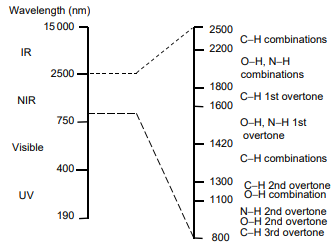
# **Case Study: Applications of Near Infrared Spectroscopy in Food Industry**

Measurement Systems – Home Assignment – Case Study

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Spectroscopy is used in physical and analytical chemistry to identify or quantify the molecular or structural composition of a sample. It is the study of the interface between matter and electromagnetic radiation as a function of the radiation wavelength or frequency. This case study is about Near Infrared Spectroscopy (NIR) and its uses in food industry. The NIR lies in that part of the electromagnetic spectrum in the wavelength range 780 nm to 2500 nm as shown in below figure –



The NIR spectroscopy is applied regularly for the compositional and sensory evaluation of food ingredients, process intermediates and output products. Milk analyzers based on mid-IR spectroscopy have been used since the 1960s but it was not until much later that NIR began to be applied in the dairy industry. Even though the mid-IR is good enough for the proximate analysis of liquid milk, dairy chemists tackled with one of the widest ranges of samples in the food industry. NIR has a main role in the evaluation control of dairy products process. It gives flexibility in the evaluation of protein, fat, and lactose contents in a various range of dairy products like liquid milk, dried milk, skim milk and cream, whey powders and cheese. A lot of these products are emulsions which are difficult for sampling for classical chemical analysis. For instance, blending such samples varies their physical properties. NIR handles the possibility of on-line analysis, which prevents the necessity for batch sampling process and decreases sampling inaccuracy by averaging of virtually instant measurements. Milk powders are evaluated on-line using a powder analyzer, which allows the moisture content to be controlled. For most other on-line uses, fiber-optic probes are used. These have the benefits of minimum maintenance owing to the absence of moving parts, robustness to the high temperature and pressure. Examples of on-line NIR fiber-optic measurement in dairy system processing are moisture control of cream cheese and processed cheese. Cream cheese is prepared in a series of set tanks from where the product is moved into a separator. NIR monitoring of products from the separator allows benefits for the changes in properties from different set tanks. NIR measurements of processed cheese is applied for process diagnostics where more understanding of the temperature effect on the final moisture content has been attained. Development of NIR applications in the milk industry is such that it is possible to buy an instrument, which is industry-calibrated for proximate-analysis for cheddar cheese. Though these calibrations are only usable for cheddar made to the traditional method and sampled from the vat; non-traditional cheddars require separate calibrations.

NIR spectroscopy is extensively used in the meat factory for proximate-analysis. A special fiber-optic probe has been designed to spear-carcasses and determine their fat. This allows the carcasses to be arranged next to butchering process. Special devices are there to determine the protein, fat and moisture in ground meat and meat products. Factory-set calibrations exists for cooked meat, ham, liver sausage, etc. Meat samples are then minced then mixed in a food processor unit before packing them into an open cell. The amount of sample needs to be adjusted by either mass or depth. Fresh fruit and vegetables are classified by shape, size and their color. Nondestructive methods of classifying allows growers and packers to market a reliable product over an extended season. Moreover, high-quality products can be separated for high-yield markets and in between lower-quality products can be recognized for processing or other applications. The objective classification of fruit for ripeness by optical-spectroscopy was originally done in the visible region. Still the availability of fiber-optic interactance-probes led to a rebirth of research in this application from the determination of sugar content. The cause for creating a direct measure of sugar content of fruit is that look is not a convincing guide to sweetness of sugar. Japanese scientists have presented the successful use of NIR to the on-line determination of sugar in intact peaches and mandarins and created an automated fruit-classifying machine on this principle basis. Australian researchers have taken this concept to tropical fruits like melons, mangoes, pineapples, etc.

When barley is developed under controlled parameters, it undergoes a several complex biochemical reactions, which outputs conversion to malt. The malt is then mixed with water to produce a liquid ‘wort’, which is then fermented and processed to beer. Since malting takes about 12 days, barley breeders need a quick means of guessing the malting quality of barley grain. Adjustments have been prepared for nitrogen, lysine and malt hot water extract. With wheat functional quality, NIR analysis of barley is applied to predict the quality of material that is created by processing of the grain and there is doubt if tests on undeveloped grain fully account for the conversation of enzymes and substrates during the process of germination. Tries have been made to develop the accuracy of guess by analysis of main quality properties of the malt or the ‘wort’. In the brewing process, NIR is extensively applied to measure the original gravity and alcohol of beer using on-line flow-through cells. Conventions errors of the calibration for alcohol content of 0.1–0.2% have been observed using transmittance cells. The Liquidate probe has been used to gain a process assurance on beer to better than the 0.04% alcohol content. NIR is applied to analyze fruit quality and find the alcohol content of wine and special filter-instruments for wine evaluation are available.

The main advantage of NIR is that usually no sample groundwork is required, therefore the evaluation is very easy and very rapid (between 15 and 90 seconds) and can be processed on-line. One of the strong points of NIR spectroscopy method is that it enables various constituents to be measured alongside.