



Committing to the future

Pocket Guide Food



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Testo AG, March 2011

Foreword

Dear reader,

we all consume food daily, and take it for granted that the producers offers us, as consumers, fresh and digestible goods. However, a considerable effort is involved in providing unrestricted enjoyment. Foodstuffs go through a complex process before we finally consume them. This requires legal standards, conscientious experts and the corresponding tools for testing quality.

Testo AG measuring instruments make a significant contribution towards taking foodstuffs safely through all processes. It is our objective to provide suitable measurement technology for the different requirements and applications of the professions working in the food sector. This was the idea for this "Pocket Guide Food". It summarizes questions frequently asked when dealing with food. Filled with much interesting information as well as tips and tricks from measurement practice, it is intended to be a useful practical assistant.

Enjoy reading!

A handwritten signature in blue ink, appearing to read "W. Schwörer".

Wolfgang Schwörer,
Director Division Portable Measuring Instruments



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1. Legal background

1.1 In the interest of world health

At the foreground of any dealings with foodstuffs are good quality, low germ content and pleasant taste. Raw materials and finished foodstuffs which are stored, transported and prepared, are, however, exposed to dangers such as damage and spoiling. Reports on food scandals draw public interest and reflect the risks involved in dealing with foods. At the UN (United Nations), the World Health Organization (WHO) has turned its attention to the subject of food safety and health.

“From farm to fork”

This is the ambitious definition of quality assurance in a WHO policy paper from the year 1992. In 1993, the “HACCP paper” was derived from this, valid for the whole of the European Union – the EU guideline 93/43/EU. This was replaced in 2004 by five regulations, and is today in force in the EU countries and their trade partners, without the need for the individual countries to make their own legislation.

EC 178/2002 =	General principles and requirements of the food law. Basic document for further directives and regulations.
EC 852/2004 =	Regulation of 29.04.04 regarding food hygiene.
EC 853/2004 =	Specific regulation governing foods derived from animals.
EC 854/2004 =	Specific process regulations for official monitoring of products derived from animals.
EC 882/2004 =	Regulation regarding official inspections to verify compliance with laws pertaining to food and animal feed.

Fig. 1: The regulations in European food law

1.2 HACCP

HACCP stands for:

Hazard **A**nalysis **C**ritical **C**ontrol **P**oints

Hazard analysis and critical control points

Why HACCP?

The objective of this concept is a minimization of food-related illness. Food should be made safer for the consumer. Reasons for food-related illness can be:

- Globalization (raw materials/import/export)
- Convenience products (semi-cooked products)
- Factory farming (salmonella)
- Mass tourism (unhygienic work, lack of time)
- Fast food, too many “producers” (street food)

In order to identify whether a food may become dangerous, we should ask ourselves the following questions:

- Does the product contain sensitive ingredients?
- Is it destined for sensitive target groups (the aged, the sick, infants etc.)?
- Is a process carried out in order to kill risk substances (sanitation, cooking)?
- Are there potentially toxic basic substances present (fungi, spores, proteins)?

The seven principles of the HACCP concept

The HACCP concept is based on self-monitoring. The HACCP concept is implemented effectively by means of a 7-point programme:

1. Determination of the relevant hazards (hazard analysis)
2. Identification of critical control points
3. Definition of limit values (only for CCPs)
4. Definition and implementation of efficient monitoring
5. Specification of corrective measures
6. Production of documents and records (documentation)
7. Designation of a regular verification process (self-monitoring obligation).

The HACCP concept draws a distinction between critical points and critical control points.

Critical points

Critical points (CPs) are those points in the process which, while they do not pose a health risk, can be regarded as critical actions; e. g. quality parameters, maintenance of specifications, identification.

Critical control points

Critical control points (CCPs) are points at which, with a high level of probability, a relevant health risk occurs as long as this point is not fulfilled (i. e. controlled) e. g. heating steps, sufficient cooling, monitoring of foreign bodies.

1.3 Obligations of the food trader

To whom does the EU regulation apply?

The regulation applies across all production, processing and distribution stages for foods and food exports. The food trader takes on a central role.

Who is a food trader?

A food trader is anyone involved in activities relating to the production, processing or sale of foods. It is irrelevant whether or not these companies are set up to make a profit, or whether they are in the public or private sector.

The central element of the obligations

Documentation

Food traders have the obligation to prove to the relevant authorities that they are conforming to the requirements of the regulation. They must ensure that the documents are up-to-date at all times, and that they are stored for an appropriate length of time.

Training

Food traders must ensure the following:

1. Company employees handling foods are monitored according to the nature of their work and are instructed and/or trained in food hygiene,
2. Those persons responsible for the development and application of this regulation or for the implementation of pertinent guidelines are given appropriate training in all areas of applying the HACCP principle, and
3. Compliance with all requirements of national laws regarding training programmes for employees in certain food sectors.

Traceability

The food and animal feed traders must be able to prove when, where and by whom the goods were harvested, produced, processed, stored, transported, used or disposed of. This can, under certain circumstances, include traceability back to the original producer, e. g. the farm. This process is known as “downstream”.



Traceability from the producer via several processing and trade steps to the shop, and from there to the consumer, is referred to as “upstream”.

This information must be made available to the relevant authorities on request.

Maintenance of the cooling chain for sensitive foods

In the case of foods which cannot be stored at room temperature without potential problems, the cooling chain may not be interrupted.

- Any deviations (e. g. during loading and unloading) are only permitted within certain limits (maximum 3 °C) and for a short period of time.
- In means of transport (e. g. containers, trailers, cargo holds of trucks) of a size larger than 2 m², or refrigerated rooms of a size larger than 10 m³, the temperature must be recorded.
- The thermometers used must be calibrated at regular intervals.

