Testo Food Solutions
White Paper
Cooking oil management

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Rising cooking oil costs: How food companies can optimise their cooking oil management.

1 Rising cooking oil prices – a challenge for food companies

Whether it's crispy fries, crunchy nuggets or sugary, deep-fried pastries – deep-fried foods are among the most popular foods worldwide. They are characterised by their special crust and their very own unique aroma. A variety of chemical reactions are responsible for creating this typical frying flavour. Because the food absorbs some of the fat during frying, the quality of the oil is an essential factor in creating the delicious taste.

However, those who do a lot of frying are currently facing a particular challenge: Suitable vegetable oil has never been so expensive. Prices for cooking oil have doubled or even tripled during 2021 and have been at an all-time high since 2015.[1]

In view of this development, restaurant chains, operators of large-scale industrial kitchens and canteens, food manufacturers and supermarkets with in-house production are looking for ways to improve their oil's lifecycle. Ideally, the total consumption of cooking oil can be reduced so that businesses with frying processes can save money while at the same time ensuring that the fried food is of a standardised quality. In this white paper, Testo's experts present solutions for efficient cooking oil management, to ensure that your customers can continue to enjoy the familiar aroma of your fried products.

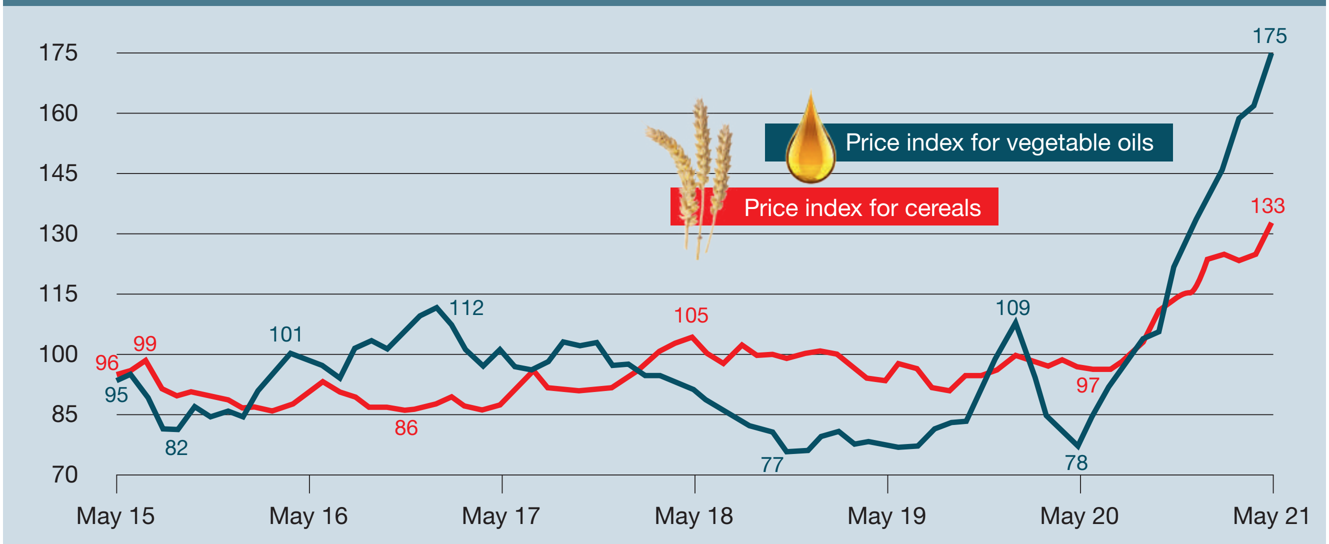
2 Background and consequences of rising vegetable oil prices

2.1 Overview of the figures

In early 2020, oil prices were lower than they had been for years. This was followed by an incredible price increase during 2021. This is according to the *Vegetable Oil Price Index report published by the* Food and Agriculture Organisation of the United Nations (FAO).[1]

Fig. 1 shows the average price trend of these oils during the period from 2015 to 2021. The index reached an average value of 175 points in May 2021. This corresponds to an increase of almost 8% compared with the previous month – and of around 224% compared with the same month of the previous year.[2]

