Moisture Analyzer

MX-50/MF-50

Users' Handbook

Version 2.20 April 2003

A&D Weighing, USA Version

Test with The Best

- True 0.01%(S.D.)

A&D WEIGHING

...Clearly a Better Value

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Specifications

MX/MF Specifications	MX-50	MF-50
Measurement Method	400W straight halogen lamp heating system with SRA filter and SHS weighing technology	
Max Sample Weight Capacity	51g	51g
Weight Resolution	0.001g	0.002g
Moisture Content Display	0.01/0.1%	0.05/0.1/1%
Moisture Content Accuracy over 1g	0.10%	0.20%
over 5g	0.02%	0.05%
Heating Technology	Halogen lamp(Straight type, 400Watt max, 5000hours)	
Drying Temperature	50-200°C(1°C increment)	
Memory of Measurement Programs	20 sets	10 sets
Measurement Programs	Standard Mode/Automatic Complete Mode/Timer Mode/Manual Mode	
Measurement Mode	Wet base/Dry base/Solid content/Ratio	
Display Type	Large VFD	
Interface	RS-232C standard	
Data Memory Function	100	50
Operating Temperature	5-40°C(41-104°F) less than 85%RH	
GLP/GMP/ISO	Available	
Self Check Function	Standard	
Communication Software	WinCT-Moisture standard	WinCT standard
Sample Pan Size	Ø85mm	
Power	AC 100V to 120 V(3A) or AC 200V to 240V(1.5A), 50/60Hz, Approx. 400W	
Physical Dimention/Weight	215(W) x 320(D) x 173(H)/Approx. 6kg	
Standard Accessories	20 Sample Pans, 2 Pan Handles, Tweezers, Spoon, Test Sample (30g of Sodium Tartrate Dihydrate), CD-ROM(WinCT-Moisture for MX-50, WinCT for MF-50), RS-232C Cable for MX-50, Display Cover, Dust Cover, Instruction Manual, Quick Reference Card, Power Cable, 2 Fuses	

Specifications are subject to change for improvement without notice.

Accessories

Accessories

AD-1700-20G	Calibration Mass (20g)
AD-8121	Dot Matrix Compact Printer
AX-31	Sample Pans (Washable, 100 each)
AX-32	Glass Fiber sheet (Ø70mm x 100 sheets)
AX-33	Test Sample (Sodium Tartrate Dihydrate, 30g x 12pcs)
AX-34	Halogen Lamp for AC100V to 120V
AX-35	Pan Handle (2pcs)
AX-36	Tweezers (2pcs)
AX-37	Spoon (2pcs)
AX-38	Display Cover (5pcs)
AX-39	Dust Cover
AX-42	WinCT-Moisture (CD-ROM, Application Software for Windows)
AX-43	Certified Temperature Calibrator (only for MX-50)
CC:MX	Storage / Carrying Case

1. What is moisture content?

Moisture content is usually shown as a percentage of water contained in a solid, liquid or vapor material. Where sample is vapor or liquid, it can be in percentage of weight of water contained in its sample's volume and it can be called hygroscopic moisture or humidity. Since moisture content may be classified into various statuses with names to them, evaluation of and dealing with measured data require a special care.
Moisture adhered to a material's surface is called water of adhesion, free water or hygroscopic moisture and moisture adhered to a material with a certain condition such as pressure, temperature, volume etc. is called absorbed water or equilibrium moisture content. Water chemically bonded to a material itself or inside of the material is crystal water or hydrated water while its moisture is bond water or combined water.

REFERENCE
In measurement of moisture content with a moisture analyzer, some materials are measured with a stable moisture content rate and a typical material with such character is Sodium Tartrate Dihydrate. Known by its name, it is a well-known material secondarily produced while alcoholic beverages such as wine is made.

The material is a hydrate that has hydrate water in crystal and a combined material (molecular formula : $Na_2C_4H_4O_6?2H_2O$, rational formula $[H_2O?CH(OH)COONa]_2$ / molecular mass 230.0823) of Sodium Tartrate (molecular formula : $Na_2C_4H_4O_6$?rational formula [- $CH(OH)COONa]_2$ / molecular mass 194.0517) and two water molecules ($2H_2O$?molecular mass 36.03056) . Sodium Tartrate Dihydrate changes into Sodium Tartrate (anhydrate) by releasing the two water molecules with heat energy. Since Sodium Tartrate Dihydrate's melting point is 150? , at room temperature it is stable and does not release crystal water in its molecules but starts releasing the decomposition of other factors than crystal water. Thus, in order to vaporize crystal water selectively when moisture is measured with a moisture analyzer using heating and drying method, it is suffice to say that heating temperature should be between 150? to 200? . Its moisture content rate is logically deemed by the ratio of 2 water molecules, that is (36.03056/ 230.0823)×100? 15.66%.

2. Method of measurement

How moisture content is measured with a moisture analyzer

Moisture content can be measured by heating method, Karl Fischer method, Dielectric?Infrared absorption method, neutron analyzer or crystal oscillation method, among which mainly heating and drying method or Karl Fischer method is utilized in many laboratories. Infrared absorption method and Dielectric method are suitable for process. Heating method is a method where moisture content is rendered by the weight of water evaporated from ground solid or liquid samples after heating the sample for a period of time at or over the sample's perspiration temperature. Weight loss occurs as samples get heated and finally converge on a certain value. Sample may pyrolyze and vaporize depending on its characteristics, which suggests that what is vaporized is not necessarily water. However suitable sample size and heating temperature such as temperature setting, heating time and so forth can lead a result comparable to the one determined by Karl Fischer method.

Among all, moisture analyzers employed with heating method is easy to handle with its good operability and clear formula of operation, low profile and can be run and maintained at a low cost, which contribute to attracting a wide range of users who test many kinds of samples. Measurement range is from 0.01% or 0.1% to 100% and so samples even with almost 100% moisture content can be correctly and easily measured. Heating method moisture analyzers utilizes halogen, infrared lamp, sheathed heater or micro wave heater as heating source to heat sample on an electric balance that weighs the sample before and after the heating to determine the moisture loss. The electric balance then needs technology that insulates heat to the load sensor and prevents temperature drift since temperature can get over 150 – 200? . Karl Fischer method is a method where moisture content is measured by electric chemical titration under favor of the characteristics that in the presence of methyl alcohol, KF reagent including iodine, hydrogen disulfide, pyridine responds specifically with water.

$$\underline{H_2O} + \underline{I_2}+\underline{SO_2}+3RN+\underline{CH_3OH} \ \textbf{?} \ 2RN?HI+RN?HSO_4CH_3(\text{anhydrate})$$

Water (reagent) KF reagent methyl alcohol (RN: base?I: Iodine?SO_2: hydrogen disulfide)

Measurement principle of Karl Fischer method is based on the chemical reaction described above. Which is to say moisture content is deemed by the quantity of KF reagent that selectively responds to water and produces anhydrate titrated and needed to react to water completely till end point. The quantity of the KF reagent is electrically detected as the reagent is titrated into the sample in the water. Karl Fischer method has two means of detection, volume method and coulometry method, the former of which is employed as an official measurement. This method requires the reagent which is a chemical agent and thus, doesn't stop natural chemical reaction and deterioration of the reagent itself, decreasing factor or water equivalent in the reagent by getting moisture out of air and reacting to it while keeping and/or using it. In which case, before measurement, the factor needs to be checked for its quantity of reagent that can be bonded to water, and the reagent must be carefully stored. As just described, Karl Fischer method requires careful control, check of the reagent and a complex procedure of operation while the heating method doesn't, however it is suitable for detecting moisture content in a material such as vapor or that with very little moisture in ppm.

Moisture analyzers using infrared absorption method work in the benefit of infrared of a specific wavelength that is absorbed by water. Moisture content is obtained by the energy ratio of reflected light when a sample is illuminated by the light whose wavelength is absorbed by water and other two wave length that are not, in order not to have variance because of material surface's irregularity or location of the material. It is suitable for stable measuring of powder and grains continuously.

Neutron analyzers detect moisture by the characteristics of hydrogen whose neutron's speed is reduced by water and differs from each material. Fast neutral ray becomes thermal neutron as water in sample reduces neutron's speed and thus, by the number of thermal neutron moisture content is measured non-contact, non-destructively and online without pausing. Typical samples are sintered materials.

Moisture analyzers with crystal oscillation method have a structure with a functional thin membrane on its electrodes, which senses absorbed moisture crystal that changes crystal oscillator's frequency. The analyzer measures the frequency to detect moisture content in the sample. This method is suitable to measure trace quantity of moisture in gas samples.

