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INTELLIGENT DEVICE TO INCREASE WATER PRESSURE

(PERANTI PINTAR UNTUK MENINGGIKAN TEKANAN AIR)

ANITA BINTI AHMAD
PM DR MOHD FUA'AD BIN RAHMAT
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BORANG PENGESAHAN
LAPORAN AKHIR PENYELIDIKAN

TAJUK PROJEK : **Intelligent device to increase water pressure**

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The authors have used their best efforts in completing this project. These efforts include the development, research, and testing of the theories and programs to determine their effectiveness.

ABSTRACT

Low water pressure always happens at the highland area. During peak hours, consumers always have this problem, especially at the end user of the water transmission. With the technology that we have today, this problem can be solved easily. In most cases this problems are solved by using pumps. This project describes a new design of a water pressure increasing device for the use of the end user. The device enables the water pressure to be increased during low water pressure condition. This project also focuses on the water transmission aspects such as the pipe design and size that is used for the water distribution system. This project uses a basic vacuum concept in science; creating a low water pressure area which will suck the water. An air compressor is used in this project to give a force to push the water in order to increase the water flow. As to connect between the pipeline transmission and the air compressor, the designs of the Y junction pipe involved. The Y junction pipe is designed with variable diameter of pipe size to see the effect in flow rate and pressure of the water. Flow meter and pressure gauge were been deployed in this project to measure the value of the flow rate and pressure of the water as the Y junction pipe is connected to the water pipeline. All the measured values will be placed in a database system to give users full access to use it and to interact with the measured data.

ABSTRAK

Tekanan air yang rendah seringkali berlaku di kawasan berkedudukan tinggi. Pada masa permintaan yang tinggi, pengguna akan menghadapi masalah ini terutama sekali pada pengguna yang terakhir atau yang terjauh dari bekalan air. Dengan teknologi yang ada sekarang, masalah ini dapat ditangani dengan mudah. Tetapi penciptaan atau rekaan yang baru masih lagi tidak diterapkan dalam menangani masalah ini. Kebanyakan daripada masalah ini akan ditangani dengan menggunakan pam sahaja. Projek ini membincangkan rekabentuk bagi alat penaik tekanan air untuk kegunaan pengguna yang terakhir atau yang jauh dari bekalan air. Alat ini membolehkan tekanan air naik semasa berlakunya tekanan air yang rendah pada bekalan. Projek ini juga memfokus kepada rekabentuk paip dan saiz yang biasa digunakan dalam sistem pembekalan air. Projek ini menggunakan asas dalam konsep vakum dalam sains; membentuk kawasan bertekanan rendah dimana ia akan menolak air masuk. Penekan udara digunakan dalam projek ini sebagai daya penolak air untuk meningkatkan aliran air. Untuk menyambungkan penekan udara dengan sistem perpaipan yang sedia ada, rekabentuk simpang Y diperlukan. Simpang Y direkabentuk dengan saiz diameter paip yang berbeza untuk memperlihatkan kesannya terhadap aliran dan tekanan air yang dibincangkan dalam projek ini. Meter aliran dan tolok tekanan digunakan untuk mengambil bacaan bagi nilai aliran dan tekanan air semasa simpang Y digunakan dalam sistem perpaipan air. Kesemua nilai – nilai yang diambil akan ditempatkan dalam satu pengkalan data untuk memudahkan pengguna untuk menggunakannya dan berinteraksi dengan nilai – nilai tersebut.

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LIST OF ABBREVIATIONS

HTML	-	Hyper Text Multi Language
ASP	-	Active Server Page
ASP.NET	-	Active Server Page for the use in the. Net
CFML	-	ColdFusion Markup Language
JSP	-	Java Server Page

CHAPTER 1

INTRODUCTION

1.1 Introduction

Low water pressure always happens at highland area. During peak hour, consumers always face the problem especially the end user of the water supply. A water pressure increaser device should be use for the water supply. The water pressure increaser is designed to maintain the pressure at certain level to ensure all consumers will have a good supply.

Pump is widely used for solving this problem. But it require continuous maintenance for consistent operation. Pump is widely used for the supply system, not for the consumers use. The design of pumps also is too big, heavy and expensive. So it's not suitable for the consumers to use the pumps. There is just a few invention of device to increase water pressure and it doesn't give a satisfaction in the result.

This research focuses on the design of a water pressure increaser device for consumer usage. Data is collected for various type of connection and pipe size in order to get optimum solution.

1.2 Objectives

The main objective of this project is to solve the problems of low water pressure at high land area. This project focuses for the use at the end consumer that always faces the problem.

The project aims to design a device that capable to increase water pressure during low water pressure situation or condition. Besides, the final design shall be suitable for domestic use and at an affordable price.

This project also focuses in the pressure value and the flow rate of the water. As to ensure the device is increasing the water pressure, the flow rate and the pressure value of the water must be measure. The study in fluid, water and measuring instruments is also required.

1.3 Scope

The project is focusing on the basic theory of vacuum creating principle in science. Normally, flow is used to remove air from a container where the vacuum effect is required. But this project is trying to use an air flow to create vacuum effect. Eventually the water is sucked to increase the flow rate. Necessary measuring equipment such as flowmeter and pressure gauge is used to collect the result of the experiment.

1.4 Organization of the Thesis

This thesis consists of 8 chapters as shown below:

1. Introduction
2. Fluid
3. Air Compressor
4. Flowmeter
5. Pressure Gauge
6. Hardware Design
7. Software Development
8. Results
9. Conclusions

CHAPTER II

FLUID

2.1 Fluids

In daily life, we recognize three states of matter: solid, liquid and gas. Although they are different in many respects, liquid and gases have a common characteristic in which they differ from solids: they are fluids. Fluids flow under the action of such forces, deforming continuously for as long as the force applied. A fluid is unable to retain any unsupported shape; it flows under its own weight and takes the shape of any solid body with which it comes into contact.

As to make this project success, the study in fluid is a must. This project includes a fluid; the water and the compressed air. And to design a device which can increase the water pressure and flow, this study is very useful and helpful.

2.1.1 Shear stress in a moving fluid

Shear stresses are developed when the fluid is in motion, if the particles of the fluid move relatively to each other so that they have different velocities, causing the original shape of the fluid to become distorted. If the velocity of the fluids is the same at every point, no shear stresses will be produced.

The fluid in contact with the boundary adheres to it and will, therefore, have the same velocity as the boundary. Considering successive layers parallel to the boundary, the velocity of the fluid will vary from layer to layer as y increases.

Figure 2.1 show the variation of the velocity with distance from the solid boundary.

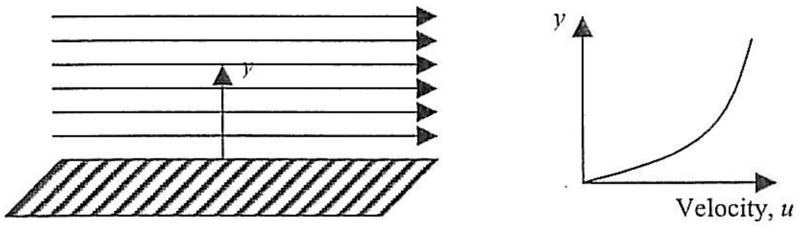

Figure 2.1 Variation of velocity with distance from the solid boundary

2.2 Pressure

A fluid will exert a force normal to a solid boundary or any plane drawn to the fluid. Since problems may involve bodies of fluid of indefinite extent and, in many cases, the magnitude of the force exerted on a small area of the boundary or plane may vary from place to place, it is convenient to work in terms of the *pressure* p of the fluid, defined as the force exerted per unit area. If the force exerted on each unit area of a boundary is the same, the pressure is said to be uniform:

$$pressure = \frac{ForceExerted}{AreaOfboundary} \qquad \text{or} \qquad p = \frac{F}{A}$$

General equation for the variation of pressure due to gravity from point to point in a static fluid

Let p be the pressure acting on the end **P** of an element of fluid of constant cross-sectional area A and $p + \partial p$ be the pressure at the other end **Q**.

Figure 2.2 show the variation of pressure in a stationary fluid.

