show spiking episodes using 2-chlorophenol at 10 ppm for sensor 501 represented in the fourth and fifth columns of Table 5.2.2.4.2. Figures 5.2.2.4.1 and 5.2.2.4.2 were generated at 15°C and 30°C respectively. The sparge gas flows and spike concentrations are identical so changes in sensor response must be due to sample temperature. The change in sensor resistance in Figure 5.2.2.4.2 is twice as large as represented in Figure 5.2.2.4.1. This suggests that increased sample temperatures increase the volatilisation of the pollution component of the sample and therefore increase the ability of the system to detect pollution occurrences. Figures 5.2.2.4.3 and 5.2.2.4.4 show spiking episodes using 2-chlorophenol at 20 ppm for sensor 501 represented in the final two columns of Table 5.2.2.4.2. Figures 5.2.2.4.3 and 5.2.2.4.4 were generated at 15°C and 30°C respectively. The RH is higher in Figure 5.2.2.4.4 resulting from the increased temperature from 10°C to 30°C. This has increased sample volatilisation.

Table 5.2.2.4.2 Parameter comparisons and their effect on sensor and RH response. 2-chlorophenol at flows of 100 ml/min. Sample concentrations of 5, 10 and 20 ppm Vs sample temperatures of 15°C and 30°C

	100 ml/min 2-chlorophenol					
Sample Conc.	5 ppm		10 ppm		20 ppm	
Sample Temp	15 °C	30 °C	15 °C	30 °C	15 °C	30 °C
Sensor 501	0.03	0.06	0.05	0.11	0.1	0.19
Sensor 502	0	0	0	0	0.02	0.06
Sensor 503	0	0	0	0	0	0
Sensor 504	0	0	0	0	0	0.14
RH	32	35	32	31	32	39

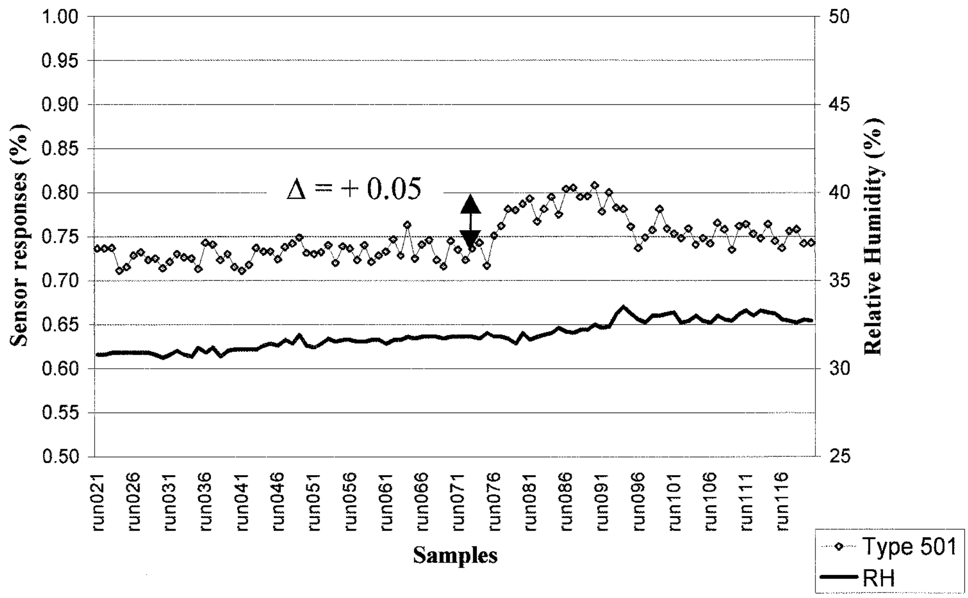

Figure 5.2.2.4.1 Sensor 501 between runs 21-120. 100 ml/min sparge flow rate. 10 ppm 2-chlorophenol spike between runs 77-92. Liquid samples at 15°C

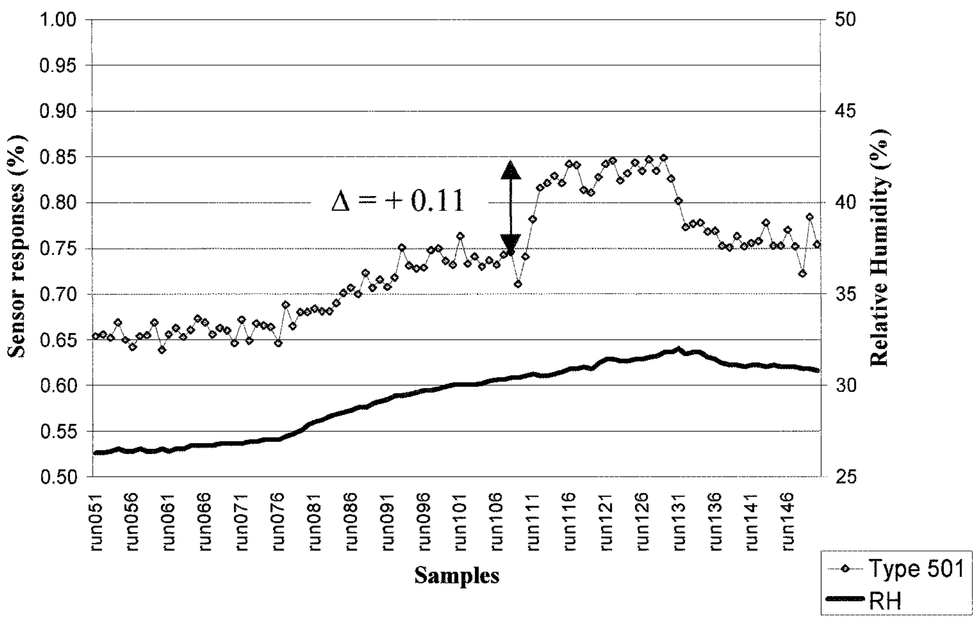

Figure 5.2.2.4.2 Sensor 501 between runs 51-150. 100 ml/min sparge flow rate. 10 ppm 2-chlorophenol spike between runs 111-129. Liquid samples at 30°C