Commercial temperature limit values in Germany and the EU

Incoming Goods	Storage
$\leq +7$ °C	Fresh meat (hoofed animals, large game) $\leq +7$ °C
$\leq +4$ °C	Fresh poultry, rabbit, hare, small game $\leq +4$ °C
$\leq +3$ °C	Offal $\leq +3$ °C
$\leq +2$ °C	Ground meat (from EU businesses) $\leq +2$ °C
	Ground meat (prepared and sold on site) $\leq +7$ °C
$\leq +4$ °C	Meat preparations (from EU businesses) $\leq +4$ °C
	Meat preparations (prepared and sold on site) $\leq +7$ °C
$\leq +7$ °C	Cooked meat products, delicatessen $\leq +7$ °C
$\leq +2$ °C	Fresh fish $\leq +2$ °C
$\leq +7$ °C	Smoked fish $\leq +7$ °C
≤ -12 °C	Meat, fish – frozen ≤ -12 °C
≤ -18 °C	Meat, fish – deep-frozen ≤ -18 °C
≤ -18 °C	Deep-frozen products ≤ -18 °C
≤ -18 °C	Ice cream ≤ -18 °C
$\leq +10$ °C	Dairy products, recommended $\leq +7$ °C
$\leq +7$ °C	Baked goods with incompletely baked filling $+7$ °C
$+5$ to $+8$ °C	Eggs (from the 18th day after laying) $+5$ to $+8$ °C

Warm kitchen

Heat through (core temperature)	$> +70$ °C
Storage until service	$> +65$ °C

Cold kitchen

Storage until service $<+7\text{ }^{\circ}\text{C}$

Serving food

Hot dishes

For short-term service $\geq+65\text{ }^{\circ}\text{C}$

Cold dishes

Delicatessen, crudités,
cold cuts $\leq+7\text{ }^{\circ}\text{C}$

Unpreserved salads,
dressings (milk, eggs), desserts $\leq+7\text{ }^{\circ}\text{C}$

Ice cream $\leq-12\text{ }^{\circ}\text{C}$

Retention samples

Keep min. 1 week at $\leq-18\text{ }^{\circ}\text{C}$

Disinfection equipment

Water $\geq+82\text{ }^{\circ}\text{C}$

Fig. 2: Limit value table according to EU legislation.
These values are monitored by official bodies.

2. Measurement technology in the food industry

In the processing and storage of foods, temperature and hygiene play an essential part. A study carried out by a Belgian restaurant chain showed that in 56 percent of all cases of spoiled foods, incorrect refrigeration was the cause.

Hazards when processing food

1. Food is insufficiently refrigerated or heated.
2. Cooked food is stored for too long without refrigeration.
3. Refrigeration systems are overloaded.
Result: temperatures are too high.
4. Insufficient attention is paid to personal hygiene of employees.
5. "Clean" and "unclean" processes are not separated strictly enough.
6. Raw and heated foods are stored together.
7. Liquid from defrosting comes into contact with other food.

2.1 Germ growth

Dependence of germs on temperature for multiplication

The term "germ" refers to microorganisms capable of reproduction. These can only multiply within a specific temperature range.

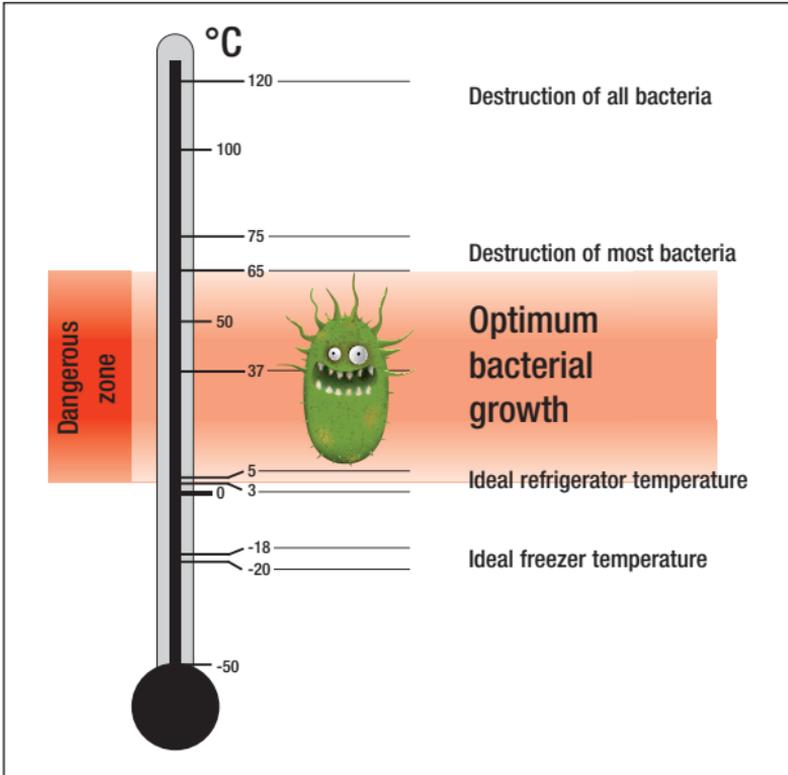


Fig. 3: Temperature-dependent germ growth

Germ growth	Temperature
Slows down	<7 °C
Stops, germs are “asleep”	-18 °C
Restricted	>40 °C
Die off	>65 – 70 °C
Dead (germ-free)	>125 °C

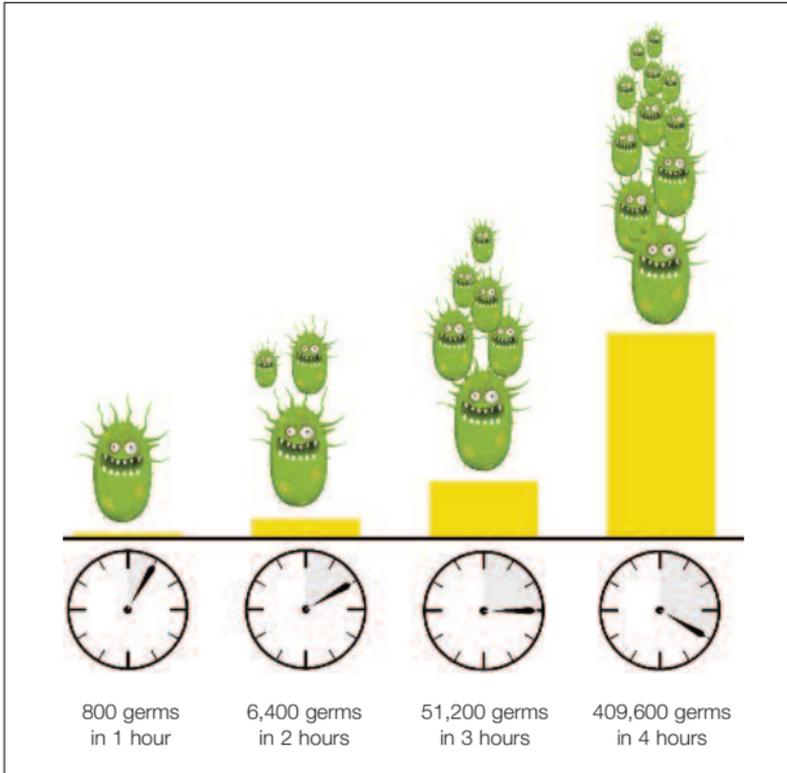


Fig. 4: Reproduction of microorganisms dependent on time

Bacteria multiply by dividing. In favourable conditions (depending on moisture and temperature) this occurs every 20 minutes.

