Kett

SCIENCE OF SENSING

Useful information about

Infrared Moisture Analyzer

What exactly is an infrared moisture analyzer?

What is an official analytical method?

Disclosure of the Infrared Moisture Analyzer mechanism

How to find the measurement condition

Line-up of Kett's Infrared Moisture Analyzers

Kett's mascot, K-chan

KETT ELECTRIC LABORATORY

What exactly is an infrared moisture analyzer?

Definition

An infrared moisture analyzer is an instrument that substitutes a loss on drying method used for many official analytical methods for moisture determination.
The equipment determines moisture of a sample by heating and drying it with infrared irradiation and displays the moisture content measured from changes in mass due to evaporation.

It's difficult already.
Official analytical method?
Loss on drying method?
See the next page for more information.

Examples of infrared moisture analyzers developed by Kett

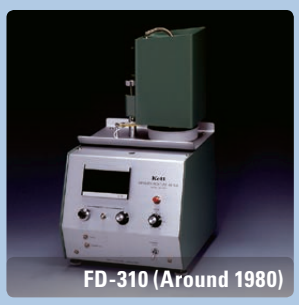
Instrument name (The release year is in parentheses)


F-1A (1950)


F-2A (Around 1950)


F-3A (Around 1950)


FP-54 (Around 1960)


FD-310 (Around 1980)


FD-220 (1985)


FD-100 (1987)


FD-600 (1991)


FD-240 (1996)


FD-720 (2004)


FD-800 (2007)


FD-660 (2014)

The basic principles are pretty much the same but the shapes and performance vary.
I will talk about the details later!

What is an official analytical method?

Since the value indicating the moisture of a substance varies depending on the measuring method, an official analytical method, which is a method specified by an international organization, national or similar official testing laboratory or institute, is defined according to the measurement target or purpose.
In many cases, the loss on drying method is used.

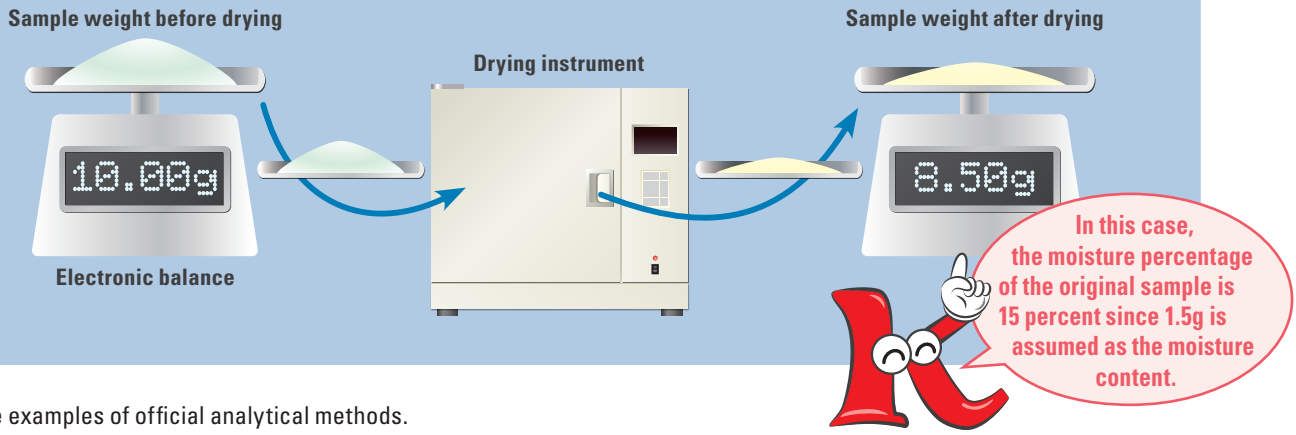
The loss on drying method obtains a moisture value by heating and drying a sample under specific conditions and assuming the mass difference between before and after drying as moisture. It is also called the complete dry method, the absolute dry method, or the oven drying method. The drying conditions differ depending on the sample.

What is the loss on drying method?