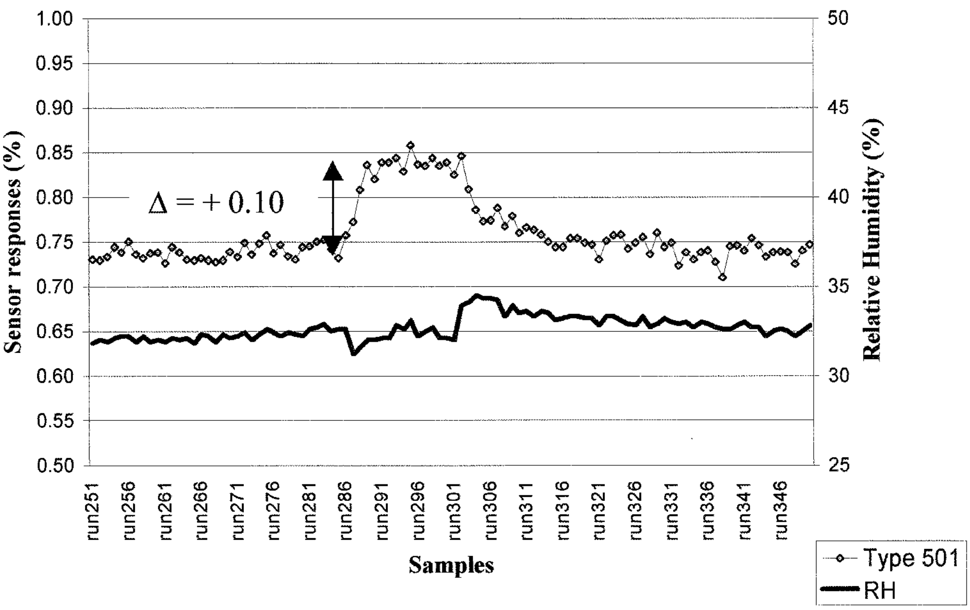

Figure 5.2.2.4.3 Sensor 501 between runs 251-350. 100 ml/min sparge flow rate. 20 ppm 2-chlorophenol spike between runs 287-301. Liquid samples at 15°C

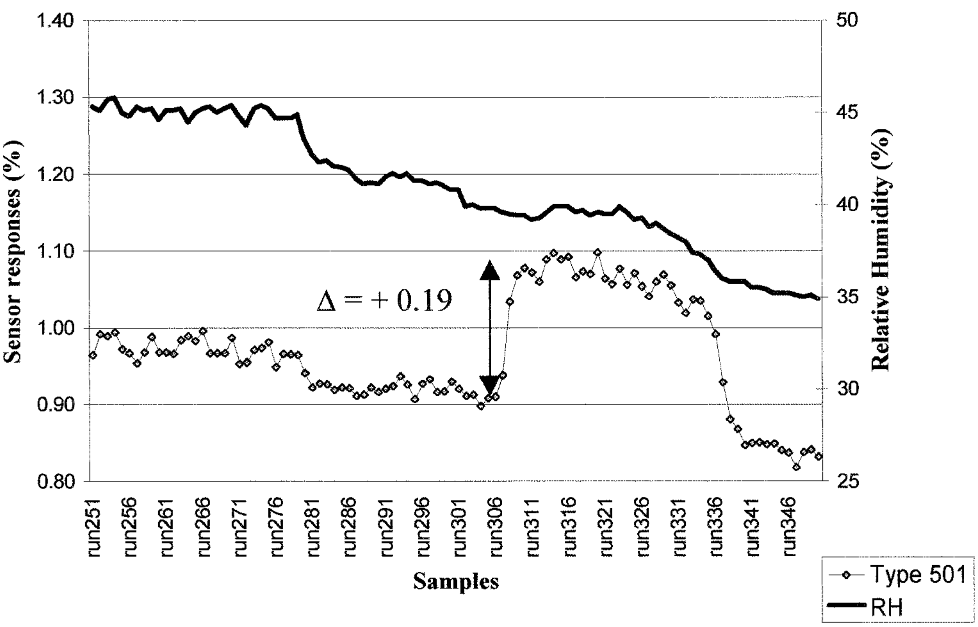

Figure 5.2.2.4.4 Sensor 501 between runs 251-350. 100 ml/min sparge flow rate. 20 ppm 2-chlorophenol spike between runs 307-335. Liquid samples at 30°C

Table 5.2.2.4.3 shows that as the sample temperature and concentration increase a larger change in sensor resistance are observed. More sensors respond as sample concentrations increase. The sample RH is higher for the 30°C samples then the 15°C samples.

Table 5.2.2.4.3 Parameter comparisons and their effect on sensor and RH response. 2-chlorophenol at flows of 200 ml/min. Sample concentrations of 5, 10 and 20 ppm Vs sample temperatures of 15°C and 30°C.

	200 ml/min 2-chlorophenol					
Sample Conc.	5 ppm		10 ppm		20 ppm	
Sample Temp	15 °C	30 °C	15 °C	30 °C	15 °C	30 °C
Sensor 501	0.05	0.06	0.07	0.12	0.09	0.22
Sensor 502	0	0	0.08	0.04	0.09	0.15
Sensor 503	0	0	0.06	0	0	0.06
Sensor 504	0	0	0	0.1	0.12	0.17
RH	36	45	33	44	32	41

The sensor response values were observed at 50, 100 and 200 ml/min gas sparge rate levels in Tables 5.2.2.4.4, 5.2.2.4.5 and 5.2.2.4.6 respectively. The effects of sample concentration and temperature at each flow rate were observed. As the gas flow rate increases the magnitude of the change in sensor response also increased. A corresponding trend is noticed as the temperature and concentration increase.

Table 5.2.2.4.4. Parameter comparisons and their effect on sensor and RH response. Diesel at flows of 50 ml/min. Sample concentrations of 5, 10 and 20 ppm Vs sample temperatures of 15°C and 30°C.

	50 ml/min Diesel					
Sample Conc.	5 ppm		10 ppm		20 ppm	
Sample Temp	15 °C	30 °C	15 °C	30 °C	15 °C	30 °C
Sensor 501	0	0.04	0	0.04	0.05	0.04
Sensor 502	0.06	0.14	0.3	0.08	0.19	0.18
Sensor 503	0	0	0	0	0	0
Sensor 504	0	0	0	0	0	0
RH	31	34	38	33	32	32

Table 5.2.2.4.5 Parameter comparisons and their effect on sensor and RH response. Diesel at flows of 100 ml/min. Sample concentrations of 5, 10 and 20 ppm Vs sample temperatures of 15°C and 30°C.

	100 ml/min Diesel					
Sample Conc.	5 ppm		10 ppm		20 ppm	
Sample Temp	15 °C	30 °C	15 °C	30 °C	15 °C	30 °C
Sensor 501	0.04	0.14	0.07	0.3	0.19	1.45
Sensor 502	0.15	0.2	0.19	0.8	0.5	2.10
Sensor 503	0	0	0	0 14	0	0.9
Sensor 504	0	0.12	0	0.32	0.2	0.78
RH	28	47	28	39	29	44

Figures 5.2.2.4.5 and 5.2.2.4.6 show spiking episodes using diesel at 20 ppm for sensor 501, corresponding to columns 6 and 7 in Table 5.2.2.4.5. Figures 5.2.2.4.5 and 5.2.2.4.6 were generated at 15°C and 30°C respectively. The RH in Figure 5.2.2.4.6 is about 15% higher than that in Figure 5.2.2.4.5 accounting for some of the difference seen between changes in sensor responses in the two plots. The high RH corresponds with the higher sample temperature indicating sample volatility increases with sample temperature.

