APPLIED DESIGN CONCEPT: ZERO ENERGY MICROIRRIGATION SYSTEM

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ABSTRACT

Irrigation (water) is one of key function in crop production. Appropriate premeditated and designed Micro (Drip) Irrigation System results in achieving benefits like increase in yield, water savings, power stash, fertilizer stash etc. In the modern scenario, power economy is becoming very important factors in Irrigation sectors because of colossal investment & chronic cost and short fall.
An assortment trials and experiments were conducted at various parts of the world and established persuading results. The present article describes a proven concept for designing of zero energy microirrigation system with photographs and sketch. This applied design concept is going to be very much useful for those who trust & thrust on energy conservation, environment fortification, pollution control and carbon credits.

Review

Micro Irrigation is the advanced method of applying water to the crops via network of macro & micro tubing and regulated emitters /drippers. It is true that most of the micro irrigation systems in the world work on higher pressure and require higher energy / power (electrical or diesel). Cumulative indirect side effects of such system are trouncing of power, addition pollution to environment and wastage of natural resources. To overcome such issue, Jain Irrigation Systems Ltd (JISL) has developed a design concept for zero energy requirement micro irrigation system.
Such systems are more popular in African countries, rural and tribal areas in India for smaller land holdings where there is no power available. Schematic layout is highlighted in next page.

Principle

This concept is very simple to understand and design. Basic fundamental of this system, potential Energy of earth is being used to counter balance the cumulative frictional head losses occurs in the hydraulically balanced network by limiting the velocity at minimal at chock-full discharge.

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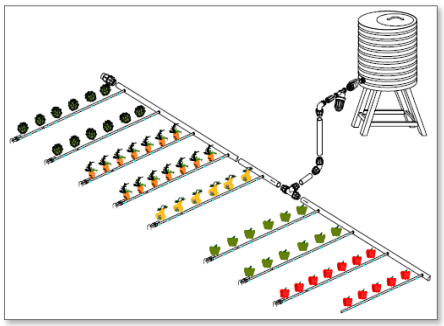
Algebraic Expression

$\sum_0^z e = \sum \Delta$ hf $\quad \lim_{0-min} v \quad \lim_{0-max} q$

e - energy.
hf - hydraulic frictional head losses.
v - velocity limit.
q - discharge limit.
z - potential head limit.



Prime objectives

Followings objectives are to be kept in mind while designing of zero energy micro irrigation System:

To maintain the higher system and irrigation efficiency by means of higher emission uniformity at lower discharge rate.

1. To maintain the zero energy level during operating of irrigation system.
2. To maintain optimum moisture level in soil for optimization of crop yield.
3. To keep both initial investment and annual cost at minimum level.
4. To design a suitable type of system that will last and perform well.
5. To design a manageable system that can be easily operated and maintained.
6. To fulfill the water and fertilizer application requirement of crops.

Design Inputs

Following inputs are required for designing of zero energy micro irrigation system:

1. Engineering Survey: Topographical map, Detailed Contour Survey.
2. Agricultural data: Crops, spacing, variety, water requirements, agronomical practices.
3. Meteorological data: Temperature, Relative humidity, Rain fall, Wind velocity / directions, Sun Shines, Evaporations etc.

4. Water Resource / Hydrology data: Main source, locations, Quantity of water available seasonal, water assessment and water balancing.
5. Soil Characteristics: Soil texture & type, water holding capacity, hydraulic conductivity, fertility, pH & EC, Salinity.
6. Soil and water sample collection and analysis in lab.

Design Output

Considering above parameters an appropriate zero energy micro irrigation system has to be designed in various stages:

7. Design of System capacity and water assessment.
8. Crop water requirement, water balancing and irrigation scheduling.
9. Hydraulic network designing and balancing of Drip Irrigation System at zero energy level.

System design starts with selection of the suitable emitter depending on type of crop, water requirement, operating time, soil type, and water quality. The length and size of lateral lines are determined based on the lateral line flow rate, field size, etc. Similarly, the size and length of the sub-main pipe is determined. Each sub-main is an individual unit with its own control valve. The whole area is then divided into different sub-main units and the number of sub-main units that can operate at any given time is based on system capacity and ground elevation. Operational sections should be designed in such a way that the discharge is equilibrium for all operational section at minimal velocity. The size of the main pipe can be determined by limiting velocity and discharge so that frictional head losses should be within specified limits given by the manufacturer. Total energy requirement has to be worked out by addition of parameter like frictional head losses in filtration unit, fittings plus permissible operating pressure of system. Total energy requirement should be adjusted in the calculation to equilibrium the potential head without addition of external power. In the below sketch there are two model layout of drip irrigation system has been illustrated to get idea of zero energy micro irrigation system. The left sketch shows the zero energy drip irrigation system on flat land with proper energy gradient. While in right sketch shows the advantage of natural gravity / slope used for working of micro irrigation system.

Zero Energy Micro Irrigation System on flat land

Zero Energy Micro Irrigation System on undulating land.

Comparison of powered & zero energy micro irrigation system for 1 ha basis.

Sr.	Parameters	Powered Micro Irrigation System (for 1 ha area)	Zero Energy Micro Irrigation System (for 1 ha area)
1.	Power (HP) required	2	0
2.	Electrical units per year	3600	0
3.	Electrical bill per year @ $ 0.15 per unit	US $ 540.00	0
4.	Irrigation efficiency	90 %	90 %
5.	Additional Investment in piping system	0	US$ 300-500
6.	Additional investment in civil works-water tank, platform to get sufficient potential head.	0	US $ 10,000-25,000 (depending upon topography)

Limitations in Zero energy micro irrigation system.

1. Topography / gravity head is the important factors in designing of system. It is not always possible to design a zero energy system for all kinds of topography.
2. To maintain a desired gradient, cost of excavation and leveling is higher.
3. Construction of storage tank may require which increases the cost.
4. Construction of platform + supporting structure are required to get substantial potential head.
5. Experienced design engineer is required to design such scheme.
6. Skilled technicians are required for installation of such system in the field.