Design of Drip Irrigation

Crop	Guayole				
Spacing		0.75 x	0.5 m		
Area	1 ha	107600 sq.ft		100 x 100	m
Slope		0.35 %			(Roughly)
Water source	Pond				
Static Head		15 m	0.075		
ET crop		12 mm/day	From WINDS Models imulation of Guayule Irrigation		

Assuming Soil Characteristics

Clay Soil

Field Capacity	48 %	
Wilting point	25 %	
Bulk density	1.3 g/cm³	
Effective root Zone Dep	60 cm	10.206
		3.6
Wetted area	10 %	
Max. Pump Discharge	0.75 gps	

Volume of water to be applied

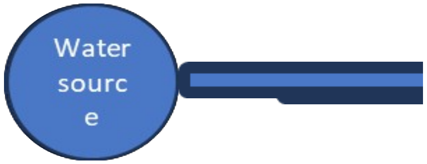
Volume Area x Depth

0.45 m³

Number of Emitters per plant

No. of emitters per plant is to be selected based on the layout

Say, one emitter per plant (0.1 g/h)



Irrigation Time

Irrigation Time Volume/Discharge rate

4.50 hrs 270 min

Number of Emitters per lateral

Length of the field 100 m

Assuming the submain is laid at the centre of layout, hence later length 50 m
Emitter spacing on lateral Plant spacing 0.5 m
No. emitters per lateral 100 no.s

Discharge through one lateral
Q lateral 10 g/h 0.166667 gpm 37.8541 l/h

Number of lateral per manifold
Pump Discharge 0.6 gps
2160 g/hr 36 gpm
No. of lateral that can be operated
216 say 220
Breadth of the field 100 m nos of lateral will have the required pressure after all the frictionloss.
No. of laterals along the breadth depend on row spacing
Distance between two laterals 1 m
Say 1.25 m to give enough space for the crop
Number of lateral on one side 80 no.s
Total number of laterals(both sides) 160
Number of Submains 0.727272727 Say 2 for uniformity in layout
Number of laterals per manifold 80 no.s Say 80

Size of lateral

D-W eq $$H_1 = \frac{KCLQ^m}{D^{2m+n}}$$

Let us assume a lateral of 12mm diameter
V Q/A
A 113.0973355 mm² 0.000113 m²
Q 37854.1 cu.m/hr 630901.7 l/min
V 92973.2582 m/s