Microorganisms – Little helpers or a health hazard?

Bacteria, fungi and microorganisms in general are useful helpers on the one hand (e. g. yeast used in bread making, bacteria which make sour milk, organisms which produce alcohol by fermentation

etc.). On the other hand, they can cause diseases (salmonella, E-coli, hyphomycetes etc.). The bacteria do so by using the same “food source” as human beings: our foodstuffs.

Germs occur naturally everywhere, and are harmless in small quantities. Only when excessive reproduction occurs (depending on the microorganism), does the consumer “notice” the presence of the germs, which manifests itself in the form of vomiting, diarrhoea or fever. In the following are a few examples of average germ contents in foodstuffs and consumer goods:

Total number per 10 square centimetres

Lettuce (unwashed)	10,000–1,000,000
Lettuce (washed)	1,000–100,000
Pork (fresh)	100,000
Pork (hung)	100,000,000
Weighing scales (butcher's)	750–4,000
Kitchen table	300
Kitchen cutlery (clean)	10–250
Palm of the hand (clean)	10–250

Total number per gram or millilitre

Tartar	100,000–30,000,000
Liver sausage	500,000
Italian salad	3,000,000
Onions chopped	20,000
Pepper ground	30,000–1,000,000
Milk pasteurized	to 10,000

Source: BERG, THIEL and FRANK, “Rückstände und Verunreinigungen in Lebensmitteln” (Residues and Contaminants in Foodstuffs), UTB 675, Steinkopff-Verlag, Darmstadt, 1987

2.2 What is being measured?

Temperature

After time, temperature is the physical variable most often measured. Different types of thermometer are used. Digital thermometers have established themselves in professional use. These are highly accurate and robust in everyday use.



Relative humidity

Relative humidity is particularly important in connection with the storage of dry goods for prolonged periods of time. Condensation can be caused, and foods can take on moisture, if they are stored in rooms for long periods of time. The result: mould growth.



a_w value

The a_w value provides information on chemically non-bonded water. The measurement is based on the equilibrium moisture. The relative humidity of the ambient air is determined by the free water contained in the solid in a closed room with a proportionally lower amount of air than solid. The water activity (a_w value) is virtually the same as the equilibrium moisture in an enclosed space. However, it is not stated in %RH, but in 0 to 1 a_w .



pH**pH value**

The pH value of foods has a direct effect on the growth of microorganisms. The pH value of meat, for example, is a valuable measure of quality. In many delicatessen and dairy products too, the pH value plays an important part in the acid content.

TPM**Cooking oil quality**

The properties and quality of cooking oil are altered mainly by the effects of heat and oxygen. Used cooking oil, for example, has a negative influence on the taste of the fried goods, and can lead to stomach pains or digestive complaints. However, cooking oil which is replaced too early, and which can still be used, causes unnecessary costs. For this reason, continuous measurement of the quality is essential in order to guarantee the best possible use of the cooking oil.

t**Time**

Time plays a large part in the monitoring of foodstuffs. Measuring instruments are used which either carry out single measurements or record data over a certain period.

2.2.1 Temperature

Temperature measurement is possible with contact probes or without contact.

Temperature contact measurement

The contact measurement of temperature can be carried out based on three different technical principles:

1. Thermocouple sensors, e. g. Type T, K, J
2. Platinum resistance sensors, e. g. Pt100
3. Thermistor sensors, e. g. NTC

Comparison of sensor types

	<i>Thermocouple Type T</i>	<i>NTC</i>	<i>Pt100</i>
Meas. range:	-50 to +350 °C	-50 to +150 °C (some up to +250 °C)	-200 to +400 °C
Response time:	Very fast	Fast	Slower
Accuracy:	Exact	Very exact	Extremely exact
Area of use:	Allrounder for food serving, Incoming goods & Kitchens	Refr. and freezer rooms, transport monitoring, Incoming goods, serving food	Laboratory

For every application there is the right probe (see appendix 4.3, page 54).

Contact-free temperature measurement

Infrared temperature measuring instruments measure the temperature without contact. However, due to the nature of the system, only the surface temperature is measured, and not the core temperature. The measurement result is extremely dependent on the surface of the goods/packaging to be measured. Larger measurement errors can occur in measurements on ice crystals and on polished and reflecting surfaces.

How does infrared measurement technology work?

Every object warmer than the absolute zero point temperature (-273°Kelvin) radiates heat energy. This heat energy is in the infrared range which is not visible to the human eye. Using special optical sensors, this heat energy can be measured and the temperature can be displayed.

Measuring instrument optics

Infrared measuring instruments are classified by their optics. This number, e. g. 8:1, describes the ideal distance between the measuring instrument and the object of the measurement. This means that at a distance of 8 cm, a measurement spot of 1 cm Ø is measured.

The larger this ratio, the greater the distance from the measurement object at which the measurement can be carried out. As a general rule, one must ensure that the measurement spot is not greater than the goods/packaging.



Fig. 5: Infrared measurement of surface temperature on foods

Stationary measuring instruments for temperature measurement on foods: Data loggers

If the requirement is not merely to measure data on the spot but to take measurements over a longer period, so-called data loggers are used.

What is a data logger?

- A data logger is an electronic measuring instrument with a memory and clock.
- A data logger records a reading at fixed intervals to be set by the user (e. g. every 10 minutes, every 30 minutes etc.) and stores it.

