

IRRIGAÇÃO POR GOTEJAMENTO

Prof. Rubens Coelho

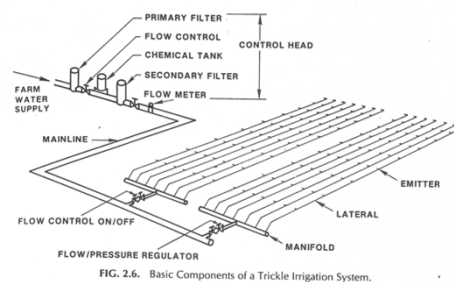
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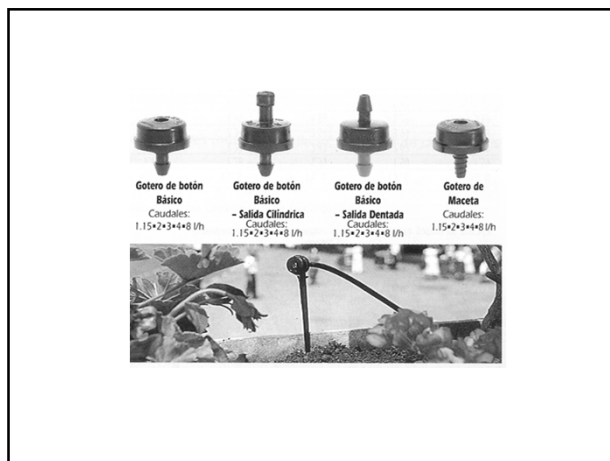
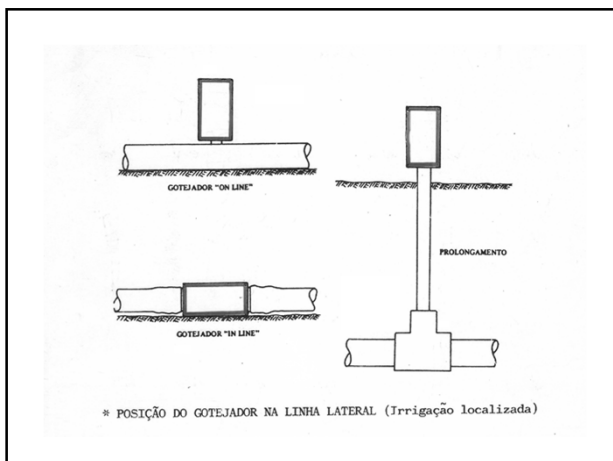
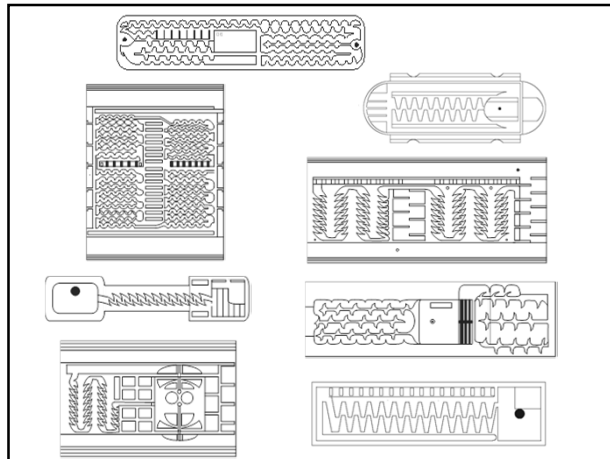
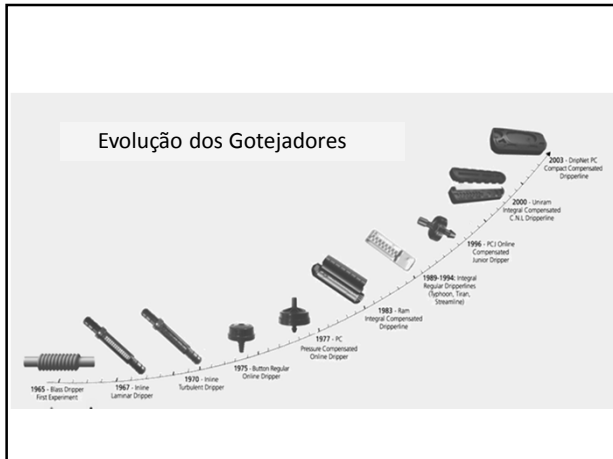
Gotejamento / Microaspersão

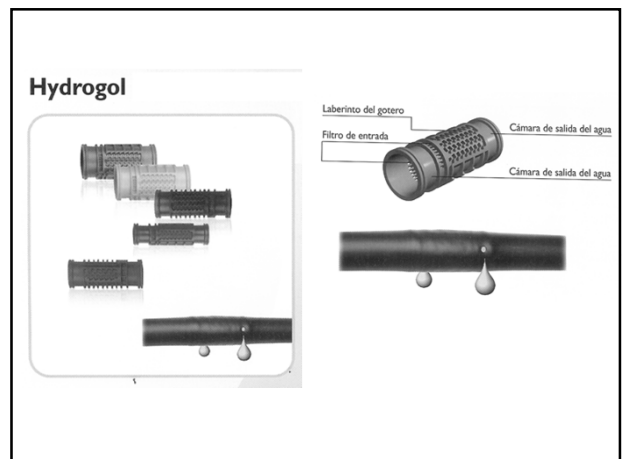
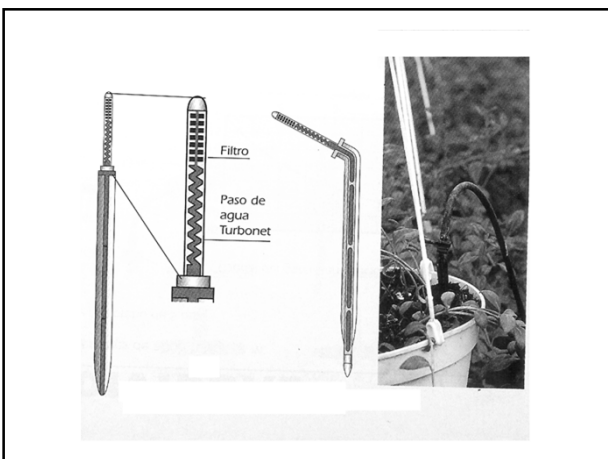
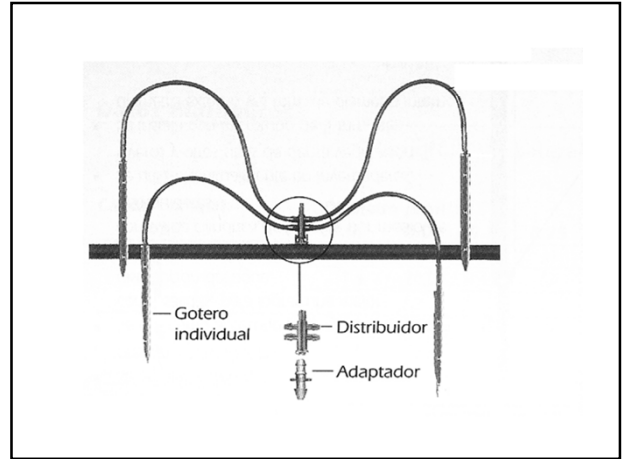
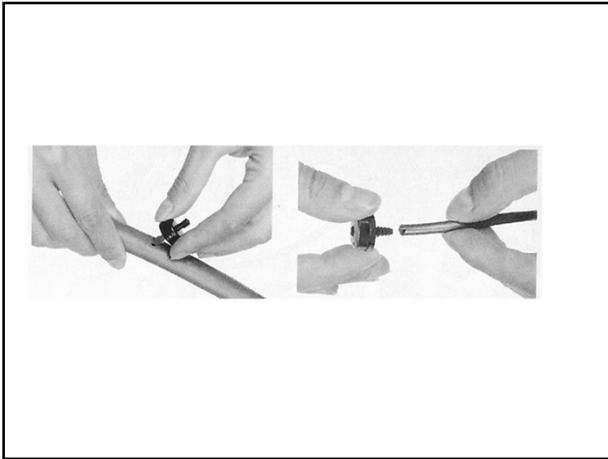
- Equipamentos de Maior Potencial Teórico
Eficiência de Uso da Água
- Desenvolvimento Inicial Israel / EUA
Áreas pequenas 5 – 100 ha
Alta qualificação profissional
Recursos Hídricos Escassos

Gotejamento / Micro : Brasil

- Projetos : 1 – 6.000 ha
- Qualificação profissional - Variável
- Manutenção Preventiva - Essencial
- Pós-Venda
 - **Requerimento de Supervisão Especializada**
 - Manejo da irrigação**
 - Manejo da fertirrigação**
 - Entupimento dos Emissores**







Hydrogol

INTEGRAL DRIPLINE

- Durable multi-season dripline with incorporated cylindrical drippers
- High clogging resistance due to large intake screen filtration area
- Available with 1, 2 or 4 outlets per dripper
- Flow rates at 1.0 bar:
 - Ø12 mm: 1.0, 2.0, 3.0 lph
 - Ø16 mm: 1.0, 1.5, 2.0, 4.0, 10.0 lph
 - Ø20 mm: 2.0, 2.5, 3.0, 4.0 lph
- Range of working pressure: 0.8 - 3.0 bar
- Wall thickness: 0.6, 0.9, 1.0, 1.1 mm (25-45 mil)
- Application: all kinds of field crops, fruit orchards & greenhouses, at any required emitter spacing (0.15-2.50m).

