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CONCEPTS OF DRIP IRRIGATION: TYPES, DESIGN, ASSESSMENT, IMPLEMENTATION AND OPERATION

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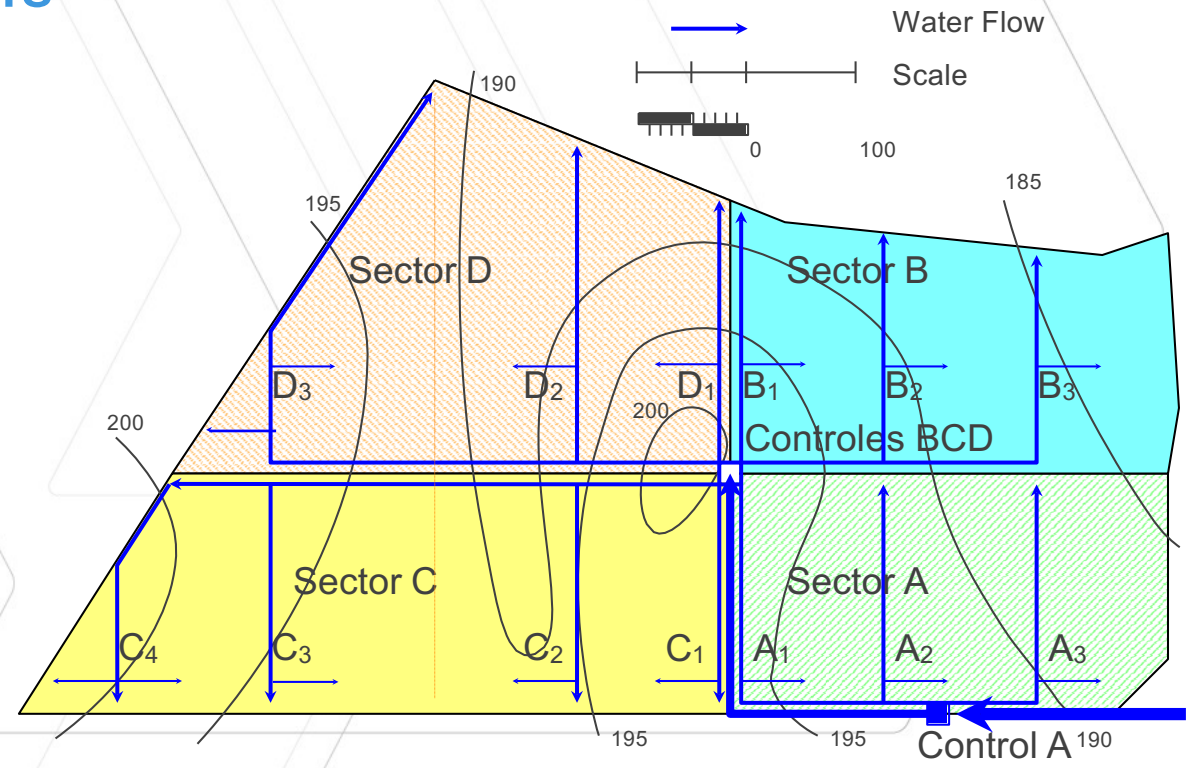
DRIP IRRIGATION SYSTEMS

