

# Application News

## No. AD-0083

### AA-7000, GFA-7000 and ASC-7000

## Analysis of Phosphorus in Waste Water and Food Using Electrothermal Atomic Absorption Spectrophotometry (ETAAS)

### □ Introduction

Phosphorus plays an important role to ensure proper functioning of the human body. However, high levels of Phosphorus in bodies of water can lead to impairment of drinking water. This results in harmful algae blooms, which reduces spawning grounds and nursery habitats, kills fish, and forms oxygen-starved hypoxic or "dead" zones [1]. The quantitative analysis of Phosphorus can be carried out using ETAAS method [2]. This application news demonstrates the analysis of Phosphorus in food and waste water Certified Reference Materials (CRM) using Shimadzu AA-7000 AAS with GFA-7000 graphite furnace controller and the ASC-7000 autosampler.

### □ Experimental

The 10,000 ppm Phosphorus standard solution and Lanthanum Nitrate Hexahydrate were from Merck, Germany. Type E-1 [3] ultra pure water with resistivity of 18MΩ was used. The Phosphorus hollow cathode lamp was purchased from Heraeus Noblelight, Germany. The AAS analysis conditions were shown in Tables 1 to 3.

Table 1: AAS conditions

|                       |           |
|-----------------------|-----------|
| Wavelength            | 213.6 nm  |
| Lamp current          | 10 mA     |
| Slit width            | 0.7 nm    |
| Background correction | Deuterium |
| Matrix modifier       | 0.1% La   |

Table 2: ETAAS heating programme

| Step | Temperature (°C) | Time (s) | Heat Mode | Sensitivity | Ar Flow (L/min) |
|------|------------------|----------|-----------|-------------|-----------------|
| 1    | 60               | 10       | Ramp      | Regular     | 0.1             |
| 2    | 120              | 30       | Ramp      | Regular     | 0.1             |
| 3    | 250              | 10       | Ramp      | Regular     | 0.1             |
| 4    | 1200             | 10       | Ramp      | Regular     | 1.0             |
| 5    | 1200             | 10       | Step      | Regular     | 1.0             |
| 6    | 1200             | 3        | Step      | High        | 0.0             |
| 7    | 2800             | 3        | Step      | High        | 0.0             |
| 8    | 2800             | 2        | Step      | Regular     | 1.0             |

Pyrocoated graphite tube  
 Sampling at step 7

Table 3: Preparation of standards by autosampler

| Standard | Diluent | 0.1% La | 4 ppm Phosphorus | Total Volume |
|----------|---------|---------|------------------|--------------|
| 0.0 ppm  | 20 µl   | 5 µl    | 0 µl             | 25 µl        |
| 1.0 ppm  | 15 µl   | 5 µl    | 5 µl             | 25 µl        |
| 2.0 ppm  | 10 µl   | 5 µl    | 10 µl            | 25 µl        |
| 3.0 ppm  | 5 µl    | 5 µl    | 15 µl            | 25 µl        |
| 4.0 ppm  | 0 µl    | 5 µl    | 20 µl            | 5 µl         |

The samples used in this analysis were:

- Certified Reference Material (CRM) – "Trace Metals in Fish" from High Purity Standards, USA. It contains 100 ppm Phosphorus and was diluted 50 times prior to analysis.
- CRM Waste Water catalogue no 739 "Simple Nutrients" from ERA, USA. It contained 4.24 ppm Phosphorus.
- CRM Waste Water catalogue no 741 "Complex Nutrients" from ERA, USA which contained 5.73 ppm Phosphorus.

Both "Simple Nutrients" and "Complex Nutrients" samples were diluted 2 times using the autosampler as shown in Table 4 below.

Table 4: Preparation of samples by autosampler

| Sample | Diluent | 0.1% La | Total Volume |
|--------|---------|---------|--------------|
| 10 µl  | 10 µl   | 5 µl    | 25 µl        |

## Results and Discussion

The Phosphorus calibration curve and ETAAS peak profiles were shown in Figure 1 and Figure 2 respectively. Figure 3 showed the ETAAS peak profiles of samples. The accuracy of the analysis was satisfactory as shown in Table 5. Both the 1% absorption and instrument detection limit (a concentration that gives absorbance equal to 3 times the standard deviation of blank [4]) was 0.1 ppm.

