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Dimensions of a fixed firefighting installation: standpipe and hose system type.

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-

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DEDECATIONS

We would like to dedicate this memory to:

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To our friends and all those who helped us in this journey of three years of study...

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ABREVIATION LIST

AHJ: authority-having jurisdiction.

FDC: fire department connection.

NFPA: National fire protection association.

PRD: pressure-regulating device.

PRV: pressure-regulating valve.

SYMBOL LIST

R = Reynolds number, dimensionless.

V = average flow velocity.

D = inside diameter of pipe.

ρ = mass density of liquid.

μ = dynamic viscosity.

γ = specific weight.

ρ = density.

g = acceleration due to gravity.

ν = kinematic viscosity.

μ = absolute viscosity.

h = frictional head loss.

L = length of pipe.

D = inside diameter of pipe.

C = Hazen-Williams C factor or roughness coefficient, dimensionless.

GENERAL INRODUCTION

The advancement of technology creates many benefits for humanity but the latter has come with major fire hazards which caused effects on humans, equipment and environment; which created the need to research and develop systems for fighting fire.

Those methods of firefighting differ in two types: mobile (extinguishers) and fixed (sprinkler and standpipe system); in the fixed means the standpipe system are characterised by precise dimensions and well-defined calculations to obtain the effectiveness of the extension.

To obtain the precise dimensions and the well-defined calculations in line with the standards (NFPA), experts creates many software that ensure fast and accurate calculations, no matter how large or complex the network is; the PIPENET software is the choice for this study.

Problematic:

So, is the standpipe and hose system is effective enough for firefighting and extinguishing? Moreover, is the PIPENET software is in line with the standards (NFPA)?

Hypothesis:

- The standpipe and hose system is an effective way for encountering and extinguishing fire.
- The PIPENET software is harmonized with NFPA standards.

The objectives of this study: mainly are:

- Providing the necessary knowledge about standpipe and hose system and its features.
- Master the PIPENET software by using the standpipe and hose system installation.
- Make the installation in line with the NFPA 14 standards.

Structure of the thesis:

This thesis is divided in two chapters, in the first chapter we discuss a theorical content titled by description of general information of standpipe and hose system where we could explain it through these sections:

- A first section mention general information of standpipe and hose system where we explain some theatrical notions related to this study.
- The second section contain the requirements of standpipe and hose system where we mention
- In the third section, we put a general overview about fluid mechanics, which helps us in the practical.

The second chapter is a practical one titled by "Standpipe network: design and application" which contains:

- The first section is titled institute of thenology, University Kasdi Merbah OUARGLA.

- The second section is titled software and calculation, which explains the software, used in the thesis "PIPENET", furthermore the schema of the installation, the input data and the result.

CHAPTER 1: DESCRIPTION OF STANDPIPES AND HOSE SYSTEM.

INTRODUCTION

Standpipe and hose system is now one of the most useful and popular methods to decrease and extinguish the fire once it spread out. So, we started by breve definition of fire, then we moved to the description of standpipe and hose system where we tried to cover all the necessary information about it (standpipe system components, system classes...).Next, we mentioned the fluid mechanics and all the necessary formulas (Hazen-Williams equation, Bernoulli's equation…).

Section I: General information of standpipe and hose system.

1. Definition of fire:

Fire is outlined by Quintieri (2017) as a “chemical reaction that involves the evolution of sunshine and energy in adequate amounts to be perceptible”

NFPA defines fire as “A chemical reaction method that may be a chemical change leading to the evolution of sunshine, heat, and combustion products”.

2. What is Fire triangle?

The fire triangle, or combustion triangle, is that the three parts required beginning and

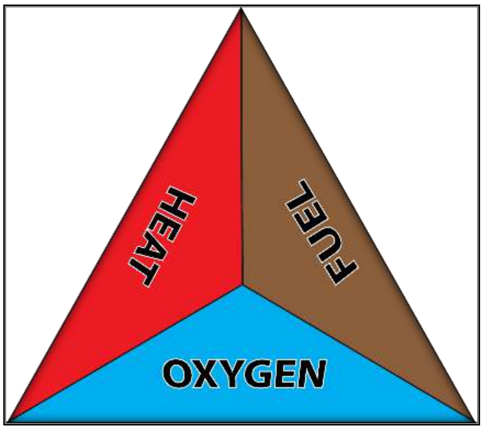


FIGURE 1 : FIRE TRANGLE.

sustaining a fireplace. The **three parts** of **the fire** triangle **area unit** Heat, Fuel and **O2.**

3. Fire classification: [1]

CLASS A: fireplace will involve any material that includes a burning coal or leaves an ash. Common samples of category “A” fires would be wood, paper, or pulp.

CLASS B: fireplace involves burnable liquid or gas. Acquainted examples would be gas, oil, propane, and gas.

CLASS C: fires involve live electrical instrumentation and need the employment of AN ending agent and/or device that may not conduct electricity back to the fire fighter(s).

CLASS D: fires involve exotic metals like zirconium, magnesium, and sodium.

CLASS K: fires involve cookery media. These may be any animal or vegetable based mostly fats or oils.

4. Importance of fire safety:

The importance of fire safety should be taken seriously because with all the most modern fire safety provisions that are provided by technology; it is still necessary to have adequate fire safety managements to assure and guarantee that the occupants of a building reach a place of safety in a fire.

5. History of Standpipe Systems: [2]

In the time period of fireplace, protection (prior to 1850) buildings were restricted tall, as a result of there was a limit to however high individuals were willing to steer upstairs. Firefighters didn't raise architects to style systems into buildings to reduce the quantity instrumentation of kit of apparatus} that they had to hold throughout a fireplace as a result of they were willing to hold their hose and equipment up constant steps that individuals used for everyday access to their buildings. All that modified in 1852 once Elisha Otis fabricated the elevator safety brake.

Prior to this, there have been elevators in use, however the ropes or cables that force them up simply worn and would break. Once this is able to happen, the elevator would drop uncontrollably. While not a security brake, folks questioned the protection of elevators and customarily did not use them. Otis' safety brake would mechanically deploy prongs on the facet of the automobile that might pin the car to racks on the facet if the hoist rope or cable snapped.

This convinced folks that elevators were safe to ride and ushered in a very new era of field style wherever the sky was virtually the limit.

With high buildings being created within the half of the nineteenth century, fireplace fighters began to admit ways to assist there firefighter in these high structures.

Fireplace mechanical device systems would be fictitious within the latter 1/2 the nineteenth century, however the price of putting in these systems unbroken them from being put in in most building. Instead, a piping network designed to hold water to hose connections, referred to as standpipes, became extremely popular.

These systems price but fire mechanical device systems and were marketed for each the public to use early in a very fire and for firefighters to use once they arrived on the scene.

Sadly, there have been no national standards for the look, installation and maintenance of those early pipe systems. Some cities developed their own necessities, a few insurance firms had suggestions relating to style, installation and maintenance, however they were every completely different and generally conflicting that caused confusion among style engineers and building house owners.

6. Fire protection standpipe definition [3]

NFPA defines a standpipe as: an "arrangement of piping, valves, hose connections, and associated equipment installed in a building or structure, with the hose connections located in such a manner that water can be discharged in streams or spray patterns through attached hose and nozzles, for the purpose of extinguishing a fire, thereby protecting a building or structure and its contents in addition to protecting the occupants."

7. Types of standpipe system: [3]

Automatic–Dry:

This piping kind is connected to a permanent installation capable of meeting flow and pressure needs. It is stuffed with air struggling. It uses a valve (similar to a dry pipe mechanical device valve) that releases water into the piping system once a hose station outlet is opened.

Automatic–Wet:

This piping kind is connected to a permanent installation capable of meeting flow and pressure needs. It is stuffed with water in the least times.

Semi-automatic–Dry:

This piping kind is connected to a permanent installation capable of meeting flow and pressure needs. It employs a valve (similar to a deluge valve) that releases water into the piping system once a distant operational device is operated.

Manual–Dry:

This piping kind is not connected to a permanent installation. The fire department connects to a hydrant and provides the system.

Manual–Wet:

This piping kind is not connected to a permanent installation. The fire department connects to a hydrant and provides the system. The piping is stuffed with “priming water” to cut back the time it takes to induce water to the hose station retailers.

8. System classification. [3]

8.1. Class I System

A Class I piping system shall provide21⁄2in. (65 mm) hose connections to produce water to be used by fire departments and people trained in handling significant fire streams.

For Class I, the minimum flow for the hydraulically most remote piping shall be500 gpm (1893 L/min), through a pair of} most remote 2 in. (65 mm) hose connections.

Wherever a horizontal piping on a class I system provides 3 or many hose connections on any floor, the minimum flow for the hydraulically most exigent horizontal piping shall be 750 gpm (2840 L/min),

- The maximum flow shall be a 1000 gpm (3785 L/min) for buildings that area unit sprinklered throughout, in accordance with NFPA 13, and 1250 gpm (4731 L/min) for buildings that don't seem to be sprinklered throughout.
- A minimum pressure of a 100 psi (6.9 bar), whereas the utmost of 175 psi (12.1 bar).
- The travel distance shall be two hundred foot (61 m) for sprinklered buildings.
- The travel distance shall be a hundred thirty ft. (39.7 m) for nonsprinklered buildings.

8.2. Class II System.

A class II piping system shall offer either 11⁄2 in. (40 mm) hose stations to produce water to be used by trained personnel or a hose connection for the fire department throughout initial response.

A minimum 1 in. (25.4 mm) hose shall be allowable to be used for hose stations in light-weight hazard occupancies wherever investigated and listed for this service and wherever approved by the AHJ.

- The minimum flow for the hydraulically most remote hose connection shall be a 100 gpm (379 L/min).

- The maximum flow needed from an 11⁄2in. (40 mm) hose connection shall be a 100gpm (379 L/min).
- A minimum pressure of 65 psi (4.5 bar), whereas the utmost of a hundred psi (6.9 bar).
- The travel distance shall be a 130ft (39.7 m) of a hose connection supplied with 11⁄2in (40 mm) hose or at intervals a 120 ft. (36.6 m) of a hose, connection supplied with but connection. (40 mm) hose.

8.3. Class III System.

A class III piping system shall offer one 1 ½ in. (40 mm) hose connection to produce water to be used by trained personnel and 2 ½ in. (65 mm) hose connections to produce a bigger volume of water to be used by fire departments and people trained in handling significant fire streams.

- The minimum flow for the hydraulically most remote piping shall be500 gpm (1893 L/min), through a pair of} most remote 2 ½ in. (65 mm) hose connections
- The maximum flow rate shall be a 1000 gpm (3785 L/min) for buildings that area unit sprinklered throughout, in accordance with NFPA 13, and 1250 gpm (4731 L/min) for buildings that don't seem to be sprinklered throughout.
- A minimum pressure of a 100 psi (6.9 bar), whereas **the maximum** of 175 psi (12.1bar), for the two ½ in. (65mm)
- A minimum pressure of 65 psi (4.5 bar), whereas **the maximum** of a100 psi (6.9 bar), for the 1 ½ in. (40mm)
- The travel distance shall be two hundred foot (61 m) for sprinklered buildings and shall be a 130 ft.(39.7 m) for nonsprinklered buildings for two 2/1in(65mm).
- The travel distance shall be a 130 ft. (39.7 m) of a hose connection supplied with 11⁄2in (40 mm) hose

Table 1: System classification.

Item	**Class I**	**Class II**	**Class III**
Hose size	**2.5 in**	**1 or 1.5 in**	**1.5 or 2.5 in**
Minimum pressure	**6.9 bar**	**4.5 bar**	**6.9 bar**
Maximum pressure	**12 bar**	**6.9 bar**	**12 bar**
Minimum flowrate	**250gpm**	**100 gpm**	**250 gpm**

9. Importance of standpipe system:

The purpose of designing Standpipe systems is to provide fire protection water for hose lines in strategic locations inside a building or structure.

10. Underground piping:

According to NFPA 24, **"**Underground piping shall be permitted to extend into the building through the slab or wall not more than 24 in. (600 mm)."

11. Standpipe system components:

11.1. Fire hose: [9]

Fire hose is inside the cabinet with length of 100ft. (30m).

The fire hose has three different diameters 1 in. (25) 1 ½ n. (40 mm) and 2 ½ in. (65mm).

FIGURE 2: Fire hose.

11.2. Cabinet: [9]

According to NFPA14, the cabinet shall be mounted on the wall at height of 90 to 150 m.

FIGURE 3: Cabinet.

There are three types of cabinet:

11.2.1. Wall mounted type (exposed) :

The cabinet is installed directly on the wall and is protruding from the wall and outside at distance of 0.25m.

11.2.2. Semi exposed type:

This type of cabinet is partly inside the wall while the rest is exposed outside of it.