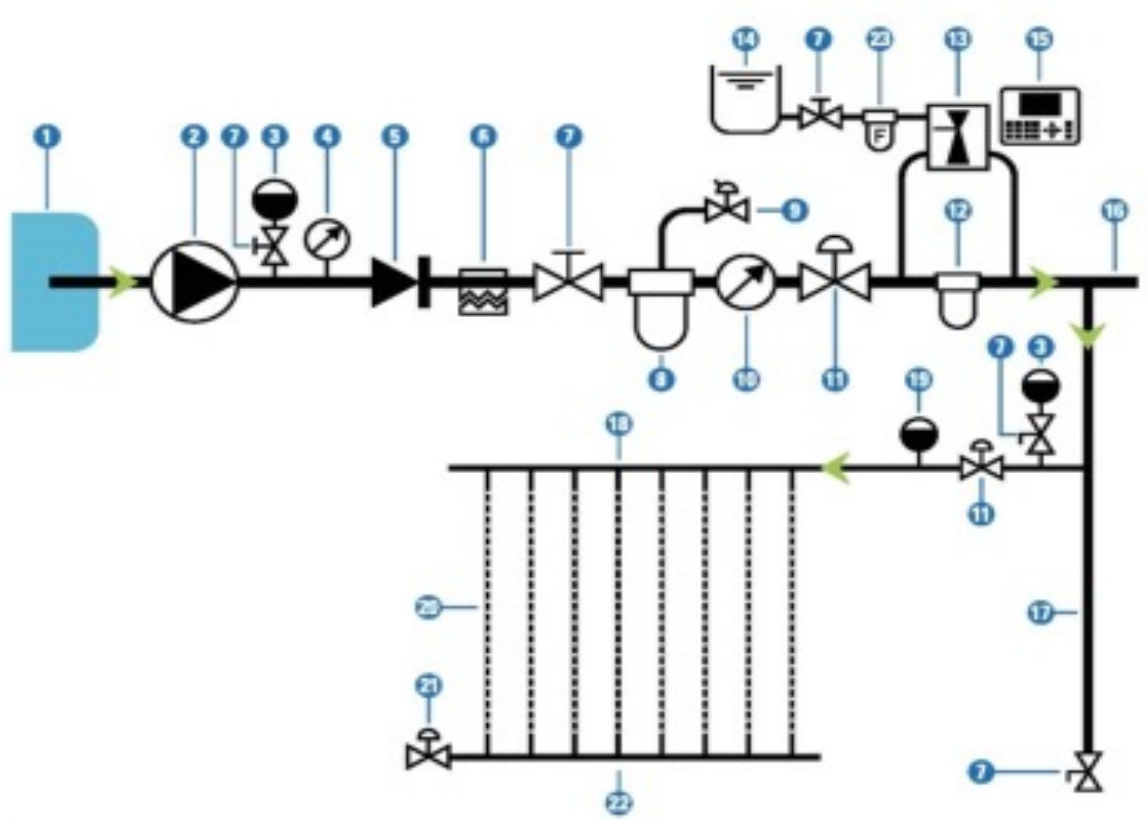
- It is slow and frequent application of water to the soils through emitters distributed along a pipe.
- These emitters dissipate or lose pressure by means of long or tortuous orifices, vortices, or flow paths.
- Therefore, the volume of water is limited and the flow rates small.
- The emitters are placed on the surface, although they can also be buried.
- The water in the soil moves in subsaturation.

DRIP IRRIGATION SYSTEMS

- Drip irrigation systems are organized in relatively small irrigation units that are grouped in irrigation sectors



DRIP IRRIGATION SYSTEMS



1. Water source
2. Pumping station
3. Air valve
4. Pressure gauge
5. Check valve
6. Shock absorber
7. Manual valve
8. Main filtration unit
9. Main filtration automatic drainage valve
10. Water meter
11. Hydraulic valve
12. Secondary filtration unit
13. Dosing unit
14. Fertilizer tank
15. Irrigation controller
16. Main line
17. Sub main line
18. Distribution line
19. Kinetic valve (vacuum breaker)
20. Dripperline
21. Flushing valve
22. Flushing manifold
23. Fertilizer filter

FILTRATION – HYDROCYCLONE SAND SEPARATORS

- When sand particle concentration ranges between 2 and 20 ppm a centrifugal sand separator can be instaled.
- Vortex action forces sand to fall into the sedimentation tank.
- They must be followed by an appropiate filter.

FILTRATION – SAND FILTERS

- Use a pressure differential to force water through a sand media.
- Generally they incorporate a backflush system. At least two filters in parallel are needed.
- They are mainly required for low quality water (algae, suspendend sediments or organic mater)

FILTRATION – SCREEN FILTERS

- The water passes through a fine mesh.
- They are classified based on a mesh size.
- Mesh number means the number of slots per inch.
- Drip irrigation manufacturers specify a mesh size required for each emitter.

FILTRATION – DISC FILTERS

- Utilize stacks of shaped discs that capture sediment between the discs.
- During filtration, the stack of discs is compressed together but during the backflush cycle, the stack is loosened as backflush water in the opposite direction through the discs.
- The backflush water and sediment are discharged from the filter to a discharge pipe.