No.	Q	A
1	What is the difference between MX/MF and Karl Fischer type analyzer?	1. MX/MF is a heating and drying method analyzer that compares weight before and after heating and drying while Karl Fischer type analyzer titrates KF reagent that contains iodine to sample electric-chemically. 2. Karl Fischer method enables a measurement from some ppm to 100% (water) but operation is complicated and the unit is expensive. MX/MF is very easy to handle, needs a shorter time to measure and is reasonably priced. 3. Where required resolution is under 0.01% MX/MF is more suitable in handling, accuracy and running cost. There is no difference between data obtained with Karl Fischer method and heating and drying method. MX/MF is likely to have better repeatability than Karl Fischer type.

3. Accuracy

No.	Q	A
1	What does 0.02% of accuracy mean?	It's the variation and repeatability of moisture content rate data where same sample is tested with the same conditions repeatedly. In statistics it is called standard deviation.

4. Samples

No.	Q	A
1	What is the reagent, Sodium Tartrate Dihydrate like and when is it needed?	It is suitable for testing a moisture analyzer itself since its moisture content rate is deemed theoretically. Sodium Tartrate Dihydrate is what Sodium Tartrate is when chemically bonded to two water molecules or crystal water and becomes Sodium Tartrate again by releasing the water molecules when heated. Its moisture content rate is the ratio of the two water molecules, that is 36.031/230.082=15.66%. This sample is a standard accessory of MX and optional accessory of MF (30g x 12pcs).
2	Why isn't the result of 15.66 obtained?	1. Moisture bonded inside of the material as crystal water is theoretically 15.66% however ambience has 10%RH ~ 90%RH moisture, which can adhere to the sample in a mechanical fashion. Also, moisture and/or impurities left on a pan, and/or measurement accidental errors can be the reason and the result may vary between 15.0% and 16.0% in actual measurement. 2. If the difference between the actual result and 15.66 is big it is concluded that heating temperature may be too low. When Sodium Tartrate Dihydrate is tested, accuracy of measurement of MX/MF-50 should be set MID, heating temperature, 160C and after pre-heating for 8 minutes 5g of the sample should be placed on the pan evenly distributed.
3	Is Sodium Tartrate Dihydrate safe? Is there any special process to handle?	1. It is perfectly harmless. Sodium Tartrate Dihydrate is used as a flavoring to foods and thus, if eaten, unless it is more than 218g which is a fatal dose, it is a safe material. However if it gets on mucosa (In eyes and nose) it should be washed immediately. 2. There should be no special treatment to the material even when disposed. It can be disposed of as a burnable waste.

4	Can Sodium Tartrate Dihydrate be recycled?	No. Moisture once decomposed from crystal of the sample by heat cannot be reconstituted.
5	Can anything be tested with the analyzer?	1. Material that is explosive and/or flammable or fumes when heated are not suitable to be tested by heating and drying method. Those materials must not be tested with the analyzer. 2. Materials whose surface gets dried first and makes a membrane which makes pressure inside high must not tested because they may be dangerous. 3. Materials whose characteristics are should not be tested.
6	What is minimum weight moisture content rate measured at?	In the case of using MX/MF-50, sample more than 0.1g is measurable. Sample mark on LCD display will light when sample amount is enough.
7	What is maximum weight moisture content measured at?	In the case of using MX/MF-50, sample less than 50g is measurable. “E” will be displayed if sample is over 50g.
8	Is it true that the more sample used the more accurate the measurement will be?	No, that’s not true. Excess of a sample may not get heated inside evenly or heating time may be longer. In such cases measurement may be non-repeatable.
9	Does placement of sample such as powder on a pan affect measurement result?	Yes. How to put a sample on a pan determines heat distribution. To measure moisture content rate accurately even heating and vaporization are needed so sample should be distributed over the pan.

5. Calibration

No.	Q	A
1	Can calibration of the moisture analyzer, MX/MF with Sodium Tartrate Dihydrate be possible?	No. However accuracy check can be done with the sample since moisture content rate of the sample is theoretically fixed. Heating and drying method moisture analyzer weighs sample before and after heating and weight and temperature calibration is possible.
2	Can a user do weight and temperature calibration?	Yes (only MX can do temperature calibration). Also, results of these calibrations can be printed out in accordance with GLP, GMP or ISO. 1. For weight calibration optional accessory calibration mass, 20g, AX-41 is recommended. 2. Use optional accessory temperature calibrator, AX-43, with certificate for temperature calibration.
3	Are traceability system diagram and certificate of measurement available?	Yes both are available upon request. 1. If it is of analyzer itself, certificate both covers weight and temperature. 2. If it is of calibrator, certificate is only about temperature calibration however the calibrator is sold with tracability certificate and certificate of measurement no additional charge.

6. Others

No.	Q	A
1	Should I consider moisture in a glass fiber sheet when it is used?	You don't usually have to. However if you want to be very strict remove moisture in a sheet dry and store it in a desiccator prior to use.
2	Is absolute measurement of moisture content rate possible? (Can only water content be measured?)	No. Minerals such as metal, glass or sand have only water as moisture content. Most other samples are is organic matter, and have other materials besides water that can vaporize. Also, measurement results depend on heating temperature.

7. Heating Method

No.	Q	A
1	What is the benefit of halogen lamp incorporated in MX/MF?	Heating value per unit of time is higher than other heating methods and its useful lifetime is longer. Moisture analyzers with halogen lamps can shorten measurement time taken. Halogen lamps emit much more light than other lamps, which is also beneficial when observing the sample while heating.
2	What is difference between halogen and infrared lamp? How do they relate to each other?	A halogen lamp emits 95 % of light that is within infrared wavelength field and its energy characteristics are basically the same as with infrared lamps.
3	How fast can moisture analyzer with halogen lamp heat up?	It can heat up the pan up to 200C from the ambient temperature within 2 minutes, much faster than by infrared or sheathed heater method.
4	What is SRA filter like?	SRA stands for Secondary Radiation Assist and is an innovative heating method A&D developed for the MX/MF moisture analyzer. The old method where halogen lamp directly heats sample on a pan, cannot heat the sample evenly because of the difference of the varying distance between the lamp and the sample. SRA improves on this and can heat the sample up evenly with the secondary radiated heat by the glass placed under the lamp.

8. Measurement

No.	Q	A
1	What is the benefit of being able to see inside the analyzer while heating?	Being able to see inside of the analyzer gives users a sense of safety. Not only water in a sample that can be overheated or is burnable may be vaporized but also other material can be carbonized or decomposed. It is very important for users to check by looking at the sample through Progress Window to evaluate the data.
2	What is the minimum measurement time?	It depends on material and moisture content but because MX/MF incorporates 400W halogen lamp as heating source the pan can be heated from ambient temperature to 200C in only 2 minutes. Also, since a SHS^{TM} sensor designed for analytical balances is installed sensing weight of sample before and after heating is precise and thus, requires less sample volume than before. With appropriate heating temperature and sample mass, measurement can generally be done within a few minutes to 20 minutes. Therefore, for the following reasons MX/MF's heating time and thus, measurement time are shortened. 1. Heating to a set temperature is fast 2. Only very little quantity of sample is needed to measure
3	Are temperatures of sample and displayed temperature the same?	Displayed temperature is the one right on the pan, that is, of sample especially when spread on the pan evenly. However when placed unevenly or it has hard skin membrane the temperature is of the surface of the sample. *MX/MF does not have the sensor right on the pan but calculates the place whose temperature is assumed to be the one of on the pan and puts the sensor there. Temperature calibration is possible by users.

4	What is SHS?	SHS stands for Super Hybrid Sensor and is the weight sensor A&D innovated to enable high speed weighing within 1 second necessary for analytical balances requiring high resolution and accuracy. SHS enables the analyzer to capture the dynamic weight and measure moisture content in shorter length of time. (Patent pending)
5	Why do the pans need two handles?	When measurement is required repeatedly a hot sample pan should not be used since once the new sample is put on the hot pan moisture would vaporize, which makes measurement data inaccurate. To avoid this 2 pans and handles should be utilized in turns, which not only enhances measurement repeatability and credibility but also prevent mishaps like burns.

9. Data Analysis

No.	Q	A
1	Can soybeans or coffee beans be tested as they are?	NO. Usually samples like peas should first be crushed in a blender or mill because temperature of surface and inside can be very much different, plus when crushed can be heated evenly. Note that when crushing sample. User should start measurement soon because the sample's crushed superficial area is bigger and can absorb additional moisture in the ambient air.
2	Can materials like milk or colloids be tested?	Colloids such as solid particles floating on water in milk or colloids that have surface tension often become dotted. In these cases use an optional accessory *glass fiber sheet to absorb the sample. This improves repeatability rate and shortens time taken from one third to a half. Be sure to tare the weight of the glass fiber sheet. *AX-32
3	How should I measure vegetables, seaweeds and mushrooms?	Sample should be a typical part of it.

B. ¦ Data Results & Analysis

1. Measurement Samples

Below is a comparative measurement result of MX and Karl Fischer type analyzer.
Sample is a material that has little moisture.