11.2.3. Recessed type:

This type is completely immersed in the wall. In this case, it is necessary to put signs that indicate its location

11.3. Pipe: [4]

The most in depth element of a pipage system is that network of pipes carries water throughout the building. The National fire Protection Association (NFPA) specifies completely different necessities for the fabric utilized in underground pipe and surface pipes.

Undergroundpipes areaunit outlined asthose“buriedinsoil” andthatthey should be manufactured from lined ductile iron, cement, copper, brass, or plastic.

Steel pipes do not seem to be permissible underground, as they have an inclination to corrode quickly within the soil.

Surface pipes embrace those found in underground basements and garages, similarly because the pipes that travel throughout the remainder of the building. They will be composed of steel, ductile iron, or copper, with steel being the foremost well-liked alternative.

This metal is commonly chosen as a result of it is sturdier than ductile iron and fewer high-ticket (and less subject to theft) than copper.

The diameter and thickness of the pipe utilized in pipage systems area unit determined by specific hydraulic calculations regarding needed system pressure and demand supported the dimensions and height of the building.

That said NFPA fourteen needs that standpipes be a minimum of 4” (100 mm) in size, whereas pipes that area unit a part of a combined pipage and system have to be compelled to be a minimum of 6” (150 mm).

FIGURE 3: Pipe.

11.4. Fire department connection: [4]

The fire department connection (FDC) is an important part of manual wet and manual dry systems, which cannot work while not firefighter’s activity water and pressure to the system.

That said, FDC’s square measure still needed all told class I and class III systems, even those with onsite fireplace pumps that serve the categorical purpose of activity-pressurised water.

The principle for requiring FDCs in these systems is simple: If a

Fire pump malfunctions throughout Associate in nursing emergency, the FDC provides a backup.

***FIGURE 4:** Fire department connection.*

11.5. **Water tank** [6]

- **Tank**

Water storage tanks square measure tanks that offer water for water-based fire protection systems.

Water tanks will be used for many very different eventualities however most typically; they are used wherever Associate in nursing adequate offer of water is not obtainable or reliable.

There square measure many kinds of tanks, which will be used as a water system like gravity tanks, suction tanks, and pressure tanks.

- ***Gravity Tank***

Gravity tanks square measure elevated water tanks that utilize gravity to supply pressure.

They could be capable of providing the mandatory pressure to work a fire suppression system on their own, or they will be wont to give water to a fire pump.

Gravity tanks are not generally utilized in non-public water provides, however they are a standard a part of a reliable waterworks system.

- ***Suction Tank***

Suction tanks square measure mounted on the bottom or below ground. Because of this, they are doing not utilize elevation as a primary means that to extend the pressure.

Suction tanks generally give water to a fire pump that then boosts the pressure.

Special thought is required for below grade tanks because of either they need to have a vertical rotary engine pump or a pump situated below the tank.

- ***Pressure Tank***

Pressure tanks contain each water and air besieged. Once a system is motivated, the pressurised air pushes the water out of the tank.

Because of this, a spare capability of air should be obtainable to discharge the water from the tank at the mandatory rate.

Pressure tanks square measure seldom used because of they are generally no larger than 10000 gallons (37,850 litters).

- **Water source:** [7]

the supply of installation for the water-fighting table isn't a demand to be a reservoir, however it may be a stream, ocean or lake, however it should be out there all the time The supply of installation may be town water network, as in some countries, it's out there all the time and within the needed quantities But the foremost common and most typical is to use a tank to store the number of water needed for quenching.

- **Conditions to be met in the fire water tank:** [7]

  - ✓ The volume of the water tank is not less than 60 m^3.
  - ✓ The tank must be divided into two halves for ease of cleaning and to provide reserve water for the firefighting system.
  - ✓ In case that the large tank must be divided and the process of stirring it and moving the water horizontally and vertically to prevent the formation of algae and bacteria.
  - ✓ The location of the tank in the building must be appropriate and easily accessible.
  - ✓ The water level in the tank should be higher than the pump level
  - ✓ It is possible to add to this tank the amount of water required for drinking, feeding and irrigation uses. In the case of using a shared tank, the water level should not be less in any case.

- **Tank materials:** [7]

  -Fire water tanks shall be made of impermeable materials

  -Resistant to corrosion from water and chlorine non-rusting.

  -It is non-toxic and must be treated repeatedly and cleaned periodically.

  -The tanks must be as thick as an eye so that they can withstand the pressure on them.

  -Water tanks are made of basic materials:

  1 concrete.

  2 galvanized iron.

  3 stainless steel.

  4 fiberglass.

  5 wood.

  6 Grp glass reformed plastic.

In general, the choice of material for making the tank depends on the project conditions, the required capacity, the available place for the tanks, and the cost

- **Location of tanks:** [7]

  The tanks should be as close as possible to the pumps room and take into account that the water level in the tank is higher than the pumps level to ensure a positive affection. The fire tank can be:

  <u>Above the ground</u>:

  The location of the fire tank above the roof is not common because the tank size is large and forms a large load on the concrete and requires an additional pump, which increases the cost.

  <u>Underground:</u> Underground tank is common for use when there is no space above ground.

- **Pipe connections of tank:** [7]

Air pipe:

- ✓ The tank is provided with two ventilation pipes on the roof of the tank, which end with an inverted elbow and a protection net is installed on it to prevent the entry of rodents and insects into the tank.
- ✓ The ventilation pipe is used to equalize the pressure inside the tank during withdrawal and filling.
- ✓ The minimum diameter of the ventilation pipe is one and a half times the diameter of the filling pipe.

Filling pipe:

- ✓ It should be less than 2 inches in diameter.
- ✓ Used to fill the tank from the city water network.
- ✓ A float valve is installed on it that shuts off the water path when reaching the desired line.

- **Tank capacity:** [7]

Tank capacity = pump flow (gpm) *required storage time (min)*3.

Table 2:*DURATION OF WATER SUPPLY*

Hazard	DURATION OF WATER SUPPLY Water
Light Hazard Occupancies	30 min
Ordinary Hazard Group 1 & 2 Occupancies	120 min
Extra Hazard Occupancies	180 min

11.6. Fire pump: [4]

Fire pumps are field devices that supply pressurized water to automatic and semi-automatic riser systems. They are not required by manual riser system because the fire department supplies water and pressure from the truck when firefighters arrive on the scene.

The correct fire pump for a standpipe system depends on the size and flow of the pump relative to the system requirements of the standpipe it is intended to serve. Most standpipes have system requirements of 750, 1,000 or 1,250 gallons per minute (GPM), and the pump can be used to service systems that require 100% to 150% pump flow. Approval required.

11.6.1 Fire pump group: [7]

A water fire extinguishing system consisting of a group of pumps, which are:

- **Main pump** [7]

It works to supply the network at the time of the fire limits with the required pressure and flow rate (according to the design).

- **Stand by pump**[7]

It works to supply the network at the time of the fire limits with the required pressure and flow rate in case that the main pump did not work for any reason (power outage, malfunction...).

- **Jokey or make up pump:** [7]

  It works to compensate the network with water in case of a leak or a slight drop in the network.

The main and jokey pumps are powered by electric motor.

The stand by pump does not work with the same source of electricity as the main pump, but rather works with another source, and a diesel engine operates most of the stand by pump.

The backup generator located in the building can operate the stand by pump, but the electrical work of the generator is increased so that it is equivalent to operating the pump as well, and this is a high cost.

11.6.1. Fire Pump Types:

- ✓ **Positive displacement pumps: [8]**

Positive displacement pumps are characterized by a method of producing flow by capturing a specific volume of water per pump revolution and pushing it out through the discharge line. A bicycle tire pump is an example of a positive displacement pump we commonly see. Positive displacement pumps create very high-pressure 400 bar.

- ✓ **Centrifugal Pumps:** [7]

This type is more common in fire systems; the condition for using this type is that the suction pressure is positive; these types give high pressure with moderate high flow.

The following are different centrifugal type pump configurations:

1. **End suction pump:**
   - It is called that because the suction is from the end of it.
   - The suction direction is in the direction of the axis of the pump and the ejection.
   - Is in the vertical direction.
   - Capacities for this type are limited (no more than 750 gpm.
2. **Horizontal Split-Case Pump**
   - It is the most common type of firefighter.
   - The direction of suction and discharge is in the direction of the axis of the pump.
   - It has large capacities up to 5000 gpm.
   - It is large and takes up a lot of space when installing.
   - It is expensive.
   - Easy to maintain, as the maintenance process is carried out in place by loosening the screws in the upper half of the pump body.

FIGURE 5: *Horizontal Split-Case Pump.*

3. Vertical inline pump

The direction of suction and ejection is on one line in the direction of the pump axis, one of its advantages is that it does not take up much space when installing, as it is used if the area of the pump room is small, the capacities of this type are limited to no more than 1500, relatively low price, but maintenance costs are high.

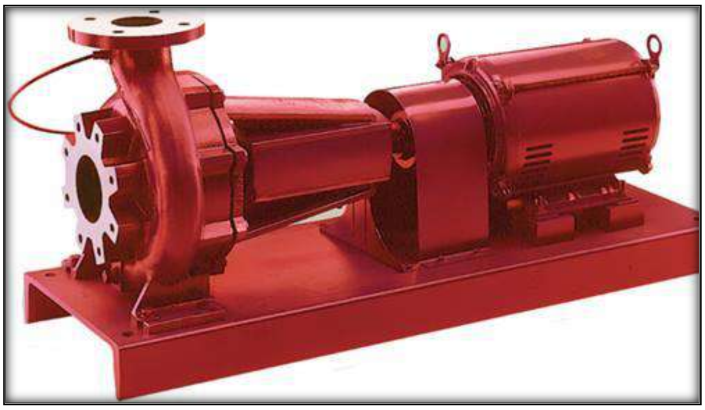


FIGURE 6: *Vertical inline pump.*

4. Vertical turbine pump:

A vertical turbine pump is the only type of pump allowed by NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection that can start with negative suction pressure or take water under a lift condition such as from a below grade source such as a river or subgrade tank. These pumps can be used with raw water sources such as ponds, lakes, and rivers. Vertical turbine pumps come in a wide range of capacities and pressures, and they can be used with diesel and electric drivers.

.

FIGURE 7: *Vertical turbine pump.*

5. Multistage Multiport Pump[8]

Multistage Multiport pumps use a single-driver that can be either an electric motor or a diesel engine that connects to a pump with multiple impellers in series in a single casing driven by a horizontal shaft. The casing has multiple ports, or discharge outlets, delivering different pressures - each port has increased pressure from the consecutive series impellers.

FIGURE 8: *Multistage Multiport Pump.*

For example, one multistage multiport pump could be installed in a high-rise building having 30 floors. The building may be divided into three zones where a multistage multiport pump equipped with three discharge outlets would use each outlet for a zone.

The first has an outlet pressure of 100 psi (6.9 bar) and feeds lower floors or lower zone (ground to 9th), the second has an outlet pressure of 175 psi (12.1 bar) and feeds middle floors or mid zone (10th to 19th), and a third has a discharge pressure of 300 psi (20.7 bar) and feeds the upper floors or high zone (20th to 30th).

Using multiport fire pumps could result in:

- Fewer pumps required.
- Less pipe work and fewer valves, as one pump could eliminate the need for some control valves and pressure reducing devices
- No requirement for water storage tanks on intermediate floors
- Lower structural loads and associated costs as only one pump may be required
- Energy conservation because less electricity and/or fuel will be consumed. Less pollution is also a potential benefit.

11.7. **Gauges:** [4]

Gauges are needed in varied parts of pipage systems. They supply a pressure reading throughout testing conditions and assess the conventional operative pressure of the system. Gauge locations embrace:

- At the highest of every pipage (required).
- At each water association (required).
- Upstream or downstream of any master pressure regulation assembly (required).
- Above and below every alarm check valve, dry pipe valve, deluge valve, flowing preventer, or system riser check valve (required).
- At hose stations that have a pressure-reducing valve (optional).

FIGURE 9: *Gauge (pressure reading device)*.

11.8. **Pressure-Regulating Device:** [3]

According to NFPA14, the PRD is “A device designed for the purpose of reducing, regulating, controlling, or restricting water pressure.”

- **Pressure-Reducing Valve (PRV):** A valve designed for reducing the downstream water pressure under both flowing (residual) and non-flowing (static) conditions.
- **Pressure-Restricting Device:** A valve or device designed for reducing the downstream water pressure under flowing (residual) conditions only.

11.9. Hose station: [3]

NFPA defines Hose Station as "a combination of a hose rack or reel, hose nozzle, hose, and hose connection."

11.10. Valves: [3]

- ✓ **Control Valve:**

A valve controlling flow to water-based fire protection systems.

- ✓ **Hose Valve:**

The valve to an individual hose connection with an outlet for attaching a fire hose.

