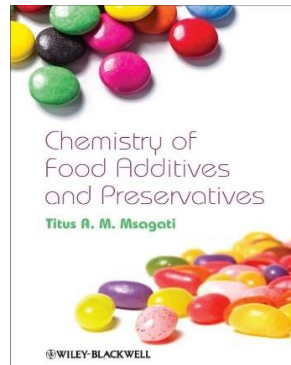


13.Week: ANTICAKING, ANTIFOAMING AND GLAZING AGENTS

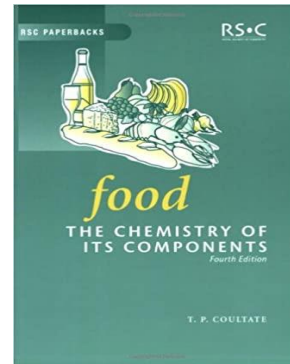


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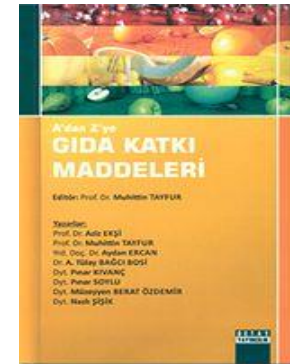
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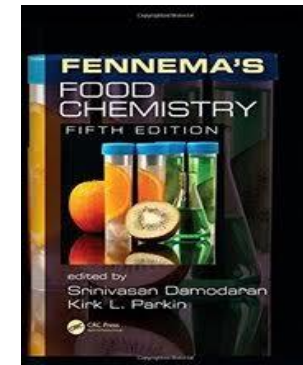
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ANTICAKING AGENTS

THE CAKING PHENOMENA

In the food industry, the caking phenomena is a nuisance as it causes low-moisture food items and those which are free-flowing, granulated or in powder form to undergo transformation into lumps. This change initially leads into an agglomerated solid and then to a sticky form, causing loss of food functionality as well as its quality. Caking is not only relevant for ready or raw food items, but is also a problem during the food production process where caking and bridge formation are known to result in reduced production rates or can even halt the whole production process due to the increased moisture.

For this reason, knowledge of the tendency of the powdered food item to absorb water is always needed to predict the kinetics of caking in the process; this may be a difficult task however, due to the fact that many food powder materials contain a variety of composition. There are also a number of uncertainties of the physical conditions, such as temperature and humidity.

There are other physical phenomena that may cause caking. These include recrystallisation, due to either the melting of fat or processes where there is surface wetting accompanied by moisture equilibration or cooling. In a true caking process, changes in low-moisture foodstuffs are related to a number of physical parameters such as temperature, moisture and the position within the powder.

These take into consideration all the **different caking stages**, which include:

- * bridging, due to surface deformation as well as the sticking of particles at contact points, without any decrease in system porosity
- * agglomeration, irreversible consolidation of bridges while maintaining the high porosity of the particulate, thus creating particle clumps with structural integrity
- * compaction, linked to the loss of the integrity of the system due to thickening of interparticle bridges because of the flow, reduction in terms of interparticle spaces and deformation of particle clumps under pressure
- * liquefaction or loss of interparticle bridges

CLASSIFICATION OF ANTICAKING AGENTS



Synthetic anticaking agents are predominantly manufactured from a number of raw materials such as silicon dioxide or solid saturated fatty acids (e.g. magnesium and calcium stearates). Examples of synthetic anticaking agents include calcium silicate (CaSiO_3), magnesium carbonate (MgCO_3), a baking soda (e.g. sodium bicarbonate or NaHCO_3), sodium ferrocyanide ($\text{Na}_4\text{Fe}(\text{CN})_6$), potassium ferrocyanide ($\text{K}_4\text{Fe}(\text{CN})_6$) and sodium aluminosilicate ($\text{Na}_2\text{AlSiO}_3$).

Natural anticaking agents include kaolin, talc and bentonite (all these being silicate materials). Talc is a powdered natural hydrated magnesium silicate containing varying proportions of materials as alpha-quartz, calcite, chlorite, dolomite, magnesite and phlogopite.

ANTICAKING AGENTS IN USE

Anticaking agents are compounds which prevent agglomeration of powdered food items, thus enabling a free-flowing state. Such agents include a variety of substances such as proteinous and polysaccharide polymers and inorganic materials such magnesium carbonate and silica. They are normally added to foodstuffs such as table salt, flours, coffee and sugar. If industrially processed powdered foodstuffs are not supported by anticaking agents, the food particles will absorb moisture and stick together to form lumps, preventing the free movement of particles.