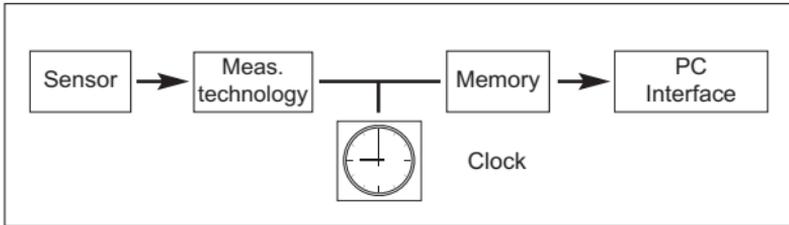


Fig. 6: Function of a data logger



Fig. 7: Use of data loggers

Legal requirements for temperature measuring instruments

According to regulation (EC) 37/2005, from the 01.01.2010 temperature measuring instruments for deep-frozen foods in transport, storage and distribution must comply with the following norms:

EN 12830 Requirements for temperature registration instruments

EN 13485 Requirements for thermometers

EN 13486 Test regulations for temperature registration instruments and thermometers

2.2.2 pH value

The pH value of foods has a direct effect on the growth of microorganisms. The acidity of certain fruits, salad dressings, jams or similar is a natural barrier to the growth of germs. The lower the pH value, the harder it is for germs to multiply. In bakery products such as sourdough, the pH value is an indicator of the quality and condition of the cooking dough.

However, the pH value is most important when it comes to processing meat and sausages. The pH value has a crucial effect on the key product properties such as the water binding capacity, taste, colour, tenderness and shelf life of the meat.

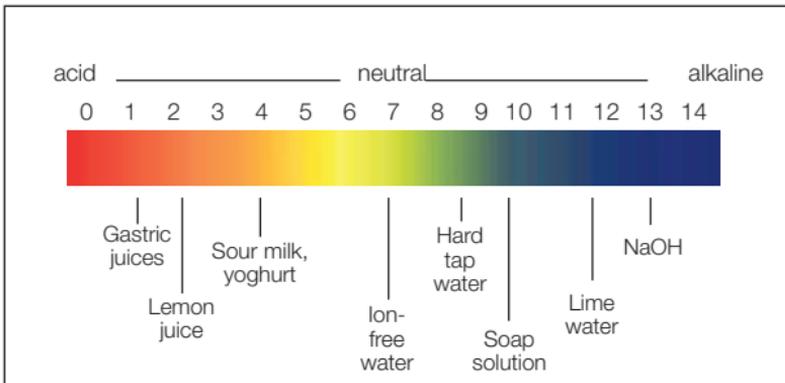


Fig. 8: pH scale with examples



Fig. 9: pH value measurement meat and sausage products

2.2.3 Relative humidity

The right storage conditions for foodstuffs are of great significance. Microbiological decomposition such as mould depends very much on the moisture present and is particularly likely to occur due to condensation following temperature fluctuations. Condensation is formed at an air humidity of over 100%. As the air is completely saturated, it cannot carry more moisture. The gaseous water vapour in the air liquefies. The warmer the air, the more water vapour it can hold without condensation being formed. For this reason, condensation always occurs first on cold surfaces. The so-called “relative humidity” shows how much of the maximum possible quantity of water vapour is present in the air at any given moment. Because this percentage depends on temperature, the temperature has to be stated at the same time. Probes used to measure relative humidity therefore have to be fitted with an additional temperature probe to record ambient temperature.



Fig. 10: Humidity measurement in supermarket shelves

2.2.4 a_w value

Significance of the a_w value measurement in foods

Water activity is a measure of the durability of a product with regard to a number of types of spoiling. Contrary to the simple water content, water activity is ideally suited to the evaluation of possible decomposition processes. It is a measure of the availability of water in the reactive medium of a product, and does not simply state the mass proportion of water. In all foodstuffs, a portion of the total water content is free, the rest is bound. The proportion of free water influences the a_w value. The free water is of crucial importance for the growth of microorganisms and their toxin production. However, there are limits under which growth and toxin formation are not possible.

Water activity, water content and food decomposition

Food examples

Substance	Water activity/ a_w range
Distilled water	1
Tap water	0.99
Raw meat	0.97–0.99
Milk	0.97
Juice	0.97
Boiled bacon	< 0.85
Saturated NaCl solution	0.75
Typical indoor air	0.5–0.7
Honey	0.5–0.7
Dried fruit	0.5–0.6

a_w values of microorganism growth inhibition

Microorganism growth inhibited	a_w
Salmonella	0.95
Most fungi	0.70
No microbe proliferation	0.60

Source: MOSSEL (1982) et al.: "Factors which determine microbial decomposition".

2.2.5 Cooking oil quality

Due to its composition and the various external influences, cooking fat is constantly exposed to chemical reactions during its life cycle (from adding fresh fat through to the replacement of the aged fat).

A fat molecule always consists of a glycerine (alcohol) and three fatty acids. During the deep fat frying process, the fatty acids are separated from the glycerine rest as a result of different reactions. In addition to free fatty acids, various decomposition products such as aldehyde and ketones are formed.

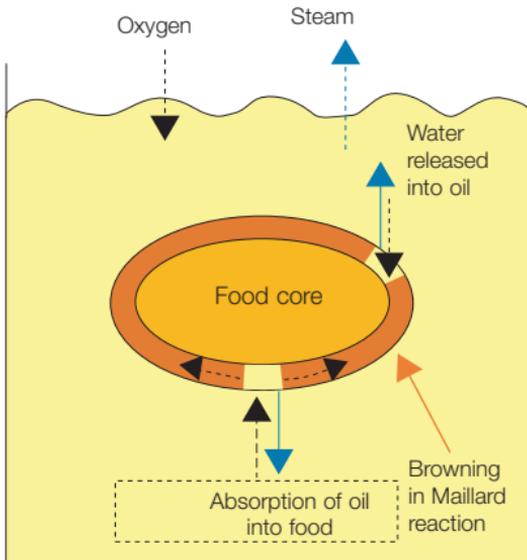


Fig. 11: Reactions between product being deep-fried and the oil during the deep frying process



The internationally recognized parameter for cooking oil quality is %TPM “Total Polar Materials”. In many countries, the permitted maximum TPM value is limited, e. g.:

Country	TPM value in %
Germany	24
Switzerland	27
Austria	27
Belgium	25
Spain	25
France	24
Italy	25
Turkey	25

The cooking fat can be used most effectively if the TPM value is measured. The oil can be kept in use until the nationally recommended limit value is exceeded, or it can be continually adjusted to the optimum frying range by partial replacement with fresh oil. This guarantees that the quality of the fried foods can remain constant. In addition to this, regular measurements can also preclude health risks and fines due to a failure to keep within the limit values.

