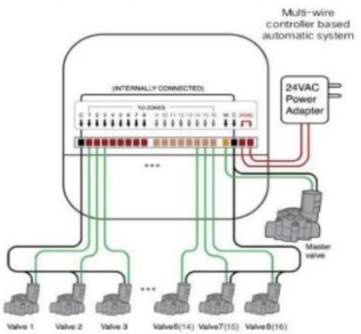
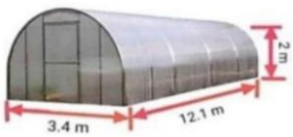




DOCUMENT ON AUTOMATIC IRRIGATION & CLIMATE CONTROL SYSTEMS WITH UNDERSTANDING OF DESIGNS

By Er. Piyal Mitra

B.Tech, Mechanical Engineering

Contents on Irrigation Automation:

Contents on Understanding of Irrigation System Design:

INTRODUCTION

An automated irrigation system refers to the operation of the system with no or just a minimum of manual intervention beside the surveillance. Almost every system (drip, sprinkler, surface) can be automated with help of timers, sensors or computers or mechanical appliances.

An automation of irrigation systems has several positive effects. Once installed, the water distribution on fields or small-scale gardens is easier and does not have to be permanently controlled by an operator.

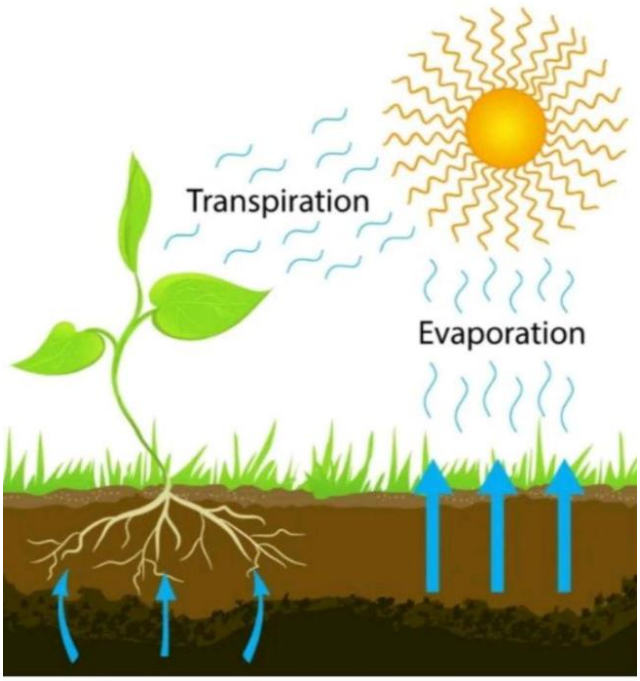
Automated Irrigation Systems work by continuously monitoring the soil moisture content and wirelessly activating the pipeline valves to open when the moisture level drops below the minimum threshold for the cultivated crop, causing the land to be irrigated.

Smart irrigation helps in minimal wastage of water. It allows to reinvest in new and improved technologies which ensure sustainable and responsible irrigation over time. It also allows controlling the amount of water delivered to the plants when it is needed.

An automation in irrigation system can be proposed in different ways like multi-wire based, Two-wire decoder based, IOT based wireless.

Here I am going to describe these three types of automation system and also brief some relevant calculations with product details generally prefer for system designs.

Amount of ET is just opposite of amount of rain..



Logic of an irrigation automation system:

1. At first Submersible pump will start automatically by water level guard meter when water in reservoir reaches below desired level.

2. Booster pump will also start automatically by another water level guard meter when water level reaches at desired height.

3. Until water is filled at certain height the booster pump will not start at programmed schedule.

4. Irrigation system will be in operation after booster pump starts.

5. Running for designed duration the booster pump will stop automatically.

6. The submersible pump will also be stopped automatically after water level reaches at desired height for next day operation.

7. The next day booster pump will start at specified time as required water is available in reservoir.

8. When water level goes below to the desired level by operation of booster pump, submersible pump will start again automatically.

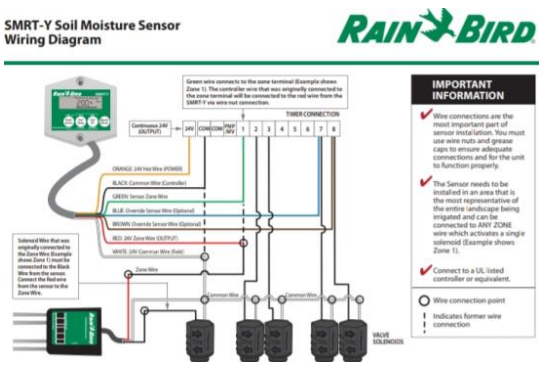
9. Irrigation system will continues with operation of solenoid valves.

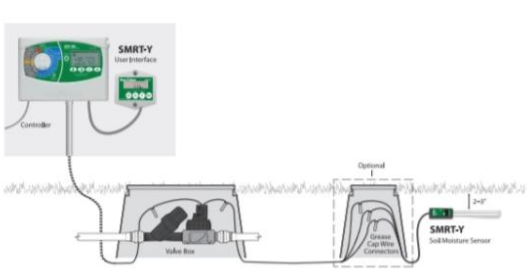
10. A moisture sensor will detects the available moisture level in soil and when threshold limit reaches at 25% (as set in the sensor display) the irrigation system will start automatically by controller to compensate water requirement of the crops.

11. The Rain Sensor automatically shuts off your sprinkler system when it rains, so you don't have to worry when you're home or away. The Rain Sensor easily connects to most irrigation system controllers. It will allow some rain (1/2" or 3/8") before shuts off the system.

An automatic moisture sensor will detects the moisture level in soil.

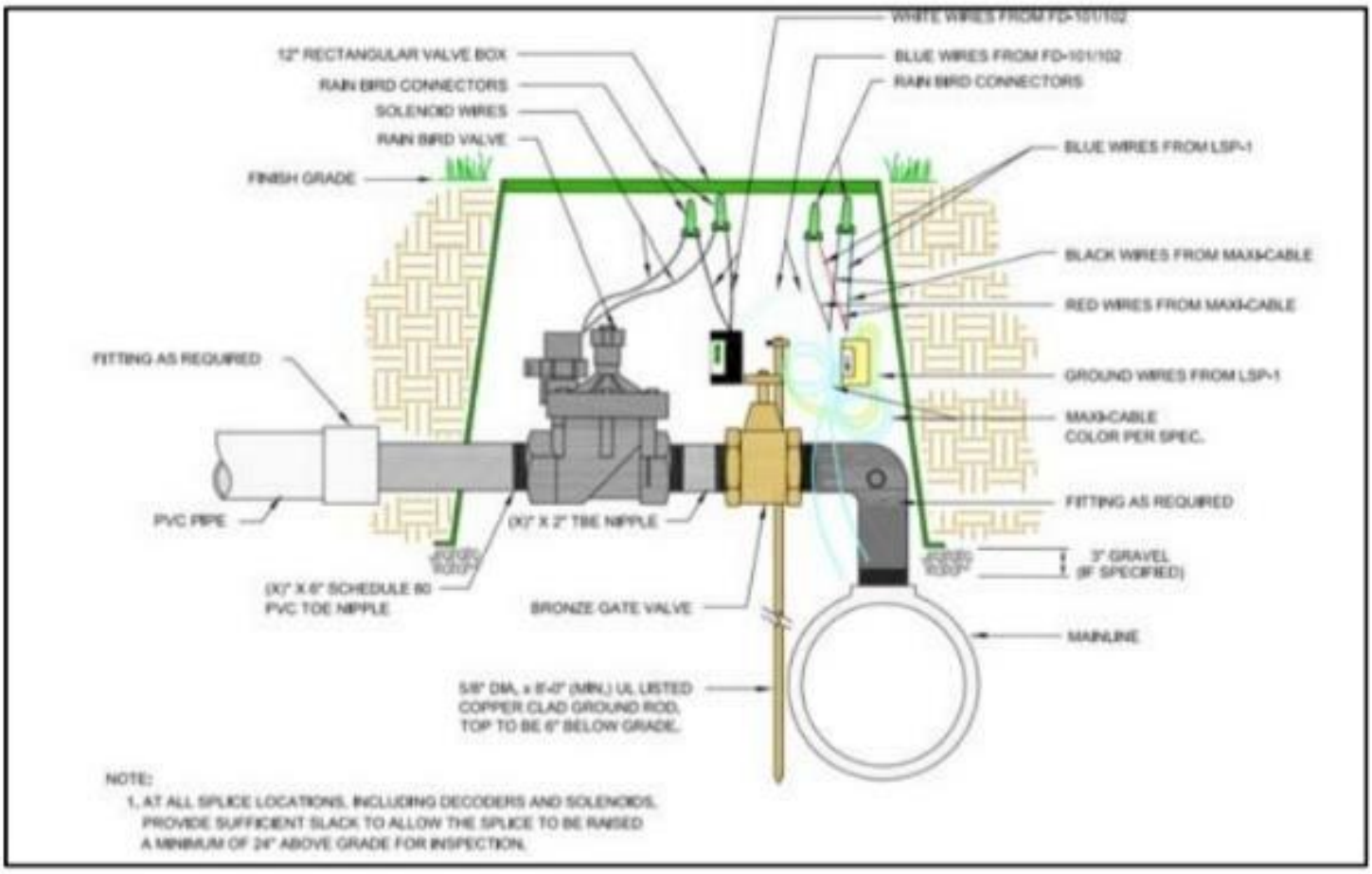
A threshold limit (in %) to be set to the LCD display screen of the moisture sensor. Threshold means lower limit and when the sensor indicates that threshold limit of the soil moisture level, the moisture sensor gives signal to the controller to start irrigation. The threshold limit is selected according to the absorption capacity of the soil. If we set higher threshold limit then water logging will be an issue when irrigation running as the capacity will not allow to absorb that much of water in the soil. **Hence there must be a threshold limit to be set in moisture sensor reaching that mark automatically the irrigation process will be started.**



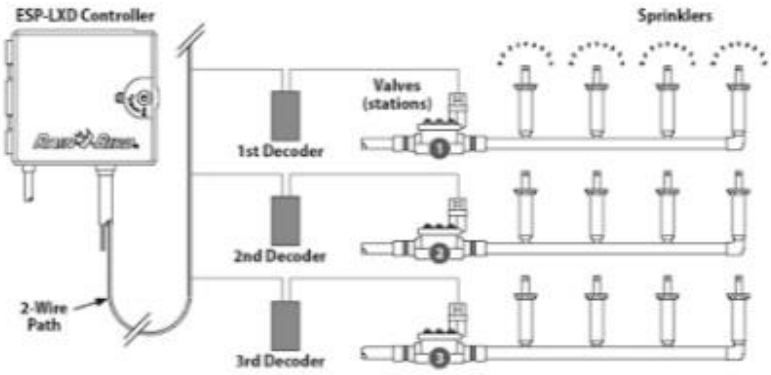


The following table includes average values for field capacity and moisture thresholds by soil type.

Soil Type	Typical Field Capacity	Suggested Moisture Threshold
Sand	15%	12%
Loamy Sand	18%	14%
Sandy Loam	21%	17%
Sandy Clay Loam	29%	23%
Loam	31%	25%
Sandy Clay	33%	26%
Silt Loam	35%	28%
Clay Loam	36%	29%
Silt	38%	30%
Silty Clay	40%	32%
Silty Clay Loam	40%	32%
Clay	44%	35%



Two-wire decoder based automation system & related equipment:




Two-wire controller

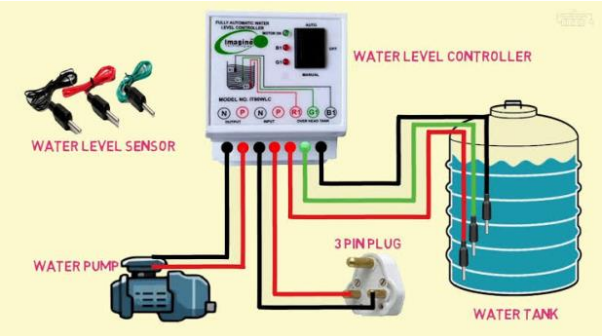

DBR Connector


Decoder


Line Surge Protector


Solenoid Valve

A stand-by booster pump is connected with operational booster pump via manifold to avoid any delay in Irrigation schedule.

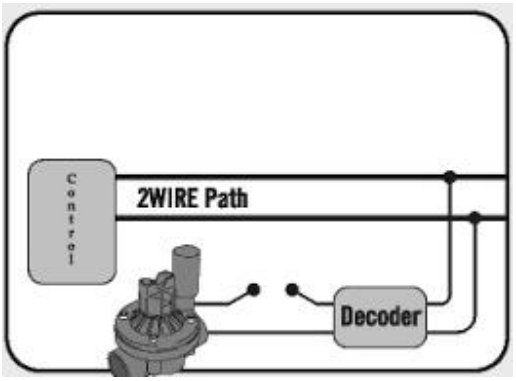


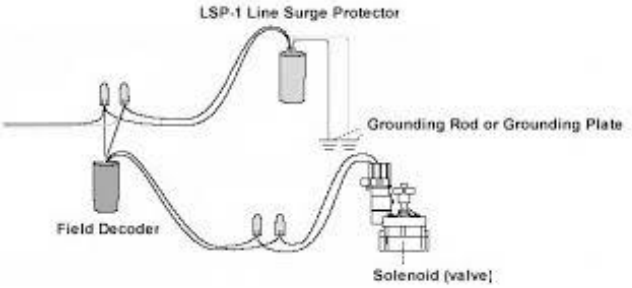
CVT Stabilizer

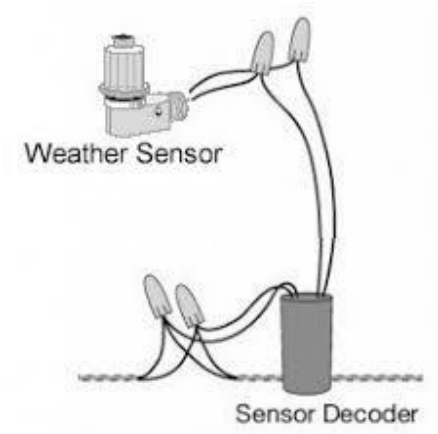

Rain Sensor

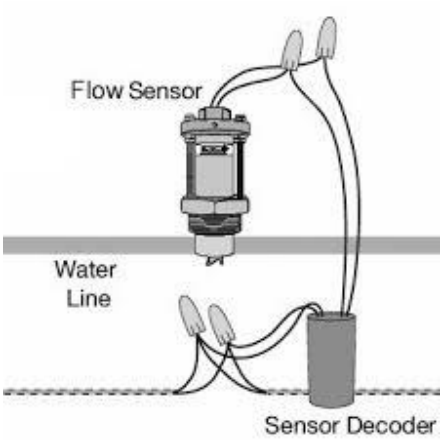
Address of each decoder to be put in the controller with designed duration to run valves.

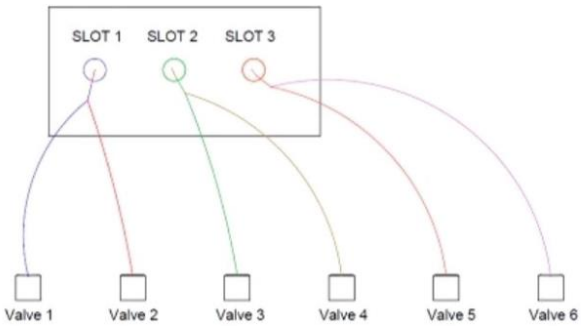
Connection arrangements of Two-wire decoder based irrigation automation











Wiring diagram for two valves operation at a time

2-Station Field Decoder is needed to run two number valves at a time

Decoder Cable Fuse Device (DCFD)™

These products were specifically designed as electrical isolation devices to help with troubleshooting of damaged or non-functioning 2-Wire irrigation systems. Single or multiple sections of the electrical circuit can be disconnected or isolated by simply removing a fuse, without cutting wires or undoing splices/joints. **Patent Pending.**

Quick-disconnect Splitter – Splits the incoming signal from the central computer into single (270DCFD1), two (270DCFD) or three (270DCFD3) directions. See wiring diagrams.

Fuses – Standard 5-amp Mini Automotive fuses are utilized to act as circuit switches when they are inserted (closed/on) or removed (open/off.) The fuses also provide lightning protection when the electrical surges exceed the capacity of the 5-amp fuse(s.) The isolation of circuit sections eliminates or minimizes electronic component failure.

Test Posts – These posts (silver dots in the wiring diagrams to the right) are accessible when the threaded cap is removed. This allows the measurements of voltage and current flow. It may be necessary to use a "True RMS" multi-meter to perform these tests. Consult with the manufacturer of the decoder system.

- Voltage can be measured by connecting the probes of the meter to the Red/Black posts
- Current flow can be measured when a fuse is removed and the probes of an in-line amp meter are connected to the posts on each side of the empty fuse holder.

Water Tight – A resin is used to waterproof the wire leads.

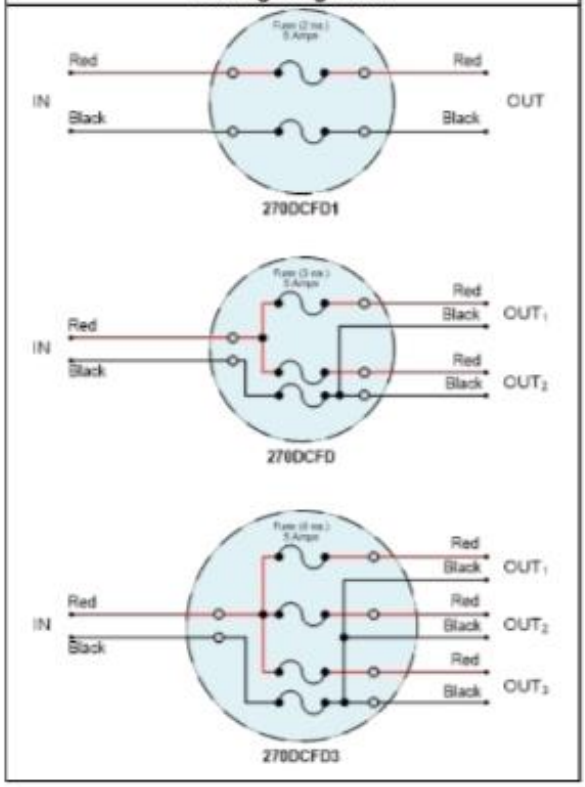
Wire Leads – All wires are 14 AWG, Type UF/TWU direct burial, 36" long. This allows the assembly to be brought above grade when troubleshooting and accessing the fuses.

O-Ring Seal – Provides a waterproof capsule. Cap is unscrewed to access the fuses.

ACME Threads – Minimizes binding of threads due to soil.

Splices/joints - All connections of the 14 AWG wire leads onto the 2-wire cables shall be made using a 3M model DBR/Y-6

Wiring diagrams:



Wireless irrigation automation

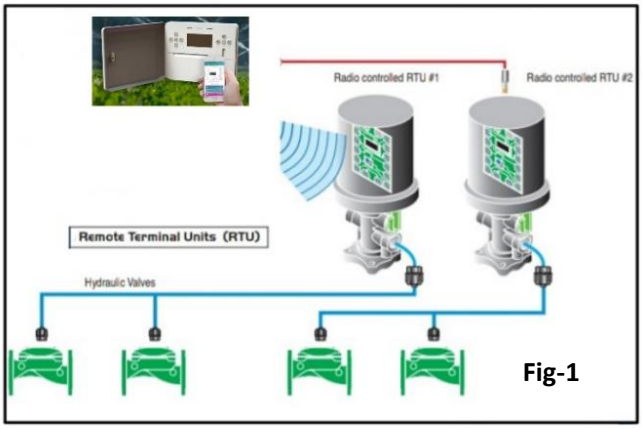
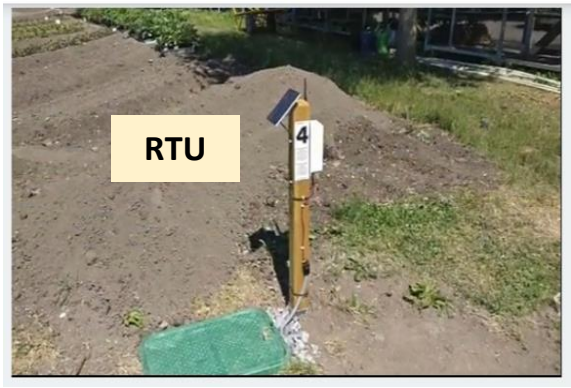


Fig-1



Wireless Irrigation Automation where the system works by radio signal and eliminates involvement of cable wires.

Each RTU Channel no. to be put in the controller with designed duration to run Valves.

The seller of the valves should be informed that latching solenoids are desired with the valves. The price of 24VAC solenoid is deducted and price of 9VDC latching solenoid is added.

Advantages of Wireless Irrigation Automation:

1. Eliminates cost for wires
2. No issue for wire maintenance
3. No extra space required in trench for wires
4. Saving in cost for LSP units
5. Valves can be shifted to anywhere in the field with RTU connection

Devices involved:


Irrigation Controller


Remote Terminal Unit (RTU)


9VDC Latching Solenoid Valve

Irrigation Controller send commands to Remote Terminal Unit (RTU) as per pre-scheduled programs via Radio signal system. Additionally a Wi-Fi connection can be set up to control the system from outside.

Remote Terminal Unit (RTU) is used in radio or cable remote control irrigation. It is a solar-powered unit. The RTU is suitable for use in irrigation applications with a master radio control system. Each RTU must be paired with irrigation controller. Irrigation Controller Unit transmits commands (by cable or radio) to an electronic card (located inside the RTU) activating Magnetic Latch Solenoid Valve(s).

2 to 4 numbers of 9VDC solenoid actuated valves can be connected to each RTU. In Fig-1, maximum of two valves will be operated at a time. RTUs are required for operating valves, pumps, fertilizers, fans, lighting and more in wireless systems. **Controller sends commands to RTUs which are solar-powered and no electricity cable is needed to connect the RTUs with controller.**

High Amplifier Antenna with Cable

RTU External ceramic antenna 3.5dBi with 3m cable and mounting kit

WiFi dongle

Installation kit (set of 2 cables + pigtail connection clams)

Magnetic Latch Solenoid Actuator- 9VDC

4w/12VDC Solar Panel to connect RTU

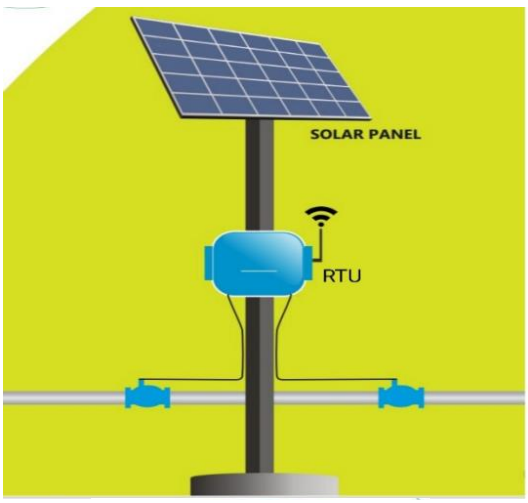
Metal frame for RTU pole/wall mounting

High Amplifier Antenna is required with RTU for reaching of Radio Frequency up to 5000 m approx.

RTU External Antenna is required with RTU for reaching Radio Frequency up to 700 m approx.

WiFi is required to transmit Radio Waves to the RTUs

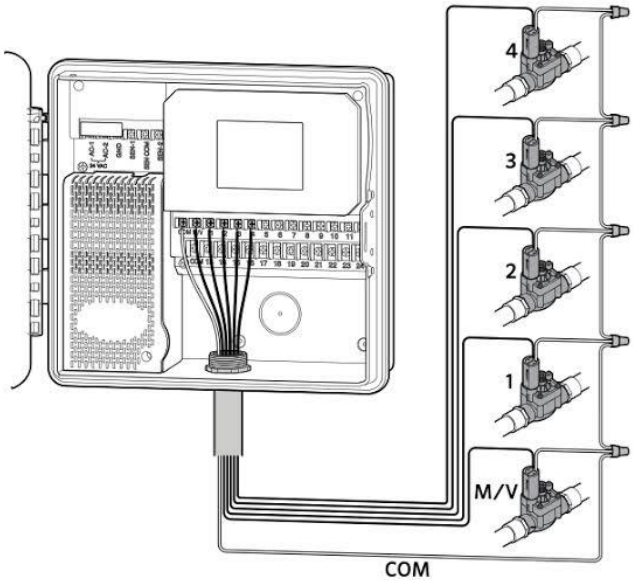
Cables are required to connect RTUs with 9VDC Latching Solenoid Valves & Required size of Solar Panel to connect with RTU is 12” x 12”

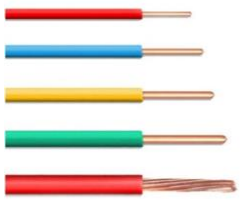

SOLAR PANEL
RTU


External Antenna

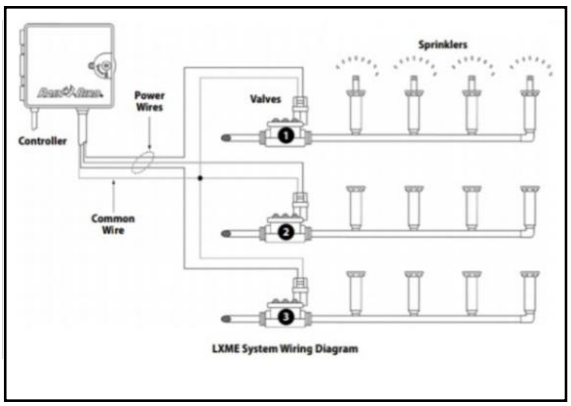
Multi-wire based irrigation automation

In this system a separate wire is connected to each Solenoid Valve from each phase of multi-wire controller. For smaller area with less than 25 Valves this type of automation system is cheaper but larger quantities of wire are involved which can cause maintenance issues over long time of usage.