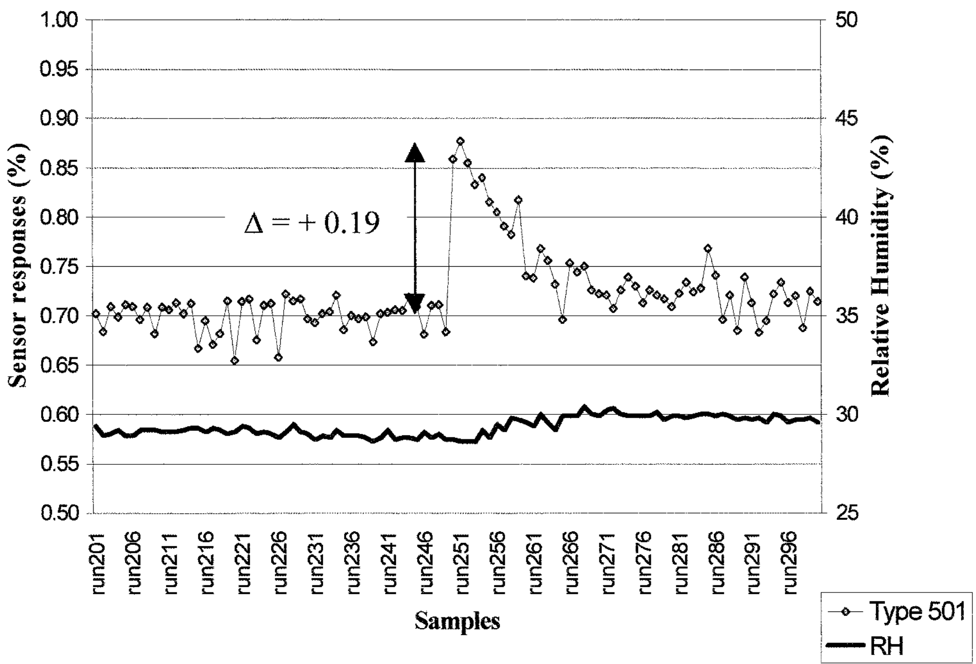

Figure 5.2.2.4.5 Sensor 501 between runs 201-300. 100 ml/min sparge flow rate. 20 ppm diesel spike between runs 250-269. Liquid samples at 15°C

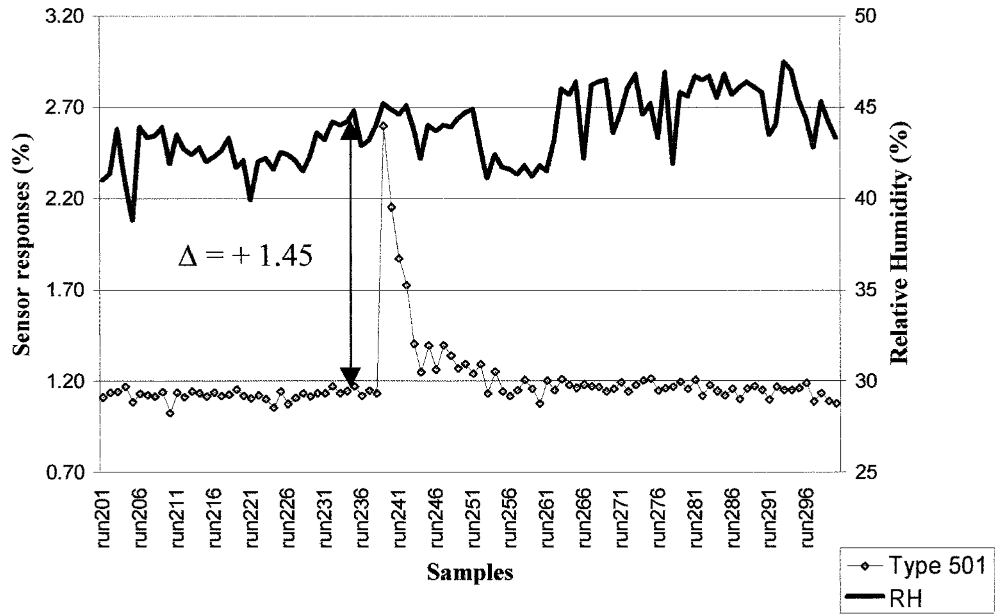

Figure 5.2.2.4.6 Sensor 501 between runs 201-300. 100 ml/min sparge flow rate. 20 ppm diesel spike between runs 239-263. Liquid samples at 30°C

Table 5.2.2.4.6. Parameter comparisons and their effect on sensor and RH response. Diesel at flows of 200 ml/min. Sample concentrations of 5, 10 and 20 ppm Vs sample temperatures of 15°C and 30°C.

	200 ml/min Diesel					
Sample Conc.	5 ppm		10 ppm		20 ppm	
Sample Temp	15 °C	30 °C	15 °C	30 °C	15 °C	30 °C
Sensor 501	0	0.12	0.11	0.62	0.12	0.68
Sensor 502	0.14	0.25	0.49	1.24	0.55	0.92
Sensor 503	0	0.1	0.08	0.44	0.07	0.55
Sensor 504	0	0.1	0.14	0.54	0.2	0.44
RH	32	46	33	42	33	48

5.2.2.5. Sample temperature - flow by concentration:

Table 5.2.2.5.1 shows the combined effects of sparge gas flow rate and sample concentration on sensor values as the temperature is maintained at 15°C. RH varies by less than 7% for all eight experiments. As sparge gas flow rate and concentration increase a slight increase is observed in sensor response. As the concentration level increases more sensors detect the pollution. Figure 5.2.2.5.1, 5.2.2.5.2 and 5.2.2.5.3 show sensor 501 during 5, 10 and 20 ppm 2-chlorophenol spikes, respectively at 15°C and 200 ml/min gas sparge rates. As the sample concentration increases the change in sensor response increases.

Table 5.2.2.5.1. Parameter comparisons and their effect on sensor and RH response. 2-chlorophenol 15°C. Sparge flows at 50, 100 and 200 ml/min Vs sample concentrations of 5, 10 and 20 ppm.

