Refrigeration and Air conditioning Engineering.

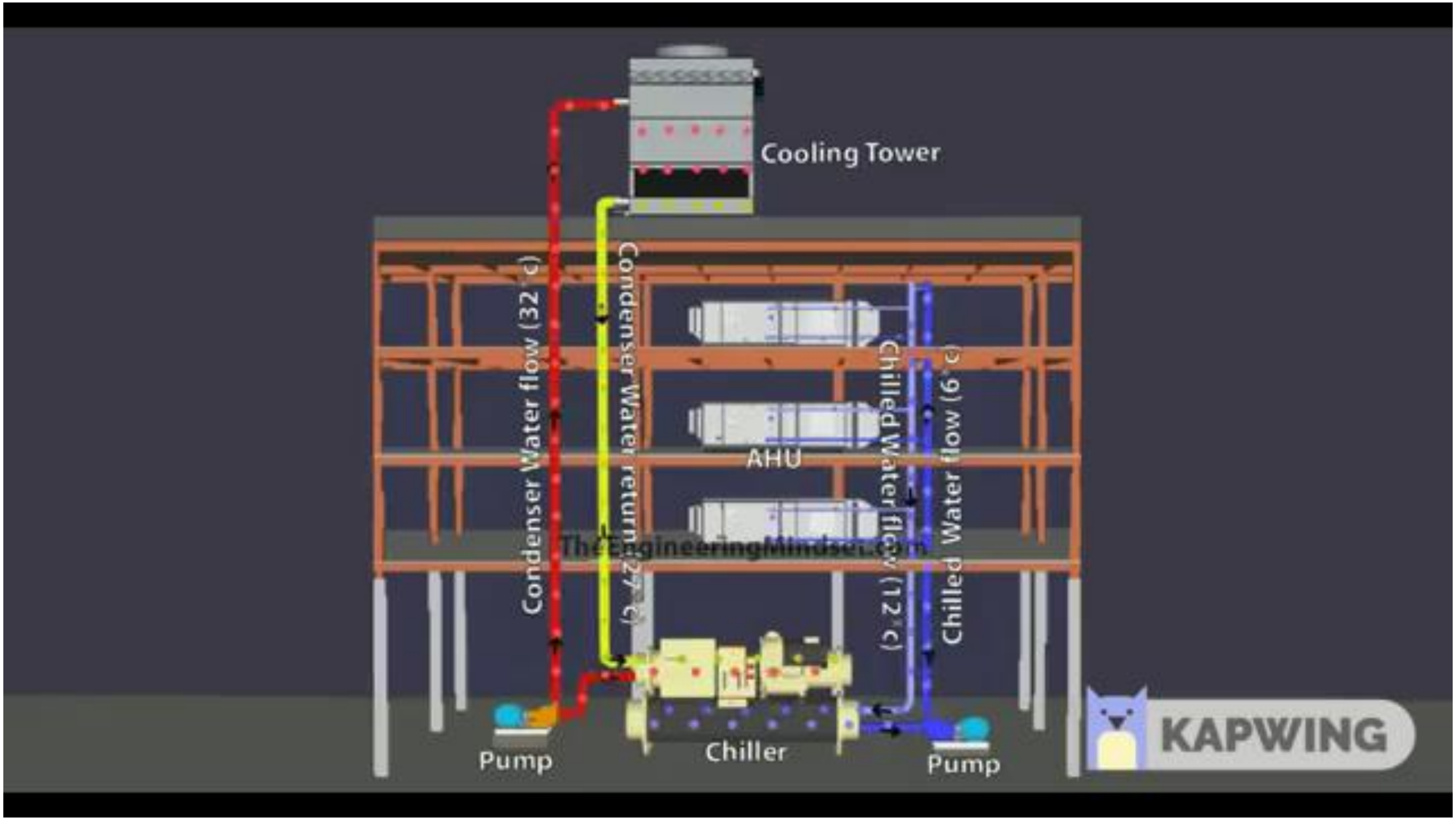
3rd year – refrigeration and Air conditioning Course

