New technique makes soil testing faster and safer

Gone are the days when a farmer applied the same fertilizer in the same concentration to the same field every year. Agricultural scientists have since characterized most crops and found the perfect soil conditions for a healthy yield. Because plant needs are known, it is crucial to determine the soil conditions before adding fertilizer.

To optimize crop yields and fertilizer use, it is important to perform quantitative soil and plant tissue tests before, during, and after the growing season. By monitoring certain components, a farmer can interpret fertilizer needs for the fields.

Farmers and co-ops have long depended on testing laboratories for this information. These older laboratories relied heavily on wet chemical testing methods for determining nitrogen, carbon, sulfur, and various other elements. Today, LECO Corporation offers laboratories a technology to conduct faster, safer, and cheaper analyses. We've developed a device that uses a combustion system without the hazards associated with earlier models.

In the past, the classical method for nitrogen determination was the Kjeldahl method, developed more than 100 years ago. The Kjeldahl method takes from one to several hours to complete and can be summarized in three steps:

1. Acid digestion with a heavy metal catalyst

2. Caustic dilution

3. Titration

This method can be hazardous. Each analysis poses a potential health risk to the operator exposed to its toxic fumes, acid, or caustic solutions.

For this method, laboratories must safely vent fumes into the environment and pay for proper disposal of spent chemicals. The costs have been accepted because no viable alternative existed.

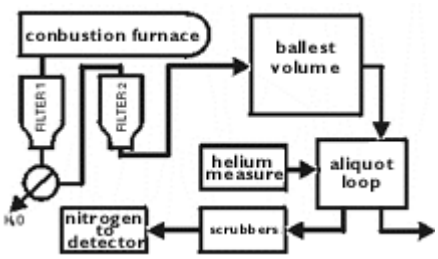
Later, a combustion system was developed for soil testing. This principle is still used today, but it has been improved by LECO.

For the combustion method, a sample is combusted in an oxygen atmosphere and the nitrogen in the sample is isolated and detected. The positive aspects of this method include faster analysis and elimination of hazardous chemicals. The samples can be analyzed in five minutes with no need for acids, caustics, or heavy metal catalysts.

The negative aspect of this method was the limitation of sample size. Its typical sample was 1-2 mg. Considering the heterogeneity of soils and plant tissue, the precision of results is far outside acceptable tolerances.

Larger sample sizes tested in these analyzers caused problems such as incomplete combustion, high ash buildup, high pressure causing system leaks and the inability to scrub by-product gases effectively. Because this method could not analyze larger samples, the slower Kjeldahl method was preferred. In the last 10 years, LECO has taken the combustion method to new levels for the agricultural community. The company improved its system and laboratories are embracing the method 100%.

With a focus on expanding the method, LECO first designed an instrument that could test 1 g of sample routinely. The product line grew to include a determinator to handle up to 4 g. Analyzing these larger samples, comparable to the Kjeldahl method, eliminates precision problems due to heterogeneity.



To use LECO's combustion analyzer, 1-4 g of sample is placed in a reusable ceramic boat on a 49-position autoloader. The boat automatically moves into a furnace where it combusts in a pure oxygen atmosphere. moisture is removed from the combustion gases via a thermo-electric cooler before being routed into a ballast. The gases are given time to equilibrate before an aliquot is taken. Interfering gases are removed and nitrogen is detected by thermal conductivity. The analysis takes five minutes.

Two parts of the analytical hardware display innovative development: the combustion schematic design and the use of a ballast system. One of the most important aspects of the combustion schematic is employing a horizontal furnace. The combustion tube is mounted horizontally and made concentric.

This allows combustion gases to flow to one end of the combustion tube and back through the outer sleeve of the tube. The effective hot zone is doubled, which helps guarantee complete oxidation of the combustion gases.

Another benefit of the furnace design is the use of pure oxygen as the carrier gas. Using pure oxygen ensures that the entire sample is combusted and that no nitrogen remains in the ash. Older systems rely on oxygen dosing and hazardous oxide materials that are unsatisfactory for larger sample weights.

Another feature in the combustion schematic is a lance to help transport oxygen to the sample as fast as possible. Three grams of solid material combusts rapidly. To ensure that the sample does not starve itself of oxygen, a lance was added. Oxygen may be introduced on top of the sample instead of relying only on flow from the front of the combustion tube. This feature has optimized the combustion process. A sample that burns rapidly can be analyzed immediately before or after a sample that burns slowly.

The second innovation is the ballast. The ballast volume expands to collect combustion gases during analysis. This eliminates any high pressure chemistry from occurring and allows all gases to form a homogeneous mixture.

When a sample combusts, not all the nitrogen is released immediately. Some nitrogen burns off quickly while the rest may evolve out slowly. Without a ballast, gases would continuously pass through the detector, which could lead to multiple and broad peaks. This could cause problems during the separation and detection.

By collecting gases in the ballast for a specified length of time, gases are allowed to form a homogeneous mixture. After that, a 10 cc aliquot sample is taken from the ballast, scrubbed of impurities, and detected for total nitrogen.

There are two major benefits of taking an aliquot instead of analyzing the entire ballast. One is that 10 cc of gas are scrubbed of impurities instead of several liters. The other is that 10 cc of gas are passed through the detector for a faster response.

This latest technology for total nitrogen is faster and safer than previous methods. Results are automatically calculated and electronically stored using a built-in microprocessor.

The combustion-based method has eliminated the Kjeldahl method from hundreds of laboratories. It has also gained accreditation from several associations including the Association of Official Analytical Chemists, American Oil Chemists' Society, and American Association of Cereal Chemists.

LECO's FP-Series Nitrogen/Protein Determinators employ the combustion method. We have the right instrument to suit your analytical needs as well as your budget.