A number of food products contain anticaking agents, such as milk and cream powders, baking powder, table salt, cocoa, coffee and hot chocolate (drinking chocolate), to mention a few examples.

ANTIFOAMING AGENTS

In the processing of food products or beverages comprising proteins, there is a high tendency for foaming. Because of their amphiphilic structure which gives them the flexibility to unfold and adsorb at the interface, protein molecules act as surfactants and create strong intermolecular interactions. This generates a viscoelastic irreversibly adsorbed layer at the air–liquid surface, which stabilises the foam. The foam is a nuisance as it results in a severe loss of production capacity, deterioration in the quality of foods as well as a loss in volume efficiency. Antifoaming agents and techniques have therefore been introduced to counter this foaming process.

Foaming phenomena arise due to the variation in surface tension caused by temperature gradients. These surface tension gradients instigate motion at the liquid surface and the lower bulky liquid, and the motion will travel from regions of lower surface tension to regions of higher surface tension (between the liquid surface and underlying bulk liquid).

Foam may be classified as one of **two main types**:

(1) metastable foam produced in the presence of charged surfactant molecules, stabilised by double-layer forces, and

(2) unstable foam produced in the presence of neutral or low-surface-active molecules.

Metastable foam has a higher stability and lasts longer than unstable foam.

Foaming which arises during processing in the food industry is highly undesirable, such that food additives capable of reducing or stopping the formation of foam have been designed.

These molecules are called antifoam agents, foam control agents or defoamers. They find application in the production process of a number of food items and beverages, especially carbonated drinks, and in the production of sugar from sugar beets. Fermentation processes (e.g. ethanol production using yeasts) are associated with foam production, and thus require defoamers to control foaming during the microbial fermentation activity until the end of the ethanol production process.

SOURCES OF FOAM IN FOOD PROCESSING

There are multiple sources of foam in the food production process. For example, in the production of sugar from sugar beets, foam may originate from non-sugar materials present in the raw materials. These **non-sugar materials** may include **cellulose, lignin, protein, betaine, choline** and **saponin**.

PROPERTIES OF ANTIFOAMING AGENTS

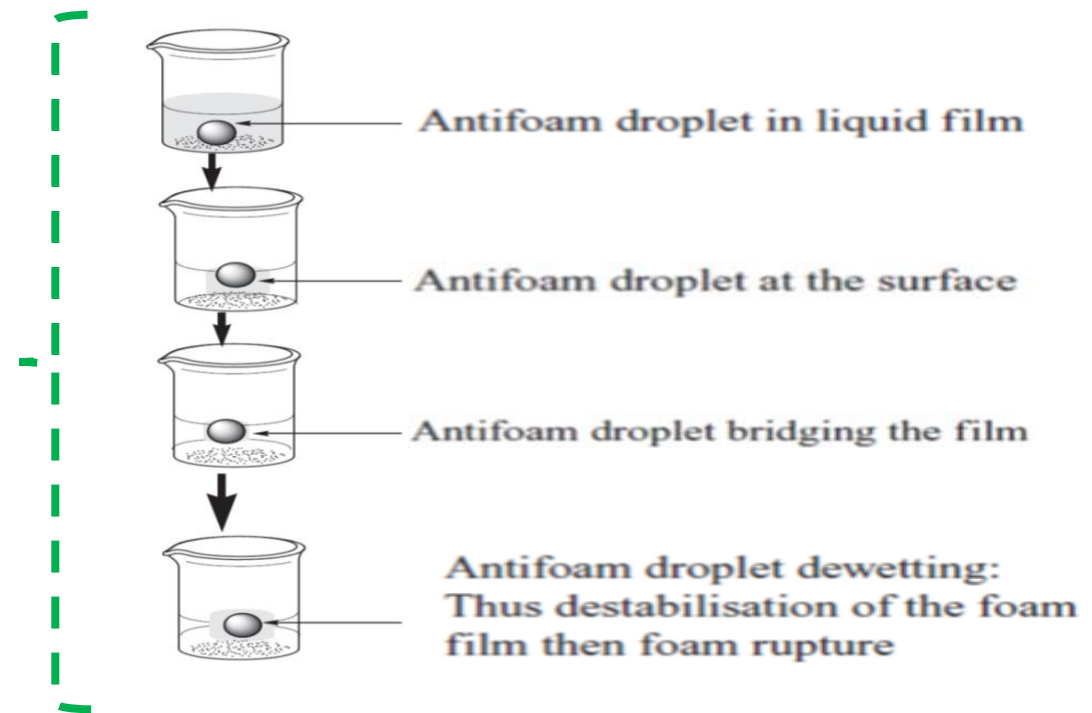
Defoamers or antifoaming agents are surface-active molecules which decrease the surface elasticity of liquids, thereby preventing the foam to attain a state of equilibrium between the surface elasticity and the antifoaming agent. This will destabilise the foam and interfere with the foam formation process.