	15 °C 2-chlorophenol								
Sparge flow	50 ml/min			100 ml/min			200 ml/min		
Sample Conc.	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm
Sensor 501	0	0	0.09	0.03	0.05	0.1	0.05	0.07	0.12
Sensor 502	0	0	0	0	0	0.02	0	0.08	0.09
Sensor 503	0	0	0	0	0	0	0	0.06	0
Sensor 504	0	0	0	0	0	0	0	0	0.12
RH	29	31	29	32	32	32	36	33	32

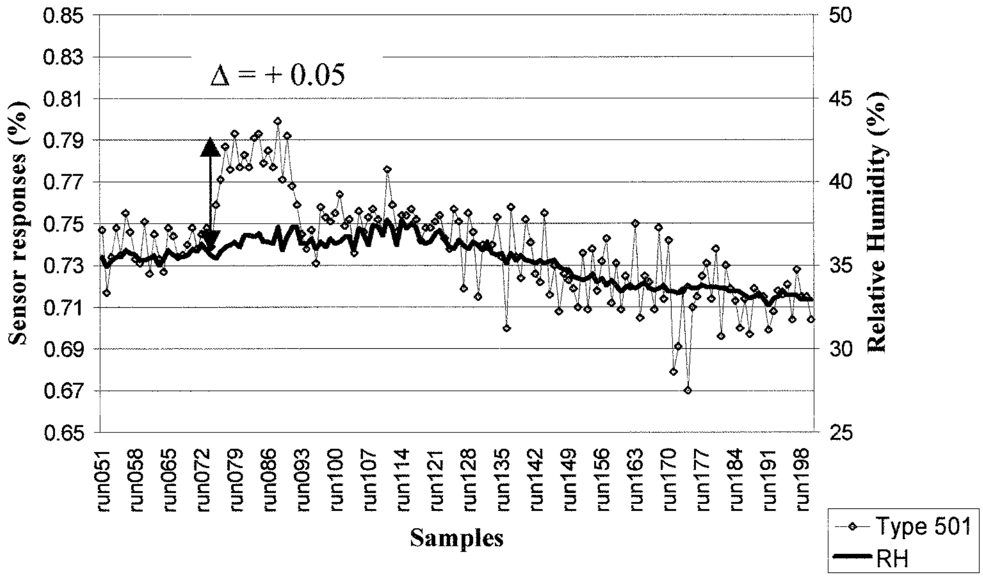

Figure 5.2.2.5.1 Sensor 501 between runs 51-200. 200 ml/min sparge flow rate. 5 ppm 2-chlorophenol spike between runs 75-90. Liquid samples at 15 °C.

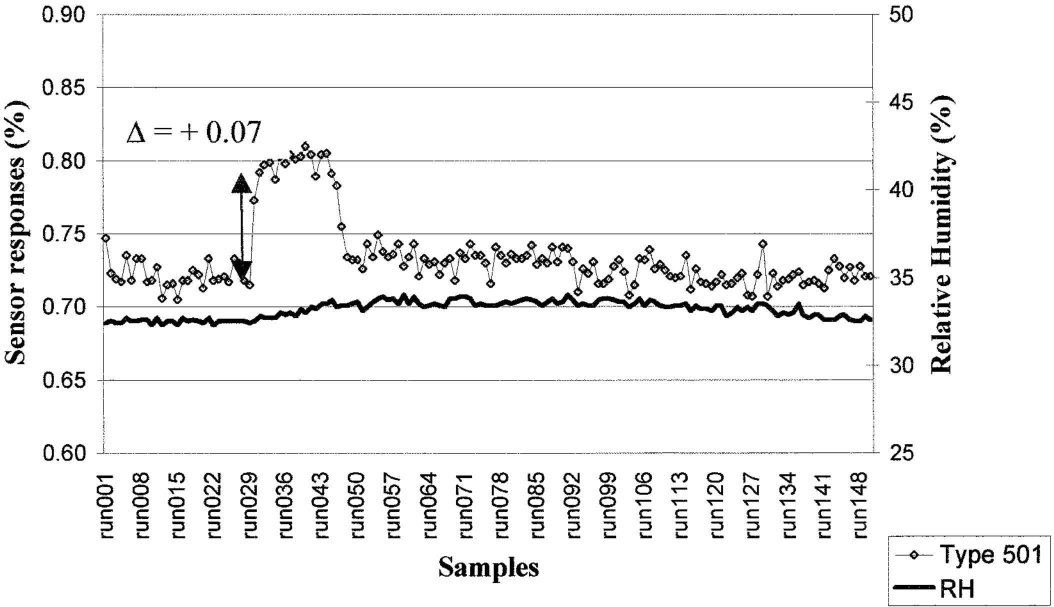

Figure 5.2.2.5.2 Sensor 501 between runs 1-150. 200 ml/min sparge flow rate. 10 ppm 2-chlorophenol spike between runs 30-45. Liquid samples at 15 °C.

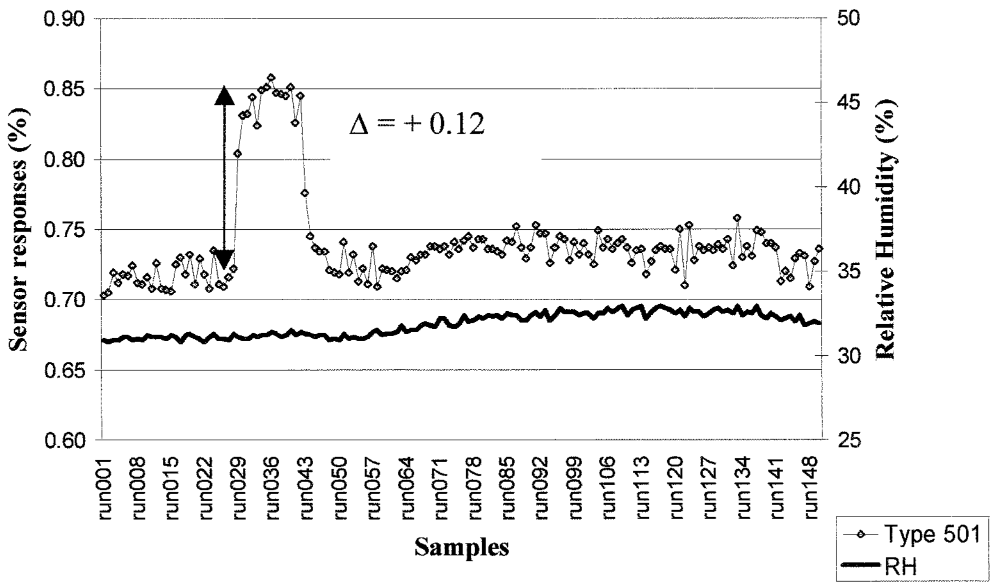

Figure 5.2.2.5.3 Sensor 501 between runs 1-150. 200 ml/min sparge flow rate. 20 ppm 2-chlorophenol spike between runs 29-42. Liquid samples at 15 °C.

Table 5.2.2.5.2 shows the combined effects of sparge gas flow rate and sample concentration on sensor values as the temperature is maintained at 30°C. The RH is more varied than for the same experiments performed at 15°C. At higher temperatures the effects of small fluctuations in temperature are more significant than at lower temperatures. The number of sensors responding and their corresponding magnitude increases at the higher sample temperature, concentration and flow rate combination for 2-chlorophenol.