Hydro PC

Hydro PC AD

Anillo de hermetización Diafragma regulador de flujo

Filtro de entrada

Laberinto

PCAD 12 mm, L.D. 10.4 mm, 1.05 l/h

Hydrodrip Super

Filtro de entrada

Recorrido turbulento del agua Cámara de Salida

RAM

Tubería integral con goteros autocompensados

La acción diferencial de la expansión de flujo en las amplias y profundas ranuras de la tubería autocompensada.

La entrada elevada del flujo da acceso al agua más allá del centro de la tubería y evita las obstrucciones.

La tubería emerge en puntas, más resistentes a las tormentas, permitiendo mayor precisión de trabajo en terrenos más largos y múltiples temporadas.

El gargajo de autocompensación responde a fluctuaciones de presión para asegurar un sistema caudal, constante y consistente, actuando dentro de los rangos para un rango de instalaciones.

El goteo modulado de presión, con dentro más quieto, controla mejor el flujo.

Casos como: arroyo de salidas mecánicas.

Selección Ram	GROSOR DE PARED (mm)	CAUDAL (l/h)	PRESION (m)	DIAMETRO (mm)	
				int.	ext.
RAM 14	1.2	1.2, 1.6, 2.3, 3.5	5-40	17.50	18.10
RAM 14Q	1.0	1.2, 1.6, 2.3, 3.5	5-35	14.10	16.10
RAM 14Q	0.9	1.2, 1.6, 2.3, 3.5	5-30	14.20	16.00
RAM 17	1.2	1.2, 1.6, 2.3, 3.5	5-40	14.40	17.00
RAM 17Q	1.0	1.2, 1.6, 2.3, 3.5	5-35	14.50	16.50
RAM 17L	0.8	1.2, 1.6, 2.3, 3.5	5-30	15.50	16.70
RAM 17L	0.6	1.2, 1.6, 2.3, 3.5	5-20	15.70	16.55
RAM 20	1.2	1.2, 1.6, 2.3, 3.5	5-40	17.50	19.40
RAM 20Q	1.0	1.2, 1.6, 2.3, 3.5	5-35	17.40	18.50

RAM

D= H_{aceleración} = 0,70 metros equivalentes

Tubería integral con goteros autocompensados

Datos hidráulicos

Longitud de Laterales (m) en suelo llano

Presión de entrada (m)	Distancia entre goteros (m)																			
	0,15	0,20	0,25	0,30	0,40	0,50	0,60	0,80	1,00	1,25	1,50									
15	12	16	22	35	12	16	22	35	12	16	22	35	12	16	22	35	12	16	22	35
16	15	20	28	42	15	20	28	42	15	20	28	42	15	20	28	42	15	20	28	42
20	19	26	36	54	19	26	36	54	19	26	36	54	19	26	36	54	19	26	36	54
25	24	33	45	68	24	33	45	68	24	33	45	68	24	33	45	68	24	33	45	68
30	30	40	54	81	30	40	54	81	30	40	54	81	30	40	54	81	30	40	54	81
40	40	53	71	107	40	53	71	107	40	53	71	107	40	53	71	107	40	53	71	107
50	50	66	89	136	50	66	89	136	50	66	89	136	50	66	89	136	50	66	89	136
60	60	80	108	164	60	80	108	164	60	80	108	164	60	80	108	164	60	80	108	164
80	80	106	142	216	80	106	142	216	80	106	142	216	80	106	142	216	80	106	142	216
100	100	132	176	270	100	132	176	270	100	132	176	270	100	132	176	270	100	132	176	270

Presión final - 5 m

RAM

Tubería integral con goteros autocompensados

Datos hidráulicos

Longitud de Laterales (m) en suelo llano

Presión de entrada (m)	Distancia entre goteros (m)																			
	0,15	0,20	0,25	0,30	0,40	0,50	0,60	0,80	1,00	1,25	1,50									
15	12	16	22	35	12	16	22	35	12	16	22	35	12	16	22	35	12	16	22	35
17D	15	20	28	42	15	20	28	42	15	20	28	42	15	20	28	42	15	20	28	42
20	19	26	36	54	19	26	36	54	19	26	36	54	19	26	36	54	19	26	36	54
25	24	33	45	68	24	33	45	68	24	33	45	68	24	33	45	68	24	33	45	68
30	30	40	54	81	30	40	54	81	30	40	54	81	30	40	54	81	30	40	54	81
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80	80	106	142	216	80	106	142	216	80	106	142	216	80	106	142	216	80	106	142	216
100	100	132	176	270	100	132	176	270	100	132	176	270	100	132	176	270	100	132	176	270

Presión final - 5 m

UniRam

La tubería integral de goteo autocompensada que no esperó al siglo XXI

5 Megaventajas

- Exclusivo mecanismo antibufo (CNL)**
Elimina los efectos del rebombido y dragaje. La mayor eficiencia en riegos por puntos.
- Exclusivo mecanismo antibufo**
Evita la succión de impurezas a la tubería local para riegos subterráneos.
- Exclusiva protección contra penetración de raíces local para riegos subterráneos.**
- Extraordinaria y superafecta protección contra las obstrucciones**
Doble laberinto con el paso más amplio, basado en la tecnología patentada Turbonet.
Mecanismo autolimpiante continuo.
Dispositivo de protección contra arena, que evita los depósitos de sedimentos en el paso de agua del gotero.
Filtro de entrada perforado, de diseño patentado.
- Amplia gama de autocompensación**
Mantiene el caudal uniforme en una gama de presiones de 1 a 10 m.

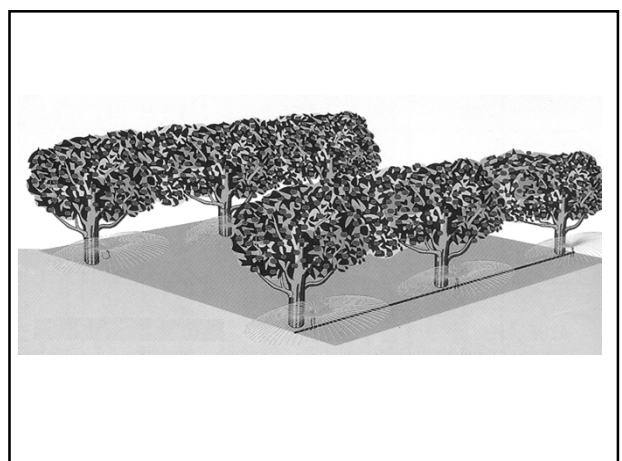
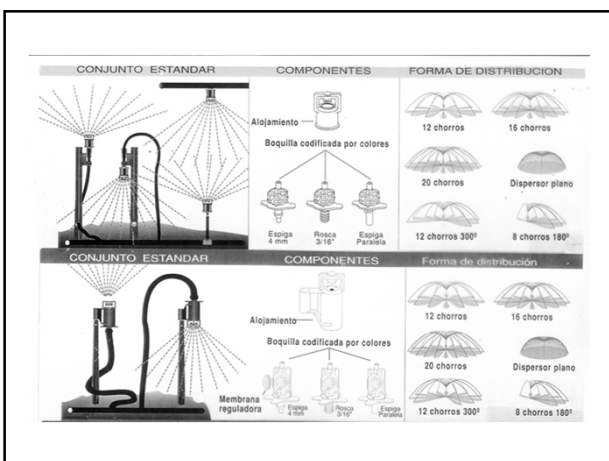
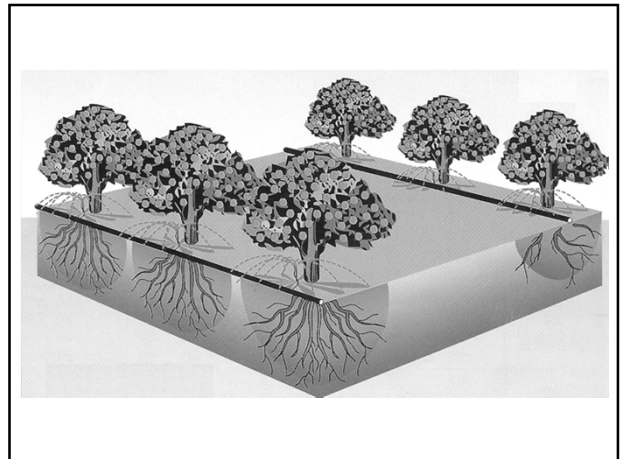
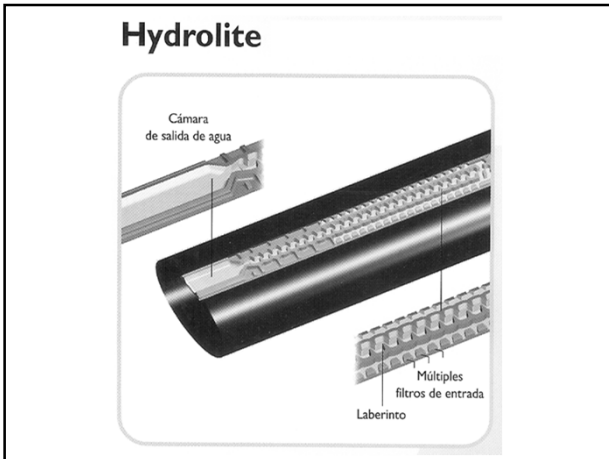
Gravity