Antifoaming agents include products made from oils, fatty acids, esters, polyglycols and siloxanes, alcohols, sulphites and sulphonates, although their antifoaming strength and properties vary. For any antifoaming agent to be considered suitable for use in the industrial production processes of food products, it must also be suitable for use with a living system without causing any harm or even having a potential harmful effect.

MECHANISMS OF ANTIFOAMING AND FOAM DESTABILISATION

The mechanisms of defoamers are dependent on a number of factors such as nature of the antifoaming compound itself (its chemistry), the type of foam and the nature of the substances causing foaming. Moreover, a surface-active defoamer molecule may destabilise foams using various mechanisms.

The bridging of a foam film by a spherical antifoam droplet



SYNTHETIC DEFOAMERS

Aqueous dispersions of antifoaming agents that display a high antifoaming and a long-term activity over a wide temperature range are most ideal for use as antifoaming agents in the food industry. The majority of such dispersions contain alcohols, which are solid at room temperature, and glycerol polyglycol ethers or polyglycerol polyglycol ethers which are liquid at room temperatures.

The most commonly used types of defoamers in bioprocesses include those which are **silicone based**, **oil based**, **water based** and **silicone surfactants** (e.g. polydimethylsiloxane (pDMS), polyoxyethylene (pEO) and polyoxypropylene (pPO) glycol based).

NATURAL DEFOAMERS

As well as synthetic antifoamers, there are also defoamers of natural origin such as the quillaia extracts. ***Quillaia extracts*** can be found naturally by performing aqueous extraction of the bark *Quillaja saponaria* molina plants. Compounds obtained from aqueous extracts of quillaia include **saponins**, **tannins**, **polyphenols** and **calcium oxalate**, although polyphenols and tannins form the major components. Quillaia extracts have also found use as foaming agents in soft drinks and other food items.

GLAZING AGENTS

Several substances are known to play a role as cryoprotectives and glazes in the food industry. In many instances, these glazes are processing aids. These include mineral hydrocarbon oils, waxes (e.g. microcrystalline wax, crystalline wax, beeswax, polyethylene wax, candelilla wax, carnauba wax and paraffin wax), stearic acid, lanolin, shellac, colophonium esters, petrolatum, chitosan-based films, polyphosphates, tea extracts and many others. Glazing agents perform the function of protective coating or sheen on the surface of foods, to give foods an improved appearance and also help to extending the shelf life of the food.

MINERAL HYDROCARBON GLAZES

Mineral hydrocarbons (MHC) are mixtures of alkane hydrocarbons (C15 to C40) derived from materials of mineral origin, particularly those of non-vegetable (mineral) source and those which are obtained through distillation of petroleum. As well as being odourless, flavourless and colourless, mineral oils possess the ability to prevent water absorption or the sticking together of foods, making them suitable for use in foods.

The term 'mineral hydrocarbons' generally refers to several hydrocarbon compounds such as white mineral oils, paraffin waxes, microcrystalline waxes and petrolatum. All of these compounds originate from petroleum products, after the separation of non-hydrocarbons by distillation processes.

Mineral hydrocarbons are used in foods either directly – whereby MHC are intentionally added to foods to play a certain important function, e.g. as coatings, polishing agents or as dust control agents – or indirectly through physical contact with potential sources of MHC.

CHEMISTRY OF MHCs

MHCs are divided into **4 main classes** according to their **sources** and **chemical properties**. These classes are:

- * Food-grade paraffin waxes
- * Microcrystalline waxes
- * Natural wax glazes
- * Commercial/synthetic food glazes