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Irrigation equipment — Automatic irrigation systems — Hydraulic control

Matériel d'irrigation — Systèmes d'irrigation automatiques — Régulation hydraulique

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The reasons which led to the decision to publish this document in the form of a Technical Report type 3 are explained in the Introduction.

0 Introduction

Automatic irrigation systems are a relatively new concept that began to develop in the second half of the 20th century. A brief review of the background of this development is therefore in order.

Food production by world agriculture depends primarily on the availability of water : food consumption increases with the increase in world population. Available resources of water that can be used by agriculture are limited. Consequently, they have become a restricting factor which demands that new water resources be developed and that strict control be exercised over existing resources. An in-depth study of plant growth requirements has repeatedly shown that improved and increased plant yields are not necessarily achieved by the application of greater quantities of water. In fact, water quantities may in many cases be reduced, provided that the water is applied in a scientific and controlled way.

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These requirements have a direct bearing on the extent and nature of human involvement in irrigation procedures. As irrigation methods become more sophisticated, so do the demands on human involvement become more complex. Much work must be devoted to supervising water application systems. The operator's responsibilities increase proportionately, and these factors make it difficult to fill the requirements of suitable and competent manpower.

The solution to these problems can be summarized in two words : control and automation.

Since irrigation operations are performed during specific periods of time, it may be reasonably assumed that irrigation control could be achieved through time control. This concept was used for a short time during the early stages of the development of automatic control devices, but was discarded later. The attempt to apply the time concept for quantitative control is an indirect approach based on two assumptions :

- a) the rate of flow is known;
- b) the rate of flow is constant.

Assumption a) is based on data supplied by the manufacturers of other system components, such as : sprinklers, drippers, pipes, valves. These data mostly present flow rates as a function of water pressure and pressure loss, which are then used as a basis for hydraulic design.

Assumption b) is in fact a combination of two separate and independent assumptions, namely :

- 1) supply pressure is constant;
- 2) the system features do not change with time.

These assumptions are not borne out by modern irrigation systems.

The flow of water at any given moment depends on the supply pressure and the resistance of the irrigation system. Changes in these factors have a great effect on the rate of flow of the water. As a result, the deviations in the quantities of water supplied may reach high percentages, when control is based on measuring the duration of water application. Several examples of changes in flow rates may serve as illustrations :

- gradual clogging of filters causes a gradual lessening of flow;
- gradual clogging of low-flow dispersion elements, such as drippers, causes reduction of flow;
- wear of sprinkler nozzles causes increased water flow;
- sediment formation on the inner walls of water pipes causes reduction of flow;
- replacement of pipes or other components by others of different flow resistance changes the water-conducting capacity.

In all these cases it was shown that the control of water quantities in irrigation through time-measurement does not and cannot provide suitable criteria. It must, therefore, be concluded that the only method capable of providing factual irrigation data, at any given moment, and permitting the use of such information for effective irrigation control, is by means of direct measurement of applied water quantities.

The interconnection between the need for control through accurate water measurement and reduced dependence on the human factor combined with the accelerated intensification of modern irrigation have resulted in the development of automatic control means.

At first, the basic instruments were developed to permit automatic quantitative control at a single specific point. These instruments are a combination of water meter, hydraulic valve and an adjustable setting device. Turning a knob and selecting the desired dose of water opens the valve, and the water is continuously measured as it flows through the valve. When the full dose has been delivered, the valve is closed by the water pressure of the pipeline, without requiring an external source of energy.

During the following stage, special-purpose accessories were developed, enabling the interconnection of any number of volumetric metering valves to form an automatic sequential system, where the operation of each valve is activated by the preceding valve. This method increases the efficiency of the entire irrigation system by maximum utilization of the distribution system.

The automatic sequential irrigation systems opened up an important new phase in the effective control of agrotechnical water requirements, while reducing dependence on human factors. As so frequently happens, the tools that were developed and the opportunities they created gave rise to new conditions which, in turn, created new requirements and new challenges.