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Design Steps for Micro Irrigation System in Canal Command Area

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ABSTRACT

In India has been tremendous development in the surface irrigation resources but the problem of our country faces is the management of these resources in a sustainable manner. 60 - 70 % of water is wasted in traditional irrigation systems over the soil that is only 30 - 40 % of water delivered from the reservoirs is utilized for irrigation and only 50% of it is actually used by the plants. Though at present with the improved water management practices in surface irrigation method there is still a considerable wastage in water deliveries through unlined channels, inadequate field channels and wild surface flooding. With the limited water resources, an alternative has to be taken into a serious consideration. Shifting from the traditional surface irrigation system to pressurized irrigation system to increase water use efficiency is an important component of the modernization of canal system. With this in view, a study on outlet of minor irrigation system was conducted to convert area from surface irrigation system to pressurized irrigation system (Conveyance) and micro-irrigation (End use distribution) to evaluate its technical feasibility.

Keywords :

Introduction

Micro irrigation, drip irrigation or trickle irrigation is the slow, precise application of water and nutrients directly to the plants' root zones in a predetermined pattern. Design can be customized to meet specific needs while maintaining an optimum moisture level within the root zones, efficiently conserving water that might otherwise be lost to non-growth areas, runoff, sun or wind, and providing the proper balance of water and air needed for successful plant growth. These benefits can be useful for any residential, commercial or agricultural installation, and may be critical for cities and municipalities that face water restrictions while aspiring to maintain or expand their green areas.

One of the main advantages of micro irrigation system over conventional irrigation systems is the flexibility to adapt to any layout above or below grade, in any location. This feature allows users and installers to customize an irrigation system to meet a specific need while satisfying today's irrigation requirements.

In micro irrigation systems, water is distributed using an extensive hydraulic pipe network that conveys water from its source to the plant (Figure 1). Outflow from the irrigation system occurs through emitters placed along the water delivery (lateral) pipes in the form of droplets, tiny streams or miniature sprays. The emitters can be placed either on or below the soil surface. In general micro irrigation systems are classified by the type of emitter used in the system.

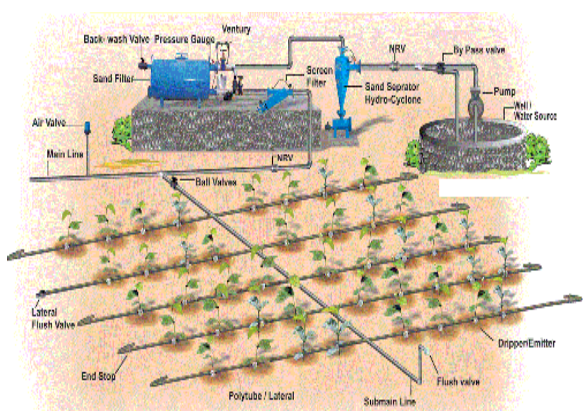

Fig 1 Micro Irrigation System (MIS)

DESIGN OF MICRO IRRIGATION SYSTEM (MIS)

Layout of Micro Irrigation System (MIS)

Layout of the study area is prepared using the software Auto CAD 2009. Layout is prepared for design of MIS by selecting two alternatives

Alternative – I considering continuous canal flow with 24 hrs power supply

Alternative - II considering continuous canal flow 8 hrs power supply

Study area is divided according to the field conditions into chak and subchak. These are connected to the center of the storage well by PINS as a bridge between them. The water supplied to field with approximately 20 m head at the sub chak level through mains, sub mains and perpendicular laterals laid in the field. The lengths of all the laterals, sub mains, main and number of emitters are calculated.

Irrigation data required for design of MIS related to Alternative I & Alternative II are as follows:

Total area of each sub chak in hectare.

Types of crop considered a major crop grown in this area.

Details of water source type i.e. Well, Bore well, River or Canal.

Details of micro irrigation system -for closely planted crops like cotton, banana, sugarcane, vegetables used in-line or online emitter or dripper system.

As per selection of crop the spacing between row to row decided.

Also considered plant to plant spacing or emitter spacing has per closely or far planted crop.

The emitter is the most important part of a micro irrigation system because it delivers water at the desired rate to the plant and maintains water application uniformity over the entire irrigated area. An emitter should match particular field conditions including type of crop, spacing of the plant, water requirement, water quality, operating time, pressure head etc.

Irrigation rate also called application rate is the rate of application of water per unit time expressed in depth. Unit of this is mm/hr. It is the ratio of dripper discharge (lph) with spacing of dripper (m) and lateral (m).

Crop water requirement or water application per irrigation also called peak water requirement. It is the maximum water requirement of matured crop throughout day expressed in mm/day. From State Water Data Centre (SWDC) meteorological data are collected and using software CROPWAT 8.0, value of water requirement is determined considering a major crop as cotton in the study area. Time of irrigation per operation is the ratio of water application per irrigation to the irrigation rate.

Electricity depends on policy of state.
Maximum shifts as per time limitation find out by total electricity available divide by time of irrigation per operation cycle.

Design Steps for Components of MIS
To design MIS with proper head loss calculation by Darcy – Weisbach formula. Water flows upto the crop of field without clogging problem and operation and maintenance cost minimized.

