EXPERIMENTAL ANALYSIS OF PHYSICAL PARAMETERS OF DROPLETS FORMATION OVER NOZZLE-PLATE SYSTEMS

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Abstracts. In this work a methodology is used to analyze the physical mechanisms that results in a liquid sheet formation over a commercial aspersor system. This methodology is based on a filming technique high speed. This system was chosen for tests due to its specific in use irrigation area that is one technique used in wide scale in all the regions of word. This type of technique presents some problems due the formation of different sizes drops. The different liquid sheet dimensions are directly related to the Reynolds number. The photograph methods and filming are used to capture images with good level of contrast. The quality of the images is primordial for the posterior analysis of the process of drop formation. The goods results point out to the applicability of this to understand drop formation mechanisms over nozzle-plate systems.

Keywords. Commercial aspersor system, high speed Filming, liquid sheet, nozzle diameter.

1.0 Introduction

The irrigation type nozzle-plate system, this make through the breack of the one jet in shape drop, after this was fling directly in a fixed obstacle, a plate with defined properties, as so great and angular of coning. Raposo (1979)

The concern in quantifying the sizes of the drops, that were produced in this type of systems, for this, had used some parameters as the speed of the spurt produced in determined outflows and roughness of the plates of the system. Gilley (1984), Kohl e Deboer (1984) e Hills (1991).

Silva (2002) using method of fast filming, make use of some variable and evidenced that the size of the drops does not only depend on the outflow of the system and the diameter of the aspersor peak, but among others, of the distance of the aspersor peak of the spurt until the deflector plate.

Silva (2002) developed a form to equate the system of formation of drops in the nozzel-plate systems being used two admensionais factors, Reynolds number and Weber number.

Reis et al., 1993, aiming at to identify the physical problems of formation of drops, had made a preliminary study and identify the phases that compose the process of transition of the spurt until the formation of the drops and had defined this make with being:
Phase 1: Jet emission for the injector peak.
Phase 2: Contact of the jet with the deflector plate and presence of a draining on this plate.
Phase 3: Formation of a continuous sheet surface called or continuous water film.
Phase 4: Continuous sheet in addition in a front of drops.

Reis et al., 1993, identified the presence of some physical phenomena significant, as the presence of instabilidades in the jet, and contact with air after its exit of the injector peak, where this phenomenon varies in relation Reynolds number.

The physical mechanisms that involve the jet in addition are the form of the aspersor peak, the turbulence and speed of the flow and thermodynamic state of the jet. Chigier and Reitz (1995)

Silva (2002) carried through a qualitative study on the jet and evidenced that involved forces in addition this, are related Reynolds, and this related parameter, have a relation of proportionality with the outflow of functioning of the system.

The distribution of the sizes of drops depends on rocking of forces that directly involves the instability of the draining of the liquid film, Van Der Geld & Vermeer, 1994, Silva & Silveira-Neto(2002).

Squire (1953), concludes that the sheet formed after the shock of the free jet with the conical plate moving in a gas, is unstable and that the waves in accordance grow with the amplitude of the instabilidades.

These processes are generated from the interfacial tensions, for the aerodynamics and the action of the forces viscid in the liquid film.

2.0 Experimental work surface

For the release the tests an experimental group of benches was used, that can be seen in Figure 4, and constitution the following parts:

1-reservoir of water;
2-Bomb of water suction;
3-Valve for the control of the water of the reservoir,;
4-Valve for the control of the rotameter;
5-Collecting water Chamber;
6-System of aspersion spurt plate;
7-Set of rotameter;
8-Measuring Manometer of pressure;

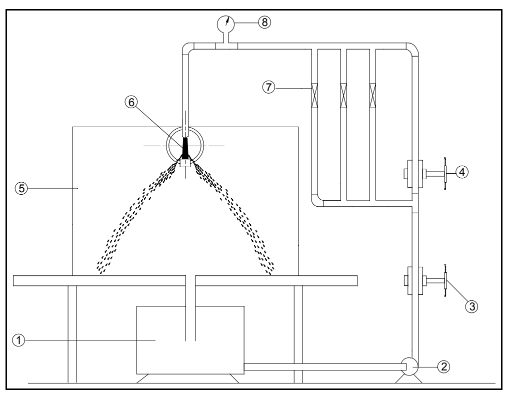


Figure 4: experimental work surface division in parts

The nozzel-plate system, Figure 5, is commercially used in the in irrigation systems cold Central Pivot, composed of a support for the deflector plate, a deflector plate of conical format and a aspersor peak that can in accordance with be modified the necessities of each culture.

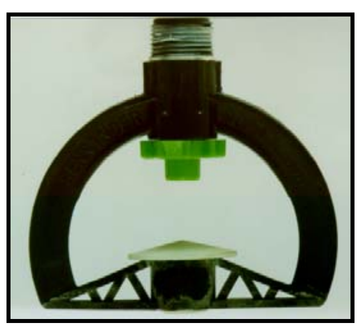


Figure 5:Detail of Nozzel-plate;

2.1 Acquisition of Images.

For the filming of the experiments, the system of images acquisition consists of the following equipment: A high resolution camera of filming of the Sony. The filming camera was located in the superior part, of the collecting box in a position above of the plan of the sheet.