M.Sc. Zahraa F. Hussain

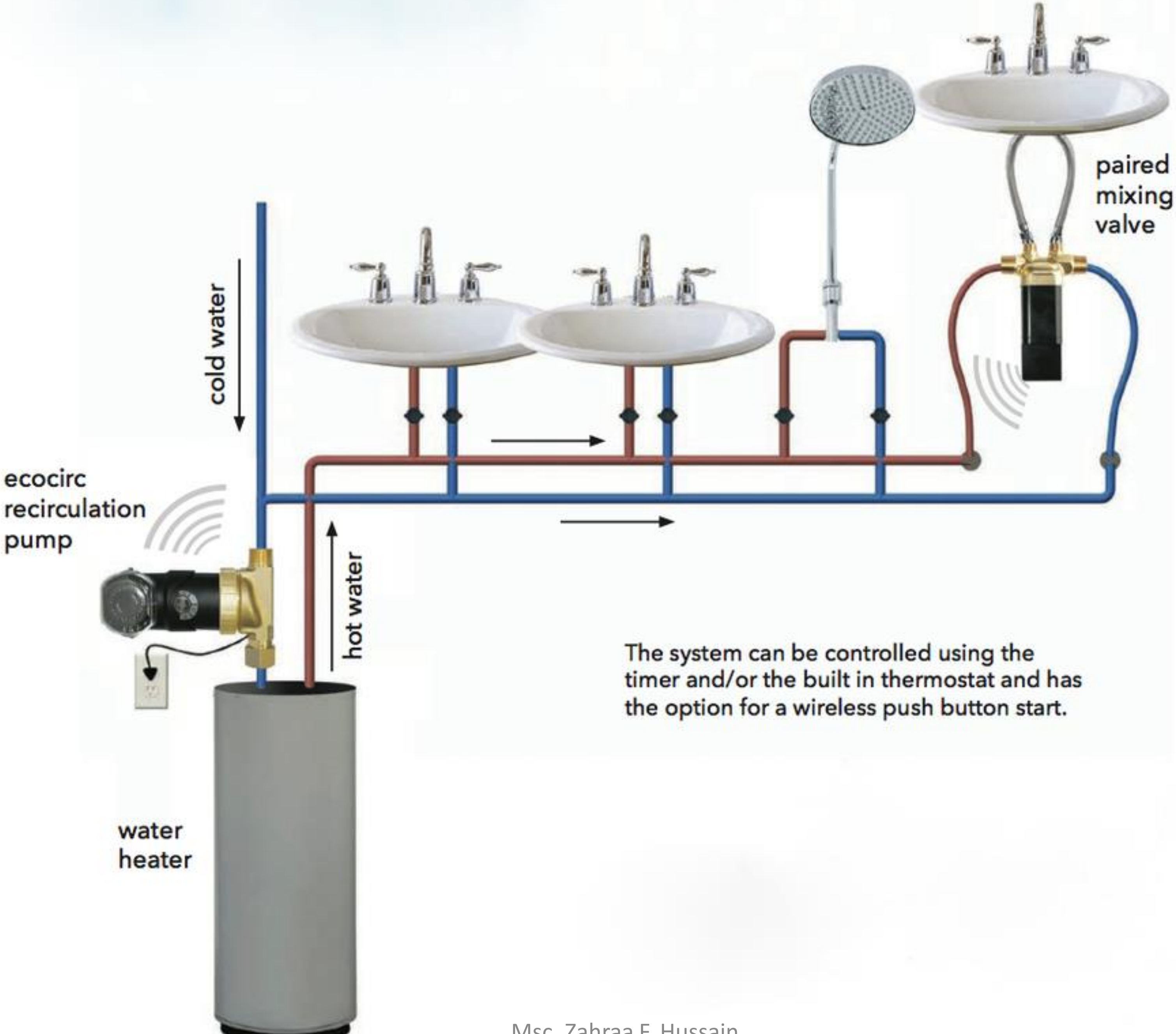
WATER PIPING SYSTEMS DESIGN
Part1

Lecture -10-

M.Sc. Zahraa F. Hussain

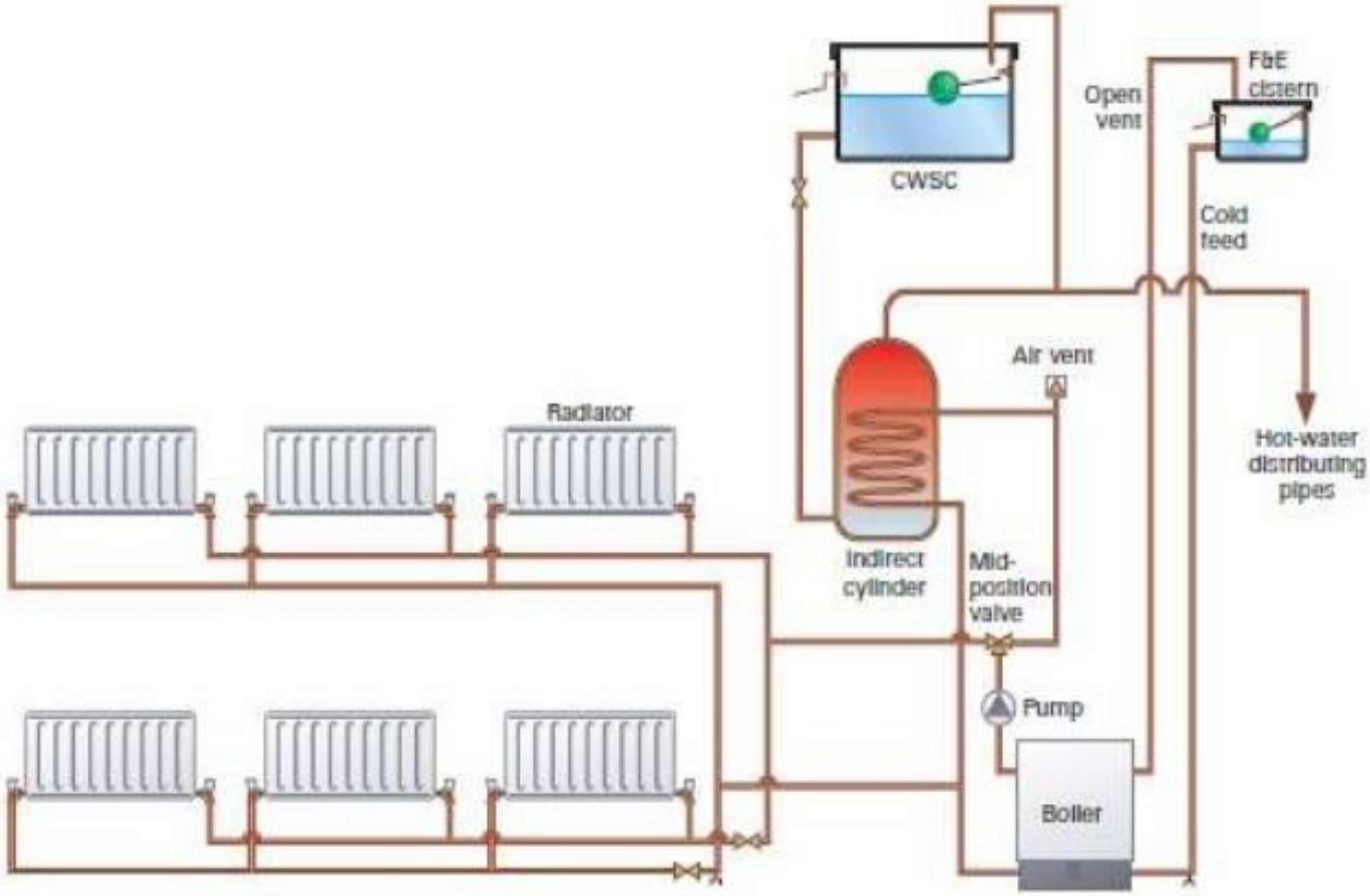


Cooling Tower
Condenser Water flow (32°c)
Condenser Water return (27°c)
AHU
Chilled Water flow (12°c)
Chilled Water flow (6°c)
TheEngineeringMindset.com
Pump
Chiller
Pump
KAPWING

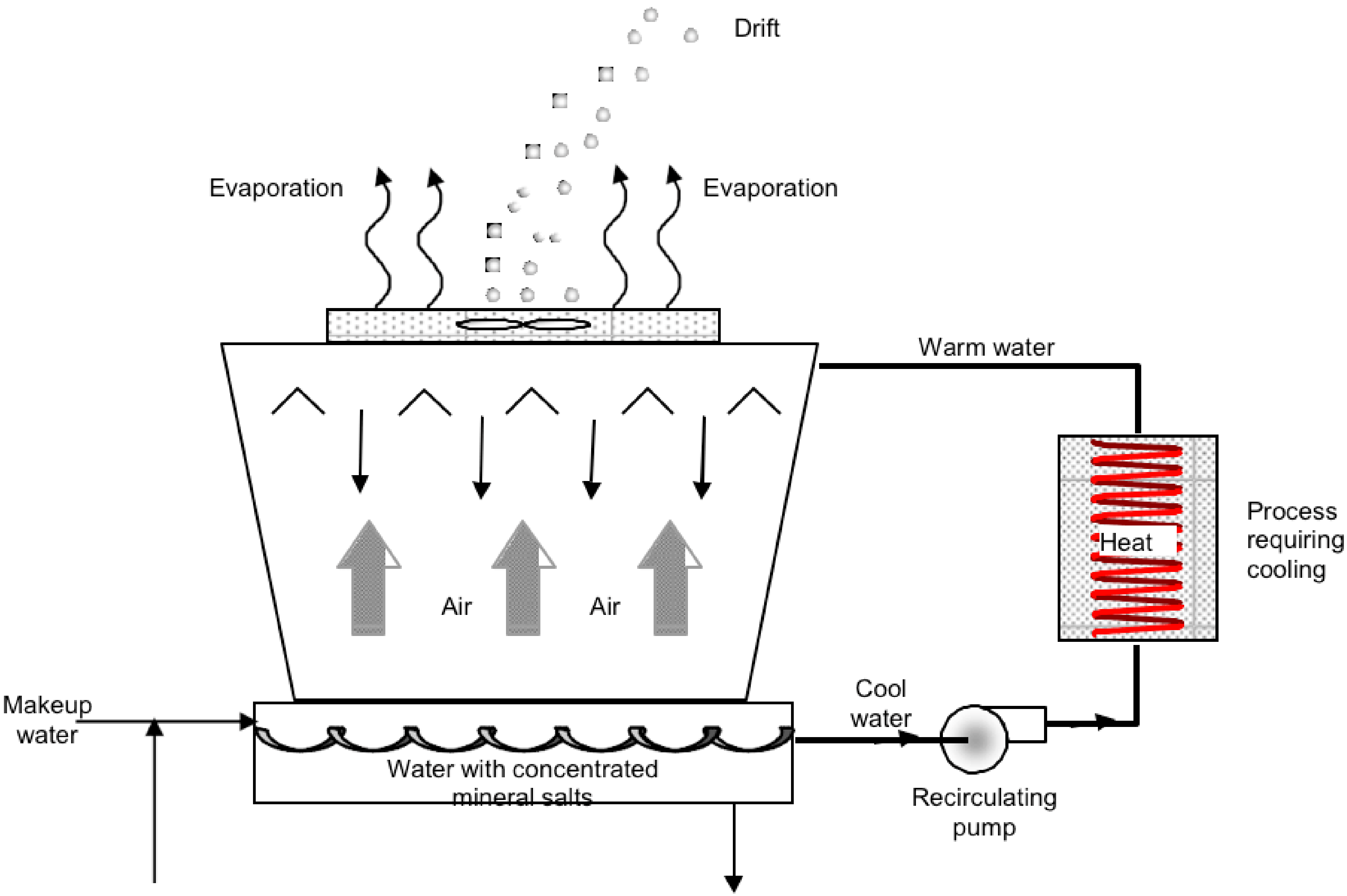


The system can be controlled using the timer and/or the built in thermostat and has the option for a wireless push button start.