Secure and fast TPM measurement on site

In addition to expensive and complicated laboratory analysis of TPM, there are also fast testing instruments available which allow reliable measurements on site. The technological principle involved is a capacitive sensor with which the polarity in the cooking oil is measured.

This allows conclusions to be drawn about the degree to which the oil has been used, and thus on its quality. The Euro Fed Lipid (European Federation for the Science and Technology of Lipids) recommends the use of such fast test instruments.

Percentage of polar substances	Fat aging level
Less than 1–14% TPM	Fresh cooking fat
14–18% TPM	Slightly used
18–22% TPM	Used, but still OK
22–24% TPM	Heavily used, change the fat
More than 0.24 % TPM	Spent cooking fat



Fig. 12: Measurement of the TPM value in cooking oil with the testo 270

3. Tips and tricks

3.1 Practical tips on using food measuring instruments

3.1.1 Temperature

Where is the best place to store the instrument?

The instrument should be stored at ambient temperatures between +4 °C and + 30 °C. Storage in an office (department office, workshop etc.) is recommended. If the instrument is only used for measuring in the Incoming Goods department, it can also be stored there. Advantage: the instrument always remains at the ambient temperature and does not need an equalization period.



Never store the measuring instrument in a deep-frozen room!

How do measuring instruments react to fluctuating ambient temperatures?

Measuring instruments with thermocouple sensors, and infrared measuring instruments, are dependent on the ambient temperature. If the instrument is only exposed to a cold environment briefly (1 to 2 minutes), the fluctuation in temperature is negligible. If the instrument is exposed for a longer time, it will need an equalization period of 15 to 20 minutes.

How deep should a probe be inserted?

Measurements with penetration probes on non-frozen food

In order for the heat to be transferred properly from the food to the probe, the probe should be inserted at least 5 times (even better 10 times) its diameter into the material.

Example: Diameter of the probe tip = 4 mm

Penetration depth = 4 mm x 5 = 20 mm

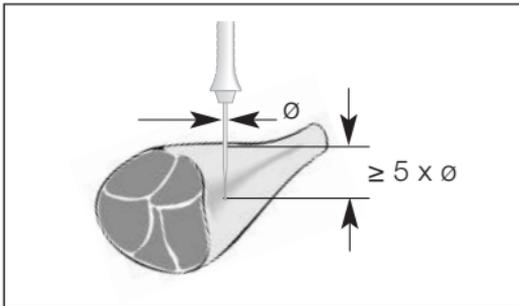


Fig. 13: Penetration depth for measurements with penetration probes

Measurements in frozen food with special probe

A special frozen food probe is available for measurements in hard, frozen food. It has a corkscrew tip. This is screwed in until the thread is no longer visible.



Measure only on sufficiently large pieces of meat (at least 2 kg weight). Not suitable for pizza, steak, fillets etc.

Proper use of a surface probe

A widened measurement tip which can be placed onto the surface is needed for correct surface measurement.

Response time

Each probe requires a certain amount of time to reach the final temperature value for the food which it is measuring. The technical name for this value is the t_{99} time and it is given in catalogues and brochures, however it refers only to measurements in water. In foods, this value is higher (approx. 15 seconds to 3 minutes, depending on the design of the probe, the materials and the thickness of the probe shaft).

Probe accuracy at different temperatures

<i>Accuracy specification</i>	$\pm 0.2\text{ }^{\circ}\text{C}$ $\pm 0.2\%$ of m.v.	$\pm 0.2\text{ }^{\circ}\text{C}$ $\pm 0.2\%$ of m.v.
<i>Display at $-18\text{ }^{\circ}\text{C}$</i>	-17.8 to $-18.2\text{ }^{\circ}\text{C}$ -17.96 to $-18.04\text{ }^{\circ}\text{C}$	-17.76 to $-18.24\text{ }^{\circ}\text{C}$
<i>Display at $+25\text{ }^{\circ}\text{C}$</i>	24.8 to $25.2\text{ }^{\circ}\text{C}$ 24.98 to $25.05\text{ }^{\circ}\text{C}$	24.75 to $25.25\text{ }^{\circ}\text{C}$
<i>Display at $+100\text{ }^{\circ}\text{C}$</i>	99.8 to $100.2\text{ }^{\circ}\text{C}$ 99.8 to $100.2\text{ }^{\circ}\text{C}$	99.6 to $100.4\text{ }^{\circ}\text{C}$

A measurement is finished when:

1. The required minimum value is reached.
2. The Auto-Hold function fixes the final value in the display.
3. The last position in the display does not fluctuate by more than \pm one digit.



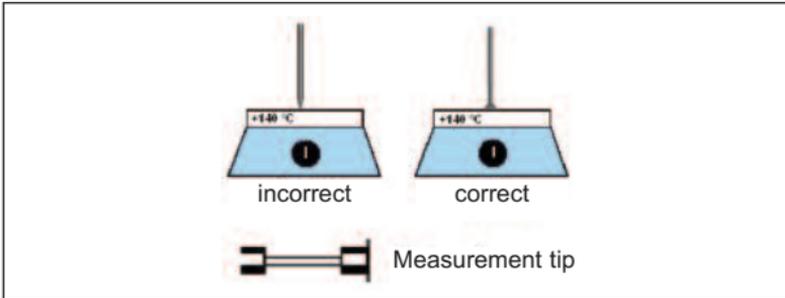


Fig. 14: Application of a surface probe

Non-contact measurement of packaged foods

In non-contact measurement of temperature using infrared measuring instruments, it is particularly important to remember that only the surface is measured. In foods packaged in cellophane, only the cellophane temperature is measured. It is therefore recommended that you should only take the measurement at points which are in direct contact with the food. For cardboard packaging, the box must be opened in order for the measurement to be made directly on the object. Measurement errors can also occur in measurements on ice crystals and on polished and reflecting surfaces.

