

Technical Note 02

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Uniphos gas detector tube and pump accuracy

Introduction

Since Uniphos gas detector tubes were first produced in 1993, several companies and agencies have evaluated the tubes and pumps for accuracy. This Technical Note summarizes some of the key test results. The high accuracy demonstrated in such tests combined with moderate costs has led to widespread use of Uniphos tubes throughout Southeast Asia, and has recently expanded to Australia, Europe, South America, and North America. Technical Note 01 gives a complete list of tube users.

Uniphos Quality Control

Uniphos uses strict Quality Control Procedures to ensure accurate calibration of the tubes. Each batch is individually calibrated and silkscreened. Gas and vapor standards are prepared by a variety of methods including dilution of pure (100%) gas or liquid, dilution of certified standards purchased from an independent supplier, diffusion tubes, and electrochemical methods. Calibration concentrations for each batch are verified in Uniphos' Quality Assurance analytical laboratory using gas chromatography or wet chemical methods. In this way, standard concentrations are established for each batch by four different methods: 1) calculation from the known amount of dilution, 2) measurement in the QA lab, 3) measurement using a competitor's tubes, and 4) measurement with earlier batches of Uniphos tubes kept in cold storage. All tubes are calibrated at a gas humidity of 50% RH in a temperature-controlled room at 20°C (68°F).

Uniphos Tube Accuracy

All Uniphos tubes have an accuracy of $\pm 10\%$ at the time of calibration. End users may find a wider variation because of differences in temperature, humidity, presence of interferences, sampling errors, user sampling time, and user storage conditions. In any case, all tubes meet the $\pm 25\%$ accuracy level accepted for gas detection tubes. Note that accuracy is reduced when using correction factors for extended ranges and cross-sensitive gases, etc.

Batch Uniformity

In order to ensure uniformity within a given batch, tube inner diameter must be strictly controlled. Uniphos uses only tubes that are within 0.05 mm (50 μm) of each other to make sure that all tubes in a batch have the same stain length.

ISO 9001 Certification

Uniphos maintains ISO 9001 certification.

Bureau of Indian Standards

The Bureau of Indian Standards (BIS) tested the H₂S 1-30 ppm SHS-2 tubes using Indian Standard No. 13293-1992 and granted a one-year license to use the BIS certification marks [Ref. 1].

Petrohawk Energy Corporation Gas Pipeline Tests

Several field tests were done measuring H₂S in natural gas pipelines [Ref. 2]. Petrohawk compared Uniphos H₂S tubes with other manufacturer's tubes and an Envent paper tape system. All measurements were done using the standard number of pump strokes called for by the manufacturer, unless otherwise noted. Table 1 compares the Uniphos 5-100 ppm tube with the RAE 25-250 ppm tube on the well head samples. All readings are in agreement within <8%. Table 2 shows similar agreement (within 11%) for the RAE and Uniphos 2.5-60 ppm tubes.

Table 1. Petrohawk Well Head Samples High Range

| Tube | RAE 10-103-18 | Uniphos SHS-3 |
|---------------------------------|---------------|---------------|
| Range | 25-250 ppm | 5-100 ppm |
| <i>UltraFab Sweetener Units</i> | | |
| C 30-1 | 75 | 73 |
| <i>Sulfatreat Towers</i> | | |
| BPM | 210 | 204* |
| W 32-1 | 95 | 88 |

* Measured using 1/2 pump stroke and doubling the reading

Table 2. Petrohawk Well Head Samples Mid Range

| Tube | RAE 10-103-10 | Uniphos SHS-3L | Uniphos SHS-3 |
|---------------------------------|------------------|-------------------|------------------|
| Range | 2.5-60 ppm | 2.5-60 ppm | 5-100 ppm |
| <i>UltraFab Sweetener Units</i> | | | |
| LAM 28-1 | 118* | 106* | |
| RGF 36-1 | 110* | 114* | 110 |
| A 12-1 | 45 | 42 | |
| BM 23-1 | 64* | 66* | 60 |
| CPST 28-1 | 96* | 104* | 96 |

* Measured using ½ pump stroke and doubling the reading

Table 3. Petrohawk Meter Run Samples Mid Range

| Tube or Tape | RAE 10-103-10 | Uniphos SHS-3L | Event Paper Tape |
|--------------------------|------------------|-------------------|---------------------|
| Range | 2.5-60 ppm | 2.5-60 ppm | |
| <i>UltraFab Units</i> | | | |
| W 12-1 | 6 | 5 | 5.92 |
| LAM 28-1 | 5 | 5 | 4.73 |
| A 12-1 | 30 | 30 | |
| BM 23-1 | 50 | 47 | |
| <i>Sulfatreat Towers</i> | | | |
| BPM | 40 | 38 | |
| W 32-1 | 0 | 0 | |