Nr ρvD/μ
1115679098 > 4000
Flow is turbulent

Compute f

f 0.001750915 $f = 0.32 N_R^{-0.25}$

K 0.000144749

$K = 0.811\left(\frac{f}{g}\right)$

Take corrected L 50 m

H1 18.617007 m

h1 FH1+M1

0.032596804 Less than 0.5% of static head 7.5 m

Size of Submains

Q submain Q lateral x No. of lateral per submain

800 g/hr 3028.328 l/hr 50.47213 l/min

13.33333333 gpm 3.028328 m3/hr

Manifold Design

Assume Manifold Diameter 28 mm 0.028 m

V Q/A

V 1.366137671 m/s

A 0.000615752 sq.m

Nr 38251.8548 > 4000

Flow Turbulent Flow

f 0.022881624

k 0.001891641

L 50 m

H1 6.17491E-07 m

h1 2.08712E-07 m Less than 0.5% of static head 7.5 m

Head at inlet of manifold H emitter +H lateral+H slope+ H manifold

0.207597012 m

Size of Main

Length of main 100 m from well location

Q main 1600 g/hr 6056.656 l/hr 100.9443 l/min

6.056656 m3/hr 6.056656 m^3/sec

Assume main diameter 30 mm 0.03 m

V Q/A

V 2.38011541 m/s

A 0.000706858 sq.m

Nr 71403.4623 > 4000 Turbulent

f 0.019575829

K 0.001618348

H1 8.381E-05 m

h1 2.83278E-05 m Less than 0.5% of static head 7.5 m

Total Head

Total Head Head manifold inlet+ H main+ H static + H local

15.00002854 m

The pipe will in the line sorce with in-line orifice

Material Polyethylene

Manufacturer's coefficient of variation Cv is maintained below 0.1

for better usage of the pipe lines. As per ASAE recommendation

Emitter Uniformity

$$EU = 100\left(1 - \frac{1.27}{\sqrt{N_e}}(C_v)\right)\frac{Q_{min}}{Q_{avg}}$$

Q 0.1 g/h 0.378541 l/hr 1.362748 m3/s

Cv 0.1

Q min - field 0.075 g/hr 0.283906 l/hr

EU 74.0475 % okay

EMITTER TYPE	SOIL TOPOGRAPHY	EU RANGE FOR ARID AREA

EI

Li

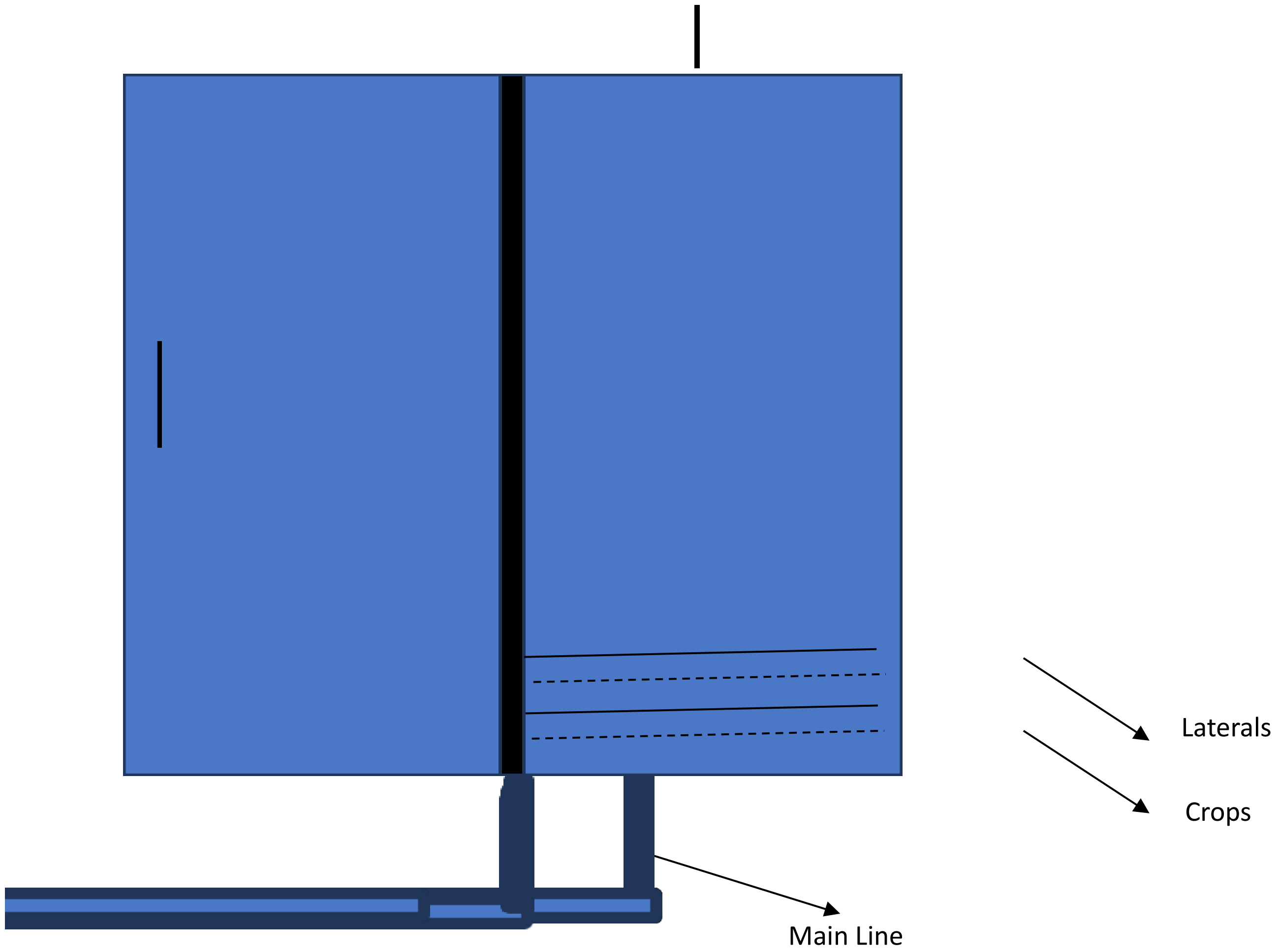
Point source on permanent crops	Uniform Steep or undulating	90 to 95 85 to 90
Point source on permanent or semi-permanent crops	Uniform Steep or undulating	85 to 90 85 to 90
Line source on annual row crops	Uniform Steep or undulating	80 to 90 70 to 85