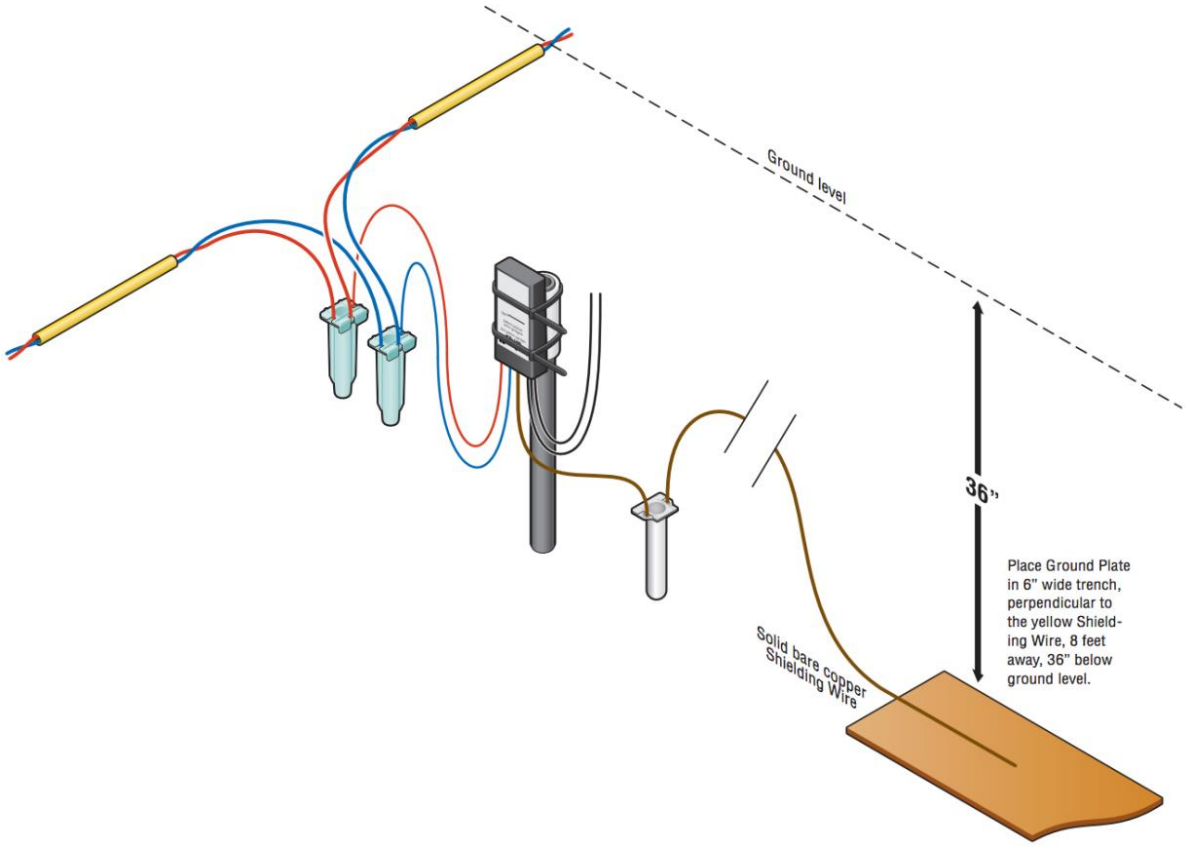
CVT Stabilizer



Valve identification number is selected as per designed location and named accordingly. If V1 is at starting point and programming is done by mentioning duration as 30 minutes then valve at starting point will be run for 30 minutes. Accordingly duration of other valves to be set as per designed location.

Necessity of Earthing

It is the responsibility of the Contractor to ground all electrical equipment installed in relation to the irrigation control system. Grounding components will include, but not be limited to, the items described in the following paragraphs. Use grounding electrodes that are UL listed or manufactured to meet the minimum requirements of the US National Electrical Code (NEC).



CONTROLLERS

At the very minimum, the grounding circuit for controllers will include a copper clad steel ground rod, a copper ground plate and 100 pounds/45 kg of PowerSet® earth contact material, as defined below and per the following detail.

Ground rods are to have a minimum diameter of 5/8"/1.5 cm and a minimum length of 10 ft/3 m. These are to be driven into the ground in a vertical position or an oblique angle not to exceed 45 degrees at a location 8 to 10 ft/2.4 to 3 m from the electronic equipment or the wires and cables connected to it, and at right angles to the two-wire path. It is to be stamped as UL listed.

The copper grounding plate assemblies must meet the minimum requirements of section 250 of the NEC. They are to be made of a copper alloy intended for grounding applications and will have minimum dimensions of 4" x 96" x 0.0625" (100 mm x 1.2 m x 1.58 mm). A 25-foot (8 m) continuous length (no splices allowed unless using exothermic welding process) of 6 AWG solid bare copper wire is to be attached to the plate using an approved welding process. The wires are to be installed in as straight a line as possible, and if it is necessary to make a turn or a bend it shall be done in a sweeping curve with a minimum radius of 8" and a minimum included angle of 90°. Mechanical clamps shall be permitted temporarily during the resistance test process, but shall be replaced with Cadweld "One-Shot" kits immediately thereafter. The ground plate is to be installed to a minimum depth of 30"/75 cm, or below the frost line if it is lower than 30"/75 cm at a location 15 to 20 feet/4.5 to 6 m from the ground rod, electronic equipment and wires and cables. Two 50-pound/22 kg bags of earth contact material must be spread so that it surrounds the copper plate evenly along its length within a 6"/15 cm wide trench. The use of salts, fertilizers and other chemicals are not to be used to improve soil conductivity because these materials are corrosive and will cause the copper electrodes to erode and become less effective with time.

Install all grounding circuit components in straight lines. When it is necessary to make bends, do not make sharp turns. To prevent the electrode-discharged energy from re-entering the underground wires and cables, all electrodes shall be installed away from said wires and cables. The spacing between any two electrodes shall be 15 to 20 feet/4.5 to 6 m, so that they don’t compete for the same soil.

The earth-to-ground resistance of this circuit is to be measured, and the reading is to be no more than 10 ohms. If the resistance is more than 10 ohms, then additional ground plates and earth contact material are to be installed in the direction of an irrigated area. It is required that the soil surrounding copper electrodes be kept at a minimum moisture level of 15% at all times by dedicating an irrigation station at each controller location.

DECODER GROUNDING

At the very minimum, the grounding circuit for a decoder will include a copper ground plate and may also include 50 pounds/22 kg of earth contact material, as defined below and per the following detail.

The copper grounding plate assemblies must meet the minimum requirements of section 250 of the NEC. They are to be made of a copper alloy intended for grounding applications and will have minimum dimensions of 4" x 36" x 0.0625" (100 mm x 1.2 m x 1.58 mm). A 10-foot/3 m continuous length (no splices allowed unless using exothermic welding process) of 10 AWG/5 mm^2 solid bare copper wire is to be attached to the plate using an approved welding process. This wire is to be connected to the decoder's ground wire and 10 AWG/5 mm^2 bare copper "shielding wire" as shown in wiring details. A 50-pound/22 kg bag of earth contact material must be spread so that it surrounds the copper plate evenly along its length within a 6"/15 cm wide trench per detail below. Salts, fertilizers and other chemicals are not to be used in an attempt to improve soil conductivity because these materials are corrosive and will cause the copper conductors and electrodes to erode and become less effective with time.

Install all grounding circuit components in straight lines. When it is necessary to make bends, do not make sharp turns. To prevent the electrode-discharged energy from re-entering the underground cables, all electrodes shall be installed 6 to 8 feet/2 to 2.5 m away from said cables, and at right angles to the two-wire path. If more than one electrode is used to achieve lower resistance, the spacing between any two electrodes shall be 15 to 20 feet/4.5 to 6 m, so that they don't compete for the same soil.

The earth-to-ground resistance of this circuit is to be no more than 10 ohms. If the resistance is more than 10 ohms, then additional ground plates and earth contact material are to be installed in the direction of an irrigated area. It is required that the soil surrounding copper electrodes be kept at a minimum moisture level of 15% at all times by dedicating an irrigation station at each controller location.

A good surge protection system works by totally protecting the system from small to medium lightning storm effects, and by minimizing the effect of large lightning storms.

The minimum recommended level of protection is to have one decoder grounded at the end of each wire path and one decoder grounded every 1,000 ft/300 m or 12th decoder. For higher levels of protection, ground the decoders more frequently. There is no limit on the number of ground connections in a decoder system.

It is important that both the controller and the decoders are grounded to ground rods or plates with less than 10 Ohms resistance. The ground should always be measured with a ground resistance meter. A "clamp on meter" cannot be used for ground measurement, since this is an isolated system. Ground resistance measurements should be performed with a "fall of potential" type meter in decoder systems. The ground should be tested regularly for resistance.

Surge protection inside the decoder can wear out, and a decoder should be replaced when it might have been damaged by a lightning strike in the immediate vicinity. The decoder is a complex electronic part and it is not possible to fully test whether it is working. Replace the decoder if there is any visible damage to the device, or if nearby decoders or controllers have been damaged.

PAIRING OF DEVICES FOR DIFFERENT AUTOMATION SYSTEMS

Two-Wire Decoder System: In this system, Solenoid valves are been paired with decoders by entering **DECODER ADDRESS** against each station or multiple stations to the controller.

Number of Addresses Per Decoder	Maximum Number of Solenoids Per Address	Maximum Addresses Operating At Once
1	1	1
1	2	1
2	2	2
4	1	4
6	1	4

Decoders are having different models based on following specifications:

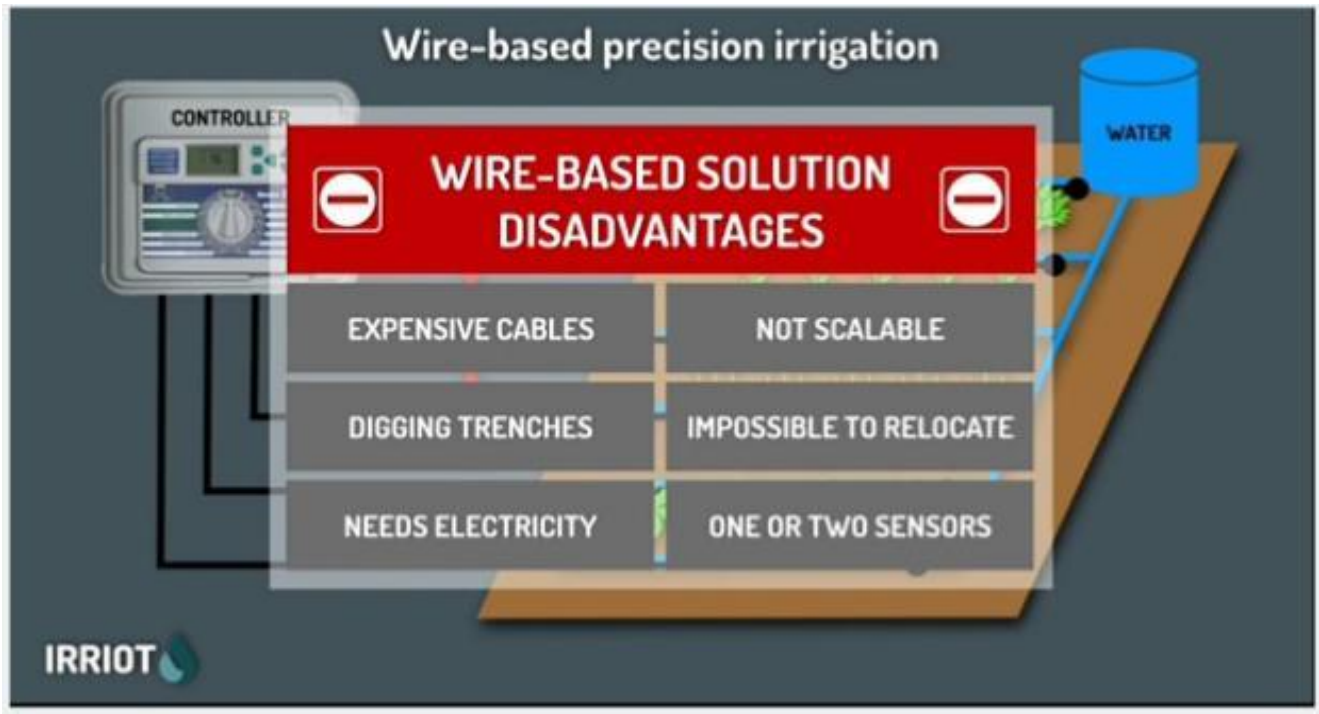
1. Number of address
2. Maximum number of solenoids per address
3. Maximum addresses operating at once

That means with one decoder number of separate start-stop functioning can be programmed by entering separate schedule with different address. In that case each phase wire are having different address.

Wireless WiFi based Automation System: In this system a WiFi is connected to the controller and network is paired via smartphone. The Radio Frequency is transmitted to inner card of Remote Terminal Unit via WiFi. The RTU is solar-powered and controlling the latching solenoid valves. Only RTUs and latching solenoid valves are been connected through cables. Cables are not required for connection of solenoid valves with controller.

Solenoid valves are paired with RTUs by entering appropriate RTU channel address to run as per scheduled program in controller.

Each RTU uses 9 VDC Latching Solenoid Voltage. If Inrush Current of Solenoid Valves is 0.37 amp and Holding Current is 0.21 amp then required power of Solar Panel will be 0.37 x 9 = 3.33 watt; Hence Specification of the Solar Panel should be 4w/12VDC.



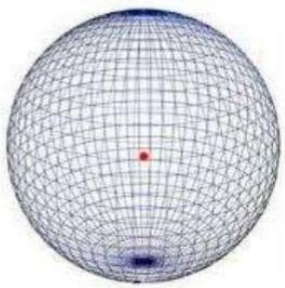
An external or high amplifier antenna is required to connect with RTU for long range applications.

High amplifier antenna is required for distance of 5000 m and external antenna is required for distance of 500 m to 700 m.

The specification of antenna is mentioned in dBi (decibels relative to isotropic) is defined as the gain in signal using an antenna. The base for dBi measurement is an isotropic radiator (idealistic model that has the same value when measured in different directions) at radio frequencies.

Isotropic Radiator: An isotropic radiator is a theoretical point source of electromagnetic or sound waves which radiates the same intensity of radiation in all directions. It has no preferred direction of radiation. It radiates uniformly in all directions over a sphere centered on the source.

Isotropic Radiation Pattern

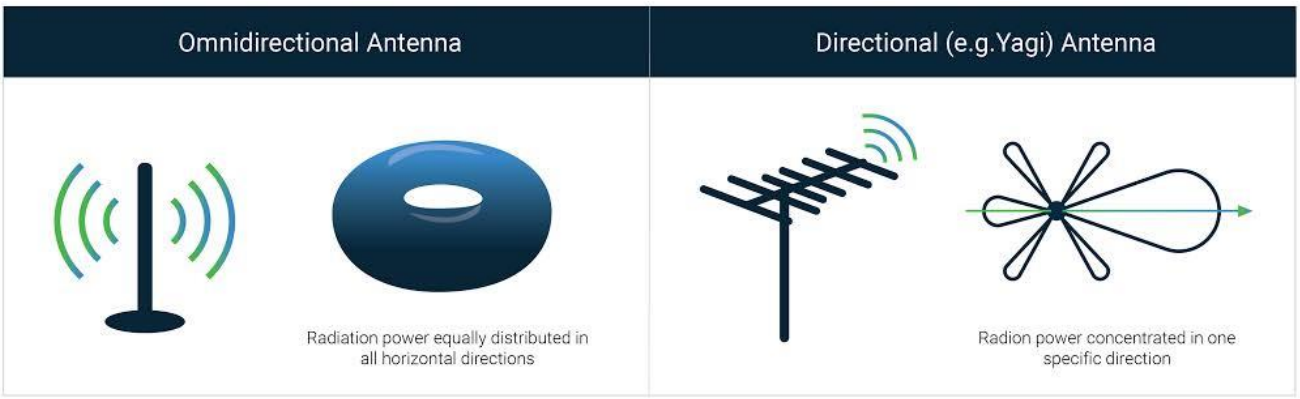


Antenna Basics

Antenna	Type	Max Range
2.5 dBi	**Omni directional**	**300ft**
5 dBi	Omni directional	500ft
7dBi	Omni directional	800ft
8dbi	Omni directional	1500ft

In radio communication, an omnidirectional antenna is a class of antenna which radiates equal radio power in all directions perpendicular to an axis, with power varying with angle to the axis, declining to zero on the axis.

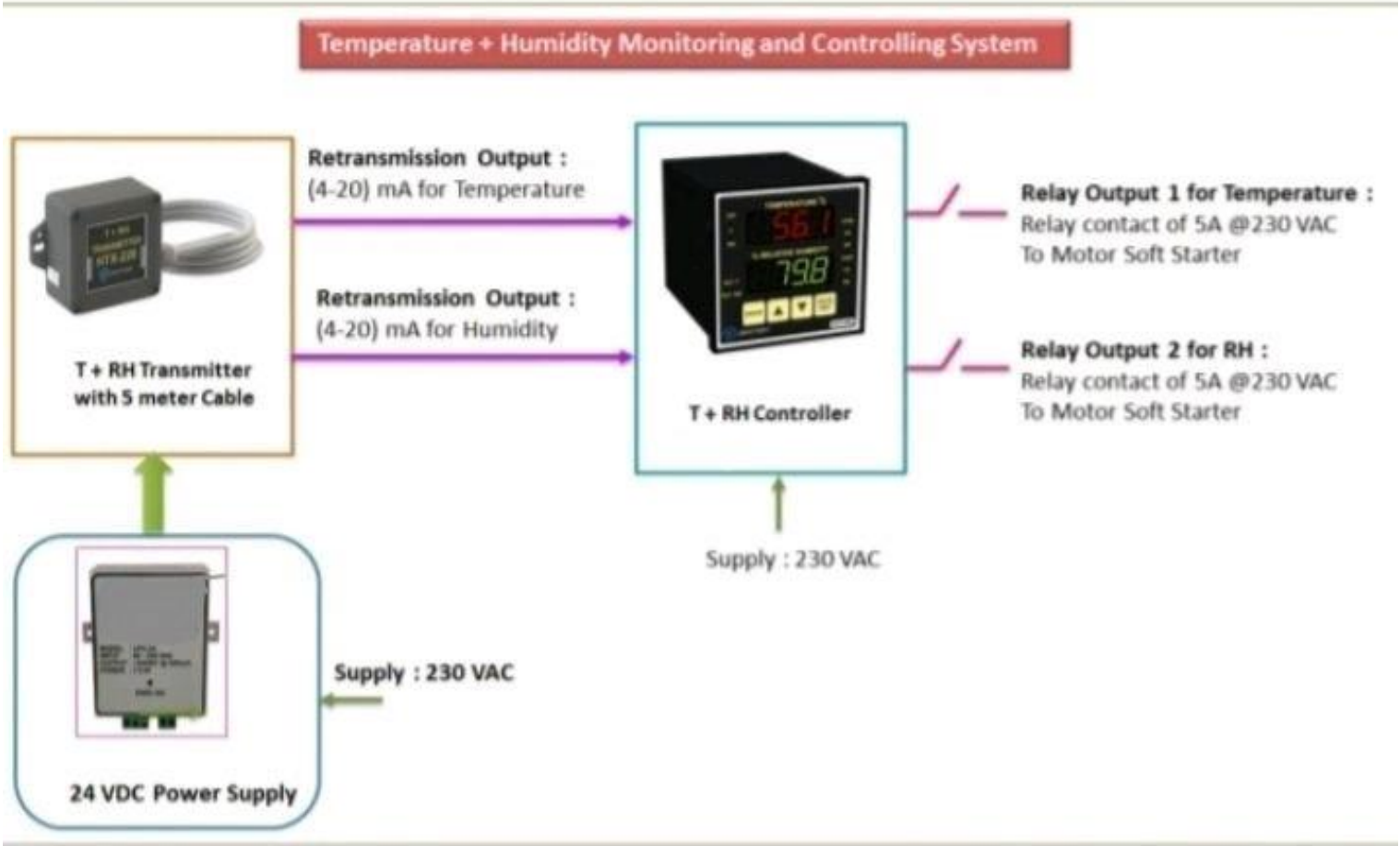
Omnidirectional antennas are widely used for radio broadcasting antennas, and in mobile devices that use radio such as cell phones, FM radios, walkie-talkies, wireless computer networks, cordless phones, GPS.



Automated Temperature & Relative Humidity Control System for Greenhouses

For Greenhouse application

- To turn off the 10 HP, 3 Phase Motor by using DOL Starter through the Relay output of T + RH Controller, when the ambient temperature & relative humidity reaches desired point which will be set at the controller.



How to calculate voltage drop in a copper wire

To calculate voltage drop in a copper wire, use the following formula:

$$\text{Volts} = \frac{\text{Length} \times \text{Current} \times 0.017}{\text{Area}}$$

Volts= Voltage drop.
Length= Total Length of wire in metres (including any earth return wire).
Current= Current (amps) through wire.
Area= Cross sectional area of copper in square millimetres.

Notes

- This formula only applies to copper at 25°C, voltage drop increases with wire temperature, at approx 0.4% per °C.
- 0.017- This figure only applies to copper.
- Area is in square millimetres of copper, there can be confusion on how cable size is rated, with some manufacturers stating wire diameter rather than area, some even including the insulation.

Resistance and Valve Wire Sizing

Resistance Method

Required Information

- Actual one-way length of wire between the controllers and at the power source of the controllers and valves
- Allowable voltage loss along the wire circuit
- Accumulative current flowing through the wire section being sized in amperes

Resistance is calculated using formula:

$$R = \frac{1000 \times AVL}{2L \times I}$$

R = Maximum Allowable Resistance of wire in ohms per 1000 feet

AVL = Allowable voltage loss

L = Wire length (one way)

I = Inrush current

AVL for controller power wire sizing is calculated by subtracting minimum operating voltage required by the controller from minimum available voltage at power source.

AVL for valve wire sizing is calculated by subtracting minimum solenoid operating voltage from controller output voltage. This number will vary depending on the manufacturer and in some cases with line pressure.

Valve Wire Sizing Example:

Given: The distance from the controller to the valve is 1800 ft. The controller output is 24V. The valve has a minimum operating voltage of 20V and an inrush current of 370 mA (0.37Amps).

$$R = \frac{1000 \times 4}{2(1800) \times 0.37}$$

$$R = \frac{4000}{332}$$

R = 3.00 ohms/1000 feet

Wire resistance can not exceed 3.00 ohms per 1000 feet. Go to table #1 and select the proper wire size. Since 16 gauge wire has more resistance that 3.00 ohms per 1000 feet, choose 14 gauge wire.

Table 2 is a quick reference and is set up to provide maximum wire runs given the information at the bottom of the table.

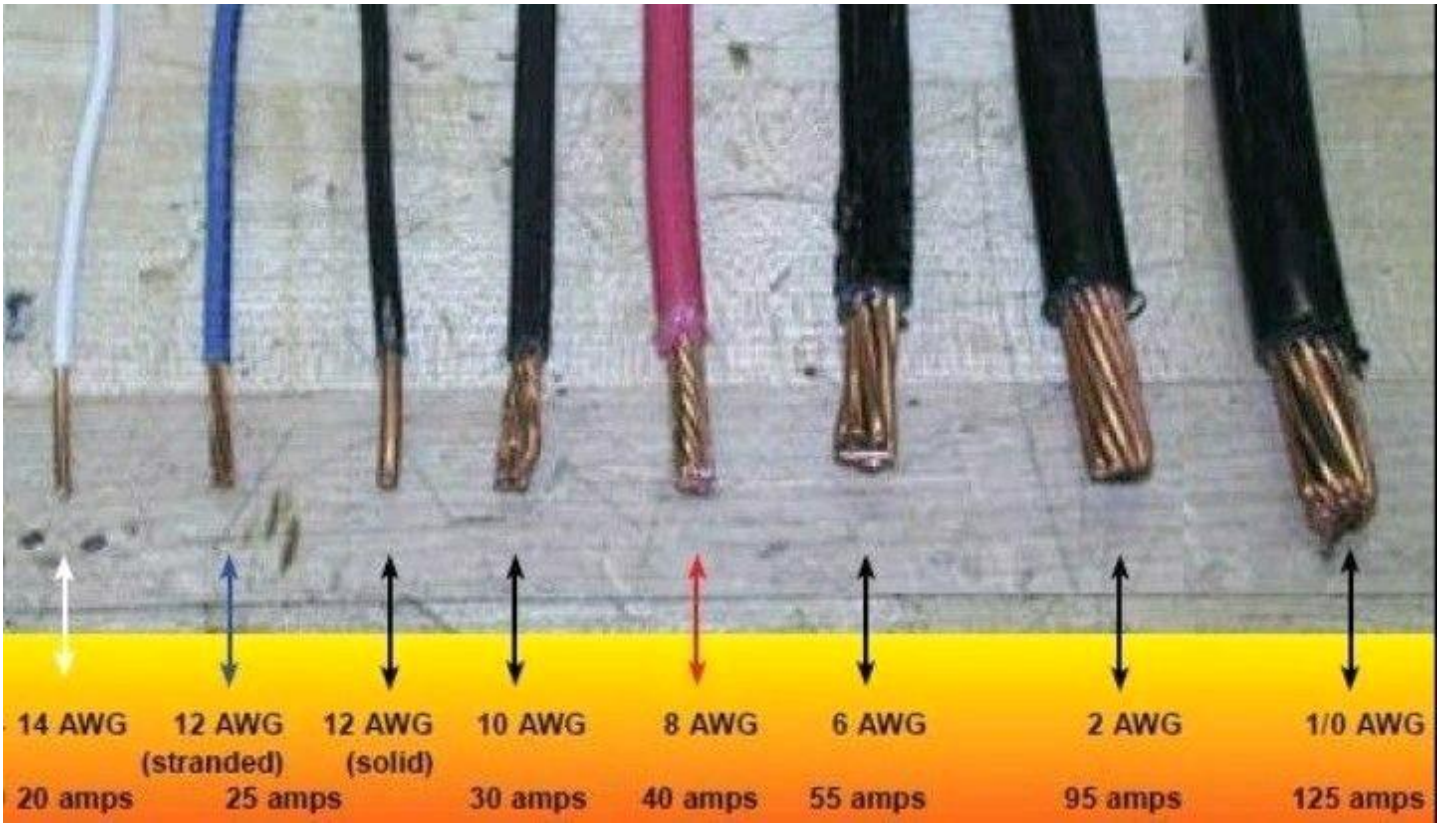
TABLE 1
Resistance of Copper Wire

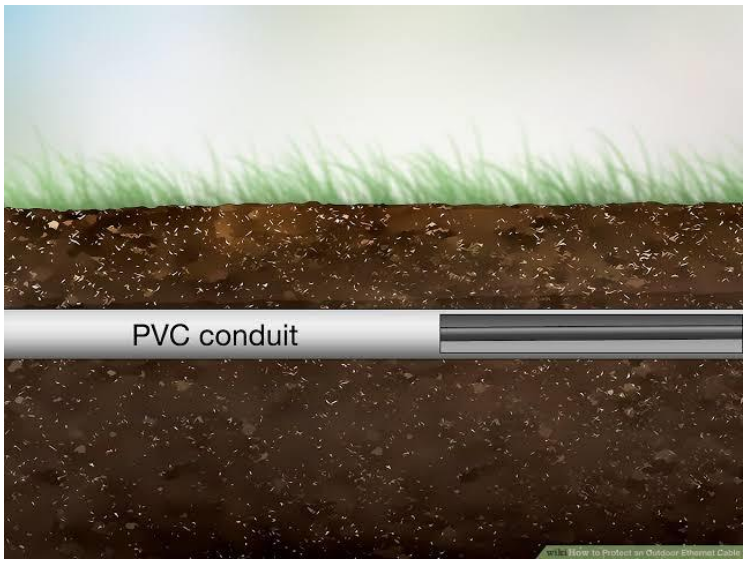
WIRE SIZE AWG No.	Resistance at 20° C (68° F) ohms per 1000 Feet
18	6.39
16	4.02
14	2.52
12	1.59
10	1.00
8	0.63
6	0.40
4	0.25

