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23FTT202 FLUID MECHANICS FOR FOOD TECHNOLOGY

UNITIII: Types of Fluid

Fluid flow is a crucial concept in food technology, influencing processes such as mixing, transport, and processing of food products. Understanding the types of fluid flow helps in designing efficient systems for food manufacturing and processing. Here are the main types of fluid flow relevant to food technology:

1. Laminar Flow

- **Definition**: In laminar flow, fluid moves in parallel layers with minimal disruption between them. This type of flow occurs at low velocities and with high viscosity fluids.
- **Characteristics**:
  - Smooth and orderly flow.
  - Reynolds number (Re) < 2000.
  - Common in small-diameter pipes and certain food processing applications.
- **Applications**: Used in delicate processes like blending and coating, where maintaining product integrity is essential.

2. Turbulent Flow

- **Definition**: Turbulent flow is characterized by chaotic and irregular fluid movement, with eddies and vortices.
- **Characteristics**:
  - High velocity and low viscosity.
  - Reynolds number (Re) > 4000.
  - More energy is dissipated due to friction.
- **Applications**: Common in large-scale mixing, pumping, and processing operations where thorough mixing is needed, such as in pasteurization and homogenization.

3. Transitional Flow

- **Definition**: Transitional flow occurs between laminar and turbulent flow, where the flow characteristics fluctuate between the two.
- **Characteristics**:
  - Reynolds number (Re) between 2000 and 4000.
  - Exhibits mixed characteristics of both laminar and turbulent flows.
- **Applications**: Often observed in varying flow conditions in food processing systems.

4. Non-Newtonian Flow

- **Definition**: Non-Newtonian fluids have a variable viscosity that changes with the applied shear rate. Their flow behavior does not follow Newton's law of viscosity.
- **Types of Non-Newtonian Fluids**:

    - **Shear-thinning (pseudoplastic)**: Viscosity decreases with increased shear rate (e.g., ketchup, yogurt).
    - **Shear-thickening (dilatant)**: Viscosity increases with increased shear rate (e.g., cornstarch slurry).
    - **Bingham plastic**: Requires a yield stress to start flowing (e.g., butter).
    - **Thixotropic**: Viscosity decreases over time under constant shear (e.g., some gels).
- **Applications**: Important in processing products like sauces, creams, and dressings, where controlling flow behavior is essential.

5. Pseudoplastic Flow

- **Definition**: A specific type of shear-thinning non-Newtonian flow where viscosity decreases with increasing shear rate.
- **Characteristics**:
    - Easier to pump and process at higher shear rates.
    - Common in many food products.
- **Applications**: Relevant for products that need to be spread or poured easily, like salad dressings and sauces.

6. Thixotropic Flow

- **Definition**: Thixotropic fluids become less viscous over time when subjected to constant shear stress.
- **Characteristics**:
    - Initially thick but flows more easily with continuous stirring or agitation.
- **Applications**: Useful in products that need to remain stable until opened or shaken, such as certain sauces and creams.

Conclusion

Understanding the types of fluid flow in food technology is essential for optimizing processes like mixing, pumping, and heat transfer. Each type of flow has distinct characteristics and applications, influencing product quality and processing efficiency in the food industry. Proper management of these flow types ensures effective food processing and enhanced product development.

i) Objective methods: You can also measure colour, flavour, texture and nutritive quality with help of instrument. However, sensory method is the best method for judging the quality.

Specifications for cereals

There are at least 330 specifications for cereals and cereal products at national and international level (over 50 countries or regions) of which at least 12 are applicable globally. The criteria assigned to grains are the intrinsic varietal qualities and those which are environment- or process induced.

Intrinsic Qualities

Colour: Cereal grains are pigmented and range through the colour spectrum from very light tan or almost white, to black. Where extractive milling is required, highly-pigmented varieties may give low yields of white flour.

Composition: Composition, e.g. protein, carbohydrate, lipids and their breakdown products, qualitatively influences product acceptability, by affecting texture and taste. Quality changes evolve slowly in stored grain and more rapidly in milled or processed intermediary products.Some grain components, for example husk, are inedible and quantitatively influence product yield and gross nutrients available to the consumer.

Bulk Density: Each type or variety of grain when in optimum health, fully mature, etc. has a characteristicbulk density.

Odour, aroma: Most grain types, when fresh, have a distinctive natural odour or aroma. This is generally accepted as an indicator of good quality, although some people prefer grain which smells 'old' or even fermented.

Size, shape: Rice, as a whole-grain food, is classified by size (length) and shape (length:breadth ratio). Other grains also have its size considered in their specification. In general a small range in size assists with processing and handling.

Induced Qualities

Age: During the post-harvest phase, grain undergoes complex biochemical changes termed 'aging'. Changes to carbohydrate, lipids and protein fractions result in, for example, firming of texture in rice on cooking, and increased gas-retention capability in wheat flour. For most consumers, the effects of these changes are considered to be desirable. When plotting consumer acceptability of a grain product against its age since harvesting, generally it is considered to be maturing during the upward curve of the graph, and deteriorates only when the curve changes direction downwards.

Broken grains: Grain is marketed normally in whole grain form and is considered to be of inferior quality if broken. Breakage may occur from fissures as a result of excessive drying/weathering conditions in the field or during handling. Breakage reduces quality by reducing acceptability and by increasing susceptibility to infestation during storage. This affects milling yield.

Chalky or immature grain: Empty grains result from sterility and pre-harvest infections and insect attack. Immature grain content is affected by time of harvest. In rice, immature grains are greenish in colour. Thin white (usually opaque) grains are caused by incomplete grain filling and may result from pests or disease. Chalkiness is caused by incompletely filled starchy endosperm which disrupts light transmission, causing opaque regions. In most cereals, chalky areas have lower mechanical strength on crush tests and may break during handling. The broken portion is more easily invaded by certain storage pests.

Foreign matter: Dilution of the prime product by foreign matter reduces the value, and also may affect handling and processing. Foreign matter may be animal origin - vegetable origin - mineral origin.

Infested, infected grain: Grain mass, and therefore yield, is reduced by infestation. Contamination not only has direct food hygiene implications but also indirect ones, as invading micro-organisms may produce toxins under certain conditions which may lead to acute or chronic illness.

Mixed varieties: A mixture is an indication of poor pre- and post-harvest management and supervision, e.g. seed selection, lot segregation and treatment, contamination, etc. Grains differing in size and other characteristics affect processing potential. Whilst preference for a particular variety may be influential nationally or regionally, internationally-traded grain is recognised usually by grain type rather than by variety e.g. yellow or white maize. Exceptions do occur, e.g. basmati rice, (due to its aroma).

Moisture content: Moisture content of grain plays a crucial role in post-harvest processing and is associated with most of the induced characteristics. Water vapour will diffuse throughout a bulk of grain and the moisture content will tend to equalise. 'Hot spots' may occur at a site of increased respiration (caused by sprouting, infestation or microbial activity), and condensation may occur on cold grain or containers