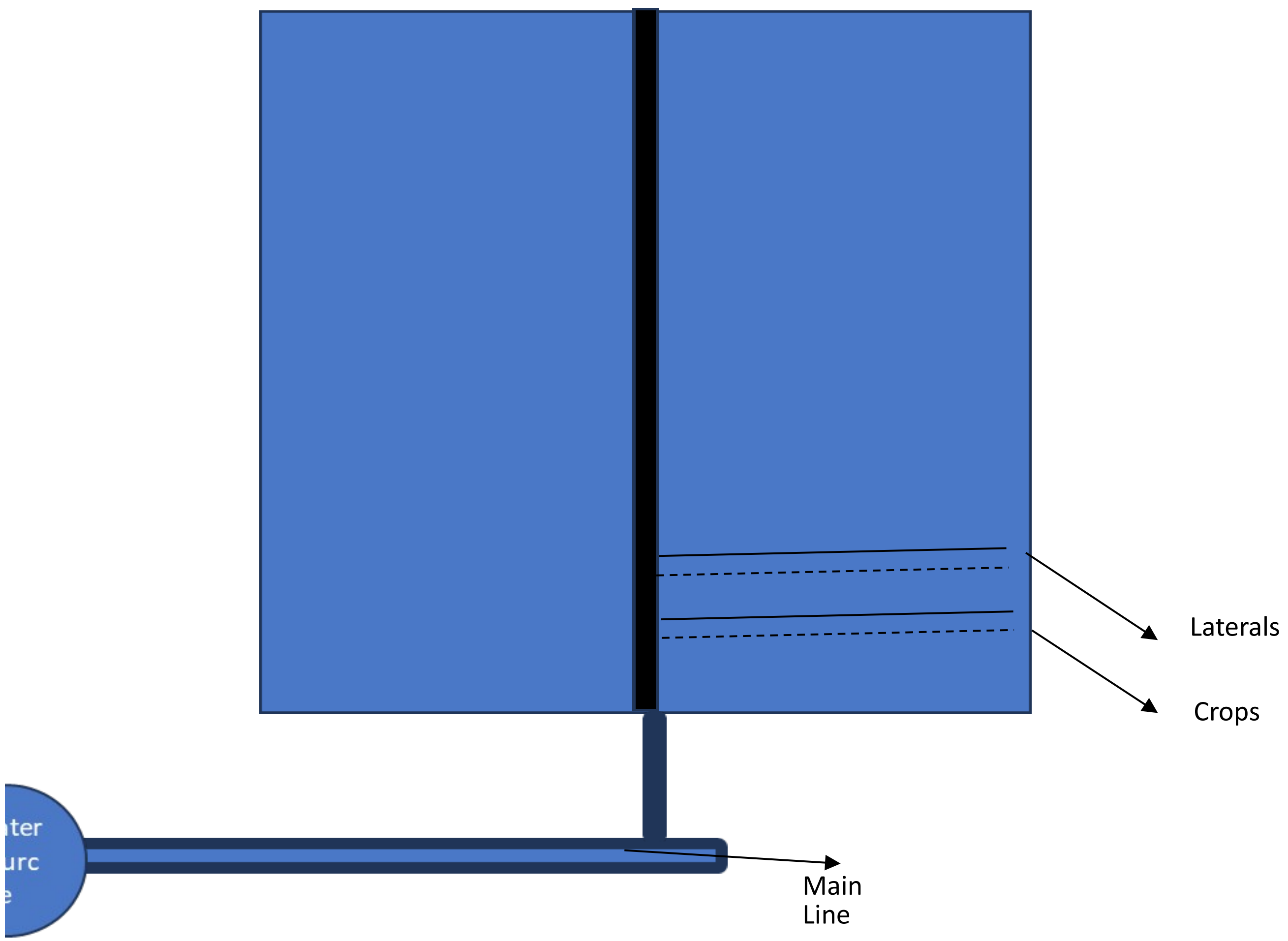
Pc

Pressure Variation along the pipeline

$$P_d = p_u - K(h_1 \pm \Delta Z)$$

K	9.81	
Δz	0.35 m	0.35
h1	18.62 m	
Pu	45 psi	
Pd	-134.20 psi	
	Gravity fed	


Laterals
Crops
Main Line


ter
urc
e
Laterals
Crops
Main
Line

MITTER TYPE	CV RANGE	CLASSIFICATION
ne Source	<0.10	Good
	0.10 to 0.120	Average

	0.10 to 0.120	Average
	>0.20	Marginal to unacceptable
oint Source	<0.05	Good
	0.05 to 0.10	Average
	0.10 to 0.15	Marginal
	>0.150	Unacceptable

Pressure Driven Drip Irrigation System

Area to be irrigated	1 Hectare	107640 sq. ft	
Crop Water Requirement	0.11 GPD		
Minimum allowable pressure variation	20 %		Assumed
Minimum operating pressure for drip emitters	7.5 psi		
maximum operating pressure for drip emitters	10 psi		
Emitter flow rate	0.11 GPH		
Emitter spacing	12 in	1 ft	
Emitter device type	Inline non- pressure compensating		
Target distribution uniformity	>0.80		
Tubing inner diameter	0.875 in		
Tubing wall thickness	13 mil	0.013 in	
Tubing outer diameter	0.901 in		
Control Valve pressure setting	12 psi		
Row Spacing	40 in		

Calculate the total water requirement

Total Water requirement Area x Crop water requirement

= 11840.4 gallons per day

LATERAL LINE DESIGN:

Emitter flow variation = 20% of 7.5 psi operating pressure

Flow variation 1.5 psi

From Manufacturer Data

Lateral Length available 820 ft 9840 in

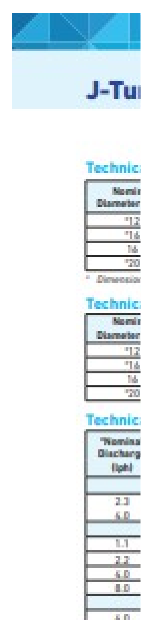
Use 820 ft lateral lines with emitters at 12 in spacing

Number of lateral Total emitters/ emitters per lateral

Total emitters 4485 emitters

Emitters/lateral 820 no.s

No. of laterals 54.69512195 Say 55



Emission uniformity

Emitter flow rate 0.11 GPH

Flow variation along 820 ft lateral with 0.11 GPH emitters is 15%

EU 1 - (1.27 * Q var/ Q avg) X Cv

0.861454545

EU 0.8614545455 >0.80 requirement

MANIFOLD DESIGN

55 laterals divided into 5 of 11 laterals each

Manifold pipe length 1100 ft

Flow 992.2 GPH

Manifold pipe diameter for 993 GPH 2 in

MAIN LINE DESIGN

Flow rate 1984.4 GPH

Main line diameter 4 in

Main pipeline length 820 ft

Miscellaneous Informations:

Filter type Sand Media 14 x 48 in high

Filter GPM/ tank 237

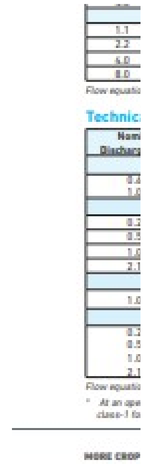
Pump Flow (GPM) 1750

Pump Total Dynamic Head (FT) 106

Pump Horsepower 60

Others Components

1. Pressure regulators / Sustaining Valves
2. Air Vents at High points
3. Flow meters, pressure gauges, backflow preventers if needed



bo Line® Super

l Features

ed from special grade virgin plastic

oing durable and gives best environmental
resistance (ESCR).