1) Measurement condition

+ Sample : Plastic (PET)
+ Heating Temp. : 180C
+ Number of times : 5
+ Analyzers : Heating and drying method moisture analyzer : MX/MF (A&D)
Karl Fischer method moisture analyzer : KF (tentative name) (K company)

2) Averaged Results

Analyzer	Sample Weight (g)	Moisture (%)	Repeatability (%)	Coefficient of variation (CV) (%)	Heating time (min)
MX-50	10	0.298	0.0045	1.49	6.8
KF	0.3	0.3072	0.0065	2.13	19

(1) By the data there is no evident difference between the two analyzer's results and it could be said that data taken by A&D's MX/MF can match a Karl Fischer type analyzer.
(2) As for accuracy, repeatability and coefficient variation, MX has less variance.
(3) A&D MX took much less time for measurement. MX took 6.8 min while KF took 19 min. Also, although not shown in the table above KF requires 6 min of preparation and set-up of the unit and reagent, all of which takes about 2 hours.
(4) In short, to measure moisture content of a material like PET with A&D's MX/MF you can get a faster result versus a KF. As for accuracy, MX gives even better results than KF. In operation MX requires a remarkably less complicated preparation than KF would and it takes much less time to measure.

2 Typical measurement results by table

Commodity

No.	Classification	Sample	Weight (g)	Measurement Mode	Pan Temp. (C)	Process Time (Min)	Moisture Content			Remarks
							Mean Value (%)	Repeatability (%)	CV Value (%)	
1	Commodity	Tobacco	1	Standard-MID	100	6.5	10.58	0.339	3.2	Flake leaves and test. Smells strong while heating.
2	Commodity	Dried Dog Food	1	Standard-MID	160	9.2	8.68	0.059	0.68	Crush with hand mixer. Smells strong while heating.
3	Commodity	Tooth Paste	1	Standard-MID	180	6.4	36.43	0.472	1.3	Place the sample evenly on the pan.
4	Commodity	Laundry Starch (Liquid)	1	Standard-MID	200	5.5	93.38	0.17	0.18	Use a glass fiber sheet.
5	Commodity	Starch Glue (Paste)	5	Standard-MID	200	14	83.34	0.102	0.12	Place the sample evenly on the pan.
6	Commodity	Bond (Paste)	1	Standard-MID	200	9.7	61.3	0.309	0.5	Place the sample evenly on the pan.
7	Commodity	Hand Soap (Liquid)	1	Standard-MID	200	6	92.01	0.157	0.17	Use a glass fiber sheet.
8	Commodity	Lipstick	1	Standard-MID	100	1.9	0.778	0.1938	24.91	Spread the sample directly.
9	Commodity	Liquid Foundation	1	Standard-MID	140	12.6	75.93	0.126	0.166	Use a glass fiber sheet.
10	Commodity	Silver Fir Chip (Dried)	1	Standard-MID	200	3.7	11.17	0.081	0.73	
11	Commodity	Silica Sand	10	Standard-HI	200	2.3	0.498	0.0741	14.88	
12	Commodity	Cement (Powder)	5	Standard-MID	200	3	0.408	0.0222	5.44	
13	Commodity	Putty (Paste)	1	Standard-MID	200	7.3	33.73	0.549	1.63	
14	Commodity	Synthetic Resin Paint (Acrylic and Aqueous Fluid Type)	1	Standard-MID	200	13.6	53.93	0.15	0.28	Use a glass fiber sheet.
15	Commodity	Xerox Paper	1	Standard-MID	200	2.8	4.69	0.174	3.17	Cut the sample into small bits.
16	Commodity	Cardboard	1	Standard-MID	100	4.2	6.66	0.109	1.64	Cut the sample into small bits.

Food A(Grain, Beans, Sea Foods, Seasonings, Spices and Flavoring)

No.	Classification	Sample	Weight (g)	Measurement Program	Pan Temp (C)	Process Time (Min)	Moisture Content			Remarks
							Mean Value (%)	Repeatability (%)	CV Value (%)	
17	Food	Corn Grits (Powder)	5	Standard-MID	160	17.5	12.06	0.072	0.6	
18	Food	Corn Starch (Powder)	5	Standard-MID	200	7.1	12.74	0.137	1.08	
19	Food	Starch	5	Standard-MID	180	7.8	15.95	0.157	0.99	
20	Food	Buckwheat Flour	5	Standard-MID	180	10.2	15.13	0.191	1.26	
21	Food	Soft Flour	5	Standard-MID	200	7.3	13.03	0.26	2	
22	Food	Floured Rice	5	Standard-MID	200	7.6	12.89	0.134	1.04	
23	Food	Oats	5	Standard-MID	200	13.7	13.56	0.066	0.49	
24	Food	Preprocessed Oats (Grain)	1	Standard-MID	160	19.7	11.8	0.352	2.98	
25	Food	White Rice	5	Standard-MID	200	14.3	15.88	0.198	1.25	Crush with hand mixer.
26	Food	Pre-cooked Rice	1	Standard-MID	200	15.3	64.51	0.384	0.6	
27	Food	Soybean Powder	5	Standard-MID	160	8.2	9.92	0.061	0.61	
28	Food	Cashew Nuts	5	Standard-MID	140	8.5	3.04	0.01	0.33	Crush with hand mixer.
29	Food	Butter Peanuts	5	Standard-MID	140	9.6	2.1	0.077	3.67	Crush with hand mixer.
30	Food	Ground Coffee Beans (Powder)	5	Standard-MID	140	9.8	4.43	0.036	0.81	
31	Food	Dried Squid	2	Standard-MID	180	20.5	26.21	0.312	1.19	Cut the sample into small bits.
32	Food	Boiled Dried Fish	2	Standard-MID	160	8.3	17.28	0.235	1.36	Crush with hand mixer.
33	Food	Dried Whitebait	5	Standard-MID	200	15.3	70.23	0.246	0.35	
34	Food	Dried Bonito Fish Flake	1	Standard-MID	120	6	14.69	0.77	5.24	Crush with hand mixer.
35	Food	Fish Sausage	2	Standard-MID	200	15.6	78.02	0.227	0.29	Cut the sample into small bits.
36	Food	Sugar Crystals (Powder)	5	Standard-MID	160	1.7	0.162	0.013	8.02	
37	Food	Soft Brown Sugar (Powder)	5	Standard-MID	160	5.4	0.973	0.0386	3.97	
38	Food	Seasoned Salt	5	Standard-MID	100	1.1	0.086	0.0151	17.56	
39	Food	Salt	5	Standard-MID	200	1.7	0.16	0.0082	5	
40	Food	Flavour Seasoning	5	Standard-MID	100	8.5	1.55	0.02	1.29	
41	Food	Ketchup	1	Standard-MID	160	16.1	70.42	0.643	0.91	Spread the sample between two glass fiber sheets.
42	Food	Mayonnaise (Egg yolk type)	1	Standard-MID	200	2.9	19.65	0.235	1.20	
43	Food	Pepper (Cracked)	5	Standard-MID	160	15.9	12.23	0.142	1.16	

44	Food	Chilli Pepper Powder	5	Standard-MID	120	17.3	5.81	0.06	1.03	
45	Food	Seasoned Chilli Pepper Powder	5	Standard-MID	120	16.9	4.9	0.085	1.73	
46	Food	Powder Mustard	5	Standard-MID	140	9.3	4.76	0.051	1.07	
47	Food	Powder Horse Radish	5	Standard-MID	140	11.4	3.7	0.082	2.22	
48	Food	Horse Radish (Grated)	1	Standard-MID	200	15.1	39.07	0.123	0.32	Crush the sample from above a glass fiber sheet.
49	Food	Ginger (Grated)	1	Standard-MID	200	11.9	84.77	0.439	0.52	
50	Food	Dijon mustard (Paste)	1	Standard-MID	200	13.5	54.55	0.416	0.76	
51	Food	Citric Acid	5	Standard-MID	100	7.2	4.54	0.21	4.63	
52	Food	Anhydrous Glucose	5	Standard-MID	140	1.7	0.696	0.0054	0.78	

Food B(Processed foods, Dairy products, Snacks and Sweets, Beverage and others)