(i) Irrigation Data
Q=Select emitters with discharge = 2,4,6,8 lph (As per type of crop)

S_r =Lateral Spacing = spacing between row of crops

S_e = Emitter Spacing = Spacing between crop/ No. of emitters /plant

Application Rate = Emitter Discharge / (Lateral Spacing x Emitter Spacing)

Duration of irrigation =Peak water requirement (mm)/Application Rate (mm/h)

(ii) Design of Laterals
Select diameter (D) of pipe in mm

Find length of laterals from figure in meter.

Compute thickness of lateral (t) = (D / 15) + 0.55 mm

Compute inner diameter (d) = D – (2 x t)

No. of emitters per laterals = Length / spacing between emitters

Discharge (Q) at entry of laterals = Length / spacing between emitters

Velocity in laterals = Q/A in m/s

Reynolds No. $R_e = vD / \mu$

D-W friction factor f = 0.316 / Re 0.25

Head –loss $h_{f\ lat.} = 6.377\ fLQ^2 / D^5$ (Q in lph,D in mm)

Add 15% loss due to online laterals.

Total head loss with full discharge = $1.15 \times h_{f\ lat.}$

Actual head loss

= Christiansen correction factor x head loss with full discharge

= $F_{0.5} \times h_{f\ lat.}$ Where $F= 1 / (m+1) + 1 / 2N + (m-1)^{1/2} / 6N^2$, N= No. of outlet

$F_{o.5}= (2NF-1) / (2N-1)$, m=2 for D-W EQ^n

The operating pressure at the mid-point of middle lateral P_a = 10 m

The pressure at entry point of middle lateral $P_d = P_a + 0.75$ Actual head loss

(iii) Design of Submain
Select diameter (D) of submain pipe in mm.

Find length submain from figure in meter.

Compute thickness of lateral (t) = (D /15) + 0.55 mm

Compute inner diameter (d) = D – (2 x t)

No. of laterals per submain on each side = Length / spacing bet. laterals

Total no. of laterals = 2 x no. of laterals in one side

Discharge at entry of submain = Total no. of laterals x lateral discharge

Velocity in laterals = Q/A in m/s

Reynolds No. $R_e = vD / \mu$

D-W friction factor $f =0.316 / R_e^{\ 0.25}$

Head –loss $h_{f\ sub.} = 6.377\ fLQ^2 / D^5$ (Q in lph , D in mm)

Add 20% loss due to lateral connections.

Total head loss with full discharge = $1.2 \times h_{f\ sub.}$

Actual head loss = Christiansen correction factor x head loss with full discharge

= $F_{0.5} \times h_{f\ sub.}$ Where $F= 1/ (m+1) + 1/ 2N + (m-1)^{1/2}/6N^2$, N= No. of outlet

$F_{o.5}= (2NF-1) / (2N-1)$, m=2 for D-W EQ^n

The operating pressure at the mid-point of midpoint of submain Pa = 10 m

The pressure at entry point of middle lateral $P_d = P_d + 0.75$ Actual head loss

The pressure at the end of submain(P_c) = P_e - 0.25 Actual head loss

The pressure at the end of last lateral(P_b)

= Pressure at entry of submain (P_e) - Pressure at the end of last lateral (P_b)

< 2 m (20% of operating pressure)

(iv) Design of Main

Select diameter (D) of main pipe in mm.

Find length main from layout in meter.

Compute thickness of lateral (t) = (D / 15) + 0.55 mm

Compute inner diameter (d) = D – (2 x t)

Velocity in laterals = Q/A in m/s

Reynolds No. $R_e = v D/ \mu$

D-W friction factor $f = 0.316 / R_e^{0.25}$

Head –loss $h_{f\ main} = 6.377\ fLQ^2/D^5$ (Q in lph, D in mm)

Pressure at the entry of main (P_f) = Pressure at the entry of submain(P_e) + $h_{f\ main}$

Pressure at the beginning of micro irrigation system(P_g)

= The pressure at the entry of main (P_f) +Loss of head in filters (Assume 6 m)

< Head required, Then Design is O. K.

CONCLUSION

Similar MIS design is adopted for both the alternatives as per field condition. MIS design can be done such way that it supply adequate water & power upto the field, in case of change its policy. Design of MIS permanently through underground network of pipelines, hence, there will be no need for land acquisition and associated costs are eliminated. Underground network of pipeline would require very low operations and maintenance costs.

Central filtration units are provided at the pump houses to eliminate sediments or other impurities carried with canal water. No need to install further filtration units at the farmers' field. Due to centralized filtration, application of water soluble fertilizers is possible along with irrigation water. Thus precise amount of irrigation water with required water soluble fertilizers would be delivered daily at the farmers' field. The filtration system ensures longevity and optimal performance of the irrigation system.

The centralized pumping system ensures easy operation of the system as flow of water through the network of pipes can be controlled from one place rather than from various locations. This also reduces operation & maintenance costs and cost of valves at various locations.

The pipe network will have control valves near the control unit to control the discharge rate of water and to ON / OFF the system as per requirement. Uniform distribution of water through micro irrigation results in uniform crop growth and maturity. Application of water at the root zone results in lesser weed incidence and lesser incidence of pest and diseases.

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