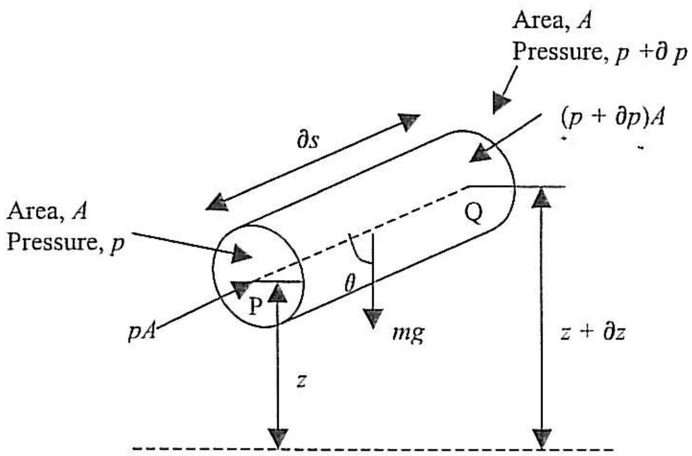

Figure 2.2 Variation of pressure in a stationary fluid

The axis of the element is inclined at an angle θ to the vertical, the height of **P** above a horizontal datum is z and that of **Q** is $z + \partial z$. the forces acting on the element are:

pA	acting at right angles to the end face at **P** along the axis of the element,
$(p + \partial p)A$	acting at **Q** along the axis in the opposite direction;
mg	the weight of the element, due to gravity, acting vertically down

= Mass density x Volume x Gravitational acceleration

$= \rho \times A\partial s \times g$

There are also forces due to the surrounding fluid acting normal to the sides of the element, since the fluid is at rest, and, therefore, perpendicular to its axis PQ.

For equilibrium of the element PQ, the resultant of these forces in any direction must be zero. Resolving along the axis PQ,

$$pA - (p + \partial p)A - pgA\partial s \cos\theta,$$

$$\partial p = -pg\partial s \cos\theta$$

Or, in differential form,

$$\left(\frac{dp}{ds}\right) = -\rho g \cos\theta$$

In the general three-dimensional case, s is a vector with components in the x, y and z directions. Taking the (x,y) plane as horizontal, if the axis of the element is also horizontal, $\theta = 90°$ and

$$\left(\frac{dp}{ds}\right)_{\theta=90°} = \frac{\partial p}{\partial x} = \frac{\partial p}{\partial y} = 0,$$

In a static fluid, pressure is constant everywhere in a horizontal plane. It is for this reason that the free surface of the liquid is horizontal.

If the axis of the element in the vertical z direction, $\theta = 0°$ and

$$\left(\frac{dp}{ds}\right)_{\theta=0^\circ} = \frac{\partial p}{\partial z} = -\rho g,$$

And, since $\partial p/\partial x = \partial p/\partial y = 0$, the partial derivative $\partial p/\partial z$ can be replaced by the total differential dp/dz, giving

$$\left(\frac{dp}{dz}\right) = -\rho g$$

Also, considering any two horizontal planes a vertical distance z apart,

Pressure at all points on lower plane $= p,$

Pressure at all points on upper plane $= p + z\dfrac{\partial p}{\partial z},$

Differences of pressure $= z\dfrac{\partial p}{\partial z}.$

2.3 Fluid Flow

The motion of a fluid is usually extremely complex. The study of a fluid at rest, or in relative equilibrium, was simplified by the absence of shear forces, but when a fluid flows over a solid surface or other boundary, whether stationary or moving, the velocity of the fluid in contact with the boundary must be the same as that of the boundary, and the velocity gradient is created at right angles to the boundary. The resulting change of velocity from layer to layer of fluid flowing parallel to the boundary gives rise to shear stresses in the fluid. Individually particles of fluid move as a result of the action of forces set up by differences of pressure or elevation. Their motion is controlled by their inertia and the effect of the shear stresses exerted by the surrounding fluid. The resulting motion is not easily analyzed mathematically, and it is often necessary to supplement theory by experiment.

2.3.1 Uniform flow and steady flow

Flow is described as uniform if the velocity at a given instant is the same in magnitude and the direction at every point in the fluid. If, at a given instant, the velocity changes from point to point, the flow is described as non-uniform. In the practice, when a fluid flows past a solid boundary there will be variations of velocity in the region close to the boundary. However, if the size and shape of the cross-section of the stream of fluid is constant, the flow is considered to be uniform.

A steady flow is one in which the velocity, pressure and cross-section of the stream may vary from point to point but do not change with time. If, at any given point, conditions do change with time, the flow is described as unsteady. In practice, there will always be slight variations of velocity and pressure, but, if the average values are constant, the flow is considered to be steady.

2.3.2 Real and ideal fluids

When a real fluid flows past a boundary, the fluid immediately in contact with the boundary will have the same velocity as the boundary. The velocity of successive layers of fluid will increase as we move away from the boundary. If the stream of fluid is imagined to be infinite width perpendicular to the boundary, a point will be reached beyond which the velocity will approximate to the free stream velocity, and the drag exerted by the boundary will have no effect. The part of the flow adjoining the boundary in which this change of velocity occurs is known as the boundary layer. In this region, shear stresses are developed between layers of fluid moving with different velocities as a result of viscosity and the interchange of momentum due to turbulence causing particles of fluid to move from one layer to another. The thickness of the boundary layer is defined as the distance from the boundary at which the velocity becomes equal to 99 percent of the free stream velocity. Outside this boundary layer, in a real fluid, the effect of the shear stresses due to the boundary can be ignored and the fluid can be treated as if it were an ideal fluid, which is assumed to have no viscosity and in which there are no shear stresses. If the fluid velocity is high and its velocity low, the boundary layer is comparatively thin, and the assumption that a real fluid can be treated as an ideal fluid greatly simplifies the analysis of the flow and still leads to useful results.

Figure 2.3 show the velocity profiles for one-dimensional flow.

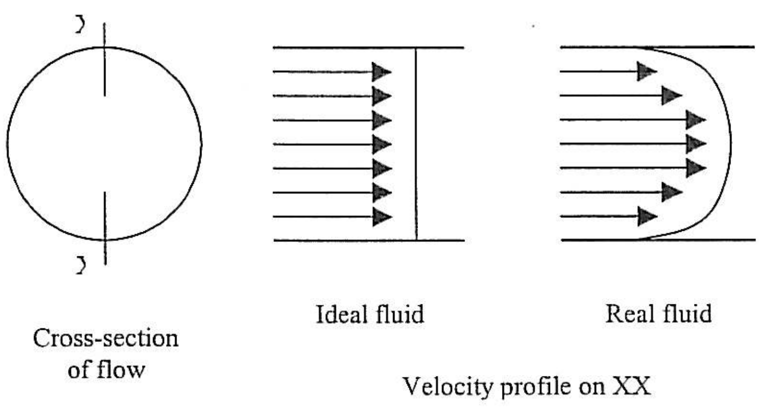

Figure 2.3 Velocity profiles for one-dimensional flow

2.3.3 Compressible and incompressible flow

All fluids are compressible, so that their density will change with pressure, but, under steady flow conditions and provided that the changes of density are small, it is often possible to simplify the analysis of a problem by assuming that the fluid is incompressible and of constant density. Since liquids are relatively difficult to compress, it is usual to treat them as if they were incompressible for all cases of steady flow. However, in unsteady flow conditions, high pressure differences can develop and the compressibility of liquids must be taken into account.

Gases are easily compressed and, except when changes of pressure and, therefore, density are very small, the effects of compressibility and changes of internal energy must be taken into account.

2.3.4 Laminar and turbulent flow

Observation shows that two entirely different types of fluid flow exist. The rate of flow could be controlled by a valve at the outlet, and a fine filament of dye injected at the entrance to the tube. At low velocities, it was found that the dye filament remained intact throughout the length of the tube, showing that the particles of water moved in parallel lines. This type of flow is known as laminar, viscous or streamline, the particles of fluid moving in an orderly manner and retaining the same relative positions in successive cross-sections.

This was demonstrated by Osborne Reynolds in 1883 through an experiment in which water was discharged from a tank through a glass tube. Figure 2.4 show the Reynolds' apparatus.

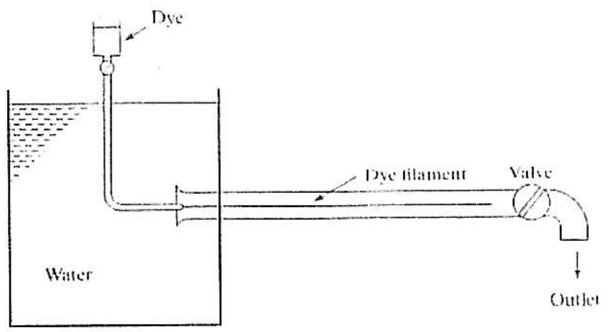

Figure 2.4 Reynolds' apparatus

As the velocity in the tube was increased by opening the outlet valve, a point was eventually reached at which the dye filament at first began to oscillate and then broke up so that the colour was diffused over the whole cross-section, showing that the particles of fluid no longer moved in an orderly manner but occupied different relative positions in successive cross-sections. This type of flow is known as turbulent and is characterized by continuous small fluctuations in the magnitude and direction of the velocity of the fluid particles, which are accompanied by corresponding small fluctuations of pressure.

When the motion of a fluid particle in a stream is disturbed, its inertia will tend to carry it on in the new direction, but the viscous forces due to the surrounding fluid will tend to make it conform to the motion of the rest of the stream. In viscous flow, the viscous shear stresses are sufficient to eliminate the effects of any deviation, but in turbulent flow they are inadequate. The criterion which determines whether flow will be viscous or turbulent is therefore the ratio of the inertial force to the viscous force acting on the particle.