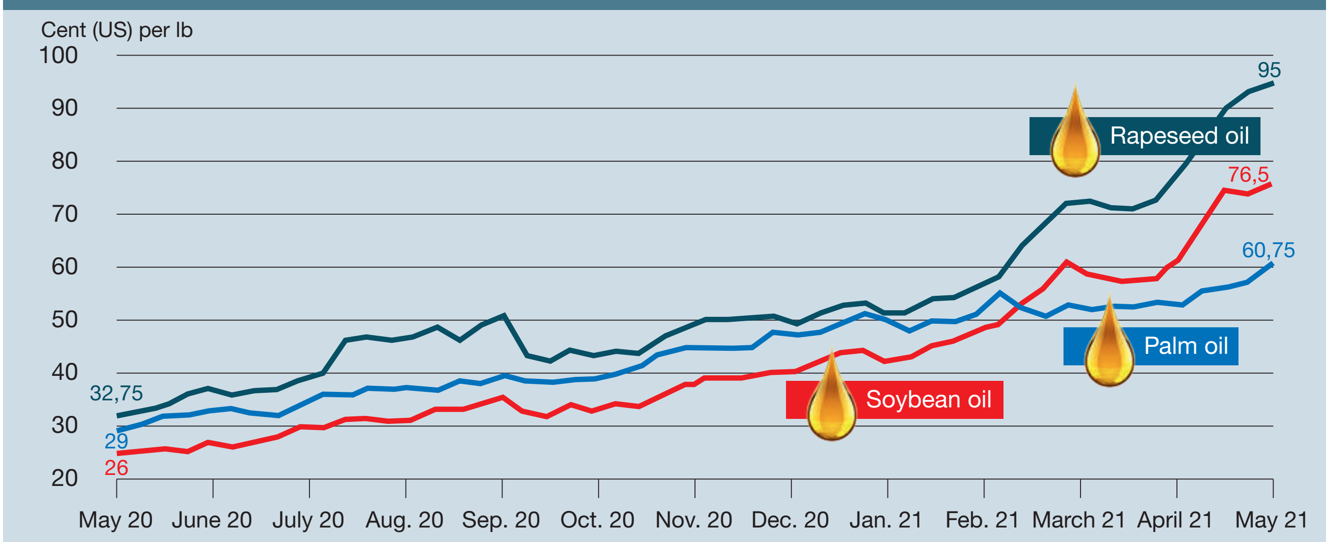
FAO Global Price Index for Vegetable Oils and Cereals



Source: FAO Price Index, AMI

Fig. 1: The trend of the FAO global price index for vegetable oils and cereals from 2015 to 2021[3]

Soybean, rapeseed and palm oil price trends



Source: Food Business News

Fig. 2: Soybean, rapeseed and palm oil price trends (May 2020 – May 2021)[4]

2.2 What are the reasons for this rapid price increase?

When it comes to vegetable oils, which vary regionally and by oil type, several factors are responsible for the huge price increase.

For **soybean oil**, which dominates the North American vegetable oil industry[5], new state and municipal biodiesel regulations in the USA have greatly increased demand. These mandate that an increasing percentage of biodiesel be made from cooking oil to reduce CO2 emissions.

The consequences of the increased demand from the fuel industry are clearly being felt by the players in the food industry, since up to now about half of the 11.8 billion kilos of soybean oil produced in the US was used for food.[5]

There's no end in sight to the price war. Calculations from the summer of 2021 show that: even if all the available vegetable oil were converted exclusively into biodiesel, it would only meet 7% of US demand.[5]

In the case of **palm oil** prices, the upward trend since February 2011 has been fuelled, in part, by the fact that production in Southeast Asia has not been able to keep pace with growing demand. According to the *Union for the Promotion of Oil and Protein Plants (Union zur Förderung von Öl- und Proteinpflanzen e. V., UFOP)*, the ongoing global supply shortage has also driven up prices for **rapeseed oil.**[6]

The increasingly significant costs of edible oils and other essential raw materials are really hitting the food industry, which is already facing a difficult situation. Supply chain bottlenecks and labour shortages due to the COVID 19 pandemic are putting additional pressure on operators – particularly in the gastronomy sector.