TABLE 2
Valve Wire Sizing (Maximum One-Way Distance in Feet Between Controller and Valve)

GROUND WIRE	CONTROL WIRE						
	18	16	14	12	10	8	6
18	850	1040	1210	1350	1460	1540	1590
16	1040	1340	1650	1920	2150	2330	2440
14	1210	1650	2150	2630	3080	3450	3700
12	1350	1920	2630	3390	4170	4880	5400
10	1460	2150	3080	4170	5400	6670	7690
8	1540	2330	3450	4880	6670	8700	10530
6	1590	2440	3700	5400	7690	10530	13330

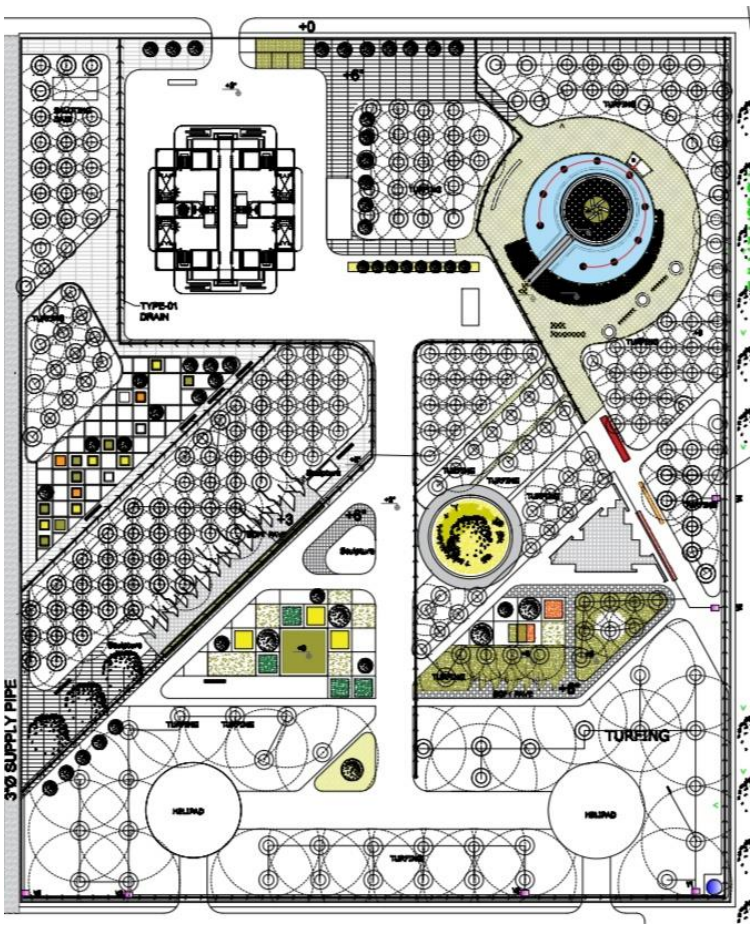
Solenoid: 24VAC, Pressure: 150 PSI, Voltage Drop: 4V, Min. Operating Voltage: 20V, Amperage Peak: .37A

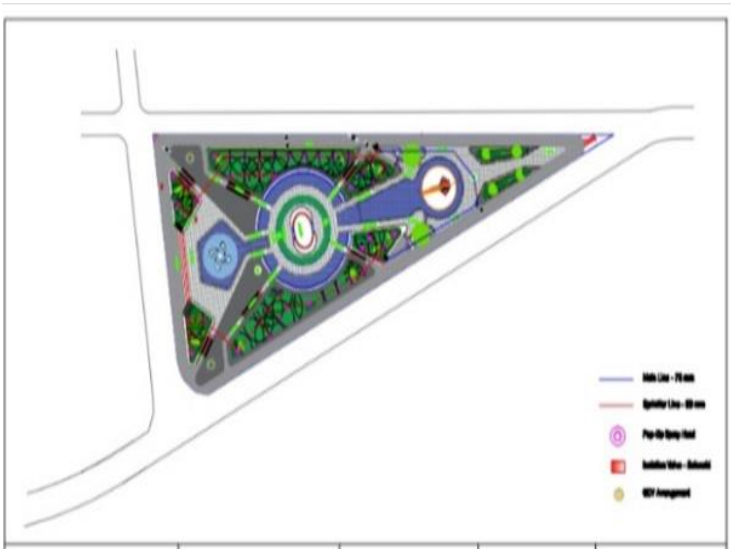


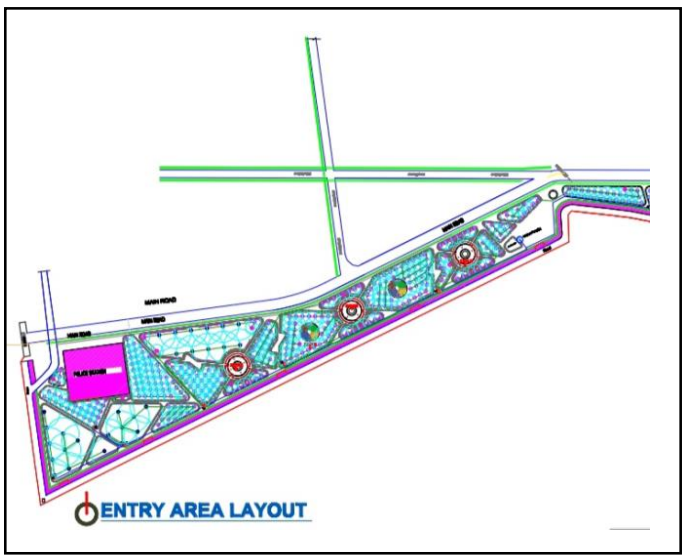


PVC Conduit Pipe to carry Wires underneath the surface

Samples of System Plan View



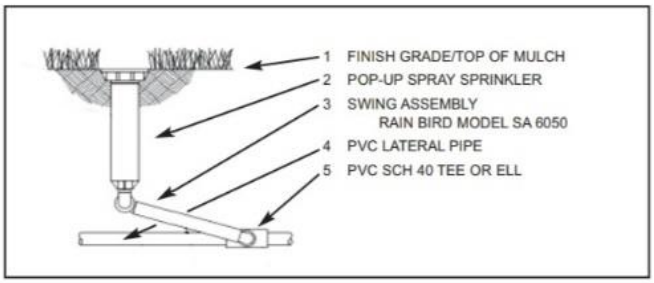


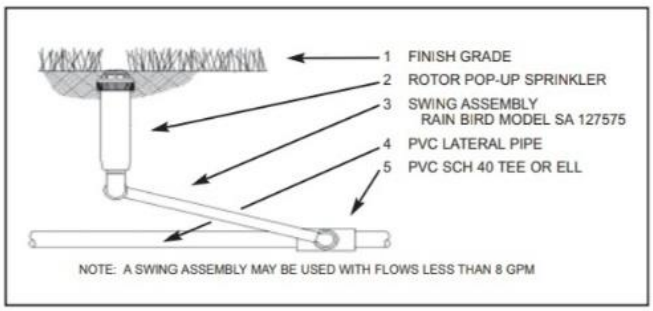


Sample of Valve-Wise Discharge Calculation Sheet

Sl. No.	Valve No.	No. of Pop-Up Spray Head	No. of On-Line Drip Emitter	Discharge Rate of Each (lph)	Valve Discharge (lph)	Spacing	Application Rate mm/hr.	Crop	Peak water requirement/Day (PWR per Day)	Duration of Operation (Minutes)
1	V1	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
2	V2	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
3	V3	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
4	V4	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
5	V5	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
6	V6	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
7	V7	N.A	315	24x2	15120	Loop at base (2 Nos. per plant)	....	Big Plant	60 Litres	75
8	V8	N.A	300	8x2	4800	Loop at base (2 Nos. per plant)	....	Medium Plant	20 Litres	75
		N.A	250	4x2	2000	Loop at base (2 Nos. per plant)	....	Small Plant	10 Litres	
		N.A	172	24x2	8256	Loop at base (2 Nos. per plant)	....	Palm Tree	60 Litres	
					15056					
9	V9	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
10	V10	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
11	V11	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
12	V12	15	N.A	1000	15000	5 m x 5 m	40	Small Grass	5 mm	9
Total	12 Zones	150	1037							240

1 Liter of Water Applied to a Field
= Area of that field as 1 m^2 x Height of water applied to the field as 1 mm (i.e. 0.001 m)
1 Liter = 0.001 m^3





The Swing Joint Assembly must be connected at one side of pipe so that pressure will not create impact on saddle and pipe.

Necessity of Safety Valves in Water Pipe Line

Air Release Valve

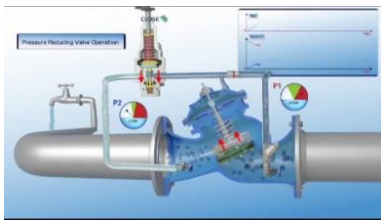
An air release valve is typically used in water or irrigation schemes **to ensure that any entrained air in the water system is automatically released in order to maximize the system performance**. Entrained air pockets in pipes can cause excessive head loss and flow reductions if air is not effectively released.

Double Acting Air Valve

Double Acting Air Valve are basically a combination of small orifice and large orifice for **automatically discharging air during pipe filling and ventilating the pipe during emptying**.

Pressure Relief Valve

A relief valve or pressure relief valve (PRV) is a type of safety valve used **to control or limit the pressure in a system**; pressure might otherwise build up and create a process upset, instrument or equipment failure, or fire.



Pressure Reducing Valve

A Pressure Reducing Valve can be defined as a **self-acting automatic control valve for reducing a higher unregulated inlet pressure to a constant,** reduced outlet pressure regardless of the fluctuations in the upstream water pressure. **Mainly used in Gravity feed systems.**

Different types of Sprinkler for irrigation systems

Landscape & Sports-field Irrigation System

Gear Driven Rotors:

Operational Pressure: 3.0 bar – 6.0 bar

Rotation: Full Circle/Part Circle

Use: Required Range upto 30 m

Spray Heads:

Operational Pressure: 2.5 bar – 4.0 bar

Rotation: Does not rotate

Use: Required Range upto 5 m

Field Irrigation System

Raingun Sprinklers:

Operational Pressure: 2.0 bar – 6.0 bar

Rotation: Full Circle/Part Circle

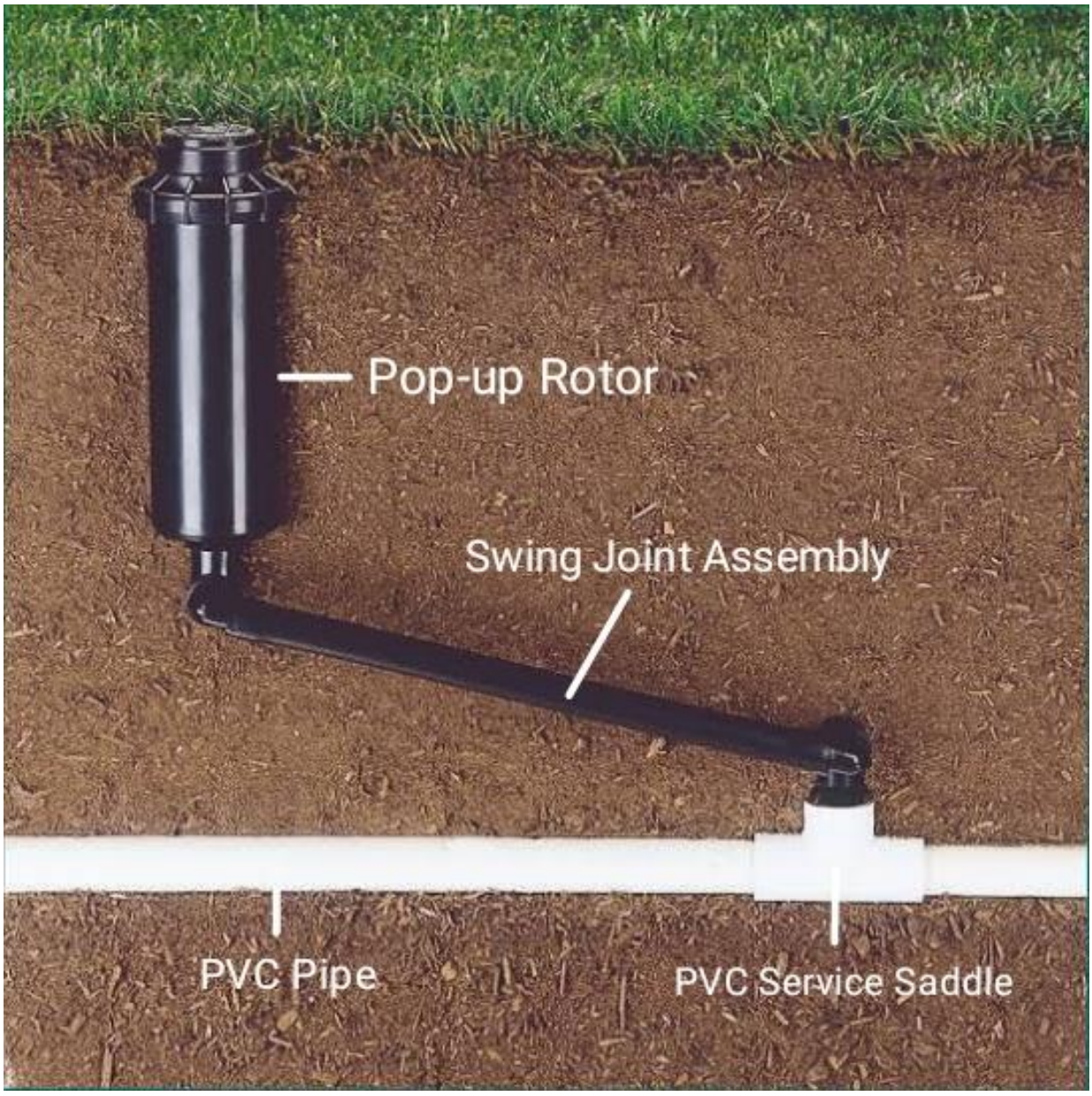
Use: Required Range upto 50 m with High Discharge Rate

Impact Sprinklers:

Operational Pressure: 1.0 bar – 4.0 bar

Rotation: Full Circle/Part Circle

Use: Required Range upto 18 m with Low Discharge Rate


Pop-up Rotor
Swing Joint Assembly
PVC Pipe
PVC Service Saddle

Different Types of Irrigation System for Different Crops

Drip for Trees and Shrubs

Pop-up sprinklers and Spray Heads for Lawns

Different Types of Drip Emitters for Different Applications & Terrains

PC: Pressure Compensating

PC drippers provide a consistent flow rate over a pressure range typically starting from 0.6-1.0 bar and up to 3.5 bar pressure and higher. Variations in pressure can happen due to long pipe laterals losing pressure after each dripper and over the length of the pipe as well as due to elevation changes such as hills and valleys. Despite these pressure variations PC drippers will give a consistent flow rate as long as the pressure in the pipe remains in the operating range of the dripper.

PCAS: Pressure Compensating Anti Siphon

PCAS drippers also provide a constant flow over an operating pressure range similar to PC drippers however **PCAS drippers** contain a check valve so that water, air, or mud can not flow backwards through the dripper even under vacuum conditions.

PCND: Pressure Compensating Non-Drain

PCND drippers also contain a check valve preventing backflow similar to PCAS drippers however in addition they retain pressure in the pipe when the pressure source is turned off. The retention pressure of **PCND drippers** is typically 0.2 bar pressure.

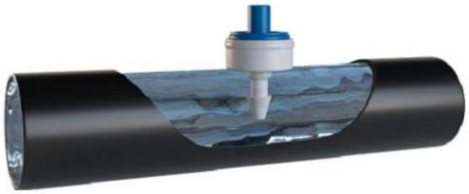
Application

PC: At over ground with undulated terrain

PCAS: At sub surface

PCND: At Over ground and sub surface

Brown Drip Lines



Online Drip Emitters

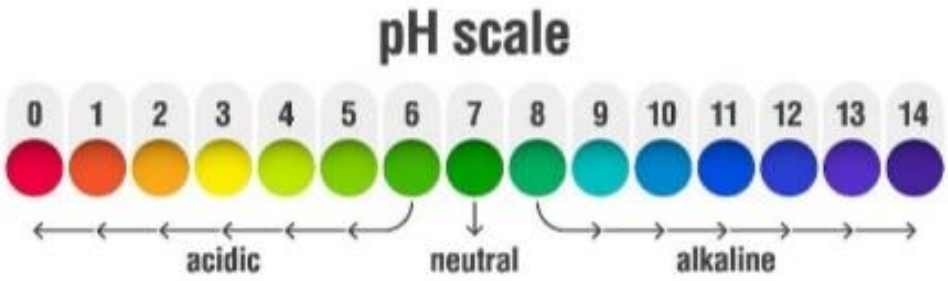
Inline Cylindrical Emitters

Inline Flat Emitters

Importance of EC-pH Transmitter in Drip Irrigation System

Soil EC: Soil electrical conductivity (EC) is **a measure of the amount of salts in soil (salinity of soil)**. It is an excellent indicator of nutrient availability and loss, soil texture, and available water capacity.

High EC levels **can indicate you are supplying too much fertilizer or that your plants are not absorbing the nutrients**, both of which can lead to a salt toxicity leaf burn.



Soil pH: Soil pH is **a measure of the acidity or alkalinity of the soil**. pH ranges from 0 to 14, with 7 being neutral. **pHs less than 7 are acidic while pHs greater than 7 are alkaline.** Most plant nutrients reach their peak availability in near-neutral soil pH. **That range from 6.5 to 7.5 is the optimal soil pH for most plants**.

It is necessary to check Soil EC & pH before incorporate Fertilizer or acid treatment in an irrigation system.

To irrigate food-crops an EC-pH Transmitter (with sensors and accessories) must be included with Fertigation unit.

IS 14791: 2000 for Prevention of Blockage in Drip System

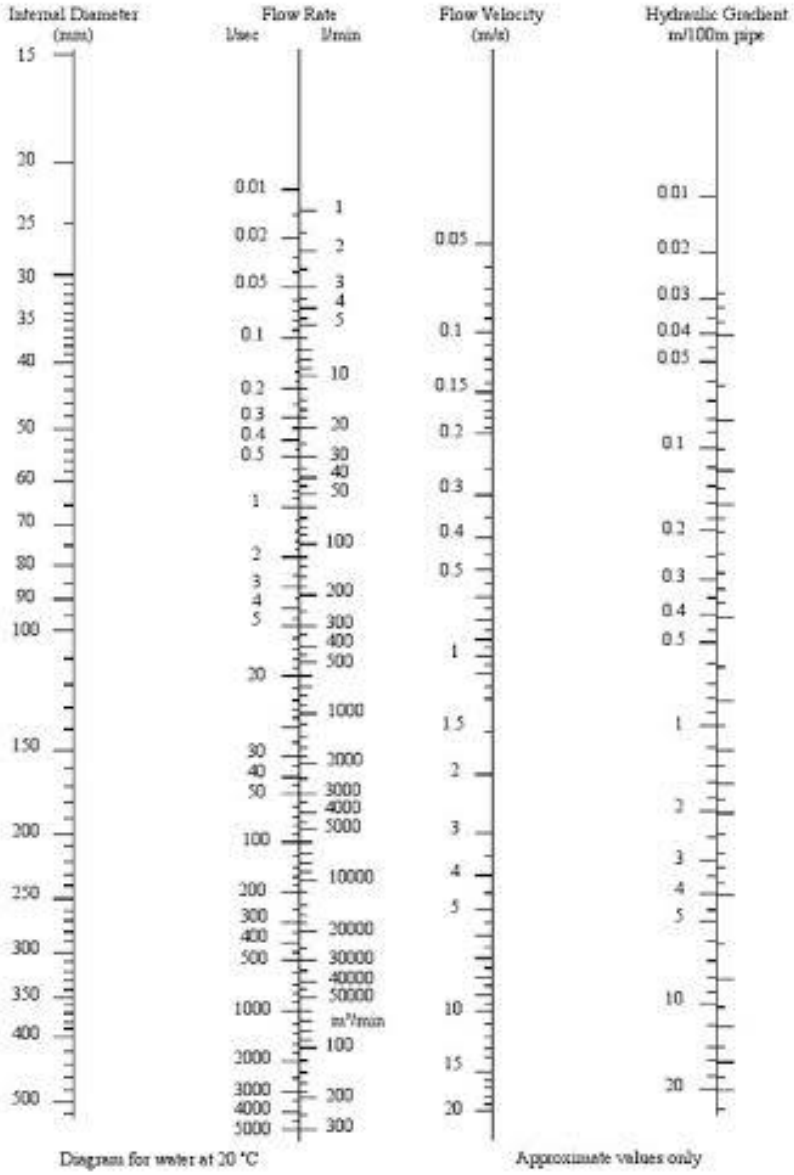
Table 1 Interpretation of Water Analysis

(*Clause* 4.3)

Sl No.	Parameters	Degree of Presence/Problem			
		Unit	Normal	Higher	Extreme
(1)	(2)	(3)	(4)	(5)	(6)
i)	pH		7	<7 Acidic	>7 A
ii)	Electrical Conductivity (Salinity)	mmhos/cm	<0.8	0.8-3.0	>3.0
iii)	Total dissolved solids	ppm	<500	500-600	>600
iv)	Hardness	ppm	<200	200-300	>300
v)	Calcium	ppm	<60	60-100	>100
vi)	Magnesium	ppm	<25	25-40	>40
vii)	Carbonate	ppm	<200	200-600	>600
viii)	Bicarbonate	ppm	<200	200-600	>600
ix)	Chloride (Toxic)	ppm	<140	140-350	>350
x)	Sulphates	ppm	<20	20-50	>50
xi)	Sodium	ppm	<100	100-200	>200
xii)	SAR	–	<3	3-9	>9
xiii)	Potassium	ppm	<10	10-20	>20
xiv)	Sulphides	ppm	<15	15-25	>25
xv)	Iron	ppm	<0.1	0.1-0.4	>0.4
xvi)	Manganese	ppm	<0.2	0.2-0.4	>0.4
xvii)	Suspended solids	ppm	<10	10-100	>100
xviii)	Permeability				
	a) Caused by low salts (EC)	mmho/cm	>0.5	0.5-0.2	<0.2
	b) Caused by sodium	SAR	<6.0	6.0-9.0	>9.0
xix)	Toxicity				
	a) Sodium	ppm	<3.0	3.0-9.0	>9.0
	b) Chloride	ppm	<140	140-350	>350
	c) Boron	ppm	<0.5	0.5-2.0	>2.0
xx)	Clogging				
	a) Iron	ppm	<0.1	0.1-0.4	>0.4
	b) Manganese	ppm	<0.2	0.2-0.4	>0.4
	c) Sulphides	ppm	<0.1	0.1-0.2	>0.4
	d) Calcium carbonates	ppm		No levels established	

Nomogram for Friction Head Calculation

Nomogram



Note: For sizes not covered by Nomogram, please contact Technical Support Department.
The nomogram is based on the Prandtl - Coalbrook formula using a k factor of k= 0.007 mm.

Factors applicable to other flow formulae are:

Hazen Williams	c = 150
Manning	n = 0.010
Darcy roughness factor	= 0.007

Automatic Auto-Flush Filters

AUTO FLUSH®

Automatic Screen Filter

ARMAS TURKEY

Applications : AutoFlush® is the ideal solution for agricultural and municipal filtration due to its large filtration area, reliable operation mechanism and simple structure. AutoFlush® works on differential pressure and cleans itself automatically without any external intervention. AutoFlush® has electronically activated models besides hydraulically controlled models. Due to suction nozzles, cleaning is achieved with little water consumption. Besides the standart 130 micron filter size, different screen sizes are available for different dirt levels.

