# Chameleon Technical Data Sheet

Publication Number: 08-091911 Rev.13

## 1. Sensitivity Data

The sensitivity of the Chameleon sensors was determined by exposing individual cassettes to a challenge agent for varying amounts of time. Observers were asked to view the cassettes and provide feedback as to when a color change was visible. The sensitivity was derived from the minimum exposure time needed for all observers to acknowledge a color change.

Table 1: Chameleon Cassette Sensitivity to Challenge Agents

| Cassette | PEL[1] | | ½ IDLH[2] | | Multiple IDLH | |
|---|---|---|---|---|---|---|
| | Concentration | Response Time | Concentration | Response Time | Concentration | Response Time |
| Acid / low pH[3] | 5 ppm | 30 min | 25 ppm | 5 min | 89 ppm | 10 sec |
| Base / high pH[3] | 50 ppm | 3 min | 150 ppm | 1 min | 247 ppm | 10 sec |
| Chlorine/Fluorine | 1 ppm | 25 min | 5 ppm | 4 min | 28 ppm | 12 sec |
| Cyanogen Chloride | 0.8 ppm | 10 min | 5 ppm | 2 min | 30 ppm | 10 sec |
| Diborane | 0.1 ppm | 10 min | 7.5 ppm | 1 min | 45 ppm | 10 sec |
| Hydrazine | 1 ppm | 30 min | 25 ppm | 5 min | 400 ppm | 55 sec |
| Hydrogen Sulfide | 20 ppm | 7 min | 50 ppm | 3 min | 610 ppm | 5 sec |
| Iodine | 0.1 ppm | 20 min | 1 ppm | 5 min | 5 ppm | 60 sec |
| Phosgene | 0.1 ppm | 30 min | 1 ppm | 5 min | 55 ppm | 4 sec |
| Phosphine | 0.3 ppm | 60 min | 25 ppm | 5 min | 150 ppm | 10 sec |
| Sulfur Dioxide | 5 ppm | 10 min | 50 ppm | 3 min | 109 ppm | 55 sec |

[1] PEL means Permissible Exposure Limit, as defined by OSHA: "8-hour Time Weighted Average." - An employee's exposure to any substance, which shall not exceed the 8-hour Time Weighted Average given for that substance, during any 8-hour work shift of a 40-hour workweek.

[2] IDLH means Immediately Dangerous to Life or Health: An atmospheric concentration of any toxic, corrosive or asphyxiate substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere. IDLH values are based on effects that might occur as a consequence of a 30-minute exposure.

[3] Reported sensitivity based on Chameleon Acid and Base cassette response to hydrogen chloride and ammonia vapor, respectively.

## 2. Stability Data

An accelerated aging study was conducted to determine the shelf life of Chameleon sensors. The purpose of this study was to accelerate the effects of long-term storage in order to predict the shelf life at various temperatures. Individually packaged sensors were stored in a 60 ºC oven and the performance was tested at regular intervals for response to a challenge agent. The results were correlated to results at 25 ºC using the Q10 rule[3]. All Chameleon cassettes passed performance testing after being aged for at least 65-days at 60 °C. Using the Q10-rule, this equates to a 2-year shelf life at 25 °C.

## 3. Service-Life Data

The following table summarizes the test conditions used to determine the service-life of each type of sensor. The sensors were stored under these conditions unpackaged. At the end of 24-hours, the samples were exposed to challenge agent and compared to unconditioned samples. The results indicate that the Chameleon sensors are fully functional for a minimum of 24-hours even under harsh environmental conditions.

Table 3: Service-life Test Parameters

| Service-Life Condition | Temperature | Relative Humidity |
|---|---|---|
| Desert | 50 °C | 20 % |
| Tropical | 50 °C | 95 % |
| Arctic | -30 °C | 60 % |
| Ambient | 23 °C | 50 % |

## 4. Interference Test Results

Cassettes were exposed for one hour to static concentrations of toluene, N,N-diethyl-*m*-toluamide (DEET), bleach, diesel, jet fuel (JP-8) and gasoline. Following exposure to the field interferent, the sensors were exposed to the challenge agent and compared to controls.

[4] Q10 Rule: An accelerated aging technique based on assumptions that the chemical reactions involved in the deterioration of materials follow the Arrhenius function; for every 10 ºC increase in temperature, the reaction rate (or rate of degradation) doubles.