Vm, manufacturer's coefficient of variation
se dimensional tolerances to ensure lowest
l field emission uniformity.

e First
h is tested for stringent quality parameter.
g to Indian standard IS 13488:2008 and
al standard ISO 9261:2006.

Line for Class 1 Tube

e colored Twin Line tube is supplied.

terrent option

e supplied with optional rodent different feature
ects tube from rats.

ns

e Super is recommended for irrigation of closely
crops like sugarcane, cotton, banana, strawberry,
spices, biofuel crops, floriculture, etc.

ded to use in greenhouses and nurseries.

r landscape, shrubs and turf irrigation.

idely spaced horticultural plants like mango,
a, apple etc. in group spacings.

r multi-seasonal applications.

r surface as well as sub surface installations.

e filter, large filtration area and clog resistant
byrinth, J-Turbo Line® Super is a perfect product
Applications.

Specifications

- **Emitter Spacings :** Standard emitter spacing of 20, 30, 40, 50, 60, 75, 90 and 100 cm. Any other emitter spacings and group spacing can be supplied on demand.
- **Sizes :** 12, 16 and 20 mm nominal diameter.
- **Nominal Discharges :**

  J-Turbo Line Super 12 mm: 2.3 and 4 lph at working pressure of 1 kg/cm^2 (0.63 and 1.06 gph at 14.2 psi)

  J-Turbo Line Super 16 mm (14.2 mm ID) : 1.1, 2.2, 4 lph & 8 lph at working pressure of 1 kg/cm^2 (0.29, 0.58, 1.06 & 2.11 gph at 14.2 psi)

  J-Turbo Line Super 16 mm (13.8 mm ID): 4 lph at working pressure of 1 kg/cm^2 (1.06 gph at 14.2 psi)

  J-Turbo Line Super 20 mm : 1.1, 2.2 and 4 and 8 lph at working pressure of 1 kg/cm^2 (0.26, 0.58, 1.06 and 2.1 gph at 14.2 psi)

Operating Specifications

- Nominal operating pressure 1 kg/cm^2. Can be used for other pressure rating after consulting company representative and with due care for filtration
- Recommended to use specially designed emitting pipe fittings.
- Filtration recommendation 130 micron or less. Actual quality of filtration can be decided by quality of source water. Please refer to our "Maintenance Manual" for further details.
- For subsurface application, install vacuum breaker valves on the submain as well as on the collective drain to avoid soil suction during system shutdown.

rbo Line® Super

al Specifications for Tubing - Metric

al (mm)	Inside Diameter (mm)	Minimum Wall Thickness (mm)				Standard Coil Length (m)
		Class-1	Class-2	Class-3	Class-4	
	10.5	0.6	0.6	0.8	1.1	250, 400, 500, 700
	14.2	0.5	0.7	1.0	1.3	300, 400, 500
	13.8	–	0.9	1.0	1.3	250, 300, 400
	18.0	0.7	0.9	1.2	1.5	250

s are as per Indian Standard IS 13488:2008.

al Specifications for Tubing - US

al (mm)	Inside Diameter (mm)	Minimum Wall Thickness (inch)				Standard Coil Length (feet)
		Class-1	Class-2	Class-3	Class-4	
	10.5	0.016	0.024	0.031	0.043	820, 1640, 2296
	14.2	0.02	0.028	0.039	0.051	984, 1312, 1640
	13.8	-	0.035	0.039	0.051	820, 1312
	18.0	0.028	0.035	0.047	0.059	328, 820

al Specifications for Emitter - Metric

l e	Emitter exponent (x)	Flow coefficient (k)	Coefficient of Mfg. Variation (CVm) ±	Flow Path Dimensions, mm			Inlet Filter Area (mm^2)	Size of Filter Openings (mm x mm)
				Length	Width	Depth		
J-Turbo Line® Super 12mm ND (10.5mm ID)								
	0.46	2.4	3.0	20	1.06	1.15	26.00	0.5 x 0.5
	0.46	4.0	3.0	20	0.86	1.15	26.00	0.5 x 0.5
J-Turbo Line® Super 16mm ND (14.2mm ID)								
	0.48	1.1	3.5	20	0.66	1.00	20.16	1.91 x 0.48
	0.48	2.2	3.5	20	1.00	1.30	20.16	1.88 x 0.48
	0.46	4.0	2.5	20	1.06	1.30	22.00	0.5 x 0.5
	0.48	4.0	3.0	20	1.20	1.80	56.00	0.5 x 0.9
J-Turbo Line® Super 16mm ND (13.8mm ID)								
	0.46	4.0	2.5	20	1.06	1.30	22.0	0.5 x 0.5