Suppose l is a characteristic length in the system under consideration, e.g. the diameter of a pipe or the chord of an aerofoil, and t is a typical time; then lengths, areas, velocities and accelerations can all be expressed in terms of l and t. For a small element of fluid of mass density ρ,

Volume of element	$= k_1 l^3$,
Mass of element	$= k_1 \rho l^3$,
Velocity of element, v	$= k_2 l / t$,
Acceleration of element	$= k_3 l / t^2$,

where k_1, k_2, and k_3, are constants. By Newton's second law,

Inertial force = Mass x Acceleration

$$= \left({k_1 k_3}/{k_2^2} \right) \rho l^2 v^2$$

Similarly,

Viscous force = Viscous shear stress x Area on which stress acts.

From Newton's law of viscosity,

Viscous shear stress = μ x Velocity gradient = $\mu\left({v}/{k_4 l} \right)$,

where μ = coefficient of dynamic viscosity.

Area on which shear stress acts = $k_5 l^2$.

Therefore,

$$\text{Viscous force } = \left({k_5}/{k_4} \right) \mu v l$$

The ratio

$$\frac{InertiaForce}{ViscousForce} = \frac{k_1 k_3 k_4 \rho l^2 v^2}{k_2^{\,2} k_5 \mu v l} = K \times \frac{\rho v l}{\mu},$$

With K is a constant.

Thus, the criterion which determines whether flow is viscous or turbulent is the quantity $\rho vl/\mu$, known as the Reynolds number. It is a ratio of forces and, therefore, a pure number and may also be written as vl/ν, where ν is the kinematics viscosity ($\nu = \mu/\rho$).

Experiments carried out with a number of different fluids in straight pipes of different diameters have established that if the Reynolds number is calculated by making l equal to the pipe diameter and using the mean velocity v, then, below a critical value of $\rho vd/\mu = 2000$, flow will normally be laminar (viscous), any tendency to turbulence being damped out by viscous friction. This value of the Reynolds number applies only to flow in pipes, but critical values of the Reynolds number can be established for other types of flow, choosing a suitable characteristic length such as the chord of an aerofoil in place of the pipe diameter. For a given fluid flowing in a pipe of a given diameter, there will be a critical velocity of flow v corresponding to the critical value of the Reynolds number, below which flow will be viscous.

In pipes, at values of the Reynolds number above 2000, flow will not necessarily be turbulent. Laminar flow has been maintained up to Re = 50 000, but conditions are unstable and any disturbance will cause reversion to normal turbulent flow. In straight pipes of constant diameter, flow can be assumed to be turbulent if the Reynolds number exceeds 4000.

2.3.5 Discharge and mean velocity

The total quantity of fluid flowing in unit time past any particular cross-section of a stream is called the discharge or flow at that section. It can be measured either in terms of mass, in which case it is referred to as the mass rate of flow m' and measured in units such as kilograms per second, or in term of volume, when it is known as the volume rate of flow Q, measured in such units as cubic meters per second.

In an ideal fluid, in which there is no friction, the velocity u of the fluid would be the same at every point of the cross-section. In unit time, a prism of fluid would pass the given cross-section and if the cross sectional area normal to the direction of flow is A, the volume passing would be Au. Thus

$$Q = Au$$

In a real fluid, the velocity adjacent to a solid boundary will be zero or, more accurately, equal to the wall velocity in the flow direction, a condition known as 'no slip', which will be true as long as the flow does not separate from the wall. For a pipe, the velocity profile would be as shown in figure below for laminar flow and for turbulent flow.

Figure 2.5 show the calculation of discharge for a circular section.

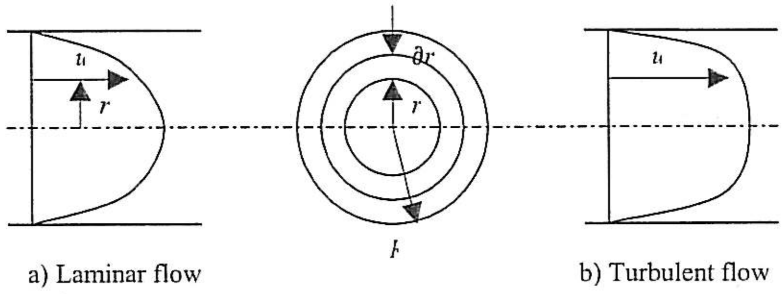

Figure 2.5 Calculation of discharge for a circular section; note 'no slip' at wall

If u is the velocity at any radius r, the flow ∂Q through an annular element of radius r and the thickness ∂r will be

$$\partial Q = \text{Area of element x Velocity}$$
$$= 2\pi r\partial r \times u$$

And, hence,

$$Q = 2\pi \int_0^R urdr$$

If the relation between u and r can be established, this integral can be evaluated or the integration may be undertaken numerically.

In many problems, the variation of velocity over the cross-section can be ignored, the velocity being assumed to be constant and equal to the mean velocity $\bar{u}$, defined as volume rate of discharge Q divided by the area of cross-section A normal to the stream;

$$\text{Mean velocity, } \bar{u} = Q/A$$

2.3.6 Continuity of flow

The principle of conservation of mass can be applied to a flowing fluid. Considering any fixed region in the flow constituting a control volume,

Mass of fluid entering = Mass of fluid leaving + Increase of mass of fluid in the
per unit time per unit time control volume per unit time.

Figure 2.6 show the continuity of flow.

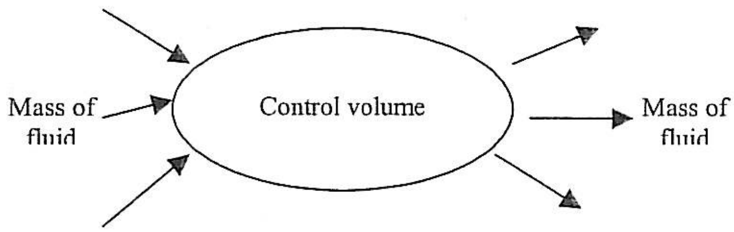

Figure 2.6 Continuity of flow

For steady flow, the mass of fluid in the control volume remains constant and the relation reduces to

Mass of fluid entering = Mass of fluid leaving
per unit time per unit time.

The continuity of flow equation is one of the major tools of fluid mechanics, providing a means of calculating velocities at different points in a system.

The continuity equation can be applied to determine the relation between the flows into and out of a junction. In Figure 2.7, for steady conditions,

Total inflow to junction = Total outflow from junction,

$$\rho_1 Q_1 = \rho_2 Q_2 + \rho_3 Q_3$$

Figure 2.7 show the application of the continuity equation.

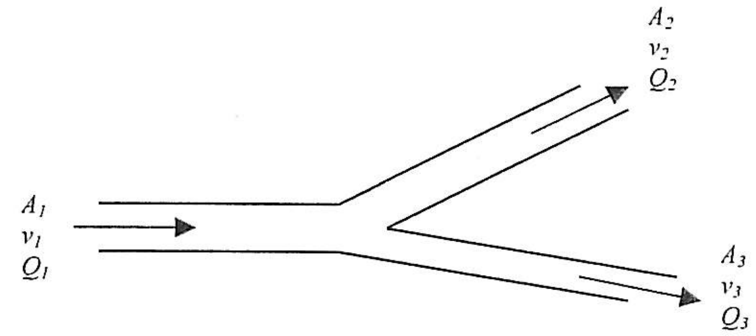

Figure 2.7 Applications of the continuity equation

For an incompressible fluid, $\rho_1 = \rho_2 = \rho_3$ so that

$$Q_1 = Q_2 + Q_3$$

Or $$A_1v_1 = A_2v_2 + A_3v_3$$

In general, if we consider flow towards the junction as positive and flow away from the junction as negative, then for steady flow at any junction the algebraic sum of all the mass flow must be zero:

$$\sum \rho Q = 0$$

CHAPTER III

AIR COMPRESSOR

3.1 Introduction

Air compressor is a device that compresses an air and release the compressed air at the output of the device. This device is one of the alternatives to give an additional force in this project. It can be replaced with pumps, valve or any other device that can give a force. This project uses an air compressor as to give an additional force which will increase the water flow and pressure. And to ensure it can increase the water pressure, the study in air compressor will help. For this project, it is focusing in the air compressor device as one of the main instrument used.

This chapter will discuss about air compressor. An air compressor can be in many sizes, shapes, designs and types. The device sizes, shapes, designs and types are depends in its demand. Commonly, an air compressor is use for an industrial development. An air compressor has three basic types. It consists with reciprocating type, rotary screw type and rotary centrifugal type.

3.2 Reciprocating Units

Reciprocating air compressors are positive displacement compressors. This means they are taking in successive volumes of air which is confined within a closed space and elevating this air to a higher pressure. The reciprocating air compressor accomplishes this by using a piston within a cylinder as the compressing and displacing element.