How can the food industry secure the supply of high-quality vegetable oil? How can future price increases be cushioned? While there is still no global response to this question, there are individual opportunities for food manufacturers and supermarkets with in-house production to optimise their oil management and reduce expenditure on vegetable oils. We present these options below and discuss the advantages and disadvantages of individual approaches.

2.3 Approaches to optimising cooking oil management

What adjustment factors do food companies have at their disposal to enable them to reduce cooking oil consumption? Besides the choice of oil type, oil consumption over time is one of the most important key figures for oil. The choice of fryer and the filter methods used also influence consumption and costs.

2.3.1 Change of oil type – A quick response to the price increase is to change the cooking oil used. However, prices of rapeseed and palm oil have also increased significantly in parallel to those of soybean oil. Moreover, regional taste preferences must be taken into account. While the neutral taste of soybean oil is particularly popular in the USA[8], the strong taste of palm oil is appreciated in other countries. Changing the type of oil changes the taste profile – as does strategic blending to combine the benefits of different varieties.
Such differences in taste are a particular problem for those companies whose customers expect the familiar flavour in hundreds or thousands of different locations.

In order to maintain standardised product quality, implementing a change of oil type must be well planned. For example, checks must be carried out in advance as to whether the existing processes are suitable for the new oil type. The effort required for the change should also not be underestimated. Many oil manufacturers are working on new cooking oil blends and will advise you on what to consider when switching to cheaper alternatives.

2.3.2 Adding antioxidants – A second approach is to use antioxidants. Most cooking oil manufacturers offer cooking oils with antioxidants and provide information on the effects on the sensory characteristics and texture of fried foods. According to the *American Oil Chemists' Society (AOCS)*, both synthetic and natural antioxidants are suitable for stabilising cooking oils against thermal lipid oxidation.

The results of two case studies conducted by *Camlin Fine Sciences laboratories* confirm the effects of rosemary extract as a natural antioxidant. The oil samples were heated to 204.4°C (400 °F) in a deep fryer, and French fries were added as the fried food. The content of primary oxidation products increased in all samples with progression of the frying or heating time. The oil samples with rosemary extract had a lower content than the control samples. This suggests that adding antioxidants improves oil stability and prolongs its life.[9]

However, given consumer sensitivity with regard to additives, increasing the level of antioxidants in cooking oil is not a sustainable solution for optimising cooking oil management.

2.3.3. Use of automated deep fryers – Deep fryers that automatically control the oil management and replace the frying medium are mainly used in large-scale industrial kitchens and fast-food or quick-service restaurants. The latest technology combines the level sensor with an oil quality sensor; this automatically calculates how much fresh oil needs to be topped up and when it is necessary to replace a certain quantity or carry out a complete oil change. Depending on the range of functions, automated deep fryers can make a key contribution to attaining consistent product quality, but are also associated with high acquisition costs and maintenance costs for the sensor system.

2.3.4. Filtration of the frying medium – There are filter solutions on the market which involve the removal of solid as well as dissolved impurities from the used cooking oil. Filtration keeps the oil clear and clean for longer. A filtration system can significantly extend the life of the cooking oil and consequently reduce the expenditure on cooking oil.[10]

In addition to the costs, filtration saves time during usage, because with optimally filtered oil, the effort required to change the oil and clean the fryers is significantly reduced. A suitable filtration solution also prevents the accumulation of harmful by-products of frying such as acrylamide, polymers and other polar substances.[11] The effectiveness and amount of cost savings offered by filtration depend on many factors, including of course the filter equipment or method.

2.3.5. Regular recording of cooking oil quality – There are various methods of specifically extending the life of the oil and offering consistently crispy fried food. Samples can be sent to an external laboratory for regular quality determination. Another option is to test the cooking oil on site using measuring strips or an instrument with a suitable sensor. This type of testing device is a cost-effective and proven technology for implementing these measurements within the applicable processes.

The data obtained can be used to deduce when the cooking oil needs to be changed or refreshed.

Often, determining when to change the oil is based on sensory indicators such as the smell of the oil or smoke formation during heating. However, human sensory perception can neither be standardised nor reproduced. To be sure that the oil is changed or refreshed at precisely the right time, it is essential to integrate the determination of the oil quality into the oil management processes using an objective method such as a testing device.

