The fate of a thin liquid filament (w/ video)

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(PhysOrg.com) -- Scientists have solved one of the printing industry's greatest challenges - whether a liquid thread will break up into drops.

Scientists from the Department of Engineering and the Institute for Manufacturing have developed a method for predicting whether a filament of fluid will condense along its length into a single droplet, or collapse into multiple droplets. The research, published today in the journal Physical Review Letters, could aid in designing processes for paint-spraying, ink-jet printing and the dispersion of drugs for inhalation .

Dr. Alfonso Arturo Castrejon Pita, first author on the paper, said: "For the first time in an experimental and quantitative way, the ultimate behavior of a filament under nothing but the action of viscous and surface tension forces has been explored."

One of the greatest challenges facing the printing industry is to develop printheads that are capable of generating "clean" single, uniform size droplets within a large range of fluid properties (viscosity, surface tension).

The University of Cambridge team, led by Professor Ian Hutchings, developed a large-scale, fully controlled model of a printhead to recreate the process droplet generation. Using a very simple fluid solution, made up of water and glycerine, the team gradually increased the viscosity of the working fluid (by increasing the amount of glycerine in the mixture). The entire process of droplet generation was then recorded using ultrafast imaging techniques to observe how long threads, or filaments (rather than drops), were being generated, which, when sufficiently viscous, would be several centimeters long and one tenth of a millimeter thick. Furthermore, these long filaments would not breakup but instead slowly contract to form a single drop.

Professor Ian Hutchings, said: "Our regime diagram can predict whether or not a certain liquid can be broken into useful droplets; it is, in simple words, a rule of thumb to determine whether a liquid can be used to produce a droplet or not."

Dr. Rafa Castrejon Pita, co-author on the paper, said: "Almost every situation in which droplets are involved, i.e. rain, splashes in the street, printers at home, water falling from a leaky faucet, pouring honey onto toast will, to some degree, follow the findings detailed in this work.

"What we found surprising is that many living organisms have evolved in certain ways such that their 'droplet/jet generators' look rather similar to our experimental systems and to commercial printheads."

Provided by University of Cambridge