AQUANTIS

Inline Measurement Solutions

Moisture-Sense

Inline moisture - dry matter analysis

INLINE MOISTURE - DRY MATTER IN FRENCH FRIES

Why dry matter measurements?

Dry matter is a key quality parameter for **French fries and other potato-based food products.** Processors must comply with legal requirements as well the desired dry matter levels demanded by the customers. Having a good control over this parameter generates considerable benefits, and high product quality. A rough estimation shows that a 1% reduction in dry matter during production leads to more than 1% increase in profit for the company.

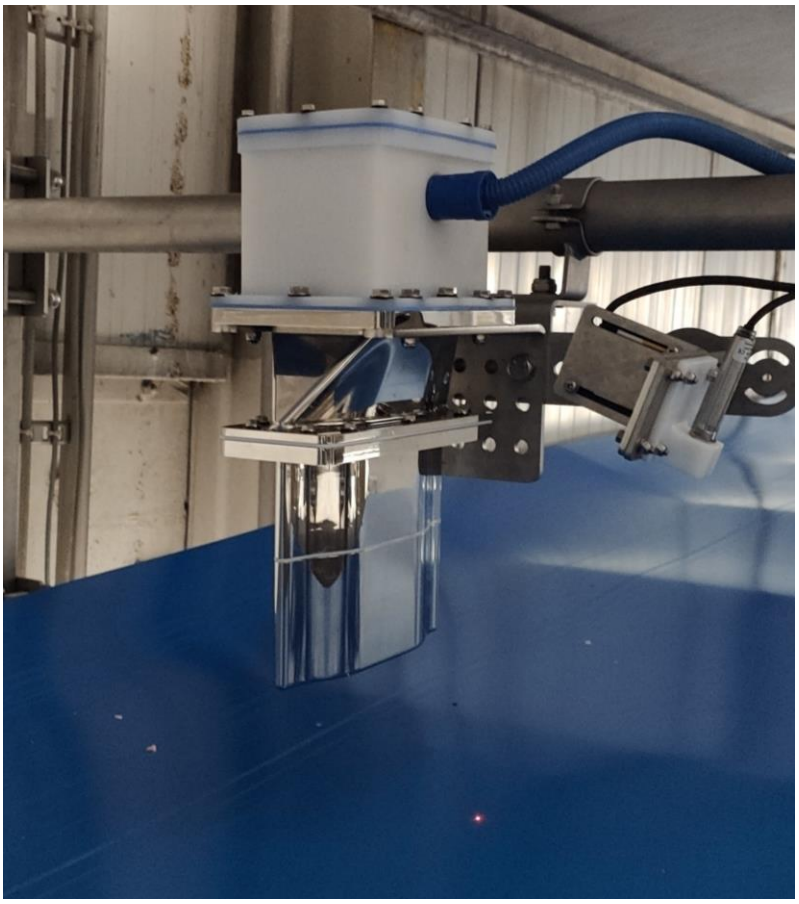
As the production process is very complex and can be influenced by various process parameters and raw material variability, it is not possible to have a constant moisture content of the fries with fixed production settings. The current quality control requires human involvement and takes 20-30 minutes before results are known which makes it impossible to adjust the production process in real time. Therefore, an inline moisture sensor providing split-second real-time feedback makes a big difference.

Moisture-Sense

Aquantis offers an inline moisture – dry matter solution - **Moisture-Sense** - based on microwave technology to track the moisture or dry matter levels after drying or frying of French fries.

The Moisture-Sense comes in the single- and double-plow versions for either plastic or metal belts, respectively. The sensors are made of from polished stainless steel and food-grade plastic materials to fulfill the highest hygienic standards.

The Moisture-Sense sensor emits very low-power microwaves. As the waves penetrate through the product, the water absorbs a part of the energy. The energy loss as a result of the moisture content is further processed to determine the dry matter content of the product. With the help of additional peripheral sensors, the Moisture-Sense determines the dry matter content of fries with an accuracy of < ±1 %.