The reciprocating air compressor is considered single acting when the compressing is accomplished using only one side of the piston. A compressor using both sides of the piston is considered double acting.

The reciprocating air compressor uses a number of automatic spring loaded valves in each cylinder that open only when the proper differential pressure exists across the valve. Inlet valves open when the pressure in the cylinder is slightly below the intake pressure. Discharge valves open when the pressure in the cylinder is slightly above the discharge pressure.

A compressor is considered to be single stage when the entire compression is accomplished with a single cylinder or a group of cylinders in parallel. Many applications involve conditions beyond the practical capability of a single compression stage. Too great a compression ration (absolute discharge pressure/absolute intake pressure) may cause excessive discharge temperature or other design problems.

Reciprocating air compressors are available either as air-cooled or water-cooled in lubricated and non-lubricated configurations, may be packaged, and provide a wide range of pressure and capacity selections.

3.3 Rotary Screw Compressors

Rotary air compressors are positive displacement compressors. The most common rotary air compressor is the single stage helical or spiral lobe oil flooded screw air compressor. These compressors consist of two rotors within a casing where the rotors compress the air internally. There are no valves. These units are basically oil cooled (with air cooled or water cooled oil coolers) where the oil seals the internal clearances.

Since the cooling takes place right inside the compressor, the working parts never experience extreme operating temperatures. The rotary compressor, therefore, is a continuous duty, air cooled or water cooled compressor package. Because of the simple design and few wearing parts, rotary screw air compressors are easy to maintain, operate and provide great installation flexibility. Rotary air compressors can be installed on any surface that will support the static weight.

The two stage oil flooded rotary screw air compressor uses pairs of rotors in a combined air end assembly. Compression is shared between the first and second stages flowing in series. This increases the overall compression efficiency up to fifteen percent of the total full load kilowatt consumption. The two stage rotary air compressor combines the simplicity and flexibility of a rotary screw compressor with the energy efficiency of a two stage double acting reciprocating air compressor. Two stage rotary screw air compressors are available air cooled and water cooled and fully packages. The oil free rotary screw air compressor utilizes specially designed air ends to compress air without oil in the compression chamber yielding true oil free air. Oil free rotary screw air compressors are available air cooled and water cooled and provides the same flexibility as oil flooded rotaries when oil free air is required.

Rotary screw air compressors are available air cooled and water cooled, oil flooded and oil free, single stage and two stages. There is a wide range of availability in configuration and in pressure and capacity.

3.4 Centrifugal Compressors

The centrifugal air compressor is a dynamic compressor which depends on transfer of energy from a rotating impeller to the air. The rotor accomplishes this by changing the momentum and pressure of the air. This momentum is converted to useful pressure by slowing the air down in a stationary diffuser.

The centrifugal air compressor is an oil free compressor by design. The oil lubricated running gear is separated from the air by shaft seals and atmospheric vents. The centrifugal is a continuous duty compressor, with few moving parts, that is particularly suited to high volume applications, especially where oil free air is required. Centrifugal air compressors are water cooled and may be packaged; typically the package includes the after-cooler and all controls.

3.5 Air Systems

In addition to the air compressor package that includes the drive, air end, and cooling system, complete air systems include: Receiver tanks, Air dryers, Filters, and Piping distribution systems.

3.5.1 Receiver tanks

The air receivers provide storage capacity to prevent rapid compressor cycling. It reduces wear and tear on compression module, inlet control system, and motor. The receiver tanks also eliminate pulsing air flow and avoid overloading purification system with surges in air demand. It also damp out the dew point and temperature spikes that follow regeneration. A rule of thumb is to provide a minimum of one gallon of receiver capacity for each cubic foot of compressor flow.

3.5.2 Air dryers

Moisture, either liquid or vapor, is present in compressed air as it exits the compressor system. If this moisture is not properly removed, your compressed air system can lose efficiency and require dramatically increased maintenance, which can result in costly downtime.

The majority of pneumatic instruments and processes can not tolerate hot compressed air; compressors are normally supplied with after-coolers and moisture separators. Aftercoolers are heat exchangers that utilize either water or ambient air to cool the compressed air. As the water and lubricant vapors within the compressed air cool, a significant amount condenses into liquid. An after-cooler discharging compressed air at 100F passes 67 gallons of water per 1,000 scfm per 24 hours.

To avoid these problems, compressed air systems have purification devices available to remove the water vapor and other contaminants. The proper selection of these devices is critical as pneumatic applications and compressed air systems become increasingly sophisticated. The pneumatic equipment in use and the lowest expected ambient temperature determine the drying method. The most common dryer is a refrigerated unit that cools the compressed air, condenses water and oil vapors, separates them, and drains them from the system. The "dried" compressed air is then fed to the air system.

Dryer performance is specified as a pressure dew point class that is based on a specific inlet and ambient conditions. The lowest pressure dew point class with a refrigerated dryer is Class H. This class delivers a pressure dew point that of 33EF to 39EF. Refrigerated dryers should not operate below the Class H range because the water vapor will freeze in the dryer. The highest practical pressure dew point for a refrigerated dryer is 60EF because higher pressure dew points give condensation in downstream piping.

3.5.3 Filters

Coalescing filters are the most common form of compressed air purification. These filters remove liquid water and lubricants from compressed air and are installed downstream in a refrigerated air dryer system or upstream in a desiccant dryer system.

Most manufacturers claim a one psi "clean and dry" pressure drop, with the normal operating (wetted) pressure drop between three and six psi. Manufacturers typically require filter changes when the pressure drop reaches 10 psi, which is approximately six to 12 months of operation. Coalescing filters will also remove particulate contamination; however, this will increase the pressure drop across the filter and shorten the filter element life.

Filters are rated according to liquid particle retention size (micron) and efficiency, such as 0.50 micron and 99.99% D.O.P. efficient, or 0.01 micron and 99.9999% D.O.P efficient. Coalescing filters can only remove previously condensed liquids; they do not remove water or lubricant vapors from the compressed air. Any condensation produced from subsequent compressed air cooling will have to be eliminated. When seeking to remove water and lubricant vapors from compressed air, specify an air dryer.

3.5.4 Piping distribution system

The piping distribution system not only controls how the air gets from the compressor room to the tools, it is a major factor in the energy consumed by the compressor. Poorly designed or maintained systems increase pressure losses and increase operating costs. A common error is to increase compressor delivery pressure to compensate for distribution problems. This substantially increases energy costs. Higher pressure increases leak rates, another major source of waste, thus the waste and increased cost is compounded.

CHAPTER IV

FLOWMETER

4.1 Introduction

It is important to know how equipment work and the use of it in daily life. This chapter will discuss about flowmeters; how the flowmeters work and its typical application. Flowmeter is use in this project as a measure equipment to determine the flow rate of the water.

4.2 How Flowmeters Work?

Variable area flowmeters are basically vertical internally tapered tubes mounted with the large end at the top. A float or rotor with an outer diameter slightly less than the minimum diameter of the tube is placed inside the tube. The clearance space between the float and the tube forms an annular passage or orifice. As the tube is tapered, the area of this orifice is larger when the float is near the top than it is when the float is near the bottom.

By connecting the tube into a fluid flow line so flow direction is from bottom to top, the float will move upward and be supported at a point where the orifice is just large enough to pass the fluid flowing through the system.

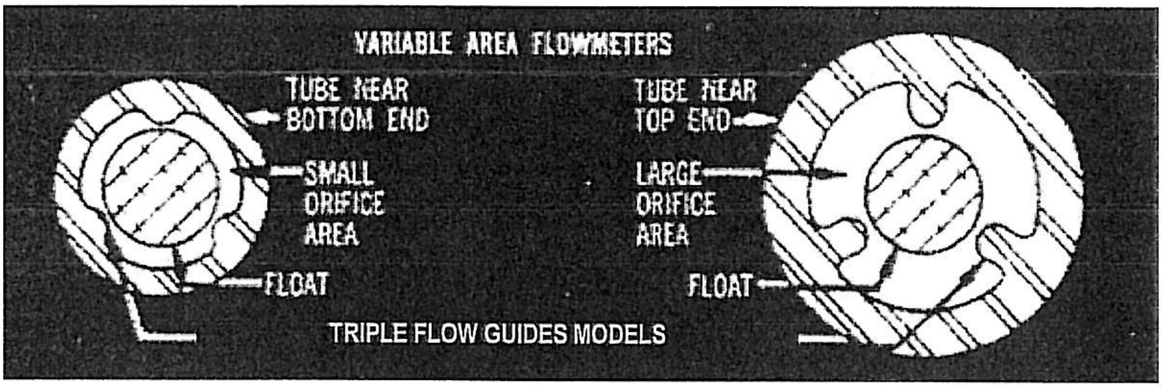

Figure 4.1 Variable area flowmeters

4.2.1 Several forces are involved

The precise position of the float within the tube is determined by several forces acting on it. These forces are: the weight of the float, the velocity pressure of the flowing fluid multiplied by the area of the float, buoyancy of the float (weight of fluid volume displaced by the float), viscous aerodynamic or hydrodynamic drag of the fluid on the float. The float's weight acts downward - while velocity pressure, buoyancy and drag all act upward on it.