Section II: Requirements of standpipe and hose system.

I. System requirement: [3]

1. Required Type of System:

1.1. Class I Standpipe Systems:

Class I pipe systems shall be allowable to be automatic dry, automatic wet, semiautomatic dry, manual dry or manual wet in buildings not classified as high-rise buildings.

Class I pipe systems in buildings classified, as high-rise buildings shall be automatic or semiautomatic. Manual standpipes shall be allowable in open parking garages wherever the best floor is found less than a 150ft. (45,720 mm) higher than rock bottom level of fireside department vehicle access.

In buildings classified as high-rise, all needed standpipes shall be automatic or semiautomatic, together with partial height and horizontal standpipes that serve solely a little or restricted range of floors among the building. Class I pipe systems shall be wet systems except wherever piping is subject to state change.

1.2. Class II and Class III Standpipe Systems.

Class II and class III standpipe systems with 11⁄2 in. (40 mm) hose stations shall be automatic wet systems unless placed during a facility wherever piping is subject to physical change and wherever a fire brigade is trained to control the system while not department of local government intervention, within which case associate degree automatic dry or semiautomatic dry system shall be permissible.

In a non-high-rise building, the category I portion of a category III system shall be permissible to be manual. The category II portion of a category III system shall be automatic.

2. Installation requirement: [3]

2.1. Gate Valves and Check Valves.

2.1.1. Connection to Water Supply

- Connections to every automatic installation shall be given an approved indicating-type valve and check valve placed getting ready to the provision and shall be allowable to be placed inside the building.
- The Indicating-type valve and check valve shall not be needed neither for automatic and semiautomatic piping systems provided by fire pumps nor on manual dry piping systems.

- An approved indicating-type valve and approved check valve shall be provided within the installation for a manual wet piping system.
- Valves shall be provided on all standpipes, as well as manual dry standpipes and horizontal standpipes, to permit isolation of a piping while not interrupting provide the availability the provision to different standpipes from constant supply of supply.
- Listed indicating-type valves shall be provided at the piping for dominant branch lines wherever the space to the remote hose association exceeds forty foot. (12 m) measured on the pipe.

Wherever wafer-type valve discs area unit used, they shall be put in in order that they are doing not interfere with the operation of different system elements.

2.2.Valves and Connections to Water Supplies: [3]

2.3.Valve Supervision

2.4.Fire Department Connections: [3]

One amongst the subsequent methods shall supervise system installation valves, isolation management valves, and different valves in feed mains in an approved manner within the open position:

- A central station, proprietary, or terminal signalling service
- an area signalling service that initiates AN hearable signal at a perpetually attended location
- lockup of valves within the open position
- Waterproofing of valves and an approved weekly-recorded examination wherever valves area unit placed inside enclosed enclosures beneath the management of the owner.

Location and identification of FDC:

The fire department connection must be visible and identifiable from the street, from the nearest fire equipment entry point, or from the street side of the building.

Fire department connections should be arranged so that the hose assembly can be attached to the entrance without interfering with nearby objects including buildings, fences, posts, landscaping, vehicles or other fire connections.

A sign «STANDPIPE» with letters that are at least 25.4 mm (1 in) high must designate each fire department connection. For manual systems, the sign must also indicate that the system is manual and that it is wet or dry.

Section III: Overview on fluid mechanics. [5]

I. Properties of Water

Mass of water = volume × density

Weight of water = mass × g

$$\text{Specific weight} = \frac{\text{weight}}{\text{Volume}}$$

1. Density and specific weight:

We can state that the specific weight is as follows:

$\gamma = \rho * g$

Where γ = specific weight, lb/ft3

ρ = density, slug/ft3

g = acceleration due to gravity

2. Viscosity

Viscosity is a measure of a liquid's resistance to flow. Each layer of water flowing through a pipe exerts a certain amount of frictional resistance to the adjacent layer.

Kinematic viscosity is defined as the absolute viscosity divided by the density. Thus:

$$\nu = \frac{\mu}{\rho}$$

Where:

ν = kinematic viscosity, ft2/s

μ = absolute viscosity, (lb · s)/ft2 or slug/ (ft. · s)

ρ = density, slug/ft3

A general equation for the pressure in a liquid at a depth h is $P = \gamma * h$

Where: P = pressure, psi, γ = specific weight of liquid, h = liquid depth.

3. Velocity

Velocity As water flows through fire protection piping at a constant flow rate, the velocity of flow can be calculated by the following equation:

Flow rate = area × velocity

Therefore: **Q = A× V**

Where: **Q** = flow rate, **A** = pipe cross-sectional area, **V** = velocity of flow.
In addition, from the equation above we conclude that the velocity equation is as follows:

$$V = 353.6777\frac{Q}{D^2}$$

Where: V = velocity, m/s, Q = flow rate, m3/h, D = inside diameter, mm.

4. Flow_velocity

The following relation determines the flow velocity of a fluid in a pipe:

$$V = \frac{4Q_v}{\pi D^2}$$

Where:

V: Represents the flow velocity in the pipe, in [m/s]

Q: Represents the flow rate in the pipe, in [m3 /s]

D: Represents the diameter of the pipe, in [m]

5. Reynolds Number:

The Reynolds number is a dimensionless parameter of flow. It depends on the pipe size, flow rate, liquid viscosity, and density. It is calculated from the following equation:

$$R = \frac{VD_\rho}{\mu} \quad \text{Or} \quad R = \frac{VD}{v}$$

Where:

R = Reynolds number, dimensionless.

V = average flow velocity, ft. /s.

D = inside diameter of pipe, ft.

ρ = mass density of liquid, slug/ft3.

µ = dynamic viscosity, slug/ (ft. /s).

ν = kinematic viscosity, ft2/s.

- Reynold number is a dimensionless parameter that facilitates the prediction of flow behaviour.
- A low Reynold number indicates laminar flow while a high one indicates a turbulent behaviour.

II. Pressure Drop Due to Friction:

As through a pipe, there is friction between the adjacent layers of water and between the water molecules and the pipe wall.

The following is a form of the Manning equation for frictional pressure drop in water piping systems:

$$Q = \frac{1.486}{n} A R^{\frac{2}{3}} \left(\frac{h}{L}\right)^{1/2}$$

Where: Q=flow rate, m3/s, A=cross-sectional area of pipe, m2, R=hydraulic radius=D/4 for circular pipes flowing full, n=Manning roughness coefficient, dimensionless, D=inside diameter of pipe, m, h=friction loss, m of water, L=pipe length, m.

1. Bernoulli's equation:

Bernoulli's equation is also known as the principle of conservation of energy.

Imagine a pipeline where liquid flows from point A to point B, as shown in Figure I.9. The elevation of point A is ZA and the elevation of point B is ZB on a common datum such as B. Mean sea level. The pressure at point A is PA and the pressure at point B is PB. Assume that the pipe diameters at A and B are different, so VA and VB represent the flow rates at A and B, respectively.

The total energy E per unit weight of liquid particles at point A in the pipe consists of three components:

Potential energy = Za

Pressure energy = $\frac{Pa}{\gamma}$

Kinetic energy = $\left(\frac{V_a}{2g}\right)^2$

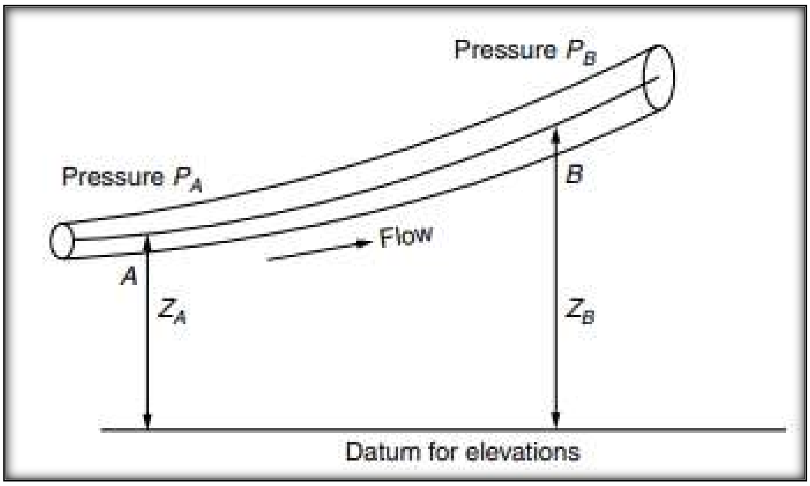


FIGURE 10: *Total energy of water in pipe flow.*

Where γ is the specific weight of liquid.

Therefore the total energy E is: $E = Z_A + \frac{P_A}{\gamma} + \frac{{V_A}^2}{2g}$

Since each term in the equation has dimensions of length, we refer to the total energy at point A as HA in feet of liquid head.

Therefore, rewriting the total energy in feet of liquid head at point A, we obtain

$$H_A = Z_A + \frac{P_A}{\gamma} + \frac{V_A^2}{2g}$$

Similarly, the same unit weight of liquid at point B has a total energy per unit weight equal to HB given by

$$H_B = Z_B + \frac{P_B}{\gamma} + \frac{V_B^2}{2g}$$

By the principle of conservation of energy: HA = HB

Therefore: $Z_A + \frac{P_A}{\gamma} + \frac{V_A^2}{2g} = Z_B + \frac{P_B}{\gamma} + \frac{V_B^2}{2g}$ (Eq 1)

In (Eq 1) referred to as Bernoulli's equation, we have not considered any energy added to the liquid, energy taken out of the liquid, or energy losses due to friction.

Therefore, modifying (Eq 1) to take into account the addition of energy (such as from a pump at A) and accounting for frictional head losses hf, we get the more common form of Bernoulli's equation as follows: $Z_A + \frac{P_A}{\gamma} + \frac{V_A^2}{2g} + H_P = Z_B + \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + H_f$

Where:

HP is the equivalent head added to the liquid by the pump at A and hf represents the total frictional head losses between points A and B.

2. Hazen-Williams equation

A more popular approach to the calculation of head loss in water piping systems is the use of the Hazen-Williams equation. In this method a coefficient C known as the Hazen-Williams C factor is used to account for the internal pipe roughness or efficiency.

Unlike the Moody diagram or the Colebrook-White equation, the Hazen-Williams equation does not require use of the Reynolds number or viscosity of water to calculate the head loss due to friction.

The Hazen-Williams equation for head loss is expressed as follows:

$$H = \frac{4.73\, L(\frac{Q}{C})^{1.852}}{D^{4.87}}$$

Where: h = frictional head loss, ft., L = length of pipe, ft., D = inside diameter of pipe, ft.

Q = flow rate, ft3/s., C = Hazen-Williams C factor or roughness coefficient, dimensionless.

Table 3: *Hazen-Williams C factor or roughness coefficient*

Piping Material Type	System type	Roughness Coefficient ("C"Factor)
Unlined Cast Iron/Ductile Iron Piping	Underground Piping	100
Cement-Lined Cast Iron/Ductile Iron Piping	Underground Piping	120
Steel Piping	Wet and Deluge System	120
Steel Piping	Dry and Precaution System	100
Galvanized Steel	All System Types	120
Stainless Steel	All System Types	150
Copper Tubing	Wet Systems	150
Plastic Pipe/Tubing	Wet Systems	150

Other forms of the Hazen-Williams equation using different units are discussed next. In the following formulas the presented equations calculate the flow rate from a given head loss, or vice versa.

In USCS units, the following forms of the Hazen-Williams equation are used:

$$Q = (6.755 \times 10^{-3})\ C*D^{2.63} *h^{0.54}$$

$$h = 10{,}460\ (Q/C)^{1.852} *1/D^{4.87}$$

$$Pm = 23{,}909\ (Q/C)^{1.852} *1/D^{4.87}$$

Where: Q = flow rate, gal/min, h = friction loss, ft. of water per 1000 ft. of pipe

Pm = friction loss, psi per mile of pipe, D = inside diameter of pipe, in, C = Hazen-Williams C factor, dimensionless.

3. Minor Losses

Minor losses in water pipes are classified as pressure drops associated with plumbing components such as valves and fittings. Fittings include elbows and tees.

Additionally, pressure losses also occur as pipe diameters increase and decrease. A pipe nozzle exiting the tank has a loss on entry and exit. All of these pressure drops are called minor losses because they are relatively small compared to friction losses in straight pipes.

In any case, the equivalent length can approximate pressure losses through valves, fittings, etc. or K times the head method

The following forms of minor losses: $M_L = f\left(\frac{L}{D}\right) * \frac{V^2}{2g}$

The term f (L/D) may be substituted with a head loss coefficient K (also known as the resistance coefficient)**.**

So: $M_L = K * (\frac{V^2}{2g})$

Where: M_L=Minor losses, K= Friction Loss in Valves—Resistance Coefficient,

V^2/ 2g= the velocity head.