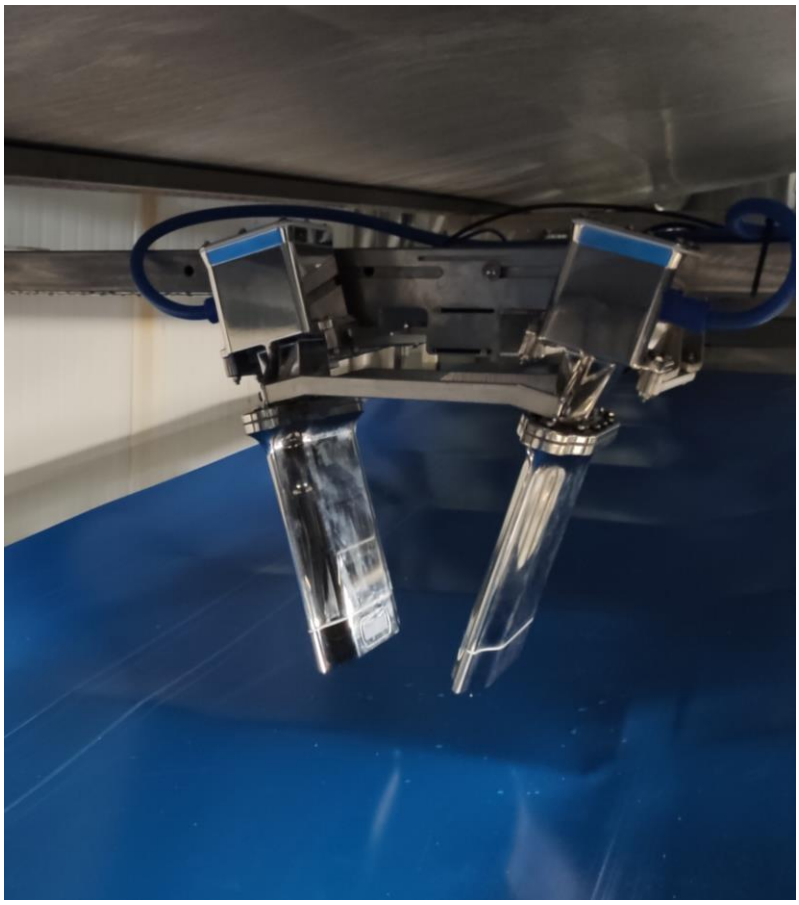


Figure 1: Installed Moisture-Sense sensor - Single Plow version (left) and Double Plow version (right).

BENEFITS OVER CONVENTIONAL METHODS

Thermogravimetric methods

Thermogravimetric measurements are frequently used for dry matter analysis. These methods are based on change of weight by heating the sample via either halogen/infrared lamp or oven method. The sample weight before and after the water removal gives a fair estimation on dry matter content determination. The main limitations include:

1. The time it takes for such a measurement usually exceeds 20 minutes which makes it impossible to adjust the process parameters in real time.

2. A typical French fries production line usually produces more than 15-20 tons per hour. It is next to impossible to have a sample of a few grams which is representative to such large volume.

A simple example: a long fry may have a dry matter which is 4% lower than a shorter fry. This variation overpowers the accuracy of all the analytical techniques.

Moisture-Sense: inline moisture

By continuously monitoring the moisture or dry matter levels, it is possible to view this product parameter in **real-time.** The dry matter or moisture content changes with multiple percentages during the drying and frying of French fries. Installing the Moisture-Sense sensors after these processes provides real-time feedback to the dryers and fryers.

Inline measurements no longer require sampling and sample preparation of the fries. Removing this intermediate step results in saving time, costs and eliminating manual errors. The Moisture-Sense sensors provide a massive amount of data which allows to optimize the processes for every specific product.