J-Turbo Line® Super 20mm ND (18mm ID)								
	0.46	1.0	2.5	38	0.66	1.00	16.67	0.45 x 0.325
	0.46	2.2	3.0	38	0.85	1.20	16.67	0.45 x 0.325
	0.46	4.0	3.0	38	1.15	1.60	25.65	0.45 x 0.5
	0.48	8.0	3.5	20	1.20	2.00	90.86	0.5 x 0.65

n q = kH^x, q = nominal discharge, lph, H = Pressure head, kg/cm², x = Emitter exponent

al Specifications for Emitter - US

inal e (gph)	Emitter Expo	Flow Coeff.	CV	Dimension (inch) L	W	D	Inlet Filter Area (inch²)	Opening (inch x inch)
J-Turbo Line® Super 1/2 inch								
3	0.46	0.187	3	0.79	0.062	0.045	0.037	0.02 x 0.02
6	0.46	0.312	3	0.79	0.033	0.045	0.037	0.02 x 0.02
J-Turbo Line® Super 7/8 inch								
9	0.48	0.079	3.5	0.79	0.026	0.039	0.031	0.75 x 0.02
8	0.48	0.163	3.5	079	0.039	0.051	0.031	0.77 x 0.02
6	0.46	0.312	2.5	0.79	0.062	0.051	0.063	0.02 x 0.02
1	0.48	0.591	3.0	0.79	0.067	0.071	0.087	0.02 x 0.035
J-Turbo Line® Super 7/8 inch								
6	0.46	0.312	2.5	0.79	0.062	0.051	0.063	0.02 x 0.02
J-Turbo Line® Super 3/4 inch								
6	0.46	0.078	2.5	1.5	0.025	0.039	0.026	0.018 x 0.013
8	0.46	0.171	3.0	1.5	0.033	0.047	0.026	0.018 x 0.013
6	0.46	0.312	3.0	1.5	0.065	0.055	0.06	0.018 x 0.02
1	0.48	0.591	3.5	0.79	0.05	0.08	0.161	0.02 x 0.026

n q = kH^x, q = Nominal Discharge, gph, H = Pressure head, psi, x = Emitter exponent

rating pressure of 1kg/cm² and for pressure Class-2 for 12 & 16mm OD (10.5mm , 13.8 and 14.2mm ID respectively) and pressure r 20mm OD (18mmID) under standard test conditions.

Total Suspended Solids

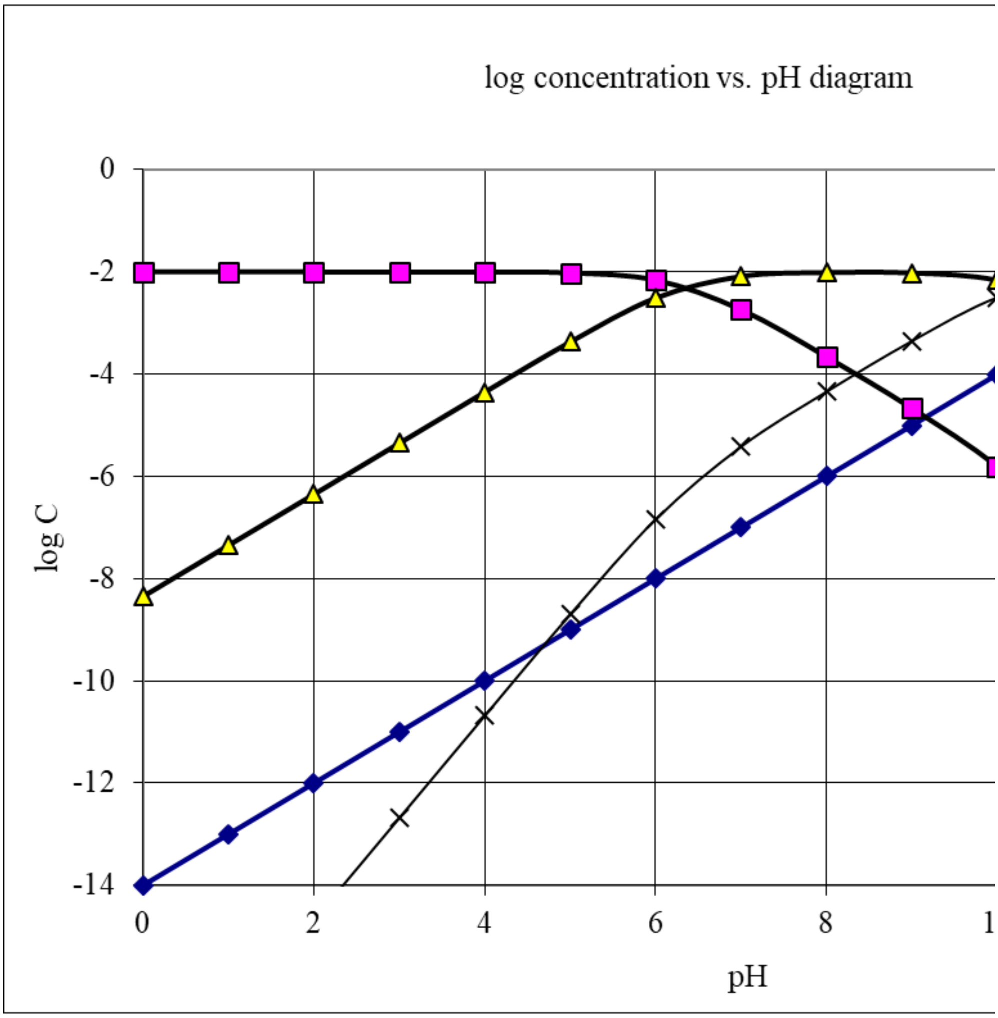
(g)Weight of the clean filter paper	W1	0.8654
(g)Wt of the filter paper and the residue	W2	0.8682
(g)Wt of the residue	W	0.0028
volume of mL	V	30