Table 4. Petrohawk Meter Run Samples Low Range

| Tube or Tape | RAE 10-103-06 | Uniphos SHS-1 | Event Paper Tape |
|-----------------------|------------------|------------------|---------------------|
| Range | 1-7 ppm | 0.5-10 ppm | |
| <i>UltraFab Units</i> | | | |
| C 30-1 | 2 | 1 | 0.88 |
| W 12-1 | 8+ | 5.5 | 5.92 |
| LAM 28-1 | 8+ | 4.5 | 4.73 |
| RGF 36-1 | 8+ | 4 | 4.34 |
| CPST 28-1 | 6.5 | 4.5 | 4.52 |
| W 30-1 | 8+ | 5 | 4.73 |

Table 3 compares the RAE and Uniphos 2.5-60 ppm tubes on the meter run samples. Again, all readings are in close agreement with each other and the Event paper tape system. Table 4 shows that the Uniphos 0.5-10 ppm H₂S tube agrees well with the Event paper tape system, while the RAE 1-7 ppm tube tends to read high in these meter run samples.

Central Mining Research Institute

This institute (CMR) certified Uniphos tubes using BIS 13293-1992 standard procedures for two tubes in different years [Refs. 3 & 4]. The results are summarized in Tables 5 and 6 below.

Table 5. CMR Tube Evaluations.

| Tube | Data Points | Avg. Deviation | Ref. |
|----------------------------------|----------------|-------------------|------|
| SHS-3 5-100 ppm H ₂ S | 6 | 12% | [3] |
| SCO-3 5-100 ppm CO | 10 | 14% | [4] |

Table 6. CMR Pump Evaluations

| Pump | Avg. Volume | Avg. Deviation | Ref. |
|--------|-------------|----------------|------|
| ASP-21 | 98.2 cc | 1.8% | [3] |
| ASP-21 | 100.0 cc | 0.1% | [4] |

Central Science Laboratory

The Central Science Laboratory (CSL), a British company, visited Uniphos in 2006 and conducted a phosphine sensor comparison study on-site [Ref. 5]. The study included a comparison of detector tubes from Uniphos, Gastec, Kitagawa, MSA, and Dräger (see Table 7.). The authors concluded that the color contrast of the Uniphos tubes was better than that of the Gastec, Kitagawa, and MSA tubes. The accuracy was also better than that of the competitors' tubes except for one case where the high-range SPH-5 tube was used to measure at the low end of its range. With this exception, all the Uniphos tubes were accurate within 10% or less.

Table 7. CSL Phosphine Tube Accuracy Tests.

| Test Concentration | Detector Tube | Range | No. Data Points | Average Deviation |
|--------------------|----------------|----------------|-----------------|-------------------|
| 1 ppm | Uniphos SPH-1L | 0.05 – 2.5 ppm | 2 | 10% |
| | Dräger 0.01/a | 0.1 – 3 ppm | 1 | 15% |
| 10 ppm & 52 ppm | Uniphos SPH-3 | 5 – 100 ppm | 2 | 7% |
| 380 ppm | Uniphos SPH-4 | 50 – 1000 ppm | 5 | 2% |
| | Uniphos SPH-5 | 150 – 3000 ppm | 6 | 18% |
| | Gastec 7J | 25 – 500 ppm | 1 | 13% |
| | Kitagawa | 20 – 700 ppm | 1 | 8% |
| | MSA | 50 – 2000 ppm | 1 | 8% |
| 950 ppm | Uniphos SPH-4 | 50 – 1000 ppm | 4 | 2% |
| | Uniphos SPH-5 | 150 – 3000 ppm | 6 | 6% |
| | Gastec 7J | 25 – 500 ppm | 1 | 5% |
| | MSA | 50 – 2000 ppm | 1 | 11% |
| 2600 ppm | Uniphos SPH-5 | 150 – 3000 ppm | 9 | 5% |

Table 8. NCL Phosphine Tube Accuracy Tests.