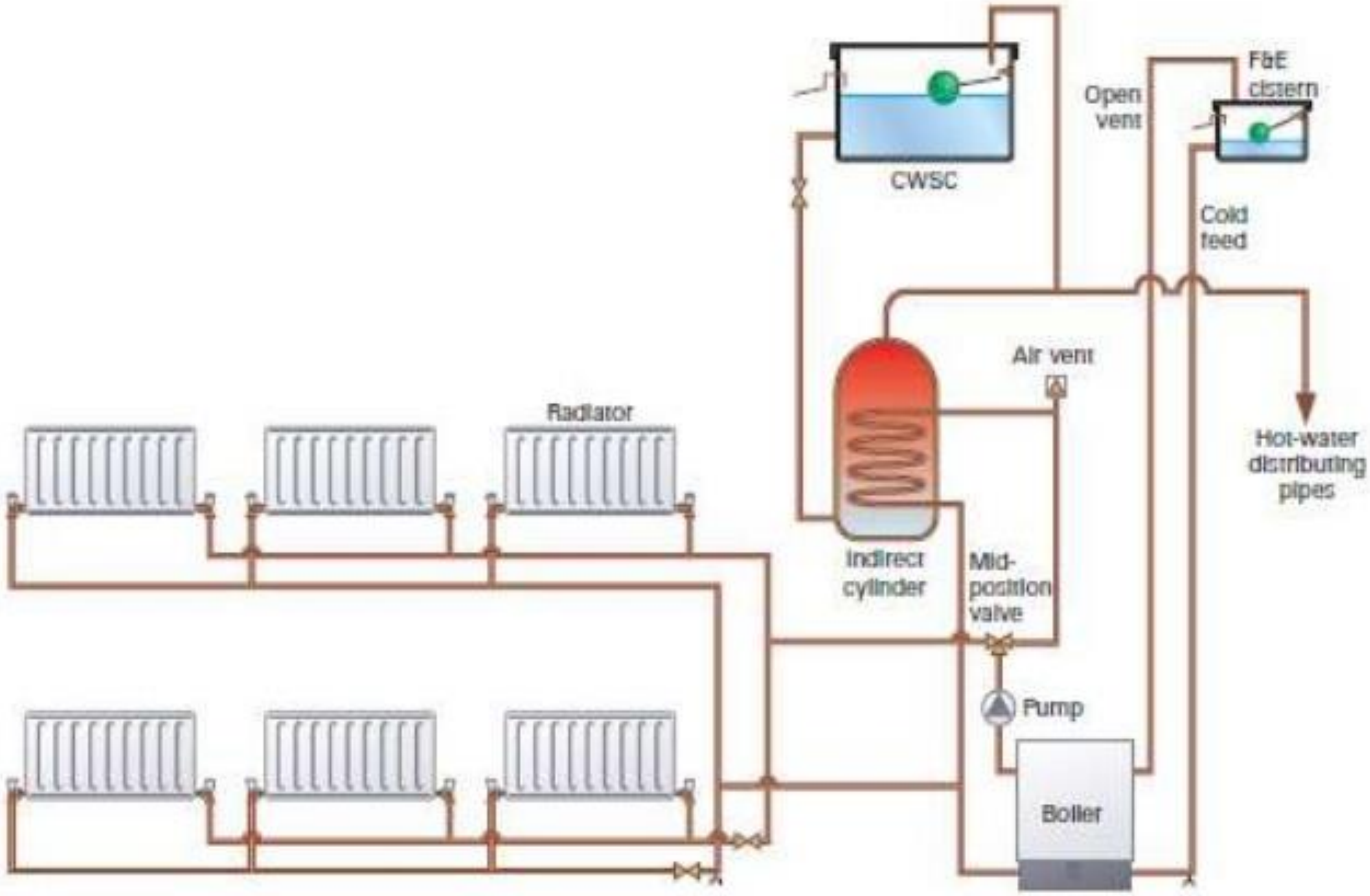
Fully pumped systems Y - plan



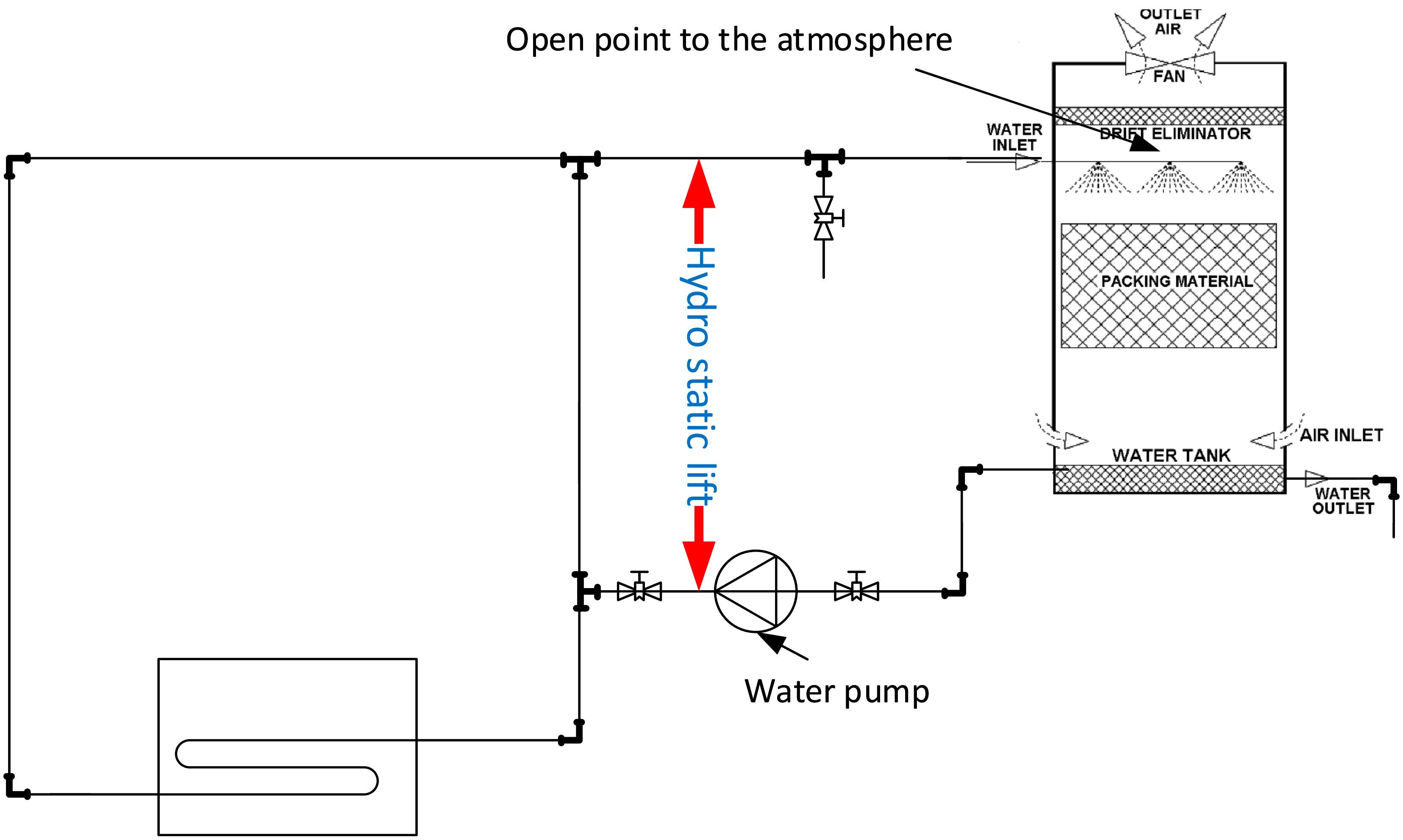
Cooling Tower Schematic



Fully pumped systems Y - plan



- All open piping systems have at least one point where atmospheric pressure is exerted on the surface of the water.
- This is the reference point for determination of hydrostatic lift imposed on the pump.