The Moisture-Sense drives further digitalization of industrial production of French fries and other potato-based products. Process variations are minimized and corrected if necessary. This system allows automated and data-driven allocation and optimization of your resources reducing errors, time and costs. **Industry 4.0 flat out.**

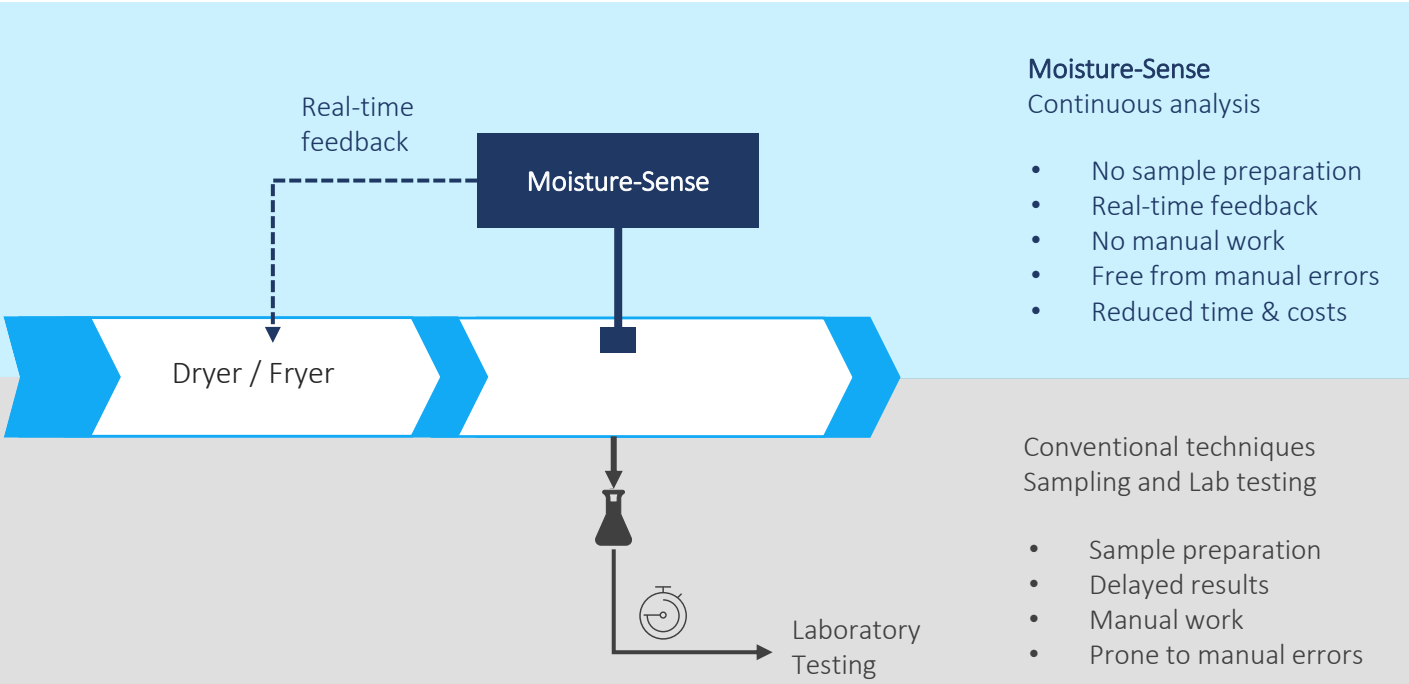


Figure 2: Benefits of the Aquantis sensors over the conventional techniques to monitor moisture – dry matter.

BENEFITS OVER CONVENTIONAL METHODS

Near Infrared: Surface measurements

Near infrared (NIR) is a very versatile technology that is suitable for the moisture detection of thin products. However, it has a limited penetration when it comes to fries and other thick potato-based products. Since the surface and inside of fries have different dry matters, it is physically impossible to measure a representative dry matter content with this type of technologies.

Moisture-Sense: Bulk measurements

In contrast to NIR technology, the Moisture-Sense measures a volume of bulk material. The low-power microwaves travel from the transmitter (Tx) to the receiver (Rx) measuring the moisture or dry matter over a large volume of French fries. This averages variations between fries providing representative measurements.