3 Optimised cooking oil management with measurement of the oil quality

In order to extend the oil lifecycle, it is important to know the factors that promote or accelerate oil degradation. In addition to the composition of the oil, external factors such as exposure to oxygen during production, storage and preparation as well as the frying time and temperature play a role here.

3.1 Oxidation and oil degradation

The more the oil comes into contact with oxygen, the faster oxidation progresses. Even though oxygen is poorly soluble in oil at the temperatures that prevail during deep-frying, the fried food, for example, increases the oxygen content in the oil. The foaming of the deep-frying medium during deep-frying also promotes oxygen absorption because it increases the surface area of the oil. Free fatty acids (FFA) also accelerate oxidation. Another influencing factor is the frying temperature. If the limit value is exceeded without temperature control, the oil spoils faster. The increase in oxidation reduces the life of the deep-frying medium and, over time, reduces the quality of the deep-fried food.[12]

Generally speaking, it can be said that the longer an oil is used for deep-frying, the more it degrades – and the quality of the cooking oil has a significant impact on the quality of the food fried in it.[13] With regard to the implementation of effective oil management, there are various approaches. For one thing, it is common practice to regularly replace part of the used oil with fresh oil, thereby reducing the concentration of chemical degradation products. Doing this maintains quality over a longer period of time. Companies which deem it particularly important for the food to have a standardised taste often work by refreshing the oil. After reaching the legal limit value or an individually defined limit, many companies replace the oil completely. It should be noted here that an optimal frying result is not attained with completely fresh oil. The best results are achieved with slightly used oil.

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How does the composition of the oil change during the deep-frying process?

During deep-frying, a number of complex chemical reactions take place simultaneously. These include hydrolysis, oxidation, polymerisation, lipid decomposition and other thermal reactions that lead to the formation of numerous undesirable compounds. The ester compounds of the oil's triglycerides are broken down and lots of degradation products are formed, including free fatty acids, monoacylglycerols, diacylglycerols and glycerol. These compounds have a higher polarity and lower molecular weight than the original triglycerides in the oil. Free fatty acids are usually volatile and can further break down and react to form other components. Volatile compounds formed during oxidative and thermal decomposition of fats include saturated and unsaturated aldehydes, ketones, hydrocarbons, lactones, alcohols, acids, esters, furans and aromatic compounds. The content of these degradation products increases as frying progresses, affecting the quality of the oil. They increase oil viscosity, reduce heat transfer, reduce the smoke point of the oil and increase oil absorption in fried foods. They also have a negative effect on the colour of the frying medium and the taste and nutritional value of the fried food.[9]

3.2 Determining the TPM value

Selecting the right time to change or replace the oil is only possible if the quality of the cooking oil is measured regularly. As described earlier, it is not sufficient to rely on subjective quality indicators such as the colour, smell and taste of the oil. Also, the foam that can form over time does not correlate with the quality of the fried food.
To evaluate cooking oil, the measurement parameter TPM (Total Polar Materials) has become well-established.[12]
The TPM value describes the total proportion of polar compounds in the oil. Carrying out the TPM measurement using a suitable testing device directly on site is one of the most widely recognised methods for evaluating the cumulative degradation of cooking oils – in other words, evaluating the quality of the cooking oil. The content of the total polar materials is specified as % TPM or in some cases % TPC (Total Polar Components). The non-polar triglycerides contained in the oil are converted into polar compounds during frying. The total polar material consists of non-volatile products, alcohols, short-chain fatty acids, aldehydes and ketones.[14] The non-polar component consists of the remaining triglycerides and other substances that have a low polarity.

3.3 Legal guidelines and limit values

The TPM value provides information on the quantitative proportion of polar and non-polar compounds in cooking oil. In Europe, determining the TPM value has become the standard reference protocol for assessing the quality of fats and oils in deep-frying conditions, since it is one of the best quality indicators.
As a result, several European countries have set limits of 24 – 27% TPM for spoiled cooking oils.[9] In countries such as the USA and Australia, where TPM is not a legal limit value at all, the parameter is nevertheless used by many companies as an internal benchmark.