1 Measure the sample weight before drying. The weight is decided by the official analytical method of the sample used.

2 Heat the sample using a drying instrument and evaporate the moisture from the sample. The temperature and time to be set on the drying instrument are decided depending on the sample.

3 Measure the sample weight again after drying. The moisture percentage is calculated by assuming the decreased weight as the moisture content.



Here are examples of official analytical methods.

Agricultural Product Inspection Law

Brown rice, milled rice	Loss on drying at normal pressure	106.5±1.0°C, 5g grinding, 5 hours
Imported wheat	Loss on drying at normal pressure	135.0±1.0°C, 5g grinding, 2 hours

Standard methods of analysis in food safety regulation

Tubers and roots	Loss on drying at normal pressure	100°C, 3 to 5g, 5 hours
Candy	Loss on drying at normal pressure	100°C, 4 to 5g, 2 hours
Soybeans	Loss on drying at normal pressure	130°C, 5g, 2 hours

JAS (Japanese Agricultural Standard)

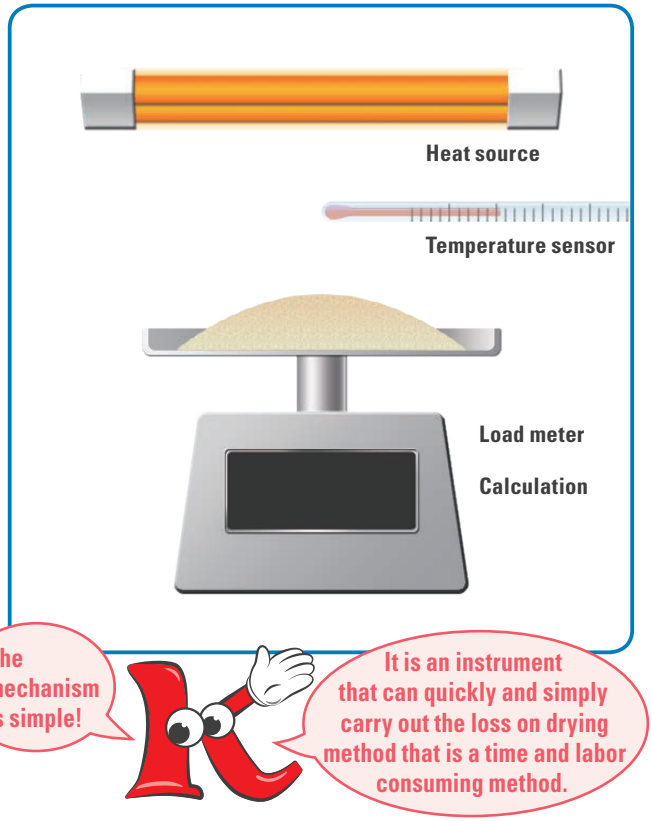
Saccharides	Vacuum drying	60°C, 5g, Constant weight method*
Dried bonito shavings	Loss on drying at normal pressure	100°C, 2g, 5 hours
Vegetable protein	Loss on drying at normal pressure	105°C, 3 to 10g, 4 hours

JIS (Japanese Industrial Standard)

Soil	Loss on drying at normal pressure	110°C, Constant weight method*
Industrial desiccant	Loss on drying at normal pressure	150 to 170°C, 0.5 to 1g, 1 hour
Paper	Loss on drying at normal pressure	105°C, 2 to 50g, 1 to 2 hours
Casting sands	Loss on drying at normal pressure	105 to 110°C, 50g, Constant weight method*

* Constant weight method: Method that continues to dry until the change in moisture content goes below a specific level.

Disclosure of the Infrared Moisture Analyzer mechanism



An infrared moisture analyzer consists of four elements: heat source, temperature sensor, load meter and calculation.
The following are the representatives of each element:

- Heat source: Infrared lamp, infrared heater, etc.
- Temperature sensor: Thermistor, platinum resistor
- Load meter: Mechanical balance, electromagnetic balance, tuning fork balance, load cell, etc.
- Calculation: Mechanical type, microcomputer, etc.

