Density measurement of food products

Identification

Key words          Density, measuring density, quality control, food control
Latest version     2012/03/03
Completed by       UTCN

How does it work?

Primary objective  It is a quality verification method for a large range of food products and represents an important quality control method in both scientific and industrial fields.

Working principle  Density of a material is defined as its mass per unit volume. It is closely related to:
• specific weight of a material (defined as its weight per unit volume)
• specific volume of a material (defined as the reciprocal of the density)
Each material has its own density, but density is not an intrinsic material property because it also depends on temperature and pressure. If the temperature increases, the volume expands and the density of an object decreases (notable exception: density of water increases between 0°C and 40°C). The effect of pressure and temperature on the density of liquids and solids is small since, for typical cases the compressibility is $10^{-6}$ and the thermal expansivity is $10^{-5} \text{K}^{-1}$.

Images

Additional effects  Density measurements cause no additional effects and also help to discover other properties (f.i. photoanalysis):

Important process parameters  temperature, pressure

In case of the vibration density measurements the stability of vibration generator is important too. In case of the nuclear density measurements additional process parameters such as nuclear radiation intensity, irradiation angle, source-sample and sample-detector distances are also important.

Important product parameters  product state (solid, liquid or gas), product dimensions, geometry, consistency
## What can it be used for?

### Products
Density measurements are used in food technology for a large number of products:
- beet sugar, syrup/molasses, sucrose, chocolate liquors, dextrose, fructose syrup, high fructose corn syrup, coffee liquor
- coffee extract, condensed milk, soy milk, soy oil
- cooked starch paste, corn starch, food coatings, potato starch, sauces
- glycerin, sodium nitrite
- chicken broth, chicken stock, pork broth

Density is frequently used in the food and soft drinks industry to provide the Brix value that expresses the sugar content of the drink. For the fragrance and flavours industry density is a primary measurement for determining the quality of incoming raw materials [5-7].

### Operations
Quality control, food packaging control, separation processes.

### Solutions for shortcomings
Quality control through density measurement.

## What can it NOT be used for?

### Products
No restricted products. Even in the case of nuclear density measurement the controlled products suffer no changes.

### Operations
None

### Other limitations
In the case of nuclear density measurements restrictions derived from the regulations concerning the use of radiation sources must be taken into account.

### Risks or hazards
None

## Implementation

### Maturity
Density measurements are a mature control method.

### Modularity
Density measurements can be easily implemented on a production line.

### Consumer aspects
The use of nuclear sources for density measurements may produce anxiety of the consumer. However, the regulations concerning the use of nuclear sources are very strict and eliminate possible negative effects.
Legal aspects
Many industry standards are used for density measurements:
• ICUMSA - International Commission for the Uniform Measurement of Sugar Analysis (molasses, white, cane and beet sugar density)
• CRA - Corn Refining Association, measurements for starch dextrose, fructose and liquefied by products from corn refining
• NFPA - National Food Processor Association
• USDA - Food and Vegetable Division, File code 135-A-3 Tables for degree brix and baume and corresponding concentration
• International Starch Institute, Denmark, for the measurement of wheat and corn starch
• Wisconsin Center for Dairy Research, measurement of whey density and percent solids
• TTB (U.S. Dept. of Treasury Tobacco Tax and Trade Bureau) AFT-P 5110.6 Gauging Manual
• OIML (International Organization for Legal Metrology) R-022-e75 for alcohol measurement by mass and volume
The nuclear density measurements must be done according to the regulations concerning irradiation of food products. The European Community has the most restrictive regulations mandatory by EC-directive and maintaining a number of national regulations. The most important regulations are:
• 1997 FAO/IAEA/WHO Joint Study Group on High-Dose Irradiation recommends to lift any upper dose limit
• 2003 Codex Alimentarius General Standard for Irradiated Foods: no longer any upper dose limit
• 2004 International Consultative Group on Food Irradiation (ICFGFI) documents

Environmental aspects
The uses of density measurements according to the regulations do not produce environmental effects; in case of nuclear density measurements the environmental aspects depend of the each country legislation.

Facilities that might be interesting for you

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<td>Fruit &amp; vegetable analysis INRA</td>
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Further Information
Institutes
Companies
Anton Paar, Krüss
References


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