TYPES OF DRIP EMITTERS

- Drip emitters dissipate energy and discharge a small flow as discrete drops.
- Flow range 2 - 8 L/h. Pressure 0.5 - 2.5 bar
- The hydraulic relationship between flow and pressure depends on the type of emitter and follows this equation:

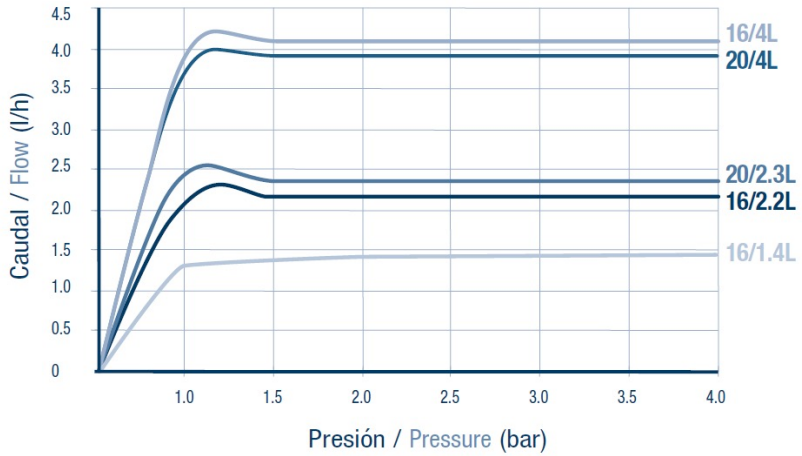
$$q = k \cdot h^x$$

Where q is the emitter discharge, h is the operating pressure, k is the emitter discharge coefficient and x is the emitter discharge exponent.

TYPES OF DRIP EMITTERS

- According to the x exponent, emitters can be classified in:
  - Laminar flow emitters. X=1. Are long narrow tubes and energy is dissipated in the tube.
  - Turbulent emitters. X=0.57. Dissipate energy in turbulent eddies in tortuous paths with the emitter.
  - Orifice emitters. X=0.5. Dissipate energy in a single extremely small orifice.
  - Vortex emitters. X=0.4. Similar to orifice emitters but water passed through one turbulent eddy before exiting the orifice.
  - Pressure compensating emitters. X=0. They have a diaphragm that closes as pressure increases. They have no change of flow over a range of pressures.

PRESSURE COMPENSATING EMITTERS

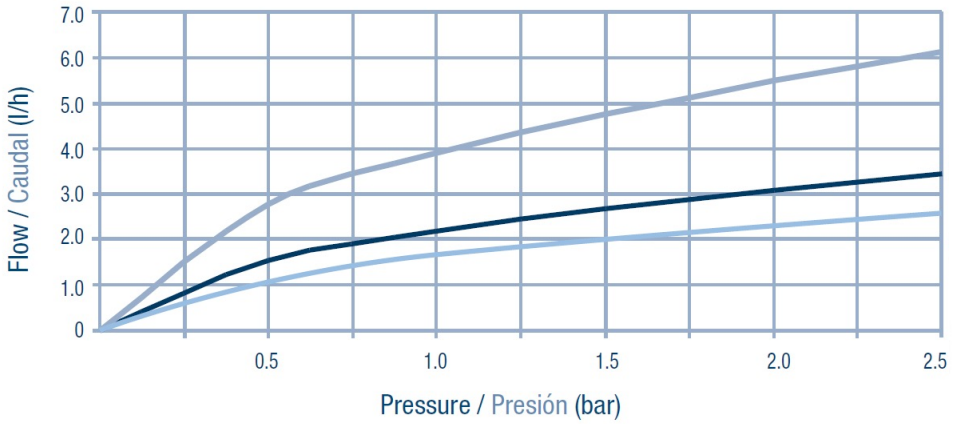


Tubería multiestacional Multi-seasonal dripline	AZUD PC-SYSTEM				
	16			20	
	1.4L	2.2L	4L	2.3L	4L
Espesor nominal (mm) Nominal thickness	0.9 - 1.0			1.2	
Diámetro interior (mm) Inner diameter	13.6			17.0	
Caudal nominal (l/h) Nominal flow	1.4	2.2	4	2.3	4
Intervalo de presión autocompensación (bar) Pressure-compensation interval	1.0 - 4.0				

Se recomienda filtración por discos ≤130 micron
Disc filtration recommended ≤130 micron