Combinations of the above elements change the functions and affect the performance as moisture analyzers.
Generally, an infrared moisture analyzer and the loss on drying method work on the same principle. However, an infrared moisture analyzer can greatly reduce the drying time by using an irradiating infrared ray in the wavelength band that effectively evaporates the moisture of a sample while the loss on drying method heats a sample using air as a medium.

Characteristics of an infrared moisture analyzer

- **Measures all types of samples!**
  The moisture content of almost all samples* including foods and medicines, regardless of their types and forms (solid, liquid, paste, etc.), can be measured.
- **Short measuring time!**
  Normally, sequential measurement that requires several hours is unnecessary.
- **Easy operation!**
  The measurement procedure has few steps and anyone can carry out moisture measurement.
- **No special device is required!**
  There is no need to prepare many devices such as a mass measuring device, drying machine, etc.

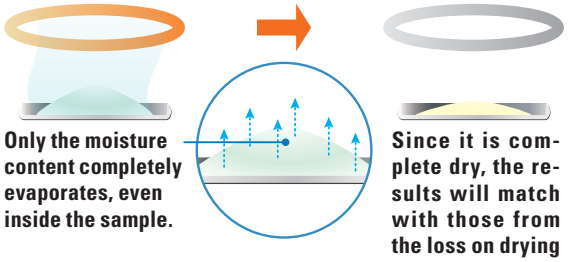
- **Setting measuring conditions is required!**
  In strict measurements, it is necessary to set measuring conditions having consistency with results, in comparison with the moisture value that is an official analytical moisture value.
- **Measures a single sample only!**
  Simultaneous measurement of multiple type of samples on a single instrument at the same time is unavailable.

*** The following samples are not suitable for measurement with an infrared moisture analyzer.**
- **Combustible substances**
- **Substances that emits toxic gas**
- **Substances that evaporates at room temperature**
- **Substances that produces a dangerous chemical reaction by heating**

Better drying makes better measurement

The measurement results from a moisture analyzer vary depending on the set drying conditions. For example, a burnt layer formed on the surface of the sample may prevent moisture content from evaporating or chemical compounds other than moisture content may evaporate. In these cases, it will not match the results from the loss on drying method. Better drying is essential for accurate measurement.

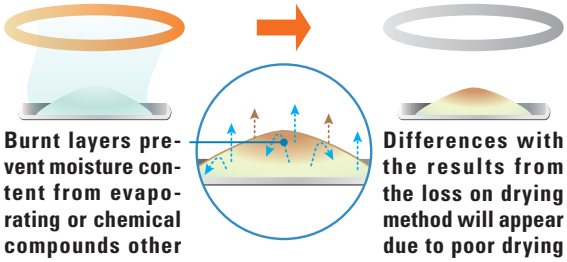
Normal drying



Only the moisture content completely evaporates, even inside the sample.

Since it is complete dry, the results will match with those from the loss on drying method.

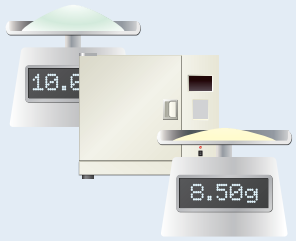
Poor drying due to burning/evaporation of compounds other than moisture content



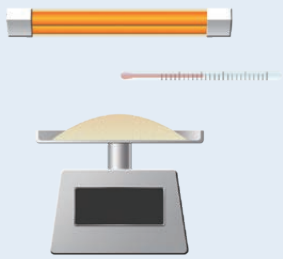
Burnt layers prevent moisture content from evaporating or chemical compounds other than moisture content evaporate.

Differences with the results from the loss on drying method will appear due to poor drying or excessive mass decrease.

Relationship between the loss on drying method and infrared moisture analyzer



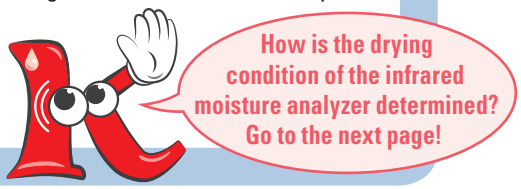
Loss on drying method



Infrared moisture analyzer

Drying condition is different even when the principle is the same.