Table 5.2.2.5.2 Parameter comparisons and their effect on sensor and RH response. 2-chlorophenol at 30°C. Sparge flows at 50, 100 and 200 ml/min Vs sample concentrations of 5, 10 and 20 ppm.

	30 °C 2-chlorophenol								
Sparge flow	50 ml/min			100 ml/min			200 ml/min		
Sample Conc.	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm
Sensor 501	0	0	0.16	0.06	0.11	0.19	0.06	0.12	0.22
Sensor 502	0	0	0	0	0	0.06	0	0.04	0.15
Sensor 503	0	0	0	0	0	0	0	0	0.06
Sensor 504	0	0	0	0	0	0.14	0	0.1	0.17
RH	30	33	39	35	31	39	45	44	41

Tables 5.2.2.5.3 and 5.2.2.5.4 show effects of sparge gas flow rate and sample concentration on sensor values as the temperature is maintained at 15°C and 30°C, respectively for diesel spiking. The RH follows the same trend observed for the same test using 2-chlorophenol. Sample volatility is increased at the higher sample temperature and hence more sensors respond to the pollution. Sensor 502 is more responsive to diesel than 2-chlorophenol at lower sample temperatures. The number of sensors responding and their corresponding magnitude increases at the higher concentration and flow rate combinations at 15°C for diesel. The tests at 30°C do not follow the same trend and the 50 ml/min and 200 ml/min 10 ppm experiments yield higher response values than for 20 ppm. This may due to sparge gas flow rate and liquid interactions or to an unnoticed abnormality during sampling.

Table 5.2.2.5.3 Parameter comparisons and their effect on sensor and RH response. Diesel at 15°C. Sparge flows at 50, 100 and 200 ml/min Vs sample concentrations of 5, 10 and 20 ppm.

	15 °C Diesel								
Sparge flow	50 ml/min			100 ml/min			200 ml/min		
Sample Conc.	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm
Sensor 501	0	0	0.05	0.04	0.07	0.19	0	0.11	0.12
Sensor 502	0.06	0.03	0.19	0.15	0.19	0.5	0.14	0.49	0.55
Sensor 503	0	0	0	0	0	0	0	0.08	0.07
Sensor 504	0	0	0	0	0	0.2	0	0.14	0.2
RH	31	38	32	28	28	29	32	33	33

Table 5.2.2.5.4 Parameter comparisons and their effect on sensor and RH response. Diesel at 30°C. Sparge flows at 0, 100 and 200 ml/min Vs sample concentrations of 5, 10 and 20 ppm.

	30 °C Diesel								
Sparge flow	50 ml/min			100 ml/min			200 ml/min		
Sample Conc.	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm	5 ppm	10 ppm	20 ppm
Sensor 501	0.04	0.04	0.4	0.14	0.3	1.45	0.12	0.62	0.68
Sensor 502	0.14	0.8	0.18	0.2	0.8	2.10	0.25	1.24	0.92
Sensor 503	0	0	0	0	0 14	0.9	0.1	0.44	0.55
Sensor 504	0	0	0	0.12	0.32	0.78	0.1	0.54	0.44
RH	34	33	32	47	39	44	46	42	48

5.2.2.6. Sample temperature - concentration by flow:

Observing the effects of concentration by flow whilst the sample temperate is held at 15°C and 30°C for both 2-chlorophenol and diesel allow us to see the influence of the parametric changes independent of temperature. Table 5.2.2.6.1 and 5.2.2.6.2 present the sensor response changes under such parameters for 2-chlorophenol at 15°C and 30°C, respectively. Higher gas flows and increased sample concentrations yield larger response magnitudes. The RH for the 15°C experiments remained ~32%. The 30°C data shows larger sensors response magnitudes compared to the 15°C data although the same trends are observed with increasing sample concentration and sparge gas flow rate.

Table 5.2.2.6.1 Parameter comparisons and their effect on sensor and RH response. 2-chlorophenol at 15°C. Sample concentrations of 5, 10 and 20 ppm Vs sparge flows of 50, 100 and 200 ml/min.

	15 °C 2-chlorophenol								
Sample Conc.	5 ppm			10 ppm			20 ppm		
Sparge flow	50 ml/min	100 ml/min	200 ml/min	50 ml/min	100 ml/min	200 ml/min	50 ml/min	100 ml/min	200 ml/min
Sensor 501	0	0.03	0.05	0	0.05	0.07	0.09	0.1	0.12
Sensor 502	0	0	0	0	0	0.08	0	0.02	0.09
Sensor 503	0	0	0	0	0	0.06	0	0	0
Sensor 504	0	0	0	0	0	0	0	0	0.12
RH	29	32	36	31	32	33	29	32	32

Table 5.2.2.6.2 Parameter comparisons and their effect on sensor and RH response. 2-chlorophenol at 30°C. Sample concentrations of 5, 10 and 20 ppm Vs sparge flows of 50, 100 and 200 ml/min.

	30 °C 2-chlorophenol								
Sample Conc.	5 ppm			10 ppm			20 ppm		
Sparge flow	50 ml/min	100 ml/min	200 ml/min	50 ml/min	100 ml/min	200 ml/min	50 ml/min	100 ml/min	200 ml/min
Sensor 501	0	0.06	0.06	0	0.11	0.12	0.16	0.19	0.22
Sensor 502	0	0	0	0	0	0.04	0	0.06	0.15
Sensor 503	0	0	0	0	0	0	0	0	0.06
Sensor 504	0	0	0	0	0	0.1	0	0.14	0.17
RH	30	35	45	33	31	43	39	39	41

Table 5.2.2.6.3 and 5.2.2.6.4 present the sensor response changes as concentration by sparge gas flow rate are considered while the sample temperate was held constant at 15°C and 30°C, respectively. Figures 5.2.2.6.1, 5.2.2.6.2 and 5.2.2.6.3 present the change in sensor response (502) during 10 ppm spiking. As the sparge gas flow rate increases the resistance change increases suggesting that pollutant volatility is increased. The RH for the 15°C experiments remained ~32%.

Table 5.2.2.6.3 Parameter comparisons and their effect on sensor and RH response. Diesel at 15°C. Sample concentrations of 5, 10 and 20 ppm Vs sparge flows of 50, 100 and 200 ml/min.

	15 °C Diesel								
Sample Conc.	5 ppm			10 ppm			20 ppm		
Sparge flow	50 ml/min	100 ml/min	200 ml/min	50 ml/min	100 ml/min	200 ml/min	50 ml/min	100 ml/min	200 ml/min
Sensor 501	0	0.04	0	0	0.07	0.11	0.05	0.19	0.12
Sensor 502	0.06	0.15	0.14	0.03	0.19	0.49	0.19	0.5	0.55
Sensor 503	0	0	0	0	0	0.08	0	0	0.07
Sensor 504	0	0	0	0	0	0.14	0	0.2	0.2
RH	31	28	32	38	28	33	32	29	33

Table 5.2.2.6.4. Parameter comparisons and their effect on sensor and RH response. Diesel at 30°C. Sample concentrations of 5, 10 and 20 ppm Vs sparge flows of 50, 100 and 200 ml/min.