Table 4: Field Interferent Study Observations

| Cassette | Field Interferent | | | | | |
|---|---|---|---|---|---|---|
| | **Toluene** | **DEET** | **Chlorine Bleach** | **Diesel Fuel** | **Gasoline** | **JP-8 Jet Fuel** |
| Acid / Low pH | n/e | - interference | false + | n/e | n/e | n/e |
| Base / High pH | n/e | n/e | n/e | n/e | n/e | n/e |
| Chlorine/Fluorine | n/e | n/e | n/e | n/e | n/e | n/e |
| Cyanogen Chloride | n/e | n/e | n/e | n/e | n/e | n/e |
| Diborane | n/e | n/e | n/e | n/e | n/e | n/e |
| Hydrazine | n/e | n/e | n/e | n/e | n/e | n/e |
| Hydrogen Sulfide | n/e | n/e | n/e | n/e | n/e | n/e |
| Iodine | n/e | n/e | n/e | n/e | n/e | n/e |
| Phosgene | n/e | n/e | n/e | n/e | n/e | n/e |
| Phosphine | n/e | n/e | n/e | n/e | n/e | n/e |
| Sulfur Dioxide | n/e | n/e | n/e | n/e | n/e | n/e |

n/e– no effect, no interference
- interference – resulted in a 1-minute delay in sensor response
false + - visible color change in viewing window to light blue (bleaching)

## 5. Chameleon Water Immersion Testing

One hundred samples of each Chameleon sensor were immersed in salt water for a minimum of one hour. Following immersion, the cassettes were evaluated for any detrimental effects. The samples were then exposed to challenge agent and compared to control samples. The performance of all the Chameleon sensors was satisfactory and no effects from water immersion were observed.

*As part of our ongoing commitment to continuous improvement, we routinely perform tests on Chameleon sensors to ensure that they operate under conditions that might be encountered in the field. After Hurricanes Rita and Katrina made landfall, for example, Morphix conducted testing to verify that Chameleon sensors would still detect agent in areas that were flooded and contaminated with oil, fuel and chemicals from plants that were severely damaged. Performance data for those sensors subjected to these tests are provided in sections 6 and 7 of this technical data sheet.*

## 6. Chameleon Oil/Fuel on Water Immersion Testing

Oil/Fuel mixture: Equal parts of commercial 10W-30 motor oil, gasoline, and diesel fuel were mixed and dispersed in salt water to form an oil/fuel on water system.

Procedure: Chameleon sensor cassettes in Chameleon armbands were immersed in the oil/fuel on water system at 10-minute intervals over a period of one hour (7 immersions total). Each immersion event consisted of three 10-second immersions through the film on water system followed by a resting period in air. The oil/fuel film on water was replenished following each immersion. The performance of the Chameleon when exposed to agent vapor challenge was evaluated relative to a control Chameleon system.

Cosmetic effects: No deleterious effects were noted on the performance of the cassette snap mechanism, the cassette and badge body labels, or the badge body materials.

Test conditions: Chameleon systems were challenged with ½ IDLH agent vapor concentrations at 70-80 %RH (22-23 $^{o}$C).

Table 5: Sensor Test Results – Oil/fuel on Water Immersion

| Cassette | Challenge agent (concentration) | Response Time |
|---|---|---|
| Acid / Low pH | Hydrogen Chloride (25 ppm) | 30 seconds |
| Base / High pH | Ammonia (150 ppm) | 3 minutes |
| Chlorine/Fluorine | Fluorine (12.5 ppm) | > 9 minutes |
| Hydrogen Sulfide | Hydrogen sulfide (50 ppm) | 3 minutes |
| Phosgene | Phosgene (1 ppm) | 3 minutes |

## 7. Chameleon Liquid Challenge Results

The following Chameleon sensors were challenged with solutions using two methods:

1. The cassettes were immersed in 100 ml of each solution.
2. A drop of solution was applied to the back of the cassette.

The visible response time was the same for each method and the response time can be found in Table 6.

Table 6: Sensor Liquid Challenge Results

| Cassette | Solution Concentration (w/v) | Response Time (min) |
|---|---|---|
| Acid / Low pH | 7.4 % | 3 |
| Base / High pH | 0.004 % | 1 |
| Chlorine/Fluorine | 0.005 % | 3-4 |
| Hydrogen Sulfide | 0.4 % | 4-5 |
| Hydrazine | 0.25 % | 4-5 |
| Iodine | 0.002 % | 4 |

Solution preparation for liquid challenges:

1. Acid/low pH sensor
   A 100 ml solution was prepared by diluting 20 ml of a 37 % stock solution of hydrochloric acid (HCl) with de-ionized water.

2. Base/high pH sensor
   A 39 ppm solution of ammonium hydroxide in de-ionized water was prepared by adding 15µl of 29 % stock solution to 100 ml de-ionized water.

3. Chlorine/Fluorine
   0.0049 g of trichloro-s-triazinetrione (pool tablets, 90 % available chlorine) was dissolved in 100 ml of de-ionized water to prepare a 0.005 % solution.

4. Hydrazine
   A 0.25% hydrazine solution was prepared by diluting 0.6 ml of hydrazine in a 250 ml volumetric flask of de-ionized water.

5. Hydrogen Sulfide
   Hydrogen sulfide gas (6,086 ppm) was bubbled into 100 ml of de-ionized for approximately 3 hours, resulting in a final solution concentration of 4,100 ppm (assuming saturation, solubility = 0.41 g in 100 ml water).

6. Iodine
   An iodine solution was prepared by dissolving 0.0020 g of iodine crystals in 100 ml of de-ionized water.