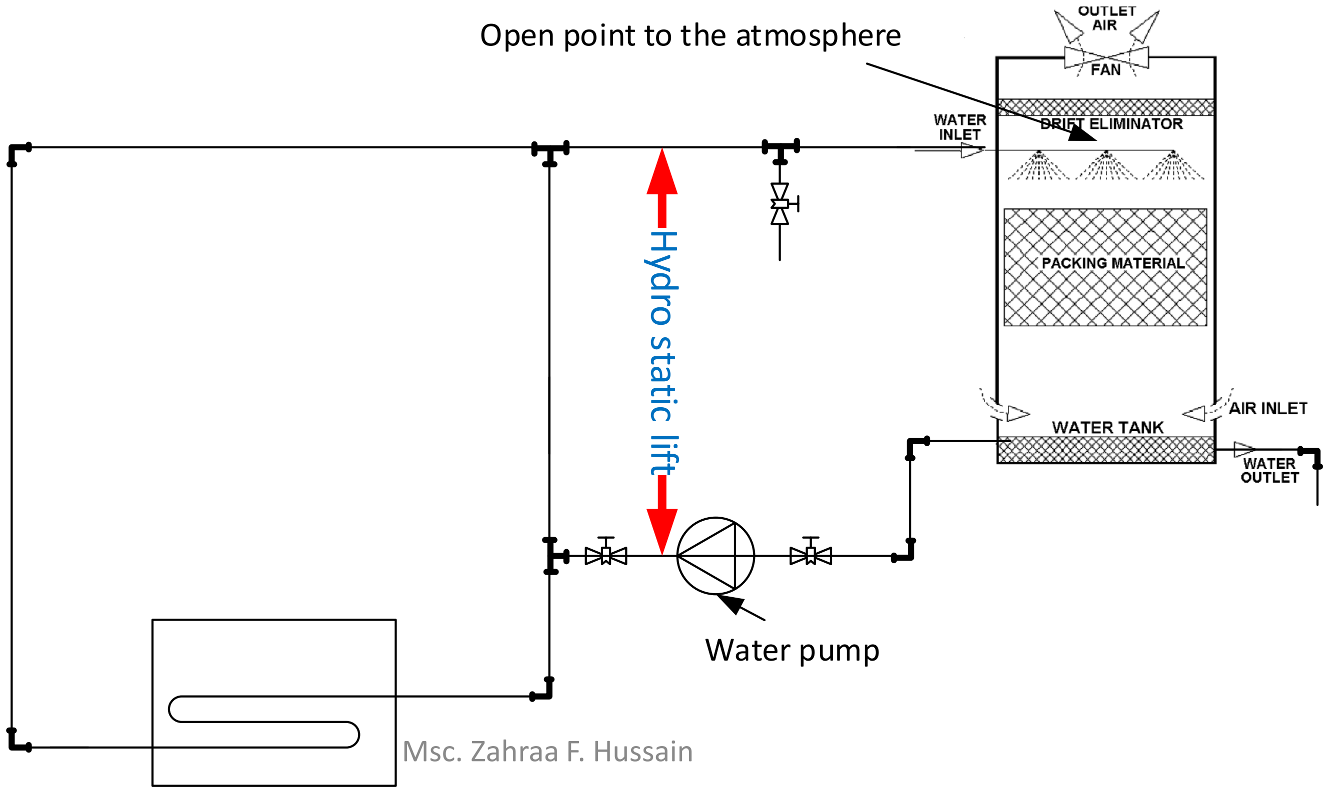


Open point to the atmosphere
OUTLET
AIR
FAN
DRIFT ELIMINATOR
WATER
INLET
PACKING MATERIAL
Hydro static lift
AIR INLET
WATER TANK
WATER
OUTLET
Water pump

- The hydrostatic lift is the vertical distance in feet between the water level on the suction side of the pump and the highest water level on the discharge side of the pump.

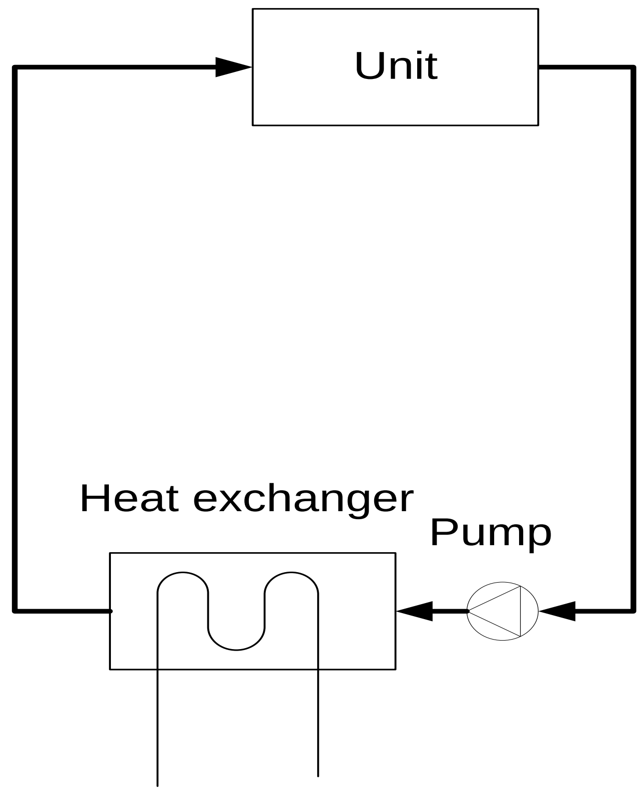
In an open system

In an open system, the suction reservoir may be at a different elevation than the discharge reservoir. The pump must overcome the **frictional losses of the system, plus the hydrostatic lift**, or the difference in elevation between the two reservoirs., as shown in Fig. 1



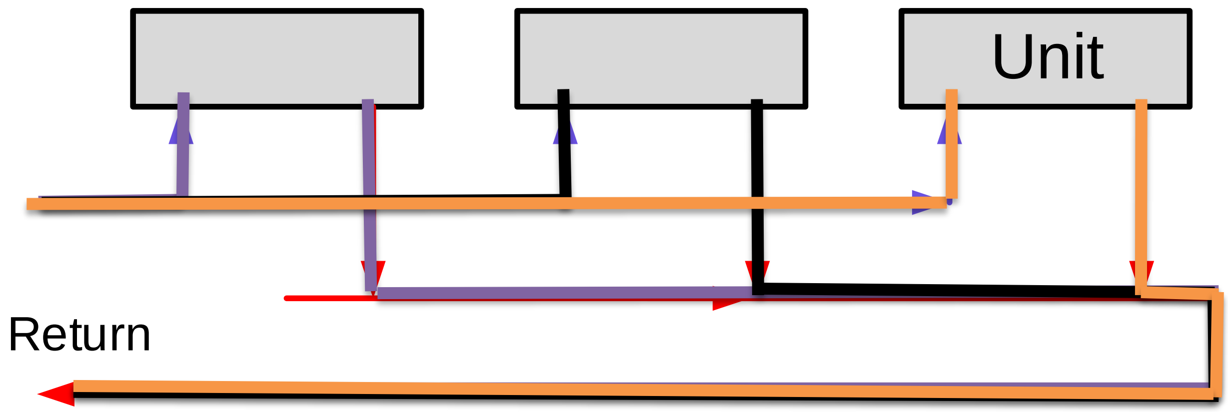
In a closed system

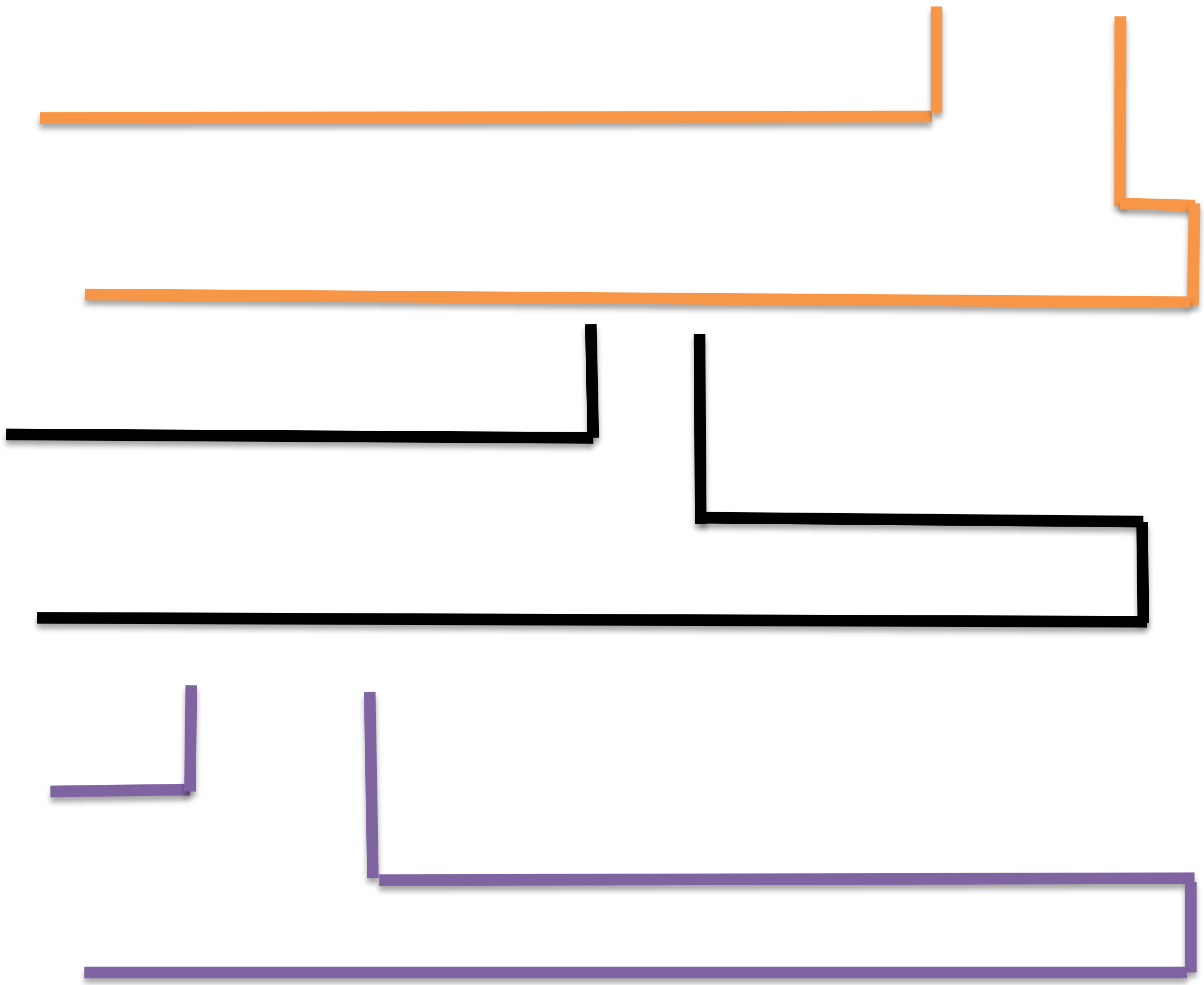
- **In a closed system** a pump must overcome **only the frictional resistance of the system**. The discharge reservoir is also the suction reservoir so there is no difference in elevation and consequently no hydrostatic lift for the pump to overcome, as shown in Fig. 2



What is the Reversed and Direct return?