Legal safeguard for non-contact temperature measurement

Non-contact temperature measurement is a good method of monitoring temperature. However, as a legal safeguard, the core temperature must be measured using contact thermometers.

The correct distance for non-contact measurement

The optics describe the ideal distance between the measuring instrument and the measurement object. A short distance is required for the measurement of small objects, and vice versa.

Examples for a measurement object with 30:1 optics:

Small measurement object with \varnothing 1.8 cm \rightarrow ideal distance: 50 cm

Large measurement object with \varnothing 6.8 cm \rightarrow ideal distance: 2 m

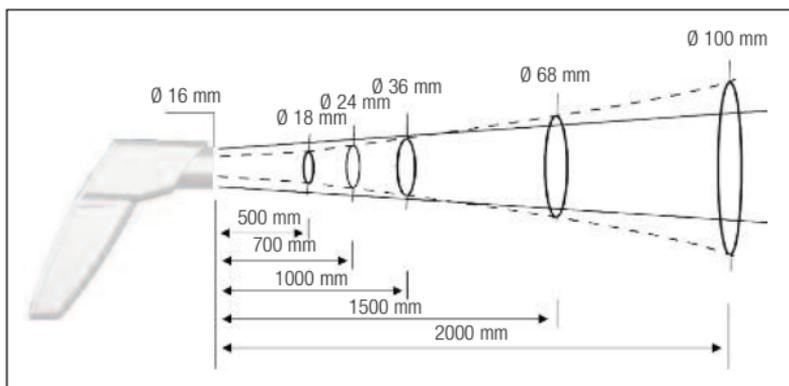


Fig. 15: 30:1 optics of the infrared measuring instrument testo 831

Tips on the selection of measurement sites for data loggers

Suitable measurement sites must be selected depending on the measurement task.

Chest freezers

As well as the product temperature, the air temperature in the freezer is important. It is advisable to measure the air temperature in the vicinity of the air recirculation using a suitable probe (air probe). This is where the air is warmest. If the air here has the correct temperature (e.g. $-18\text{ }^{\circ}\text{C}$), the chest freezer can be assumed to be working properly. Data loggers with several input channels are recommended for monitoring chest freezers over a longer period of time. One probe measures the air temperature at ground level, another at the maximum load line, while a third measures the air temperature at the air recirculation. For simple monitoring, it is sufficient to place a data logger with an internal sensor in with the frozen goods.

Cold rooms, store rooms

As well as monitoring the air temperature and product temperature (core temperature of the chilled goods), the use of a data logger is recommended. For chilled and deep-frozen rooms which are larger than 10 m^3 , data recording is even compulsory. According to EN 12830, 15 minutes are considered a suitable measurement interval. The limit values for a data logger are set to the maximum acceptable temperature ($-18\text{ }^{\circ}\text{C}$, $-15\text{ }^{\circ}\text{C}$). If overly high values are detected, the data logger can be read out on the PC. A graph provides a precise picture of when the measurement data strayed over the permissible limits and for how long.

3.1.2 Cooking oil measurement with the testo 270 – The right way to measure

Preparation



⚠ Plastic components may not come into contact with the cooking oil.



⚠ Do not touch the hot probe. Danger of burn injury!



Remove fried goods before measuring.

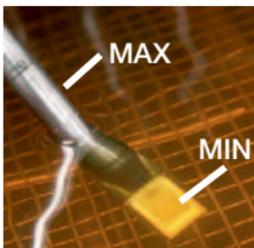


Wait until bubbles no longer rise to the surface (approx. 5 min.).

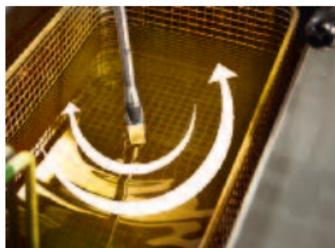
Measurement



Switch instrument on
[⏻/Hold]



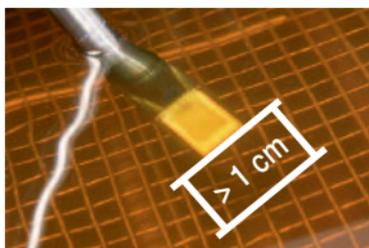
Immerse sensor in hot oil.
Observe min/max marks!



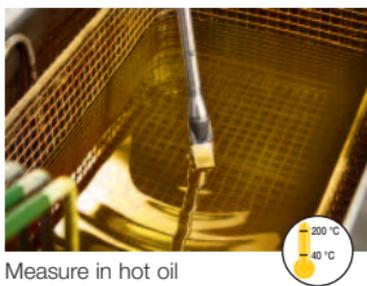
1. Move sensor in oil (adjustment time approx. 20 s)

Auto Hold activated:

- Auto Hold in the display indicates the end of the measurement. If set, an audible signal additionally sounds.
- Final value is fixed.



Observe minimum distance of 1 cm to metal objects.



Measure in hot oil (min. 40 °C, max. 190 °C).



Auto Hold deactivated:

- When the temperature display no longer changes, a stable TPM final value has been reached.
- 1. To fix measurement values: press briefly [◊/Hold] (< 1sec)
- 2. To return to measurement mode press briefly [◊/Hold] (< 1sec)



Note the recorded measurement values.

Free download of the form for recording your measurement results at: www.testo.com/measurement-results

Cleaning



Clean instrument with mild detergent. Rinse sensor under running water and dry carefully with a soft paper towel.



The TopSafe and hand strap can be conveniently cleaned in the dishwasher.

Which oils or deep-frying fats can be measured?

In principle, all oils and fats intended for deep fat frying can be measured. This includes, for example, rapeseed, soya bean, sesame, palm, olive, cotton seed or peanut oil, as well as animal fats. The starting values may be higher for pure coconut oil (from the core flesh of the coconut) and palm seed oil (not to be confused with palm oil). Coconut oil and palm seed oil are usually used to make margarine and rarely for deep fat frying. However, a correct measurement is still possible.