No.	Classification	Sample	Weight (g)	Measurement Program	Pan Temp (C)	Process Time (Min)	Moisture Content			Remarks
							Mean Value (%)	Repeatability (%)	CV Value (%)	
53	Food	Bread	1	Standard-MID	160	7.3	36.65	0.550	1.50	Measure after breaking into bits.
54	Food	Bread Crumbs	1	Standard-MID	200	6.2	32.36	0.505	1.56	
55	Food	Dried Soup	5	Standard-MID	140	14.1	4.73	0.079	1.67	
56	Food	Instant Bean Paste Soup	1	Standard-MID	160	12.9	63.43	0.728	1.15	Spread the sample between two glass fiber sheets.
57	Food	Instant Chinese Noodle	2	Standard-MID	140	9.6	1.53	0.091	5.96	Crush the sample by tapping the sample
58	Food	Sippet	2	Standard-MID	160	8.4	5.68	0.119	2.1	Crush the sample by tapping the sample.
59	Food	Brown Rice Cereal	2	Standard-MID	160	7.9	4.42	0.071	1.61	Crush the sample by tapping the sample.
60	Food	Dried Pasta	2	Standard-MID	200	15.8	13.7	0.211	1.54	Crush the sample by tapping the sample.
61	Food	Dried Wheat Noodle	5	Standard-MID	200	20	13.36	0.109	0.82	Cut the sample by about 3cm.
62	Food	Dried Bean Starch Vermicelli	2	Standard-MID	200	15.8	14.8	0.15	1.01	Cut the sample by about 3cm.
63	Food	Dried Brown Seaweed	1	Standard-MID	200	9.2	11.49	0.367	3.19	Crush with hand mixer.
64	Food	Wood Ear (Sliced)	2	Standard-MID	180	18.3	13.13	0.227	1.73	Cut the sample by about 3cm.
65	Food	Beef Jerky	2	Standard-MID	200	26.7	27.65	0.243	0.88	Cut the sample into small bits.
66	Food	Rice Cracker	5	Standard-MID	140	17.1	6.93	0.045	0.65	Crush the sample by tapping the sample.
67	Food	Cookie	5	Standard-MID	140	5.5	2	0.054	2.7	Crush the sample by tapping the sample.
68	Food	Caramel	2	Standard-MID	140	16.4	5.94	0.071	1.2	Press the sample to 1mm thick and put on a glass fiber sheet.
69	Food	Banana chips (Sliced and Dried)	1	Standard-MID	180	7.0	4.53	0.060	1.32	Measure after crushing.
70	Food	Potato Crisps	5	Standard-MID	140	9.3	1.88	0.054	2.87	Crush the sample by tapping the sample.
71	Food	Snack (Shrimp Flavour)	5	Standard-MID	160	6.4	2.54	0.043	1.69	Crush the sample by tapping the sample.
72	Food	Snack (Instant Fried Noodle)	5	Standard-MID	140	8.7	1.31	0.039	2.98	Crush the sample by tapping the sample.
73	Food	Jam	1	Standard-MID	160	17.0	33.96	0.109	0.32	
74	Food	Honey (Drying temp., 120C)	1	Standard-MID	120	20.3	17.76	0.282	1.59	Put on a glass fiber sheet.
75	Food	Honey (Drying temp., 140C)	1	Standard-MID	140	14.5	19.38	0.539	2.78	Put on a glass fiber sheet.

76	Food	Honey (Drying temp., 160C)	1	Standard-MID	160	20.4	22.92	1.599	6.98	Put on a glass fiber sheet.
77	Food	Condensed Milk	1	Standard-MID	140	11.9	25.59	0.4	1.59	Put on a glass fiber sheet.
78	Food	Milk Substitute (Liquid)	1	Standard-MID	200	4.5	61.83	0.491	0.79	Use a glass fiber sheet.
79	Food	Butter (Solid,Salted)	1	Standard-MID	140	4.1	14.94	0.186	1.24	
80	Food	Grated Cheese	1	Standard-MID	160	8.1	10.65	0.252	2.37	
81	Food	Skimmed Milk	2	Standard-MID	140	16.7	6.49	0.255	3.93	
82	Food	Milk	1	Standard-MID	140	6.7	87.11	0.069	0.08	Use a glass fiber sheet.
83	Food	YoghurtA	1	Standard-MID	160	11.5	81.17	0.383	0.47	Use a glass fiber sheet.
84	Food	YoghurtB	1	Automatic-(0.5%/min)	180	5.4	88.07	0.209	0.24	Measure after putting the sample between folded glass fiber sheet and pressing it hard.
85	Food	Soy Milk	1	Standard-MID	180	5.6	90.11	0.142	0.16	Use a glass fiber sheet.
86	Food	Green Tea Leaves	5	Standard-MID	140	11.6	5.53	0.023	0.42	Crush with hand mixer.
87	Food	Instant Coffee A	1	Standard-MID	120	7.1	7.66	0.100	1.31	
88	Food	Instant Coffee B	4	Standard-MID	100	5.9	2.06	0.055	2.67	
89	Food	Orange Juice	1	Standard-MID	140	7.3	89.48	0.209	0.23	Use a glass fiber sheet.
90	Food	Powdered Cold Beverage	5	Standard-MID	120	2.7	0.408	0.0476	11.67	
91	Food	Cold Beverage (Jellylike)	1	Standard-MID	140	17.5	76.3	0.285	0.37	Use a glass fiber sheet.
92	Food	Agar Powder	5	Standard-MID	180	8.5	17.76	0.125	0.7	
93	Food	Gelatin (Powder)	5	Standard-MID	200	15.4	16.03	0.223	1.39	

Chemicals, Plastic and Rubber

No.	Classification	Sample	Weight (g)	Measurement Program	Pan Temp (C)	Process Time (Min)	Moisture Content			Remarks
							Mean Value (%)	Repeatability (%)	CV Value (%)	
94	Chemicals	Skin-Care Cream (Paste)	1	Standard-MID	160	16	77.06	0.543	0.7	Spread the sample between two glass fiber sheets.
95	Chemicals	Sodium Tartrate Dihydrate	5	Standard-MID	160	7.7	15.7	0.026	0.17	
96	Chemicals	Cellulose	5	Standard-MID	180	5.2	4.37	0.136	3.11	
97	Chemicals	Calcium Stearate	5	Standard-MID	180	7.6	2.9	0.03	1.03	Smells strong while heating.
98	Chemicals	Zinc Oxide	5	Standard-HI	200	2.3	0.142	0.0216	15.21	
99	Chemicals	Aluminum Oxide	5	Standard-HI	200	2.4	0.098	0.013	13.27	
100	Chemicals	Magnesium Oxide	2	Standard-HI	200	5.2	1.52	0.164	10.79	
101	Chemicals	Talc	5	Standard-HI	200	2.5	0.144	0.0114	7.92	
102	Chemicals	Calcium Carbonate	5	Standard-HI	200	3.1	0.228	0.0205	8.99	
103	Commodity	Charcoul (Powder)	1	Standard-MID	200	2.5	11.24	0.591	5.26	
104	Industrial Products	Activated charcoal (Particulate, For deodrant use)	5	Standard-MID	120	6.6	9.96	0.142	1.43	
105	Industrial Products	Silica gel (Particulate)	5	Standard-MID	200	5.2	11.74	0.072	0.61	Left 23C room temperature for 24 hours.
106	Industrial Products	Silica gel (Tablet)	3	Standard-MID	200	4.7	8.25	0.068	0.82	Left 23C room temperature for 24 hours.
107	Industrial Products	Printer toner (Powder, Black)	5	Standard-MID	100	1.6	0.298	0.0130	4.36	
108	Plastic	Polyethylene Terephthalate Pellet	10	Standard-HI	180	6.8	0.298	0.0045	1.34	Reference: Average moisture content 0.307%, Repeat-ability 0.0065% and average process time 19.0 mins at 180C with 0.3g by Karl Fischer method.
109	Plastic	ABS Resin	10	Automatic-(0.005%/min)	140	12.1	0.425	0.0093	2.19	
110	Plastic	Polymethyl-methacrylates	10	Automatic-(0.005%/min)	100	19.4	0.488	0.015	3.07	Smells strong while heating.
111	Electronic parts	CPU (100pin, Plastic QFP, 14*20mm)	10	Standard-HI	120	1.7	0.064	0.0055	8.59	Left in a thermostatic chamber of 80%RH and at 30C for 48hours.
112	Rubber	Ground Tire	5	Standard-MID	200	4.3	22.3	0.08	0.36	Crush finely.

3. Windows TM communication software: WinCT-Moisture

"WinCT-Moisture", in combined use with heating and drying method moisture analyzer MX-50 and MF-50, manufactured by A&D, enables easy transfer of measurement data to PC through RS-232C for storage and analysis.
WinCT-Moisture (CD-ROM) is a standard accessory attached to MX-50, but it could also be obtained on its own under accessory No. AX-42
WinCT-Moisture, includes four operation modes:

(1) Data transmission softwares

? RsFig ???designed for graphic display of moisture content measurement procedure and results.