Electric Activated Automatic Screen Filter

VE Series

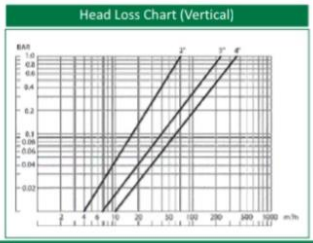
HE Series

Hydraulic Controlled Automatic Screen Filter

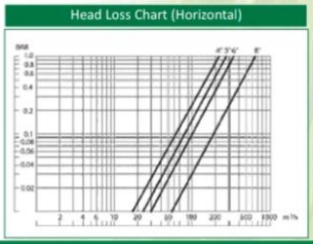
VH Series

HH Series

Head Loss Chart (Vertical)



Head Loss Chart (Horizontal)



E-mail: contactus@automatworld.com
Website: www.automatworld.com

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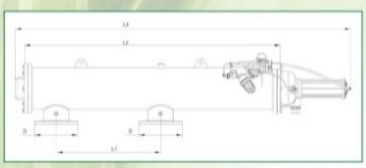
AUTO FLUSH®

Automatic Screen Filter

ARMAS TURKEY

Model	Connection Size	Connection Type	Control Unit	Screen Degree
VH-80	4"	Flanged (F)	Hydraulic	130 micron
HE-120	6"	Flanged (F)	Electric	130 micron



Sizes Available

MODEL	D	L	L1	L2	L3
	inch	mm	mm	mm	mm
VH-25	2"	630	-	-	-
VH-40	3"	623	-	-	-
VH-60	3"	727	-	-	-
VH-80	4"	720	-	-	-
VH-100	4"	-	900	1894	2400
VH-120	5"	-	900	1894	2400
VH-160	6"	-	900	1894	2400
VH-180	8"	-	900	1894	2400

Available Models

Filter Model Code	VH-25 / VE-25	VH-40 / VE-40	VH-60 / VE-60	VH-80 / VE-80	HH-100 / HE-100	HH-120 / HE-120	HH-160 / HE-160	HH-180 / HE-180
Max. Flow Rate	25 m³/h	40 m³/h	60 m³/h	80 m³/h	100 m³/h	120 m³/h	160 m³/h	180 m³/h
Inlet/Outlet Dimension	2"	3"	3"	4"	4"	5"	6"	8"
Standard Filtration Degree	130 micron	130 micron	130 micron	130 micron	130 micron	130 micron	130 micron	130 micron
Min. Operation Pressure	2,5 bar	2,5 bar	2,5 bar	2,5 bar	2,5 bar	2,5 bar	2,5 bar	2,5 bar
Max. Operation Pressure	8 bar	8 bar	8 bar	8 bar	8 bar	8 bar	8 bar	8 bar
Max. Operation Temperature	60°C	60°C	60°C	60°C	60°C	60°C	60°C	60°C
Cleaning Cycle Time	10-16 sn	10-16 sn	10-16 sn	10-16 sn	15-22 sn	15-22 sn	15-22 sn	15-22 sn
Cleaning Criteria	Differential Pressure (DP) 0.5 bar	Differential Pressure (DP) 0.5 bar	Differential Pressure (DP) 0.5 bar	Differential Pressure (DP) 0.5 bar	Differential Pressure (DP) 0.5 bar	Differential Pressure (DP) 0.5 bar	Differential Pressure (DP) 0.5 bar	Differential Pressure (DP) 0.5 bar
Filtration Area	500 cm²	500 cm²	1000 cm²	1000 cm²	4500 cm²	4500 cm²	4500 cm²	4500 cm²

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Creating a Green World

AUTO FLUSH®

Automatic Disc Filter Systems

ARMAS TURKEY

Back flushing control valves adjusting filtration and back flushing positions of AutoFlush® automatic disc filters connected parallel to the manifold collector system are programmed by differential pressure sensor (DP) for pressure and by control device for timedependent parameters.

Mesh No	Micron	Effective Filtering Surface (%)	Disc Color
80	200	%39	
120	130	%39	
150	100	%40	

Specifications

- Back-flushing pressure is 1 bar.
- Back flushing process is completed in automated manner.
- Water supply is not interrupted during back flushing process.
- As it can be cleaned within short time, very low amount of water is used in back flushing process.
- Due to discs with varying dimensions, desired filtration degree is ensured.
- Maintenance during operation is very easy.
- As it is used in modular filter systems, filtration at desired rates can be performed.
- Due to body and framework reinforced against corrosion, it has long operation life.
- Controller, connection equipments, air valves and pressure gauges are included in the system.
- Fertilizer kit and fertilize tank are not included in the system.
- Package: Wooden crate

Applications:

- Filtration of well water
- Filtration of river, lake and reserve water
- Filtration of applications such as process water and cooling water
- Upwards the ultra-filtration systems
- Agricultural drip and micro-irrigation systems
- For recreational irrigation system practices

BACK-FLUSHING PRESSURE	1BAR

AutoFlush® automatic disc filter system

Code	Collector Size (inch)	Disc Filter Quantity	Connection Type	Recommended Flow Rate (m³/h)
ADF-02	4	2	Grooved End or Flanged	50
ADF-03	4	3	Grooved End or Flanged	75
ADF-04	5	4	Grooved End or Flanged	100
ADF-05	6	5	Grooved End or Flanged	125
ADF-06	6	6	Grooved End or Flanged	150
ADF-07	8	7	Grooved End or Flanged	175
ADF-08	8	8	Flanged	200

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Creating a Green World

AUTO FLUSH®

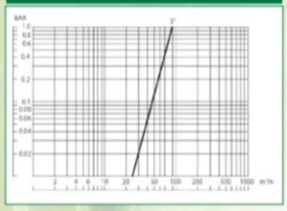
Automatic Plastic Disc Filter

ARMAS TURKEY

Material List

Part no	Part name	Material
1	Body	Polyamide (PA6.6 %30 GFR)
2	Lid	Polyamide (PA6.6 %30 GFR)
3	Hydrocyclone Wing	PET – P
4	Manual Filter Frame	PET – P
5	Disc	Nylon Reinforced PP
6	Bolt	8.8Js-500 Steel
7	Collar	SST

Head Loss Chart



Available Models and Recommended Flow Rates

Modules pcs	Recommended Flow (m³/h)	Min. Back-Flushing Flow Rate (m³/h)	Max. Operating Pressure (bar)	Min. Back-Flushing Pressure (1 bar)	Filtering Area (cm²)	Connection
2 module	60 m³/h	18 m³/h	8 bar	1 bar	3040 cm²	Grooved End
3 module	90 m³/h	27 m³/h	8 bar	1 bar	4560 cm²	Grooved End
4 module	120 m³/h	36 m³/h	8 bar	1 bar	6080 cm²	Grooved End
5 module	150 m³/h	45 m³/h	8 bar	1 bar	7600 cm²	Grooved End
6 module	180 m³/h	54 m³/h	8 bar	1 bar	9120 cm²	Grooved End

Technical Specifications

Max. Operating Pressure	Min. Back-Flushing Pressure	Min. Back-Flushing Flow Rate	Temperature	Connection
8 (bar) 120 (psi)	1 (bar) 14 (psi)	9 – 11 m³/h	0 °C – 60 °C (32 °F – 132 °F)	3" (80 mm) Grooved End

Water Meter to check Area Covered based on Water Flow

Water Discharge Rate of Pump	2	LPS
Duration of System Operation	120	Minutes
Total Water Discharged through System/Day	14400	Litre
Height of Water Application / Day	5	mm
Area Irrigated / Day	2880.00	m^2

* 1 Litre = 0.001 m^3
* 1 m^2 x 1 mm = 1 Litre Or, 1 m^2 = 1 Litre / 1 mm

Calculation Sheet will be provided on enquiry basis

N.B:

1. It is advisable that a Gate Valve/ Manual Valve should be incorporated with each Solenoid Valve because if the Solenoid Valve is malfunctioning then system can be controlled by Manual Valves.

2. A stand-by booster pump should be designed with a operational booster pump to avoid any delay in irrigation schedule. The stand-by pump will be in operation when other pump is needed to be repaired.

3. Connections should be Flanged for ease of repairing of equipment. Flanged connections can be opened up easily.

4. Depth of trench should be calculated by considering (body + piston) height of Pop-up sprinklers + OD of pipe + height of Swing joint assembly

5. A **Pressure Relief Valve** must be incorporated after pumping station and before filtration unit. This safety control valve is designed to protect system by releasing pressure surges in water network elevation lines to atmosphere quickly which is caused by sudden changes in water speed due to pumps put into/out of service. When network pressure exceeds set point, valve opens by itself quickly and protects system by releasing over pressure. When the pressure decreases to normal level, it is closed slowly and automatically tightly without causing surge. An **Air Relief Valve** also must be incorporated at every undulating point and 200 meters intervals.

Note

1) The Potential Evaporation depends on the place.
2) The canopy plays a important role in the water requirement calculation
3) The water requirement of the crop depends upon the grwoing stage

SIMPLE FORMULA TO CALCULATE PWR FOR ANY CROP					
Example					
Mango	spacing	25	sqm		
Peak ETP at WB		6	mm		
Crop factor		0.7	wide spaced crops		
Canopy factor		0.64	Canopy area/crop area		
PWR		**67**	say 4m x 4m canopy area		
			5m x 5 m crop area		
If Mango spacing is 8 m 8m		64	sqm		
Peak ETP at WB		6	mm		
Crop factor		0.70	wide spaced crops		
Canopy factor		0.39	Canopy area/crop area		
PWR		**105**	say 5m x 5m canopy area		

The spacing makes a major impact for the same crop Mango

$$PWR = Area \times Peak\ ETp \times Crop\ Factor \times Canopy\ Factor$$

Pipe ID calculation according to discharge and flow rate

$Q = AV$ .... (1)

Q = Discharge Rate through Pipe

A = Cross-Sectional Area of Pipe as per ID

V = Velocity of flow

Now, if $Q = 120\ m^3/hr.$; $V = 2\ m/sec$ (for laminar flow) then we have to calculate ID of Pipe

From equation (1) it is find that,

$A = Q / V$

Hence, $\pi/4\ ID^2 = \{120 / (2 \times 3600)\}\ m^2$

$ID^2 = \{(120 \times 4) / (7200 \times 3.14)\}\ m^2$

$ID^2 = 0.022\ m^2$

Therefore, ID = 0.148 m = 148 mm ~ **150 mm**

Surge Pressure in Pipeline

Surge Pressure occurs when a valve is suddenly closed.

Rule of thumb to calculate Surge Pressure in psi:

P = 0.8 x wt. of per cubic feet of liquid x velocity of flow in ft. / sec.

Ex-

If a pipeline transports water at 5 fps velocity then amount of surge created when valve is suddenly closed:

P = 0.8 wV =0.8 x 62 lb x 5 = **248 psi**

Maximum allowable surge pressure of **1.1 times the design pressure of the system for long distance pipelines**

Chemical and petrochemical plant piping systems specifies a maximum allowable surge pressure of **1.33 times the design pressure of the system**

DESIGN PROCEDURE OF TELESCOPIC PIPE LINE

Carrying capacity of different diameter pipes (considering hydraulic gradient as 2 m per 100 m for laminar flow):

1. 40 mm – PN 6: 4000 lph
2. 50 mm – PN 6: 8000 lph
3. 63 mm – PN 6: 14000 lph
4. 75 mm – PN 6: 21000 lph
5. 90 mm – PN 6: 32000 lph
6. 110 mm – PN 6: 44000 lph

Now, if discharge of a valve is 44000 lph and length of sub-main line is 600 m, then the sub-main will be telescoped as below:

OD 40 mm: (4000 lph/44000 lph) x 600 m = 54 m

OD 50 mm: (8000 lph/44000 lph) x (600 m – 54 m) = 100 m

OD 63 mm: (14000 lph/44000 lph) x {600 m – (54 m + 100 m)} = 140 m

OD 75 mm: (21000 lph/44000 lph) x {600 m – (54 m + 100 m + 140 m)} = 146 m

OD 90 mm: (32000 lph/44000 lph) x {600 m – (54 m + 100 m + 140 m + 146 m)} = 116 m

OD 110 mm: 600 m – (54 m + 100 m + 140 m + 146 m + 116 m) = 44 m

Power Deration Factors of Motors & Diesel Engines

Engine derating is the reduction of an engine's output due to less-than-ideal operating conditions.

manufacturers typically design their motors assuming air density at or near sea level — enabling successful operation at nominal rating up to 1000 meters (3280 feet). But, **at higher altitudes, the air gets thinner — reducing an air-cooled motor's ability to dissipate the heat it generates.** Depending on your motor's elevation above sea level, its ambient temperature, and its particular temperature rise characteristics, you may need to derate the motor to prevent it from exceeding the maximum temperature for its insulation class rating.

In the MG1, NEMA offers users a rule-of-thumb: to derate motors by 3% per 500 meters (1640 feet) of elevation above 1000 meters (3280 feet). Also motor temperature rise increases 1% per 100 feet. Many manufacturers provide a table, based upon these rules of thumb, and generally assuming Class F insulation.

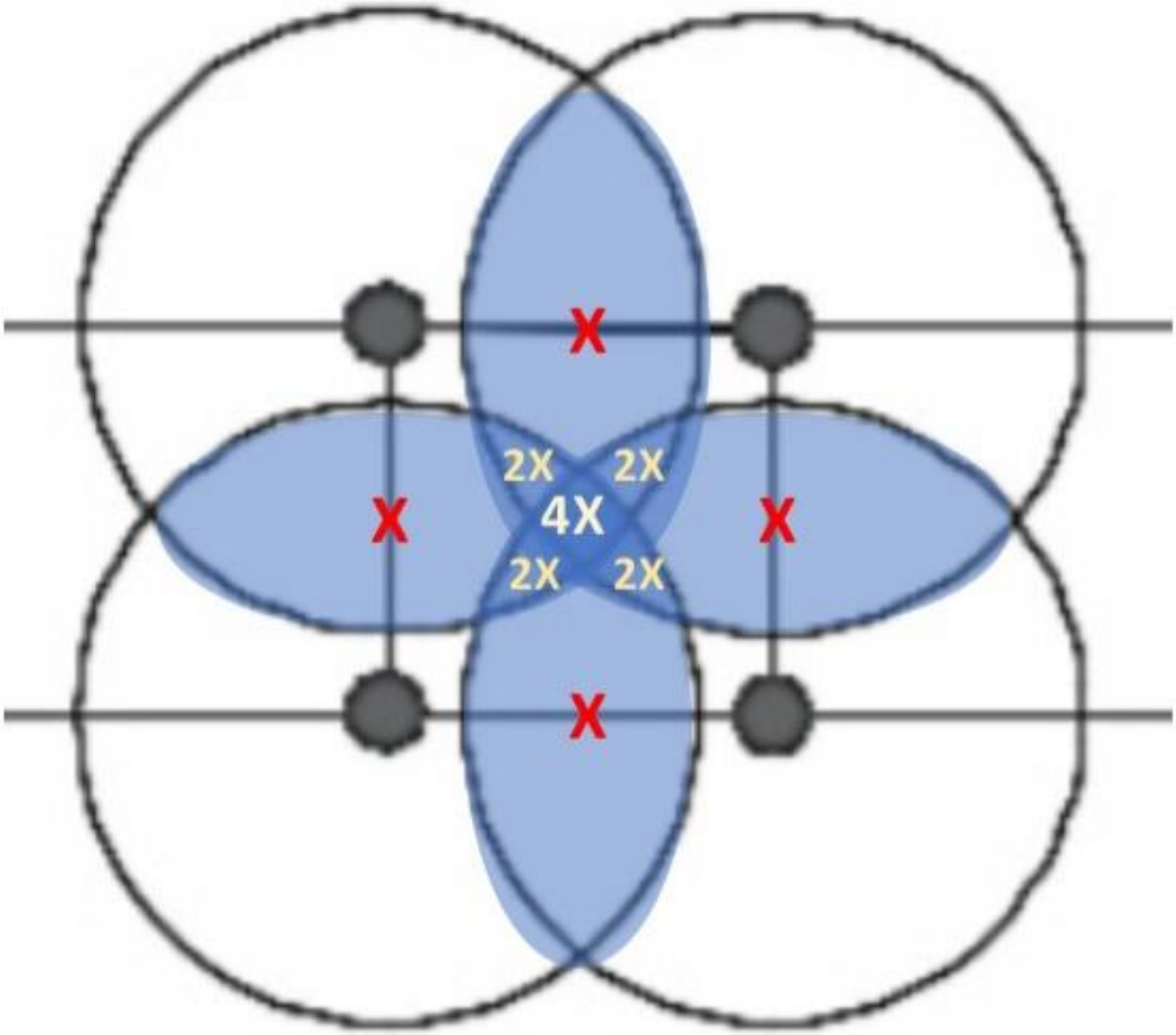
Reduced oxygen in high altitudes can lead to inefficient, sluggish engine performance because there is less air to feed the internal combustion engine. Generally speaking, an engine loses 3% of its rated power for every 300 meters (1000 feet) of altitude gained.

N.B.
Manufacturer should confirm the operational conditions of prime movers (i.e. Motors & Engines)

	AMBIENT TEMPERATURE							
	25°C	30°C	35°C	40°C	45°C	50°C	55°C	60°C
ELEVATION	(77°F)	(86°F)	(95°F)	(104°F)	(113°F)	(122°F)	(131°F)	(140°F)
1000 meters (3280 feet)	1.08	1.06	1.03	1.00	0.96	0.92	0.87	0.82
1500 meters (4920 feet)	1.06	1.03	1.00	0.97	0.93	0.89	0.84	0.80
2000 meters (6560 feet)	1.03	1.00	0.97	0.94	0.90	0.86	0.82	0.77
2500 meters (8200 feet)	0.97	0.95	0.93	0.90	0.86	0.83	0.78	0.74
3000 meters (9840 feet)	0.93	0.91	0.89	0.86	0.83	0.79	0.75	0.71
3500 meters (11480 feet)	0.89	0.87	0.84	0.82	0.79	0.75	0.71	0.67
4000 meters (13120 feet)	0.84	0.82	0.79	0.77	0.74	0.71	0.67	0.63

This rule-of-thumb provides a decent approximation of how air density changes compared to an elevation of 1000 meters and ambient temperature of 40°C.

Concept of overlapping in sprinkler irrigation system



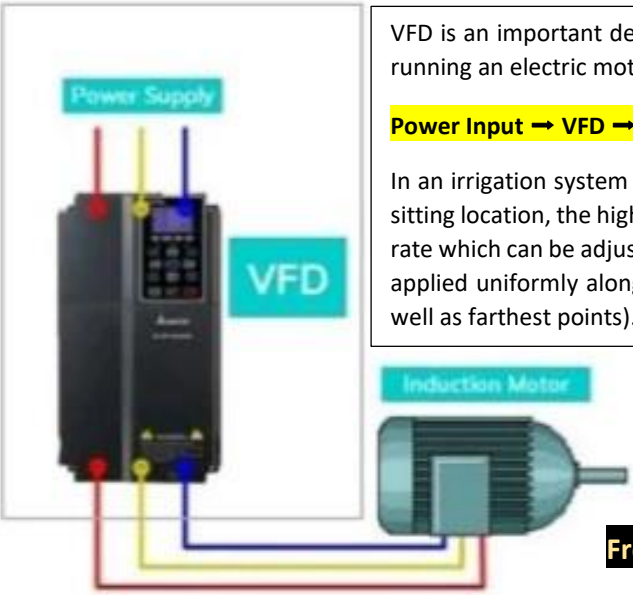
Percentage of Overlapping= $\frac{\text{Total area of regions under overlapping of water throws}}{\text{Total area as per Square spacing between sprinklers}} \times 100$

Regions under overlapping of water throws:

X, X, X, X, 2X, 2X, 2X, 2X, 4X

Variable Frequency Drive (VFD)

A variable frequency drive (VFD) is **a type of motor controller that drives an electric motor by varying the frequency and voltage of its power supply**. The VFD also has the capacity to control ramp-up and ramp-down of the motor during start or stop, respectively.



VFD is an important device by which a substantial energy can be saved at the time of running an electric motor.

Power Input ➞ VFD ➞ Electric Motor

In an irrigation system when isolation valve is operating at nearby areas of the pump sitting location, the higher available pressure from pump incorporates higher discharge rate which can be adjusted by done programming correctly in VFD so that water can be applied uniformly along the field (i.e. Equal water application in the nearby areas as well as farthest points). By this process waste of energy can also be eliminated.

Frequency of Motor ∝ Revolutions per Minute (RPM)

Purpose of VFD:

Primary function of a VFD in aquatic applications is **to provide energy savings**. By controlling speed of a pump rather than controlling flow through use of throttling valves, energy savings can be substantial. By way of example, a speed reduction of 20% can yield energy savings of 50%.

Variable Frequency Drive (VFD) can be used in lots of fields. Variable frequency drives are widely used **to control the speed of AC motors, like conveyor systems, blower speeds, pump speeds, machine tool speeds, & other applications that require variable speed with variable torque**.

Working Principle of VFD:

VFDs manipulate the frequency of their output by **rectifying an incoming AC current into DC, and then using voltage pulse-width modulation to recreate an AC current and voltage output waveform**. A variable frequency drive controls the speed of an AC motor **by varying the frequency supplied to the motor**.

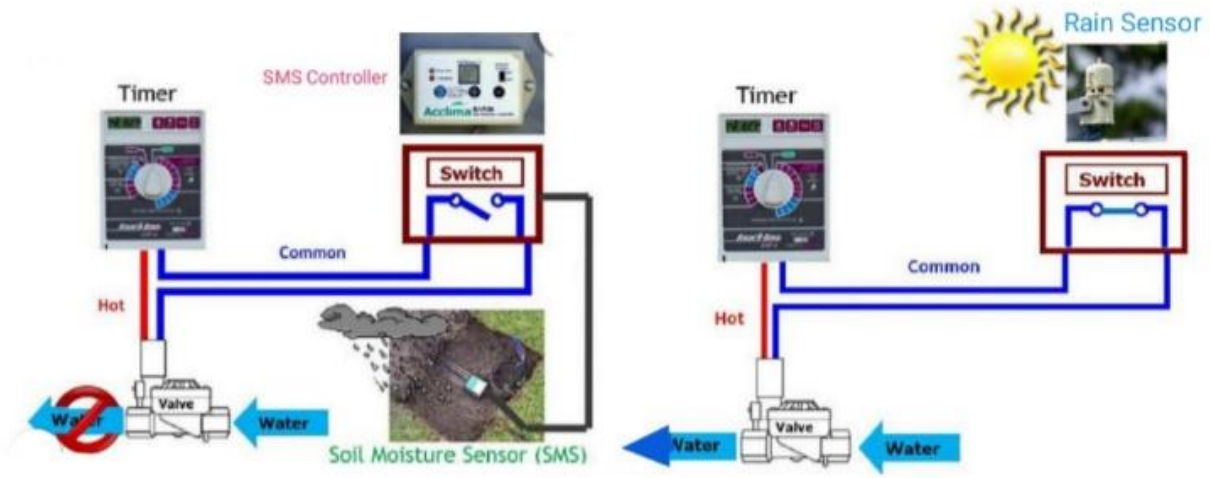
Controlling Pump Pressure through VFD:

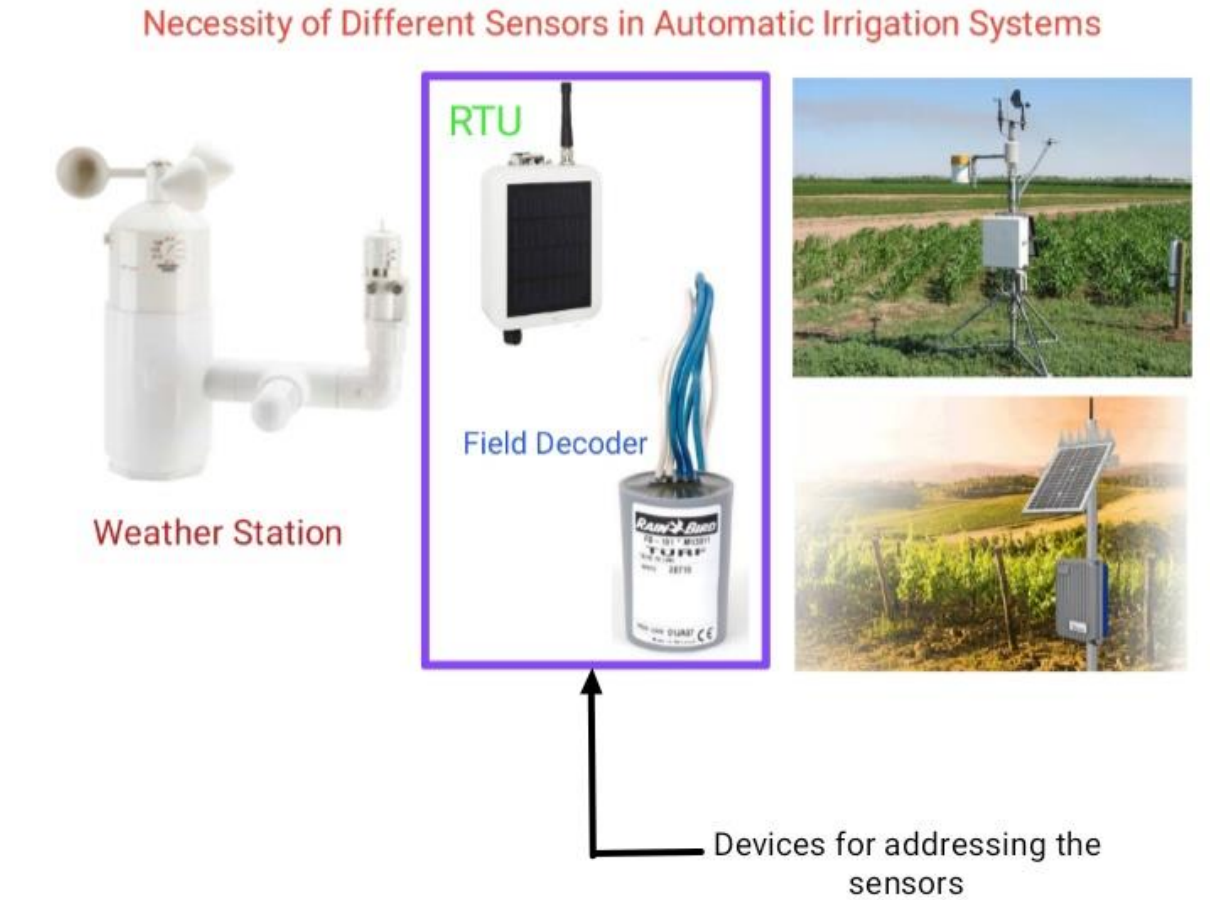
For every pressure, the pump will only deliver one specific flow rate. Therefore, to control the flow of a centrifugal pump, simply **set the output pressure to the point on the P-V diagram that allows the pump to deliver the desired flow rate**. The output pressure of the pump is set using a back pressure regulator.