In addition to the TPM value, many countries have legal guidelines on the free fatty acid content to determine the oil quality. The FFA content can be used to determine the degree of hydrolysis of the oil. However, FFA are volatile and evaporate quickly during frying, so while this parameter indicates some of the fat degradation, it cannot give a cumulative indication of the total changes caused by the frying process. In the cooking oil studies conducted by Camlin Fine Sciences laboratories, various indicators of oil quality were measured and compared. It was concluded that the FFA content offers only an imprecise indication of heat damage in cooking oils and their degradation.[9]

If there is a legal limit for FFA, it makes sense to determine the TPM value in addition to the FFA content, because this value can be used to make a more accurate statement about the quality of the cooking oil.

TPM and FFA limit values

Country	TPM limit values	FFA limit values
Belgium	25%	1.25%
Brazil	25%	
Chile	25%	1.00%
China	27%	
Germany	24%	1.00%
France	25%	
India	25%	
Italy	25%	
Japan		1.25%
Netherlands	27%	2.25%
Malaysia	25%	
Austria	27%	1.25%
Poland	25%	
Portugal	25%	
Switzerland	27%	
Spain	25%	
South Africa	25%	
Czech Republic	25%	
Turkey	25%	2.50%
Hungary	25%	
USA		2.00%

Table 1: Overview of country-specific TPM and FFA limit values[15, 16, 17, 18]

One of the main benefits of TPM measurement is the ability to adjust the frying medium to the optimal frying range and thus save cooking oil. The TPM value of fresh oils varies depending on the type. For example, palm oil has a higher TPM start value than rapeseed oil, due to the composition of the fatty acids. The best frying results are achieved with a polar component between 14% and 20% (see Fig 3).

By means of regular measurement, this optimum range can be maintained by mixing older oil with fresh oil. This results in reduced oil consumption while maintaining high quality in terms of taste and crispiness of the fried food.