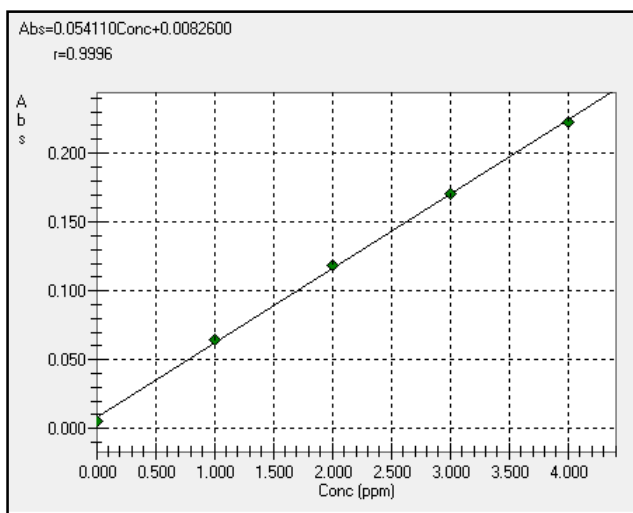


Figure 1: Phosphorus calibration curve

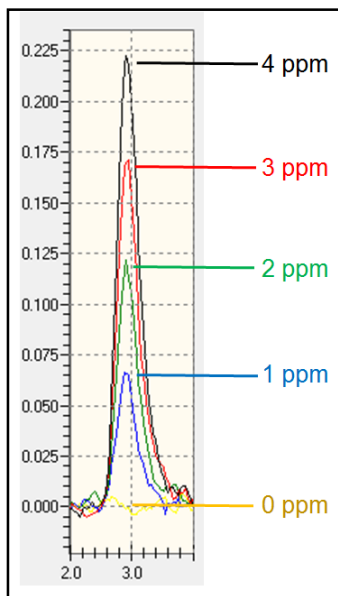


Figure 2: ETAAS peak profiles for standards

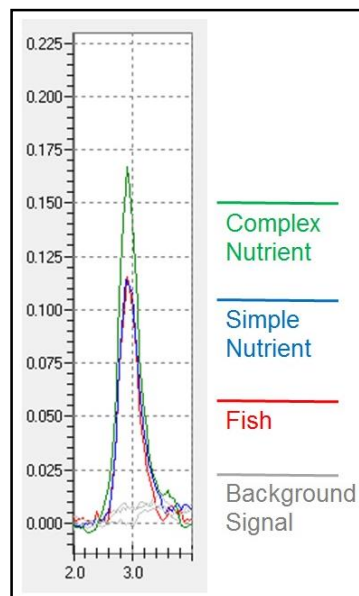


Figure 3: ETAAS peak profiles for CRM samples

Table 5: Phosphorus results for CRM samples

| Sample               | Certified Concentration | Measured Concentration | Percentage Accuracy |
|----------------------|-------------------------|------------------------|---------------------|
| Trace Metals in Fish | 100.00 ppm              | 98.17 ppm              | 98.2%               |
| Simple Nutrient      | 4.24 ppm                | 4.00 ppm               | 94.3%               |
| Complex Nutrient     | 5.73 ppm                | 6.03 ppm               | 100.5%              |

## Conclusions

The quantitative analysis of food and waste water samples was carried out accurately using AA-7000 with GFA-7000 and ASC-7000.

## References

1. On-line Wastewater Nutrient Monitoring (2009) USEPA No EPA/600/S-09/028.
2. BS ISO 10540-2:2003. Animal and vegetable fats and oils. Determination of phosphorus content. Method using GFAAS.
3. ASTM D5127 (1999). Standard Guide for Ultra Pure Water Used In The Electronics and Semiconductor Industry.
4. Shimadzu AAS Cookbook No 3.