The heat source and temperature sensor used differ between the infrared moisture analyzer and loss on drying method.
As mentioned above, the heat source of the infrared moisture analyzer is irradiation from infrared in the wavelength band that effectively dries the sample moisture.
Since the temperature sensor of the infrared moisture analyzer detects the ambient temperature of the drying part, as well as the temperature detected by the loss on drying method that has a different structure in the drying part, the temperature will not be the same even between different moisture analyzer models.
Therefore, in most cases, the same drying condition as in the loss on drying method cannot be used for moisture measurement using an infrared moisture analyzer.



How to find the measurement condition

For accurate measurement using an infrared moisture analyzer, the drying condition configuration is important.
To find an appropriate drying condition, it is necessary to know the measurement results from the official analytical method in advance and use trial and error in order to arrive closer to the results.
There are three points to observe in the trial and error process:

1 Refer to an average value of the measurement values obtained from multiple measurements.

2 Know that the moisture value tends to go higher when raising the temperature.
> This happens because a change in mass occurs in addition to the evaporation of moisture content when the temperature is too high, which depends on the sample.

3 Do not greatly change the mass of the sample when measuring multiple times.
> It is necessary to reduce the deviation of the measurement results due to differing quantities of the sample.

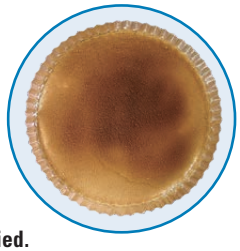
The following examples provide explanations about the methods when actually determining the drying condition while observing the above points.

Setting example of drying condition

Used measuring instrument: FD-720
Sample: Powder
Official analytical value: Method for loss on drying at normal pressure (10g, 110°C, 2hrs)
Official analytical moisture value: 2.80%

Automatic measuring mode/110°C/5g

	Mea. time	Mea. mass	Moisture value	Difference from the official analytical value
1st mea.	20 min	5.021g	6.23%	3.43%
2nd mea.	23 min	5.020g	6.64%	3.84%
3rd mea.	22 min	5.035g	6.41%	3.61%
Average	-	-	6.43%	3.63%



The moisture value largely deviated and the sample was burnt and solidified.
It is assumed that the mass changed due to changes in components other than the moisture content.
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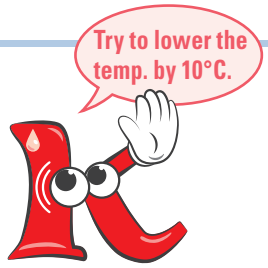


Automatic measuring mode/100°C/5g

	Mea. time	Mea. mass	Moisture value	Difference from the official analytical value
1st mea.	6 min	5.008g	2.52%	-0.28%
2nd mea.	6 min	5.014g	2.64%	-0.16%
3rd mea.	6 min	5.025g	2.57%	-0.23%
Average	-	-	2.58%	-0.22%

The measuring time is reduced, burning is suppressed and repeatability is good.
However, the moisture value is slightly lower than the official analytical value.

Automatic measuring mode/105°C/5g

	Mea. time	Mea. mass	Moisture value	Difference from the official analytical value
1st mea.	7 min	5.028g	2.82%	0.02%
2nd mea.	6 min	5.009g	2.76%	-0.04%
3rd mea.	6 min	5.011g	2.80%	0.00%
Average	-	-	2.79%	-0.01%

Comparing with the results of 100°C, it seems burnt but not solidified.
Both the difference from the official analytical value and the repeatability are good.

As a result, the automatic measurement mode/105°C is the best option.
(With consideration given to burning, the setting at 100°C is considered acceptable.)
Although it went well with only the temperature setting, try by changing the mass or measurement mode if it does not go well.

Line-up of Kett's Infrared Moisture Analyzers

Infrared Moisture Analyzer FD-800

Since the heater is controlled while directly measuring the sample temperature with the irradiation thermometer, samples that are easily burnt will be safe from burning.
It is possible to perform highly effective measurement that automatically raises the heater temperature when there is substantial moisture content and a lower heater temperature when the moisture content is becoming reduced.

