A Study of Factors Affecting Nucleation and Bubble Growth in Pressurised Metered Dose Inhalers

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Summary

Various hypotheses have been introduced to explain disintegration of the continuous liquid phase into individual droplets leading to spray formation in pressurised metered dose inhalers (pMDIs). In a practicable system, the liquid formulation to be discharged from the pressurised container needs to be nucleated to ensure spray generation. Nucleation can be described as the generation of a nucleus of the vapour phase within the bulk liquid. As a stable nucleus is formed, it grows significantly and then detaches from its nucleation site to move upwards in the liquid phase. In our research, the effects of various parameters on the nucleation of HFA227 was systematically analysed with the aim of gaining a better understanding of bubble formation and the nucleation process in HFA propellants , including the surface geometrical properties, actuator orifice size and the mass flow rate through the orifice. Other important factors influencing the nucleation process that were considered comprised the viscosity and surface tension of the formulation, thermodynamic state variables including temperature, pressure and degree of superheat. The results highlighted the effect of surface imperfections on the rate of nucleation and bubble growth. A comparison of different actuator orifice sizes was made and a significant change in the shape and motion of the bubbles was observed. An intense nucleation was also observed at higher mass flow rate of HFA227 through the valve. It is anticipated that recognising the factors affecting nucleation and bubble growth of HFA227 may lead to potential routes of influencing the medical aerosol generation mechanism inside the pMDI and control the fine particle size distribution.