? RsTemp ???designed to automatically determine heating temperature of samples

? RsCom???data transmission software

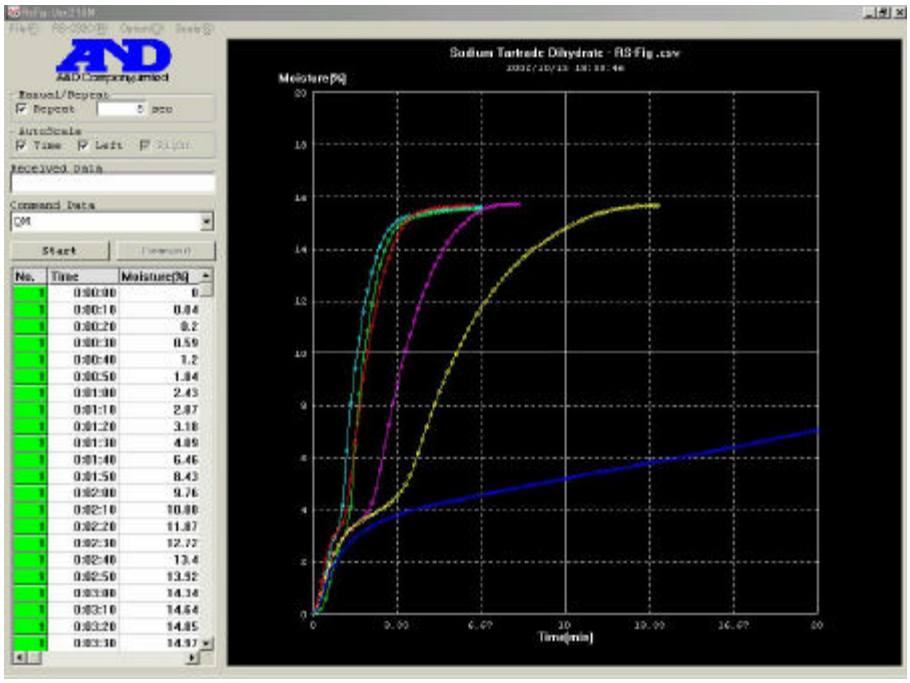
? RsKey ???data collection into other application software

Software	Details
? RsFig	RsFig processes data received from MX-50 and MF-50 through RS-232C into graphs during measurement. Users are able to observe the entire process of change and how it converges (convergence process). Overlapped display of multiple graphs is also possible. Processes of measurements performed repeatedly under different heating temperatures could be displayed in a single graph. Data could be stored in CSV files. A useful software for examining measurement conditions of moisture content.
? RsTemp	RsTemp automatically determines optimum heating temperature for measurement of moisture content, by raising heating temperature of MX-50 and MF-50 every 5minutes by 20C, from 100C to 200C. Heating temperature is automatically determined in about 30min. Moisture content (M) and moisture loss (dM/dt) is displayed in graphs during operation (measurement). Data could be stored in CSV files. RsTemp is a software useful for examining heating temperature most suitable for samples. **Patent pending.*
? RsCom	Data could be transmitted between MX-50/MF-50 and PC, through RS-232C. RsCom is a software useful for operating MX-50/MF-50. Data could be stored in text files. GLP output data could be received from the moisture analyzer.
? RsKey	Output data from MX-50 and MF-50 can be transferred to commercial application software (Microsoft Excel, etc.) through RS-232C. Output can be automatically entered in the same manner as with keyboard operation. Transferable to various types of applications, such as Excel, Text Editor (Word, notepad), etc. GLP output data could also be received from the moisture analyzer.

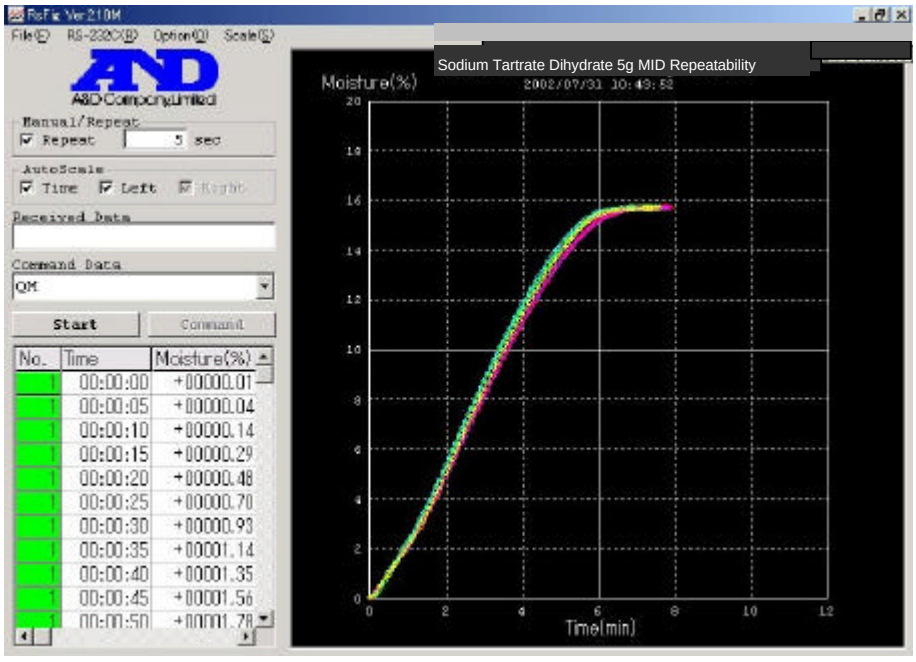
4. Display sample of RsFig

RsFig reads data of moisture content rate measurement process (CSV files) and processes it into graphs. The horizontal axis represents elapsed time from commencement of measurement (min.), while the vertical axis represents moisture content rate (%). Moisture content rate is calculated from decrease in sample quantity, caused by vaporization of moisture from heating. It is determined at a point where changes no longer occur (displayed on graph with planarized line). Measurement results can be graphed out overlapping one another, as shown below, in a single window.

Sodium Taratrate Dihydrate: heated from 100C to 200C, temperature raised by 20C.



Sodium Tartrate Dihydrate: measured five times at 160C heating temperature. All five moisture content measurement lines are shown overlapping one another, proving high repeatability.



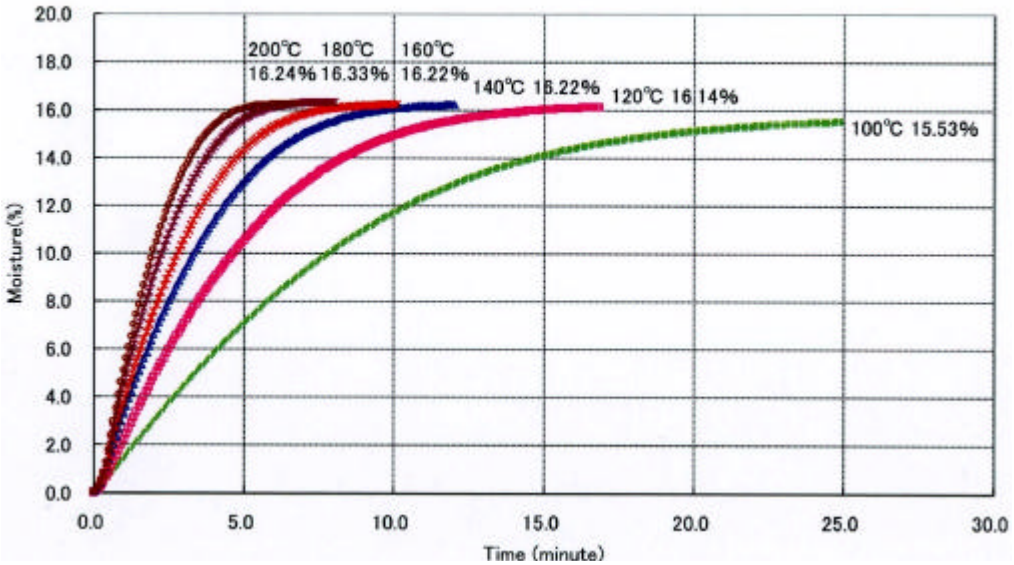
*Following are samples of measurement performed with RsFig.

Example 1: Final moisture content rate remains unchanged at different temperatures, due to the sample's high heat-resistance

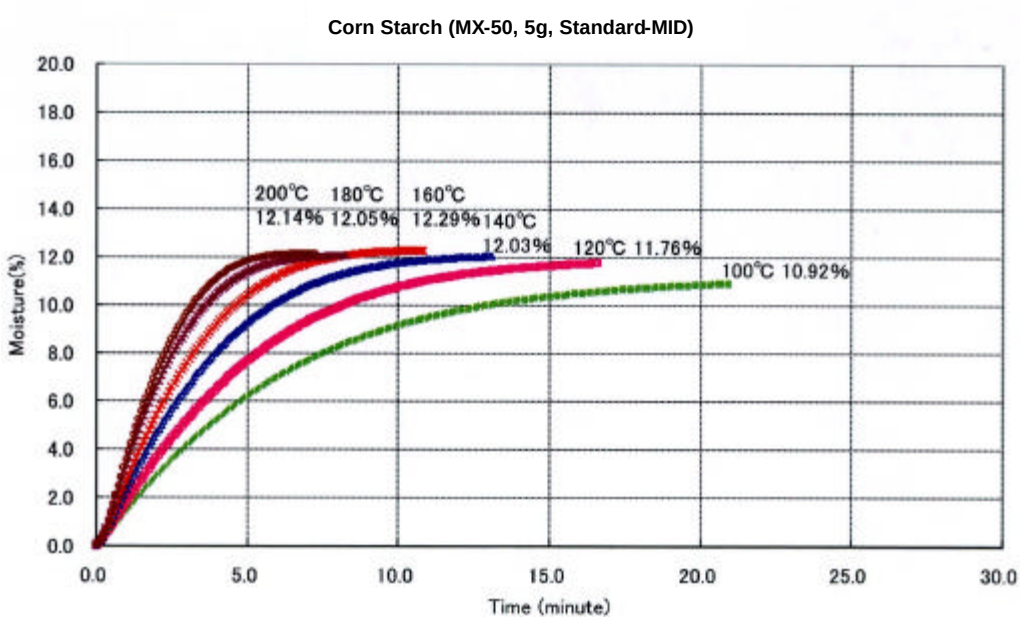
Measurement of such samples can be completed in a short time, by heating at the highest possible temperature.