Today, natural oils are hardly ever used, instead special strains from rape and sunflower plants with a high oil acid content, so-called “blends” or HO oils (High Oleics), are employed. These cooking oils are especially long-lasting and heat-stable.

3.1.3 pH value measurement

Carrying out a measurement

Before commissioning, first the condition of the measuring instrument and the electrodes should be checked optically. If necessary, the measuring system can be calibrated according to the manufacturer's instructions.

After this, the following procedure should be followed:

1. Select the right electrode and instrument for the application.
2. Check the electrode (liquid level, glass breakage, open sealing plug before measuring).
3. Connect electrode to the pH measuring instrument.
4. Rinse electrode with water and dry off. Drying can cause electrical charging on the glass membrane, leading to a delay in display.
5. Immerse electrode in the measurement solution and stir briefly, then leave to stand. Immerse the electrode so deep that at least the diaphragm is covered by the measurement solution. It is possible that a slightly different pH value is displayed in stirred solutions than in standing solutions. The "unstirred" pH value is usually more accurate. For probes with a protective cage, it must be ensured that there are no air bubbles attached to the glass membrane or the diaphragm.
6. Wait until a stable value has been reached (e. g. with the help of an automatic Hold function), and read off value.
7. Rinse electrode with tap water, and store according to the manufacturer's specifications.

8. The temperature of the measurement solution must be documented with the pH value. This applies to all pH measurements and all pH measuring instruments. For instruments with a fixed electrode, it is not necessary to connect the electrode to the measuring instrument.

Storage



A single-rod measuring cell should always be stored in the solution which is also used in the reference system.

Recognizing aging symptoms in the pH electrode:

- Increase in reaction time of electrode
- Increase in sensitivity towards friction on the glass membrane (electrostatic influences)
- Increase in cross-sensitivity of the electrode e. g. towards sodium ions
- Decrease in steepness¹
- Change in zero-point voltage²

1) The voltage change when a pH value changes by one unit is described as the gradient of the pH electrode. This is also dependent on the condition of the pH electrode (age, load etc.)

2) A single-rod measuring cell is characterized by its gradient and zero-point voltage. While the zero-point voltage is a constant in good electrodes, the gradient of the pH electrode is a function of the temperature. A pH electrode must be calibrated regularly, as its zero-point and its gradient can change as a result of the external measurement conditions and the natural aging process.

Possible causes for measurement errors:

- Evaporation of reference solution
- Leakage of measurement solution into the electrode
- Defective or blocked diaphragm
- Defective or incorrect reference electrolyte
(only for refillable electrodes)
- Incorrect storage

What are buffer solutions?

Buffer solutions are needed for testing and for the calibration of a pH measurement system. They are called buffer solutions because they keep the pH value very stable, i.e. they “buffer” it.

3.1.4 a_w value measurement

How do I obtain reliable measurements?

An accurate a_w measurement is guaranteed when the temperature of the measurement chamber, sensor and item being measured are identical during or before the measurement (the equalization period with temperature differences between the probe and sensor should be observed). A measurement at a constant temperature (e. g. 25 °C) is recommended.

Influence of temperature on the a_w value

A generalized statement on the influence of temperature on the a_w value cannot be made. The influence of temperature on the a_w value is dependent on the type of goods being measured. There are products whose a_w value increases with increasing tempera-

ture (e. g. flour), products whose a_w value sinks with increasing temperature (e. g. lactose) and products which show no temperature-dependency.

Duration of the measurement

The duration of the measurement can be different depending on the measurement goods. The a_w value measurement is ended when there are no more changes within a defined period.

Filling level

The measurement chamber should be at least half filled.



In principle, the a_w value can be measured when the goods to be measured are hygroscopic. Substances which absorb or disperse water in humid air with a relative humidity of <100% are described as hygroscopic. Sand, for example, cannot absorb water, so it is not hygroscopic. An a_w value measurement in sand is therefore not possible.

3.2 Calibration and official calibration

Calibration/official calibration – who needs what?

Calibration means comparing the measuring instrument (with a connected probe) to a reference instrument. Calibration provides information on the extent to which the measurement value displayed by a measuring instrument or a measurement system (i.e. the stated nominal value of a material measure) corresponds to the respective correct value of the measurement parameter. The “correct” value is represented by a reference norm, which in turn is based on a national norm and thus on the respective SI unit (SI unit = international metric system).



Fig. 16: Calibration seal

The discrepancies are recorded on a calibration certificate. A calibrated instrument is required for performing measurements in accordance with HACCP/the Food Hygiene Ordinance. Calibrations may be performed by all authorised calibration centres.



A core feature of ISO 9000 is the calibration of measuring and test equipment at regular intervals. Since temperature is one of the critical control points in HACCP, the thermometers used should also be calibrated at regular intervals.

Official calibration means “calibration by an authority”. The Board of Weights and Measures calibrates specially approved instruments and probes. The instrument and probe are given a calibration mark that is visible to the user. In this case the calibration certificate is referred to as an official calibration certificate. Food inspectors, veterinarians and other people working on behalf of the government need officially calibrated instruments.

Testo Industrial Service carries out ISO, DAkkS calibrations, and official calibrations for all measuring instruments.

4. Appendix

4.1 Glossary

A

Absolute humidity

The absolute humidity states how many grams of water are in a cubic metre of air or gas.

Accuracy

The measurement error, i.e. the accuracy, can be stated in three different ways:

- **Absolute specifications:**
In the measuring range, each reading that is read off can have a maximum tolerance of e.g. ± 0.2 °C.
- **Percentage specifications:**
In the measuring range, each reading that is read off can have a tolerance of e.g. ± 0.3 %.
- **Accuracy specifications with an absolute and a percentage part:**
In the measuring range, each reading that is read off can have a maximum basic tolerance of e.g. ± 0.2 °C. In addition, a fault of e.g. ± 0.5 % of the reading occurs, which is added to this.

a_w value

The a_w -value, also known as water activity, is a measure of the freely available water in a material, and the shelf life of foodstuffs. It influences the occurrence of microorganisms which have diffe-



rent requirements regarding freely available water. Depending on the availability of free water, the microorganisms can reproduce or die off.

C

Calibration

Procedure in which the measurement values of an instrument (actual values) and the measurement values of a reference instrument are recorded and compared. The result allows conclusions to be drawn about whether the actual values of the instrument are in a permitted limit/tolerance range.