Tss(mg/L)	(W1-W2)x1000/V	0.093333 mg/L

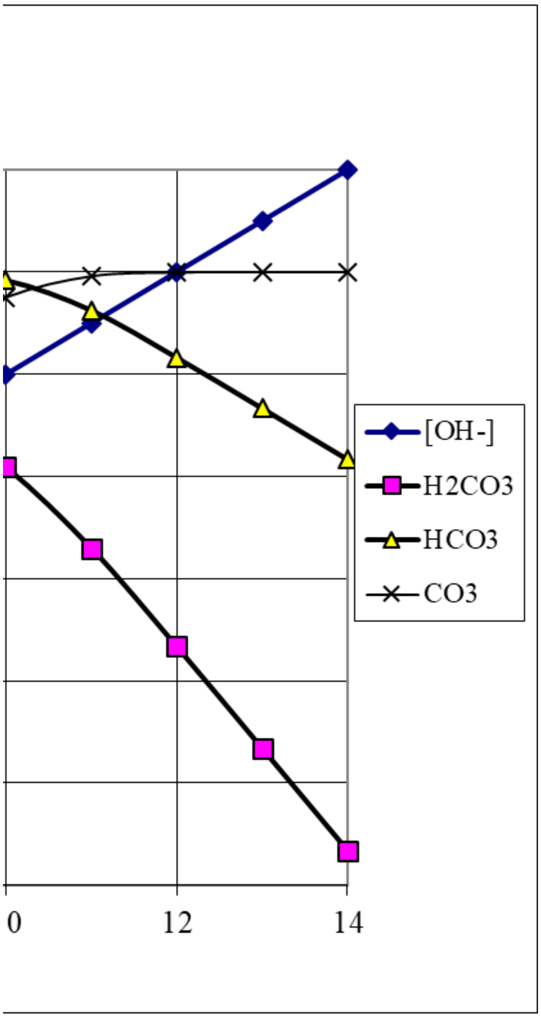
Total Suspended Solids	0.093333 mg/L
TDS	810.1 µS/cm
	518.464 mg/L

pH of water	8.72		
Total Alkalinity			
IC	6.673 ppm		
Mg	43.137 ppm		
TA	333.65 +	1984.302	
	2317.952 mg/L of CaCO3		
Acid required (mL)	TA (mg/L as CaCO3) x Volume of Water (L) x (10^-pH t - 10^-pH 0)/ Acid Normali		
pH 0	8.72		
pH t	6.5		
Volume of water	7570 L		water distributed per hour
Acid Normality	1 N		Sulfuric Acid
Acid Required	779.08221082 mL		

ty x 50000



log concentration vs. pH diagram
0
-2
-4
-6
-8
-10
-12
-14
log C
0
2
4
6
8
1
pH



0
12
14
[OH-]
H2CO3
HCO3
CO3

Desired softness of water 100 mg/L $CaCO_3$

Q 44.815914 m^3/sec

Temperature 20 C

Softening 100 mg/L

Column Diameter 1.5 m

Regeneration HCl bases on manufacturer spec.

Resin type SAC Dowex 50W-X8

Manufacturer's data about the resin

Softening Capacity 250 Kg/m3

capacity 1.5 eq/L

Leakage 1 % of untreated water hardness

Maximum Diameter 1.5 m

Bed Depth 1 m

Backwash bad Expansion >50%

Recommended Operating Conditions

Operation	Rate	Solution	Time in min.
Service Flow ra	1- 6 Bv/h	Water	
Backwash		Water	5 to 15
Regenation	1- 10 Bv/h	4 - 8% HCl	45 to 75
Rinse	8 - 40 Bv/h	Water	10 to 40

Convert $MgCl_2$ to meq/L

Concentration 357.770945108 mg/L $CaCO_3$

Co 7.1554189 meq/L

Ceff. 2 meq/L

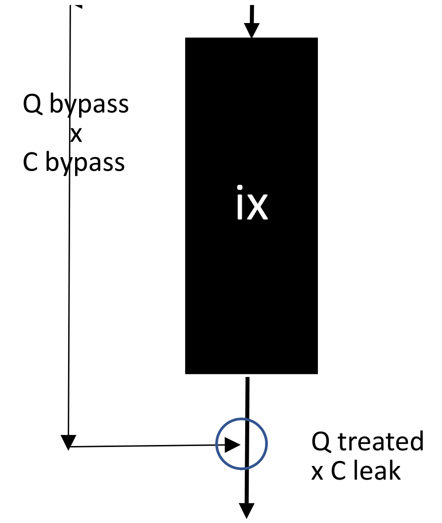
Compute the $MgCl_2$ in the effluent from the ion exchange column due to leakage