In this in case, the lighting system were mounted under the collecting box in way such that it directly focalize the light in the plan of the sheet.

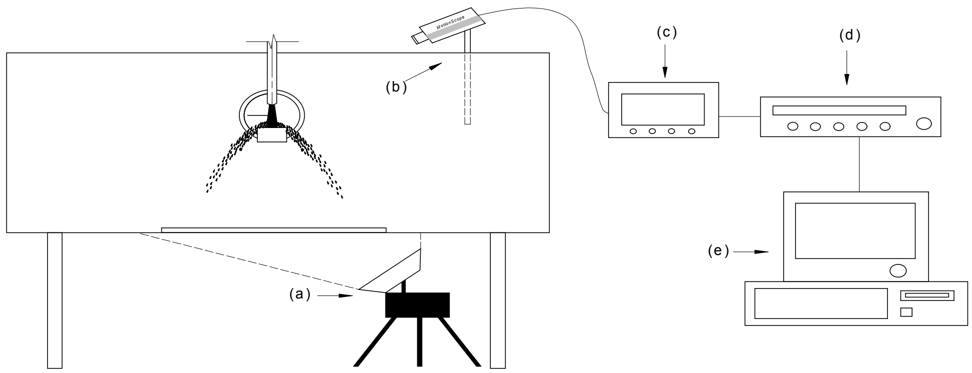


Figure 6: Experimental ostentation of benches and its basic parts as acquisition and lighting system of images as camera of filming and video cassette

2.2 Procedure of Analysis

These images selected by the program DT Acquire and are transformed into sequential photographs. For the initial analysis use of a unit of measure. This calibration, is made used a object with dimensions known.

Using of the Measurement tool of the Global lab Image, with can be seen in Figure 7, taking in consideration the measures of the object of calibration already previously chosen.

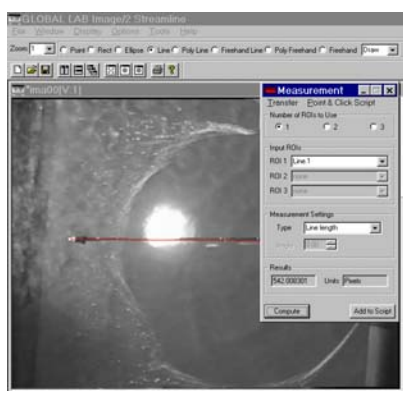


Figure 7: Measurement tool of program GLI.

This tool, has a capacity to use ROI of program, it is a line located in the extremities of the object, this line make a measure of the calibration and make that correlation of the measures sheet.

3.0 Results

The primordial interest of this work is to investigate experimentally the behavior of a sheet formed in a system jet-plate, using of experimental variable already previously argued,.

The levels of significance for the outflows initially of 250 l/h for a lesser outflow of the system arriving until 750 l/h, with a variation between values of outflows that are around 80 l/h.

This served to observe the symmetry that exists between the two parts of a sheet that is cut by the support of the aspersor peak, as it can be verified in Figure 8

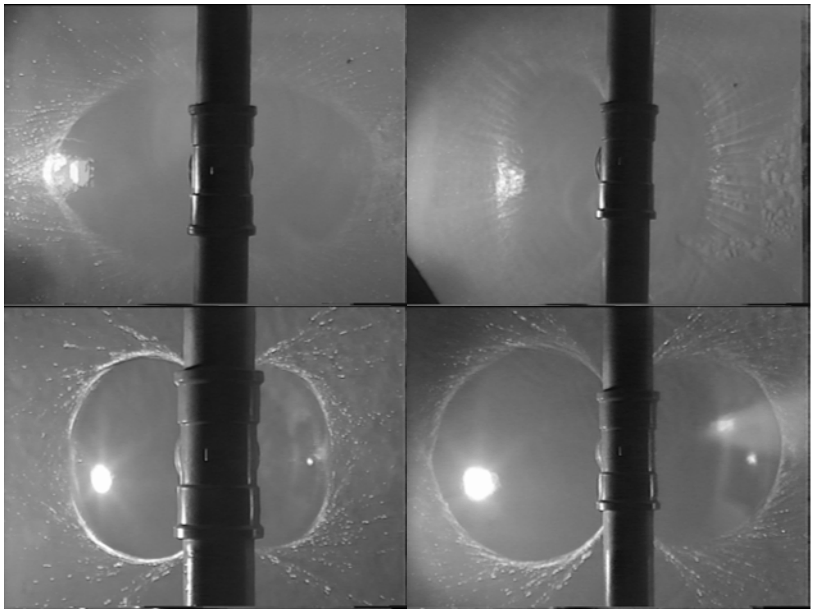
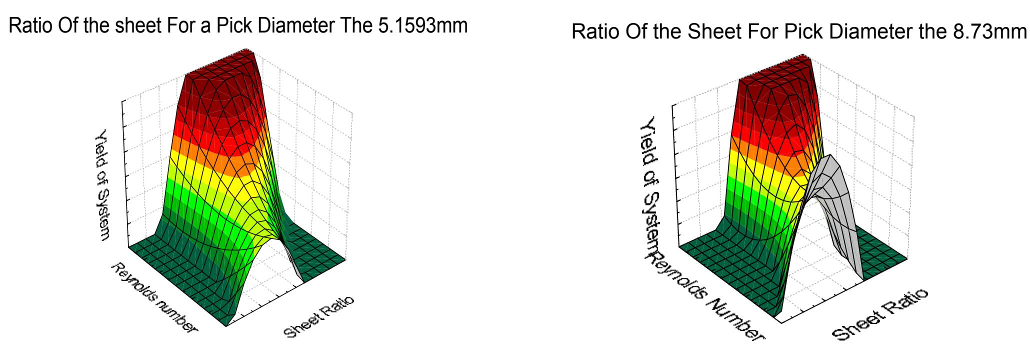