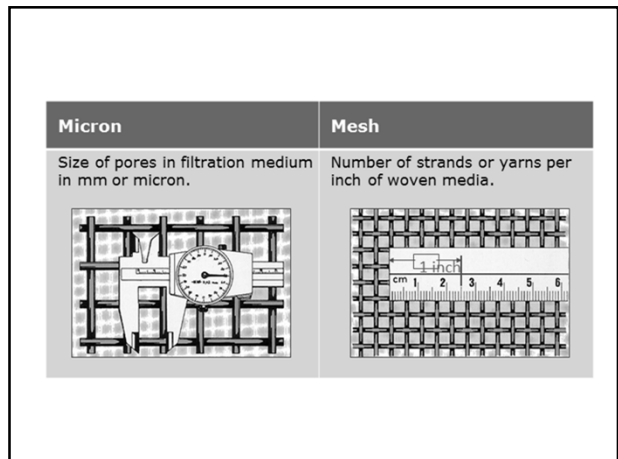
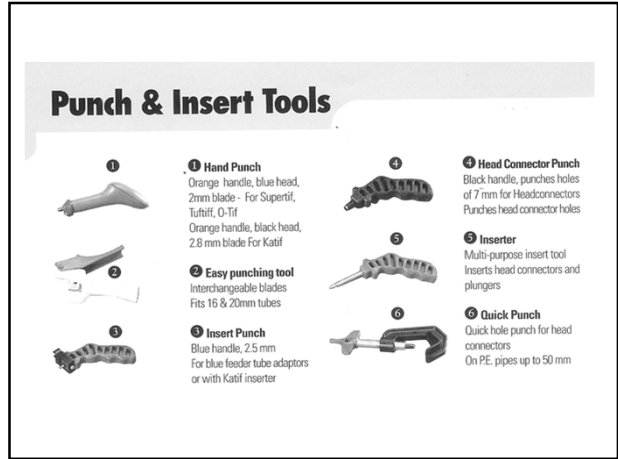
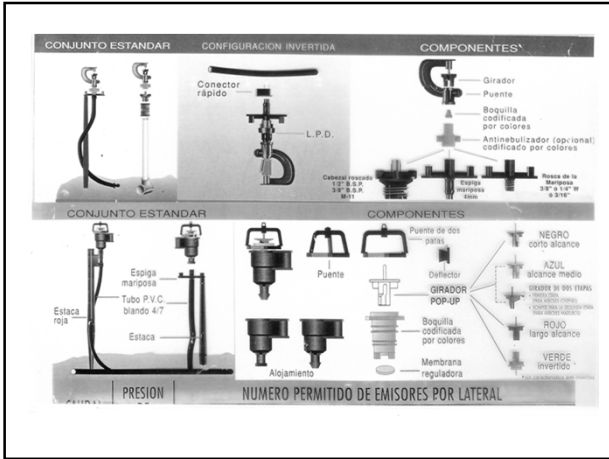
DRIP IRRIGATION

The most economical solution for small growers

No need for pressurized water source

Layout: Several plots can be served sequentially from one water tank





Filtering degrees

Ring Colour	Mesh	Micron	mm
Blue	40	400	0.4
Yellow	80	200	0.2
Red	120	130	0.13
Black	140	115	0.12
Green	200	75	0.08
Grey	600	25	0.025

Tabla de Grados de Filtrado de las Anillas y Códigos de Color

Código de Color	Azul	Amarillo	Rojo	Negro	Verde	Grís
Mesh	40	80	120	140		
Micras	400	200	130	100	55	20

Table 18.1. Plugging potential of irrigation water used in trickle systems¹

Type of problem	Little	Some	Severe
<i>Physical²</i>			
Suspended solids (maximum ppm)	< 50	50-100	> 100
<i>Chemical²</i>			
pH	< 7.0	7.0-8.0	> 8.0
Dissolved solids (maximum ppm)	< 500	500-2000	> 2000
Manganese (maximum ppm)	< 0.1	0.1-1.5	> 1.5
Iron (maximum ppm)	< 0.1	0.1-1.5	> 1.5
Hydrogen sulfide (maximum ppm)	< 0.5	0.5-2.0	> 2.0
<i>Biological³</i>			
Bacteria populations (maximum number/mL)	< 10,000	10,000-50,000	> 50,000

¹From Bucks et al. (1979).
²Maximum measured concentration from a representative number of water samples using standard procedures for analysis.
³Maximum number of bacteria per milliliter can be obtained from portable field samplers and laboratory analysis. Bacterial populations do reflect increased algae and microbial nutrients.

Sulfete de H: Ortofosfo de Acido sulfureo

Limites de Tamanho de Partículas de Acordo com Diversas Classificações

	Fines (silt or clay)		Fine sand	Coarse sand
DA-CE USBR	Fines (silt or clay)		Fine sand	Coarse sand
FAA	Clay	Silt	Fine sand	Coarse sand
AASHTO ASTM	Clay ¹⁾	Silt	Fine sand	Coarse sand
USDA	Clay	Silt	Very fine sand Fine sand Medium sand	Coarse sand Very coarse sand
ISSS	Clay	Silt	Fine sand	Coarse sand

0.001 0.002 0.005 0.01 0.02 0.05 0.10 0.20 0.50 1.0 2.0
Particle size (mm)

¹⁾ Reported with clay
 DA-CE = Department of Army, Corps of Engineers
 USBR = U.S. Bureau of Reclamation
 FAA = Federal Aviation Authority
 AASHTO = American Association of State Highway Officials
 ASTM = American Society for Testing and Materials
 USDA = U.S. Department of Agriculture
 ISSS = International Society of Soil Science

115 MESH → 0.125 mm
120 MESH → 0.090 mm
250 MESH → 0.063 mm

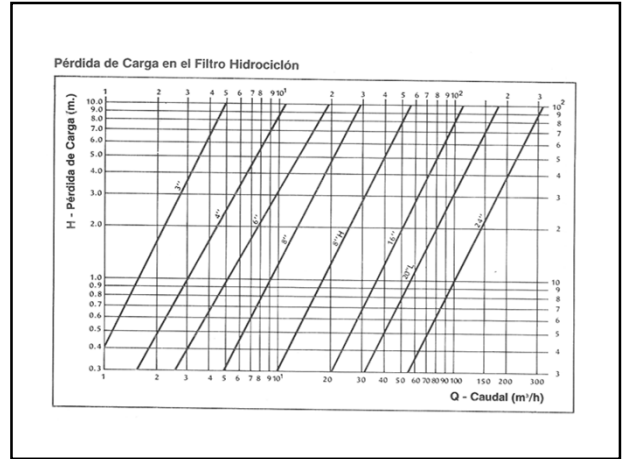
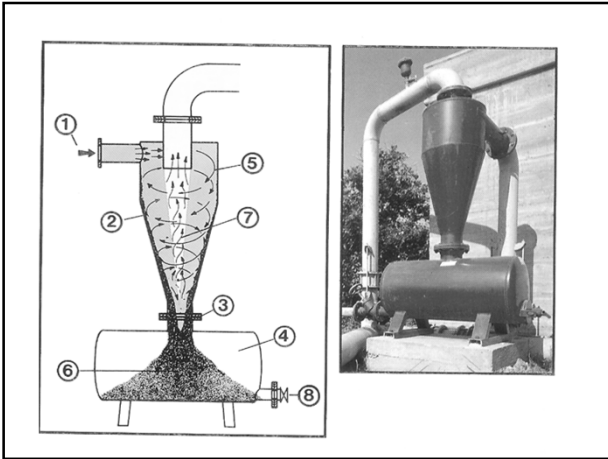
Fig. 1-1. Classification of soil separates <2.0 mm on the basis of particle size. (Adapted from USDA, 1951, and Portland Cement Association, 1962.)