Friction Loss in Valves—Resistance Coefficient K:

TABLE 1.6 Friction Loss in Valves—Resistance Coefficient *K*

		Nominal pipe size, in											
Description	L/D	$\frac{1}{2}$	$\frac{3}{4}$	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$–3	4	6	8–10	12–16	18–24
Gate valve	8	0.22	0.20	0.18	0.18	0.15	0.15	0.14	0.14	0.12	0.11	0.10	0.10
Globe valve	340	9.20	8.50	7.80	7.50	7.10	6.50	6.10	5.80	5.10	4.80	4.40	4.10
Angle valve	55	1.48	1.38	1.27	1.21	1.16	1.05	0.99	0.94	0.83	0.77	0.72	0.66
Ball valve	3	0.08	0.08	0.07	0.07	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04
Plug valve straightway	18	0.49	0.45	0.41	0.40	0.38	0.34	0.32	0.31	0.27	0.25	0.23	0.22
Plug valve 3-way through-flow	30	0.81	0.75	0.69	0.66	0.63	0.57	0.54	0.51	0.45	0.42	0.39	0.36
Plug valve branch flow	90	2.43	2.25	2.07	1.98	1.89	1.71	1.62	1.53	1.35	1.26	1.17	1.08
Swing check valve	50	1.40	1.30	1.20	1.10	1.10	1.00	0.90	0.90	0.75	0.70	0.65	0.60
Lift check valve	600	16.20	15.00	13.80	13.20	12.60	11.40	10.80	10.20	9.00	8.40	7.80	7.22
Standard elbow													
90°	30	0.81	0.75	0.69	0.66	0.63	0.57	0.54	0.51	0.45	0.42	0.39	0.36
45°	16	0.43	0.40	0.37	0.35	0.34	0.30	0.29	0.27	0.24	0.22	0.21	0.19
Long radius 90°	16	0.43	0.40	0.37	0.35	0.34	0.30	0.29	0.27	0.24	0.22	0.21	0.19
Standard tee													
Through-flow	20	0.54	0.50	0.46	0.44	0.42	0.38	0.36	0.34	0.30	0.28	0.26	0.24
Through-branch	60	1.62	1.50	1.38	1.32	1.26	1.14	1.08	1.02	0.90	0.84	0.78	0.72
Mitre bends													
$\alpha = 0$	2	0.05	0.05	0.05	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02
$\alpha = 30$	8	0.22	0.20	0.18	0.18	0.17	0.15	0.14	0.14	0.12	0.11	0.10	0.10
$\alpha = 60$	25	0.68	0.63	0.58	0.55	0.53	0.48	0.45	0.43	0.38	0.35	0.33	0.30
$\alpha = 90$	60	1.62	1.50	1.38	1.32	1.26	1.14	1.08	1.02	0.90	0.84	0.78	0.72

III. Total Pressure Required:

So far we've got examined the resistance pressure call in water systems piping consisting of pipe, fittings, valves, etc. we tend to conjointly calculated the whole pressure needed to pump water through a pipeline up to a delivery station at Associate in Nursing elevated purpose.

The whole pressure needed at the start of a pipeline, for a mere flow, consists of 3 distinct components:

$$P_t = P_f + P_{elev} + P_{del}$$

P_f = Frictional pressure drop, P_{elev}= Elevation head, P_{del}=Delivery pressure.

Pressure Loss due to Elevation Change: $\boldsymbol{P_{elev} = \rho g Z}$

With: ρ = acceleration due to gravity and Z = the change in elevation.

CONCLUSION:

In this chapter, we discussed general information of standpipe and hose system covering all the necessary information about it (history, importance, types and components...).Next, we moved to its requirements where mentioned the classes of standpipe and hose system, the installation requirements.

After that, we stated to fluid mechanics where we mentioned properties of water (velocity, viscosity, flow velocity, Reynold’s number…).

Finally, the hydraulic calculation equations (pressure drop due to friction, Bernoulli and Hazen-William’s equations.

CHAPTER II: Standpipe network: design and application.

Introduction

Standpipe and hose system installation hydraulic calculations need to be precise, accurate and fast; for that that the experts created different software for it .in this thesis we used PIPENET software which is one of the most useful program for it.

Therefore, we divided this practical chapter in two parts:

In the first part, we described the institute of technology, its creation, specialities and location.

In the second part we started with description of the software, then, we moved to the application of the calculation on the institute where we put a design of the installation, the input data and the result of the application.

Section I: institute of technology, University Kasdi Merbah OUARGLA.

I.1. Creation of the institute of technology:

Created by executive decree n°19-100 of march 14,2013 supplementing and modifying executive decree n°0.1-210 of July 23,2001 establishing the university of Ouargla; the Institute of Technology sees its birth, The Institute of Technology aims to attract future graduates with an emphasis on the world of work through a short training course of three (3) years entitled professional diploma, the specification of the Institute of Technology focuses on the theme "orientation, professional integration and professionalization" for future students. A system of reception, tutoring, accompaniment and support for the orientation of each student in order to promote the success of his "Personal and professional project" called the "P.P.P", The Institute will open its doors for the 2014/2015 University year with two different specialties:

1- HSE (Health, Safety and Environment),
2- BMA (Business Management and Administration),
3- POM (Precise optics and mechanics).

The following is the diagram of the institute specialities:

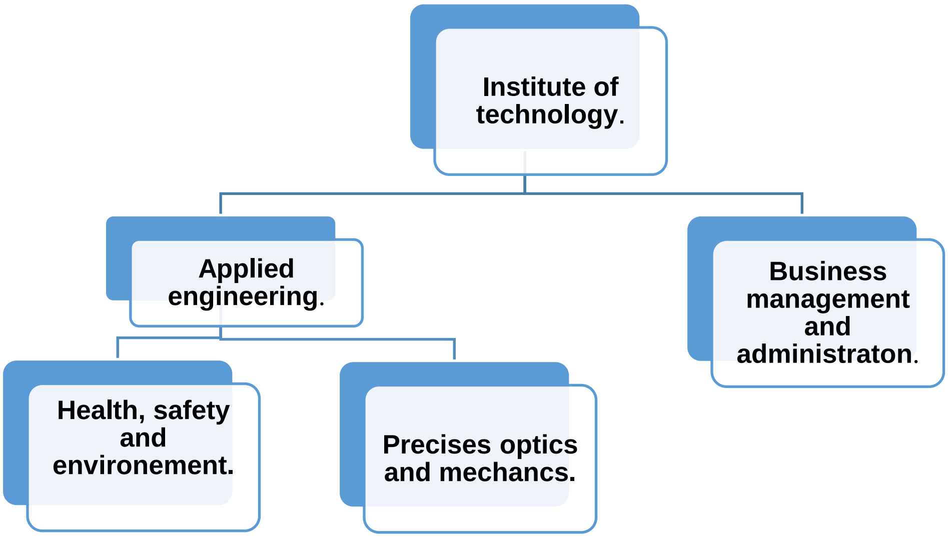


FIGURE 11: *diagram of the institute specialities*

I.2. Location of the institute of technology:

It is located on Ouargla road Ghardaia BP, 511, 3000.

FIGURE 12: *Location of the institute of technology on map.*

Section II: Software and calculation

1. PIPENET program Introduction

PIPENET is the leading software for rapid liquid flow analysis of pipes and pipe networks.

Three software modules:

Ensure fast and accurate pipeline flow simulations in PIPENET, no matter how large or complex your network is.

Each of the three **PIPENET** software modules is professionally designed for different types of fluid flow analysis and a wide range of applications, incorporating customer input. The result is three world-leading modules from PIPENET. Each is independent, allowing PIPENET modules to be licensed individually or in any combination.

1) - PIPENET Spray/Sprinkler Module:

Specifically intended for the design of fire protection system. PIPENET Spray/Sprinkler is NFPA13, NFPA15 and NFPA16 compliant. This module can be used to design various fire protection systems: sprinkler systems, deluge systems, loop main systems and foam solution systems.

2) - PIPENET Transient Module:

A versatile, easy-to-use and extremely powerful software tool for modelling transient phenomena and calculating the resulting hydraulic transient forces. The **PIPENET Transient Module** is widely used for surge analysis, water hammer and steam hammer analysis of cooling water systems, fire water systems, and hydrocarbon loading and unloading systems.

3) - PIPENET Standard Module:

A steady state hydraulic calculations software for compressible as well as incompressible flow. PIPENET Standard Module has a number of applications such as air, water, steam utility systems design, and ventilation (HVAC) systems design.

2. Installation Requirement of the institute standpipe system:

2.1.Choice of standpipe class system :

According to the NFPA 14, the institute is classified as class II system.

2.2.Hose reel placement classes (2) requirement:

A class II piping system shall offer either 11⁄2 in. (40 mm) hose stations to produce water to be used by trained personnel or a hose connection for the fire department throughout initial response.

A minimum 1 in. (25.4 mm) hose shall be allowable to be used for hose stations in light-weight hazard occupancies wherever investigated and listed for this service and wherever approved by the AHJ.

The minimum flow for the hydraulically most remote hose connection shall be a 100 gpm (379 L/min).

The maximum flow needed from an 11⁄2in. (40 mm) hose connection shall be a 100gpm (379 L/min).

A minimum pressure of 65 psi (4.5 bar), whereas the utmost of a hundred psi (6.9 bar).

The travel distance shall be a 130ft (39.7 m) of a hose connection supplied with 11⁄2in (40 mm) hose or at intervals a 120 ft. (36.6 m) of a hose, connection supplied with but connection. (40 mm) hose.

2.3.**Calculating the total water demand**:

After the application of the requirement and obligations in the NFPA 14 standard of hose and standpipe systems on the institute, we came out with 14 hose reels to cover the case of study andmeets the minimum requirements.

- Hose reel number: 14
- Each one we needs 100 gpm = 23 m3/h

2.3.1. Duration of water supply:

Hazard	DURATION OF WATER SUPPLY Water
Light Hazard Occupancies	30 min
Ordinary Hazard Group 1 & 2 Occupancies	120 min
Extra Hazard Occupancies	180 min

In our case, the institute is classified as light-hazard.

Therefore, the total water demand shall be:

379l/min* 14 *30 min= 159180 l

3. Installation design:

According to the NFPA design standards, the simulation results from the Software PIPENET are shown in the diagram below (DESIGN PHASE).