1. Reverse return piping.

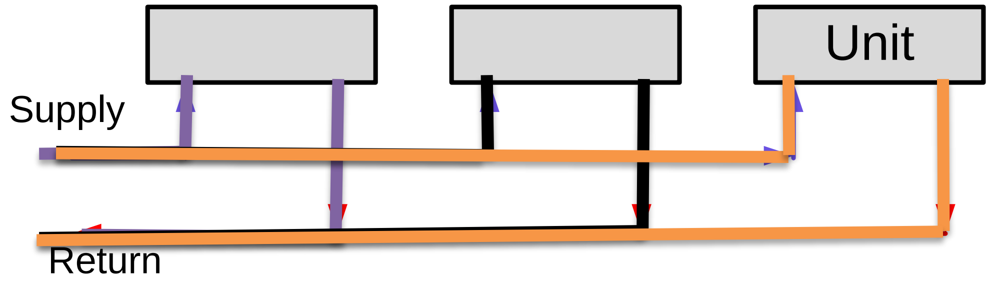




- If the units have the same or nearly the **same pressure drop through them, one of the reverse return methods of piping is recommended**.
- Reverse return piping is recommended for most closed piping applications. It is often the most economical design on new construction.

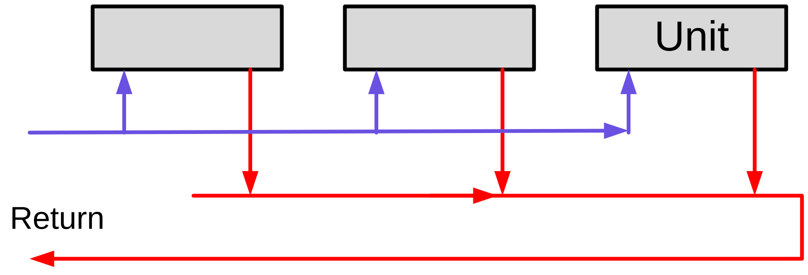
Water Piping System Return Arrangements

2. Direct return piping.

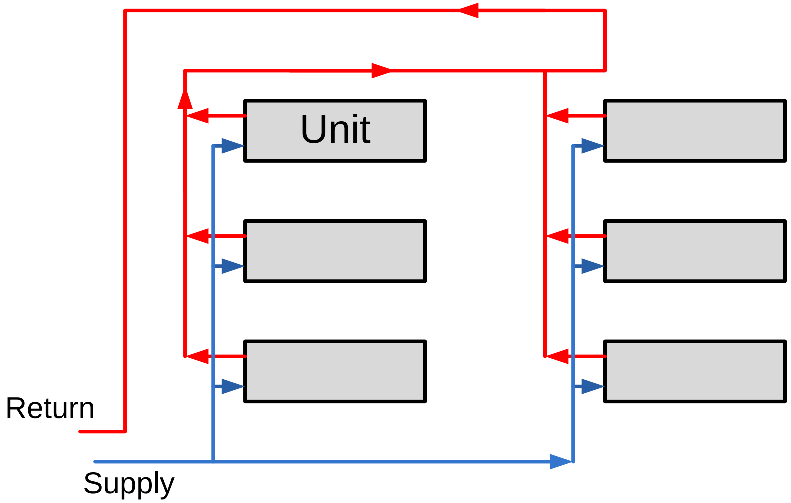


- However , if the units have **different pressure drops or require balancing valves, then it is usually more economical to use a direct return**.

Reverse return piping system

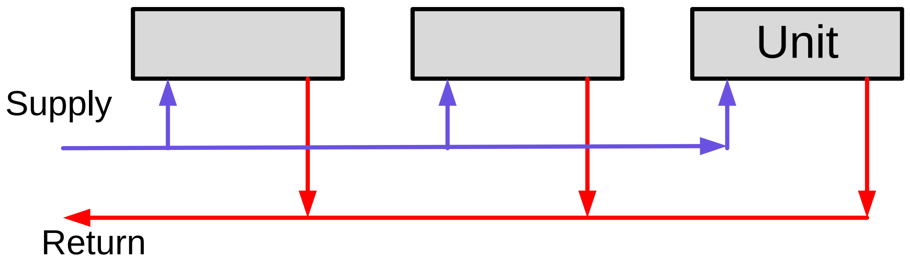


Reverse return piping

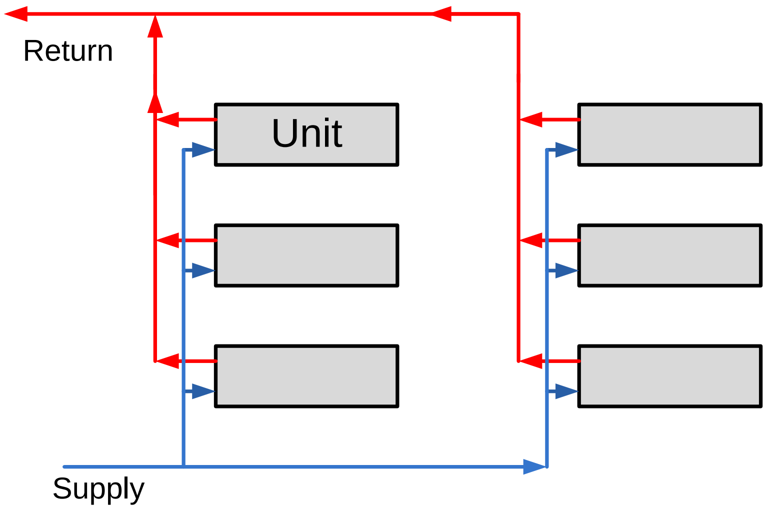


Reverse return header with direct return risers

Direct return piping system



Direct return piping



Direct return header with direct return risers

WATER CONDITIONING

- Normally all water piping systems must have adequate treatment to protect the various components against corrosion, scale, slime and algae.
- Water treatment should always be under the supervision of a water conditioning specialist. Periodic inspection of the water is required to maintain suitable.

PIPE SIZING

1. **Maximum velocity permissible which is established by:**

a-Noise generated by water flowing through piping.

b-Erosion of piping by water and entrained sand, air and other foreign particles

2. **Friction loss**:

- Once through systems must be sized to provide the required flow at a pressure loss within the pressure available after all other losses (Condenser Pressure Drop, Hydrostatic and Line, Valve and Fitting Losses) have been deducted.
- Re-circulating pump systems are sized to provide a reasonable balance between increased pumping horse-power due to high friction loss and increased piping first cost due to larger pipe sizes.

DESIGN LIMITATIONS

1. **Velocity — between 1 and 3.6 m/s**, as shown in table 1and table 2.
2. **Friction Loss - maximum 300 kPa. per 100** meter equivalent length.

- The system should be laid out with **valves, fittings, length of runs and water quantities shown for all mains and branches**. The size of the mains should be determined first and tabulated as shown in Table 5.
- The pressure should be indicated at the points in the system where branch run outs are taken.

WATER PIPING FOR COOLING TOWER SYSTEM

To select the proper water piping for a cooling tower system, the following information must be available:

1. Volume flow rate of water to be circulated.
2. Total length of piping.
3. Pressure drop across condenser (this varies widely and must be obtained from equipment manufacturer).
4. Hydrostatic lift of tower.
5. Number of valves, fittings and any other resistances in piping system.
6. Type of pipe used (Copper Tubing or Iron Pipe).

Example 1:

- Size the pipe system for a cooling tower shown in Fig. 4 with the following information:
- 1- Total length of piping 25.5 m
- 2- Water flow rate 2 lit/s
- 3- Pressure drop across condenser at 5 lit/s = 79 kPa.
- 4- Hydrostatic lift across tower = 1.5 m
- 5- 6 standard 90^{o} elbows
- 6- 2 Gate valves
- 7- 1 standard tee through side outlet
- 8- 1 standard tee straight through.