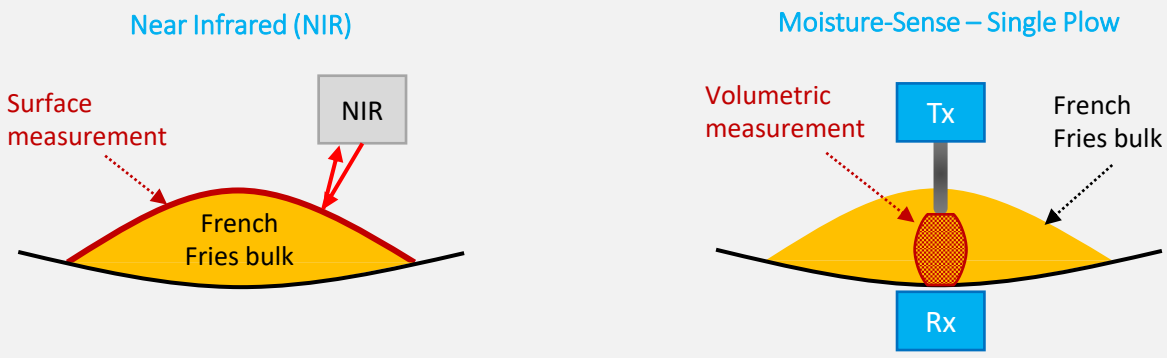


Figure 3: Cross section of bulk French fries on a conveyor belt for NIR and Moisture-Sense measurements.

Case study

A triplet of samples is taken on a regular basis during the production of fries. The dry matter contents are analyzed by halogen moisture analyzers. The results show that within each group the individual difference exceeds 2 percent within the sample group. This indicates that samples are frequently not representative for the production at the sampling moment.

By averaging the threefold measurements, one can have a better estimation of the dry matter content of the product. This is also in better agreement with the Aquantis Inline sensor. The Moisture-Sense measures a large portion of the production continuously, therefore, the representativeness of the measured sample is guaranteed.

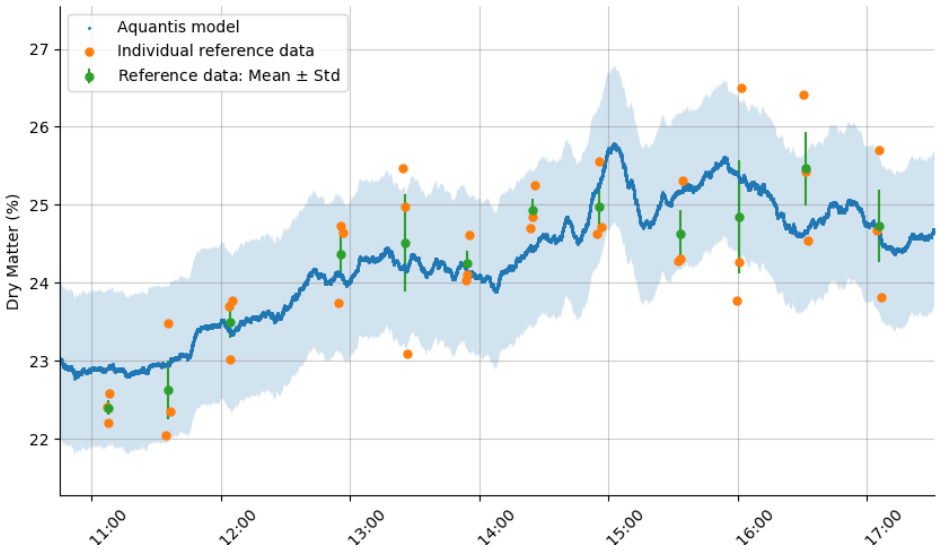


Figure 4: Dry matter measurements using the Moisture-Sense (blue curve ± 1% blue shadow) and reference measurements using thermogravimetric method (Halogen lamp). The orange dots represent the individual thermogravimetric measurements, and the green dots are the corresponding means ± standard deviation.

FINANCIAL GAIN OF THE MOISTURE-SENSE

Case study: 30% dry matter target

When targeting a dry matter target, it is common practice to foresee an additional safety margin of more than 1%. In case of a 30% dry matter target, the process operator aims for a dry matter content of 31%.