Injection of Acids and Chloride

Both algae and slime can be inexpensively controlled by chlorination. Algae and slime can usually be eliminated in trickle systems by maintaining a continuous concentration of 1.0 ppm residual chlorine at the ends of laterals. It can also be done by injecting sufficient chlorine to bring the concentration to between 10 and 20 ppm during the last 20 min of the irrigation cycle. Typical recommended chlorine dosages for different organic growth and precipitation problems are:

- For algae use 0.5 to 1.0 ppm continuously or 20 ppm for 20 min at the end of each irrigation cycle;
- For hydrogen sulfide use 3.6 to 8.4 times the hydrogen sulfide content;
- For iron bacteria use 1.0 ppm over the number of ppm of iron present (this can vary depending on the number of bacteria to be controlled);
- For iron precipitation use 0.64 times the Fe²⁺ content to maintain 1.0 ppm free residual chlorine at the ends of laterals;
- For manganese precipitation use 1.3 times the Mn content; and
- For slimes maintain 1.0 ppm free residual chlorine at the ends of laterals.

Efficiency of chlorine injection is related to the pH of the water to be treated. More chlorine is required at a high pH. In severe cases for algae and slime treatment, a detention destruction facility is necessary. This consists of a pond or concrete tank to retain the irrigation water long enough for sufficient oxidation and destruction of the chlorinated algae-slime mixture.



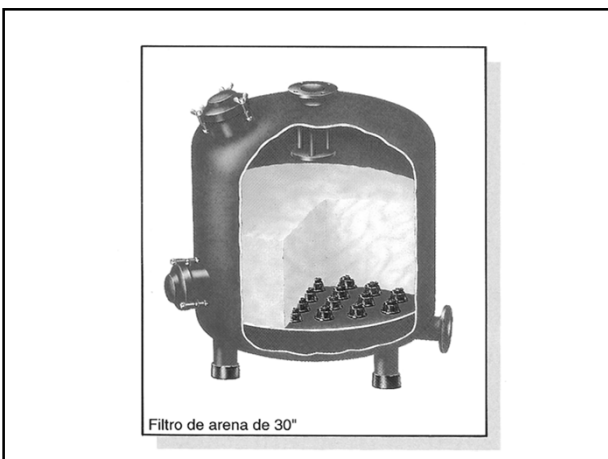
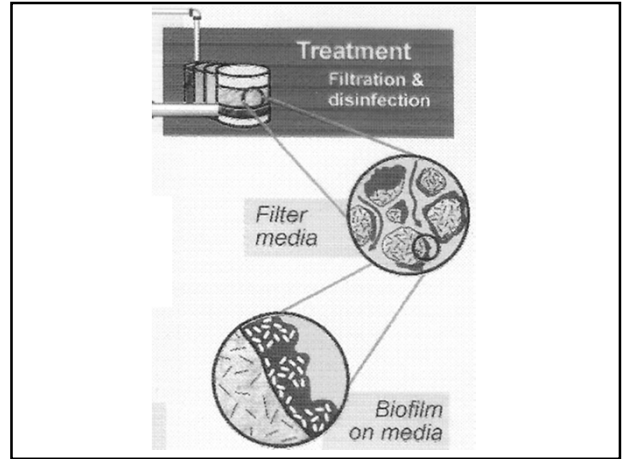
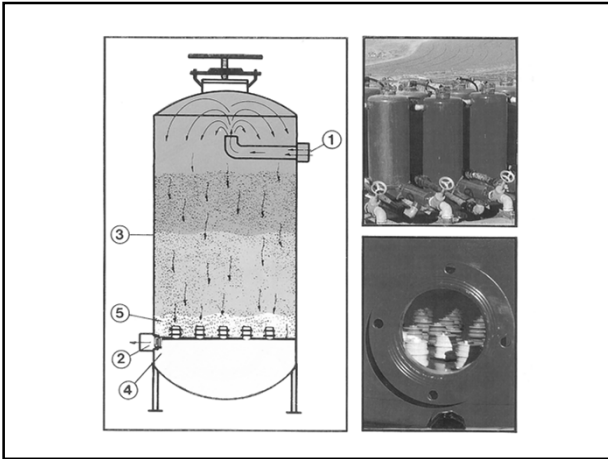


Table Classification of soils by particle size, with corresponding screen mesh numbers

Soil classification	Particle size			Screen mesh number
	mm	microns	in.	
Very coarse sand	1.00-2.00	1000-2000	0.0393-0.0786	18-10
Coarse sand	0.50-1.00	500-1000	0.0197-0.0393	35-18
Medium sand	0.25-0.50	250-500	0.0098-0.0197	60-35
Fine sand	0.10-0.25	100-250	0.0039-0.0098	160-60
Very fine sand	0.05-0.10	50-100	0.0020-0.0039	270-160
Silt	0.002-0.05	2-50	0.00008-0.0020	400-270 ¹
Clay	<0.002	<2	<0.00008	—

¹400 mesh wire screen has the smallest opening, i.e., approximately 0.03 mm (0.0012 in.).