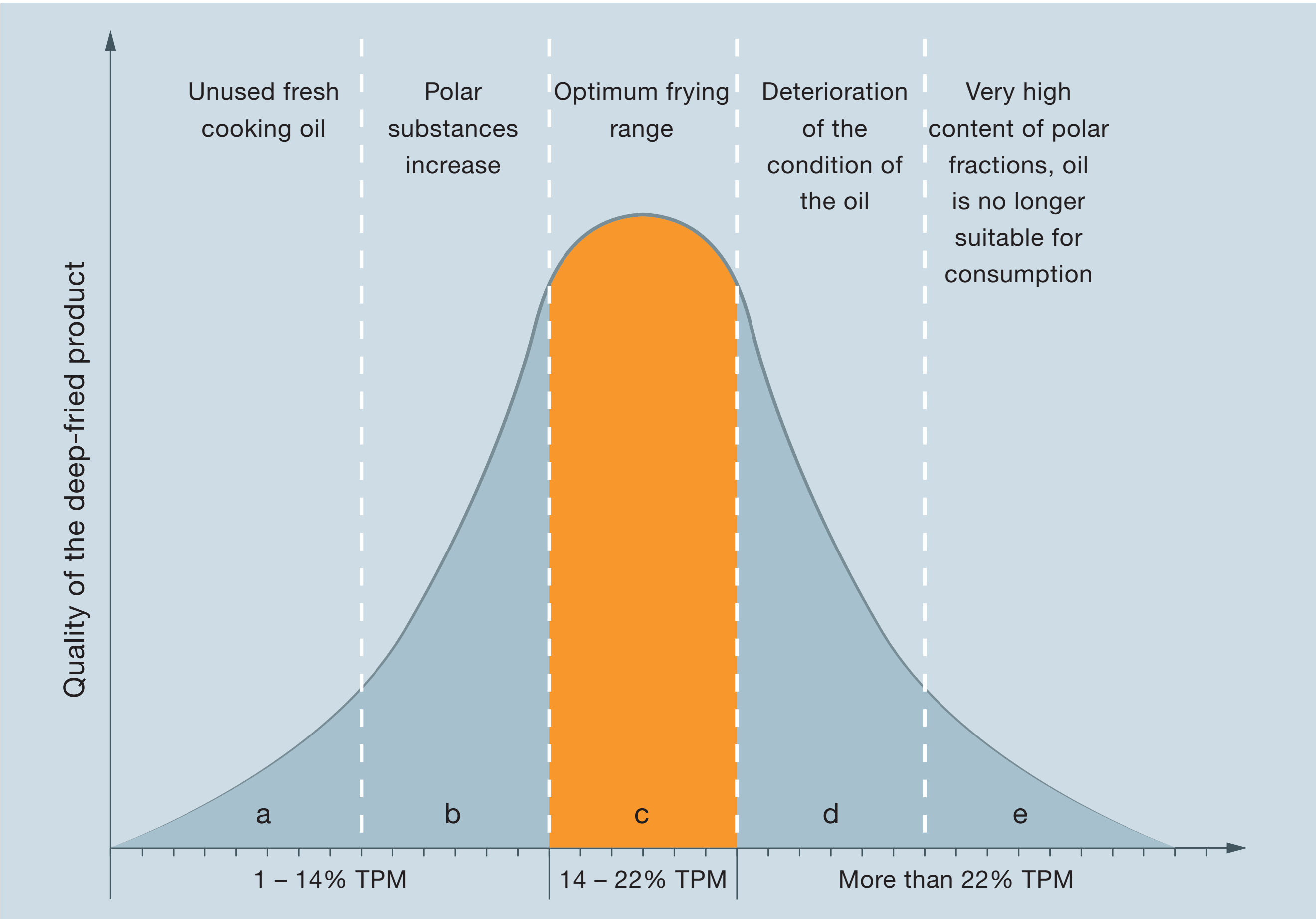


Fig. 3: Lifecycle of the cooking fat

4 Conclusion: Concrete approaches to optimising cooking oil management

4.1 Evaluation of the measures presented

The enormous price increase for cooking oils during 2021 is forcing all frying companies to rethink their handling of frying and cooking fats. In order to optimise cooking oil management, a combination of several different approaches has proven to be useful. In particular, a combination of filtration and recording the cooking oil quality represents an effective and cost-efficient approach which enables companies to offer consistently tasty products while reducing oil consumption and costs. Each company needs to consider whether additional measures such as changing the frying medium, using antioxidants or investing in automated deep fryers would be worthwhile.

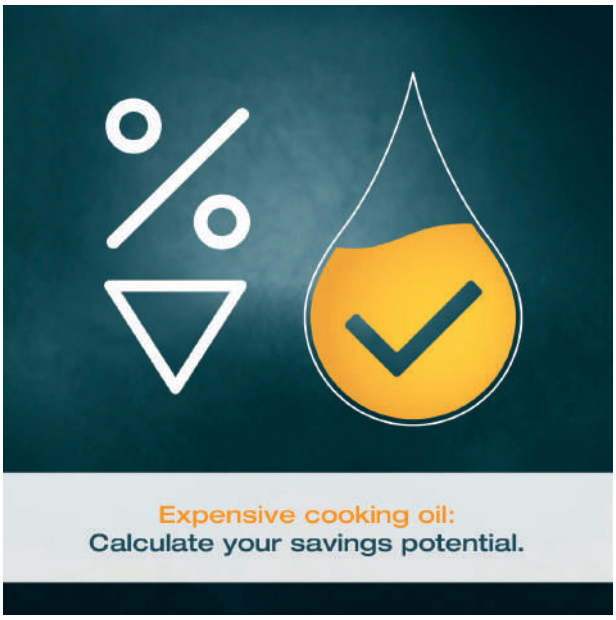
An optimised oil lifecycle is the appropriate and efficient response to the issue of rising costs of vegetable oil. This not only reduces the amount of oil, but also opens up the possibility of introducing the used frying medium into the recycling circuit. This enables the vegetable oil that is no longer suitable for human consumption to be reused in the fuel industry, among other things. Not only does this type of optimised lifecycle have a positive effect on the sustainability performance, it could also permanently cushion the rise in vegetable oil prices.

4.2 Optimising oil management with TPM measuring technology from Testo

Testo offers the testo 270 robust cooking oil tester, which was created specifically for the food sector, for the quick and cost-effective recording of cooking oil quality. Customers who already use the testo Saveris Food digital quality management solution can also benefit from the tried-and-tested TPM technology: This can be optimally integrated into the customer processes using the latest technology, also with regard to calibration of the sensor.