For AC Induction Motor, (Hz x 60 x 2) / number of poles = no-load RPM

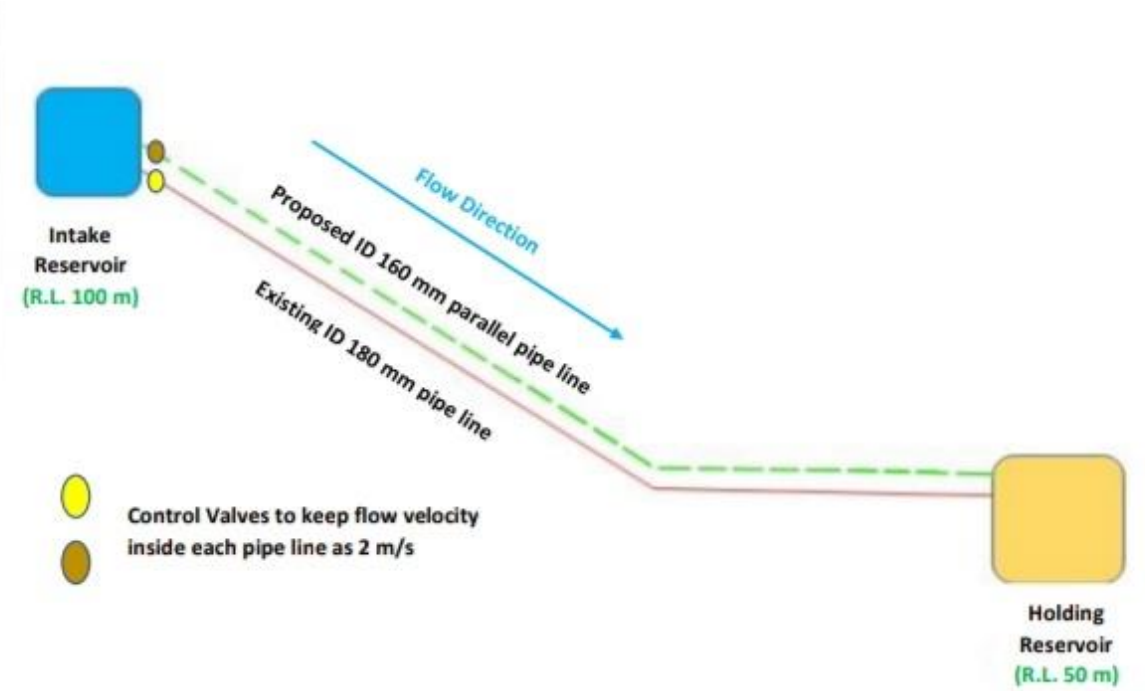
VFD controls Frequency by controlling Speed of electric motor

Purpose of different sensors related to irrigation systems





Idea of Gravity Feed Water Conveyance System



From the above figure it is find that the existing pipe line of ID180 mm having length of 5000 m can carry maximum water at a rate of **25,000 gph** with required drop of **(5000 m x 1)/100 = 50 m**; Considering Velocity of flow as 2 m/s and Hydraulic Gradient as 1 m/100 m.

Now, if water to be conveyed at a rate of 40,000 gph then what will be the size of the additional pipe line to be placed parallel with existing ID180 mm pipe line and by keeping flow velocity as 2 m/100 m for laminar flow of water?

Solution:

Additional required water conveyance rate: (40,000 gph – 25,000 gph) = 15,000 gph

Available drop: (100 m – 50 m) = 50 m

Length to reach: 5000 m

ID 160 mm pipe can carry water at a conveyance rate of 15,000 gph with 1 m/100 m Hydraulic Gradient and flow velocity of 2 m/s

Hence, required drop to convey the additional calculated rate of water with ID 160 mm pipe line:

(5000 m x 1)/100 = 50 m which is adequate as available drop is 50 m.

Note: Datas are been mentioned as per assumptions which may be varied as per actual condition of pipe lines and other factors.

The main objective of the above presentation is to show the concept of Gravity Feed Water Conveyance System.

Description of lawn grass species

S. No	Botanical Name	Common name	Texture	Situation
1	*Cynodon dactylon*	Hariyali (or) Arugu (or) Doob grass	Medium fine	Suitable for open sunny location; drought resistant
2	*Stenotaphrum secundatum*	St. Augustine grass or Buffalo grass	Coarse texture	Suitable for shady situation; requires frequent watering
3	*Sporobolus tremulus*	Chain grass (or) Upparugu	Fine	Suitable for saline soils and open sunny locations
4	*Poa annua*	Annual blue grass	Medium fine	Suitable for acid soils and suitable for higher elevations
5	*Pennisetum clandestinum*	Kikuyu grass	Rough	Grow well in acids soils, suitable for higher elevations.
6	*Zoisia japonica*	Japan grass	Coarse	Suitable for poor sandy soil; open sunny situation, slow in growth
7	*Z. matrella*	Manila grass	Medium	Suitable for open sunny situation
8	*Z. tenuifolia*	Korean grass or velvet grass or carpet grass	Fine	Suitable for open sunny situation
9	*Cynodon* sp.	Bermuda grass (or) Hyderabad grass	Fine	Suitable for open sunny situation, needs mowing
10	*Cynodon* sp.	Dwarf Bermuda	Medium	Suitable for open sunny situation
11	*Festuca* sp.	Fescue grass	Coarse	Shade tolerant, survive on inferior soils
12	*Paspalum vaginatum*	Paspalum grass	Medium	Suitable for open sunny situation

Problem	Symptoms	Control
Chlorosis	Grass turns yellow with the deficiency of magnesium and iron	Iron: Spray Ferrous sulphate 25 g dissolved in 10 litres of water per 100 sq. metre. Magnesium: Spray Magnesium sulphate 100 g in 10 litres of water per 100 sq. metre.
Dog urine	Dead grass in the lawn	Re-plant grass in a circular manner
Fertilizer burn	Grass browns especially in hot weather	Drench the lawn in injured areas to leach excess fertilizers deep into the soil.
Improper mowing	Lawns cut too closely turn yellowish and often look diseased or dried	Mow enough to remove not more than 1/3rd height of the grass at a time. Keep mower blades sharp.
Improper watering	Light sprinkling encourages shallow roots. Over watering causes diseases	Water the lawn to wet the soil about10 to 15 cm depth.

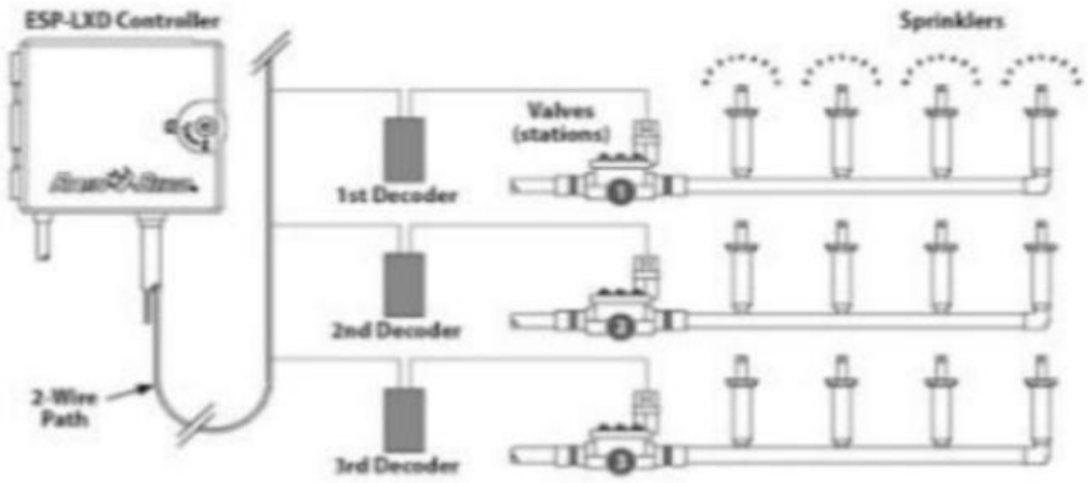
Pest	Symptoms	Control
Leafhoppers	Suck the juice from grass blades causing stripped white, then yellow and finally brown leaves.	Spray Dimethoate 2 ml/l
Nematodes	Affect the roots, lawn takes a bleached out appearance	Apply Furadan 40 g /sq.m

Useful Formulas:

1. Water Application Rate (in mm/hr) = Discharge Rate in Litre per hour/ ($Spacing_{Row\ to\ Row}$ x $Spacing_{Emitter\ to\ emitter}$); Spacings are in meter
2. HP of pump = $\frac{\text{Discharge Rate (in litre per second) x Head (in meter)}}{75 \text{ x eff. of motor or engine x eff. of pump}}$
3. 1 cubic ft. = 6.23 imperial gallons
4. 1 m^3 = 1000 litres
5. 1 imperial gallon = 4.54 litres
6. Area coverage with sprinklers = Spacing between sprinklers x spacing between rows
7. 1 ft. = 0.305 meter
8. 1 m = 3.281 ft.
9. 1 Bar = 10 m = 1 kgf/cm^2
10. 1 HP = 0.933 kVA
11. 1 HP = 0.746 kw
12. 1 kw = 1.25 kVA
13. **Electric power consumption:**
    Kw x duration of operation x per unit (kw) consumption cost
14. **Diesel consumption:**
    Fuel consumption of DE (in %) x HP x duration of operation x per litre diesel cost
15. 1 litre = 1000 cm^3
16. More trajectory angle of throw means more obstruction by air
17. Maximum water carrying capacity of pipes should be obtained by considering hydraulic gradient as 1.5 m per 100 m
18. 1 Mwc = 1 Meter water column = Height given by the pump to the liquid (i.e. Generated Head by the pump at specified discharge rate)
19. Standard Dimension Ratio (SDR) = OD / Wall Thickness; Pipes with a lower SDR can withstand higher pressures.
20. **Filter size selection:**
    Maximum discharge rate of pump(s) x 1.25; Means if maximum discharge of pump(s) are calculated as 500 m^3/hr then size of filter should be selected by considering its discharge rate as 500 x 1.25 = 625 m^3/hr so that inner volume will be more resulting less pressure required to allow 500 m^3/hr discharge rate.
21. Head loss in Ring-Main Line: (Total Length/2) x 0.01 Hydraulic Gradient
22. Head loss in Sprinkler/Drip Lateral Lines: Total Length x 0.01 Hydraulic Gradient x M.O.F
23. Sprinkler discharge rate (GPM) = 28.9 x d^2 x $\sqrt{p}$; d=Nozzle dia (inches), p=pressure at nozzle (PSI)

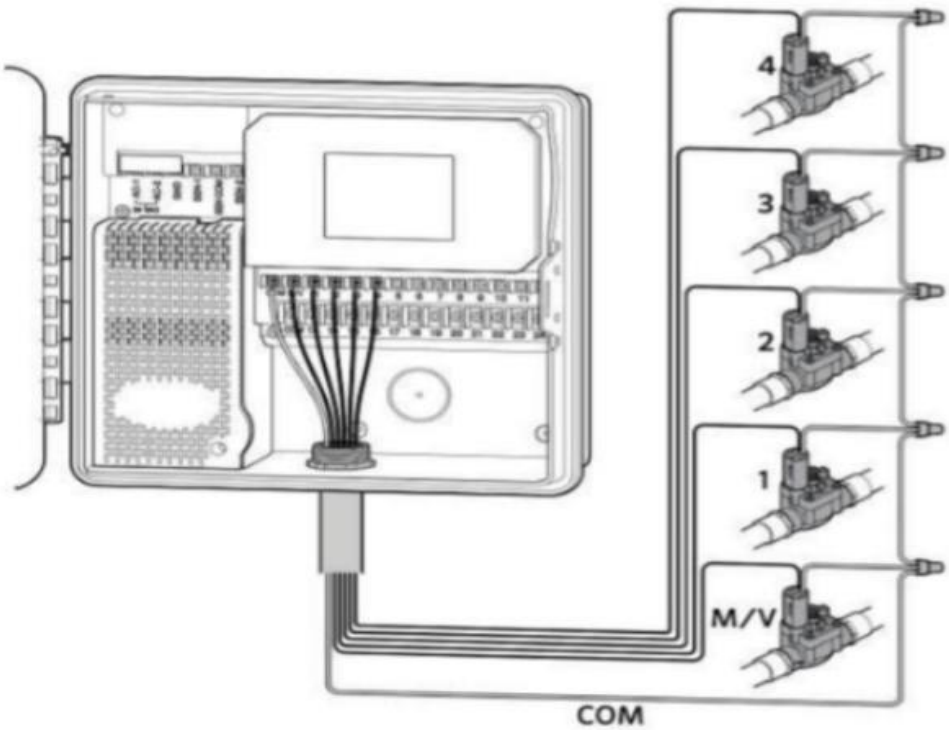
TWO-WIRE DECODER BASED AUTOMATION (Example)

Sl. No.	Description of Items	UOM	Qty.
1	2" Solenoid Valve - BSP Fm - 24VAC	No.	7
2	50 mm PVC MTA - PN 6	No.	14
3	Single Zone Field Decoder	No.	14
4	Decoder Cable Fuse Device	No.	14
5	Surge Arrestor	No.	4
6	12" Rectangular Valve Box	No.	7
7	14 AWG 2 Core Direct Burial Cable	M	360
8	DBR Cable Connector	No.	50
9	CVT Stabilizer for Controller	No.	1
10	Irrigation Controller 14 Stations; Compatible with Decoder; 2 nos. Sensor Input	No.	1
11	Soil moisture sensor with wire nuts and grease caps complete	Set	1
12	Wired Rain Sensor with Bracket	Set	1
13	Water Level guard meter arrangement for automatic switching off the system during low water level	Set	1
14	Line Surge Protection Unit complete with 5/8" x 8 ft. copper grounding Rod and 5/8" Grounding Clamps complete in all respect	Set	2
15	Pump start relay 24 VAC to 230V will be fitted in pump control panel will be installed in Pump panel box	No.	1
16	1" PVC Conduit Pipe for Decoder Cable	M	360



MULTI-WIRE WiFi BASED AUTOMATION (Example)

Sl. No.	Description of Items	UOM	Qty.
1	2" Solenoid Valve - BSP Fm - 24VAC	No.	7
2	50 mm PVC MTA - PN 10	No.	14
3	Surge Arrestor	No.	4
4	12" Rectangular Valve Box	No.	7
5	2 Sq. mm Single Core Copper Cable for both Common & Phase Connection	M	900
6	DBR Cable Connector	No.	80
7	CVT Stabilizer for Controller	No.	1
8	Irrigation Controller 14 Stations Compatible with Bluetooth and WiFi module	Set	1
9	Soil moisture sensor with wire nuts and grease caps complete	Set	1
10	Wired Rain Sensor with Bracket	Set	1
11	Water Level guard meter arrangement for automatic switching off the system during low water level	Set	1
12	Line Surge Protection Unit complete with 5/8" x 8 ft. copper grounding Rod and 5/8" Grounding Clamps complete in all respect	Set	2
13	Pump start relay 24 VAC to 230V will be fitted in pump control panel will be installed in Pump panel box	No.	1
14	1" PVC Conduit Pipe for Cable	M	900



WIRELESS IOT BASED AUTOMATION (Example)

I	Description of Items	UOM	Qty.
1	2" Solenoid Valve - BSP Fm with 9VDC Latching Solenoid	No.	7
2	50 mm PVC MTA - PN 10	No.	14
4	12" Rectangular Valve Box	No.	7
5	2 Sq. mm Single Core Copper Cable	M	20
6	DBR Cable Connector	No.	10
7	CVT Stabilizer for Controller	No.	1
8	Irrigation Controller 14 Stations for Wireless IOT based Irrigation Automation	Set	1
9	Soil Moisture Sensor	Set	1
10	Rain Sensor with Bracket	Set	1
11	Water Level guard meter arrangement for automatic switching off the system during low water level	Set	1
12	4-Zones Remote Terminal Unit (RTU)	No.	4
13	Metal Frame for RTU Pole/Wall Mounting	No.	4
14	Connection Cables for Valves & RTU with Pigtail Connection Clamps	Set	14
15	WiFi (LTE) Dongle compatible with Irrigation Controller	No.	1
16	4w-12VDC Solar Panel with Charge Controller & Connection Cables	Set	4
17	Line Surge Protection Unit complete with 5/8" x 8 ft. copper grounding Rod and 5/8" Grounding Clamps complete in all respect	Set	2
18	Pump start relay 24 VAC to 230V will be fitted in pump control panel will be installed in Pump panel box	No.	1
19	1" PVC Conduit Pipe for Cable	M	20

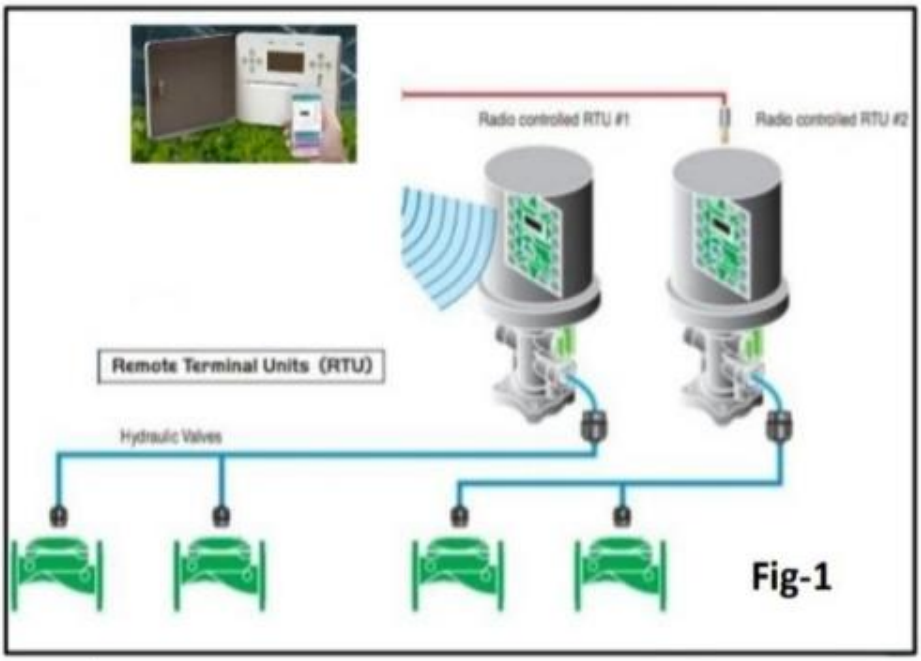


Fig-1

AUTOMATED TEMPERATURE & RELATIVE HUMIDITY CONTROL SYSTEM FOR GREENHOUSES (Example) BOQ for Automation Part

Sl. No.	Description of Items	UOM	Qty.
1	GALCON Series 2" Solenoid Valve - BSP m - 12VDC Latch Solenoid	No.	7
2	50 mm PVC FTA - PN 6	No.	14
3	12" Rectangular Valve Box	No.	7
4	14 AWG 2 Core Direct Burial Cable	M	150
5	DBR Cable Connector	No.	30
6	CVT Stabilizer for Controller	No.	1
7	GALILEO W DC Model Greenhouse Version Climate Control Controller 14 Stations; 12V DC power supply for operation of DC Latch solenoids	No.	1
8	4-Zones G2W bidirectional radio units (RTU); DC Outputs – Latch 18 VDC	No.	4
9	Metal Frame for RTU Pole/Wall Mounting	No.	4
10	Connection Cables for Valves & RTU with Pigtail Connection Clamps	Set	14
11	WiFi (LTE) Dongle compatible with Controller	No.	1
12	RTU Power Source: 4 D-type 1.5 VDC batteries, relay: 7.4 VDC lithium battery for Greenhouse Climate Control	Set	4
13	Water Level guard meter arrangement for automatic switching off the system during low water level	Set	1
14	Pump start relay 24 VAC to 230V will be fitted in pump control panel will be installed in Pump panel box	No.	1
15	1" PVC Conduit Pipe for Decoder Cable	M	150

GALILEO PC SOFTWARE / APP allows the program to operate.

AUTOMATED DUST SUPPRESSION SYSTEM

In factory haul roads, goods loaded trucks & other vehicles are moves through dirt roads. If the mentioned vehicles move through concrete roads then there may be some damage on the concrete, hence the haul roads are made by soil.

When the vehicles moves through dirt roads which are made of soil then there will be a possibility of dust flying which is not good for environment also.

To resist dust in haul roads, automated dust suppression systems should be installed so that adequate moisture level available in the soil.

A soil moisture sensor with compatible irrigation controller can solve the above mentioned purpose. A threshold limit to be set in the mentioned soil moisture sensor which sends signal to the irrigation controller to open solenoid valve (s) if moisture level comes to the low limit (i.e. threshold limit).

When water passes through the mentioned solenoid valve (s), sprinkler starts operation and the system runs until maximum absorption limit of soil is reached. Thus the possibility of dust flying can be reduced by maintaining adequate moisture level in haul roads.

AUTOMATED DUST SUPPRESSION SYSTEM (Example)

Length of Road: 70 metres; Width of Road: 10 metres

No. of Zone Isolation Valve: One

BOQ for Automation Part

Sl. No.	Description of Items	UOM	Qty.
1	2" Solenoid Valve - BSP Fm - 24VAC	No.	1
2	50 mm PVC MTA - PN 6	No.	2
3	Single Zone Field Decoder	No.	8
4	Decoder Cable Fuse Device	No.	8
5	Surge Arrestor	No.	2
6	12" Rectangular Valve Box	No.	1
7	14 AWG 2 Core Direct Burial Cable	M	60
8	DBR Cable Connector	No.	10
9	CVT Stabilizer for Controller	No.	1
10	Irrigation Controller 10 Stations; Compatible with Decoder; 2 nos. Sensor Input	No.	1
11	**Soil moisture sensor with wire nuts and grease caps complete**	Set	1
12	**Wired Rain Sensor with Bracket**	Set	1
13	Water Level guard meter arrangement for automatic switching off the system during low water level	Set	1
14	Line Surge Protection Unit complete with 5/8" x 8 ft. copper grounding Rod and 5/8" Grounding Clamps complete in all respect	Set	1
15	Pump start relay 24 VAC to 230V will be fitted in pump control panel will be installed in Pump panel box	No.	1
16	1" PVC Conduit Pipe for Decoder Cable	M	60

Operational Logic of Different Automation Systems

Sl. No.	Type of Irrigation Automation	Operational Logic of System	Remarks
1	Two-wire Decoder based Automation	24VAC solenoid valves receives necessary commands from irrigation controller through the decoders. In the controller, address of decoders to be paired with zone-wise solenoid valves. 2-Conductor Direct Burial Cable is used for this type of Irrigation Automation. Inside the cable one conductor is for COMMON connection and another one is for PHASE connection.	Should be used for plot over 20 zones to maintain standard project cost.
2	Multi-wire based Automation	24VAC solenoid valves receives necessary commands from irrigation controller through electric energy and then the energy is converted into mechanical energy for functioning of solenoid valves. Single Core Copper conductors are generally used for this type of irrigation automation.	Should be used for plot with less than 20 zones to maintain standard project cost.
3	Wireless IOT based Automation	In this type of irrigation automation system, the 24VAC solenoids are converted into 9VDC magnetic latch solenoid actuators and connected with valves. Here the valves receives necessary commands from irrigation controller through Remote Terminal Units (RTUs). The RTUs runs by getting necessary power from 4w-12VDC solar panels. The irrigation controller sends commands to the RTUs by WiFi signaling process. In the controller, address of RTUs to be paired with zone-wise latching solenoid valves.	Should be used for large area where more than 250 zones to be controlled.
4	T+RH Control System for Greenhouses	A greenhouse climate controller is required by which Temperature & Relative Humidity can be controlled inside greenhouse by controlling automatic functions of 12VDC Latch solenoid valves (through battery operated radio units) which opens to allow Foggers to operate and closes when a perfect climate for crops is built.	Can be used for greenhouse climate control or open field irrigation systems.

Operational Logic of Automated Dust Suppression Systems are similar to the 'Two-wire Decoder based Automation' Systems. Here adequate moisture level to be maintained in soil to reduce chances of dust flying when vehicles move through haul roads made by soil.

Irrigation System Design & Relevant Calculations

Concept on Sprinkler Irrigation System

Sprinkler irrigation is the method of applying water in a controlled manner in way similar to rainfall.

Use:

To Irrigate Agricultural Crops, Landscapes, Lawns, Golf Courses etc.