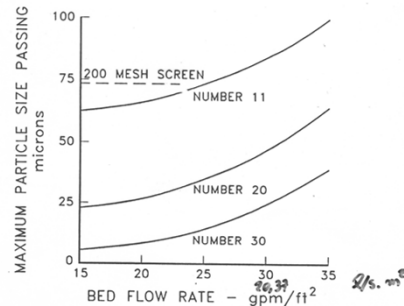
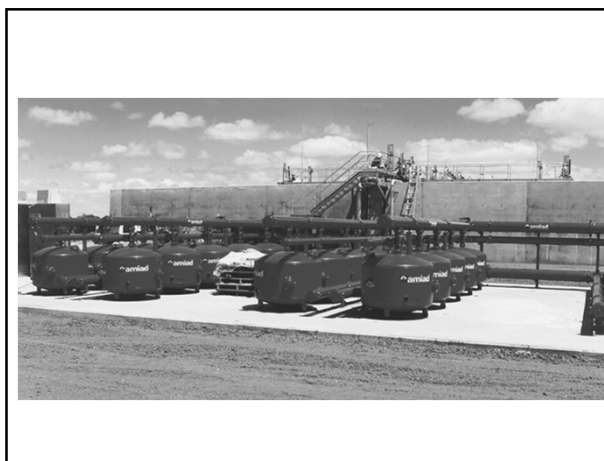
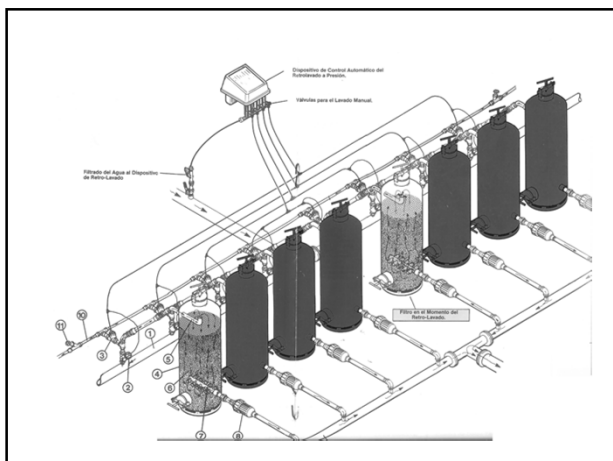
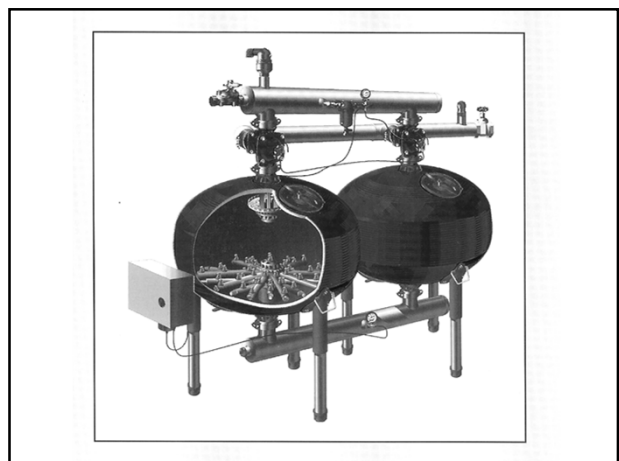
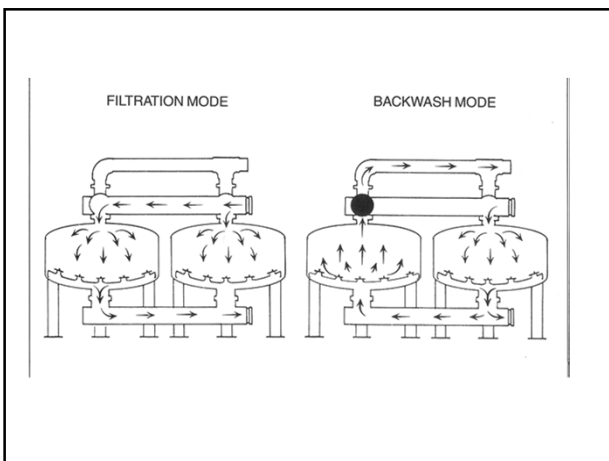
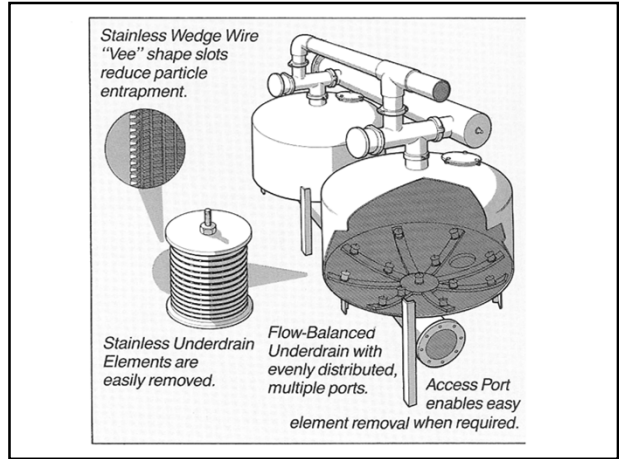
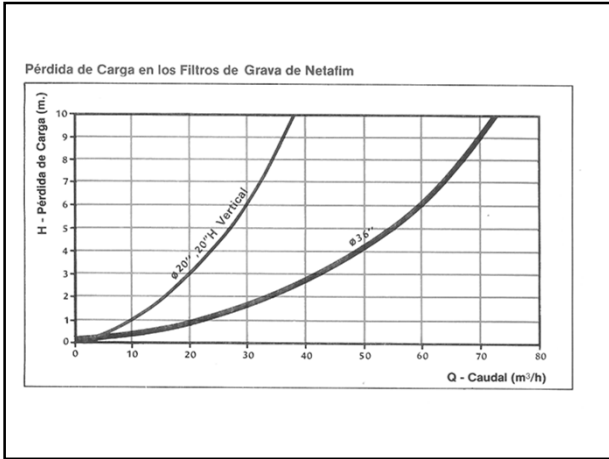
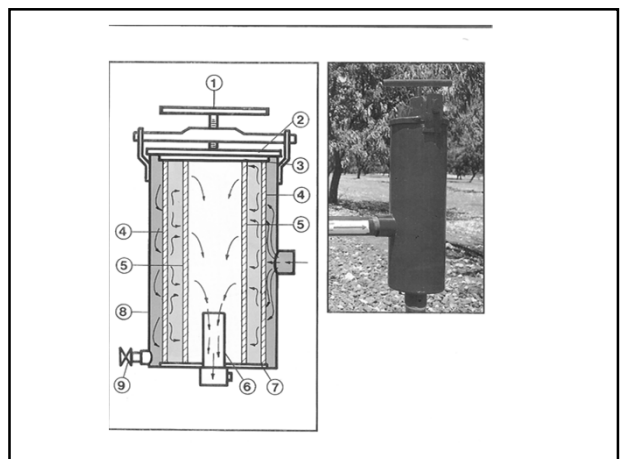
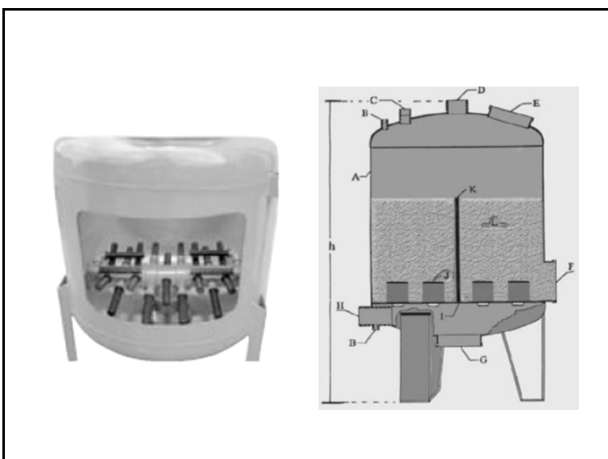
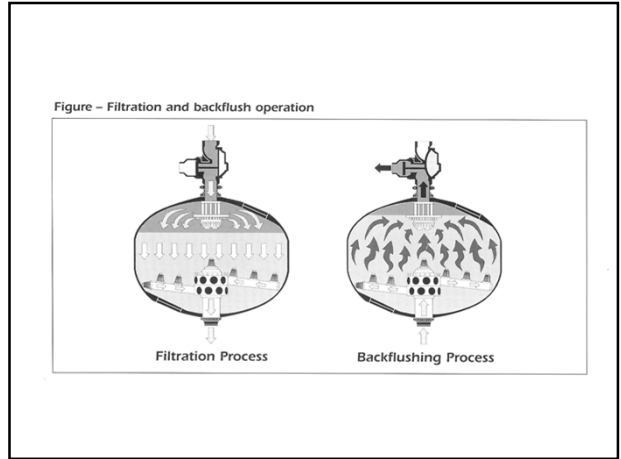
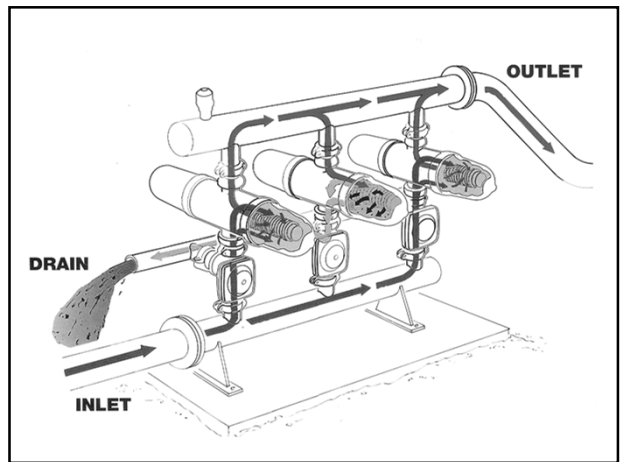
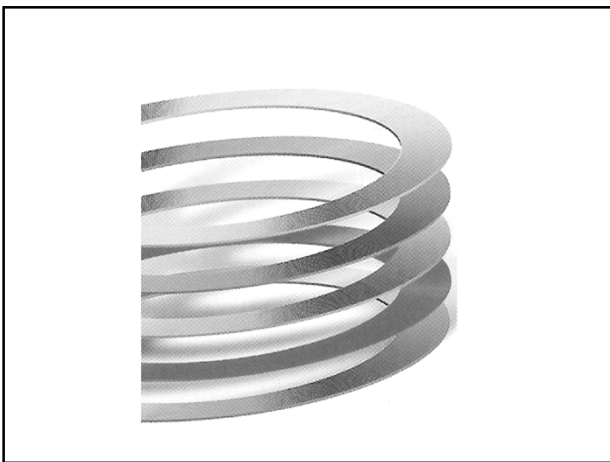
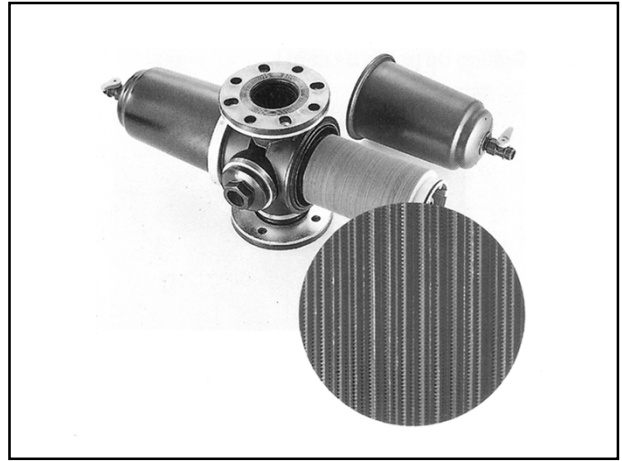


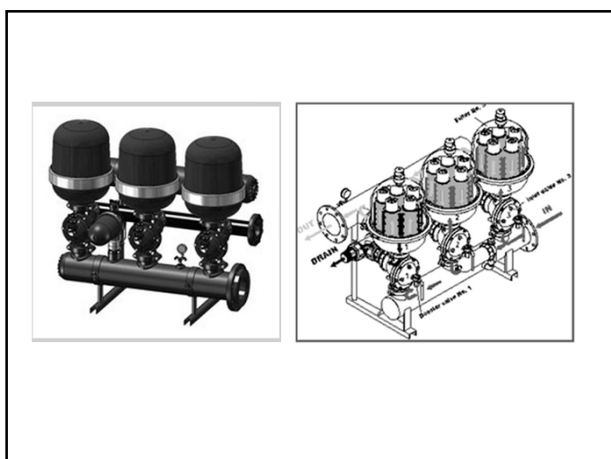
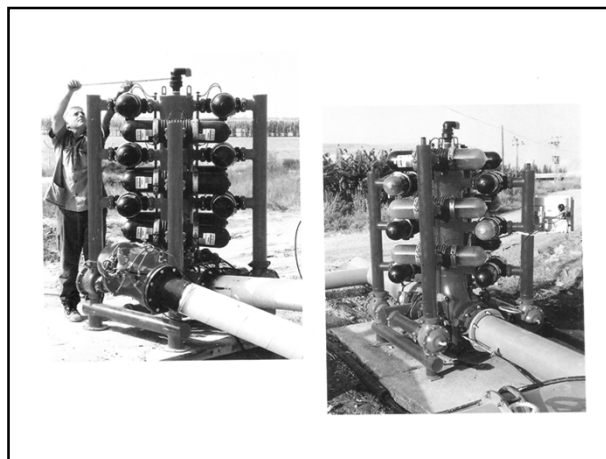
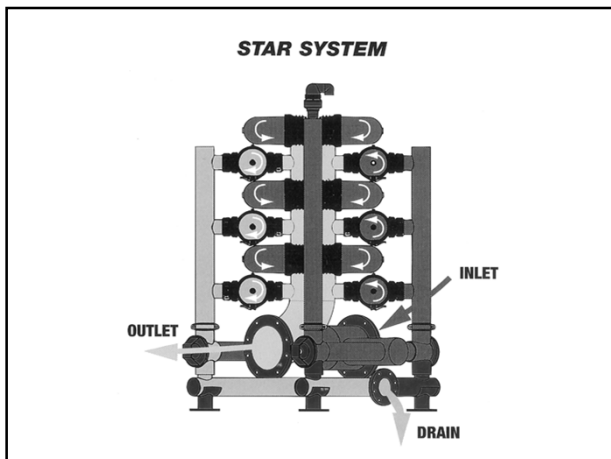
FIG. Effect of Flow Rate on Maximum Particle Size Passing Through Typical Free Flow Sand Filters with Different Media.