- The built-in irradiation thermometer directly reads the sample temperature
- Full-specification high-end model

Sample weight	0.1 to 120 g/Optional weight sampling format
Min. displayable digit	Moisture content/Solid content: 0.1% or 0.01% (selectable), Weight: 0.001 g
Repeatability (Standard deviation)	Sample weight of 5 g or more: 0.05%, 10% or more: 0.02% (When using standard samples and measuring conditions as determined by Kett)
Measurement modes	Automatic halting mode, timed halting mode, high-speed drying mode, low-speed drying mode, stepped drying mode and predictive (comparative) measuring mode
Mea. condition storage	100 conditions
Temp. sensors	Thermistor, radiation thermometer
Power consumption	Max. 900 W
Dim. and weight	220 (W) x 415 (D) x 220 (H) mm, 5.4 kg

Infrared Moisture Analyzer FD-720

Equipped with a mid-wavelength infrared light quartz heater having a large heat capacity as a heat source (200W x 2).
In addition, equipped with measuring modes including a high-speed drying mode that enables performing measurements under the drying conditions most appropriate to the drying characteristics of the sample to be measured.

- Equipped with a high performance mass sensor having high durability
- Multiple measurement modes

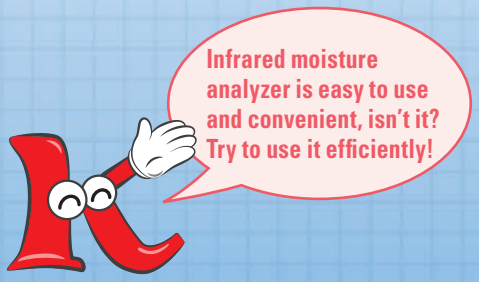
Sample weight	0.5 to 120 g/Optional weight sampling format
Min. displayable digit	Moisture content/Solid content: 0.1% or 0.01% (selectable), Weight: 0.001 g
Repeatability (Standard deviation)	Sample weight of 5 g or more: 0.05%, 10% or more: 0.02% (When using standard samples and measuring conditions as determined by Kett)
Measurement modes	Automatic halting mode, timed halting mode, high-speed drying mode, low-speed drying mode, stepped drying mode and predictive (comparative) measuring mode
Mea. condition storage	10 conditions
Temp. sensors	Thermistor
Power consumption	Max. 900 W
Dim. and weight	220 (W) x 415 (D) x 190 (H) mm, 4.5 kg

Infrared Moisture Analyzer FD-660

Easy-to-use standard instrument equipped with light-emitting keys to indicate the status and operation of the instrument. Newly equipped with an organic carbon heater with a small load on the environment and the PreHeat Mode for stable measurement.

- Easy-to-operate and simple standard instrument
- Light-emitting keys indicate the instrument status

Sample weight	1 to 80g/Optional weight sampling format
Min. displayable digits	Moisture content/Solid content: 0.1% or 0.01% (selectable), Weight: 0.005g
Repeatability (Standard deviation)	Samples with a weight of 5 g or higher: 0.1% (When using standard samples and measuring conditions as determined by Kett)
Measurement modes	Automatic halting mode, timed halting mode
Mea. condition storage	5 conditions
Temp. sensors	Thermistor
Heat source	Organic carbon heater (280W x2)
Power consumption	Max. 900 W
Dim. and weight	222 (W) x 360 (D) x 196 (H) mm, 3.2 kg



Kett's mascot, K-chan

Notes

- It is strictly prohibited to transfer all or part of this manual without permission.
- The contents of this manual are subject to change without any notice.
- All efforts have been made to ensure that the contents of this manual are accurate. However, if you notice that any parts in this manual are unclear, incorrect, omitted or have any other issues, please contact us.
- Be aware that we are not liable for any issues resulting from operations according to this manual regardless of the items above.

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Management system enhancement department of the Japanese Standards Association (JSA) registers the Quality Management System of the above organization, with conform to JIS Q 9001, ISO 9001.
The scope of the registration.
Design, development and production management, calibration and repair of Moisture testers, NIR composition analyzers, Grain inspectors and Coating thickness testers.

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