Changes in dry matter content can be translated in potato efficiency (PE). The PE is a good indicator of the efficiency of the production process and is defined as

$$\text{PE} = \frac{\text{Weight of end products}}{\text{Weight of infeed potatoes}}$$

By having better control over dry matter, the process operator can reduce the dry matter up to 1%. **A 1% reduction in dry matter results in a 2% PE increase.**

For a 30 ton/h production line

When targeting a dry matter of 31%, 54.5 tons potatoes per hour are needed for 30 tons of end product. Reducing the dry matter with 1%, only 52.6 tons are needed, increasing the potato efficiency with 2%. On a 30 ton/h production line, this gives a reduction of **1.9 ton/h** of raw material usage .

Dry Matter	31%	30%	Δ
Potato efficiency	55%	57%	2
Potatoes (ton/h)	54.5	52.6	**-1.9**

Table 1: Impact dry matter on the raw material needs.

Considering a price €80 / ton* of potatoes, the reduced raw material cost is

1.9 ton/h * €80 / ton = **€152 per hour**.

* Data taken from Belgapom

Assuming that the production runs 24/7 and 300 days a year, a **1% dry matter change on a single 30-ton line results** in

- Reduced potato usage per day: 45.6 ton
- Reduced potato usage per week: 319.2 ton
- Reduced potato usage per year: 13680 ton

456 trucks of potatoes less per year for the same output

- **Reduced potato cost per year: € 1.09 million**

Note that the reduced energy cost, waste, transportation etc. are not included.

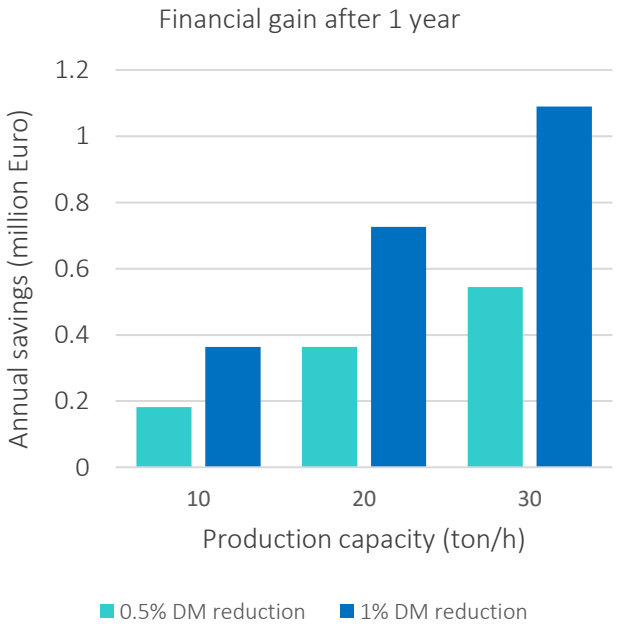


Figure 5: Annual savings for individual production lines for a 0.5% and 1% dry matter reduction.

The cost of potatoes is the most important cost in producing French fries. Consequently, monitoring and controlling the dry matter will result in a significant financial gain.

WEB INTERFACE AND NETWORK COMMUNICATION

The web interface is used to visualize the processed data and manage the device settings for the different type of products.

The software supports Modbus TCP/IP communication to integrate the data in the used SCADA systems. Other communication protocols can be foreseen.