ISO 9261

TURBULENT EMITTERS

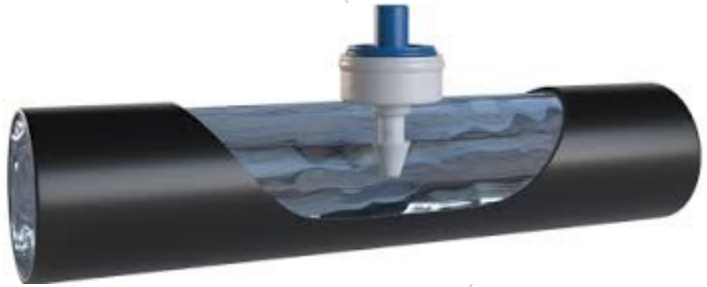


Multi-seasonal dripline Tubería multiestacional		AZUD DRIP				
		16			20	
		1.6L	2.2L	4L	2.2L	3.4L
Nominal thickness (mm) Espesor nominal		0.9 - 1.0			1.2	
Inner diameter (mm) Diámetro interior		13.6			17	
Nominal flow (l/h) Caudal nominal		1.6	2.2	4.0	2.2	3.4
$q = K \cdot h^x$	K	0.49	0.73	1.34	0.64	1.04
q (l/h) - h (mca)	x	0.52	0.47	0.47	0.53	0.51

ISO 9261
Maximun pressure: 3 - 3,5 - 4 bar according to thickness
Disc filtration recommended ≤ 130 micron
Presión máxima: 3 - 3,5 - 4 bar segun espesor
Se recomienda filtración por discos ≤ 130 micron

TYPES OF DRIP EMITTERS

- On-line dripper. Emitter intended for installation in the wall of an irrigation lateral, either directly or indirectly by means such as tubing



- In-line dripper. Emitters manufactured into the tubing wall or injection molded emitters.