ARKAL
SISTEMAS DE FILTRACION

SISTEMA ESTRELLA - 7/94

**Diseño del SISTEMA ESTRELLA - Caudal máximo recomendado/
Calidad del agua**

Dimensionado del SISTEMA ESTRELLA según caudales a 400 - 130 micras (40 - 120 mesh)

Calidad del agua	Carga	8 Unidades	12 Unidades	15 Unidades	18 Unidades
Calidad buena	SST < 50	360 m ³ /h	540 m ³ /h	675 m ³ /h	810 m ³ /h
Calidad media	SST < 100	290 m ³ /h	430 m ³ /h	540 m ³ /h	650 m ³ /h
Calidad mala	SST < 150	200 m ³ /h	300 m ³ /h	375 m ³ /h	560 m ³ /h
Calidad muy mala	SST < 200	145 m ³ /h	215 m ³ /h	270 m ³ /h	325 m ³ /h

Dimensionado del SISTEMA ESTRELLA según caudales a 110 micras (140 mesh)

Calidad del agua	Carga	8 Unidades	12 Unidades	15 Unidades	18 Unidades
Calidad buena	SST < 50	320 m ³ /h	480 m ³ /h	600 m ³ /h	720 m ³ /h
Calidad media	SST < 100	240 m ³ /h	360 m ³ /h	450 m ³ /h	540 m ³ /h
Calidad mala	SST < 150	160 m ³ /h	240 m ³ /h	300 m ³ /h	360 m ³ /h
Calidad muy mala	SST < 200	120 m ³ /h	180 m ³ /h	225 m ³ /h	270 m ³ /h

Dimensionado del SISTEMA ESTRELLA según caudales a 75 micras (200 mesh)

Calidad del agua	Carga	8 Unidades	12 Unidades	15 Unidades	18 Unidades
Calidad buena	SST < 50	190 m ³ /h	280 m ³ /h	350 m ³ /h	420 m ³ /h
Calidad media	SST < 100	160 m ³ /h	240 m ³ /h	300 m ³ /h	360 m ³ /h
Calidad mala	SST < 150	110 m ³ /h	160 m ³ /h	200 m ³ /h	305 m ³ /h
Calidad muy mala	SST < 200	80 m ³ /h	120 m ³ /h	150 m ³ /h	180 m ³ /h

Dimensionado del SISTEMA ESTRELLA según caudales a 25 micras (600 mesh)

Calidad del agua	Carga	8 Unidades	12 Unidades	15 Unidades	18 Unidades
Calidad buena	SST < 50	90 m ³ /h	135 m ³ /h	170 m ³ /h	200 m ³ /h
Calidad media	SST < 100	80 m ³ /h	120 m ³ /h	150 m ³ /h	180 m ³ /h
Calidad mala	SST < 150	55 m ³ /h	85 m ³ /h	105 m ³ /h	125 m ³ /h
Calidad muy mala	SST < 200	40 m ³ /h	60 m ³ /h	75 m ³ /h	90 m ³ /h

* Cuando la presión es baja, es necesario cerrar la válvula de salida durante el contralavado.
 Nota: Los números marcados en los gráficos son m³/h.
 SST se mide en mg/l.

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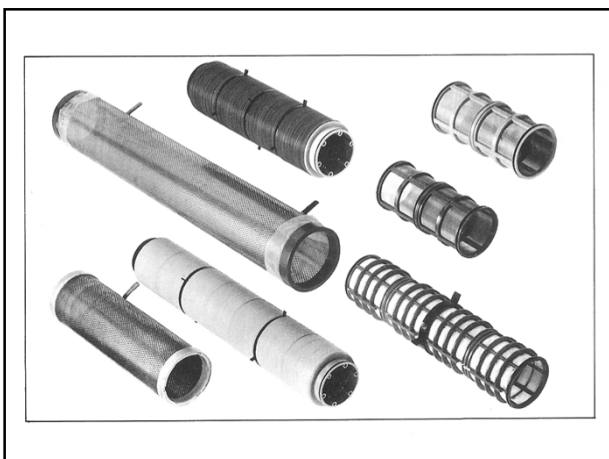
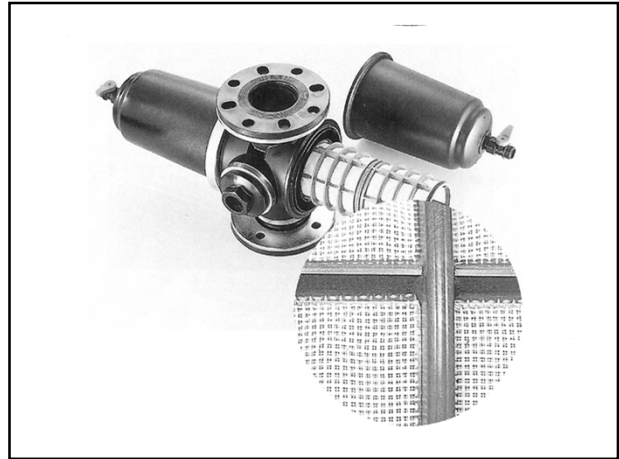
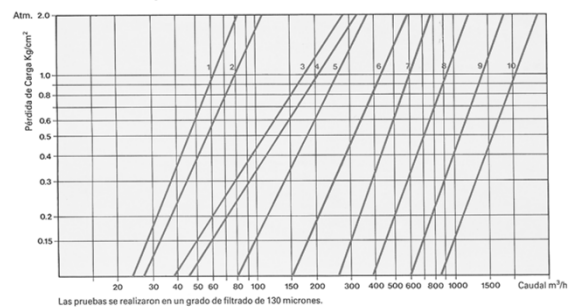
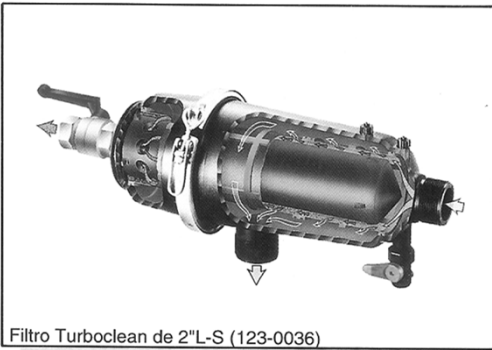
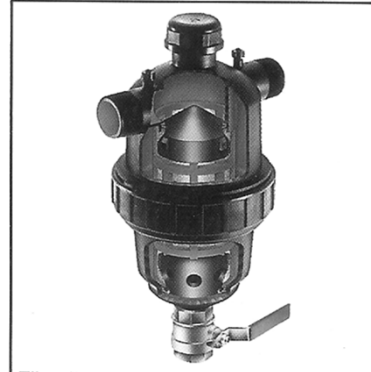


Gráfico de Pérdida de Carga – Filtros de Metal

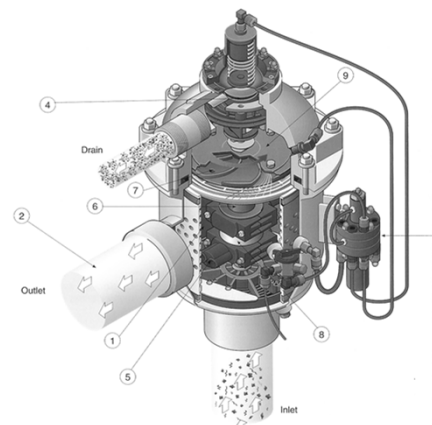
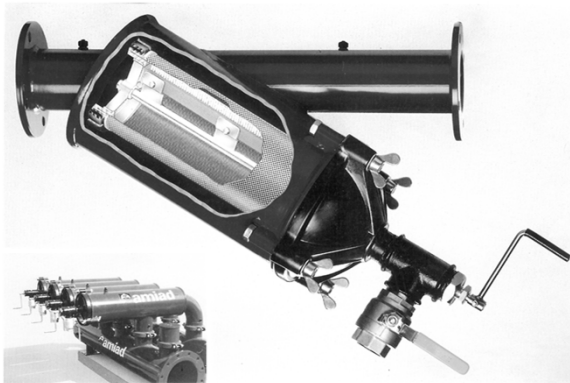