	30 °C Diesel								
Sample Conc.	5 ppm			10 ppm			20 ppm		
Sparge flow	50 ml/min	100 ml/min	200 ml/min	50 ml/min	100 ml/min	200 ml/min	50 ml/min	100 ml/min	200 ml/min
Sensor 501	0.04	0.14	0.12	0.04	0.3	0.62	0.4	1.45	0.68
Sensor 502	0.14	0.2	0.25	0.8	0.8	1.24	0.18	2.10	0.92
Sensor 503	0	0	0.1	0	0.14	0.44	0	0.9	0.55
Sensor 504	0	0.12	0.1	0	0.32	0.54	0	0.78	0.44
RH	34	47	46	33	39	42	32	44	48

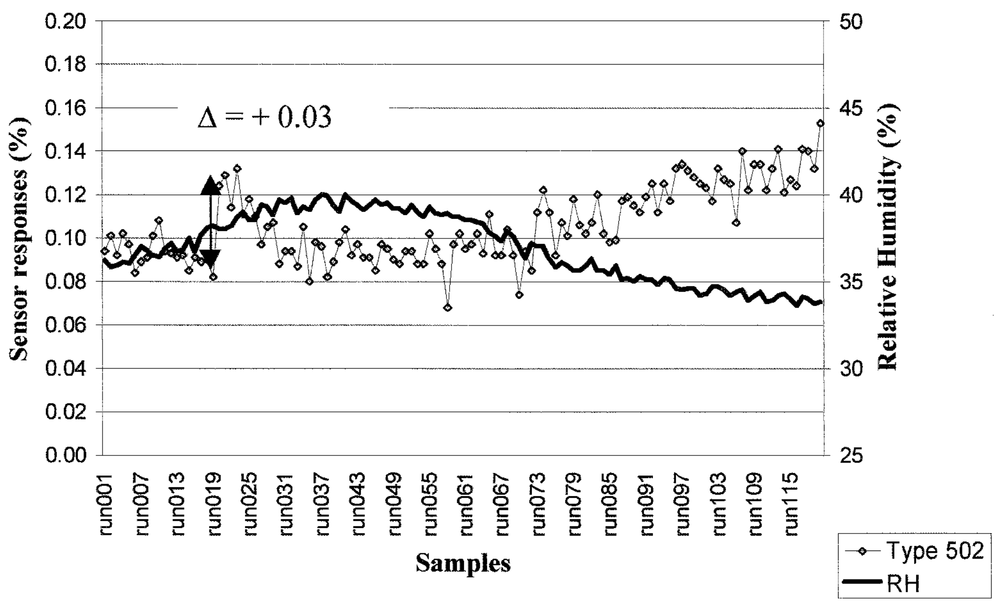

Figure 5.2.2.6.1 Sensor 502 between runs 1-120. 50 ml/min sparge flow rate. 10 ppm diesel spike between runs 20-37. Liquid samples at 15 °C.

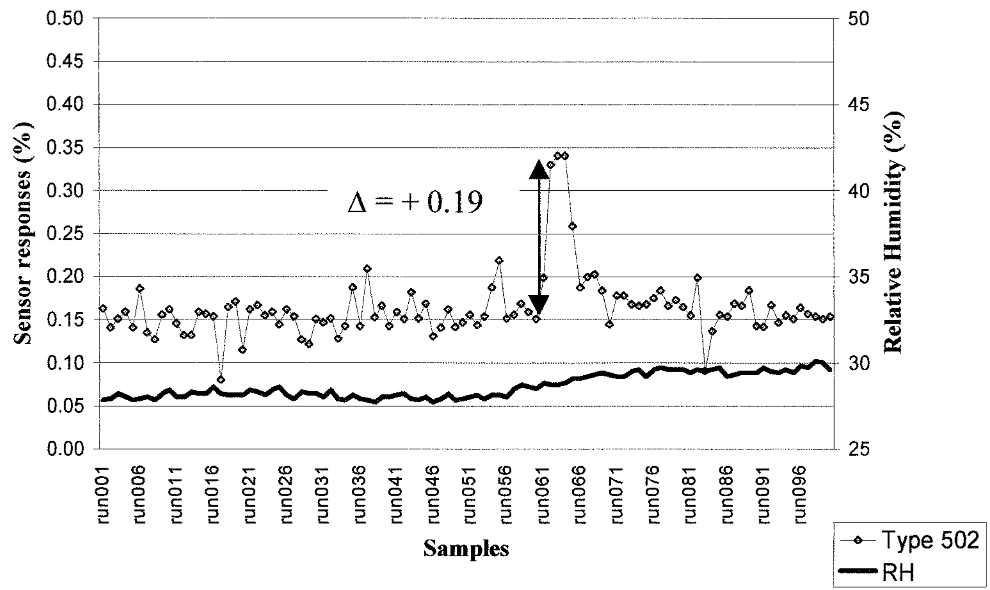

Figure 5.2.2.6.2 Sensor 502 between runs 1-100. 100 ml/min sparge flow rate. 10 ppm diesel spike between runs 61-78. Liquid samples at 15 °C.