Samples with similar measurement processes include Sodium Tartrate Dihydrate, hand soap, washing powder, soft flour, milk, etc.

Starch (MX-50, 5g, Standard-MID)



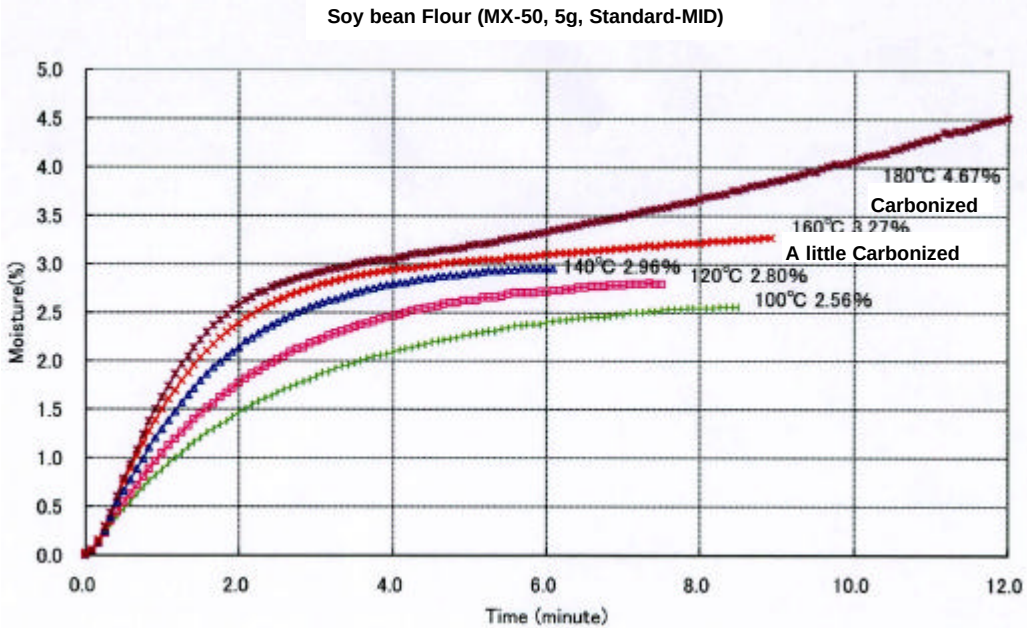
Corn Starch (MX-50, 5g, Standard-MID)

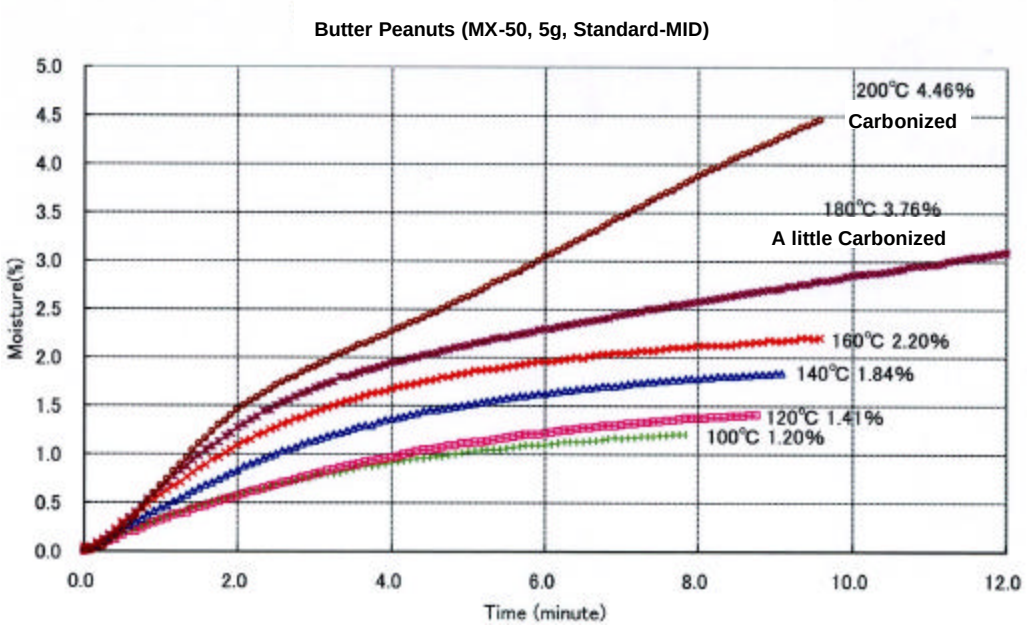


Example 2. Moisture content measurement curve inclines sharply from above a particular point in heating temperature

It is recommended that such samples be measured at a temperature where moisture content is stabilized and rapid changes in curve do not occur.

When stabilized moisture content curve re-inclines, it is assumed that materials other than water (additives, organic matter) vaporized. In such cases, excessively high temperature could lead to lack of credibility, repeatability and accuracy of measurement values.





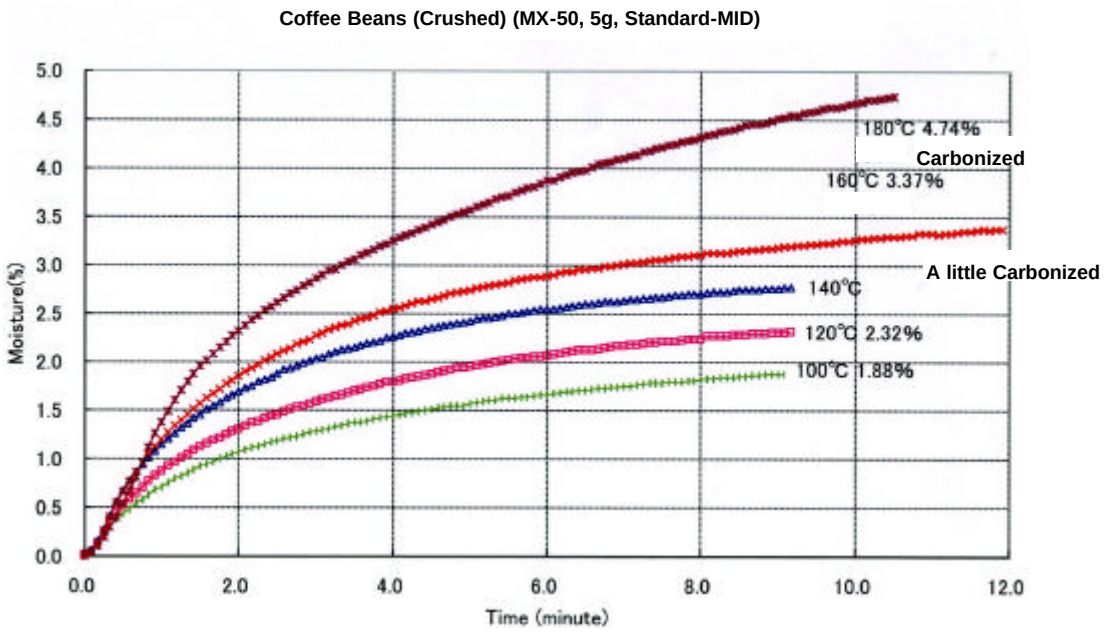
Example 3. Unable to determine stable heating condition by changing temperature setting

Suspected causes of this are high content of volatile oil (liquid) in sample or carbonization of sample surface, due to its darkness in color.