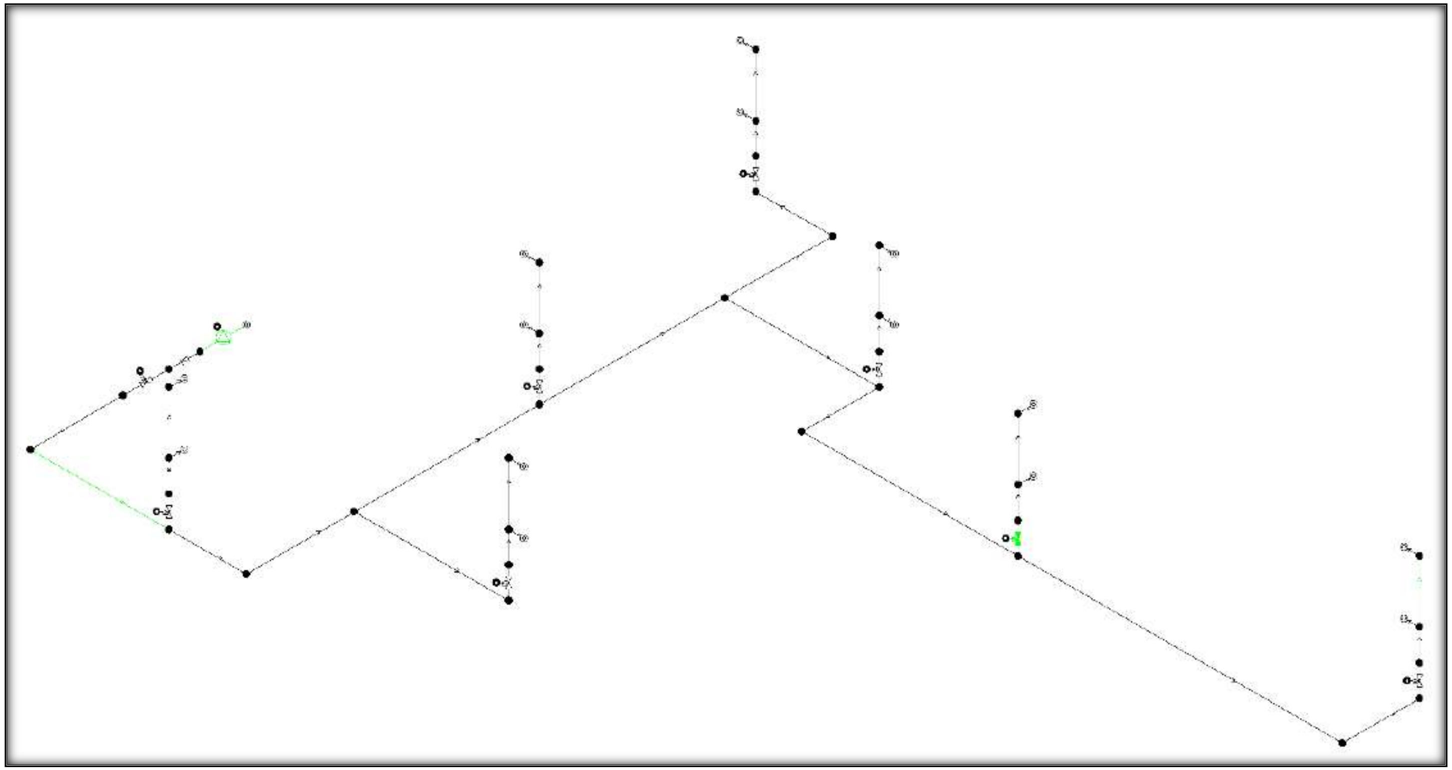


FIGURE 13: *the institut installation design.*

3.1. Elevation :

This figure indicates the elevation on the design as colors

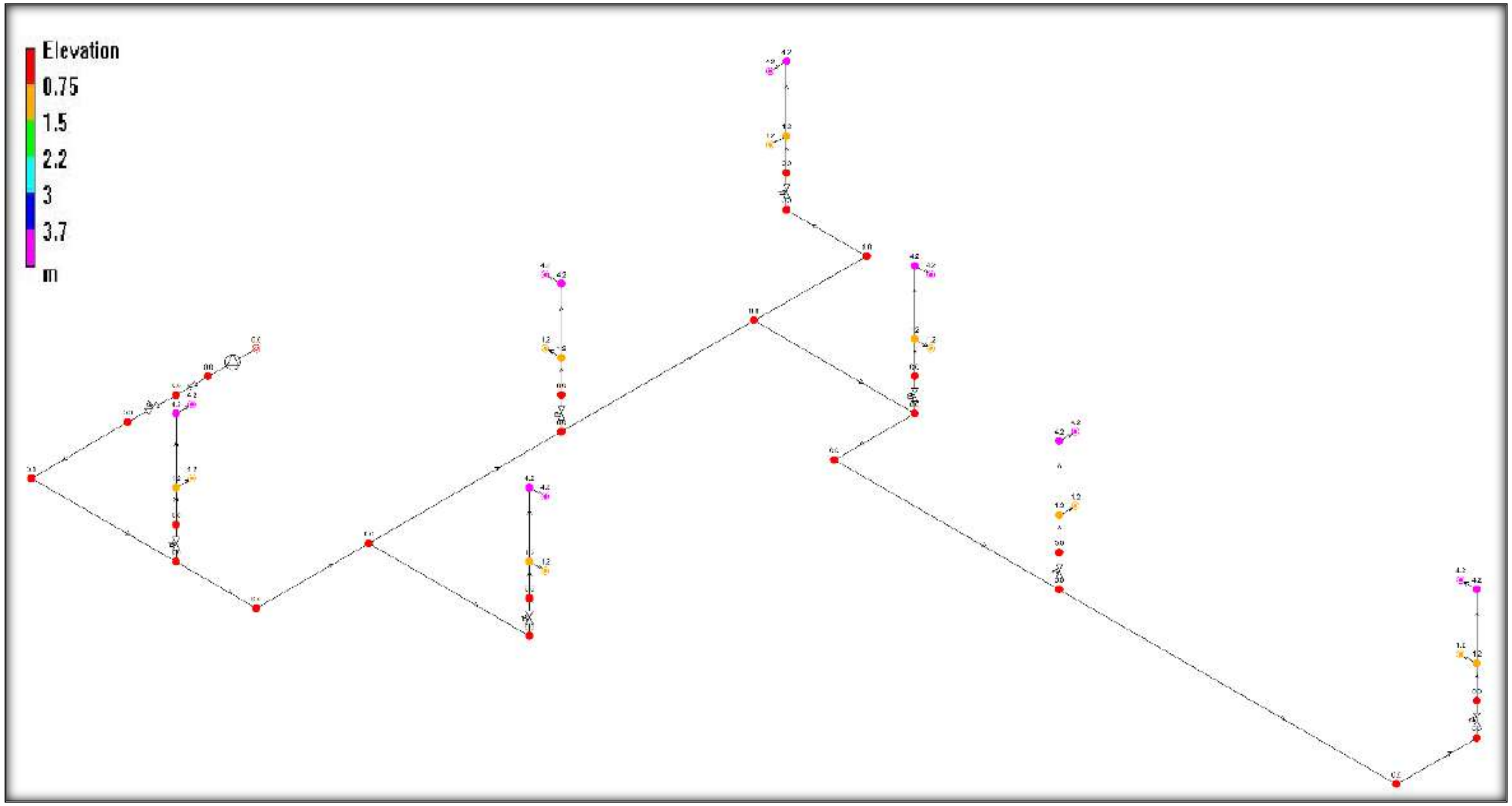


FIGURE 14: *elevations of the institute installation.*

3.2. Pipe lengths: This design is presenting the pipes lengths after we defined the measurements of the instutute installation.

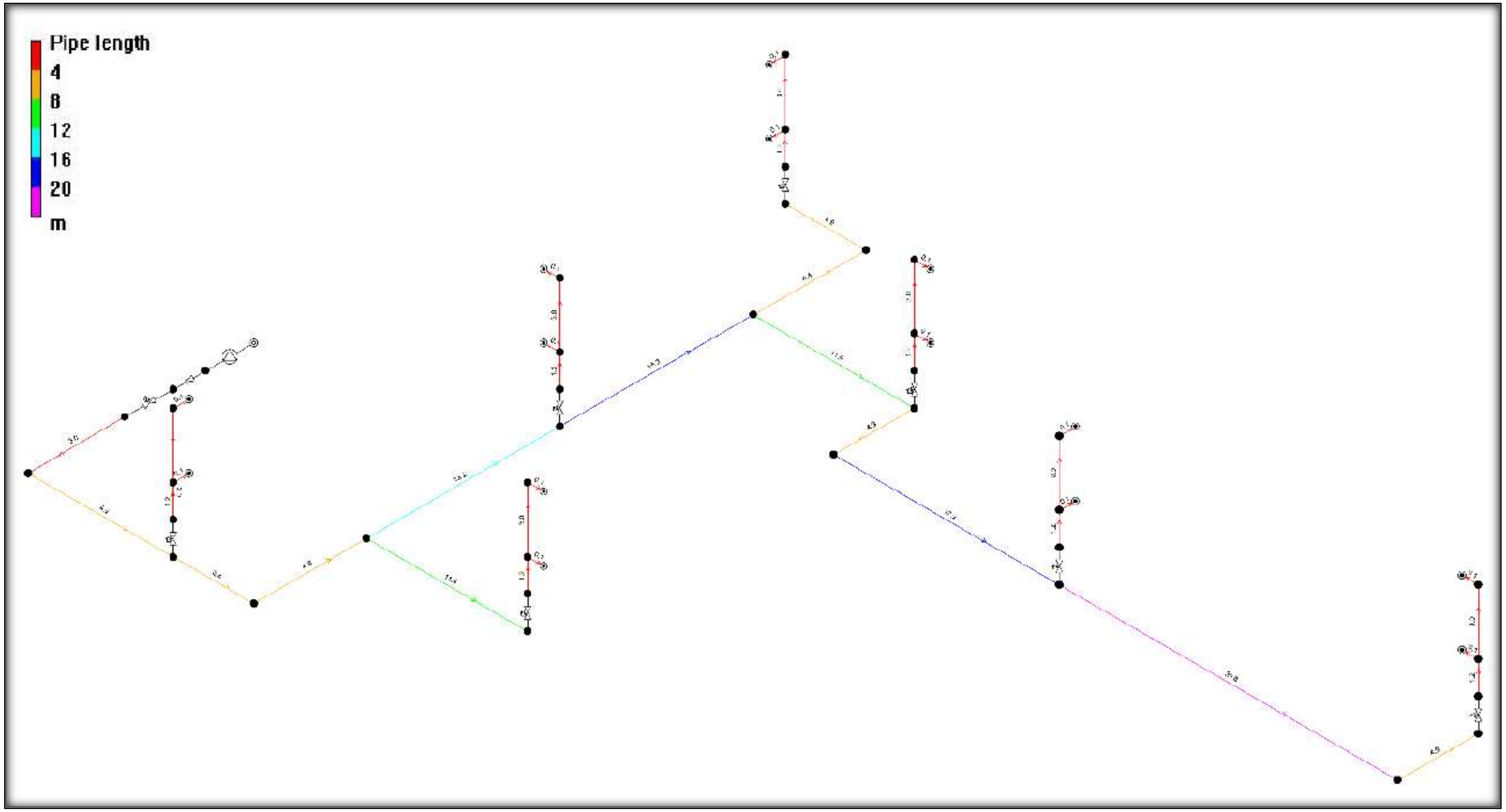


FIGURE 15: *the lengths of pipes of the institute installation.*

3.3. Flow rate: This design presents the different flowrates on pipes of the institute conception as colors ;where the red is the lowest with 50 gpm and the purple is the utmost with 250 gpm.

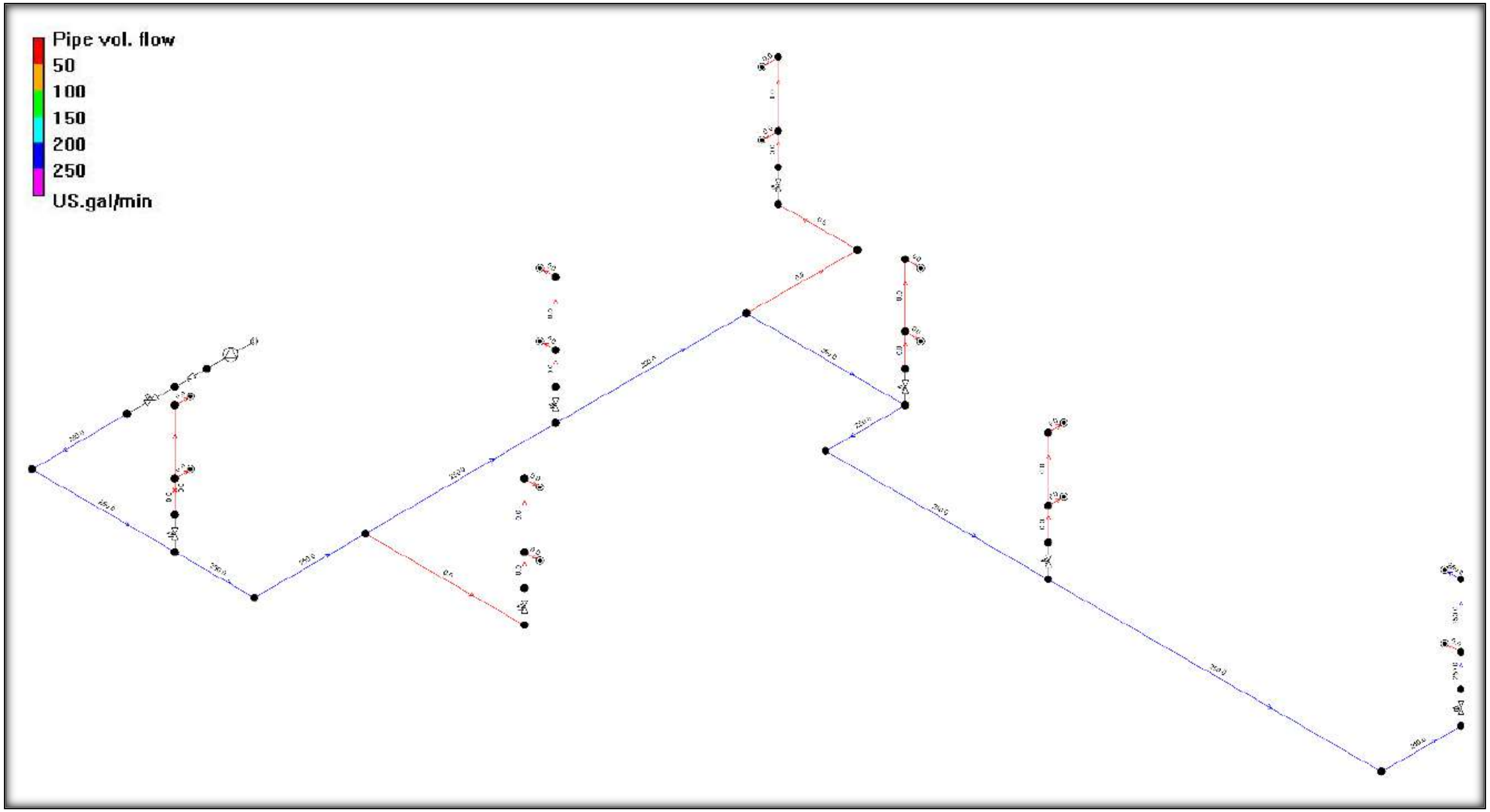


FIGURE 16: *flow rate of the institute installation.*

4. INPUTE DATA:

Unit of measure:

Pipe diameter.	In.
Pipe length.	m
Pipe elevation.	m
Pressure.	Psi G
Flow.	L/min

Table 4: *Input data*

Label	Diameter In	Length M	Elevation M	Roughness mm
1	4	3	0	0.0018
2	4	4.9	0	0.0018
3	4	1.2	1	0.0018
4	4	3	3	0.0018
5	1.5	0.1	0	0.0018
6	1.5	0.1	0	0.0018
7	4	6.4	0	0.0018
8	4	4.8	0	0.0018
9	4	13.2	0	0.0018
11	4	1.2	1	0.0018
12	1.5	0.1	0	0.0018
13	4	3	3	0.0018
14	1.5	0.1	0	0.0018
15	4	16.3	0	0.0018
16	4	4.4	0	0.0018
17	4	4.9	0	0.0018
18	4	1.2	1	0.0018
19	1.5	0.1	0	0.0018
20	4	3	3	0.0018
21	1.5	0.1	0	0.0018
22	4	11.9	0	0.0018
23	4	1.2	1	0.0018
24	1.5	0.1	0	0.0018
25	4	3	3	0.0018
26	1.5	0.1	0	0.0018
27	4	4.9	0	0.0018
28	4	17.9	0	0.0018
29	4	1.2	1	0.0018
30	1.5	0.1	0	0.0018
31	4	3	3	0.0018
32	1.5	0.1	0	0.0018
33	4	20.8	0	0.0018
34	4	4.9	0	0.0018
35	4	1.2	1	0.0018
36	1.5	0.1	0	0.0018
37	4	3	3	0.0018
38	1.5	0.1	0	0.0018
39	4	11.9	0	0.0018
40	4	1.2	1	0.0018
41	1.5	0.1	0	0.0018
42	4	3	3	0.0018
43	1.5	0.1	0	0.0018

5. Results:

Table 5: *Results*

label	Input node	Output node	Input Pressure	Output pressure	velocity	Pipe Friction/length	Static headloss	Friction factor	Flow rate
1	N3	N4	83.2667	84.727	0.77	0.008545	0	0.0051198611	100
2	N4	N5	83.2667	84.6848	0.77	0.008545	0	0.0051198611	100
3	N6	N7	79.0124	83.2667	0	0	1.4181	n/a	0
4	N7	N9	84.6848	79.0124	0	0	4.2543	n/a	0
5	N7	N8	84.6302	83.2667	0	0	0	n/a	0
6	N9	N10	84.5891	79.0124	0	0	0	n/a	0
7	N5	N11	84.4764	84.6302	0.77	0.008545	0	0.0051198611	100
8	N11	N12	83.0582	84.5891	0.77	0.008545	0	0.0051198611	100
9	N12	N19	83.0582	84.4764	0.77	0.008545	0	0.0051198611	100
11	N20	N21	78.8039	83.0582	0	0	1.4181	n/a	0
12	N21	N22	84.4764	83.0582	0	0	0	n/a	0
13	N21	N23	84.3371	78.8039	0	0	4.2543	n/a	0
14	N23	N24	84.3371	78.8039	0	0	0	n/a	0
15	N19	N25	84.3371	84.3371	0.77	0.008545	0	0.0051198611	100
16	N25	N26	82.919	84.3371	0	0	0	n/a	0
17	N26	N27	82.919	84.3371	0	0	0	n/a	0
18	N28	N29	78.6646	82.919	0	0	1.4181	n/a	0
19	N29	N30	84.3371	82.919	0	0	0	n/a	0
20	N29	N31	84.2354	78.6646	0	0	4.2543	n/a	0
21	N31	N32	82.8173	78.6646	0	0	0	n/a	0
22	N25	N34	82.8173	84.2354	0.77	0.008545	0	0.0051198611	100
23	N35	N36	78.5629	82.8173	0	0	1.4181	n/a	0
24	N36	N37	84.2354	82.8173	0	0	0	n/a	0
25	N36	N38	84.1935	78.5629	0	0	4.2543	n/a	0
26	N38	N39	84.0406	78.5629	0	0	0	n/a	0
27	N34	30	82.6225	84.1935	0.77	0.008545	0	0.0051198611	100
28	30	N40	82.6225	84.0406	0.77	0.008545	0	0.0051198611	100
29	N41	N42	78.3681	82.6225	0	0	1.4181	n/a	0
30	N42	N43	84.0406	82.6225	0	0	0	n/a	0
31	N42	N44	83.8629	78.3681	0	0	4.2543	n/a	0
32	N44	N45	83.6322	78.3681	0	0	0	n/a	0
33	N40	N46	82.2038	83.8629	0.77	0.008545	0	0.0051198611	100
34	N46	N47	82.2038	83.821	0.77	0.008545	0	0.0051198611	100
35	N48	N49	77.9238	82.2038	0.77	0.008545	1.4181	0.0051198611	100
36	N49	N50	84.5891	82.2038	0	0	0	n/a	0
37	N49	N51	84.5891	77.9238	0.77	0.008545	4.2543	0.0051198611	100
38	N51	N52	83.171	77.8371	4.8	0.867014	0	0.00534320297	100
39	N12	N13	83.171	84.5891	0	0	0	n/a	0
40	N14	N15	78.9167	83.171	0	0	1.4181	n/a	0
41	N15	N16	79.0204	83.171	0	0	0	n/a	0
42	N15	N17	79.0204	78.9167	0	0	4.2543	n/a	0
43	N17	N18	74.7661	78.9167	0	0	0	n/a	0

6. Pressure: This following figure is a pressure design that presents the pressure results as colors from red as 15 Psi G pressure to purple as 75 Psi G .

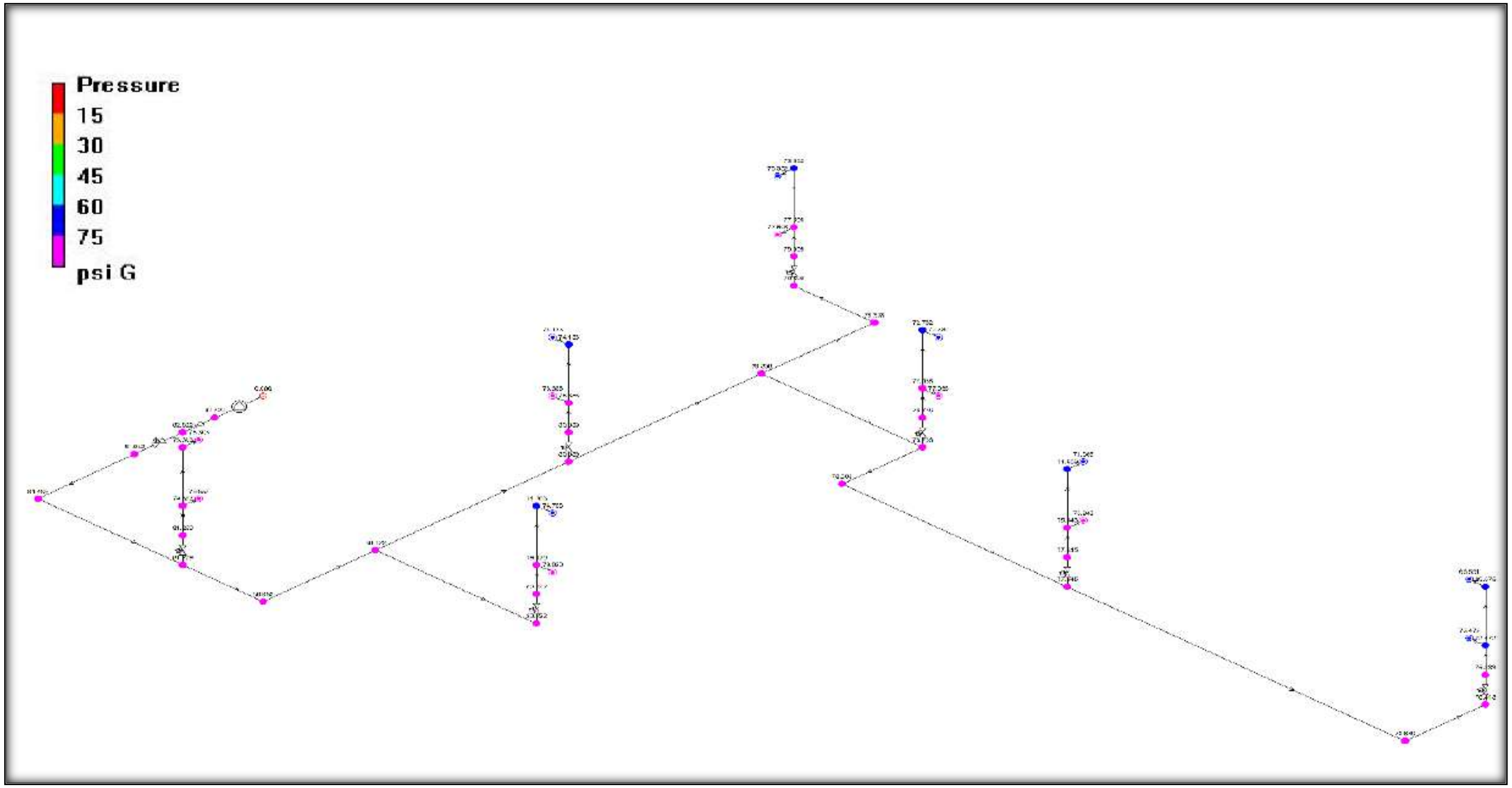


***FIGURE 17**: result pressure*

7. Transient module:

In this transient module for the graph results we selected the simple pump1, pipe 2 and 37, the nodes 45 and 52 and the the operating valve 6.

For node N45, the information can be entered in the Properties window like this:

Label	N45	
Input/Output node	YES	
Results selected?	YES	
Specification Type	Flowrate	
Time Function	Constant	
Constant value	0	US.gal/min

The constant value of N45 indicates that the pump operates at full speed through out. We wish to simulate a sudden opening of the outlet at node N45, which we do by defining a Power Ramp time function , with the flow rate value at the node N45 increasing from -200 to 0 gpm between 3 an d 5 seconds.

Label	N45	
Input/Output node	YES	
Results selected?	YES	
Specification Type	Flowrate	
Time Function	Power ramp	
Start time	3	sec
Start value	0	US.gal/min
Stop time	5	sec
Stop value	-200	US.gal/min
Exponent	1	

7.1. Graphs results:

1. **Outlet pressure/flow simple pump 1:**

This following graph indicates the outlet pressure and flow on the simple pump where we see that at the moment of opening of N45 the dropped from 82.9 Psi G to 80Psi G while the flow increased from 260 Us gpm to 450 Us gpm in just 2 seconds.