4.2.2 Read-out and scales

By making the tube transparent so that float position can be seen and by providing a scale along side, we may "read" the float position in terms of numbers on the scale. These scale numbers can be of two types: Of an arbitrary nature (by themselves they mean nothing, but become meaningful when compared with a calibration curve) or; They can be precalibrated for direct reading, to show the actual volume flow (in cfm, cc per minute, etc.) of the fluid for which the flowmeter is calibrated.

4.2.3 Limiting factors

Although the basic relationship outlined above is linear, certain fluid properties tend to modify this relationship. These changes are accentuated where the variable orifice formed between float and tube becomes either very large or very small. For example: sonic velocity

4.2.4 Sonic velocity

Where the orifice is particularly large and is combined with a heavy float, velocities of a gas or other fluid through the orifice area can approach sonic velocity. In this velocity range, reflected shock waves cause the float to become unstable, and it will typically hunt from side to side and from top to bottom within the bore. At best, this condition makes it impossible to take a reading, and at worst may even destroy the flowmeter. The addition of flow guides (built into certain flow meters) can often improve the stability and performance of the system by channeling the flow into multiple streams that equalize dynamic effects and preventing oscillation of the float. This has the net effect of moving the limit of satisfactory operation upward, and thereby expanding the range and accuracy we can achieve with any given flowmeter tube.

4.2.5 Laminar flow

In flow meters where the orifice area is extremely small, the conditions result in smooth flow, or laminar flow. Other factors which contribute to the transition to laminar flow are low velocity (often associated with a lightweight float), low density or specific gravity and high viscosity of the flowing fluid. When laminar flow conditions prevail, a greatly expanded scale is usually required. Meters operating in the laminar flow area are very difficult to manufacture and calibrate to the degree of accuracy usually expected of variable area flowmeters.

4.2.6 Turbulent flow

Most variable area flowmeters operate in the turbulent flow range which occurs below sonic velocities and above the laminar flow range. In turbulent flow, the flowing fluid particles move in random paths within the stream - rather than in violent shock waves as in sonic flow or very smooth parallel paths as in laminar flow. In turbulent flow, variables follow the relationships in curves. These curves are quite accurate for small changes in pressure and specific gravity. For large changes or where a change in viscosity is involved, it is much better to have the flowmeter recalibrated for the specific conditions under which it will be used.

4.2.7 Reynolds numbers

Reynolds Numbers are useful in the study of fluid behavior and are quite helpful in separating laminar and turbulent flow. The Reynolds Number of a fluid flow system is described as a dimensionless index. It is equivalent to the diameter of the orifice in feet times the average velocity of the fluid in feet per second times the density of the fluid in pounds per cubic foot divided by the absolute viscosity in pounds per second foot. A system operating with a Reynolds Number of less than 2000 is said to be subject to laminar flow, whereas Reynolds Numbers above 3000 are clearly in the turbulent flow area.

4.3 How Sight Flow Indicators Work?

A sight flow indicator basically consists of a small housing equipped with a glass window which is inserted in a run of pipe to observe the flow of the fluid in the pipe. To enhance the visibility of the flow, a spinner is often incorporated in the indicator. The axis of the spinner is offset from the center of the flow stream so that fluid impinging on the spinner vanes causes it to turn. The spinner also aids in the detection of low flows as well as providing visibility of flow from a distance. In addition, the speed of rotation gives a relative indication of flow velocity. Midwest Sight Flow Indicators are available with hinged flappers instead of spinners to indicate bi-directional flow.

Sight flow indicators can be provided with a single window on the front of the indicator or double windows, one on the front and one on the back of the indicator. Double window units are best when observing the clarity or color of a liquid. Midwest single window units are always equipped with spinners to provide for observation of clear fluid flows at the lowest cost.

Vertical tube-type sight flow indicators consist of a clear glass tube, equal to or greater than the diameter of the pipe into which it is inserted, and are utilized to observe high flow rates in vertical pipe runs. No spinners or other type of detection devices are incorporated in these units. As a result, they offer no significant resistance to flow and therefore provide the lowest pressure drop of any type sight flow indicator. Midwest Sight Flow Indicators are available with special materials to meet various applications. Optional materials are available for the sealing gaskets, spinners, and housings or flanges.

4.4 Typical Applications of Flowmeters

4.4.1 Flowmeters used to check dry air flow protecting cables

Figure 4.2 show the flowmeters used to check dry air flow protecting cable.

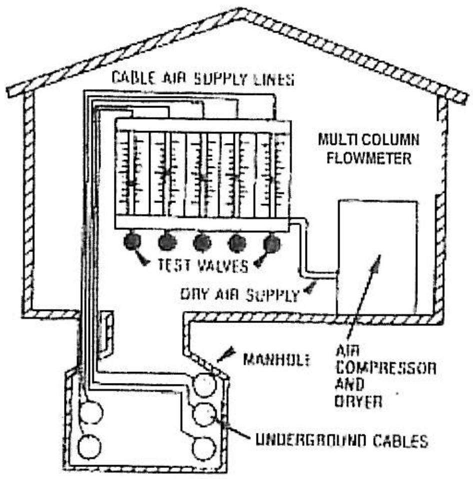

Figure 4.2 Check dry air flow protecting cables

Telephone cables are kept under pressure with dry air for protection against damage due to moisture. The flow of air to each cable is monitored to detect leaks that may develop due to cable damage. Flowmeters are widely used in this application.

4.4.2 Flowmeters monitor vital purge gas flow to motors, switchgear, instruments

Figure 4.3 show the flowmeters monitor vital purge gas flow to motors, switchgear and instruments.

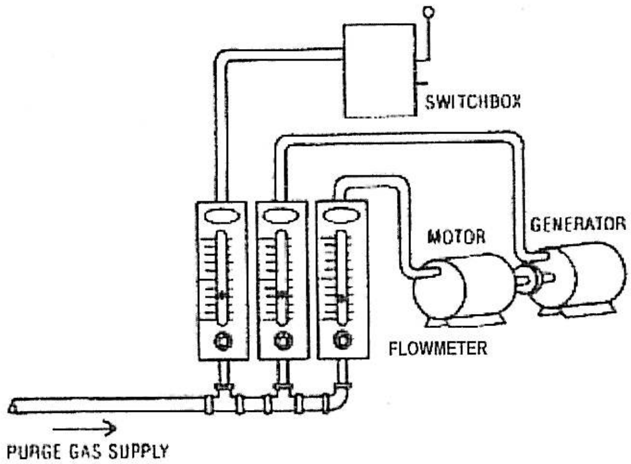

Figure 4.3 Monitor vital purge gas

To purge motors, generators, switchgear, and industrial instrument cases, flowmeters are installed in the supply line to indicate a flow of air, manufactured inert gas, or nitrogen to these devices. The flow meters (with valves) allow maintenance personnel to set the flow quickly and recheck anytime to make sure proper flow continues.

4.4.3 Midwest sight flow indicator reveals flow or stoppage

Figure 4.4 show the Midwest sight flow indicator reveals flow or stoppage.

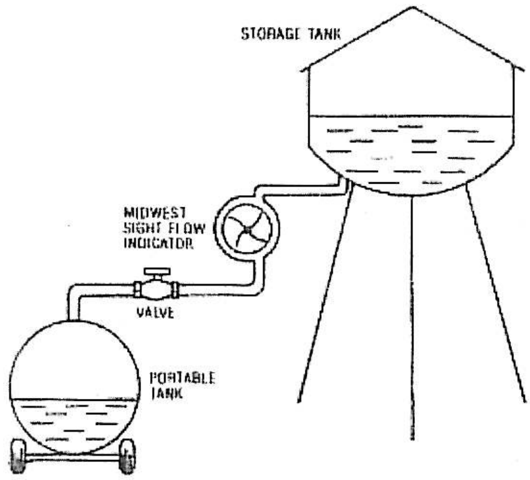

Figure 4.4 Reveals flow or stoppage

In this gravity feed system delivering liquid fertilizer to portable tanks, a sight flow indicator was installed. The operator can see the rotating vanes to check for adequate flow at any time.

4.4.4 Flowmeters reveals proper suction flow into portable halogen leak detector

Figure 4.5 show the flowmeter reveals proper suction flow into portable halogen leak detector.