1- total length of piping 25.5 m
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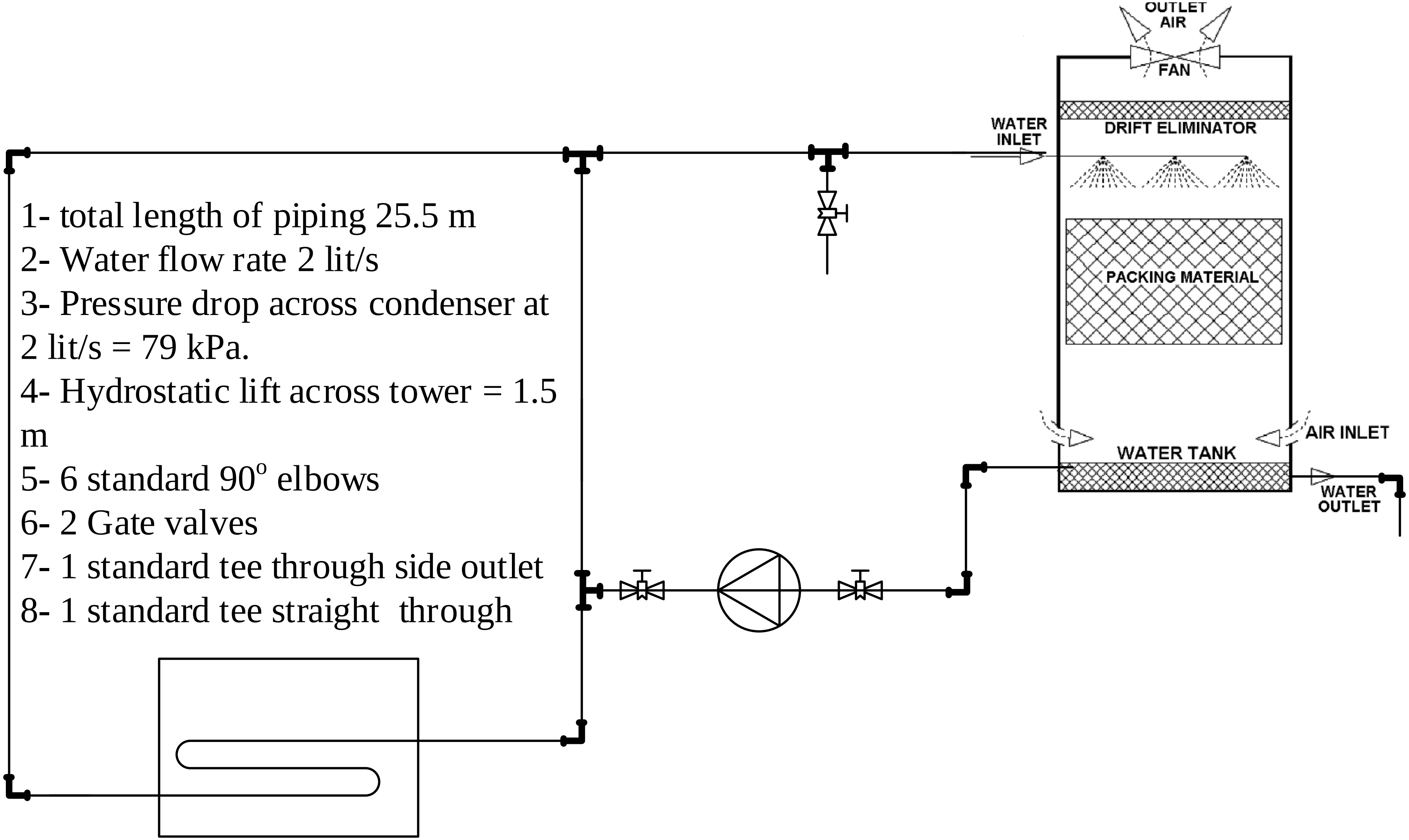


Solution:

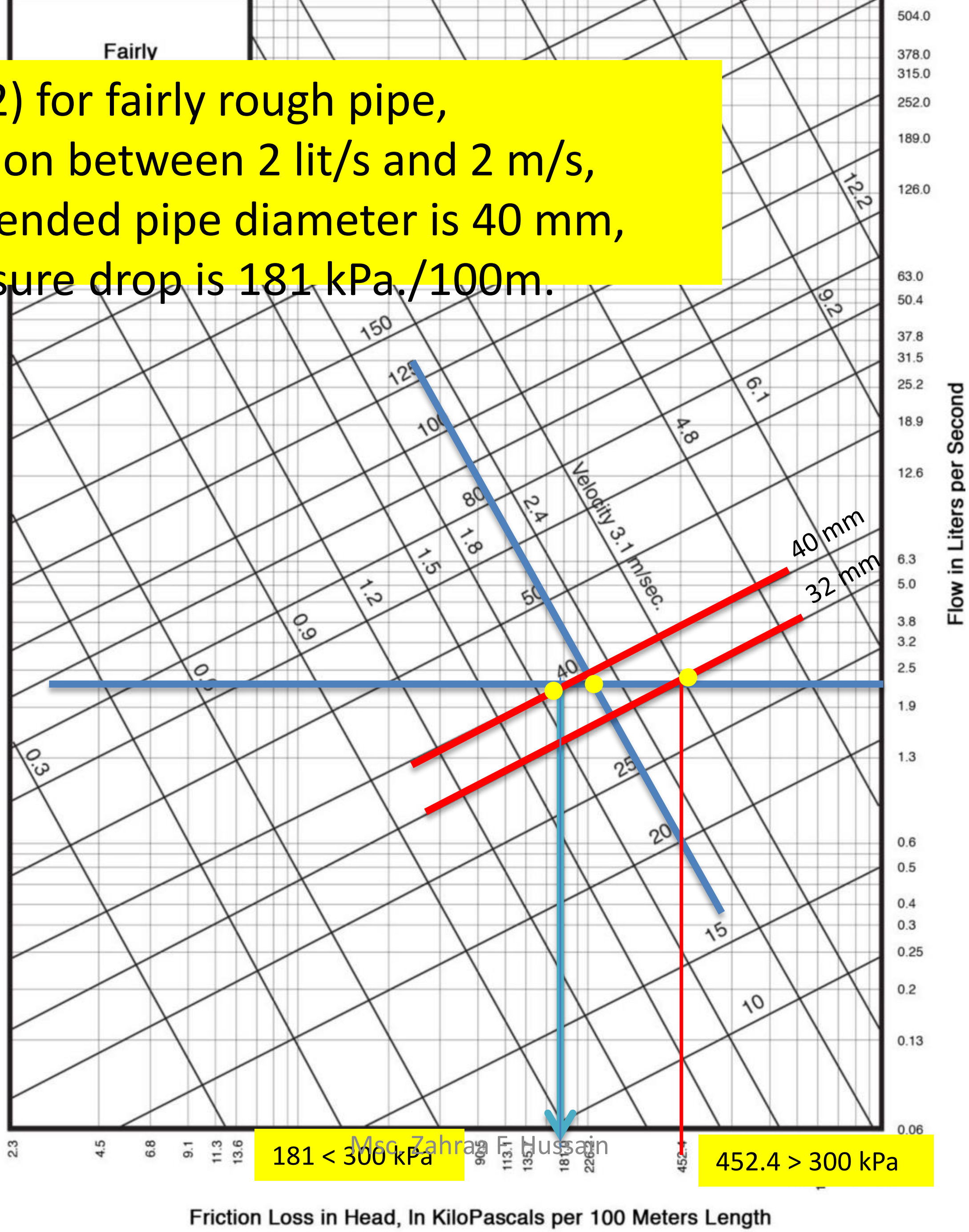
1. From table 1, the recommended velocity for header and riser are between 1 to 3.6 m/s, let the velocity is [illegible] m/s

Service	Velocity m/s
Pump discharge	2.5- 3.6
Pump suction	1.3 – 2.2
Drain line	1.3 – 2.2
Header	1.3 – 3.6
Riser	1 - 3
General service	1 – 3
City water	1 – 2.2

From chart (2) for fairly rough pipe,
the intersection between 2 lit/s and 2 m/s,
the recommended pipe diameter is 40 mm,
and the pressure drop is 181 kPa./100m.

