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INFLUENCE OF FLOW PROPERTIES ON MICRO SIZE DROPLETS DYNAMICS

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Atomization of liquid jets and evaporation of droplets is very important process in several industrial processes such as atomization and evaporation of liquid fuel in aeroengines, gas turbines or combustion of liquid fuels. This process depends upon several factors such as relative velocity between the liquid jet and the surrounding air, cavitation in the nozzle atomizer and the interferential friction between emerging liquid jet and surrounding medium [1]. One of the dominant trend in industry nowadays is to improve of engine efficiency and decrease level of pollutants in exhausts gasses, what can be achieved by decreasing of mean droplets diameter by injection to high shear stress environment. The interest of industry in the problem stated above was the reason for establishing EU STREP Project TIMECOP [2], devoted to experimental and numerical investigations on atomization and evaporation of liquid fuels in jet engines.

In present paper evaporation rate of droplets injected to the counntercurrent flow was investigated for different liquids. The reason why the countercurrent flow was selected is as follows: with this type of flow in easy way it is possible to achieve different flow parameters in a given point by changing ratio between inner and outer velocity, what is really convenient from optical measurements point of view.

Injector used in a present study was built from glass capillary and piezoelectric transducer (see Fig. 1a), which was driven by signal with resonance frequency which causes vibrations of glass capillary. The tip of the injector was bended in comparison to original design presented in work done by El-Sayed and Gödde [2], [3] to enable introducing droplets in flow direction (see Fig 1b).

a) b)

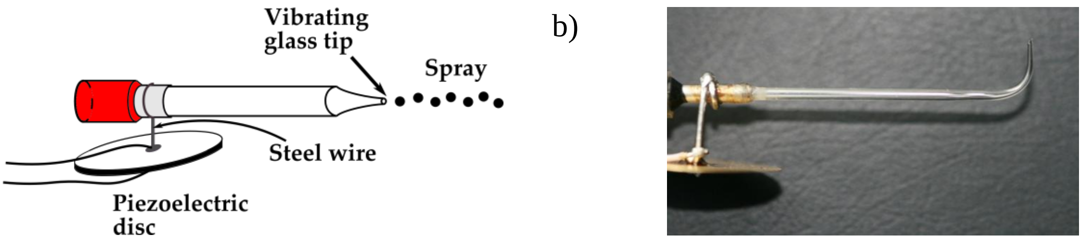
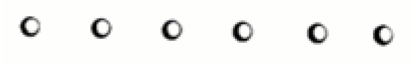


Figure 1: Vibrating injector based on Gödde observation designed at Institute of Thermal Machinery

Because investigated phenomenon was quasiperiodic the investigation was done with short time exposure macro photography. Images were recorded with digital camera equipped witch macro lens and extension tube which enable to achieve high resolution of droplets (2.7 μm per pixel). Similar measurement technique was used in work done by Y. Jiang and all [5].

During experimental work two parameters were investigated. Droplets evaporation rate and droplets velocity evolution. First parameter was measured, as a change of droplets diameter in consecutive cross section, and second parameter was measured based on the double imagining. From known time delay between two impulses triggering the LED lamp and from distance between the centers of the droplets the droplets velocity was calculated as a function of time and distance. Recorded pictures were processed in software prepared in MatLab, which allows for automatic post processing.

a)



b)

Rys. 1 Sample Picture for measurements of **a)** Droplets evaporation**, b)** droplets velocity measurements

The research was performed for constant Re = 10000 and for suction ratio = 0 ÷ 0.4 and for different density of flow defined as density ratio between main and reversed flow. The main interest was focused on the influence of macro and microscales of turbulent motion upon the evaporation velocity of droplets. The multiregression analysis allowed to conclude that scales of turbulent motion are among the important factors in the phenomenon investigated.

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References

[1] Lefebvre, A. H.(1989), *Atomization and Sprays Hemisphere Publishing Corporation*, New York
[2] Website of TIMECOP project http://timecop-ae.com
[3] El-Sayed A., Gödde J., Arn H. (1999) *Sprayer for Quantitative Application of Odor Stimuli, Environmental Entomology*, Vol. 28, No. 6, 947-953,
[4] El-Sayed A. M, Bayers'a J. A.; (2000) *Inhibitory effect of monoterpenes on response of pityogenes bidentatus to aggregation pheromone released by piezoelectric sprayer*". Journal of Chemical Ecology, Vol. 26, No. 8, 1795-1809
[5] Y. Jiang, H. Y. Jeon , L. Tian , L. E. Bode (2010) *Measuring particle size distribution using LED-illumination* International Journal of Multiphase Flow Vol. 36 193–201