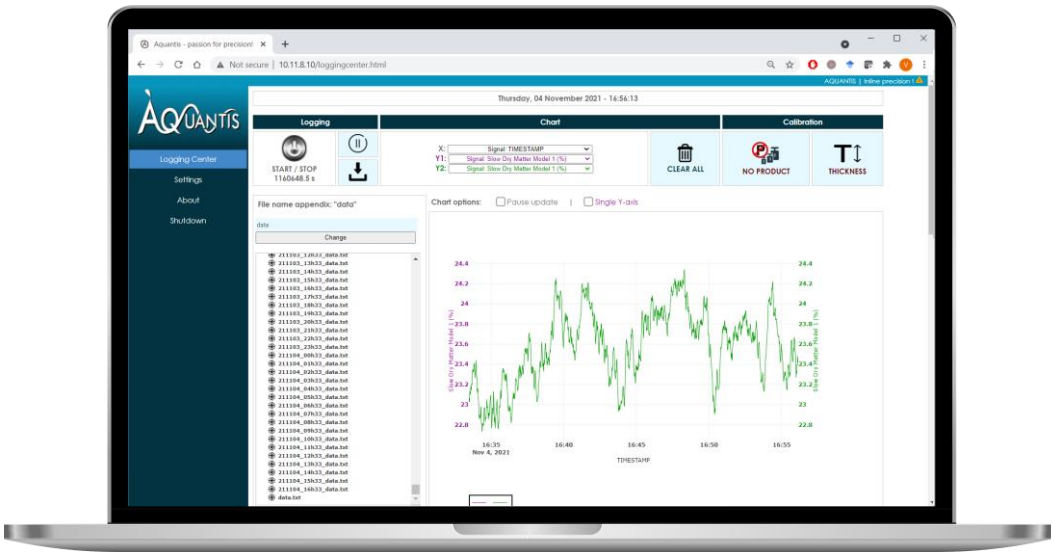


Figure 6: The web interface of the Moisture-Sense.

INTEGRATED PROCESS CONTROL

The Moisture-Sense is a part of the Aquantis inline sensor series for the food industry. While the Moisture-Sense provides the moisture level, the MICROFREEZE® monitors how much of the water is frozen indicating the quality of the freezing process.

The collected data after every production step can be consulted via the Aquantis web interface or a SCADA system. Combining multiple inline sensors after drying, frying and freezing processes provides a powerful tool to steer and coordinate the different production steps to maximize efficiency.

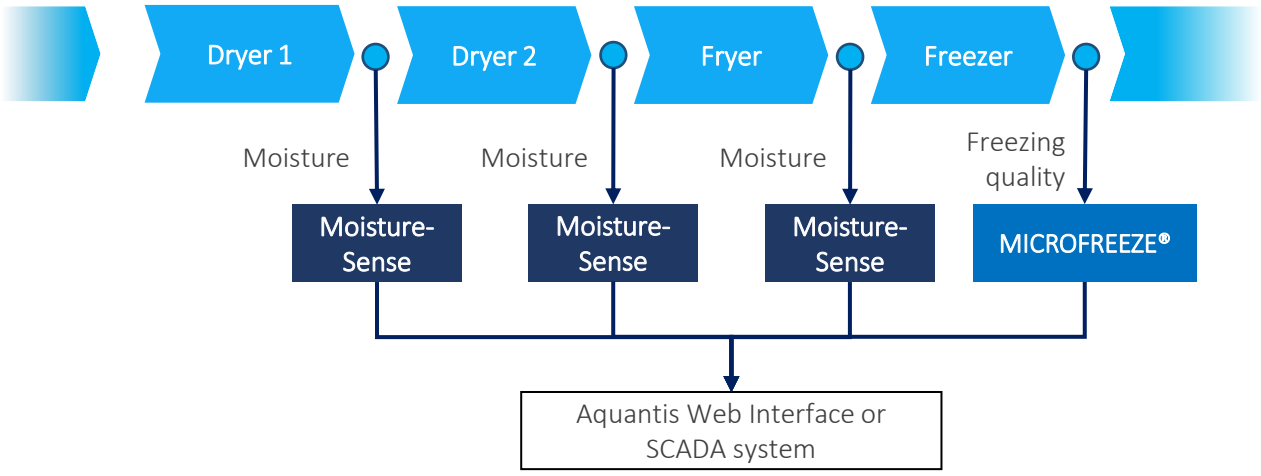


Figure 7: Aquantis inline sensors at different production steps of French Fries.

MAIN FEATURES

Our inline technology has various benefits compared to conventional methods:

- **High penetration:** The microwaves emitted by the Moisture-Sense penetrates the entire layer of fries. This guarantees that both the surface and the core of the fries are measured
- **Non-stop dry matter readout:** The Moisture-Sense performs 500 measurements/sec on a 24/7 basis. This gives non-stop, real time measurement results on the dry matter content.
- **Representative measurement**: The volumetric measurements averages variations of individual products within the layer providing representative measurements. Based on received signal the moisture level is calculated.
- **Non-destructive measurements:** The power of the used electromagnetic waves are very low and consequently do not affect measured product in any matter.