Area coverage by a sprinkler:

π.Type equation here.$\pi D^2 / 4$, where 'D' denotes diameter of water throw by sprinkler

Area coverage by a sprinkler irrigation system:

Spacing between sprinklers (m) X Spacing between lateral lines (m)

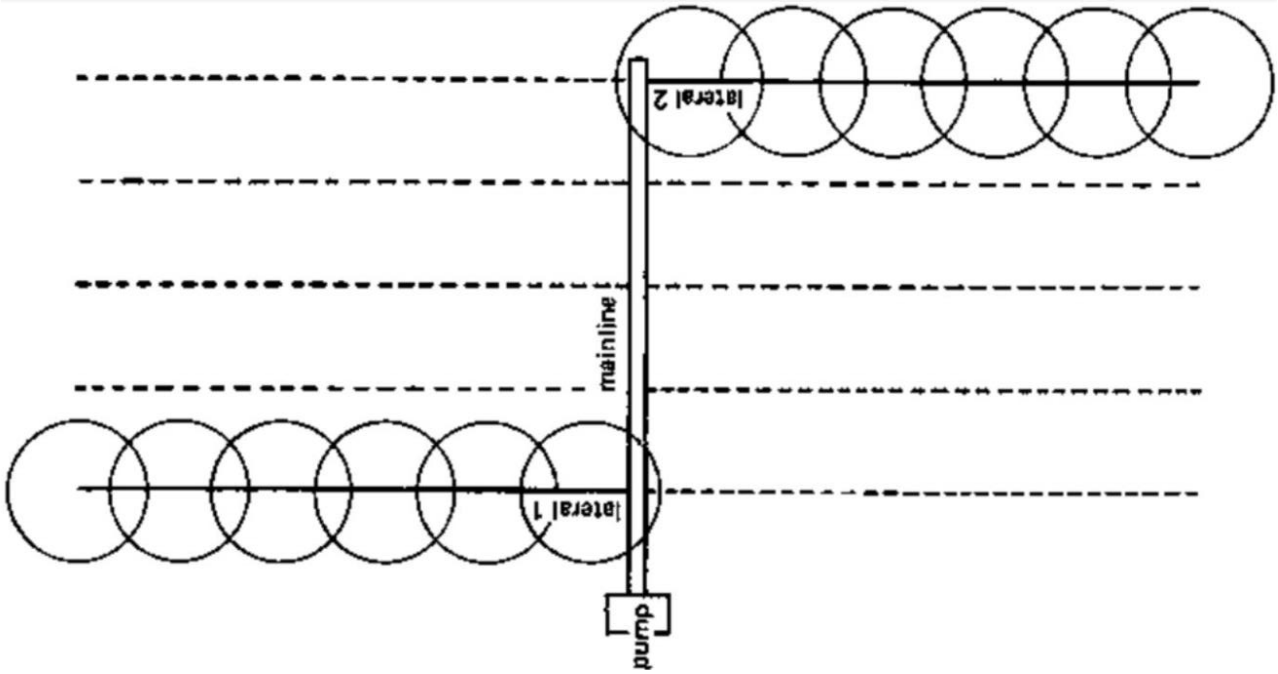
Water Precipitation Rate by a sprinkler irrigation system (mm/hour):

Water discharge rate of each sprinkler (Liter per Hour)
Spacing between sprinklers (m) X Spacing between lateral lines (m)

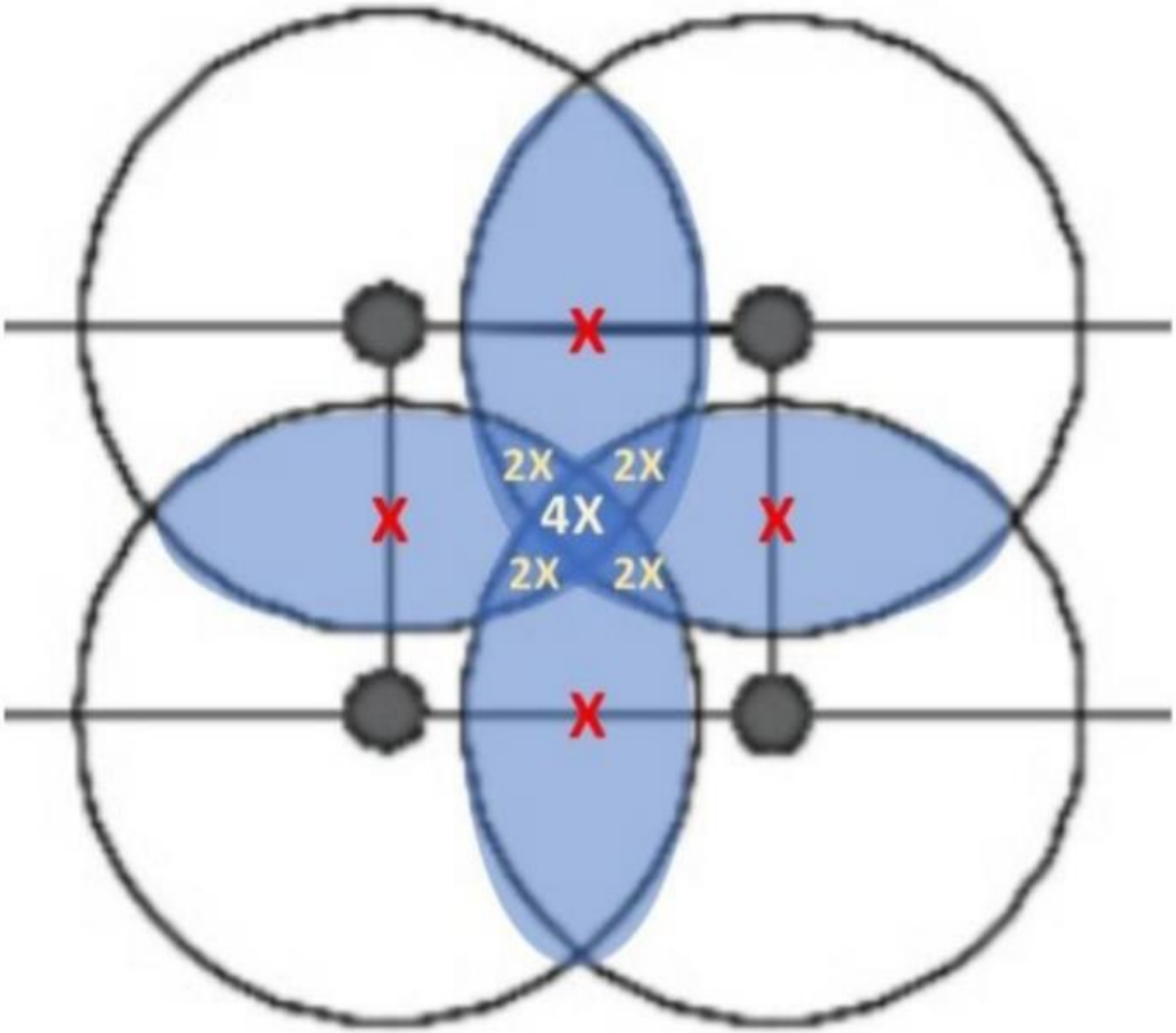
Or, Water discharge rate of each sprinkler (0.001 m^3 per Hour)
Spacing between sprinklers (m) X Spacing between lateral lines (m)

= 0.001 m per Hour = **mm per hour**

Spacing between sprinklers and lateral lines are been calculated based on water Discharge Rate and required Precipitation Rate to maintain Distribution Uniformity.



Concept of overlapping in sprinkler irrigation system



Percentage of Overlapping= $\frac{\text{Total area of regions under overlapping of water throws}}{\text{Total area as per Square spacing between sprinklers}} \times 100$

Regions under overlapping of water throws:

X, X, X, X, 2X, 2X, 2X, 2X, 4X

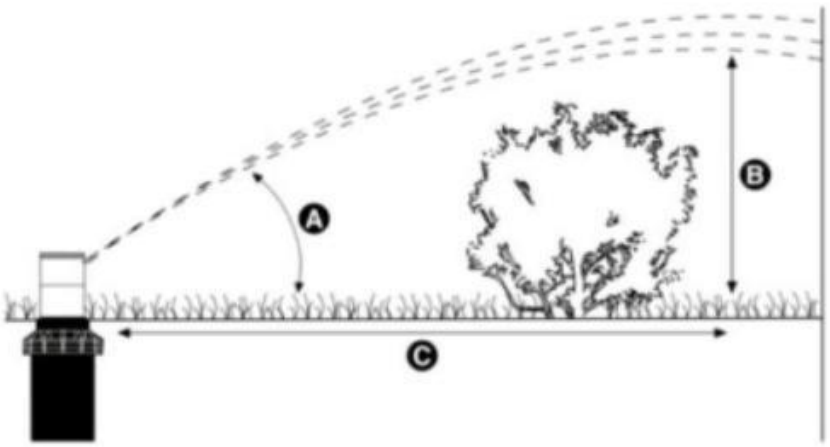
Selection of Sprinkler Trajectory Angel for Better Throw Range

Selection of water stream Trajectory Angel is an important task while designing a sprinkler system.

Higher Trajectory Angel means Lesser Range of water throw achieved.

At a Higher Trajectory Angel, the water stream leaving a sprinkler nozzle gets more Resistance by Air resulting in Lesser Range of water throw.

So, it is advisable to select a sprinkler with a Low Trajectory Angle of water stream to get a Higher water Throw Range.



A = Degrees of trajectory

B = Max Height of Spray

C = Distance from head to Maximum Height

Pipe ID calculation according to discharge and flow rate

$Q = AV$ .... (1)

Q = Discharge Rate through Pipe

A = Cross-Sectional Area of Pipe as per ID

V = Velocity of flow

Now, if Q = 120 $m^3/hr.$; V = 2 m/sec (for laminar flow) then we have to calculate ID of Pipe

From equation (1) it is find that,

$A = Q / V$

Hence, $\pi/4\ ID^2 = \{120 / (2 \times 3600)\}\ m^2$

$ID^2 = \{(120 \times 4) / (7200 \times 3.14)\}\ m^2$

$ID^2 = 0.022\ m^2$

Therefore, ID = 0.148 m = 148 mm ~ 150 mm

Surge Pressure in Pipeline

Surge Pressure occurs when a valve is suddenly closed.

Rule of thumb to calculate Surge Pressure in psi:

P = 0.8 x wt. of per cubic feet of liquid x velocity of flow in ft. / sec.

Ex-

If a pipeline transports water at 5 fps velocity then amount of surge created when valve is suddenly closed:

P = 0.8 wV =0.8 x 62 lb x 5 = **248 psi**

Maximum allowable surge pressure of **1.1 times the design pressure of the system for long distance pipelines**

Chemical and petrochemical plant piping systems specifies a maximum allowable surge pressure of **1.33 times the design pressure of the system**

Hazen-Williams Equation for Friction Head Calculation:

$$H_f = L\left[\frac{V}{k C R^{0.63}}\right]^{\frac{1}{0.54}}$$

WATER IN PRESSURIZED PIPE

H_f = headloss due to friction (ft or m)

L = length of pipe (ft or m)

V = velocity (ft/s or m/s)

C = roughness coefficient (unitless)

k = unit conversion (US = 1.32, SI = 0.85)

R = hydraulic radius (ft or m)

$$R = \frac{A}{P_w} = \frac{\pi r^2 r}{2\pi r} = \frac{r}{2} = \frac{D}{4}$$

TABLE 3.2 Hazen–Williams Coefficient, C_{HW}, for Different Types of Pipes

Pipe Materials	C_{HW}
Brass	130–140
Cast iron (common in older water lines)	
New, unlined	130
10-year-old	107–113
20-year-old	89–100
30-year-old	75–90
40-year-old	64–83
Concrete or concrete lined	
Smooth	140
Average	120
Rough	100
Copper	130–140
Ductile iron (cement mortar lined)	140
Glass	140
High-density polyethylene (HDPE)	150
Plastic	130–150
Polyvinyl chloride (PVC)	150
Steel	
Commercial	
Riveted	140–150
Welded (seamless)	90–110
Vitrified clay	100
	110

Example of design a sprinkler irrigation system:
A 10,000 m² plot to be irrigated with 10 mm water application rate per day with 10 hours of operation. Design the system.

- To apply 10 mm of water with 10 hours of operation, 1 mm water to be applied per hour.

  Size of plot: 10,000 m²

  Say, selected sprinkler with discharge rate of 1440 lph spacing as 12 m between sprinklers and lateral lines.

  Hence, the design calculations are as follows:

  1440 lph / (12 m x 12 m) = 10 mm per hour

  Total number of sprinkler to be led in the plot: 10,000 m² / (12 m x 12 m) = 70 nos.

  Total discharge rate = 1440 lph x 70 no. of sprinklers = 1,00,800 lph

  Available yield of water at source: 10,100 lph (i.e. **pump discharge @2.8 lps**)

  Hence no. of lateral line with isolation valve: 10 numbers;

  Number of sprinkler under each isolation valve: 70 / 10 = 7 numbers

  Duration of each lateral valve operation: (10 mm / 10 mm) x 60 Minutes= 60 Minutes
  = 1 hour
  Hence, total duration of operation per day for 10 numbers of lateral line isolation valves
  = 1 hour X 10 number of lateral line isolation valves
  = **10 hour per day**

  Water discharge rate through each lateral line: 1440 lph X 7 number of sprinklers
  = 10,080 lph

  Hence ID of each lateral line: 63 mm & ID of mainline: 63 mm

  Length of mainline from water source: 150 m
  Friction Head: 150 m x 1.5 / 100 m = **2.3 m**

  Length of each lateral line: 7 sprinklers @12 m apart with 1st sprinkler distance from mainline as 6 m for overlapping; hence total length of each lateral line: (7 x 12) – 6 = 78 m
  Friction Head: 78 m x 1.5 x 0.4 (say) as multiple outlet factor / 100 = **0.5 m**

  Operational pressure of sprinkler: **25 m**; Pump Suction pressure: **5 m**
  Calculated Total Dynamic Head: (2.3 + 0.5 + 25 + 5) X 1.1(for bends, tees & valves)= 36 m

Sprinkler irrigation system involves following types of sprinkler:

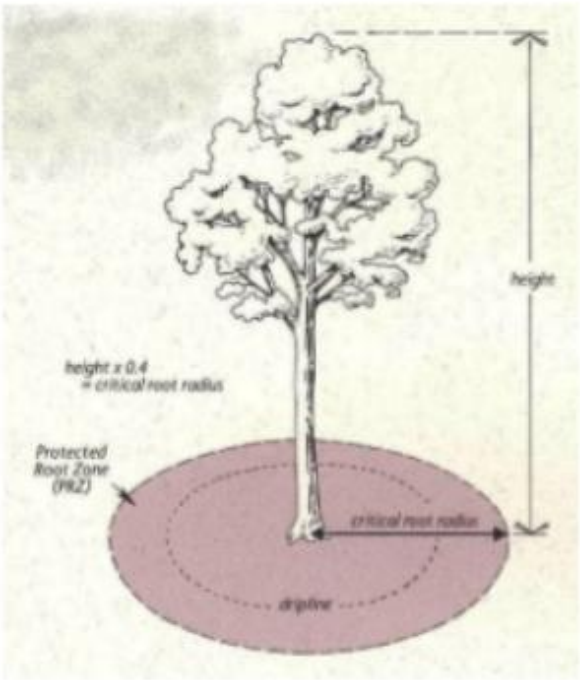
1. Raingun Sprinkler : Applicable for long range with heavy droplets.
2. Impact Sprinkler : Applicable for crop irrigation with lighter droplets.
3. Micro Sprinkler : Applicable for greenhouses with mist sprays.
4. Mini Sprinkler : Applicable for agricultural & horticultural crops with light droplets and smaller spacings of 5-6 m between sprinklers.
5. Pop-up Sprinkler : Applicable for lawns & Golf Courses with underground positioning.

Concept on Drip Irrigation System

Drip irrigation is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface. The goal is to place water directly into the root zone and minimize evaporation.

As water is directly applied into the root zone of each plant, hence emitters should be placed at root zone of each plant.

Area of root zone is nearly equal to canopy area of plant.



Types of Drip Irrigation System:

In-line : Emitters are placed inside of drip lateral lines

On-line : Emitters are to be placed outside of lateral lines

Example of design an In-line Drip Irrigation System:

A 10,000 m² plot to be irrigated with In-line Drip Irrigation System & PWR is 10 mm of water application per day with 10 hours of operation. Distance between Plants 0.5 m and distance between rows 0.5 m. Design the system.

- To apply 10 mm of water with 10 hours of operation, 1 mm water to be applied per hour.
  Size of plot: 10,000 m²

  Say, selected emitter with discharge rate of 2 lph spacing as 0.5 m between emitters and lateral lines.

  Hence, the design calculations are as follows:
  2 lph / (0.5 m x 0.5 m) = 8 mm per hour

  Total discharge: (100 m x 100 m) x 2 lph / (0.5 m x 0.5 m)= 80,000 lph
  Available yield of water at source: 10,100 lph (i.e. **pump discharge @2.8 lps**)
  Hence no. of sub-mainline line with isolation valve: (80,000/10,100) = 8 numbers (Apprx.)
  Discharge Rate of each isolation valve 10,000 lph

  Duration of each isolation valve operation: (10 mm / 8 mm) x 60 Minutes= 75 Minutes
  = 1 hour 15 minutes
  Hence, total duration of operation per day for 8 numbers of sub-mainline line isolation valve
  = 75 minutes X 8 number of sub-mainline isolation valves
  = **10 hours per day**
  Area under each isolation valve: 10,000 m² / 8 = 1,250 m²
  No. of emitters under each isolation valve: 10,000 lph / 2 lph = 5,000 nos.

  No. of lateral rows under each isolation valve: 30 m / 0.5 m = 60 nos. (Assuming length under each isolation valve is 30 m and breadth as 42 m)

  Hence, discharge rate of each lateral row: 10,000 lph / 60 rows = 167 lph

  Length of mainline of ID 63 mm from water source: 150 m
  Friction Head: 150 m x 1.5 / 100 m = **2.3 m**

  Length of each sub-mainline of ID 63 mm: 50 m
  Friction Head: 50 m x 1.5 / 100 = **0.75 m;** Friction Head under each 12 mm lateral row: **1.5 m**
  Operational pressure of emitters **15 m**; Pump Suction pressure: **5 m**
  Calculated Total Dynamic Head: 24.5 X 1.1(for bends, tees & valves)= 27 m

Example of design a On-line Drip Irrigation System:

A 10,000 m² plot to be irrigated with On-line Drip Irrigation System and PWR of plants is 40 litres of water per day with 10 hours of operation. Distance between Plants 5 m and distance between rows 5 m. Design the system.

- Size of plot: 10,000 m²

Say, selected emitter with discharge rate of 4 lph and 4 no. of emitters are looped along the base of each plant apart by equal distance.

Hence, the design calculations are as follows:
Water discharge rate for each plant: 4 lph X 4 no. of emitters= 16 lph
Required water per plant per day: 40lph

Hence, **duration of operation for each zone isolation valve: 40 lph/16 lph = 2.5 hours**
Total number of plants in the plot: 10000 m² / (5 m X 5 m) = 400 nos.

Total discharge: 400 no. Plants X 16 lph = 6400 lph
Available yield of water at source: 1600 lph (i.e. **pump discharge @0.45 lps**)
Hence no. of sub-mainline line with isolation valve: (6400/1600) = 4 numbers

Discharge Rate of each isolation valve 1600 lph
Hence, total duration of operation per day for 4 numbers of sub-mainline line isolation valve = 2.5 hours X 4 number of sub-mainline isolation valves
= **10 hours per day**

Area under each isolation valve: 10,000 m² / 4 = 2500 m²
No. of emitters under each isolation valve: 1600 lph / 4 lph = 400 nos.

No. of lateral rows under each isolation valve: 50 m / 5 m = 10 nos. (Assuming length under each isolation valve is 50 m and breadth as 50 m)

Hence, discharge rate of each lateral row: 1600 lph / 10 rows = 160 lph
Length of mainline of ID 50 mm from water source: 150 m
Friction Head: 150 m x 1.5 / 100 m = **2.3 m**

Length of each sub-mainline of ID 50 mm: 100 m
Friction Head: 100 m x 1.5 / 100 = **1.5 m;** Friction Head under each 12 mm lateral row & loop at plant base: **1.5 m**

Operational pressure of emitters **30 m**; Pump Suction pressure: **5 m**
Calculated Total Dynamic Head: 40.3 X 1.1(for bends, tees & valves)= 44.3 m

Pressure Compensating & Anti-Suction Drip Emitters

Pressure Compensating Emitter: "Pressure Compensating", or "PC", is a term used to describe **an emitter that maintains the same output at varying water inlet pressures**. Therefore, PC drip emitters compensate for uneven terrain, length of supply tube and varying inlet flows. The pressure-compensating component of the emitter **involves an elastic diaphragm that enlarges or contracts an orifice open area in relation to inlet pressures to provide a more consistent flow rate**.

PC In-line Drip Emitter

PC On-line Drip Emitter

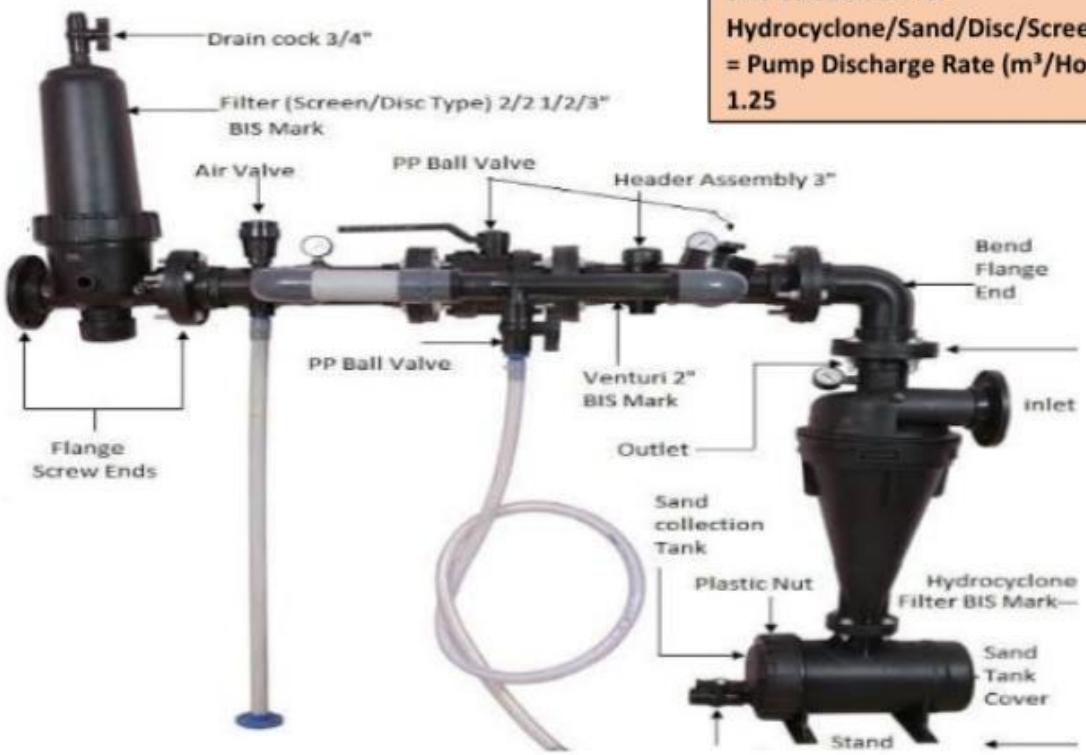
Anti-Suction Emitter: "Anti-Suction" emitters are specially built to resist root intrusion and sand suction inside emitters. The Anti-Siphon mechanism blocks external contaminants from being drawn into the dripper, making it a great solution for buried drip lines (SDI).

Anti-Suction In-line Emitter

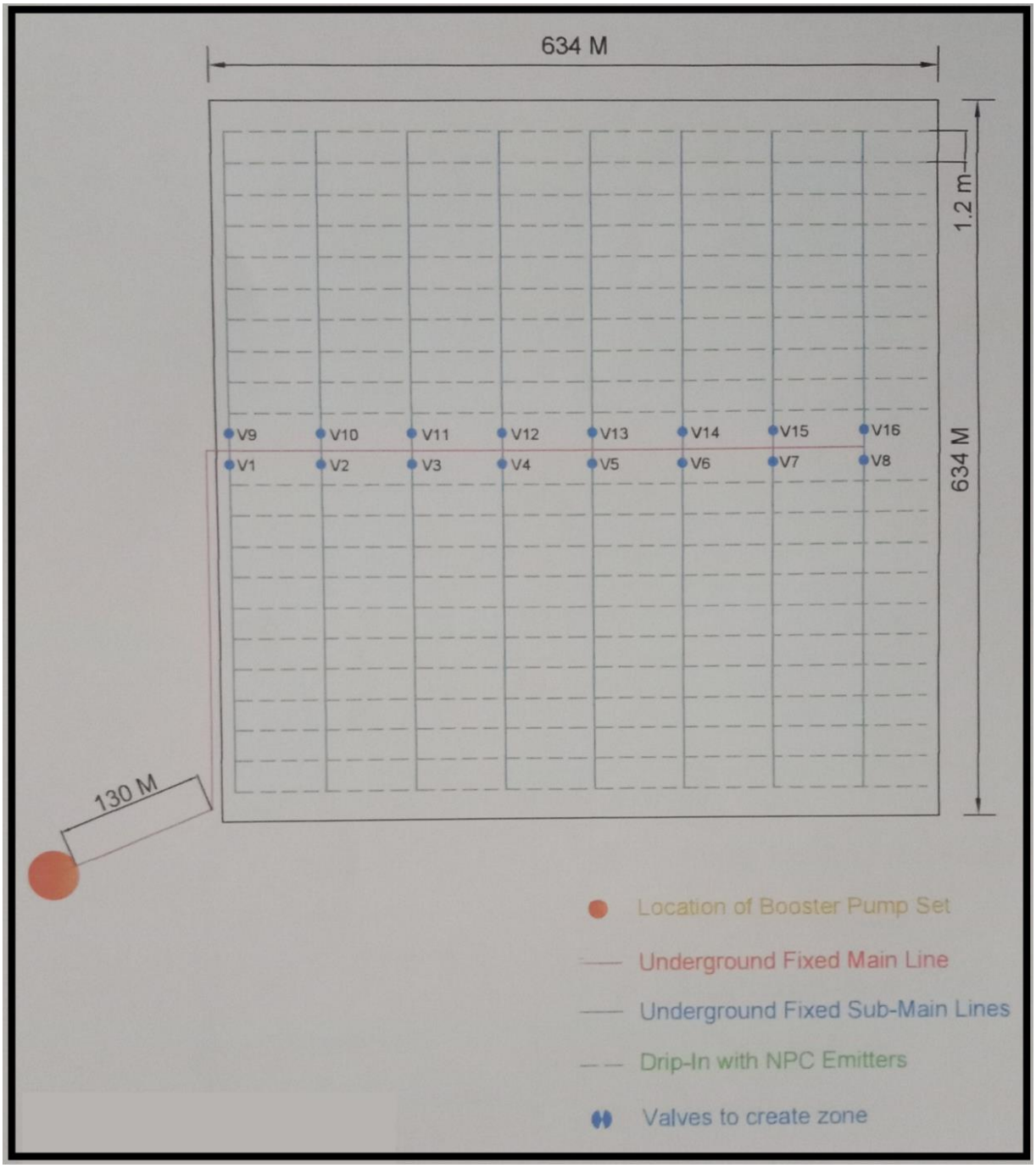
Sub-surface Drip System

Head Control Unit of Drip System with Hydrocyclone Filter as Main Filter (to resist Sand Particles) used for Tube Well Water & Screen or Disc Filter as Backup filter

Size Calculation for Hydrocyclone/Sand/Disc/Screen Filter = Pump Discharge Rate (m^3/Hour) X 1.25



Head Control Unit of Drip System with Sand Filter as Main Filter (to resist Mud & Algae) used for River & Pond Water & Screen or Disc Filter as Backup filter



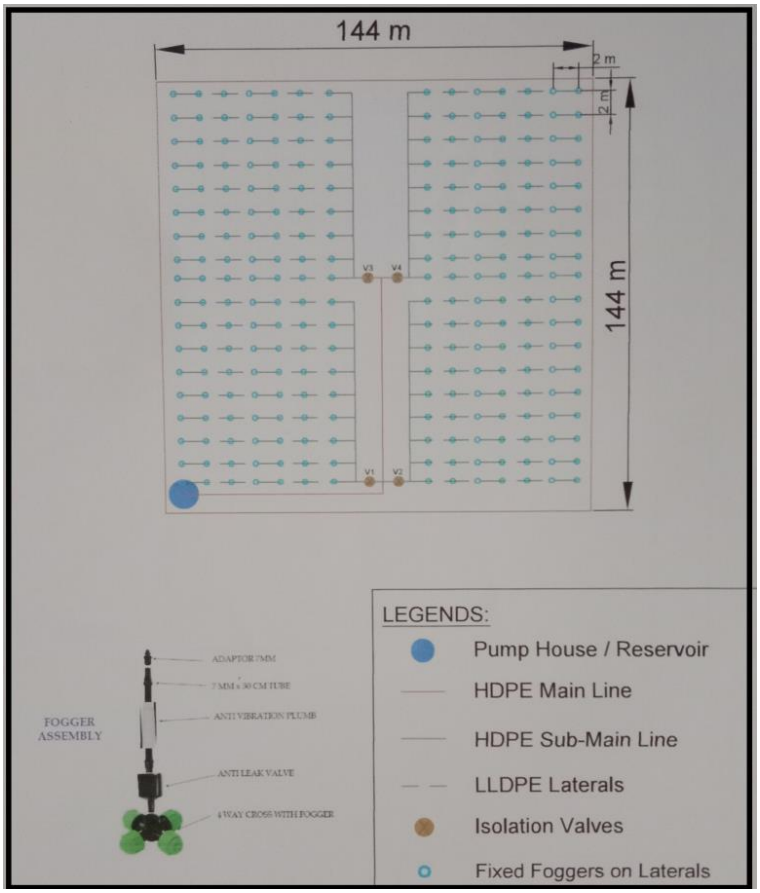
Plan Layout for Piping Networks of Drip Irrigation System

Concept of Fogger System for Greenhouse Climate Control

Greenhouse where plants are grown with Hydroponic system (method of growing plants in a water-based, nutrient-rich solution) and in controlled ambience.
To provide crop-wise tailor-made ambience, Temperature & Relative Humidity to be controlled as per crop requirements. When the mentioned set parameters reaches the desired numeric, the system shuts-down automatically by temperature & RH controller.

