Effervescent atomization in the agriculture sector

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The atomization process is used in industry for wetting bulk materials, and also in scrubbers and washers. A special type of spraying is effervescent atomization. Gas is introduced into the liquid in order to break it into small fragments (Orzechowski et al., 2008). This type of system has been successfully implemented in gas turbines, combustion engines, furnaces, boilers, and waste incineration plants. It has also been used in atomizers for consumer products (Sovani et al., 2001). In this article, the authors will focus on the use of effervescent atomization in the agricultural atomizers that are used to spread plant protection products.

The advantage of such an atomizer is its large outlet opening. When comparing the diameter of the outlet opening of an effervescent atomizer and a jet atomizer (most often used for care treatments), the diameter of the effervescent atomizer can be increased approximately 5 times (Agro-Tech Junoszyn, 2023). Such a large diameter affects the reliability of operation, as such atomizers are insensitive to contaminants that are supplied with water. Due to the high tolerance to contamination, the number of filters and the filtration accuracy can be reduced. The above feature allows for the drawing of water from reservoirs or rivers without a threat of the nozzle becoming clogged. The use of a lower quality of water is particularly important when growing crops that are close to watercourses and far from the farm. Large outlet openings are less susceptible to becoming blocked with deposits of salts dissolved in water (Orzechowski et al., 2008). If a clog does occur, it is faster and easier to clear it in the field and to continue working. A larger opening enables a higher flow rate of liquid to be used, thanks to which plant protection products and fertilizers can be applied faster. The shorter treatment time directly translates into a larger surface area that can be sprayed during a day.

An effervescent atomizer is characterized by being very versatile. Changing the ratio of the gas and liquid mass flow rates influences the diameter of droplets. In this way, an atomizer can be adapted to the requirements specified by the manufacturer of plant protection products. There is no need to buy a new atomizer for each substance that is used, which in turn saves money and the time that is needed to retool the machine. Depending on the conditions, fine, medium, coarse and very coarse droplets can be produced. The selection of the appropriate droplet size is important not only due to the type and properties of the used substances, but also with regards to the weather conditions, especially wind, which causes the drift of droplets that are too small (Agroplast, 2023). A simple structure, which consists of a body, nozzle and aerator, ensures reliable operation and easy maintenance.

