

# Piezoelectric Single Nozzle Droplet Generator for Production of Monodisperse Droplets of Variable Diameter

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The further development of a droplet generator which functions without the use of pressure (drop-on-demand system) for the production of monodisperse droplets of variable diameter opens up new fields of application.

## 1 Introduction

The drop-on-demand/droplet generator which functions without the use of pressure / consists of a capillary system filled with liquid that is enveloped by a piezoceramic tube. The outlet orifice of the capillary system is shaped into a nozzle. An electric impulse onto the piezoceramic produces a pressure wave which causes a single droplet to be ejected from the nozzle at a high velocity [1]. Previous publications on this subject maintain that such droplets can only be produced with any measure of stability if the droplet diameter corresponds approximately to the diameter of the outlet nozzle [2]. This observation is taken to mean that any desired alteration in droplet diameter necessitates switching the complete head unit of the droplet generator. Inasmuch as the droplet path is of significance, this would also in most cases necessitate the head being newly adjusted.

## 2 Further Development of the Droplet Generator

The improved droplet generator is capable of producing droplets of variable diameter using the same droplet generator head. Fig. 1 shows the adjustable droplet size range (from 10  $\mu\text{m}$  to 75  $\mu\text{m}$ ) of such a droplet generator using a single nozzle orifice of 60  $\mu\text{m}$  in diameter. This development could be achieved by means of increasing the energy coupling

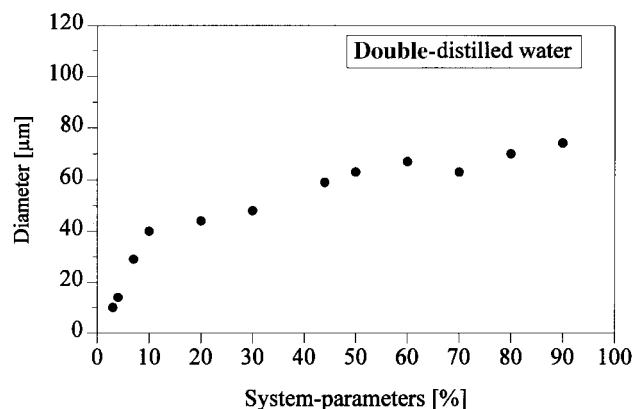


Figure 1. Stable generation of droplet diameter using a 60  $\mu\text{m}$  nozzle in a double-distilled water.

and changes to the construction. In addition to the increased spectrum of different (constant) diameter droplets there are also other benefits resulting from the further development:

- more stable operation
- extended durational stability
- no point deviation

Fig. 1 shows measurements obtained by Phase-Doppler-Anemometry (PDA). Each data point is based on the evaluation of 5.000 measured droplets. The individual standard deviation of the twelve data points lies between 0.25  $\mu\text{m}$  and 0.7  $\mu\text{m}$ . Double-distilled water was used for the tests. In addition, measurement runs were made using 50 % glycerin (w / w) to test the effect of viscosity on the droplet generator system (Fig. 2). This reveals that viscosity has an effect on the droplet generator system solely in the extreme ranges of operation.

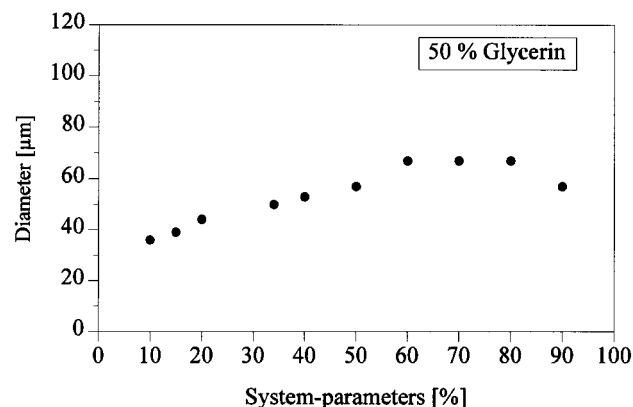


Figure 2. Stable generation of droplet diameter using a 60  $\mu\text{m}$  nozzle in a 50 % glycerin.

## 3 Application

Application in the field of bio-technology often entails pipetting sub-microliter volume into dense arrays. The droplet path of conventional droplet generators often does not correspond to the geometrical axis of the droplet generator system. Moreover, the droplet path generally changes during extended operation. These problems do not arise with the newly developed droplet generator. The droplets always follow the geometrical axis of the capillary exactly. This directional stability is crucial for the future development of 16 fold and 32 fold dispensers.

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## 4 Conclusion

The further development of the droplet generator which functions without pressure results in two significant improvements over conventional systems.

On the one hand, the new system is characterized by its extremely high operational and durational stability. On the other hand it is capable of producing monodisperse droplets of variable diameter in the range  $0.5 < d_{\text{droplets}}/d_{\text{nozzle}} < 1.35$  using a single droplet generator head.

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## References

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