LATERALS DESIGN

- The difference of pressure in the lateral

$$H_o = H_L + hf_L + \Delta Z_L$$

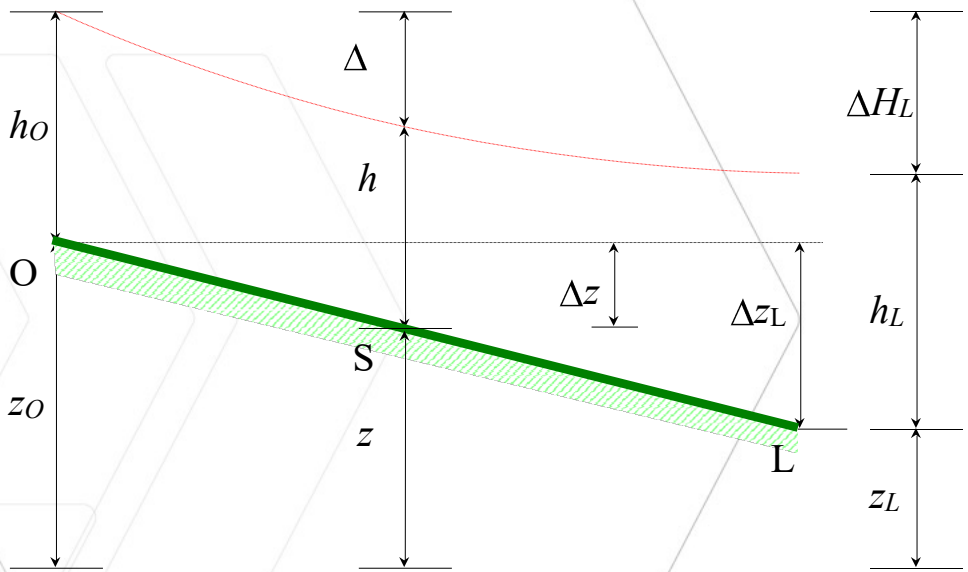
Where

H_o **is the pressure at the begining**

H_L **is the pressure in the last emitter**

hf_L **represents the energy friction losses in the lateral**

ΔZ_L **is the difference in elevation**



LATERALS DESIGN

- *Energy friction losses in the lateral*

$$hf_L = hf \cdot F$$

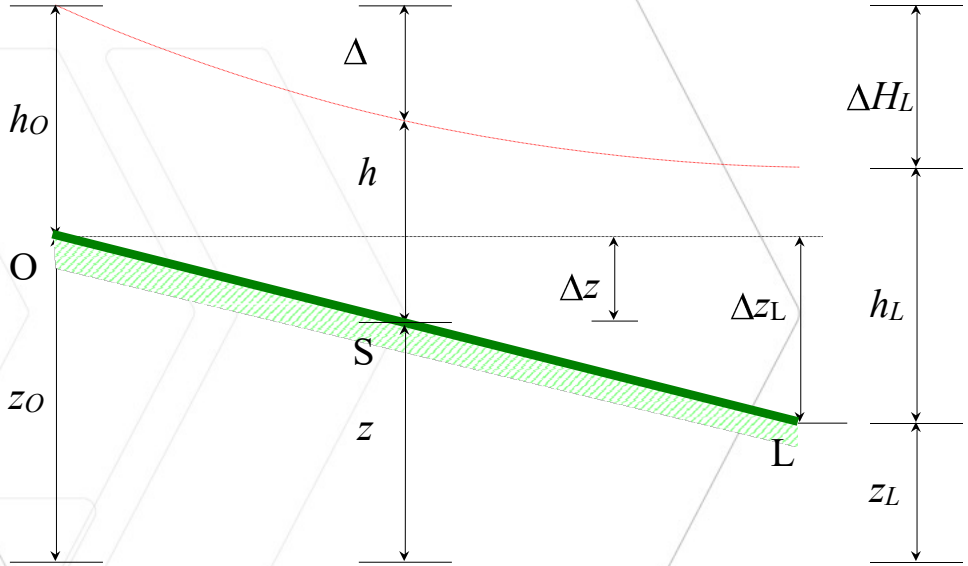
Where

hf are the friction losses in a fully flowing pipe

F is the Christiansen's friction factor

$$F = \frac{1}{m+1} + \frac{1}{2 \cdot N} + \frac{(m-1)^{0.5}}{6 \cdot N^2}$$

being N the number of emitters and m the exponent of the friction losses equation (2 in case of Darcy – Weisbach)



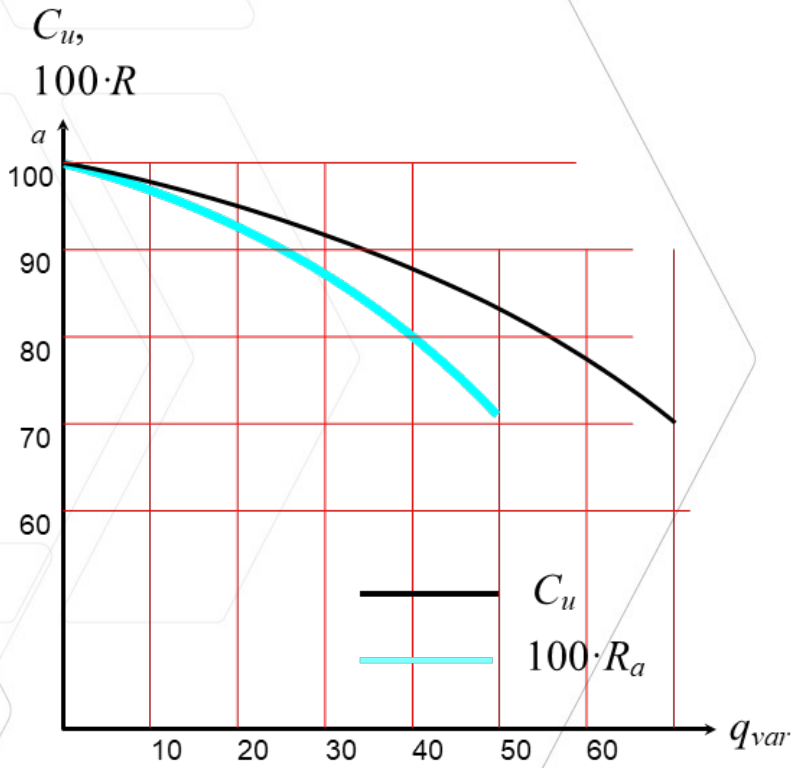
LATERALS DESIGN

$$q = k \cdot h^x$$

- *It is possible to estimate the maximum (qM) and the minumum Flow of the emitters (qm)*

$$q_{var} = \frac{q_M - q_m}{q_M} \cdot 100$$

- *Recommendations:*

Max qvar of 20% in the irrigation unit (CU=95%)

Min qvar of 10% in the lateral (CU=97.5%)