Analysis of the water atomization process using a supesonic nozzle

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Introduction

This study aims to analyze the process of water atomization utilizing a supersonic nozzle. The investigation focuses on understanding the key factors and mechanisms involved in the efficient dispersion of water droplets through the implementation of supersonic technology. The experimental setup includes a supersonic nozzle designed for optimal atomization performance. The analysis encompasses several parameters, such as nozzle geometry, inlet pressure, and temperature, which influence the atomization process. High-speed imaging techniques and computational simulations are employed to observe and quantify the breakup of the water stream into fine droplets. The findings contribute to a comprehensive understanding of the intricacies of water atomization with supersonic nozzles, providing insights into potential applications in various fields, including combustion, cooling systems, and industrial processes. This research facilitates the optimization of supersonic atomization techniques for enhanced efficiency and performance in water spray applications.

In this study, research was conducted using a supersonic nozzle designed and manufactured at the Department of Chemical Engineering and Apparatus of Poznan University of Technology.

The experiments were carried out on a station, the simplified schematic of which is presented in Figure 1.

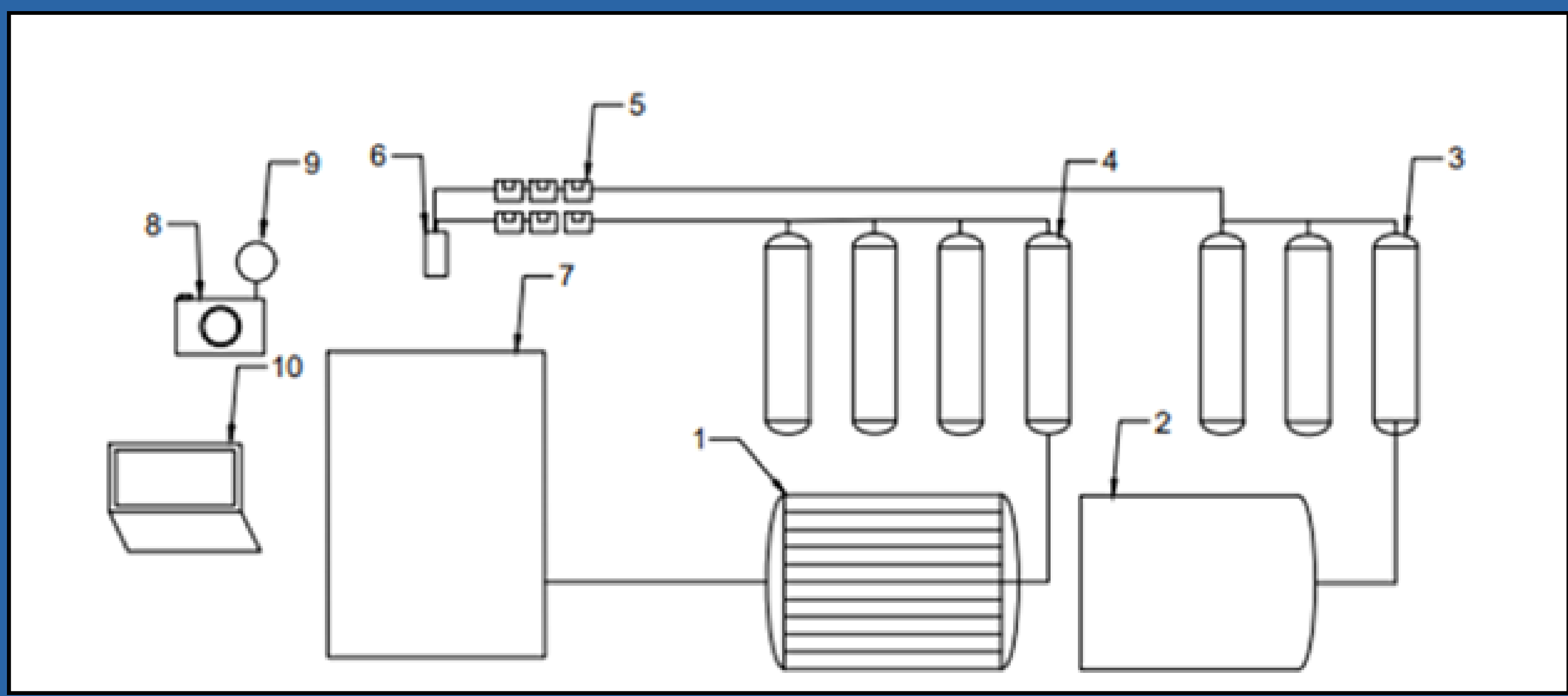

Figure 1. Experimantal set-up:
1 - pump, 2 - compressor, 3 - gas rotameters, 4 - liquid rotameters, 5 – thermometer/flow meter/pressure gauge, 6 - nozzle, 7 - tank, 8 - camera, 9 - flash lamp, 10 - computer.