The above mentioned process is generally done by using Foggers which are hung from the ceiling of greenhouse and at a minimum spacing of 2 m between each two Foggers.

Foggers sprays water in the form of mist with droplet size of 10-30 microns.



Plan Layout for Piping Networks of Fogger System

Operational Logic of System: Plan layout for the fogger system shows that total area is divided into four zones/isolation valves to reduce capital cost for piping networks & required HP for pump set to reduce running cost as well. Hence only one zone will be run at a time. Remaining three zones will be closed until T & RH reaches to the desired numeric in running zone. Now to program the operational logic in this manner 'Solenoid Valves' with 'Greenhouse Climate Controller' are necessary.

GALILEO GREENHOUSE controller is one of the best solution for the above mentioned purposes. The data to be input via programming through PC software.

Smart Greenhouse Model

A Smart Greenhouse should contain following items:

1. Temperature & Relative Humidity Controller
2. Rail-mounted camera system that captures close up high definition images in combination with in-canopy sensors the system helps growers track the growing process of their entire operation.
3. Foggers/Misters
4. Pump Set with Water Level Guard Meter to Switch On/Off the pump set automatically.
5. Constant Voltage Transformer (CVT) for Controller.
6. Automatic Auto-flush Screen Filter.
7. Solenoid Valve.

An advanced modular controller for irrigation, fertigation and climate control in greenhouses...

CVT Stabilizer

Pump

Water Level Guard Meter

Automatic Auto-flush Screen Filter

Foggers

Solenoid Valve

Security Cameras to Track Daily Grow Process

When the ambient temperature & relative humidity exceed the set limits of the controller, the latch solenoid valve opens automatically and Foggers starts to spray water in the form of mist, and when the environment is ideal for greenhouse crops, the latch solenoid valve automatically closes and Foggers stops spraying.

The Smart Greenhouse Model shows Items for the Greenhouse Climate Control System only. Growth of crops shall be achieved by using the Hydroponic or Aeroponic system which NOT SHOWN in the document.

Features of GALILEO GREENHOUSE CONTROLLER for Climate Control & Multiple Valves Operation

An advanced modular controller for irrigation, fertigation and climate control in greenhouses...

When the ambient temperature & relative humidity exceed the set limits of the controller, the latch solenoid valve opens automatically and Foggers starts to spray water in the form of mist, and when the environment is ideal for greenhouse crops, the latch solenoid valve automatically closes and Foggers stops spraying.

GALILEO Greenhouse version

Greenhouse irrigation software combines an irrigation system with up to 4 climate control systems in the same controller. The irrigation system for greenhouses consists of one irrigation head with a fertilizer center that performs sophisticated fertilizer injection of up to 8 different fertilizers.

Climate Control

Differential management of 4 climate cells in one controller

- Indoor climate sensors – Temperature, humidity, CO_2
- Outdoor Climate Sensors – Wind speed and direction, radiation, rain, outside temperature, outside humidity
- Windows/curtains – Control of up to 10 windows including roof, at 10 different opening degrees
- Shading processes – For controlling long/short day processes
- Fans – Differential control of up to 4 groups of fans
- Thermal screens – Control up to 4 screens in 4 opening degrees
- Cooling system – Based on wet pads or misting system
- Heating system – Based on water or air, including a circuit heating program that allows PID control of the water temperature
- CO_2 enrichment – CO_2 generator control according to windows and ventilation control
- Air Circulation – Differential control up to 6 ventilators, according to the settings of temperature, humidity, CO_2 and more
- Spraying – Optimal spray spreading by means of window control, ventilation and cooling

Irrigation

- 100 Irrigation programs operating 4 generators and 16 valves in each program
- Up to 50 fertigation programs according to proportional fertigation, in order to obtain the required pH/EC
- Mist – Spraying time control, according to temperature and humidity conditions. Operates in relation to logical conditions, drainage monitoring and flushing of filters.

Necessity of Safety Valves in Water Pipe Line

Air Release Valve

An air release valve is typically used in water or irrigation schemes **to ensure that any entrained air in the water system is automatically released in order to maximize the system performance**. Entrained air pockets in pipes can cause excessive head loss and flow reductions if air is not effectively released.

Double Acting Air Valve

Double Acting Air Valve are basically a combination of small orifice and large orifice for **automatically discharging air during pipe filling and ventilating the pipe during emptying**.

Pressure Relief Valve

A relief valve or pressure relief valve (PRV) is a type of safety valve used **to control or limit the pressure in a system**; pressure might otherwise build up and create a process upset, instrument or equipment failure, or fire.

Pressure Reducing Valve

A Pressure Reducing Valve can be defined as a **self-acting automatic control valve for reducing a higher unregulated inlet pressure to a constant,** reduced outlet pressure regardless of the fluctuations in the upstream water pressure. **Mainly used in Gravity feed systems.**

DESIGN PROCEDURE OF TELESCOPIC PIPE LINE

Carrying capacity of different diameter pipes (considering hydraulic gradient as 2 m per 100 m for laminar flow):

1. 40 mm – PN 6: 4000 lph
2. 50 mm – PN 6: 8000 lph
3. 63 mm – PN 6: 14000 lph
4. 75 mm – PN 6: 21000 lph
5. 90 mm – PN 6: 32000 lph
6. 110 mm – PN 6: 44000 lph

Now, if discharge of a valve is 44000 lph and length of sub-main line is 600 m, then the sub-main will be telescoped as below:

OD 40 mm: (4000 lph/44000 lph) x 600 m = 54 m

OD 50 mm: (8000 lph/44000 lph) x (600 m – 54 m) = 100 m

OD 63 mm: (14000 lph/44000 lph) x {600 m – (54 m + 100 m)} = 140 m

OD 75 mm: (21000 lph/44000 lph) x {600 m – (54 m + 100 m + 140 m)} = 146 m

OD 90 mm: (32000 lph/44000 lph) x {600 m – (54 m + 100 m + 140 m + 146 m)} = 116 m

OD 110 mm: 600 m – (54 m + 100 m + 140 m + 146 m + 116 m) = 44 m

Procedure of Valve Sizing

$$Cv = \frac{Q}{\sqrt{\frac{\Delta P}{Sg}}}$$

Cv = Valve Flow Coefficient

Q = Flow Rate in GPM

ΔP = Pressure Drop = 1 PSI

Sg = Specific Gravity of Liquid

Example:

Q = 100 GPM

Sg = 1 for Water

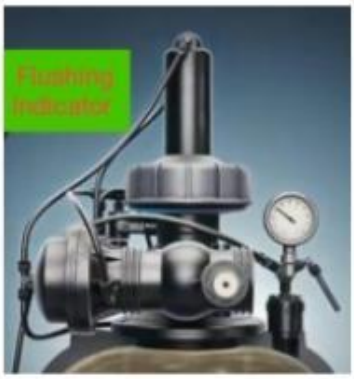
Cv = 100 GPM / √1 = 100

Cv Values - Valve Sizing Coefficients (US - GPM @ 1 PSI Δ P)									
Size	Flow in GPM @ 1 PSI Δ P @ Various Disc Angles								Full 90° Open
	10°	20°	30°	40°	50°	60°	70°	80°	
2	0.1	5	12	24	45	64	90	125	115
2 1/2	0.2	8	20	37	65	98	144	204	196
3	0.3	12	22	39	70	116	183	275	302
4	0.5	17	36	78	139	230	364	546	600
5	0.8	29	61	133	237	392	620	930	1,022
6	2	45	95	205	366	605	958	1,437	1,579
8	3	89	188	408	727	1,202	1,903	2,854	3,136
10	4	151	320	694	1,237	2,047	3,240	4,859	5,340
12	5	234	495	1,072	1,911	3,162	5,005	7,507	8,250
14	6	338	715	1,549	2,761	4,568	7,230	10,844	11,917
16	8	464	983	2,130	3,797	6,282	9,942	14,913	16,388
18	11	615	1,302	2,822	5,028	8,320	13,168	19,752	21,705
20	14	791	1,674	3,628	6,465	10,698	16,931	25,396	27,908
24	22	1,222	2,587	5,605	9,989	16,528	26,157	39,236	43,116

From the above calculated result, size of the valves should be 2” with full 90^{o} open

Working Principle of Automatic Auto-Flush Filters:

Dirt particles are retained and the cleaned medium reaches the filter outlet. When the dirt particles stucked in the filter screens, a differential pressure reaches a certain value at filter outlet as flow of water is resisted. A signal is transmitted from the differential pressure indicator to the control unit, which automatically triggers the backwashing process.



Working Principle of Semi-Automatic Auto-Flush Filters:

Dirt particles are retained and the cleaned medium reaches the filter outlet. When the dirt particles stucked in the filter screens, a differential pressure reaches a certain value at filter outlet as flow of water is resisted. An indication is viewed from the differential pressure indicator which moves to the upward to indicate the necessity of opening the flush valve for backwashing process. By seeing the movement of differential pressure indicator, flush valve is then opened manually.

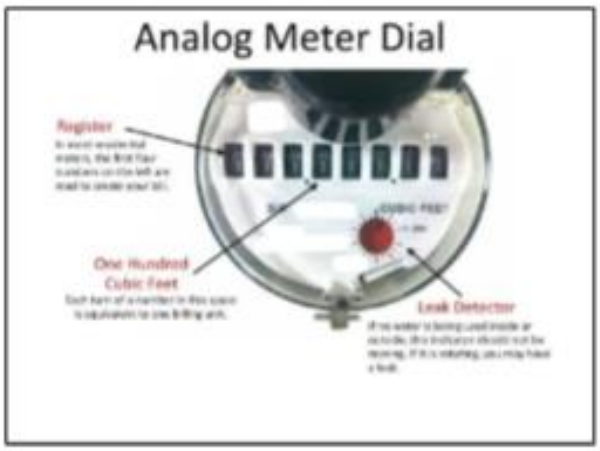
Use of Water Meter for Various Purposes

Procedure of Leak Detection through Water Meter:

In Water Meter, the Leak Indicator could be a small triangular shaped dial or a small wheel that rotates when water is flowing through the water meter.
These indicators are very sensitive and are useful in determining whether or not a plumbing leak may exist.

Below the steps to detect leakage in pipeline 👇

1. All the zone isolation valves are needed to be closed slowly.
2. No sprinkler system or any water tapping outlet should be in operation.
3. If water is not running to the sprinkler system or any other water tapping outlet and still the water meter indicates water is flowing, then there probably has a leak in the pipeline and plumbing work to be done accordingly.



Area coverage by irrigation system can also be checked with the use of water meter.

In water meter we can found how much water was flow through pipeline and from that data we can get the result about **Area Coverage** by putting **Height of Water Application** in the appropriate cell in spreadsheet.

Calculation Sheet for Checking Area Irrigated as per Flow of Water

Water Discharge Rate of Pump	0.2	LPS
Duration of System Operation	30	Minutes
Total Water Discharged through System / Day	360	Litre
Height of Water Application / Day	6.65	mm
Area Irrigated / Day	**54.14**	**m²**

*** 1 Litre = 0.001 m²**
*** 1 m² x 1 mm = 1 Litre Or, 1 m² = 1 Litre / 1 mm**

Water Meter to measure flow of water through pipeline

Battery Operated Electromagnetic Flow Meter

BERMAD | BERMAD Meters

The MUT2200 with MC406 is a battery powered electromagnetic water meter for use in district metering areas (DMA), water abstraction, and custody transfer measurement of potable water (M-001, OIML R49), irrigation, and many other applications. Unlike other water meters, the MUT2200 is a maintenance-free meter, offering a much wider range of flow, in a compact or remote mounted version. Thanks to the optimized flow profile, the MUT2200 can be installed virtually anywhere with minimal straight inlet or outlet runs. With optional pressure and temperature sensors, GSM/GPRS integrated modem and 12...24Vdc power source, the meter is the perfect solution for pressure management systems. The highly robust structure, allows burial installation or the use in flooded areas. A full on-site verification without process interruption can be carried out using the Field Verificator service tool

Applications

- District metering of potable water
- Distribution, municipal water
- Industrial waste water
- Industrial process liquids, muds and concretes
- Fiscal measures, custody transfer
- Irrigation
- Booster pump stations
- Lift stations

Key advantages

- No moving parts
- Neglectable pressure drop
- Long lasting stability and precision
- Zero maintenance
- Extremely sturdy structure
- High chemical resilience
- Wider range of measurement

AC Powered Electromagnetic Flow Meter

BERMAD | BERMAD Meters

The MUT2200 with MC608 is a mains powered electromagnetic water meter for use in district metering areas (DMA), water abstraction, and custody transfer measurement of potable water (OIML R49), irrigation, and many other applications. Unlike other water meters, the MUT2200 is a maintenance-free meter, offering a much wider range of flow, in a compact or remote mounted version. Thanks to the optimized flow profile, the MUT2200 can be installed virtually anywhere with minimal straight inlet or outlet runs. With optional pressure and temperature sensors, GSM/GPRS integrated modem and 12...24Vdc power source, the meter is the perfect solution for leak detection, and pressure management systems. The highly robust structure, allows burial installation or the use in flooded areas. A full on-site verification without process interruption can be carried out using the Field Verificator service tool.

Applications

- District metering of potable water
- Distribution, municipal water
- Industrial waste water
- Industrial process liquids, muds and concretes
- Leak detection and monitoring
- Fiscal measures, custody transfer
- Irrigation
- Booster pump stations
- Lift stations

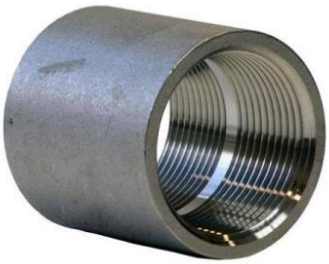
Key advantages

- No moving parts
- Neglectable pressure drop
- Long lasting stability and precision
- Zero maintenance
- Extremely sturdy structure
- High chemical resilience
- Wider range of measurement

TOOLS FOR CONNECTING THREADED, FLANGED & HOSE CONNECTIONS

FM Threaded Companion Flange

Threaded Bush



Threaded Socket

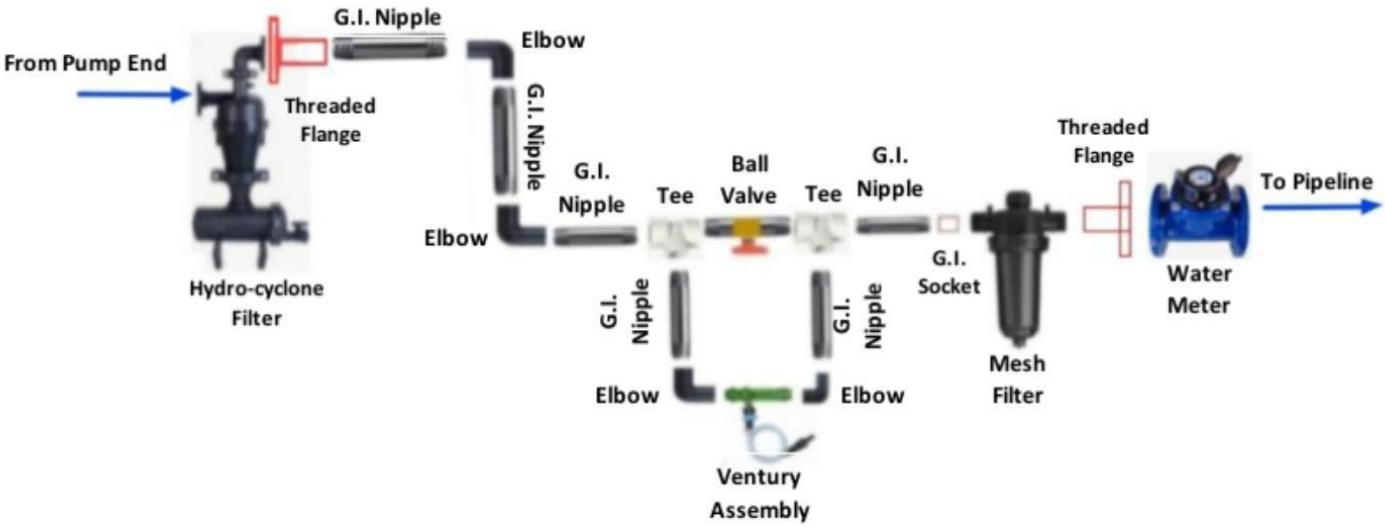
Nipple

Male Threaded Adaptor
(MTA)

QCV Cutaway

1" QCV

Connection Arrangement of Head Control Unit (HCU)



HEAD CONTROL UNIT FOR DRIP IRRIGATION SYSTEM

WELD-ON® SOLVENT CEMENT AVERAGE SET AND CURE TIMES

AVERAGE INITIAL SET SCHEDULE FOR WELD-ON® PVC/CPVC SOLVENT CEMENTS**

Temperature Range	Pipe Sizes ½" to 1¼" 20mm to 40mm	Pipe Sizes 1½" to 2" 50mm to 63mm	Pipe Sizes 2½" to 8" 75mm to 200mm	Pipe Sizes 10" to 15" 250mm to 380mm	Pipe Sizes 15"+ 380mm +
60°-100°F/16°-38°C	2 minutes	5 minutes	30 minutes	2 hours	4 hours
40°-60°F/5°-16°C	5 minutes	10 minutes	2 hours	8 hours	16 hours
0°-40°F/-18°-5°C	10 minutes	15 minutes	12 hours	24 hours	48 hours

Note - Initial set schedule is the necessary time to allow before the joint can be carefully handled. In damp or humid weather allow 50% more set time.

AVERAGE JOINT CURE SCHEDULE FOR WELD-ON PVC/CPVC SOLVENT CEMENTS**

Relative Humidity 60% or Less	Pipe Sizes ½" to 1¼" 20mm to 40mm		Pipe Sizes 1½" to 2" 50mm to 63mm		Pipe Sizes 2½" to 8" 75mm to 200mm		Pipe Sizes 10" to 15" 250mm to 380mm	Pipe Sizes 15"+ 380mm +
Temperature range during assembly and cure periods	up to 160 psi/ 11 Bar	160 to 370 psi/ 11 to 26 Bar	up to 160 psi/ 11 Bar	160 to 315 psi/ 11 to 22 Bar	up to 160 psi/ 11 Bar	160 to 315 psi/ 11 to 22 Bar	up to 100 psi/ 7 Bar	up to 100 psi/ 7 Bar
60°-100°F/16°-38°C	15 min	6 hrs	30 min	12 hrs	1½ hrs	24 hrs	48 hrs	72 hrs
40°-60°F/5°-16°C	20 min	12 hrs	45 min	24 hrs	4 hrs	48 hrs	96 hrs	6 days
0°-40°F/-18°-5°C	30 min	48 hrs	1 hour	96 hrs	72 hrs	8 days	8 days	14 days

Note - Joint cure schedule is the necessary time to allow before pressurizing system. In damp or humid weather allow 50% more cure time.

** These figures are estimates based on testing done under laboratory conditions. Field working conditions can vary significantly. This chart should be used as a general reference only.

AVERAGE NUMBER OF JOINTS/QUART (1Kg) OF WELD-ON CEMENT*

Pipe Diameters	½" 20mm	¾" 25mm	1" 32mm	1½" 50mm	2" 63mm	3" 90mm	4" 110mm	6" 160mm	8" 200mm	10" 250mm	12" 315mm	15" 380mm	18" 450mm
Number of Joints	300	200	125	90	60	40	30	10	5	2-3	1-2	¾	½

Note - **For Primer:** Double the number of joints shown for cement.

* These figures are estimates based on our laboratory tests. Due to the many variables in the field, these figures should be used as a general guide only. **Note: 1 Joint = 1 Socket**

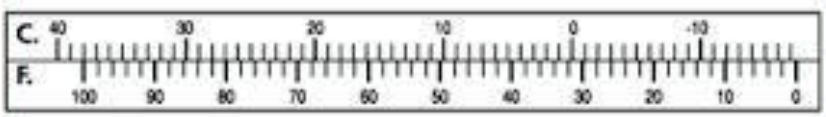
PIPE SIZE EQUIVALENT CHART - INCHES/MILLIMETERS

in.	½"	¾"	1"	1¼"	1½"	2"	2½"	3"	4"	6"	8"	10"	12"	14"	18"	24"	30"
mm.	20	25	32	40	50	63	75	90	110	160	200	250	315	355	450	600	800

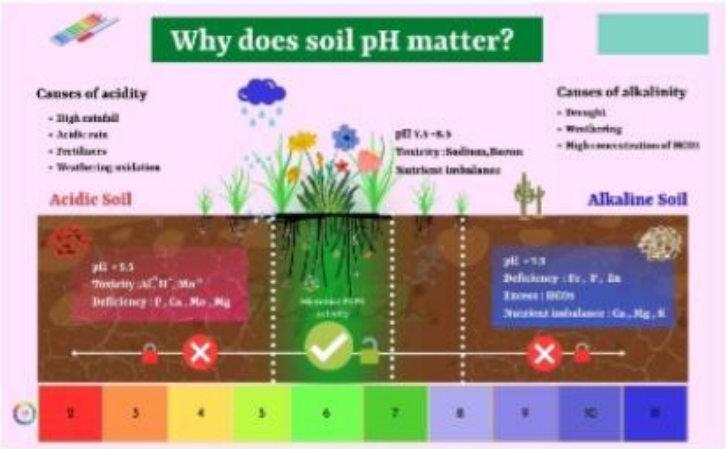
PRODUCT SHELF LIFE

Weld-On Products	Shelf-life
Primers / Cleaners	3 years
PVC Solvent Cement	3 years
CPVC Solvent Cement	2 years

FAHRENHEIT TO CELSIUS CONVERSION CHART



Acid Treatment for Drip Irrigation System



Before starting to discuss about Acid Treatment, we should be cultured about pH factor of soil. The range of **pH factor should be maintained within 6.5-7.5 for healthy growth of crops.**

Soil with pH>7.5 called as 'Alkaline Soil' and pH<5.5 called as 'Acidic Soil'.

Acid Treatment & Fertigation Injection are generally been done by Ventury Assembly. Suction of liquids is achieved by occurring pressure difference inside Ventury.

Method of Acid Treatment: Most commonly used acid for Acid Treatment in Drip Irrigation System is Hydrochloric acid (HCl). By closing the throttle valve allow the acid to get mixed with the irrigation water, check the pH of the Acidulated water at the nearest dripper and adjust the throttle valve, if the pH is less than 5.5, then decrease the acid suction rate by slightly opening the throttle valve so that more water can be mixed with soil without of any acid.

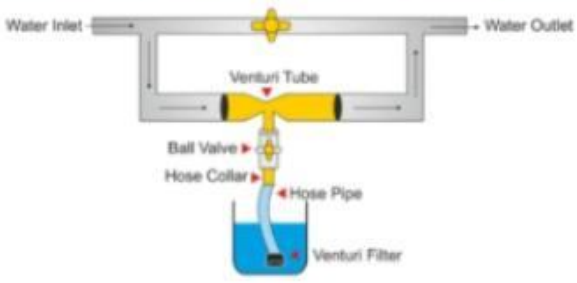
If the pH of soil is more than 7.5, then increase the acid suction rate by slightly closing the throttle valve to mix more acid with flown water through pipeline.

Suppose, injection rate is 20% of flow rate of 200 litre per hour and required acid to mix about 40 litre to get neutralized soil (i.e. pH 6.5-7.5) then the calculation should be as follows:

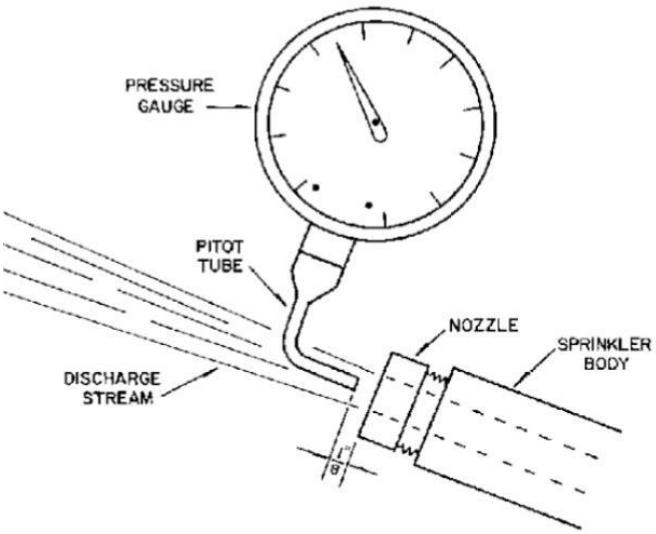
- **Acid injection rate through Ventury: 200 litre per hour x 0.2 = 40 litre per hour.**

Hence, the acid treatment should be done for an hour to decrease the pH factor within specified limit.

Note: Acid to mix with Water not Water to mix with Acid because If we add water to acid it will be exothermic reaction which will produce a lot of heat and If we add acid to water, the solution that forms is very dilute and the small amount of heat released is not enough to vaporize and spatter it.