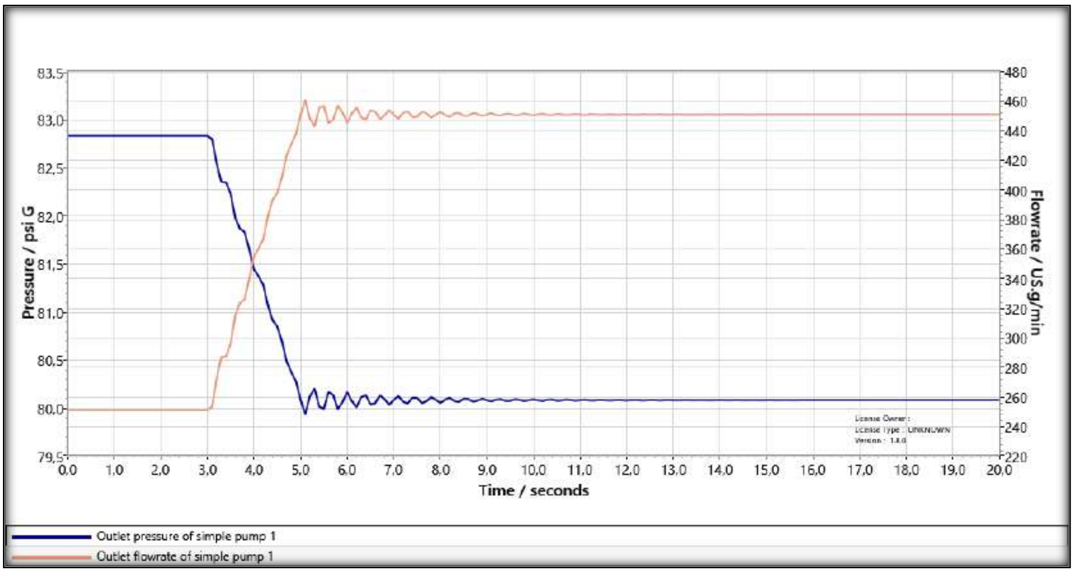


FIGURE 18 *Outlet pressure/flow simple pump 1*

2. **Outlet pressure/flow rate at the operating valve 6:**

This graph shows that at the moment of opening of N45 suddenly the outlet pressure of valve6 decreased from 78 Psi G to 51 Psi G while its flowrate increased from 0 Us gpm to 200 Us gpm in just 2 second

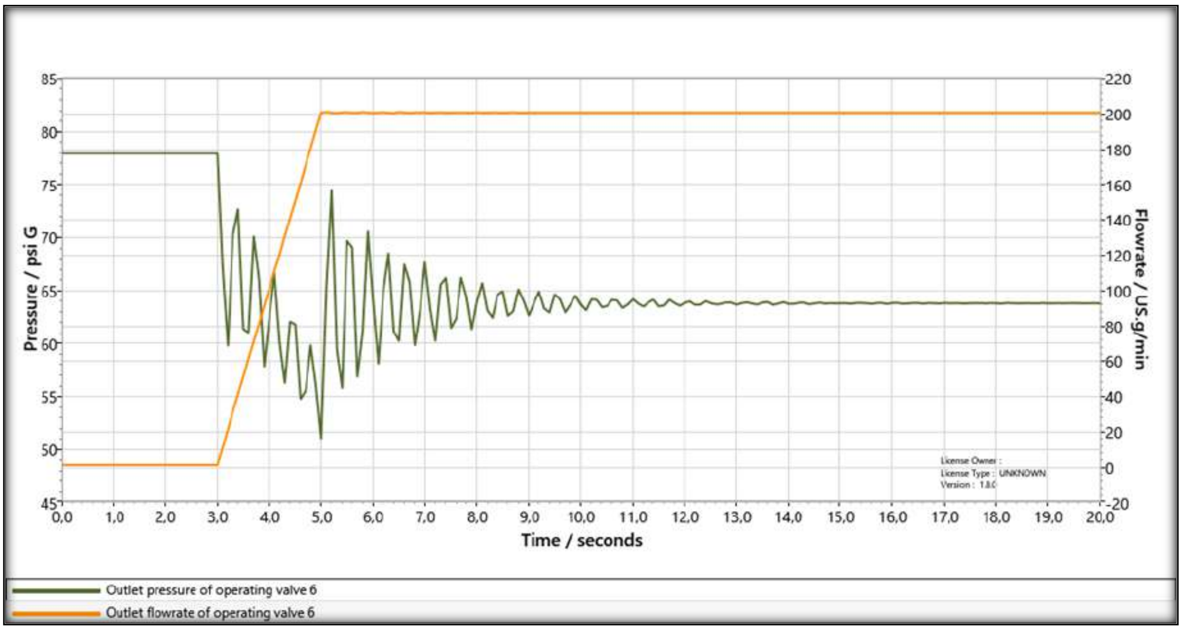


FIGURE 19*: Outlet pressure/flow rate at the operating valve 6*

3. Flow rate of pipe 2 in period of seconds:

On this graph we selected random moments to analyse the flowrate of pipe 2 where

We noticed that the flow rate of pipe 2 starts to increase gradually from the 2 s (250 gpm) to (450 gpm) at the 5 second.

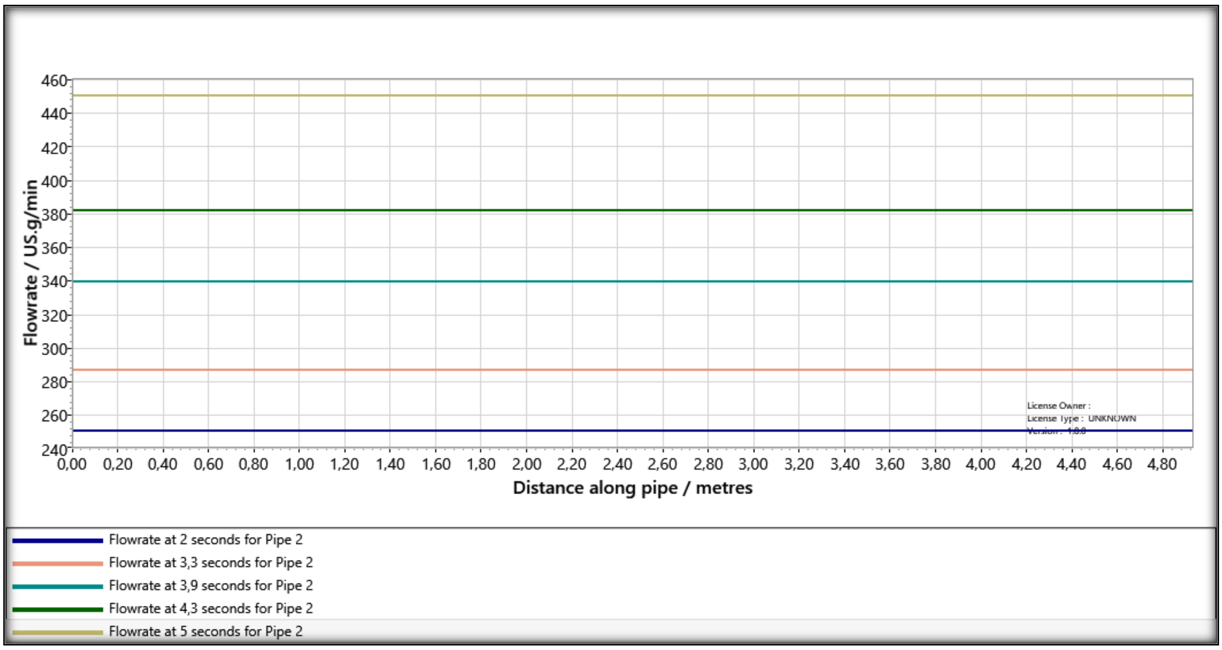


FIGURE 20: *Flow rate of pipe 2 in period of seconds*

4. **<u>Pressure of pipe 2 in period of seconds</u>**:

The graph shows that the pressure onpipe2is gradually decreasing from 80.8 Psi G at 2s to 75.4 Psi G at 5s.

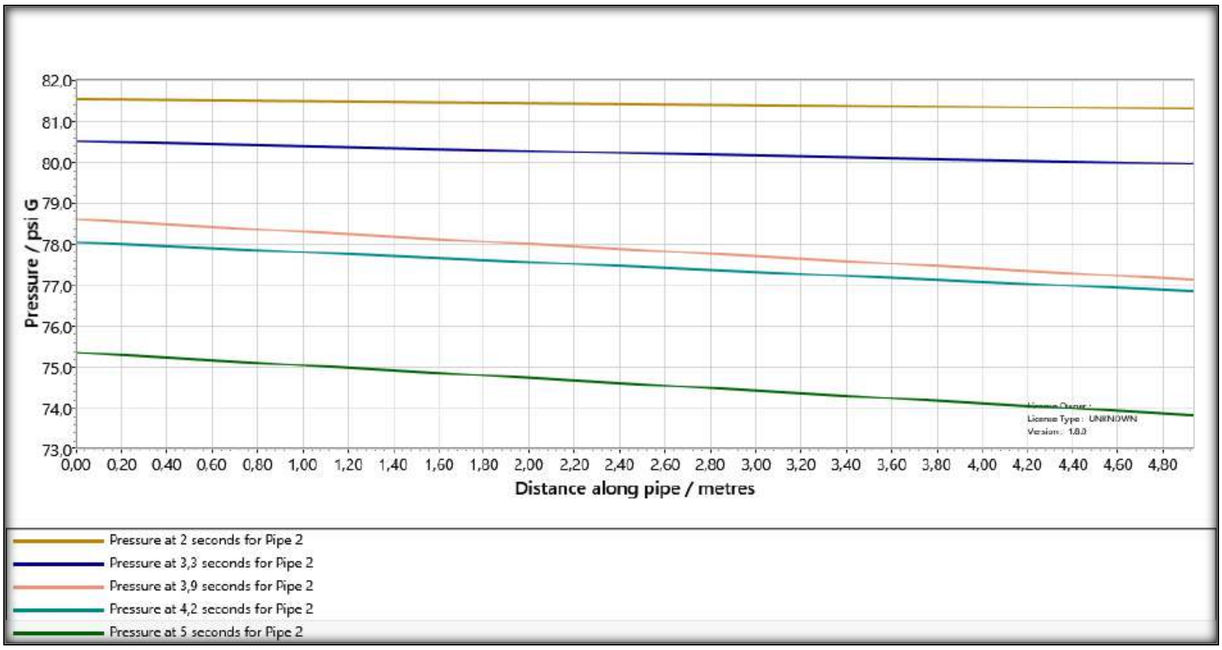


***FIGURE 21:** Pressure of pipe 2 in period of seconds*

5. **<u>Flow rate of pipe 37 in period of seconds:</u>**

From the following graph we notice that because of the sudden opening of N45 the Flowrate on pipe 37 has been instable for few seconds.

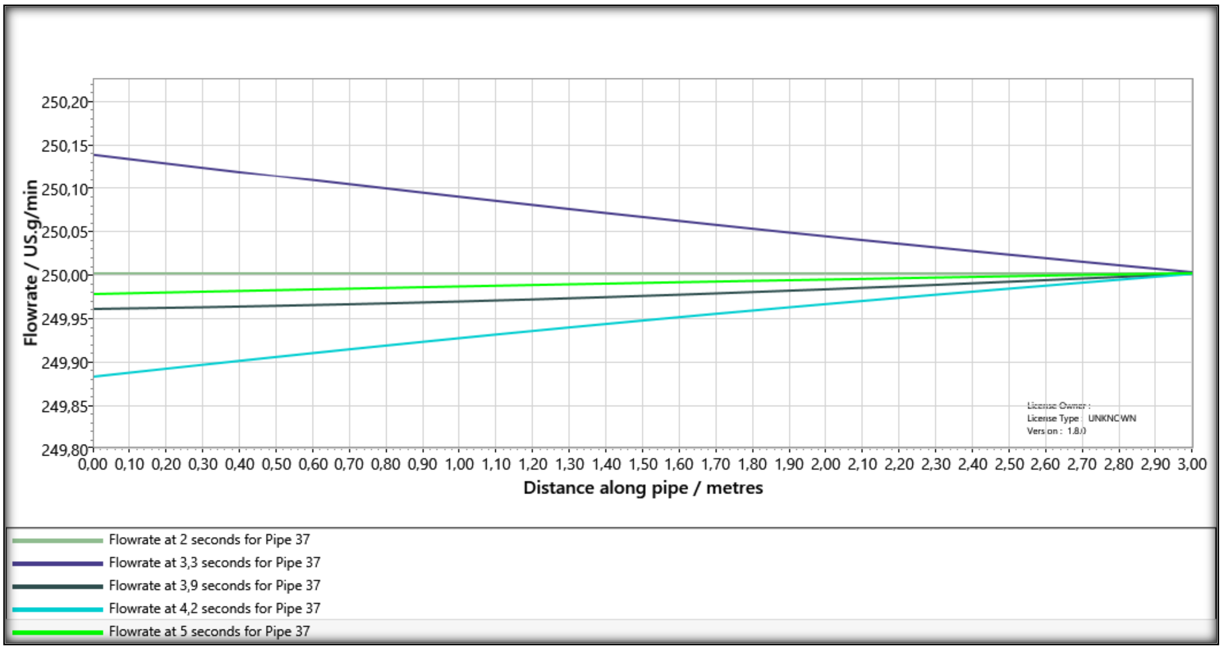
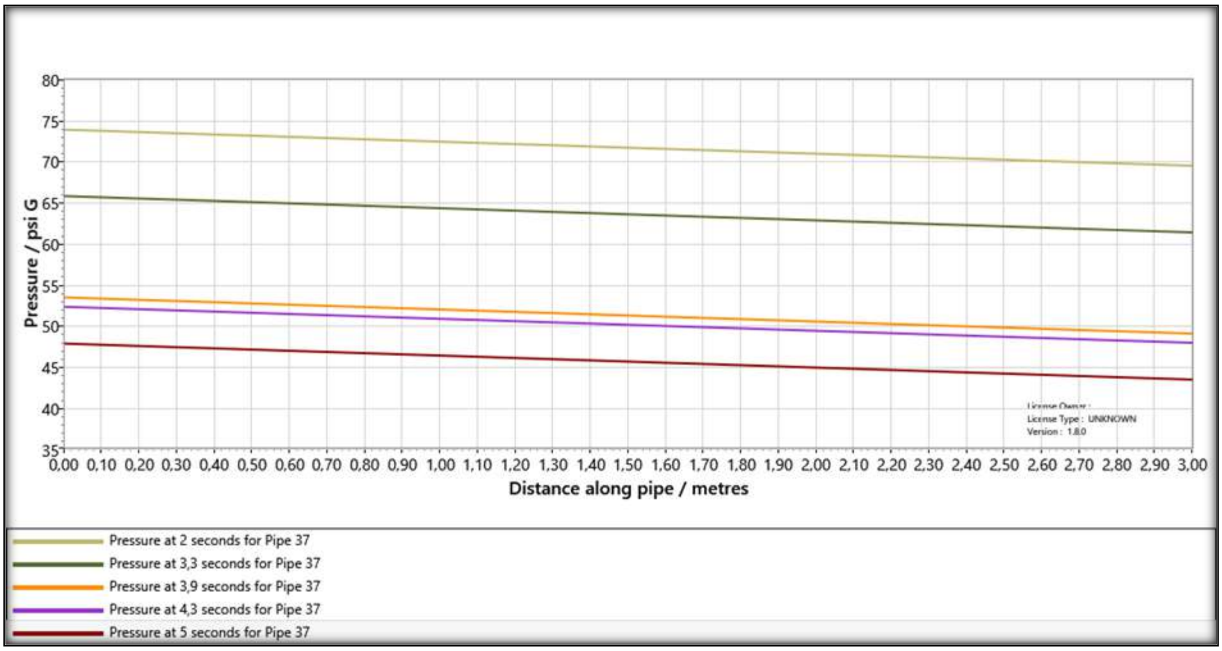