TECHNICAL SPECIFICATIONS

Item	Moisture-Sense
Sensing Technology	Microwave technology
Measuring range moisture	60 - 90% *
Measuring precision	<±1% *
Sampling rate	500 Hz
Field frequency	ISM frequency band
Transmitted power	~1 dBm (~1.25 mW)
Housing	Food-grade Stainless steel AISI 304 - Hygienic design
IP class	IP66
Dimensions transmitter unit (W x H x D)	210mm x 350 mm x 130 mm
Dimensions receiver unit (W x H x D)	177 mm x 187 mm x 178 mm
Dimensions computing unit (W x H x D)	390 mm x 794 mm x 268 mm
Operational temperature range	-40 °C to 40 °C
Data connection	Ethernet RJ45 plug
Industrial interface	Modbus TCP/IP server
User interface	Web-based user interface

Table 2: Technical specifications of the Moisture-sense.
* Less than 1 % is also possible depending on product and measurement conditions

FURTHER CUSTOMIZATION IS ALSO POSSIBLE

Aquantis also provides **customized sensor solutions** tailored to the individual needs of a customer. Further customizations of Moisture-sense are possible to fit the application(s)-dependent needs. Each of your requirements will be evaluated by conducting different study to ensure our technological solutions fulfill your needs.

If the outcome is satisfactory, the technical specifications for the inline solution will be determined in collaboration with the customer. On-site validation will be conducted to prove technological benefits. The final step includes the delivery of the inline customized solution which is integrated in the production process.

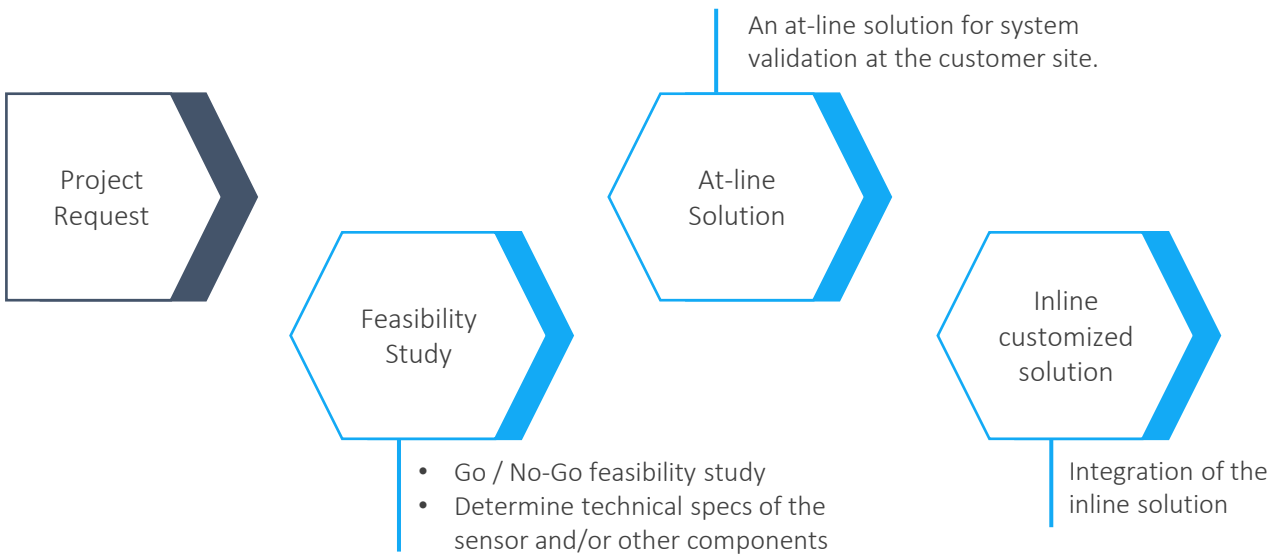


Figure 8: Project-based approach for inline customized solutions.

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