Celsius [°C]

Temperature unit. Under normal pressure, the zero point of the Celsius scale (0 °C) is the freezing temperature of water. A further fixed point for the Celsius scale is the boiling point of water at 100 °C.

$$^{\circ}\text{C} = ({}^{\circ}\text{F} - 32) / 1.8 \text{ or } ^{\circ}\text{C} = \text{K} - 273,15.$$

D

Data loggers

A data logger is a storage unit which records data at certain intervals and saves them in a storage medium. The data logger is often combined with sensors which record measurement data over a certain period, such as temperature and relative humidity.

E

EU

European Union. Economic union of 27 European states.

F

Fahrenheit [°F]

Temperature unit used mainly in North America

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 1.8) + 32.$$

Example 20 °C in °F: $(20\text{ }^{\circ}\text{C} \times 1.8) + 32 = 68\text{ }^{\circ}\text{F}$.

G

Germs

Microorganisms capable of life and reproduction.

H

HACCP

HACCP is the abbreviation for “Hazard Analysis Critical Control Points”.

I

Infrared temperature measurement

All bodies radiate heat energy. Using special optical sensors, this heat energy (infrared radiation) can be measured and the surface temperature can be displayed.

K

Kelvin [K]

Temperature unit.

0 K corresponds to the absolute zero point (-273.15°C). The following applies: $273.15 \text{ K} = 0 \text{ °C} = 32 \text{ °F}$.

$\text{K} = \text{°C} + 273.15$.

Example 20 °C in K: $20 \text{ °C} + 273.15 \text{ K} = 293.15 \text{ K}$

M

Maillard reaction

The Maillard reaction (named after the chemist Louis Camille Maillard) is a so-called non-enzymatic browning reaction. It involves the conversion of amino acids and reducing sugars into new compounds. It should not be confused with caramelization, however both reactions can occur together.

O

Official calibration

Official calibration means “calibration by an authority”.

P

pH value

The pH value is a measure for the acidic or alkaline reaction of an aqueous solution. The pH value is a dimensionless number. It is the negative decadic logarithm of the hydrogen ion activity.

R

Relative humidity (%RH)

Percentage specification of the water vapour saturation level of the air. For example, at 33 %RH, the air contains only approx. 1/3 of the maximum water vapour quantity which could be carried by the air at the same temperature and the same air pressure.

Resistance sensors (Pt100)

When performing temperature measurements with resistance sensors, the temperature-dependent change in resistance of platinum resistors is used. The measuring resistor is supplied with a constant current, while the voltage drop, which changes with the resistance value as a function of the temperature, is measured. Basic values and tolerances for resistance thermometers are specified in IEC 751.

T

Temperature

State function for the energy contained in a body.

Thermistors (NTC)

Temperature measurement with thermistors is likewise based on a temperature-dependent change in resistance of the sensor element. Unlike resistance thermometers, thermistors have a negative temperature coefficient (resistance falls as temperature rises). Characteristic curves and tolerances are not standardised.



Thermal elements

Temperature measurement with thermocouples is based on the thermoelectric effect. Thermal elements (thermocouples) consist of two wires of different metals or metal alloys which are spot-welded to each other. The basic values of the thermoelectric voltages and the permitted tolerances of thermocouples are specified in the IEC 584 standards. The most widely used thermocouple is NiCr-Ni (the type is referred to as K).

TPM

Stands for "Total Polar Material" and states the polar proportion in cooking fat which can be measured using a capacitive procedure.

U

UN

United Nations Organization. International union of 192 states. Internationally recognized organization for ensuring world peace, the observance of public international law and for the protection of human rights.

W

WHO

World Health Organization. Special UN organization for international health, with headquarters in Geneva.

Z

Time

Physical parameter with the formulaic symbol t .



4.2 Testo measuring instruments for food

Location	Temperature			Analytics			
	Contact	Infrared	Stationary	pH	TPM	Humidity	aw
<i>Incoming goods</i>							
	t 104 t 105 t 106 t 110 t 112 t 926	t 826 t 831 t 845		t 205 t 206			
<i>Manufacturing process</i>							
	t 103 t 104 t 105 t 106 t 110 t 735 t 926	t 826	t 175	t 205 t 206 t 230	t 270		t 650
<i>Refrigerator and deep-freeze chests and glass cabinets</i>							
	t 104 t 110 t 735 t 926	t 826	t 174			t 177-H1	
<i>Food processing in the kitchen</i>							
	t 103 t 104 t 106 t 926	t 805 t 826 t 831 t 845					

Location	Temperature			Analytics			
	Contact	Infrared	Stationary	pH	TPM	Humidity	aw
<i>Deep-frying</i>							
					t 270		
<i>Refrigerated rooms, storerooms</i>							
	t 105 t 110	t 805 t 826 t 831 t 845	t 175 Saveris			t 177-H1	
<i>Transport</i>							
		t 805 t 826 t 831 t 845	Saveris			t 177-T3	
<i>Quality assurance and laboratories</i>							
	t 103 t 110 t 112 t 735	t 805 t 831	t 174 t 175	t 206 t 230	t 270	t 177-H1	t 650

Find more Testo measuring instruments on the internet at www.testo.com

4.3 Probe designs and their applications

Immersion/penetr. probes	Air probe
 <p data-bbox="163 487 512 749">Immersion/penetration probes are designed specifically for measuring temperature in liquids and semi-solid substances (meat, fish, dough etc.) With sufficient time, they are also suitable for air measurements.</p>	 <p data-bbox="557 487 906 749">Air probes are specifically intended for measuring air temperatures in cold shelves, chest freezers or air conditioning systems (air output temperature), or in the area of ventilation (air input/output), for example.</p>
Surface probe	Screw probe
 <p data-bbox="163 1048 512 1172">A wider tip is needed to measure surface temperature (on packs, packaging, frozen food, hotplates etc.).</p>	 <p data-bbox="557 1048 906 1244">To measure the temperature inside frozen food, a probe must be inserted into the food. As a rule, a hole must be drilled in order to insert the penetration probe.</p>



The current addresses of our subsidiaries and agents worldwide can be found at www.testo.com.