Instruments for Measuring Different Parameters

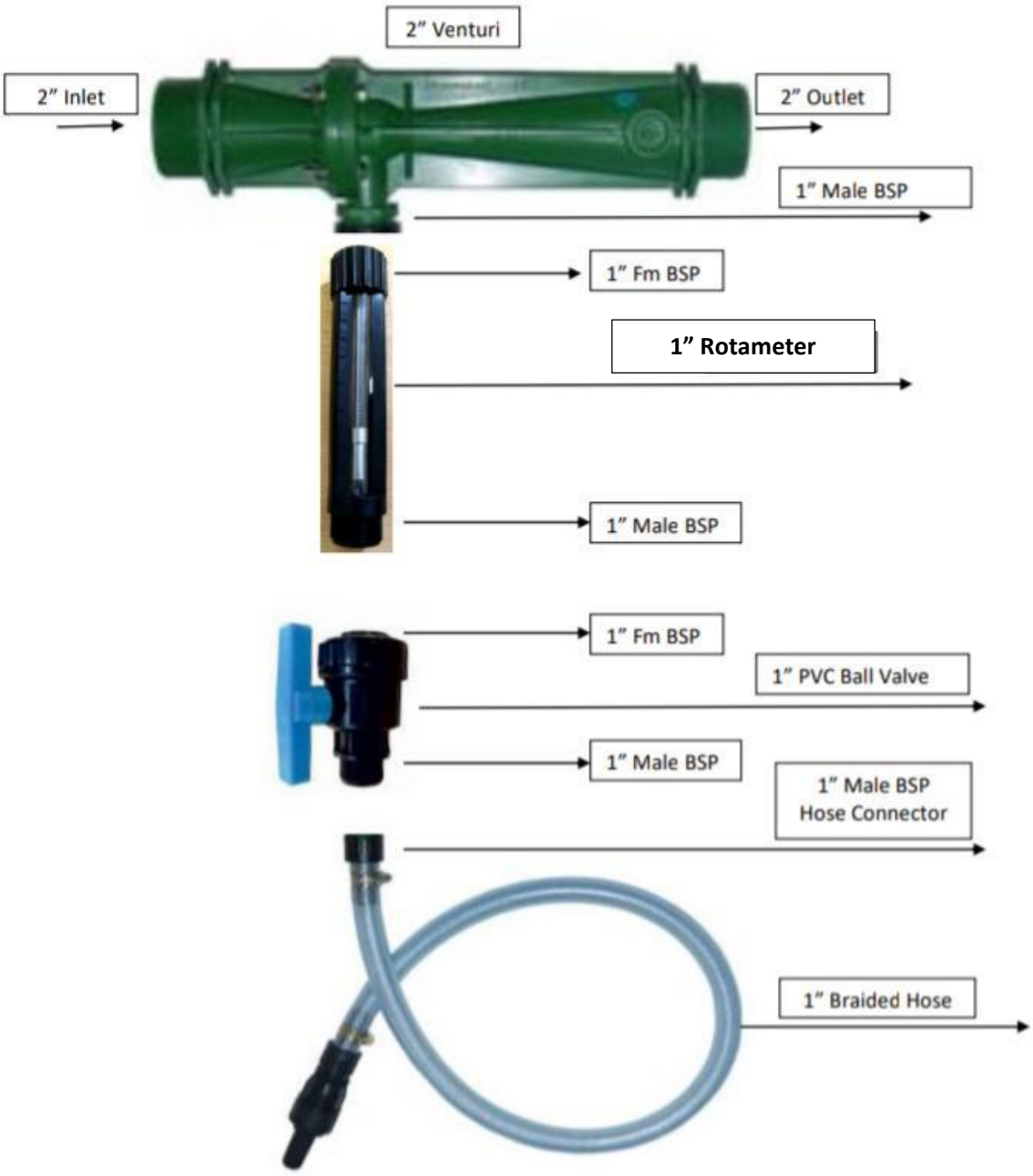


Pitot Tube: Pitot tubes were invented by Henri Pitot in 1732 **to measure the flowing velocity of fluids**. Basically a differential pressure (d/p) flow meter, a pitot tube measures two pressures: the static and the total impact pressure.

Pressure Gauge is generally used to measure Pressure generated by fluid at any point. For irrigation systems, pressure gauges are fitted to various positions i.e. pump, Ventury inlet and outlet, starting point of mainline, inlet points of Zone-isolation valves etc.

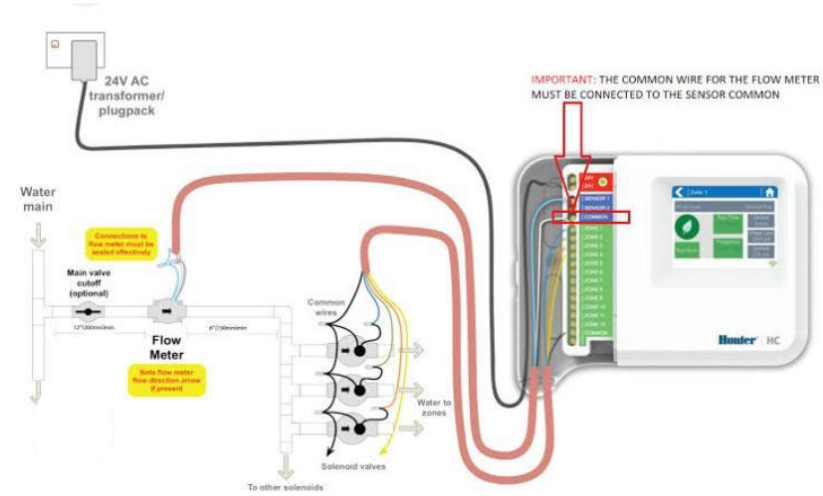
Pressure Gauges should be filled with glycerine to prevent pointer flutter, fogging window.

Ventury with Rotameter



A Rotameter (variable area flow meter) is a flow meter that measures the volumetric flow of liquids and gases. There is no difference between a Rotameter and a flow meter, and these terms are interchangeable.

Flow Sensors



With wire based automation systems, wires coming from flow sensor to be connected with sensor port marked in wire based irrigation controller.

With wireless automation systems, an extra Solar Powered Remote Terminal Unit (RTU) help the flow sensor to transfer recorded information to wireless irrigation controller. In that case, channel number of the mentioned RTU to be paired with wireless irrigation controller.

Flow sensors can be installed in various points of piping network. Flow sensors are used to record data of water usage and also detect leaks in pipeline.

Water Tap Timer for Home Gardening

Just set irrigation schedule in the timer and forget worry about manual operation!

TAP TIMER

AMICO+

AMICO 2+

Applications : Amico+ ™ Taptimer has been studied to be the most userfriendly and a high quality produa in the market. Programming has never been so easy, the large display 3" allows to see all the data in one look. The backlit display and the large characters allow to program the controller during the day and the night.

Applications : Amico 2+ TM Tap timer has been studied to be the most user friendly and a high quality product in the market. Using the same programming of Amico+, Amico 2+ allows to set 2 different valves completely independent. The backlit display allows to program the controller during the day and the night without problems.

Features

- 1 program.
- Run time min/max: 1/240 minutes.
- Watering frequenry: from every 6 hours up to once 15 days.
- Current time indication.
- Start time indication.
- Duration of watering indication.
- Frequency indication.
- Next irrigation indication.
- Watering countdown.
- Low battery function.

1.Removable Control Unit

3.3" Backlit Lcd Display

5.Start Time

2.Easy Readable Screen Position

4.Programming Bottons

6.Duration

7.Frequency

3 PROGRAM WITH 3 SIMPLE STEPS.

1 START TIME 2 DURATION 3 FREQUENCY

Specifications

- 1 Zone (Amico+) & 2 Zone (Amico 2+)
- Inlet thread ¾"-1 "
- Outlet thread ¾"
- Max working pressure 8 bars
- Max flow 40 l/m
- Diaphragm 9 VDC electric valve
- Removable control unit
- ABS Body
- Hard plastic cover for LCD display protection
- Wide backlit 3" LCD display
- Powered by 2 alkaline 1.5 volt (AA)

E-mail: contactus@automatworld.com
Website: www.automatworld.com

Creating a Green World

Parallel & Series Connected Filtration Units

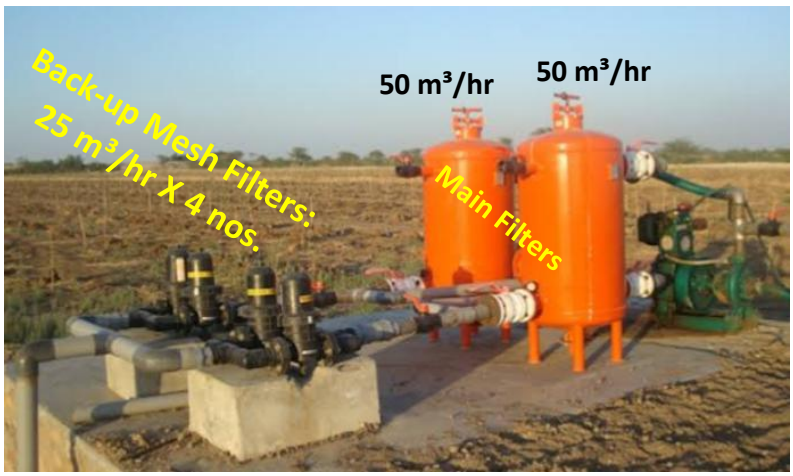


Fig.1

Parallel Connection of Main & Back-up Filters to Reduce Pressure Requirement for operation

In Fig.1, we have seen that 2 nos. of main filter of capacity 50 m^3/hr each are connected in parallel and 4 nos. of back-up filter of capacity 25 m^3/hr each are also connected in parallel to reduce requirement of pressure (head) for smooth operation.

In this case, required system capacity = 2 nos. x 50 m^3/hr = 4 nos. x 25 m^3/hr = 100 m^3/hr.

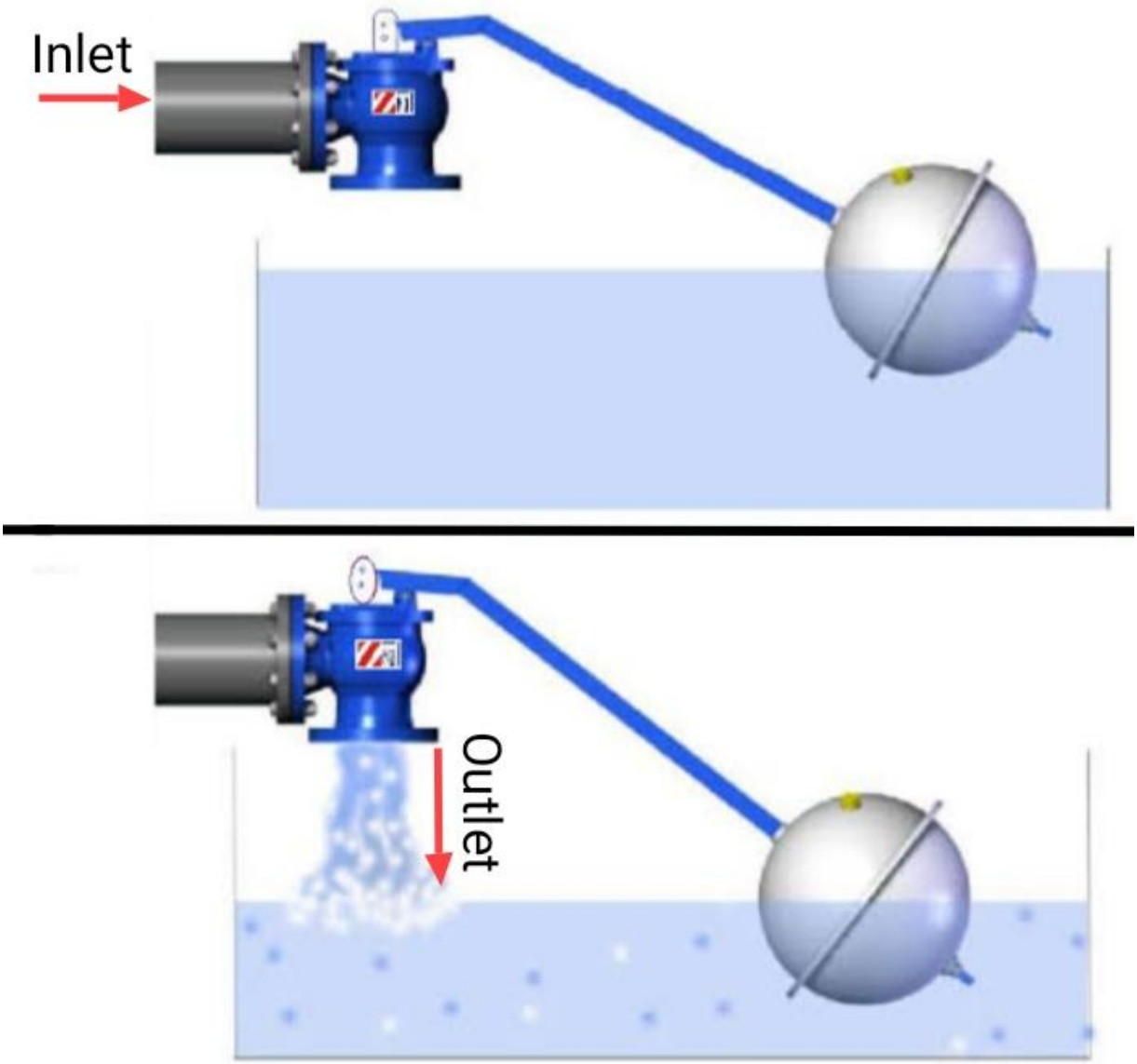
Series connection of filtration units should not be recommended due to high pressure (head) requirement.

Many of cases where capacity of main filters are matched with capacity of back-up filters, there two nos. of parallely connected main filters can be connected with two nos. of parallely connected back-up filters (See Fig.2).

Fig.2

Operation of Float Valves for Gravity Feed Systems

Float Valves are generally used for gravity feed water conveyance systems. The float valve aims at keeping on a determined level the stretch of water in a water tank. It is set up on the supply pipe at the bottom. It opens when the water tank goes down below the chosen level and closes progressively whenever the maximal level is reached.



Design Solution #1

Problem:

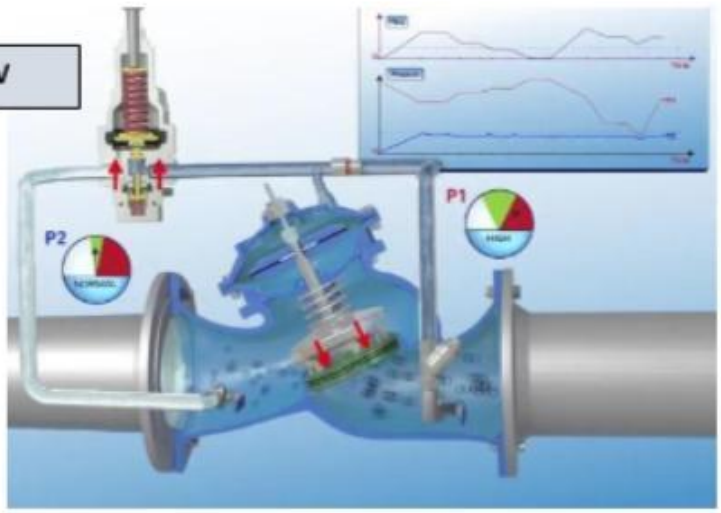
Suppose a two hectare plot is covered with different crops and for one hectare area sprinkler irrigation system to be installed which requires a flow rate of 15000 litre per hour at 40 metres head. For the next one hectare area drip irrigation system to be installed which requires much lower flow rate of 10000 litre per hour at 25 metres head. Now if the two systems to be run by a single pump set and the mentioned two systems to be run at a time then what should be the design plan for mainline installation?

- To begin with the design plan for mainline installation, we need to understand the working principle of '**Pressure Reducing Valve**' by which higher inlet pressure can be reduced to lower outlet pressure with constant flow rate at the outlet.
  Performance capacity of the Pump should be as 15000 LPH at 40 m + Suction Head (in m).

  Now in this case as the mentioned two systems (i.e. sprinkler & drip irrigation systems) to be run at a time hence the propose mainline should be '**Telescopic**' i.e. Higher diameter of mainline to get higher flow rate for the mentioned sprinkler irrigation system and then the diameter of the mentioned mainline to be reduced by the use of a **Reducer** which should be proposed for the mentioned drip irrigation system requires much lower flow rate.
  Also a '**Pressure Reducing Valve**' to be installed after ending of mainline under sprinkler irrigation system.
  Sizing of the mentioned telescopic mainline to be calculated as per norms by considering system-wise required flow rate and head.

  Telescopic Mainline Internal Diameters Calculation:
  Flow Rate of 15000 litre per hour at a required head of 40 metres (for sprinkler irrigation system); Pipe ID for mainline?
  Flow Rate of 10000 litre per hour at a required head of 25 metres (for drip irrigation system); Pipe ID for mainline?

Operation of PRV



Design Solution #2

For the above mentioned plot if the mentioned two different systems to be run separately then what should be the design plan for mainline installation?

- Performance capacity of the Pump should be as 15000 LPH at 40 m + Suction Head (in m) by considering maximum required capacity.

Now in this case as the mentioned two systems (i.e. sprinkler & drip irrigation systems) to be run at two different times hence the propose mainline should be '**Telescopic**' i.e. Higher diameter of mainline to get higher flow rate for the mentioned sprinkler irrigation system and then the diameter of the mentioned mainline to be reduced by the use of a **Reducer** which should be proposed for the mentioned drip irrigation system requires much lower flow rate.
Also a '**Pressure Reducing Valve**' to be installed after ending of mainline under sprinkler irrigation system.
Sizing of the mentioned telescopic mainline to be calculated as per norms by considering system-wise required flow rate and head.
Two nos. of Zone-isolation valves are required for different zones (Zone 1 for sprinkler irrigation system & Zone 2 for drip irrigation system) and also a water by-pass assembly (consists of a Reducer Tee, an Elbow and a Valve).
The excess amount of water (the mentioned pump provides) to be returned to water source by the use of 'by-pass assembly' when drip irrigation system will be operating with lower required flow rate.
The valve of the mentioned 'by-pass assembly' to be closed when sprinkler irrigation system will be operating which requires designed maximum capacity of pump.

Telescopic Mainline Internal Diameters Calculation:
Flow Rate of 15000 litre per hour at a required head of 40 metres (for sprinkler irrigation system); Pipe ID for mainline?
Flow Rate of 10000 litre per hour at a required head of 25 metres (for drip irrigation system); Pipe ID for mainline?

Valve Sizing Calculation Procedure for the mentioned By-pass Assembly:

$$Cv = \frac{Q}{\sqrt{\frac{\Delta P}{Sg}}}$$

Cv = Valve Flow Coefficient

Q = Flow Rate in GPM

ΔP = Pressure Drop = 1 PSI

Sg = Specific Gravity of Liquid

Cv Values - Valve Sizing Coefficients (US - GPM @ 1 PSI Δ P)									
Size	Flow in GPM @ 1 PSI Δ P @ Various Disc Angles								Full 90° Open
	15°	20°	30°	45°	60°	70°	75°	90°	
2	0.1	5	12	24	45	64	90	125	115
2 1/2	0.2	8	20	37	69	98	144	204	185
3	0.3	12	22	39	70	118	193	279	302
4	0.5	17	36	78	139	230	364	546	600
5	0.6	28	61	133	237	360	625	930	1,020
6	2	46	90	205	366	605	958	1,437	1,579
8	3	88	166	439	727	1,232	1,803	2,854	3,138
10	4	151	320	694	1,237	2,047	3,240	4,959	5,340
12	5	234	495	1,072	1,911	3,152	5,009	7,507	8,350
14	8	336	719	1,546	2,751	4,566	7,230	10,844	11,917
16	8	464	983	2,130	3,797	6,292	9,842	14,913	16,380
18	11	615	1,302	2,822	5,029	8,321	13,168	19,752	21,700
20	14	791	1,674	3,629	6,465	10,698	16,931	25,396	27,906
24	22	1,222	2,587	5,605	9,988	16,529	26,157	39,236	43,116

Why it is suggested to electric technicians to use coil wires at the controller and valves?

Answer: The advantage of using wires in coil shape at irrigation controllers & solenoid valves is that it increases the strength of the magnetic field produced by a given current. The magnetic fields generated by the separate turns of wire all pass through the center of the coil and add (superpose) to produce a strong field there.

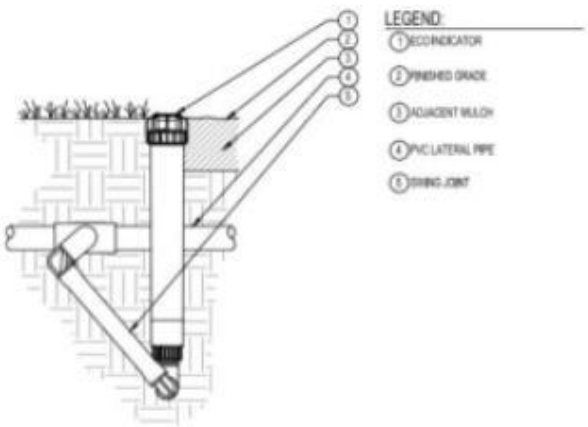
Higher magnetic field ∝ Higher current flow rate

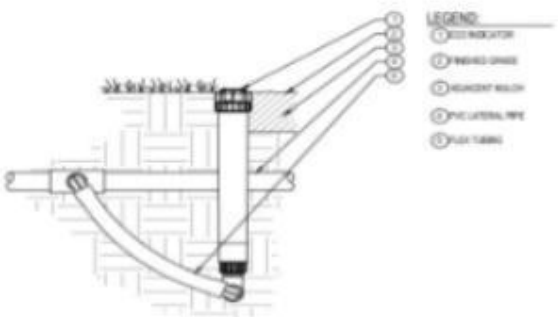
Wires at Controller

Wires at Valves

Procedure and Tool for Checking Operation of Sub-surface Drip

Hunter make **Eco-indicator** is a special pop-up indicator which pops up from sub-surface when water flows through pressurized pipeline and it indicates that Drip Irrigation System is properly running. When drip system is not running then piston of the Eco-indicator goes down into protected place which is beneath the surface level. **It is always better to install Two nos. of Eco-indicator at both ends of a pipeline to evidence water is flowing in all directions of that pressurized pipeline. #SDI**





Advantage of Using Flanged Valves

While preparing BOQ for an irrigation system, it is always advisable to mention 'Flanged-end' valves in place of 'Threaded-end' valves as because if the valves get damaged or to be replaced for some another reason then the 'Flanged-end' valves can be unfastened easily as there is a bolted joint but to bring out 'Threaded-end' valves, the connecting pipeline arrangements would be disturbed to move.

Flanged-end Valve with Bolted Joints

'Threaded-end' valves are CHEAPER than 'Flanged-end' valves but INAPPROPRIATE for smooth handling.

Some Important Abbreviations related to Automatic Irrigation Systems

AR: Application Rate
AVRV: Air & Vacuum Relief Valve
BHP: Brake Horse Power
Bicoder: Binary Decoder
CDU: Coefficient of Distribution Uniformity
Cv: Valve Flow Coefficient
CVT: Constant Voltage Transformer
DBC: Direct Burial Cable
DF: Disc Filter
DR: Dimension Ratio (Outside Dia of pipe:Wall Thickness of pipe)
DU: Distribution Uniformity
ESCR: Environmental Stress Cracking Resistance
ET: Evapo-Transpiration
ETc: Evapo-Transpiration of Crop
GPH: Gallon Per Hour
GPM: Gallon Per Minute
HCF: Hydro-cyclone Filter
HCU: Head Control Unit
HP: Horse Power
Kc: Crop Coefficient
LPH: Litre Per Hour
LPM: Litre Per Minute
LPS: Litre Per Second
MF: Mesh Filter
NPSHa: Net Positive Suction Head available
NPSHr: Net Positive Suction Head required (For any pump operation, NPSHa>NPSHr)
PR: Precipitation Rate
PRS: Pressure Reducing Stations
PRV: Pressure Reducing Valve
PVC: Poly Vinyl Chloride
RL: Reference Level
RTU: Remote Terminal Unit
RV: Relief Valve or Pressure Relief Valve
SDR: Standard Dimension Ratio
SF: Sand Filter
TDH: Total Dynamic Head
VAC: Volt-Alternating Current
VDC: Volt-Direct Current
VFD: Variable Frequency Drive

Product Description	Manufacturer
1" - 2" Solenoid Valves with Threaded End Connection	Rainbird
2" - 3" Solenoid Valves with Threaded End Connection	Bermad
3",4",6" Solenoid Valves with Flanged End Connection	Bermad
2" - 8" Kinetic Air Valves	Armas
Double Acting Air Valves	Armas
2"-25 m^3/h to 8"-180 m^3/h Automatic Auto-flush Screen Filters	Armas
Single Station to Six Station Field Decoders	Rainbird
Greenhouse Climate (Temperature, Relative Humidity etc.) Controllers with PC Software	Galcon made Galileo Controller
Multi-wire Controllers	Hunter, Rainbird
Two-wire Decoder Controllers	Hunter, Rainbird
Wireless IOT based RTU Controllers with RTU and Related Accessories	IRRIOT
Two-wire Burial Cable (Two-conductor Cable)	Paige Electric
Decoder Cable Fuse Device	Paige Electric
Single Conductor Copper Cable	Havells
Constant Voltage Transformer (CVT)	Servokon, Any Reputed make
Rain Sensor, Soil Moisture Sensor	Hunter, Rainbird
Mini Weather Station to Sense Rain, Wind Speed & Freeze for Automatic Shut-down & Start Irrigation Schedule	Hunter
Decoder System Line Surge Protection (LSP-1) An LSP-1 must be installed and grounded every 500 feet and at the end of a decoder wire Run	Rainbird
Earthing Unit for Multi-wire Automation Systems	Any Reputed make
Water Level Guard Meter for Automatic ON/OFF of Pumps	Any Reputed make
Hydro-pneumatic pumps to distribute water at a consistent pressure to all outlets on all floors	Any Reputed make
Battery Operated & AC Powered Electromagnetic Water Flow Meters	Bermad
Mechanical Water Flow Meters	Aquamet Woltman
Pressure Reducing Valves to Lower Residual Pressure at Outlet from Higher Inlet Pressure	Bermad
Pressure Relief Valve or Relief Valve	Any Reputed make
CCTV Camera with App based Software to Monitor Growth of Crops inside Greenhouse	Any Reputed make

About the author:

Er. Piyal Mitra (Talks about Irrigation Automation)

| Author: Document on Automatic Irrigation & Climate Control Systems with Understanding of Designs | Micro Irrigation | Dust Suppression | Greenhouse Climate Control | Fogger | CAD | BOQ | Estimation | DPR | PPT | 💧💦🌿

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System Designer

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1. Landscape irrigation system
2. Sports-field irrigation system
3. Micro irrigation system
4. Drip irrigation system
5. Portable & Fixed irrigation systems
6. Temperature & Relative Humidity Control system with Foggers
7. Dust suppression system
8. Gravity fed system
9. Lift irrigation system
10. Roof-Top cooling system
11. Flood irrigation system
12. Water conveyance system
13. Pump capacity calculation
14. Running and operational cost analysis
15. Product performance comparison
16. Wire selection
17. Multi-wire based automation system
18. Two-wire decoder based automation system
19. Wireless irrigation automation
20. Reservoir size calculation based on water holding capacity