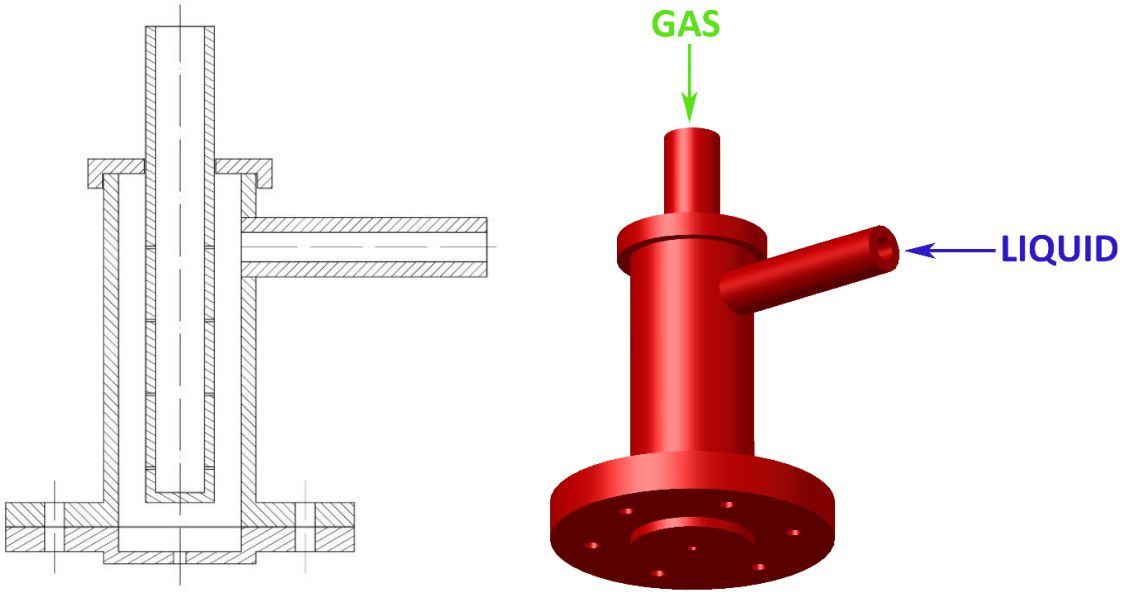

Figure 1. The construction of an effervescent atomizer.

To carry out the tests, the authors' own design of an atomizer with replaceable nozzles was used (Figure 1). The individual elements of the nozzle were made using 3D printing. Flat nozzles with outlet opening diameters of 2.5 mm and 4.0 mm were used. The ratio of the diameter to the length of the outlet opening remained the same and was equal to 1. The aerator had 8 openings with a diameter of 1.1 mm. During the tests, liquid and gas pressure drops were measured, and images were recorded using a set of devices equipped with a stroboscopic lamp. The volumetric flow rate of the gas varied from 0 to 2.5 m^3/h, and of the liquid – from 10 to 40 l/h. The measured values of the pressure drops at given flow rates enabled the relationship between the pressure drop at the atomizer and the mass flow rate of the liquid to be determined (Figure 2).

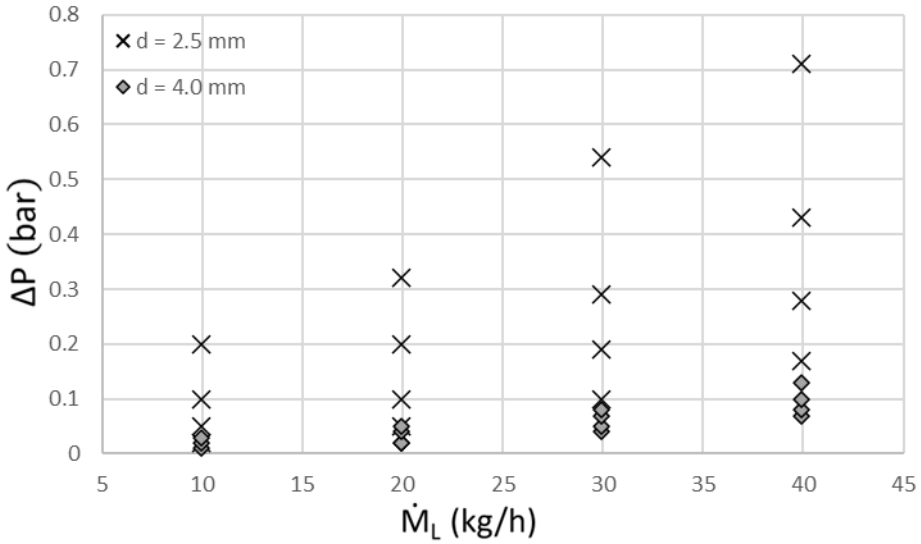

Figure 2. The dependence between the pressure drops at the atomizer and the mass flow rate of the liquid with regards to different gas flow rates for nozzles with different outlet diameters.

Regardless of the outlet diameter, a greater volumetric flow rate corresponded with a greater pressure drop. By enlarging the outlet opening, the pressure drop in the atomizer decreased. Lower operating pressures were achieved in the effervescent atomizers when compared to the jet atomizers. This affects the efficiency of the pumps that should be used for a given type of atomizer. Lower pressure means a smaller loss of pressure when transporting fluid from a tank to an atomizer.

To sum up, effervescent atomizers allow for a reduction in the operating costs of the devices that are used to apply plant protection products. They also enable water of lower quality to be used, and reduce the time that is needed to perform agrotechnical treatments.

References

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