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Cascade Puffing and Micro-Explosion in Composite Droplets

Dmitrii Antonov, Pavel Strizhak, Sergei Sazhin
National Research Tomsk Polytechnic University
Lenina Avenue, 30, 634050, Tomsk, Russia
antonovdv132@gmail.com; pavelspa@tpu.ru; sergei.sazhin@icloud.com

Extended Abstract

Puffing and micro-explosion effects in composite droplets make it possible to improve integral characteristics of secondary atomisation processes in combustion chambers, increase completeness of fuel combustion, reduce ignition time delay, and reduce anthropogenic emissions [1]. This work focuses mainly on the experimental study of cascade puffing and micro-explosion in composite droplets. Some preliminary modelling ideas are discussed.

The experimental study of puffing and micro-explosion effects in composite droplets was carried out by varying the temperature of the ambient gas (850–1150 K) [2]. It is shown that breakup of typical composite parent droplets can lead to stable evaporation, puffing, and micro-explosion resulting in an array of secondary fragments of different sizes. A parent droplet can break up several times following alternating puffing and micro-explosion regimes.

A physical cascade fragmentation phenomenological model was developed for a composite droplet (Fig. 1). Cascade fragmentation of fuel droplets is expected to improve their combustion efficiency in engines and power plants and reduce fuel consumption. The presence of water vapour in the combustion zone of a finely dispersed liquid fuel is expected to reduce gaseous anthropogenic emissions.

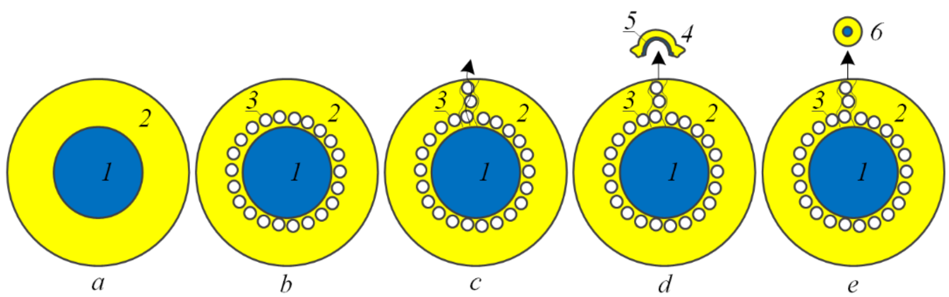

Fig. 1. Scheme of cascade formation and atomisation of a composite droplet showing the main stages of the process (the formation of one child droplet is used as an example): *a* – initial state, *b* – bubble nucleation at the inter-component interface, *c* – bubbles moving through the combustible liquid film, *d* – a combustible liquid fragment separating from the parent droplet with water vapour condensing on its surface, *e* – formation of a secondary composite droplet. *1* – water core of the parent droplet, *2* – combustible liquid film around the core of the parent droplet, *3* – water vapour bubbles near the inter-component interface, *4* – a fragment of the combustible liquid film that broke off during the parent droplet fragmentation, *5* – a thin water layer forming on the surface of a combustible liquid film fragment as it breaks off, *6* – a composite child droplet with a water core and combustible liquid film around it.

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References

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