***FIGURE 22**: Flow rate of pipe 37 in period of seconds*

6. Pressure of pipe 37 in period of seconds:

The graph in the following present the pressure on pipe 37, where we see that the pressure is dropping gradually from 74 Psi G at 2s to 47 Psi G at 5s.



7. Pressure/flow rate of pipe 2 (according to time):

This graph present the flow rate and pressure on pipe 2 according to time (s) where we see the pressure is dropping starting from 2s (81 Psi G) to 5s (74.1 Psi G) while in the flow rate we see an increasing from 250 gpm at 2s to 450 gpm at 5s .

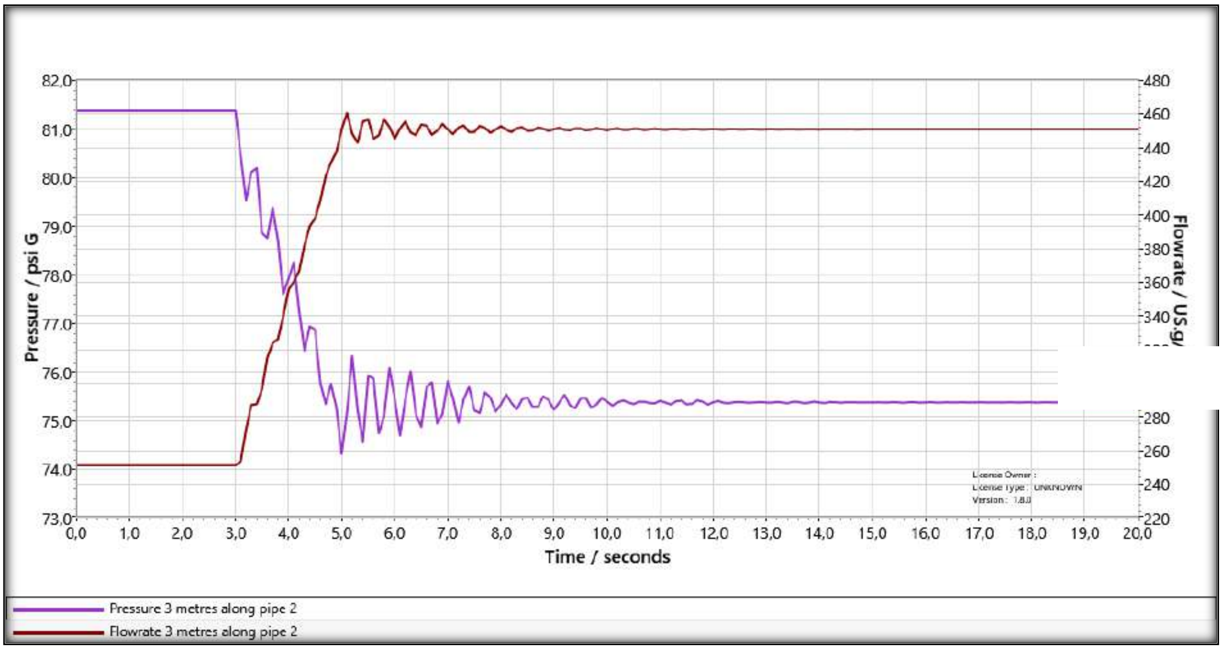


FIGURE 24: *Pressure/flow rate of pipe 2 (according to time)*

8. Pressure/flow rate of pipe 37 (according to time):

The following graph indicates the pressure and flowrate on pipe 37 on a period of seconds, where we witness the drop of pressure that started at 2s (81 Psi G) until the 5s (74 Psi G).

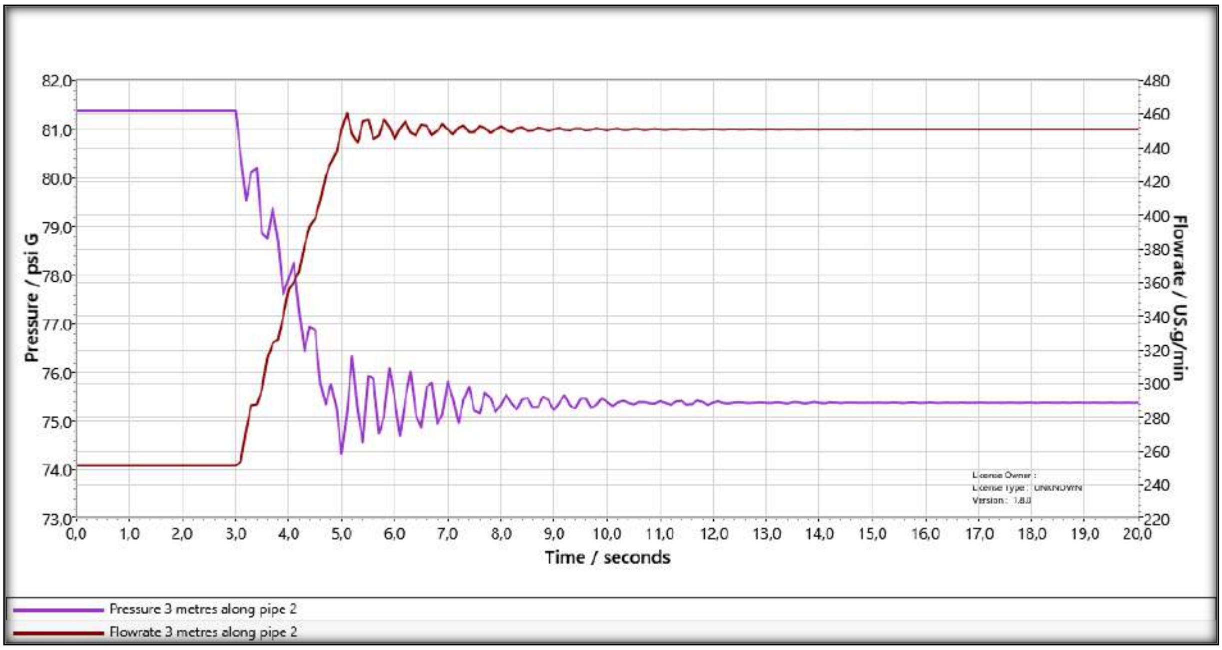


***FIGURE 25**: Pressure/flow rate of pipe 37 (according to time)*

GENERAL CONCLUSION.

At the bottom of our study, we have shown how to design a standpipe and hose system of the institute of technology, University of kasdi Merbah Ouargla and how to do the manual calculation in line with NFPA (14, 20, and 22).

This study is a starting point for future studies on standpipe and hose system and developing the installations complexity using PIPENET software to have a precise and fast calculation of necessary flow and pressure to extinguish fires.

Finally, after completing this study we concluded that:

- The standpipe and hose system an effective system for encountering and extinguishing fire.
- The PIPENET software is an adequate for the NFPA standards.

Therefore, we recommend the PIPENET software for rapid and precise results when there is a hydraulic calculation in the future specially for health, safety and environment engineers.

BIBLIOGRAPHIE

[1] J. C. VOELKERT, “Fire and Fire Extinguishment,” a Br. Guide. To Fire Chem. Extinguishment Theory Fire Equip. Serv. Tech., pp. 1–28, 2015.

[2] K.E. Isman, Standpipe Systems for Fire Protection.

[3] NFPA 14.

[4] Quick respance fire supply.

[5] E. S. Menon, “Piping calculations manual,” p. 666, 2005, [Online].

[6] Types of Water Supplies for fire protection systems by BRIAN O'CONNOR.

[7] Handwritten fire course lectures.

[8] Fire pump types by Brian O’Connor.

[9] Freighting notes Ahmed DARWICH (translated from Arabic).

ABSTRACT

This study aims to check the dimensions of a fixed firefighting installation of standpipe and hose system type in (institute of technology university Kasdi Merbah OUARGLA). Therefore, before we check it, we need to know the basics and its concepts.

First, we did a general introduction about standpipe and hose system, and then we moved to the first chapter "Description of standpipe and hose system" where we mentioned all the necessary information concerned the standpipe system then, we noted its requirements,. Next, we put a clear explanation of fluid mechanics and its calculation equations.

After that we moved to the practical chapter titled standpipe network design and application where we put a general description about the institute of technology university Kasdi Merbah OUARGLA,

After that, we did a description of PIPENET software; finally, we made a design of an installation for the institute where we put the input data for it and the result of it.

In the end, we did a general conclusion for this work where we stated that the installation we proposed is in line with NFPA 14.

خلاصة

تهدف هذه الدراسة إلى التحقق من أبعاد تركيب إطفاء ثابت من نوع أنبوب رأسي ونظام خراطيم لمعهد التكنولوجيا بجامعة قاصدي مرباح ورقلة. لذلك، قبل أن نتحقق منها، نحتاج إلى معرفة الأساسيات ومفاهيمها.

أولاً، قمنا بعمل مقدمة عامة حول نظام الأنابيب الرأسية والخرطوم، ثم انتقلنا إلى الفصل الأول "وصف الأنابيب الرأسية ونظام الخرطوم" حيث ذكرنا جميع المعلومات الضرورية المتعلقة بنظام الأنابيب الرأسية، ثم متطلباته. بعد ذلك، وضعنا شرحًا مفصلا لميكانيكا الموائع ومعادلات حسابها.

ثانيا، انتقلنا إلى الفصل العملي بعنوان تصميم وتطبيق شبكات المواسير الرأسية حيث وضعنا وصفاً عاماً لمعهد التكنولوجيا بجامعة قاصدي مرباح ورقلة، بعد ذلك، قمنا بوصف برنامج PIPENET.

أخيرًا، قمنا بتصميم منشأة للمعهد حيث وضعنا بيانات الإدخال الخاصة بها ونتيجتها.

في النهاية، قمنا باستنتاج عام لهذا العمل حيث ذكرنا أن التثبيت الذي اقترحناه يتماشى مع متطلبات

NFPA 14

ABSTACT

RESUME

Cette étude a pour objectif de vérifier le dimensionnement d'une installation fixe de lutte contre l'incendie de type robinet d'incendie armé (RIA) et lance à (institut de technologie de l'université Kasdi Merbah OUARGLA). Par conséquent, avant de le vérifier, nous devons connaître les bases et ses concepts.

Tout d'abord, nous avons fait une introduction générale sur le système de lutte contre incendie de type RIA, puis nous sommes passés au premier chapitre "Description du système RIA " où nous avons mentionné toutes les informations nécessaires concernant le système de RIA, puis nous avons noté ses exigences. Ensuite, nous mettons une explication claire de la mécanique des fluides et de ses équations de calcul.

Après cela, nous sommes passés au chapitre pratique intitulé Conception et application du réseau d'où nous avons mis une description générale de l'institut universitaire de technologie Kasdi Merbah OUARGLA,

Après cela, nous avons fait une description du logiciel PIPENET ; enfin, nous avons fait une conception d'une installation pour l'institut où nous avons mis les données d'entrée pour celle-ci et le résultat de celle-ci.

Au final, nous avons fait une conclusion générale pour ce travail où nous avons déclaré que l'installation que nous avons proposée est conforme à la NFPA 14.