C leakage 0.0715542 meq/L

C desired 2 meq/L

Compute the bypass flow rate to achieve the desired hardness level

7.155 meq/L



Assumptions at the connection of the Q bypass and Q treated

1. CSTR
2. No reaction occurs
3. Steady state

Q total = Q treat + Q bypass

Q treat x C leakage + Q bypass x C bypass = Q total x C desired

Q bypass = f(Q total)

Q treat = (1 -f) Q total

f = 0.964 96.4 %

Q Bypass = 43.202541096 m^3/sec

Q treat = 1.613372904 m^3/sec

Total MgCl2 to be removed each day

= 987458289 meq/day of hardness

987458.289157 eq/day of hardness

Total Resin capacity = 1.5 eq/L

Reduce by 15 % for nonideality

Operating Resin Capacity = 1.275 eq/L

Bed Depth

As per specification not < 0.75m

Service flow rate

= 5 Bv/h m^3/m^3.h

Cross Sectional Area per column

= 1.76714586764 m²

Maximum Diameter 1.5 m

Volume of column

= 2.65071880147 m^3

Total volume required

$$\frac{\text{Total flowrate}}{\text{Loading Rate}} = 1161.628 \text{ m}$$

No. of Columns Required

$$\frac{\text{Volume required}}{\text{Volume of 1 column}} = 4.382315$$

Say 5 with 1 standby

Exchange capacity of each column

= 3379.66647 eq

3379666 meq

Service time of the column

$$\frac{\text{Column Capacity X No. of columns}}{\text{Total Hardnes to remove per day}}$$

= 0.01711296 day

0.410711 hr

Total weight of Regenerant required per column From Man. Specs

= 16 kg

Total weight of solution

Assume 10 % HCl solution

= 160 kg

Volume of the salt required '

Sp. Gravity of the salt 1.18

= 0.13559322034 m^3 Salt Solution

Regenartion time	atleast 0.5 hr		So take	0.75 hr
Starting Q	4 Bv/h	0.08985487 h		
Reduced Q	3 Bv/h	0.1198065 h		

Backwash flow rate

Temperature 20 C

= 15 m/h

Backwash Duration

= 10 min

Rinse rate and time

From Table

At 35 Bv/h for 35 min

Total Time

Operation time + Regenration time + Rinse Time +Backwashing time (in hr)

0.4107109952 + 0.75 + 0.583333 + 0.166667

= 1.910711 hr

Not treated to 0 hardness cause water will become corrosive due to decrease in pH

SECTION 2: Physical Properties:

- Matrix: Styrene-divinylbenzene copolymer
- Functional Group: Sulfonic acid
- Physical Form: Amber, spherical beads
- Ionic Form as Shipped: Hydrogen (H+)
- Total Capacity: 1.8 meq/mL (minimum)
- Moisture Content: 52-56%
- Particle Size: 16-50 mesh (300-1200 μm)
- Particle Density: 0.81 g/mL
- Shipping Weight: 840 g/L

- Regenerant: Hydrochloric acid (HCl) or
- Regenerant Concentration: 4-8% HCl o
- Regenerant Flow Rate: 1-10 bed volum
- Regenerant Level: 60-200 g/L of resin

SECTION 6: Shipping and Storage:
Precautions for safe handling

For precautions see SDS
section 2.2.

- Shipping Weight: 840 g/L
- Storage Temperature: 4-38°C (39-100
- Shelf Life: 2 years from the date of mar

SECTION 3: Performance Properties: Substances

- Operating pH Range: 0-14
- Maximum Operating Temperature: 120°C (248°F)
- Oxidizing Agents: <5%
- Organic Fouling: Moderate

SECTION 4: Typical Applications:

- Demineralization
- Softening
- Condensate Polishing
- Uranium Recovery
- Industrial Water Treatment

SECTION 5: Recommended Operating Conditions:

- Service Flow Rate: 1-6 bed volumes/hour
- Backwash Flow Rate: 50-100% bed expansion

Sulfuric acid (H2SO4)
r 2-6% H2SO4
es/hour

°F)
ıufacture

Parameter	Strong acid cation resin	Strong base anion resin	Unit
Exchange capacity	3.6–5.5	1.8–2.0	meq/g as CaC
	1.6–2.2	0.8–1.4	meq/mL as C
Operating capacity[a]	50–70	40–60	% of exchang
Moisture content	40–80	35–80	%
Shipping weight (moist)	640–930	670–720	kg/m^3
Screen size	16 × 50	16 × 50	
Service flow rate	200–2000	200–2000	$m^3/d \cdot m^3$ of r
	8–40	8–40	BV/h
Surface loading rate	400–800	400–800	$m^3/d \cdot m^2$ or r
Backwash rate	12–20	5–7.5	$m^3/h \cdot m^2$ or r
Backwash duration	5–15	5–20	min
Bed expansion	50	50–75	%
Regenerant	NaCl	NaCl	
Regenerant concentration	5–10	2–15	%

Regenerant concentration	[illegible]	[illegible]	[illegible]
Regenerant dose	80–320	80–320	kg NaCl/m^3 o
Regeneration flow rate	60–120	60–120	$m^3/d \cdot m^2$ or r
	2–5	2–5	BV/h
Rinse volume	2–5	2–10	BV
pH range	0–14	0–14	units
Max. operating temp.	140	OH^- form = 60; C^- form = 100	°C
Turbidity limit	5	5	NTU
Iron limit	5	0.1	mg/L as Fe
Total Fe + Mn	0.3	0.3	mg/L
Chlorine limit	1.0	0.1	mg/L of Cl_2

[a]Operating capacity depends on the method of regeneration and amount of regenerant applied.