Figura11: images of flake formed in nozzel-plate system.

For a account of values of Reynolds number, take in consideration of the pick diameter in the equation: $\mathrm{Re} = \frac{\rho v D}{\mu}$ where: ρ = it corresponds to the density of the fluid; V = Outflow of the system; D = diameter of the aspersor peak e μ = viscosity of the fluid.

The diameter of the peak was established, the outflow of the system and the ray of the sheet measured for the program and with this if got the following results that can be visualized in the following figures.



(a) (b)

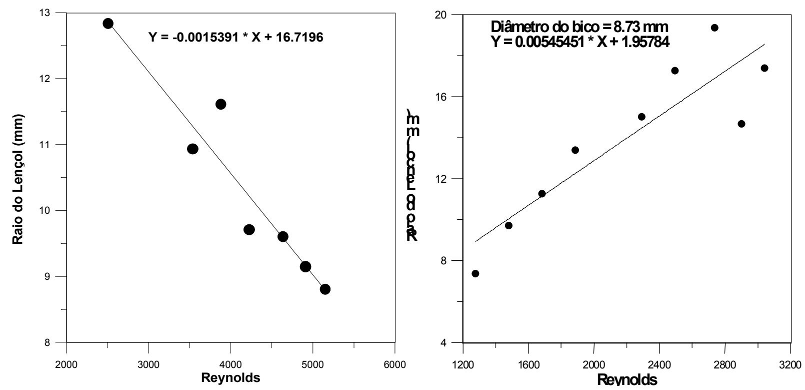
Figure 12 (a): Curve of the behavior of the ray of the sheet for the peak of 5.13mm, in relation to the parameters Reynolds and the Outflow of the Arched system (b) of the behavior of the ray of the sheet for the peak of 8.73mm, in relation to the parameters Reynolds and the Outflow of the system

The ray of the sheet, inversely proportional in the peak of 5.15 mm and a directly proportional behavior when it is about a peak of great diameter as the peak of 8.73mm.

Therefore this can occur in the peak of 5.13 mm of diameter when in functioning in high outflows.

While for the peak of great diameter, 8.73mm, this transition occurs with great difficulty, this the formation of a sheet of bigger length is favored with the increase of Reynolds.

This relation can be observed with great easiness when it is about the relation Outflow of the system & Reynolds, who can be seen in the 13 Figure (a) e (b).



(a) (b)

Figure 13(a): Demonstrative graph of the relation Outflow of Sistema & Reynolds for the Graphical peak of 5.13mm. (b) of the relation Outflow of Sistema & Reynolds for the peak of 8.73mm.

The result of Figure 13 points previously with respect to the demonstrated relation already, where the proportionality relation is observed for the two peaks, but this if inversely differentiates of the peak of 5.13mm being proportional and for the peak of bigger diameter 8.73mm being directly proportional.

4.0 Concluding Remarks

The purpose of this work, was the analysis of the correlation between the values of Reynolds number and the values assumed for the ray of the sheet in determined outflows, using a system of acquisition of fast images.

For this a series of experiments were carried through, considering three peaks of different diameters and outflows of different amplitude arriving the following conclusion:

For the peak of lesser diameter the behavior assumed for the sheet, is inversely proportional to the Reynolds number, what it indicates that how much bigger the lesser outflow is so great of the sheet, therefore the draining tends to transition with bigger easiness for the turbulent type.

Another explanation can be accepted, the formation spray in the peaks of lesser diameter more is facilitated and with this the sheet tends to diminish with the increase of the outflow.

The behavior for the peak of bigger diameter, was that the relation ray and Reynolds number of the sheet, assumes a direct proportionality, what it indicates a bigger difficulty in transition of flows , therefore this Physical phenomena only goes to occur the very high outflows, not being able to be observed in the following research therefore, the maximum value of outflow given to the system was of 750 l/h, and in this in case that a proportional graph of the relation Ratio and Reynolds were gotten.

5.0 References

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