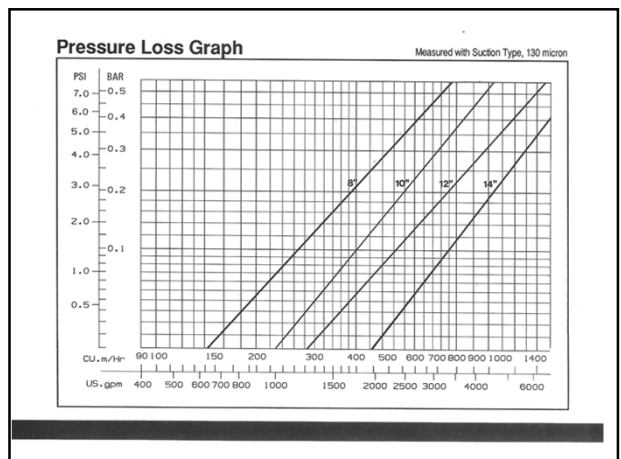
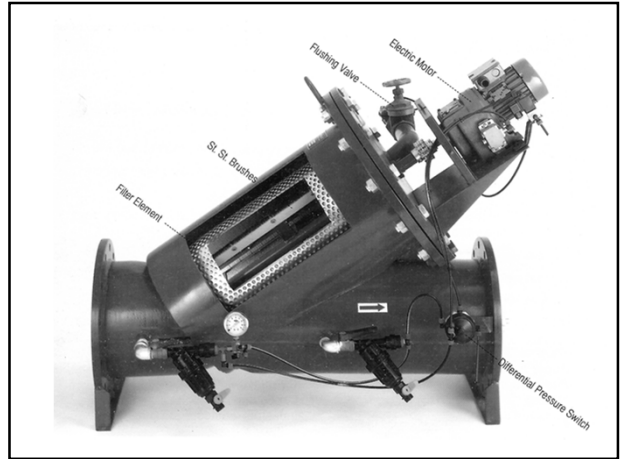
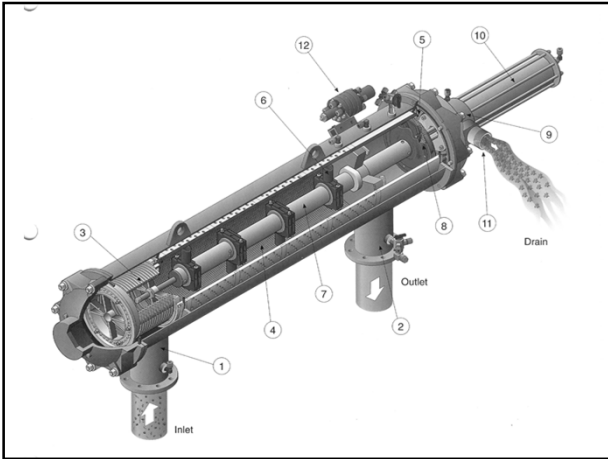


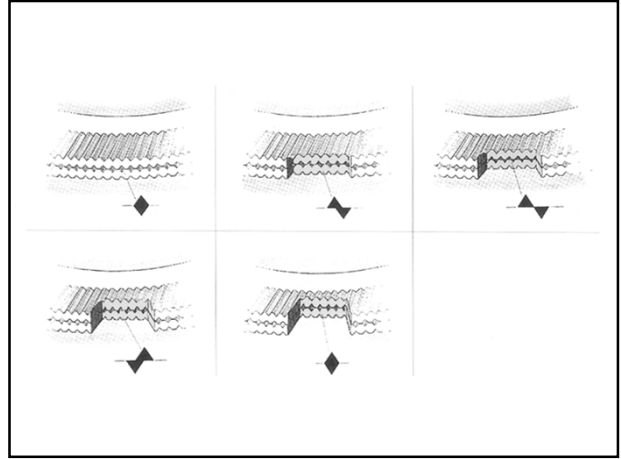
Filtro Turboclean de 2"L-S (123-0036)



Filtro Turboclean de 2"T (122-0036)







The Thompson Filter

Sizes Available: 2", 4", 6", 8", 10"

Model Nos:
 MLJ2 2" MLJ4 4" MLJ6 6"
 MLJ8 8" MLJ10 10"

Maximum recommended flow rates:
 MLJ2: 100 GPM MLJ8: 1300 GPM
 MLJ4: 350 GPM MLJ10: 2000 GPM
 MLJ6: 750 GPM

Can be manifolded to increase flow rates.
 No minimum gallon per minute requirements.

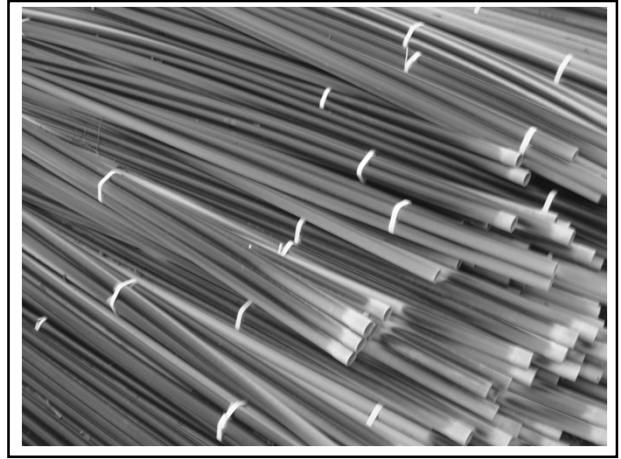
Screen Meshes Available:
 10M 80M
 30M 100M
 40M 120M
 50M 150M
 60M

Additional mesh sizes are available upon request.

Working pressures:
 Standard up to 100 PSI
 High pressure models up to 150 PSI

Construction Materials:
 Body:
 MLJ2, MLJ4, MLJ6, MLJ8 & MLJ10:
 Type 304 Stainless Steel
 Flanges:
 MLJ4, MLJ6, MLJ8 & MLJ10: 150 lb.
 Type 304 Stainless Steel
 Filter Elements:
 MLJ2, MLJ4, MLJ6, MLJ8 & MLJ10:
 Type 304 Stainless Steel
 Pressure Gauge Ports: 1/4" NPT are standard.
 Flush Port Sizes:
 MLJ2 1/2" NPT MLJ6 2" NPT MLJ10 2" NPT
 MLJ4 1 1/2" NPT MLJ8 2" NPT

CARE FREE CONDITIONERS





Modelo	Vazão		CVF	Ud ₂₀₀₀
	nominal (L h ⁻¹)	VM (L h ⁻¹)		
NAAN TIF PC	1,6	1,15	2,79	96,82
NAAN PAZ	2,0	2,23	1,29	99,48
NAAN PC	2,1	2,09	5,74	97,80
NAAN PC	3,8	3,90	3,99	95,49
HYDROGOL	3,0	3,09	4,64	95,06
RAM	2,3	2,34	2,73	97,20
RAM	1,6	1,55	3,52	97,03
HYDRO PC	2,0	2,13	3,49	96,24
HYDRO PC	2,2	2,14	4,11	95,66
HYDRO PC ND	2,35	2,25	5,17	94,51
HYDRO DRIP	2,0	2,32	2,53	97,55
CARBODRIP	2,0	2,86	1,72	98,04
TIRAN	2,05	2,47	3,04	97,20
TWIN PLUS	1,8	1,80	3,93	95,88
VIP LINE	3,6	3,33	9,26	89,82
IRRIDRIP PLUS	2,5	2,75	2,38	97,33
SUPER THYPHOON	2,0	2,36	5,01	93,94
AZUD	1,4	1,71	4,05	95,95
DRIP IN	2,5	2,67	3,49	96,07
PETRODRIP	1,5	1,71	4,29	95,86
CARBORUNDUM CD/AC	2,3	2,33	4,22	94,97
IRRILOC	1,1	1,28	2,67	97,17
QUEEN GIL	2,0	1,74	4,31	95,30
DRIPNET	1,6	1,57	2,83	96,83
UNIRAN	1,6	1,53	3,34	97,02

Projeto de Pesquisa : FAPESP

DESEMPENHO DE GOTEJADORES NA IRRIGAÇÃO LOCALIZADA NO BRASIL (2000-12863-1)

Prof. Rubens Coelho (Coordenador)

