

Surface Tension in Pharmaceutical Dosage Forms



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ABSTRACT

Surface tension is the physical property of the surface of a liquid to resist an external force. The intermolecular bonds or cohesive forces between the molecules of a liquid cause surface tension; this tension is due to intermolecular forces, which are the same forces that cause molecules to compress into a liquid. Factors having influence on surface tension includes chemical nature, temperature and presence of solute. Chemical nature like polar solvents tends to increase surface tension in other hand an increase in temperature tends to cause surface tension to fall.

KEYWORDS: Surface tension, intermolecular bonds, molecules

INTRODUCTION

Surface tension is the physical property of the surface of a liquid to resist an external force. The intermolecular bonds or cohesive forces between the molecules of a liquid cause surface tension; this tension is due to intermolecular forces, which are the same forces that cause molecules to compress into a liquid. Factors having influence on surface tension includes chemical nature, temperature and presence of solute. Chemical nature like polar solvents tends to increase surface tension in other hand an increase in temperature tends to cause surface tension to fall. The interactions depend on temperature, at higher temperature the attraction is weaker. When the temperature of the liquid approaches the critical temperature the intermolecular cohesion forces approach zero and surface tension becomes very small.

Pressure also causes surface tension to fall. Surface tension depends on the ionic strength, ionic size and ion-surface interaction, and electrolytes by solvation in solution usually increase surface tension (1). Humidity also plays an important role in surface tension, at higher humidity small particles continuously uptake water, which changes the concentration and surface tension of the droplets (2). Surface active agent, (surfactants) lowers the surface tension of the medium in which it is dissolved and also the interfacial tension with other phases by stabilizing interfaces. Surface tension of a liquid is lowered by surfactant by spreading spontaneously over its surface (3).

Surface tension is measured with tensiometers and several techniques are described in the literature such as Capillary rise method, Stallagmometer method – drop weight method, Wilhelmy plate or ring method, Maximum bulk pressure method, Methods analyzing shape of the hanging liquid drop or gas bubble, Dynamic methods. Wilhelmy plate method; universal method for measuring the surface tension of a liquid, the interfacial tension between two liquids and the contact angle between a liquid and a solid and especially suited to check surface tension over long time intervals. When measuring unit (Wilhelmy plate) makes contact with the surface of the liquid, the liquid will wet the Wilhelmy plate upwards. In this case, the surface tension acts along the perimeter of the plate and the liquid pulls in the plate. This method detects the pulling force is read and determines the surface tension. A vertical plate of known perimeter is attached to a balance, and the force due to wetting is measured. The Stallagmometer method – drop weight method: This method is one of the most common methods used for the surface tension determination. Several drops of the liquid leaked out of the glass capillary of the stalagmometer are weighed. To determine surface tension, weight of each drop of the liquid is measured known, and numbers of drops are counted which leaked out of the stalagmometer. The weight (volume) of the drop is dependent on the characteristics of the liquid. Capillary rise method: This phenomenon used to determine the liquid surface tension and is the oldest method used for surface tension determination. In this method a thin circular capillary which is usually made of glass is immersed in the tested liquid. A consequence of the surface tension appearance at the liquid/gas interface is moving up of the liquid into the thin capillary. The difference in

adhesion force and cohesion force is used to measure the surface tension, where the adhesion force is interaction forces of the liquid with the capillary walls whereas the cohesion force is interaction between the liquid molecules. If the adhesion force is stronger than cohesion force, the liquid wets the walls and rises in the capillary to a defined level and the meniscus is hemispherically concave. Oppositely if the adhesion force is weaker than cohesion force, the forces cause decrease of the liquid level in the capillary below that in the chamber and the meniscus is semispherically convex. Maximum bubble pressure method: This method is also called the bubble pressure method. When a gas bubble is produced in a liquid at the tip of a capillary, the curvature initially increases and then decreases, resulting in the occurrence of a pressure maximum. The greatest curvature and therefore the greatest pressure occur when the radius of curvature is equal to the radius of the capillary. The internal pressure of a spherical gas bubble depends on the radius of curvature and the surface tension. If the radius of the capillary is known, the surface tension can be calculated from the pressure maximum (4).

In order to meet challenges and develop new and better performing pharmaceutical products, knowledge of surface tension is of utmost importance. Applications of surface tension in pharmaceutical industry, namely pharmaceutical products and dosage forms specifically solid dosage forms such as tablets is very important and plays an essential role in manufacturing industry. Tablets being the most commonly used type of dosage form due to quite a few advantages they present to the patient and manufacturer. The ease of administration to the patient and a low mass production cost for the manufacturer are key advantage of the tablet dosage form. Surface

tension is also associated with tablet coating, the coating on tablet improves the appearance of the product as well as shields the taste, smell and rate at which the drug is released (5). If the surface tension is too high, the wetting process will be hindered, conversely low surface tension leads to peeling of the tablet surface. Therefore, to make a presentable product control of the surface tension is a significant factor in the coating solution (6, 7). Likewise surface tension affects other formulation factors such as disintegration, dissolution, and solubility, which in turn affect the rate of drug absorption in the GI tract. These factors have a large impact on pharmacokinetics of drugs properties such as uptake, distribution, transport, and bioavailability (8). Applying surface treatments to regulate surface tension leads to effective dissolution and release pattern in numerous body fluids can be enhanced. Several surfactants have been reported in literature, AOT (Dioctyl sulfosuccinate), HTAB (Hexadecyltrimethyl ammonium bromide), Tween 20 (Polyoxyethylene 20 sorbitan monolaurate), Brij 35 (Polyoxyethylene 23 lauryl ether), SLS (Sodium lauryl sulfate), Tween 80 (Polyoxyethylene 20 sorbitan monooleate), TXR / Triton X-100 (Polyoxyethylene 9 p-isooctyl phenyl ether), DCH (Sodium deoxycholate), POE 10 LE (Polyoxyethylene 10 lauryl ether). These surfactants are used in the pharmaceutical industry (9, 10).

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