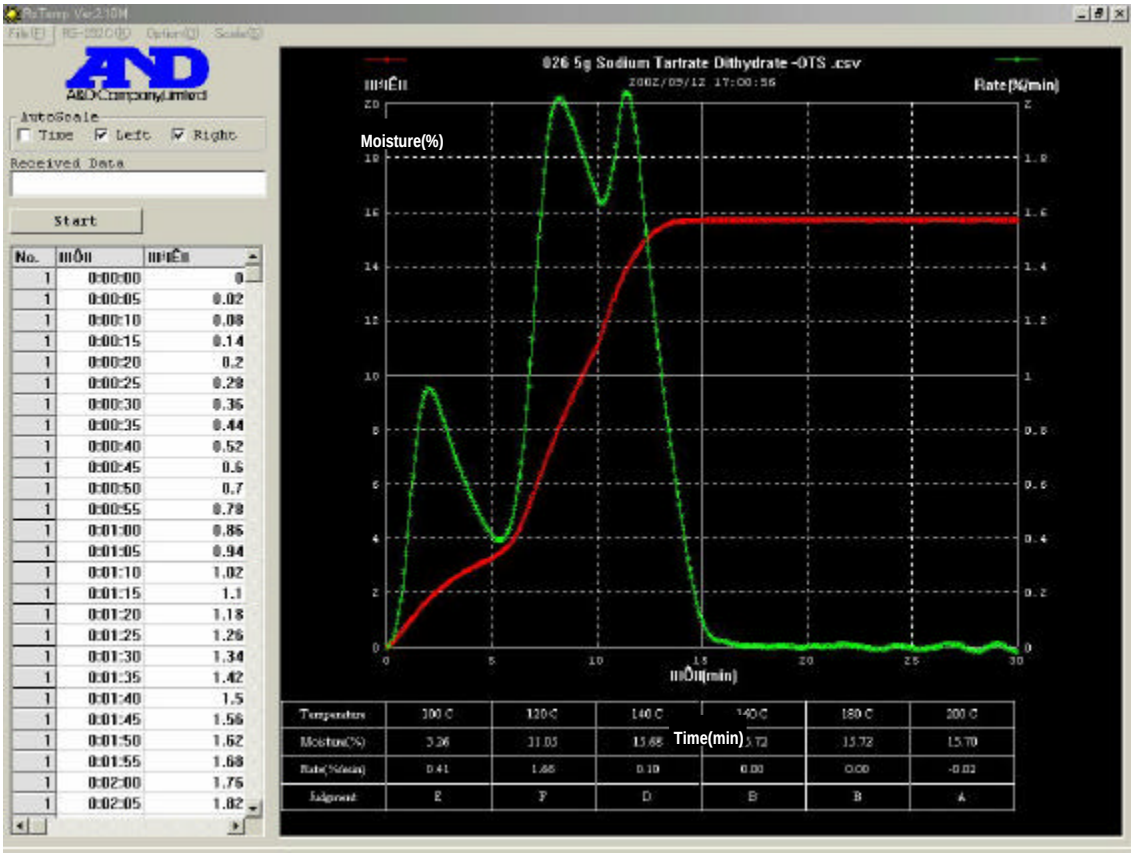
However, it is possible to measure and evaluate moisture content of such samples by measuring under the same conditions (sample quantity, heating temperature, measurement termination condition), with previously set heating temperature and measurement termination condition (terminates measurement when the moisture loss value per unit of time underruns certain conditions).

Meanwhile, carbonization of sample surface could be avoided by placing a glass fiber sheet on top of the sample, which enables heating under high temperature, therefore shortening measurement time and improving measurement accuracy.

Such samples include coffee beans and green tea.



5. Automatic determination of heating temperature by RsTemp



RsTemp is a “Heating temperature determination software”, which determines optimum heating temperature for measurement of moisture content using MX-50 and MF-50.
(OTS program: Optimal Temperature Search Program.)

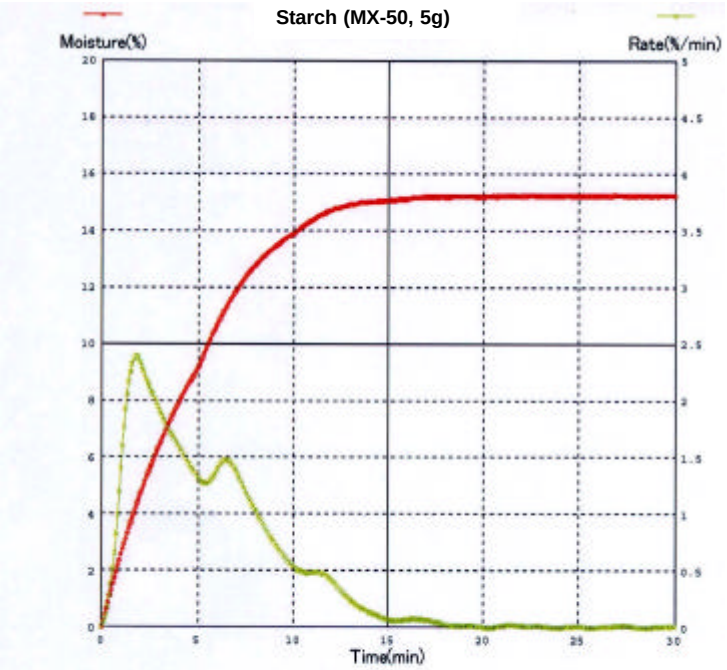
The graph shown above displays an example in which Sodium Tartrate Dihydrate is measured with RsTemp. Horizontal axis represents elapsed time. Moisture content is measured according to automatic increase of temperature every 5minutes, by 20C:
0-5min.: 100C, 5-10min.: 120c, 10-15min.:140C, 15-20min.: 160C, 20-25min.: 180C, 25-30min.: 200C.
Curve displayed in red shows change of moisture content, its value described with the vertical axis at the left. Change of inclination could be seen in change of heating temperature. Curve displayed in green plots inclination of moisture content curve (red) by 1minute (%/min.), its value described with the vertical axis at the right. In other words, the green curve shows the results of primary derivative of red curve (function) by time (t)=dM (t)/dt. (temperature T remains unchanged between each heating temperature zone).

Measured and calculated results are displayed in tables, below the graph. From the top column to bottom:
Temperature Heating temperature, automatically set.
Moisture (%) Moisture content rate
Rate (%/min.) Change of moisture content per 1min.
Judgment shows results of determining optimum heating temperature for moisture content measurement, its ranking given in alphabetical order (A,B,C,D,E,F). Temperature judged A would be the temperature most suitable for measurement of moisture content.

Heating temperature is judged upon results of measurement performed at different temperatures, evaluating stability of moisture content rate at each temperature (inclination of moisture content rate curve, or primary derivative value Rate (%/min.)).
RsTemp is a software designed to determine heating temperature most suitable for the sample, from measured and calculated results. However, it is important to take into consideration the importance of visual evaluation of sample condition by the test conductor, that is, to make a final decision on the suitable heating temperature based upon observance of sample during test, such as dissolution, carbonization, odor, fragmentation, etc.

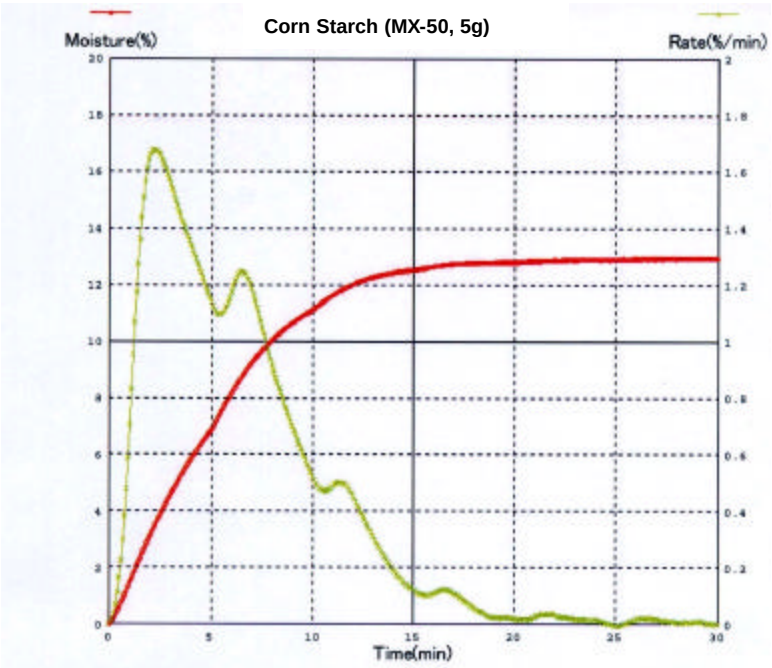
The following are examples in which heating temperatures are judged with RsTemp. *(Printer output*

Example 1: Final moisture content rate remains unchanged at different temperatures,