| Approximate Tube Range* | Test Conc. | Uniphos | | Kitagawa | | Dräger | |
|--------------------------|------------|----------|------------|----------|-------------|----------|-------------|
| | | Reading | Deviation | Reading | Deviation | Reading | Deviation |
| 0.05 – 2.5 ppm | 0.85 ppm | 0.85 ppm | 0% | 0.95 ppm | +12% | | |
| | | 0.95 ppm | +12% | 0.6 ppm | -29% | | |
| | 0.97 ppm | 0.8 ppm | -18% | 0.7 ppm | -28% | | |
| 5 – 100 ppm | 1.23 ppm | 1.2 ppm | -2% | 0.95 ppm | -23% | | |
| | 53.4 ppm | 50 ppm | -6% | 40 ppm | -25% | | |
| | | 72.0 ppm | 78 ppm | +8% | 50 ppm | -31% | 55 ppm |
| 50 – 1000 ppm | 74 ppm | 74 ppm | +3% | 50 ppm | -31% | 40 ppm | -45% |
| | | 377 ppm | 350 ppm | -7% | 300 ppm | -20% | |
| | 491 ppm | 590 ppm | +20% | 450 ppm | -8% | 200 ppm | -59% |
| 150 – 3000 ppm | 526 ppm | 520 ppm | +6% | 450 ppm | -8% | 200 ppm | -59% |
| | | 526 ppm | 500 ppm | -5% | 450 ppm | -14% | |
| | 1270 ppm | 1360 ppm | +7% | 1100 ppm | -13% | 1250 ppm | -2% |
| | | 1285 ppm | 1500 ppm | +17% | 1200 ppm | -7% | 750 ppm |
| 1460 ppm | 1400 ppm | +9% | 1020 ppm | -21% | | | |
| | 1560 ppm | 1500 ppm | +3% | 1000 ppm | -32% | 950 ppm | -35% |
| Average Deviation | | | ±8% | | ±20% | | ±38% |

* Different manufacturers do not provide identical tube ranges. Tubes were selected to match this concentration range as closely as possible.

National Chemical Laboratory

The Indian National Chemical Laboratory (NCL) evaluated various phosphine monitoring systems including Uniphos tubes and compared them to Kitagawa and Dräger tubes [Ref. 6]. Detailed accuracy results are given in Table 8. Uniphos had the lowest average deviation of $\pm 8\%$, compared to Kitagawa at $\pm 20\%$ and Dräger at $\pm 38\%$. The overall evaluation in Table 9 is a summary of tube accuracy, color contrast, boundary sharpness, and stain stability.

Table 9. NCL Phosphine Tube Evaluation Summary

| Uniphos | Kitagawa | Dräger |
|------------------|------------|--------------|
| SPH-1L Very good | 121U Good | ARCH-33 Good |
| SPH-2 Very good | 121SC Good | ARHA-11 Good |
| SPH-3 Excellent | | |
| SPH-4 Excellent | | |

Ion Science Tests at SPL Laboratory

At Ion Science USA we have done comparison tests from time to time on various Uniphos and competitor tubes. An example is given in Table 10, using a natural gas sample before treatment containing 600 ppm H₂S by gas chromatography (GC). The Uniphos and Gastec tubes read very close the GC result, while the RAE tube was lower by 17% (albeit still within range expected for tube measurements).

Table 10. H₂S Measurement on Field Sample

| Tube | GC | Uniphos SHS-4 | Gastec 4H | RAE 103-20 |
|---------------|-----|---------------|-----------|------------|
| Range | | 50-800 | 100-2000 | 50-800 |
| Reading (ppm) | 600 | 600 | 610 | 500 |

References

- [1] Bureau of Indian Standards, **2001**. Grant of Certification Marks License, No. CM/L-7337878 for H₂S Gas Detector Tubes with Aspirating Pump, 2001-2002.
- [2] Ryan Langlinais, Petrohawk Energy Corp. **2011**, personal communication.
- [3] Central Mining Research Institute, India, **1997**. Test Certificate for ASP-21 Sampling Pump and H₂S SHS-3 Gas Detector Tubes.
- [4] Central Mining Research Institute, India, **2002**. Test Certificate for ASP-21 Sampling Pump and H₂S SCO-3 Gas Detector Tubes.
- [5] Central Science Laboratory, UK, Study Report P3NA1030, **2006**. Evaluation of the Methods Used to Calibrate United Phosphorus Phosphine monitors and Detector Tubes.
- [6] National Chemical Laboratory, Pune, India, **1996**. Evaluation Report on the Phosphine Gas Monitoring Systems Developed by M/S United Phosphorus Ltd. Vapi.

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