Mechanism of Atomization of Non-Newtonian Suspensions using Hydraulic Spray Nozzles

Addo-Yobo, F*, Kutsanedzie, F., Amevi Acakpovi, Anthony Woode, Edwin Mends Brew,
The Research & Innovation Centre, Accra Polytechnic, Barnes Road, P.O. Box GP 561, Accra, Ghana.
waddoyob@hotmail.com, kingknt11@yahoo.co.uk.

Abstract

A high-speed photographic technique has been used to record the break-up of sheets of suspensions, of Glass particles and Attapulgite particles to form a network of ligaments and nodes and the subsequent disintegration of the network to form droplets. The work is important for applications of atomization in which films are formed. These include combustion of rocket fuel and other single fluid low pressure atomization. The suspension of Glass used in this work, has no strong interactions with the solvent or other particles and is Newtonian. On the contrary, Attapulgite suspension do form structures when hydrated and behave in a non-Newtonian manner when sheared. The secondary disintegration processes have been characterized by studying the connectivity of the nodes to the network. The network of suspension of Glass is simpler and can be accounted for by nodes that are connected to the network by three or four ligaments. Nodes in the network of Attapulgite suspensions may be connected to the network by three, four or as many as five ligaments. The number of holes which surround a node in both suspensions is very close to the number of ligaments by which it is attached. This data ties in with the supposition that ligaments are formed from material between holes which contract. The nodes are the meeting points of three or more ligaments. The observation that the Ligaments and rims of the Attapulgite suspensions persists longer, compared to those of Glass suspensions accounts for the observation of higher number of ligaments per nodes (and therefore perforations per nodes). Thirteen types of the break-up of the ligaments are postulated although from the analysis of the photographs, five are observed for Glass suspension and nine for the Attapulgite suspensions. The droplets formed from the above can be grouped into three: nodal droplet, mid section droplet, satellite droplets. The perforations which lead to the formation of the above drops have different ages giving rise to the possibility of the formation of multimodal distribution of drop sizes. The ligaments formed from the suspensions of Attapulgite break-up give a higher proportion of satellite drops compared to those made up of Glass suspensions. The analysis of the two dimensional images of the drops formed indicate that multi-modal distributions of drops could result from this type of secondary disintegration. Further studies are required to make it possible to use the existing knowledge of the atomization of Newtonian suspensions to account for the atomization of non-Newtonian suspensions. More experimental as well as theoretical research on perforation statistics and wave growth under forced convection and single fluid conditions, are required. More theoretical work is required in order to be able to predict important measures of size such as the Sauter Mean Diameter of drops, which are produced from sprays of non-Newtonian suspensions.

* Corresponding Author: waddoyob@hotmail.com