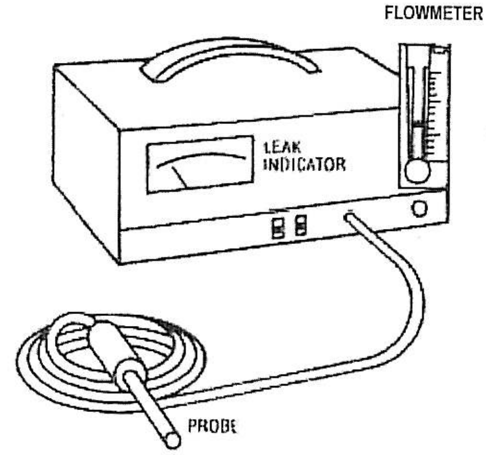

Figure 4.5 Reveals proper suction flow

A flowmeter provides a low-cost means of checking that proper suction flow is maintained so that leaks do not go undetected due to obstruction of the probes or failure of the pumping system.

4.4.5 Flowmeters monitor water cooling and fuel flow to large engines and compressors

Figure 4.6 shows the water cooling and fuel flow to large engines and compressors monitored by flowmeters.

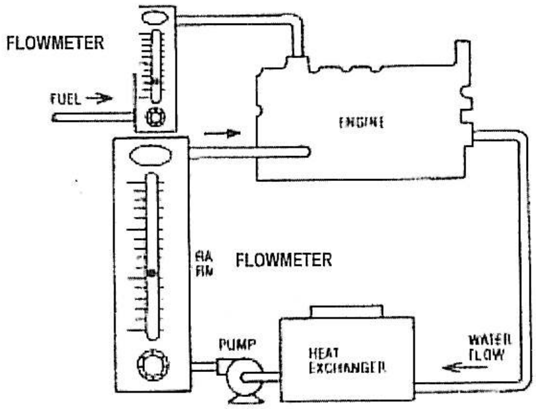

Figure 4.6 Water cooling and fuel flow

By precisely indicating true flow of cooling water to engines, compressors and other machinery, flow-meters permit the operator to adjust the proper flow to save water, increase efficiency, and protect the equipment. Engine fuel flow can be monitored in the same way.

4.4.6 Flowmeters measuring liquid level

Figure 4.7 shows the flowmeter measuring liquid level.

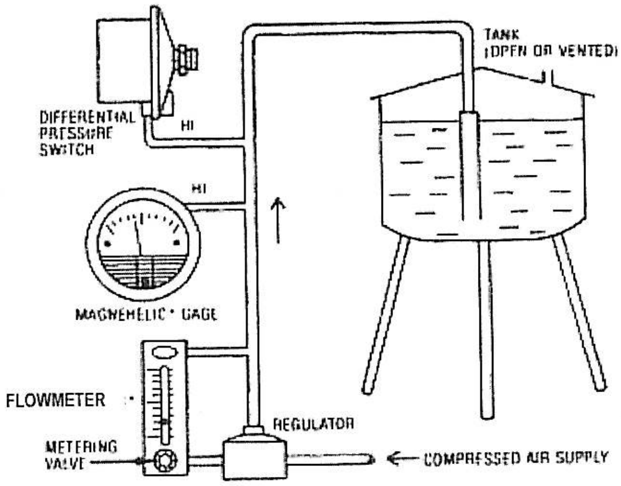

Figure 4.7 Measuring liquid levels

A flowmeter in conjunction with a constant differential pressure regulator is used to keep the sensing line purged of liquid. Changes in liquid level will affect static head. This will affect internal pressure in the sensing line, which can be indicated by a pressure gage.

4.4.7 Flow of air and gas used in a special furnace are controlled by eleven flowmeters

Figure 4.8 shows the flows of air and gases used in a special furnace are controlled by eleven flowmeters.

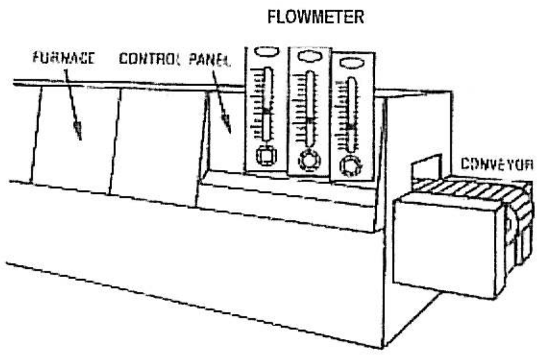

Figure 4.8 Special furnace

This sophisticated conveyor belt furnace is used in manufacturing electronic devices. The flow meters provide precise adjustment and monitoring of the flows of air and gases into the various portions of the furnace.

4.4.8 Flowmeter's controls flow rate of chemical concentrate

Figure 4.9 shows the flowmeter controls flow rate of chemical concentrate

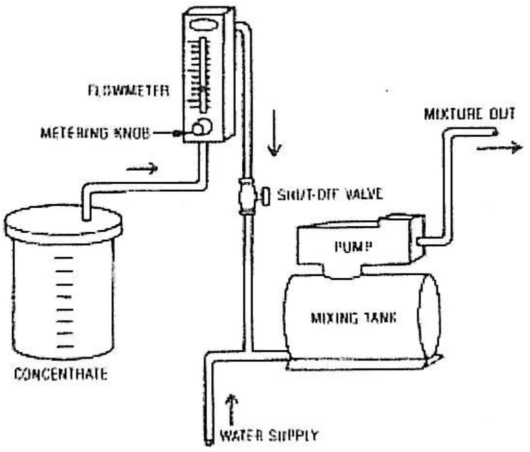

Figure 4.9 Controls chemical concentrate

When adding a chemical concentrate to a large volume of water or other fluid, you can determine the rate at which the concentrate is being added by using a flowmeter. The concentrate is added on the input side of the pump. This draws the concentrate from its container and also utilizes the mixing action of the pump.

4.4.9 Oxygen concentrator replaces heavy tanks and includes a flowmeters for easy adjustment of oxygen flow

Figure 4.10 shows the oxygen concentrator replaces heavy tanks and includes a flowmeter for easy adjustment of oxygen flow.

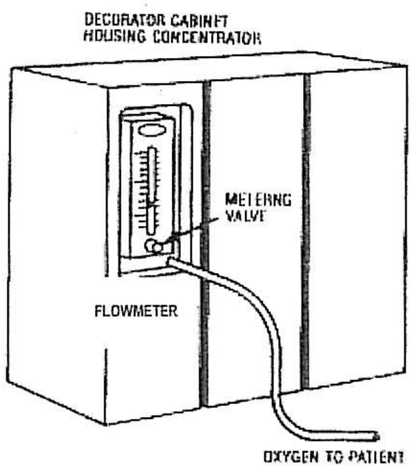

Figure 4.10 Easy adjustment of oxygen flow

An oxygen concentrator delivers oxygen from the surrounding air to those who frequently require oxygen at home. A flowmeter with a metering valve is placed in the oxygen output line to adjust the flow to the prescribed level.

4.4.10 Special dual column flowmeter delivers anesthetic

Figure 4.11 shows the special dual-column flowmeter delivers anesthetic.

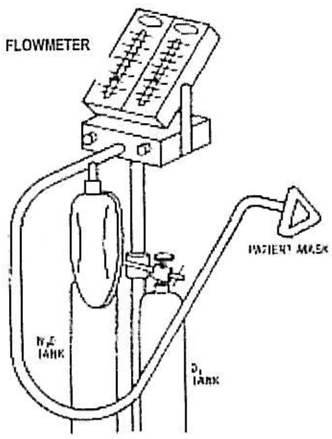

Figure 4.11 Delivers anesthetic

Physicians who use anesthesia in their offices on an occasional basis require a system that is reliable but small and portable. One such system employs special flowmeters to meter and monitor precise flows of nitrous oxide and oxygen to the patient.

4.4.11 Leak testing system by using a flowmeters

Figure 4.12 shows the leak testing system by using a flowmeter.

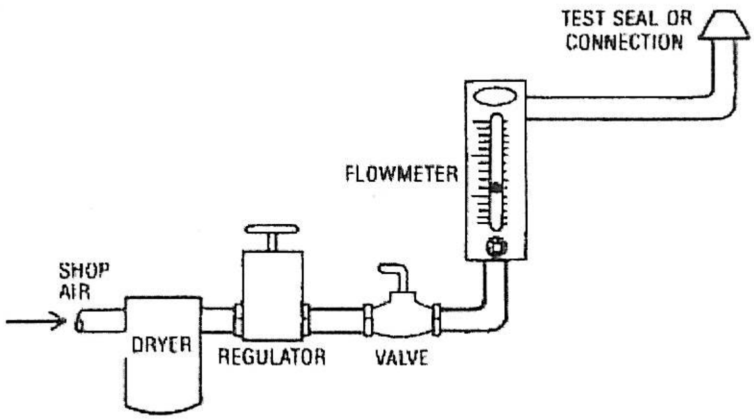

Figure 4.12 Leak testing

During testing, the valve is opened and the float will go to the top of the flowmeter bore. However as soon as a unit under test is placed in position, the float will fall to the zero mark if no leakage exists.