The ageing of the frying medium in % TPM can be determined quickly and easily on site. The crucial advantage of using the quality measurement is the more efficient use of the oil. Regular measurement prevents our customers from changing their cooking oil at a stage that is either too early or too late. Users of TPM measuring technology from Testo can reduce their expenses by up to 20% in total, while at the same time increasing the quality of the deep-fried food.

Would you like to find out how you can efficiently use TPM measuring technology in your processes to sustainably reduce your costs? You can use our free ROI calculator to calculate the savings potential for your company in just a few clicks.



The Online calculator allows food manufacturers and producers with frying oil processes to calculate the potential savings by monitoring their cooking oil quality.

Access the calculator via this link.

4.4 Next steps

Testo has been researching and developing TPM measuring technology for over fifteen years and has been continuously developing this technology ever since. The reliability and objectivity of the measuring technology has established a de facto standard for on-site determination of cooking oil quality. Testo's experts are continuously adapting the sensor technology to new varieties, and collaborate closely with cooking oil manufacturers to ensure that our customers benefit from TPM-supported oil management in the best possible way.

We look forward to consolidating the concrete opportunities that you have for sustainable cost reduction by discussing this with you personally. You can find more information on the subject of optimised cooking oil management at **testo.com.au**

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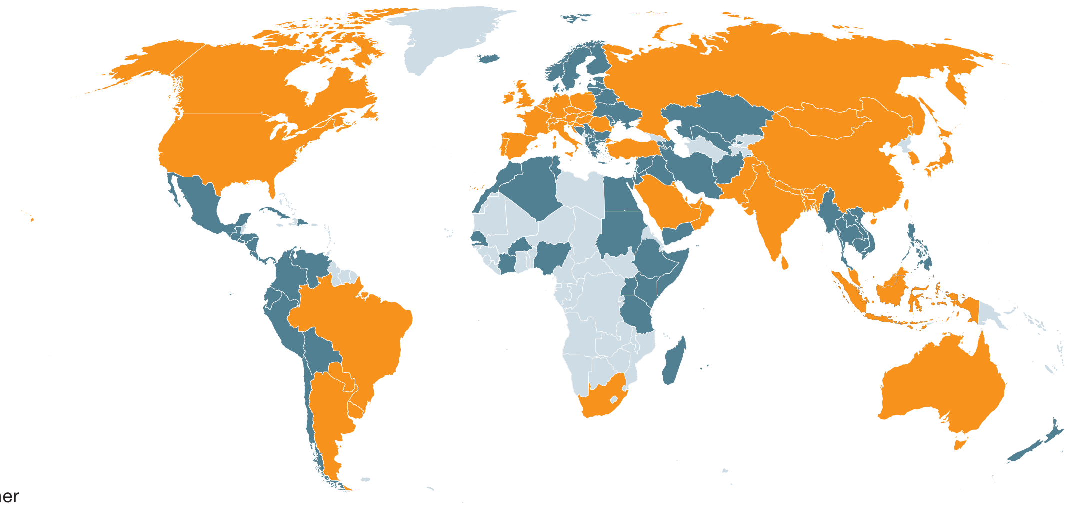
About us: This is Testo.



Subsidiary
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Testo, with its headquarters in Titisee in the Black Forest, Germany, is a world market leader in the field of portable and stationary measurement solutions. There are 3,000 employees involved in research, development, production and marketing for the high-tech company in 34 subsidiary companies all around the world. Customers all over the world are impressed by the measuring technology expert's high-precision measuring instruments and innovative solutions for the measurement data management of the future. Testo products help save time and resources, protect the environment and human health and improve the quality of goods and services.

In the food sector, measuring instruments and monitoring systems from Testo have proven themselves for decades, and belong to the standard equipment of food services, supermarkets and food producers.

An average annual growth of over ten percent since the company's foundation in 1957 and a current turnover of over a quarter of a billion euro clearly demonstrate that the Black Forest and high-tech systems are a perfect match. The above-average investments in the future of the company are also a part of Testo's recipe for success. Testo invests about a tenth of annual global turnover in research and development.

For the food sector, Testo has developed specific solutions which combine precise sensors with intuitively operated software and comprehensive services, tailor-made for the requirements of the respective field.

More information at testo.com.au

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