GO - Marconi Teixeira

CE - Lilian C. C. Carvalho

ES - Ronaldo Resende

MG - Luis Fernando Farias

PE - Ralini Ferreira

TO - Pablo Atahualpa

BA - Allan Cunha BARROS

RN - Pedro Róbinson Fernandes de MEDEIROS

BA - Cícero René A. Barbosa Júnior

RS - Marcelo Peske HARTWING

SP - Osvaldo RETTORE NETO,

MG - João Batista Ribeiro da Silva REIS

SP - Tiago Cappelo GARZELLA

SP - Marcus VINÍCIUS

RN - Nildo da Silva DIAS

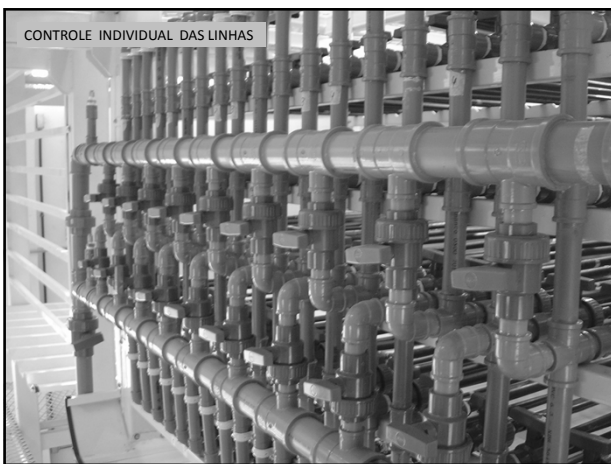


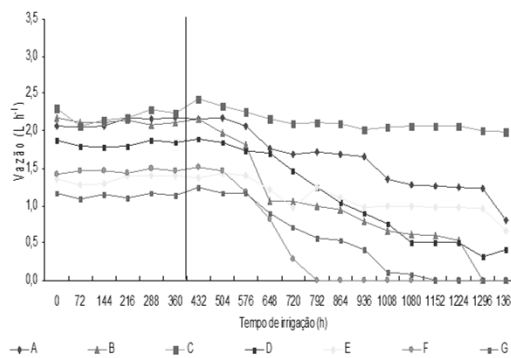
Tabela 1 - Modelos de gotejadores Ensaados : Teste Comparativo

Fabricante	Modelo	Fluxo	Vazão (L h ⁻¹)	Ø N (m)	Espaçamento entre gotejadores (m)
Netafim	Ram	AC	2,3	16	0,50
	Unitam	AC	1,6	16	0,33
	Dripnet	AC	1,6	16	0,75
Toro Ag	Tiran	NC	2,05	16	0,60
	Super Typhoon	NC	2,0	16	0,75
Plastro	Drip In	AC	2,5	17	0,50
	Hydro PC	AC	2,2	17	0,80
	Hidro Dnp	AC	2,0	16	0,80
Naandan	Hydrogel	NC	3,0	17	0,40
	Naan Paz	NC	2,0	16	0,75
Irimon	Twin Plus	AC	1,8	17,5	1,00
	Vip Line	AC	3,6	16	1,00
Azud	Irriloc	NC	1,1	16,4	0,40
	Azudline	NC	1,4	17	0,50
Petroisa	Petroisa GI	NC	1,5	16	0,50
Mataspis	Vered	AC	2,1	17	0,50

Fonte: Catálogo dos fabricantes

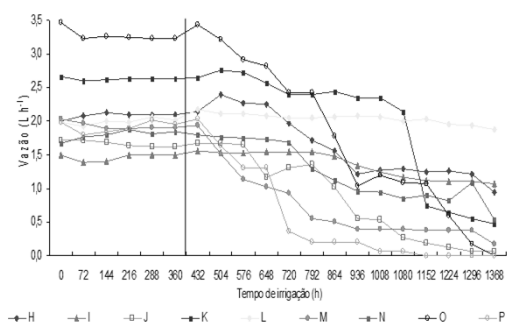
Dinâmica do Entupimento de Tubos Gotejadores sob Aplicação de Ferro Solúvel e Sólidos em Suspensão

Lilian Cristina Carvalho & Rubens Duarte Coelho



Dinâmica do Entupimento de Tubos Gotejadores sob Aplicação de Ferro Solúvel e Sólidos em Suspensão

Lilian Cristina Carvalho & Rubens Duarte Coelho



Irrigação Localizada - Brasil
Perspectivas Futuras

- Curto Prazo : Incremento de área significativo nas culturas de hortaliças, citos e café
- Médio / Longo prazos : cana-de-açúcar / Vinhaça !
- Preço do Maquinário Diminuindo -> Empresas Pequenas
- Base Tecnológica de Apoio – Instituto Nacional de Irrigação

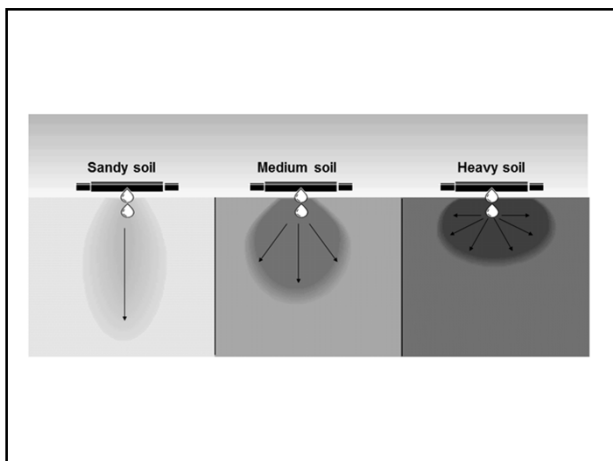
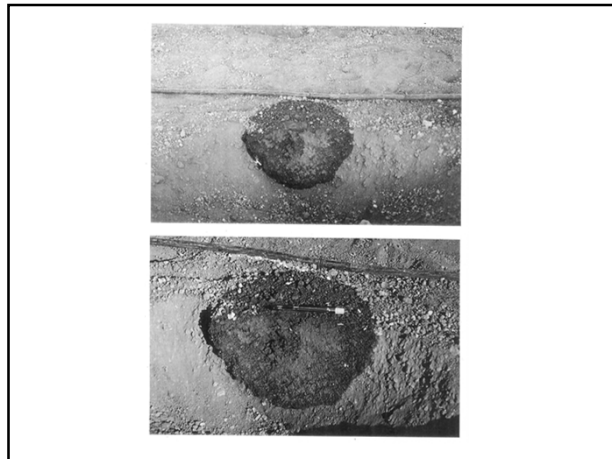
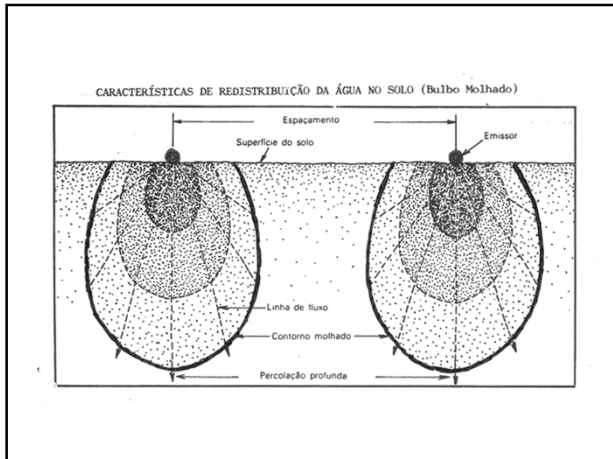


Tabela 2.4: Guia para determinar P

P = porcentagem de solo umedecido para distintas vazões dos emissores e os espaçamentos (entre tubulações laterais e emissores) no caso de uma só tubulação lateral retilínea equipada com emissores uniformemente espaçados que aplicam uma lâmina de 40 mm por turno de rega sobre toda a superfície.

Espaçamento entre tubulações laterais S _l (m)	Vazão dos emissores															
	Menos de 1,5 l/h			2,0 l/h			4,0 l/h			8,0 l/h			mais de 12 l/h			
	Espaçamento recomendado para os emissores na tubulação lateral S _d em m, em solos de textura grossa (G), média (M) e fina (F)															
	G	M	F	G	M	F	G	M	F	G	M	F	G	M	F	
0,8	38	88	100	50	100	100	100	100	100	100	100	100	100	100	100	100
1,0	33	70	100	40	80	100	80	100	100	100	100	100	100	100	100	100
1,2	25	58	92	33	67	100	67	100	100	100	100	100	100	100	100	100
1,5	20	47	73	26	53	80	53	80	100	80	100	100	100	100	100	100
2,0	15	35	55	20	40	60	40	60	80	60	80	100	80	100	100	100
2,5	12	28	44	16	32	48	32	48	64	48	64	80	64	80	100	100
3,0	10	23	37	13	26	40	26	40	53	40	53	67	53	67	80	80
3,5	9	20	31	11	23	34	23	34	46	34	46	57	46	57	68	68
4,0	8	18	28	10	20	30	20	30	40	30	40	50	40	50	60	60
4,5	7	16	24	9	18	26	18	26	36	26	36	44	36	44	53	53
5,0	6	14	22	8	16	24	16	24	32	24	32	40	32	40	48	48
6,0	5	12	18	7	14	20	14	20	27	20	27	34	27	34	40	40