4.4.12 Flowmeters on concrete mixer show flow of special additives

Figure 4.13 shows the flowmeters on concrete mixer show flow of special additives

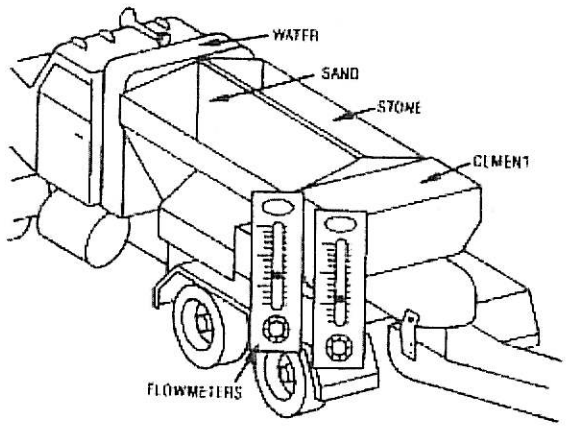

Figure 4.13 Show special additives

This on-site mixer delivers the exact amount and the proper formulation required for the specific job. The flowmeters permit setting the proper admixture flows to add the specified quantities of accelerators, retarders, air-entraining agents and others.

CHAPTER V

PRESSURE GAUGE

5.1 Introduction

In this chapter, pressure gauge will be discussed for how pressure gauge is working, the design of pressure gauge and the typical use of pressure gauge. This device is a measuring instrument that can be useful and effective for its application. Pressure is use in this project as to measure the value of the pressure of the water supply. The study of this instrument will help to understand the working device and the use of the device.

5.2 How Pressure Gauges Work?

Pressure gauges are used for many applications. The importances of pressure gauges are often overlooked. A well designed and properly sized pressure gauge should provide accurate service for years. The performance of spray nozzles, pumps and other fluid components are often judged in part by pressure gauges in the fluid system. A quality pressure gauge will pay for itself within a short period of time by increasing the accuracy and control of your process. These pages serve as a brief introduction to pressure gauge design.

Figure 5.1 shows the two most popular types of pressure gauges - regular and (more reliable) filled. The two most common causes for gauge failure are pipe vibration and water condensation (which can lead to freezing in colder environments). The delicate links pivots and pinions of a regular gauge are sensitive to both condensation and vibration. Filled gauges last longer because they have fewer moving parts and the housing is filled with a viscous glycol or silicon fluid. The fill in a gauge helps dampen pointer vibration and eliminates corrosion as a result of condensed water in areas having humid air. Pressure gauges are classified by their precision, from Grade 4A (permissible error of 0.1% of pressure range) to Grade D (5% error).

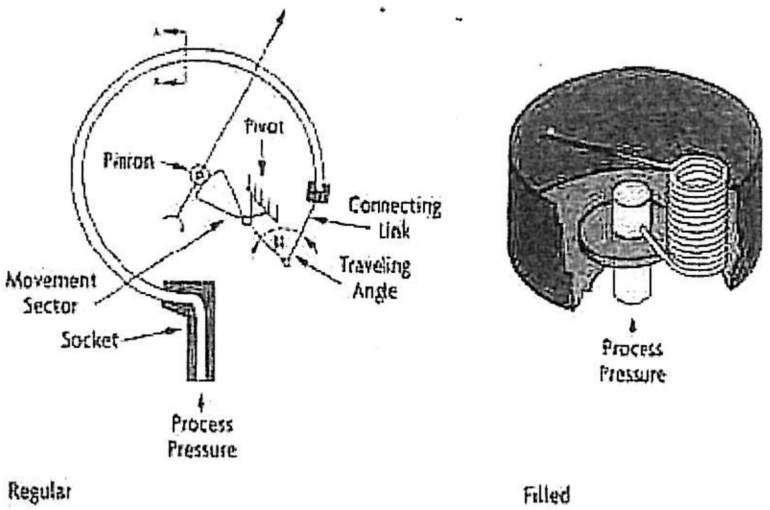

Figure 5.1 Types of pressure gauges

5.2.1 Inside a pressure gauge

Figure 5.2 shows the inside of a pressure gauge.

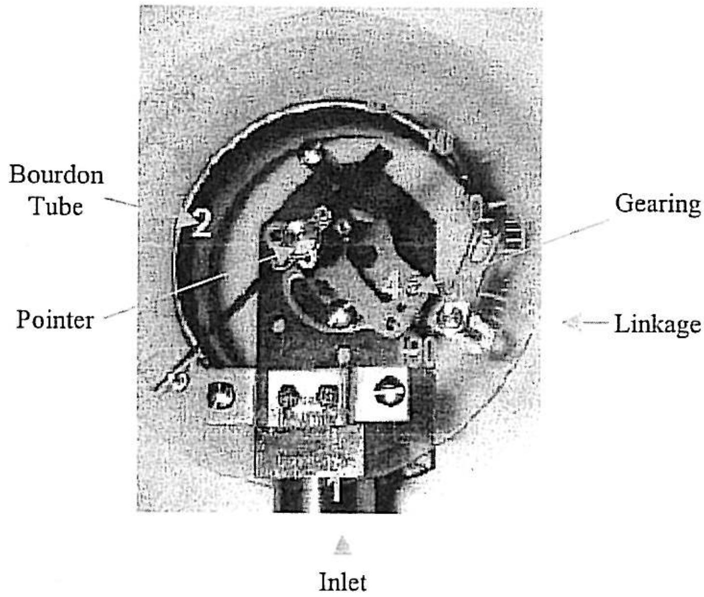

Figure 5.2 Inside a pressure gauge

5.2.1.1 Inlet

Fluid enters through the inlet of the gauge and into area, the Bourdon Tube.

5.2.1.2 Bourdon Tube

The Bourdon Tube is a tubular alloy that has been compressed and bent into an arc. As fluid enters the Bourdon Tube, it causes the tube to flex as it attempts to regain its' natural "round" shape. Essentially the arc tries to straighten itself out.

5.2.1.3 Linkage

The flexure of the Bourdon Tube is linked to the gearing mechanism of the gauge. This is where quality becomes important. As the Bourdon Tube moves, the linkage indexes the gears.

5.2.1.4 Gearing

Precision built gears control the movement of the pointer. Finer increments or higher accuracy gauges require more complicated gearing than used by "standard gauges".

5.2.1.5 Pointer

The pointer moves with the gearing to indicate the operating pressure within the ANSI accuracy rating of the gauge.

The quality of the welds at either end of the Bourdon Tube is critical - poor quality welds can rupture, ruining the gauge and perhaps contaminating the process.

The materials of the Bourdon Tube and inner parts of the gauge are determined by the requirements of the process. The accuracy required temperature of the environment and fluid characteristics all play key roles in pressure gauge component selection.

5.3 Pressure Gauge Designs

Pressure gauges come in many different shapes and sizes.

Figure 5.3 shows the safety gauge that commonly used.

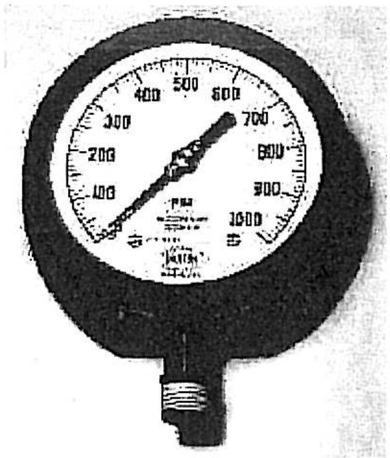

Figure 5.3 Safety gauge

This type of gauge has a solid wall between the dial and the gauge mechanism. The idea behind this design is that in the event of over-pressurization and failure of the Bourdon Tube, process fluid would be directed out the back of the gauge, reducing potential harm to operators (back of the case is designed to give-out under a certain amount of pressure). Safety gauges are common in the chemical processing industry, since many of the fluids used in that industry are harmful to operators if they escape the system. Dials and cases are available in a variety of sizes and designs. As a manufacturer of gauges, Precision can customize dials to suit the requirements of the application.

In some cases customers want their name and logo on the dial and in others the dial may be calibrated to read in GPM (Gallons per Minute). Some customers prefer the use of color or symbols on their dial rather than numbers. For instance, when the pointer moves from the "green zone" to the "red zone", it may signify a problem.

Pressure gauges can be customized in other ways too. The inlet can be at any orientation to the dial and there are several different case styles to choose from, including flange, panel and front mounted cases. Some gauges even glow or light-up for dark areas.

5.4 Typical Gage Application

These applications serve only the wide range of applications by the versatile of low pressure gages.

Although many of the applications obviously solve problems for users of air conditioning, heating and ventilating equipment, a number of others involve monitoring low pressures in pollution control devices, clean rooms, fluidic systems, medical-surgical patient care equipment and similar uses.