Q=2 lit/s

C= 2 m/s



Pressure loss or friction loss

- In the piping system the pressure is taken as a the pipe length and the equivalent fittings or valves length in meter

No.	Type	Leq	No. or length	Length	Net length
1	Straight pipe				
2	standard 90^{o} elbows (table 4)				
3	Gate valve (table 3)				
4	standard tee through side outlet				
5	standard tee straight through				
6	Hydrostatic lift across tower				
	Total				

1- total length of piping 25.5 m
2- Water flow rate 2 lit/s
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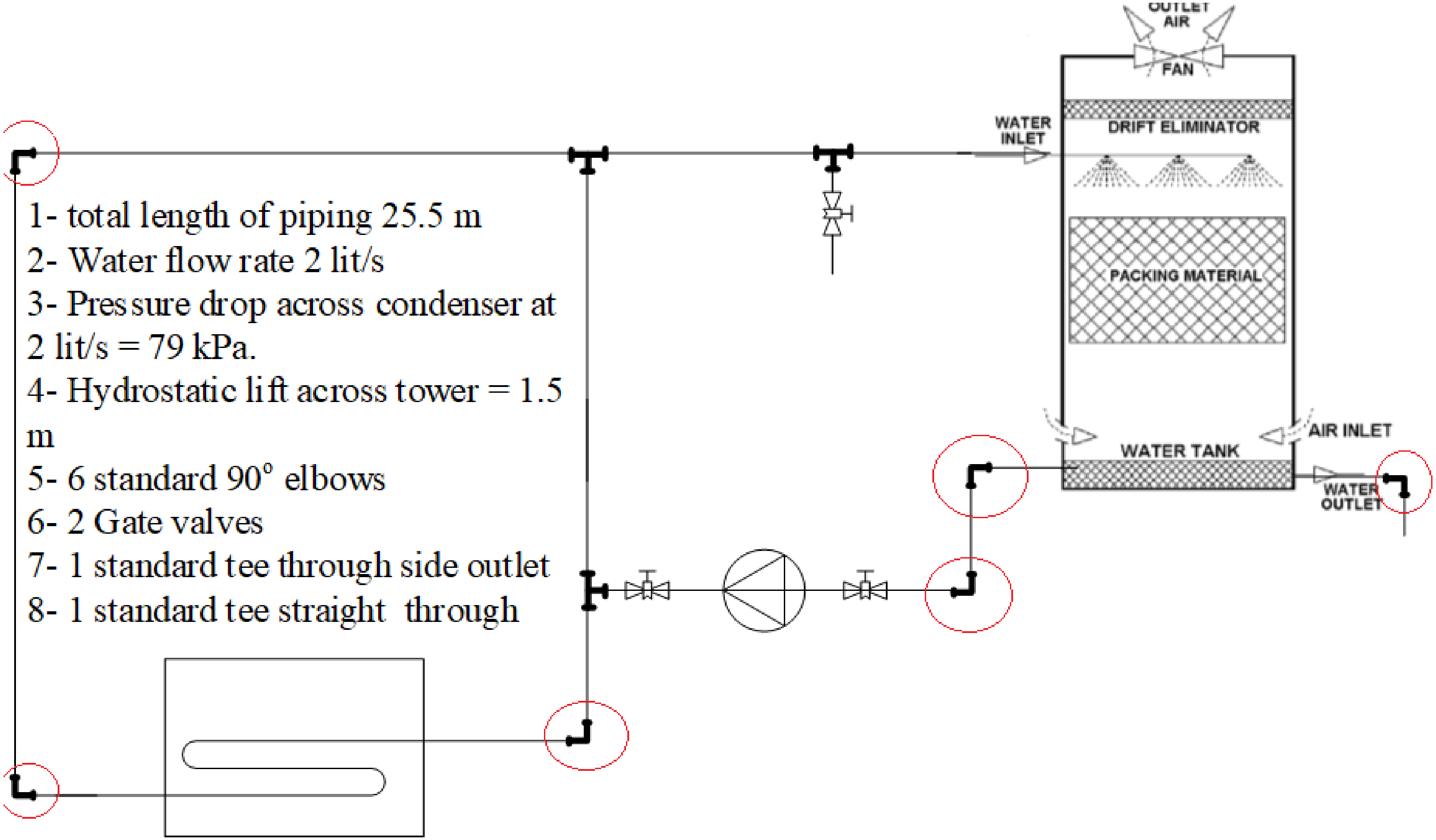

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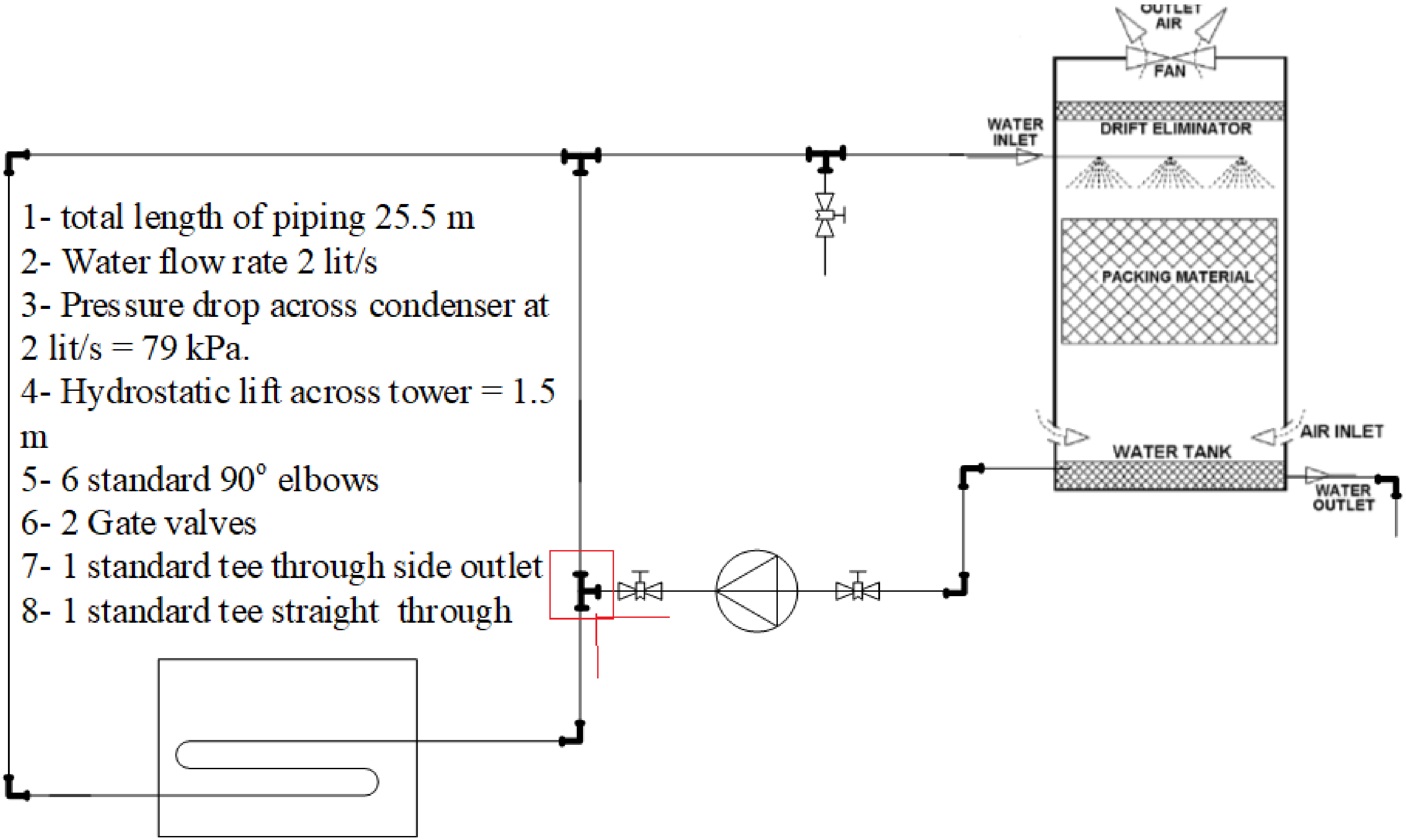