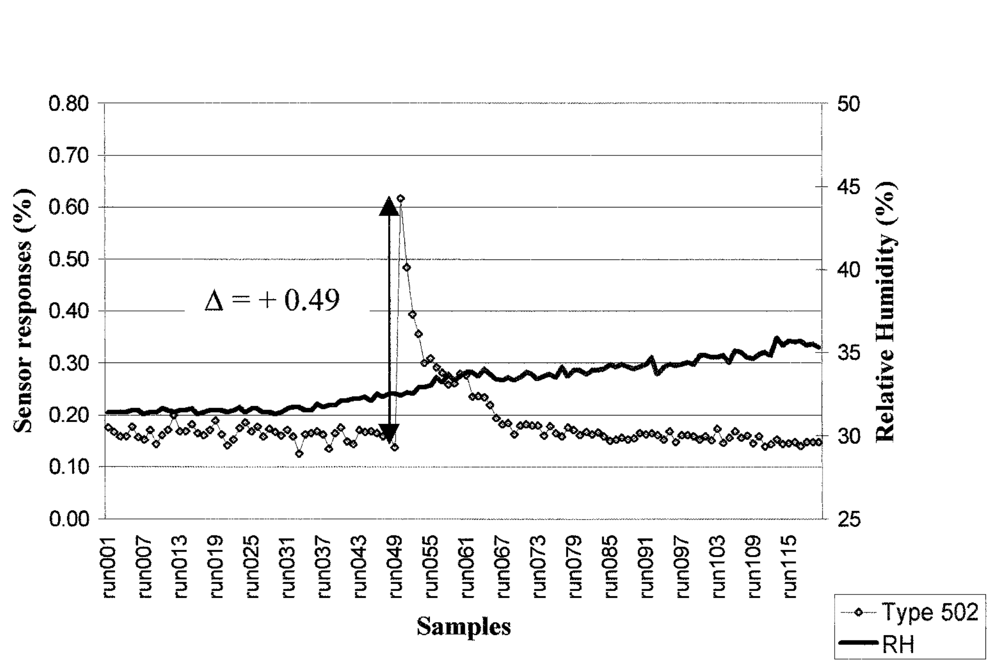

Figure 5.2.2.6.3 Sensor 502 between runs 1-120. 200 ml/min sparge flow rate. 10 ppm diesel spike between runs 50-64. Liquid samples at 15 °C.

Table 5.2.2.6.4 shows that nearly all the combinations at the higher temperature of 30°C provide sensor response values. As the sparge gas flow rate increases the resistance change increases, except for the 100 ml/min 20 ppm combination. In this case the 100 ml flow produces are larger response change than at 200 ml. As mentioned earlier this may be due to sample/sparge interactions or possibly an unobserved occurrence during sampling. The RH for the 30°C experiments was not constant but remained around the 40% value.

Experimental work showed that by elevating and stabilising sampling temperatures the promotion of low ppm levels of volatiles present from the liquid phase could be enhanced enabling the system to detect pollutants easier within the gas phase. In summary as the combinations of sample temperature, sparge gas flow rate and pollutant concentration increased a corresponding increase in sensor resistance change was observed for both compounds. Sensor 501 was key for detecting 2-chlorophenol and sensor 502 for diesel. The significance of observed effects for the variables and the interactions present are determined for RH, sensor 501 (for 2-chlorophenol) and 502 (for diesel) in section 5.4.2.

5.3. Field based assessment

5.3.1. Background river monitoring

A ProSAT system (Marconi Applied Technologies) was installed upon the River Trent at Severn Trent's abstraction monitoring station at Shardlow. The system was operated in accordance with the most suitable methodology determined under laboratory conditions. Data has been collected in real-time, once every fifteen minutes since December 2001.

After analysing background data from the River Trent monitoring station it was decided that there would be no temperature control added prior to sample analysis. Laboratory studies showed that sample temperatures played a significant role in promoting volatiles from solution into the headspace sample. River Trent data showed that temperature changes in the river were never sudden and at most only changed by one degree in 24 hours or two degrees in 48 hours (Figures 5.3.1.1 and 5.3.1.2). Since only small windows of data would be considered, in which fluctuations would be minimal, this would not be a problem. Although some headspace promotion would be lost due to not having the river sample at 30 °C this saved money and simplified the system. Sampling occurred once every 15 mins rather then every 5 in the lab. This was to preserve gas and lengthen the time the system could remain operational in the remote unmanned monitoring station whilst reducing operational costs.

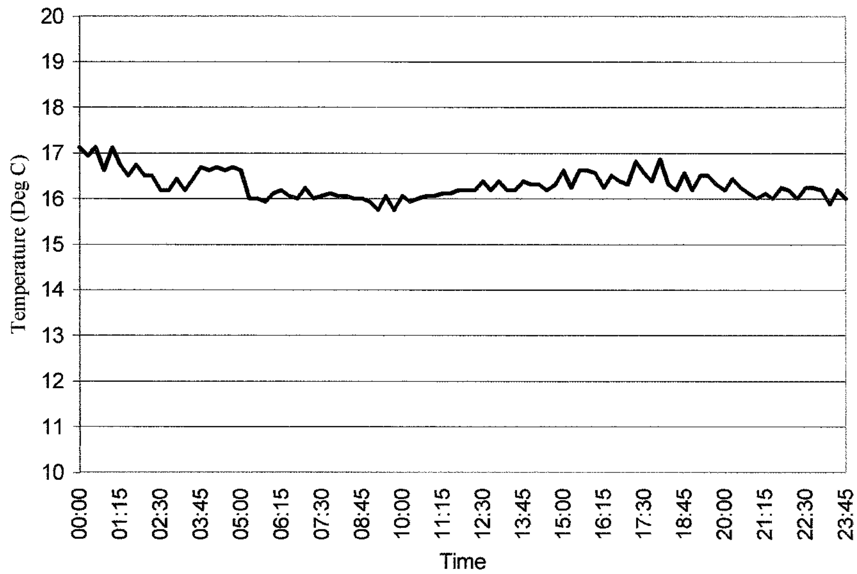

Figure 5.3.1.1 River Trent temperature profile over a 24 hour period (June 1st 2001)

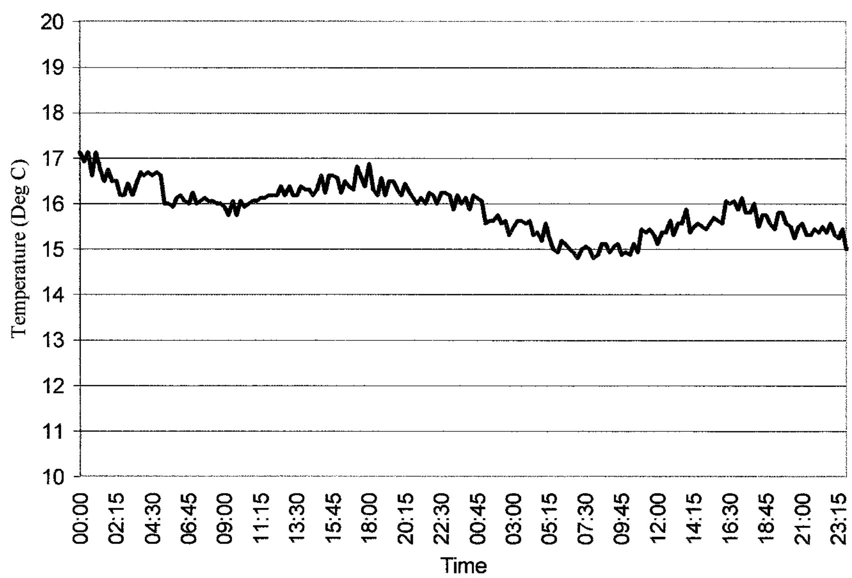

Figure 5.3.1.2 River Trent temperature profile over a 48 hour period (June 1st and 2nd 2001)

5.3.2. Field spiking

The sensor response profile in Figure 5.3.2.1 shows how the system reacted to an on-line spike at the abstraction station. There is an evident peak due to the introduction of the 20 ppm 2-chlorophenol pollution yet there is also a corresponding peak in both sample RH and sample temperature (interior temp). Simulating the event inadvertently disrupted the natural events that should be occurring. Had the pollution already been within the river sample it would arrive at a uniform temperature.

