

# Application of Kjeltex Method to Determine Hydrolytic Nitrogen in Soil in Land Engineering

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## Abstract

In this paper, based on the principle of alkaline hydrolysis and distillation, a Kjeltex nitrogen analyzer is established to determine soil hydrolytic nitrogen. Through experiments, the accuracy and precision of the method were verified by using soil reference materials. The results show that the accuracy and precision of the method meet the relevant requirements. This method replaces the traditional alkaline hydrolysis diffusion measurement method, shortens the hydrolysis time from the traditional method of 24 h to about 5 min, and is easy to operate, greatly improving work efficiency, and meeting the needs of rapid detection and analysis of large quantities of soil samples.

## Keywords

Soil; Hydrolytic nitrogen; Kjeltex nitrogen analyzer; Alkali-hydrolyzed distilling method.

## 1. Introduction

Soil hydrolytic nitrogen includes inorganic nitrogen (ammonium nitrogen, nitrate nitrogen) and a part of easily hydrolyzed organic nitrogen (amino acid, amide, protein nitrogen, etc.). Soil hydrolytic nitrogen is an important component of soil nitrogen. Compared with total soil nitrogen, it can better reflect the supply level of soil nitrogen in the near future. Knowing the content of soil hydrolytic nitrogen can provide a basis for the rational application of nitrogen fertilizer [1]. Therefore, soil hydrolytic nitrogen is a must-test item in routine soil tests, which is of great significance for studying soil fertility and implementing soil testing and fertilization. The determination methods of soil hydrolytic nitrogen mainly include biological culture method, acid hydrolysis method, alkaline hydrolysis diffusion method and alkaline hydrolysis distillation method, etc. [2]. At present, the only standard method for determination of soil hydrolytic nitrogen in China is the alkali used in forestry industry standards. De-diffusion method [3]. This method has the following disadvantages: time-consuming, cumbersome operation, low work efficiency.

Contamination is prone to occur, and the results have poor repeatability and reproducibility. The alkaline hydrolysis distillation method can effectively avoid these problems, and can improve the accuracy and speed of detection [4-8]. In order to improve work efficiency on the basis of ensuring the accuracy and stability of data, based on the principle of alkaline hydrolysis

and distillation, the author studied and established a Kjeltex nitrogen analyzer to determine soil hydrolytic nitrogen to meet the rapid detection and analysis of large quantities of soil samples.

## 2. Materials and Methods

### 2.1. Principle

Put the soil in the digestive tube, hydrolyze and reduce it with sodium hydroxide solution and ferrous sulfate reducing agent, so that the easily hydrolytic nitrogen and nitrate nitrogen in the soil are converted into ammonium nitrogen under alkaline conditions, Distilled ammonia is quantitatively absorbed by boric acid solution, titrated with standard acid solution and calculated hydrolytic nitrogen content

### 2.2. Instrument

K9840 automatic Kjeltex nitrogen analyzer, one-ten-thousandth balance.

### 2.3. Reagents

Hydrochloric acid (analytical purity), 20g/L boric acid solution, bromocresol green-methyl red mixed indicator, 40% sodium hydroxide, reducing iron powder.

### 2.4. Experimental Method

Weigh 3 g (accurate to 0.01 g) of the air-dried soil sample passed through a 2 mm sieve into a 750 ml digestion tube, and add 1 g of ferrous sulfate reducing agent. Place the digestion tube on the Kjeltex nitrogen analyzer, set to automatically add 50 ml water, 40 ml sodium hydroxide solution and 30 ml boric acid-indicator solution, set the distillation efficiency to 80% and the distillation volume to 150 ml. Start distillation and titration. Do a blank test at the same time.

Calculation formula of soil hydrolytic nitrogen content:

$$N \text{ (mg/kg)} = \frac{14 \times M \times (V - V_0)}{W \times K} \times 1000$$

In the formula, WN is the content of hydrolytic nitrogen (mg/kg), V is the volume of the hydrochloric acid standard titration solution used in titration of the sample (m L), V<sub>0</sub> is the volume of the hydrochloric acid standard titration solution used in the titration blank (m L), and c is the hydrochloric acid standard titration The concentration of the solution (mol/L), m is the weight of the air-dried soil sample (g), and 14 is the molar mass of the nitrogen atom (g/mol).

## 3. Results and Analysis

Method stability verification: Choose the actual sample content of about 140mg/kg, conduct 4 independent experiments, and verify the stability of the results in Table 1.

Method accuracy verification: Select 4 national certified standard soil samples with different contents: ASA-5a (44 ±4 mg/kg) and ASA-3a (97±7 mg/kg), each sample is subjected to 7 parallel determinations, the method accuracy is evaluated by the deviation of the standard value of the reference material, and the precision is evaluated by the relative standard deviation of the parallel determination value of the reference material. The data statistical analysis results are shown in Table 6. The results showed that the determination results of the four soil reference materials were all within the standard value range, the RSD values were all less than 5%, and the precision met the relevant requirements. The verification results are shown in Table 2.

**Table 1.** Method stability verification

Number	Sampling amount(g)	Titration volume (ml)	Nitrogen content (mg/kg)	Average (mg/kg)	Absolute deviation (mg/kg)
1	1.0028	1.4760	145	143	5
2	1.0024	1.4435	141		
3	1.0064	1.4821	146		
4	1.0025	1.4424	141		

**Table 2.** Method accuracy verification

content	ASA-5a	ASA-3a
1	48	94
2	44	94
3	48	93
4	45	95
5	45	94
6	48	92
7	46	100
Average (mg/kg)	46	95
standard deviation	1.89	2.76
The relative standard deviation(%)	4.1	2.9
Standard substance content(mg/kg)	44	97
Uncertainty(mg/kg)	4	7
deviation(mg/kg)	2	-2

According to the national standard "LYT 1229-1999 Determination of Hydrolytic Nitrogen in Forest Soil", the absolute deviation is 2.5-10mg/kg when the alkali Hydrolytic nitrogen is 50-200mg/kg. It can be seen that the Kjeltac method to determine the alkali Hydrolytic nitrogen in the soil meets the requirements of the national standard, and has good parallelism and simple operation.

Under the test conditions specified in this method, the Hydrolytic nitrogen in the soil was determined with a Kjeltac nitrogen analyzer. The hydrolysis time was shortened from 24 h to about 5 min. The method has good accuracy, high precision, simple operation, high efficiency and speed, and is suitable for The need for rapid detection and analysis of large quantities of samples.

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