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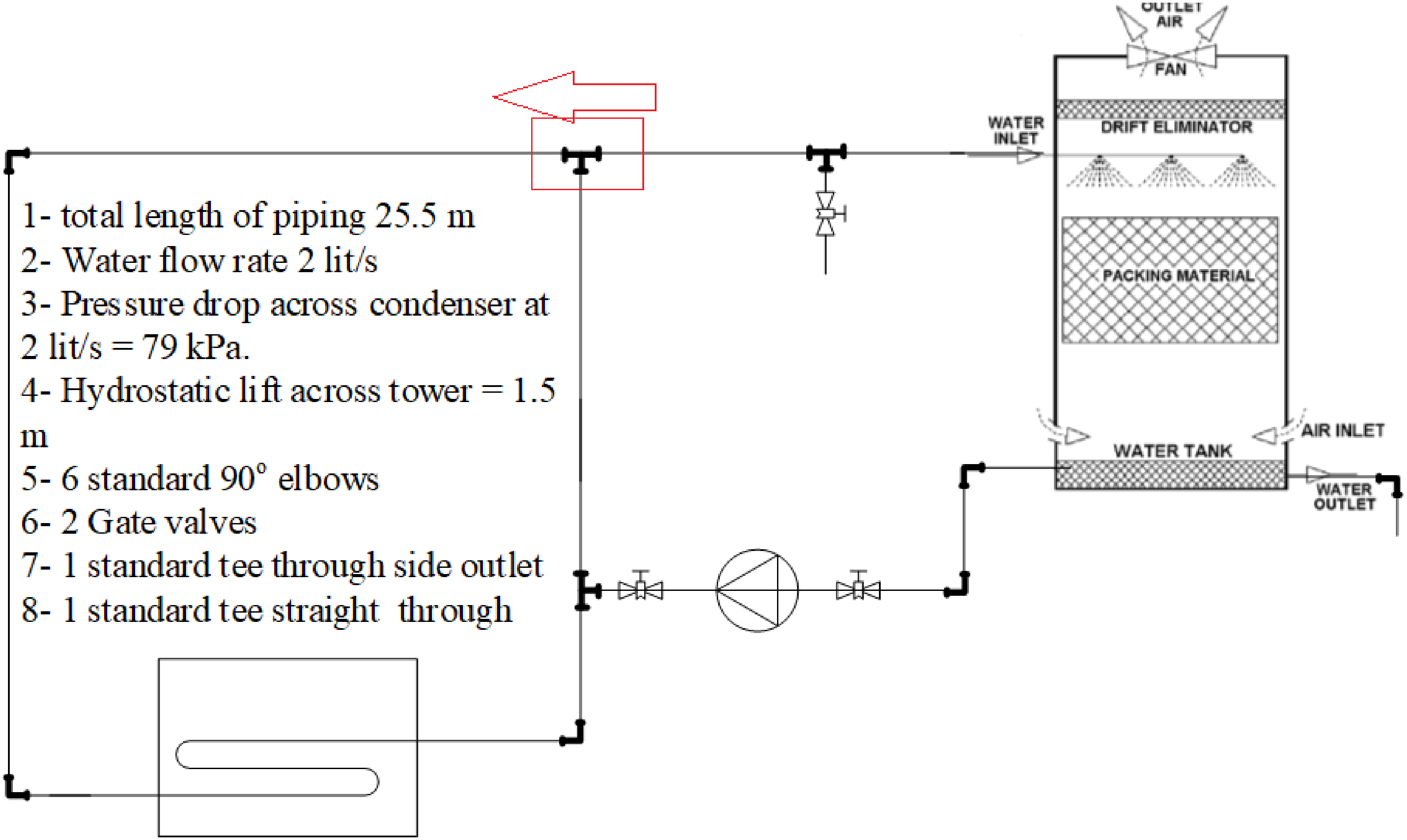
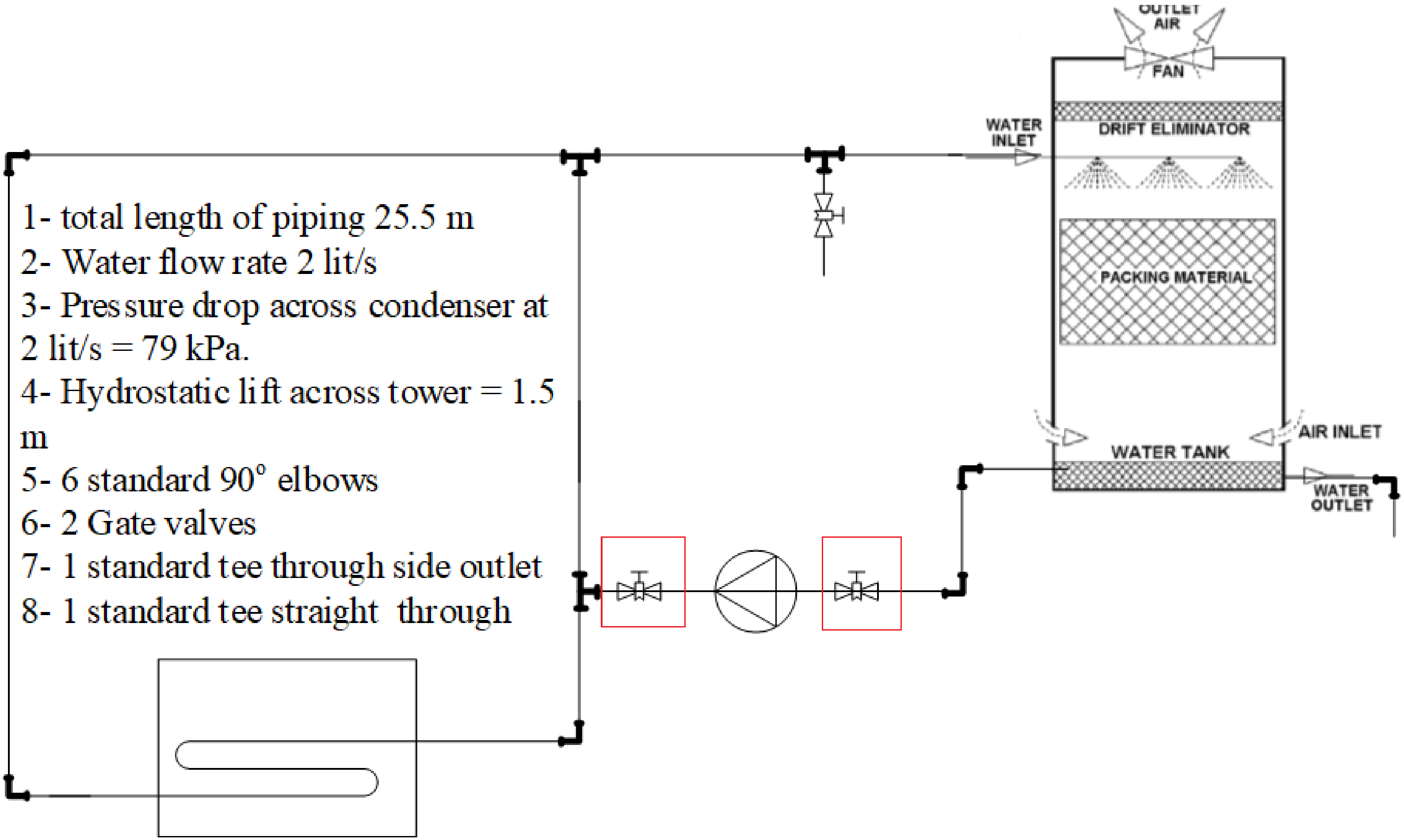


No.	Type	Leq	No. or length	Length	Net length
1	Straight pipe	1	25.5	25.5	25.5
2	standard 90^o elbows (table 4)	1.22	6	6×1.22	7.32
3	Gate valve (table 3)				
4	standard tee through side outlet	2.44	1	1×2.44	2.44
5	standard tee straight through	0.793	1	1×0.793	0.8
6	Hydrostatic lift across tower				
	Total				

2 Gate valves



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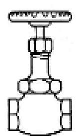
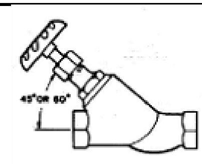
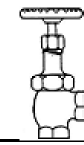
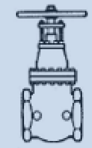
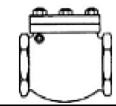
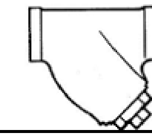
2 Gate valves   Leq=549 mm=0.549 m

Table (3) Valve loss in equivalent (mm) length

Nominal diameter mm	 Globe	 Angle 60° Y	Angle 45° Y	 Angle	 Gate	 Swing Check	 Y type strainer Flanged	Y type strainer Screwed end
10	5185	2440	1830	1830	183	1525	------	------
15	5490	2745	2135	2135	2135	1830	------	915
20	6710	3355	2745	2745	275	2440	------	1220
25	8845	4575	3660	3660	305	3050	------	1525
32	11590	6100	4575	4575	458	4270	------	2745
40	13115	7320	5490	5490	549	4880	------	3050
50	16775	9150	7320	7320	702	6100	8235	4270
65	21045	10675	8845	8845	854	7625	8540	6100
80	30500	15250	12505	12505	1220	10675	14640	------
100	36600	17690	14335	14335	1373	12200	18300	------
125	42700	21655	17690	17690	1830	15250	24400	------
150	51850	26840	21350	21350	2135	18300	33550	------

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3	Gate valve (table 3)	0.549	2	2×0.549	1.1
4	standard tee through side outlet	2.44	1	1×2.44	2.44
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6	Hydrostatic lift across tower				
	Total				

Hydrostatic lift across tower = 1.5 m

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3	Gate valve (table 3)	0.549	2	2×0.549	1.1
4	standard tee through side outlet	2.44	1	1×2.44	2.44
5	standard tee straight through	0.793	1	1×0.793	0.8
6	Hydrostatic lift across tower	1	1.5	1.5	1.5
	Total				38.99 m

- Equivalent length Pressure drop due pipe length, valves and fittings=$39m$
- $(39) * \frac{181}{100} = 71\ kPa$.
- Pressure drop across condenser at 2 lit/s = 79 kPa
- Total pressure loss= 71+79=150 kPa.