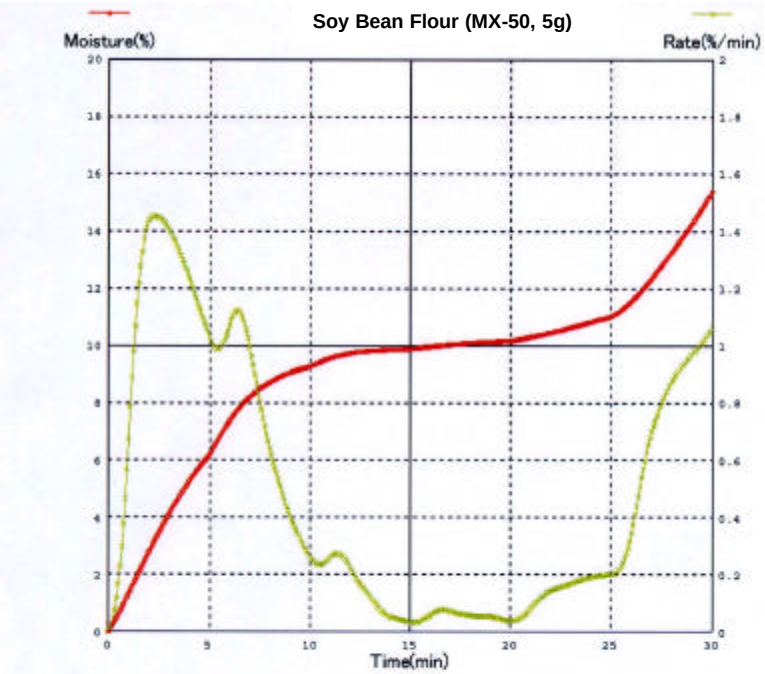
Temperature	100 C	120 C	140 C	160 C	180 C	200 C
Moisture(%)	9.11	13.88	15.05	15.20	15.22	15.22
Rate(%/min)	1.33	0.54	0.07	0.00	0.01	0.00
Judgment	F	E	D	A	C	A

The top graph displays results of measurement on starch, below on cornstarch.
The Rate(&/min.) constantly keeps low values at a higher temperature zone.
Measurement of such samples could be completed in a short time, by measuring at the highest possible heating temperature.
Samples with similar measurement processes include Sodium Tartrate Dihydrate, hand soap, washing powder, soft flour, milk, etc.

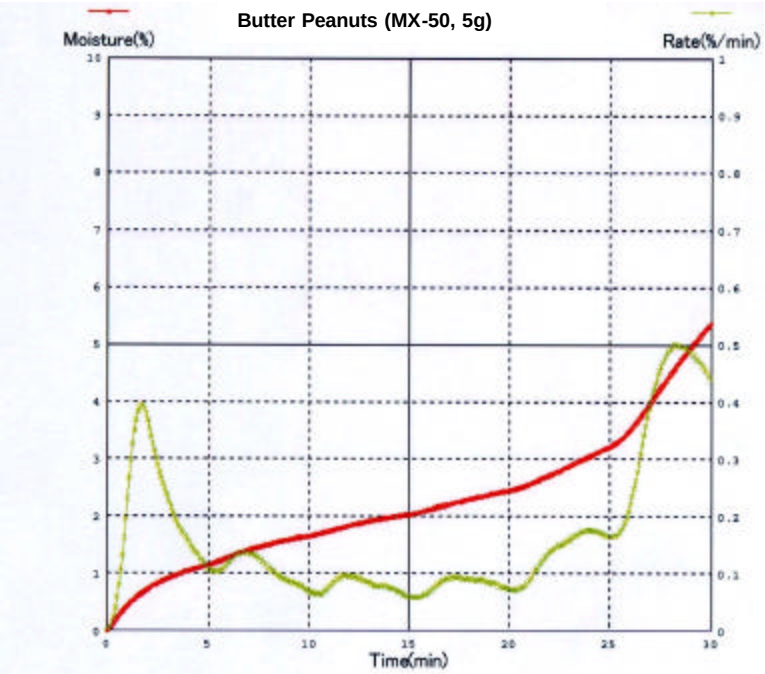


Temperature	100 C	120 C	140 C	160 C	180 C	200 C
Moisture(%)	6.87	11.10	12.51	12.79	12.88	12.93
Rate(%/min)	1.14	0.52	0.12	0.02	-0.01	0.00
Judgment	F	E	D	C	A	B

Example 2. Moisture content measurement curve inclines sharply from above a particular point in heating temperature



Temperature	100 C	120 C	140 C	160 C	180 C	200 C
Moisture(%)	6.19	9.25	9.88	10.17	11.02	15.39
Rate(%/min)	1.03	0.27	0.04	0.04	0.20	1.06
Judgment	E	D	A	A	C	F



Temperature	100 C	120 C	140 C	160 C	180 C	200 C
Moisture(%)	1.14	1.64	2.03	2.45	3.21	5.37
Rate(%/min)	0.11	0.07	0.06	0.07	0.17	0.44
Judgment	D	B	A	B	E	F

The top graph displays results of measurement on soy powder, below on butter peanuts.

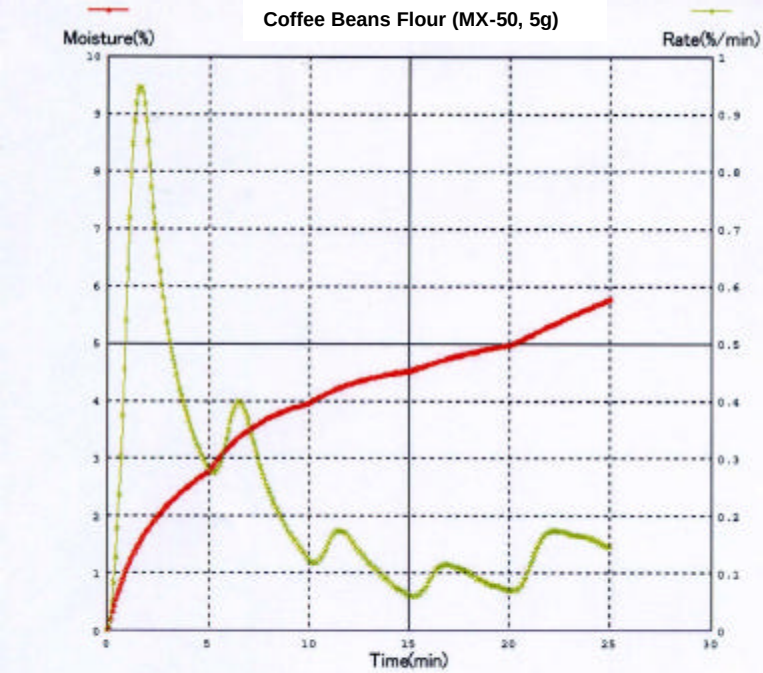
Rate (%/min.) increases shortly after commencement of heating, then decreases, setting at low values to increase again.

Suspected causes to this increase of Rate above 180C is that either ingredients other than water (liquid, additives, organic matter) have vaporized, or samples have started to carbonize.

In such cases, excessively high temperature could lead to lack of credibility, repeatability and accuracy of measurement values.

It is recommended that such samples be measured at a temperature where moisture content is stabilized and rapid changes in curve do not occur.

Example 3. unable to determine stable heating condition by changing temperature setting



Temperature	100 C	120 C	140 C	160 C	180 C	200 C
Moisture(%)	2.76	3.95	4.51	4.97	5.76	
Rate(%/min)	0.28	0.12	0.06	0.07	0.15	
Judgment	E	C	A	B	D	

This graph shows results of measurement on coffee beans.
Moisture content rate curve (red) does not stabilize into a planarized line. Derivative curve (green) increases and decreases after commencement of heating, re-increasing when heated above 180c. With such samples, continuous vaporization of other ingredients or carbonization is assumed to follow water vaporization.
Such samples are not suitable for measurement with heat and dry method moisture analyzer.
However, it is possible to measure and evaluate moisture content of such samples by measuring under same conditions (sample quantity, heating temperature, measurement termination condition), with previously set heating temperature and measurement termination condition (terminates measurement when moisture loss value underruns certain conditions).
Meanwhile, carbonization of sample surface could be avoided by placing a glass fiber sheet on top of the sample, which enables heating under high temperature, therefore shortening measurement time and improving measurement accuracy.
Such samples include coffee beans and green tea.

C. ¦ Maintenance

1. Halogen Lamp

No.	Q	A
1	How long can halogen lamps last?	About 5,000 hours. E.g. if you use a halogen lamp for 8 hours a day life time is 2 years.
2	Can I (a user) change the halogen lamp?	YES, you can replace it with A&D's optional accessory AX-34 for MX/MF per instruction manual.

2. Cleaning

No.	Q	A
1	Does stained glass housing affect moisture content rate measurement?	YES it may. Through stained glass heat conduction may not be good enough to heat sample evenly, which can lead to low repeatability. One of the MX's features is that it is easy to clean. When glass gets stained do the following: After the unit cools down remove SRA unit (glass) and clean inside with water-based or neutral detergent, not with organic solvent or disposable cloth. To replace the glass refer to "how to change halogen lamps" under "maintenance" in instruction manual.