:O$_3$
aCO$_3$
e capacity
esin
n/d
n/h

f resin
n/d

Desired softness of water 100 mg/L CaCO3

Q 44.815914 m^3/sec 2 SETUPS

Temperature 20 C

Softening 100 mg/L

Column Diameter 2 m

Regeneration NaOH bases on manufacturer spec.

Resin type WBA Amberlite IRA-67

Manufacturer's data about the resin

Softening Capacity 250 Kg/m3

capacity 1.25 eq/L

Leakage 0.1 % of untreated water hardness

Maximum Diameter 1.5 m

Bed Depth 1.25 m

Backwash bad Expansion >50%

Recommended Operating Conditions

Operation	Rate	Solution	Time in min.
Service Flo	2-8 Bv/h	Water	
Backwash		Water	10 to 30
Regenation	0.5 -2 Bv/h	4 - 8% NaOH	45 to 75
Rinse	2-5 Bv/h	Water	10 to 30

`

Convert sulfate to meq/L

Concentration 164.15 mg/L CaCO3

Co 3.283 meq/L

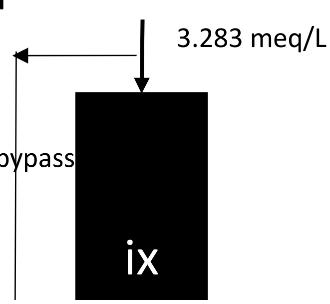
Ceff. 2 meq/L

Compute the SO42 in the effluent from the ion exchange column due to leakage

C leakage 0.003283 meq/L

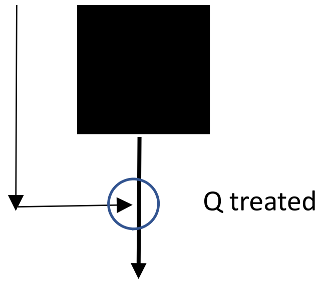
C desired 2 meq/L

Compute the bypass flow rate to achieve the desired hardness level



Assumptions at the connection of the Q bypass and Q treated

1. CSTR



2. No reaction occurs
3. Steady state

Q total = Q treat + Q bypass

Q treat x C leakage + Q bypass x C bypass = Q total x C desired

Q bypass = f(Q total)

Q treat = (1 -f) Q total

f = 0.135 13.5 %

Q Bypass = 13.5 mg/L

Q treat = 86.5 mg/L

Total Sulfate to be removed each day

= 24511292971.20 meq/day of hardness

24511292.9712 eq/day of hardness

Total Resin capacity = 250 Kg/m3

Reduce by 15 % for nonideality

Operating Resin Capacity = 212.5 Kg/m3

Bed Depth

As per specification not < 0.75m

Service flow rate

= 6 Bv/h m^3/m^3.h

Cross Sectional Area per column

= 3.14159265359 m^2

Maximum Diameter 2 m

Volume of column

= 6.28318530718 m^3

Total volume required

$$\frac{\text{Total flowrate}}{\text{Loading Rate}} = 51.9 \text{ m}$$

No. of Columns Required

$\frac{\text{Volume required}}{\text{Volume of 1 column}}$ = 8.260142

Say 9 1 is standby

Exchange capacity of each column

= 1335176.878 eq

1335176878 meq

Service time of the column

$\frac{\text{olumn Capacity X No. of columns}}{\text{Total Hardnes to remove per day}}$

= 0.490247165 day

11.76593197 hr

Total weight of Regenerant required per column From Man. Specs

= 17 kg

Volume of the salt required '

Sp. Gravity of the salt 1.18

= 0.014406779661 m^3

Regenartion time atleast 0.5 hr So take 0.75 hr

Starting Q	2 Bv/h	0.045260233 h
Reduced C	1.5 Bv/h	0.060346978 h

Backwash flow rate

Temperature 20 C

= 15 m/h

Backwash Duration

= 20 min

Rinse rate and time

From Table

At 5 Bv/h for 25 min

Total Time

Operation time + Regenration time + Rinse Time +Backwashing time (in hr)

11.76593 + 0.75 + 0.416667 + 0.333333

= 13.26593 hr

Area to irrigate	1 ha		
	2.46913580246914 acre	Conversion	
UAN 32 supplied for each stage	30 gallons/acre	1 acre	0.405 hectare
Total UAN 32	74.0740740740741 gallons		
		1 hec	2.469136 acre

UAN 32

Stages	Nitrogen
(Months)	Required (gallons/acre)
April	30
May	30
June	30
July	30
April	30
May	30
June	30
July	30

30 Gallons/acre of otl

Stages	Nitrogen	Phosphorus
(Days)	Required (kg/ha)	Required(kg/ha)
0-90	20	15
90-182	10	45
182 - 270	7	20
270- 360	20	55
360- 450	15	20
450 - 540	25	50
540-630	15	20
630- 730	112	225
	0	0

N	100	45.4	112.0988
	lbs/acre	kg/acre	kg/ha
P	200	90.8	224.1975
	lbs/acre	kg/acre	kg/ha

her work.