Sensor 1 closely follows the pattern obtained for the internal (river sample) temperature in the flow-cell. This plot indicates that over a 50-hour sampling window the river sample within the flow-cell fluctuates by ± 3°C.

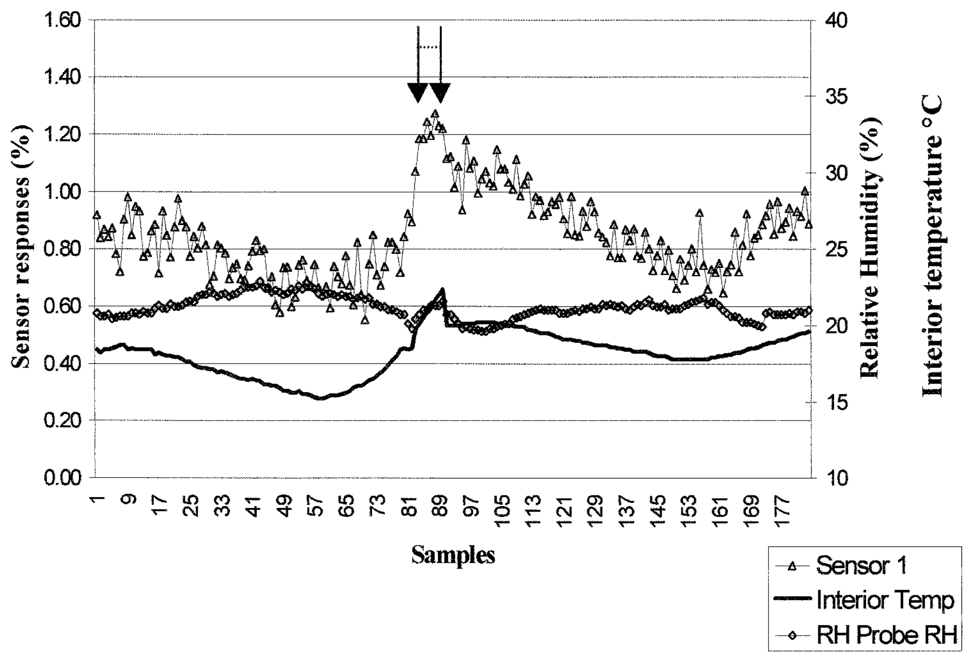

Figure 5.3.2.1 Sensor 1 (501) between 15.17 p.m. (15-5-02) and 13.09 p.m. (17-5-02). 20 ppm 2-chlorophenol spike introduced between runs 85-90.

5.3.3. On-line sampling modification

The jumps in interior temperature during spiking are due to the sample and river system not being at exactly the same temperature. To minimise and hopefully irradicate this effect the pollutant could be blended into the river water. A suggested means of doing this is presented in schematic Figure 5.3.3.1.

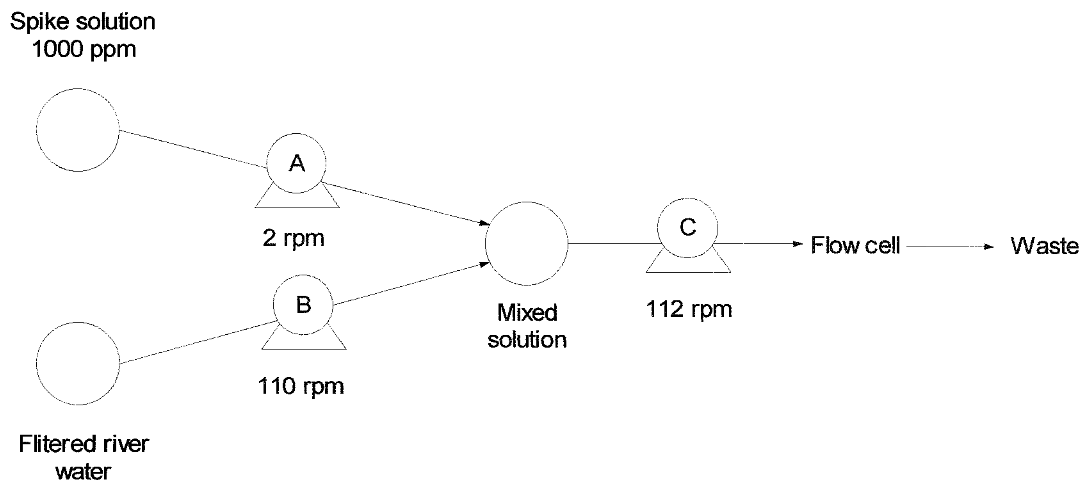

Figure 5.3.3.1 Schematic of proposed on-line sampling modification.

Taking information on the pump heads and tubing used for pollutant and river sample delivery it is possible to calculate the set up required to produce a constant delivery of a known concentration of pollutant within the mixed stream:

6.4 mm bore tubing / 1.6 mm wall thickness

OEM313 pump heads with this tubing provides a flow of 3.6 ml/rev @112 rpm therefore the flow is 403 ml/min.

Pump A set at 2 rpm
Pump B set at 110 rpm
Pump C set at 112 rpm (this pump is remotely controlled by ProSAT

A and B produce a combined mixed flow which is pumped into a vessel from which C draws the flow for the cell.

Pump A provides: 2 rpm x 3.6 ml/rev = 7.2 ml/min (therefore 432 ml/hr)
Pump B provides: 110rpm x 3.6 ml/rev = 396 ml/min (therefore 23760 ml/hr)

The combined flow drawn by pump C (at 112 rpm) is 403.2 ml/min (therefore 24192 ml/hr)

Therefore pump A supplies, 7.2/403.2 x 100 = 1.78 % of the flow.

If A supplies a 1000 ppm solution then 1.78/98.22 x 1000 ppm = 18 ppm in the mixed stream.

Only one successful spiking episode was achieved on-line before the system was decommissioned due to time constraints. No pollution incidents were reported from the monitoring station during our trials except a slight earthy/musty odour from the smell bell apparatus (Dr Mike Purvis - Personal communication).

5.4. Data analysis

Data analysis techniques allow alternative approaches to presenting trends in the data. Principal component analysis and statistical analysis were applied.

5.4.1. Principal component analysis of 2-chlorophenol and diesel peaks

Principal component analysis (PCA) provides an alternative approach to presenting the graphical change in sensor responses. Figure 5.4.1.1 shows a 20 ppm 2-chlorophenol spike for sensor 501, indicating the presence of the pollution. By analysing the data with respect to its principal components, plots can be produced that separate the main body of data from the pollution (Figures 5.4.1.2 and 5.4.1.3).