Results

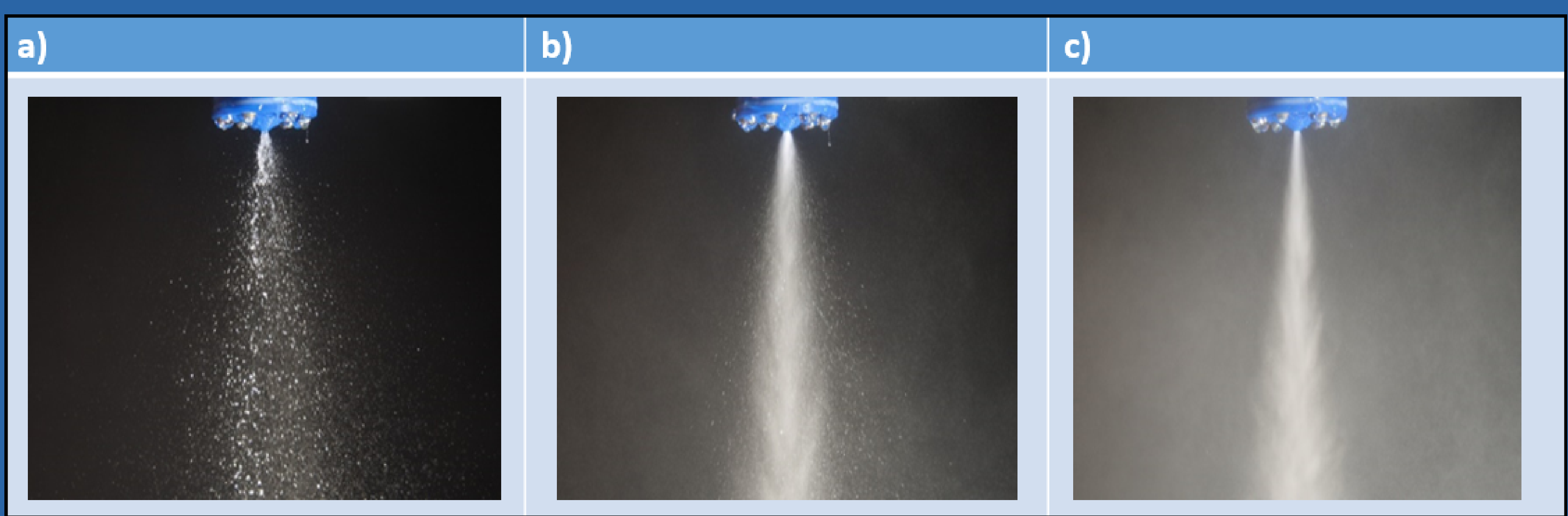

Figure 2. Visualization of the spray for liquid flow rate 20 l/h:
a) gas flow rate 1 m3/h, a) gas flow rate 3 m3/h, c) gas flow rate 5 m3/h.

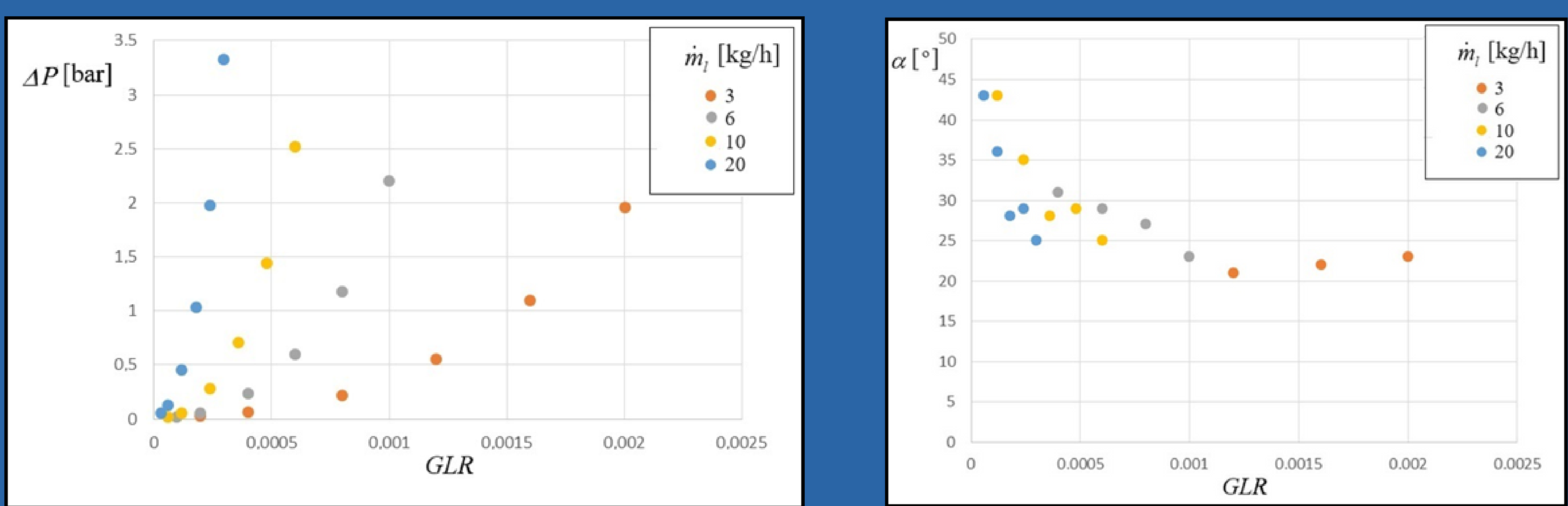

Figure 3. Exemplary plots:
a) dependence of pressure drop vs. GLR for different values of liquid flow rates,
b) dependence of spray angle vs. GLR for different values of liquid flow rates.

Conclusions

→ The pressure drop is higher for higher values of the liquid mass/volume flow rates.

→ The spray angle reached a certain maximum value (Figure 2a); up to this point, the formed spray was generated. Afterward, the spray angle decreased, forming a more compact spray (Figure 2c).

→ With the increase in the GLR, the spray angle decreases; however, the liquid distribution within the jet becomes more uniform and compact.

→ The largest observed spray angle values were approximately 45 degrees, while the smallest were around 20-25 degrees (at higher GLR values).

This research was carried out under the SBAD program of the Ministry of Education and Science.