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Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

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COMPREHENSIVE STUDY OF THE MECHANICAL PROPERTIES OF OOBLECK IN A ZERO-GRAVITY ENVIRONMENT: INVESTIGATING THE EFFECT OF EXTERNAL DEFORMING FORCES AND VIBRATIONS ON SHEAR THICKENING FLUIDS

Abstract

Shear-thickening liquids, such as Oobleck, are non-Newtonian fluids that display a solid-like reaction under impulsive stresses while remaining liquid under moderate or smooth loading. The proposed study aims to understand the mechanical behaviour of Oobleck in zero gravity. The variation in viscosity has negative repercussions in other sectors, despite the use of these dilatant liquids in the self-healing capabilities of injectable hydrogels. To study the behavior of Oobleck; cornstarch and water, the research focuses on its response to deforming impact forces and external vibrations in a zero-gravity environment achieved through controlled freefall. A comprehensive test setup is constructed, including an oobleck holder, a spring-controlled impactor arm, electromechanical delay systems, a force sensor, speakers for inducing external vibrations, and a video camera. The entire setup, including the wooden plank on which it is mounted, is dropped from a height of 15 to 20 meters, providing almost 2 seconds of freefall.

The primary objective of the study is to assess the mechanical behavior of Oobleck in response to external deforming forces and vibrations during freefall. The automated electromechanical system actuates the impacter arm to strike the surface of the oobleck when subjected to free fall. The striking end of the impacter arm is integrated with a force sensor that measures the opposing normal force experienced by it when hitting the oobleck thus the response to deforming force under freefall can be analyzed. Similar procedures are employed in vibration analysis studies to see how the produced vibrations at the oobleck's surface affect the viscosity and vibration waveforms. The impacter arm is made to strike the oobleck while also being subjected to external vibration in a separate test to get comprehensive evidence of the oobleck's mechanical behavior. These comparative experiments are run under both freefall and normal conditions, and the findings are examined. The results show that when exposed to free fall, Oobleck's viscosity displays minute fluctuations in reaction to the applied external forces. Additionally, the introduction of vibrations improves the efficient management and stabilization of its viscosity, aiding in the improved understanding of this special liquid. In conclusion, this study offers insightful information on the mechanical behaviour of Oobleck in a zero-gravity environment. This work has the distinct benefit of allowing researchers to

examine how external stimuli influence the behaviour of these fluids, which has important ramifications for the creation of novel materials and technologies for deployment in space and beyond.