5.4.1 As a gage to check air filters

Pressure gages provide an instant visual indication when filters need servicing. Select a model with range appropriate to the filter manufacturer's recommendation for maximum permissible pressure drop across a filter. Install a gage with a red pointer flag (an option), to be set at the maximum allowable pressure drop point for air volume being handled. This assures easy reading of the gage, even by relatively inexperienced operators.

Figure 5.4 shows the pressure gauge as a gage to check air filters.

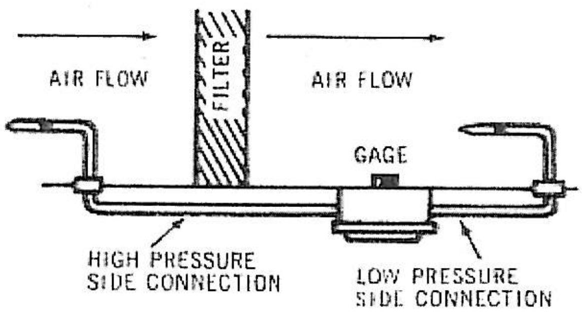

Figure 5.4 Check air filters

5.4.2 To sense static pressure

For the most accurate measurement of static pressure in an air stream, use a pressure gage connected to a static pressure tip. The next most accurate pick-up is a smooth, burr-free soldered connection flush with the inside surface of the duct. Only slightly less accurate is a simple connection.

Figure 5.5 shows the pressure gage used to sense static pressure

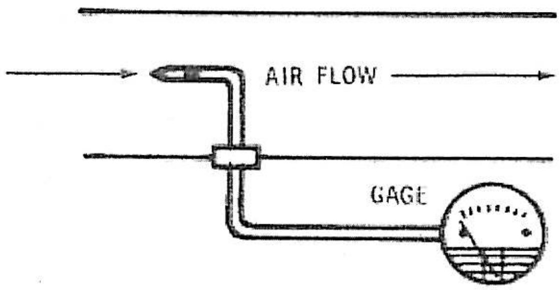

Figure 5.5 Sense static pressure

5.4.3 Measure air velocity

Connect a pressure gage to a pitot tube in the air stream. Or, the simple alternative method pictured above shows a static tap plus a simple tube installed in the center of duct to pick up total pressure. The differential pressure reading on the gage is center velocity pressure which may be converted to air velocity.

Figure 5.6 shows the pressure gage used to measure air velocity.

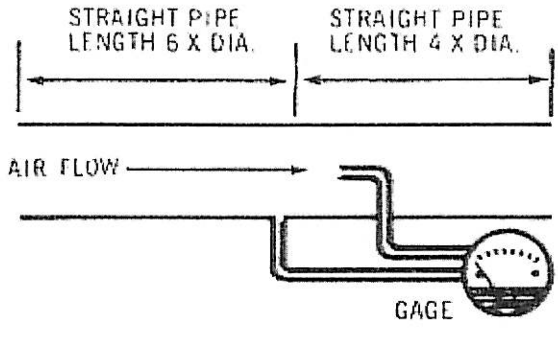

Figure 5.6 Measure air velocity

5.4.4 To determine flow

In this set-up, the pressure gage measures the pressure drop across a sharp-edged orifice plate. Details regarding available sizes, ranges, installation, and limitations are available from orifice plate manufacturers and from standard handbooks.

Figure 5.7 shows the pressure gage used to determine flow.

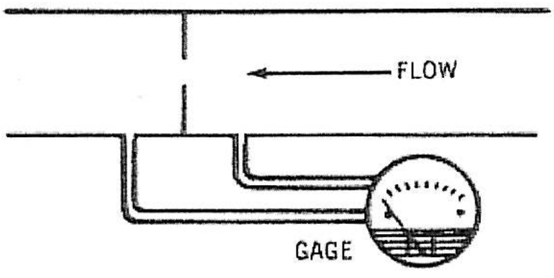

Figure 5.7 Determine flow

5.4.5 To monitor engine or compressor air filters

Gage gives continual reading of air pressure drop across filter and signals need for cleaning or replacement of filter. Gage is installed with negative or low pressure port connected to intake pipe between filter and engine or compressor. A pressure gage can be used to monitor pressure drop across the oil filter.

Figure 5.8 shows the pressure gage used to monitor engine or compressor air filters

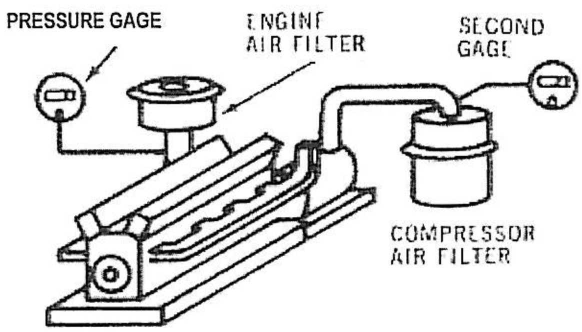

Figure 5.8 Monitor engine or compressor

5.4.6 Air volume measurement

An elliptical flow nozzle with an egg crate air straightener located upstream provides an accurate, easily constructed air volume measurement system. Air velocity distribution at the point of discharge across the outlet of nozzle is uniform; static pressure is zero. Consequently, total pressure upstream from the nozzle is the velocity pressure at the nozzle outlet - and the volume of flow is easily calculated.

Figure 5.9 shows the pressure gage used to measurement air volume.

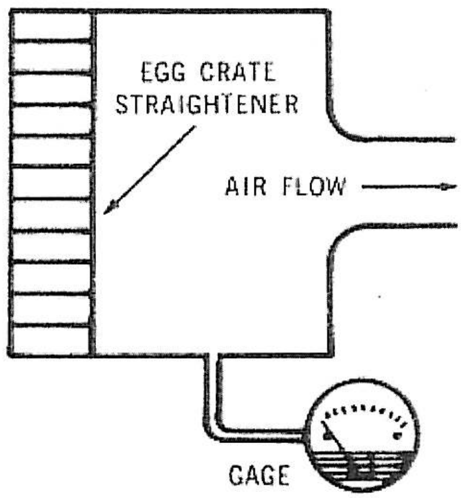

Figure 5.9 Air volume measurement

5.4.7 As an orifice meter

Pressure gages can be used as orifice meters by purging the orifice with air pressure to protect gage from direct contact with fluid or to prevent clogged meter lines. Gage is shown connected to two flow meters with constant differential pressure regulators - one for the low pressure tap line and one for the high pressure side (a pressure gage may be used without purge on compatible liquid streams).

Figure 5.10 shows the pressure gage used as an orifice meter.

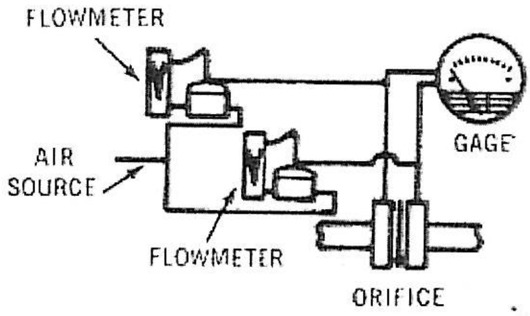

Figure 5.10 Orifice meter

5.5 Typical Pressure Switch/Gage Application

Pressure switch/gages furnish all the advantages of the pressure gage plus one or two easily set pressure switches with visible set point indicators. The switches provide an electrical signal to operate audio or visual alarms or control motors, fans, valves and other equipment with reliable accuracy.

5.5.1 To measure liquid level

Use a pressure gage in conjunction with a flow meter with constant differential pressure regulator as shown. The flow meter provides constant rate of purge air to dip tube. Changes in liquid level affect head, causing static pressure changes inside the tube. These changes are sensed by the gage. Using the same configuration, specific gravity changes can be detected in the liquid if level is kept constant. Using a pressure switch/gage permits both in measuring and controlling liquid level plus easily changing the level control settings.

Figure 5.11 shows the pressure gage used to measure liquid level.

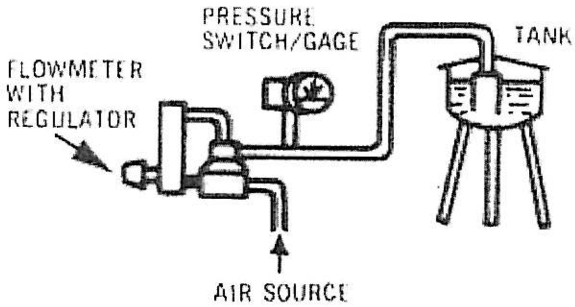

Figure 5.11 Measure liquid levels

5.5.2 To control pressure in air-inflated buildings

A pressure switch/gage senses over pressure that may extend building, or loss of pressure that may cause collapse, and controls the blower to maintain correct pressure.

The pressure gage is easily reset to conserve power - or provide extra pressure to resist strong winds.

Figure 5.12 shows the pressure gage used to control pressure in air-inflated buildings.

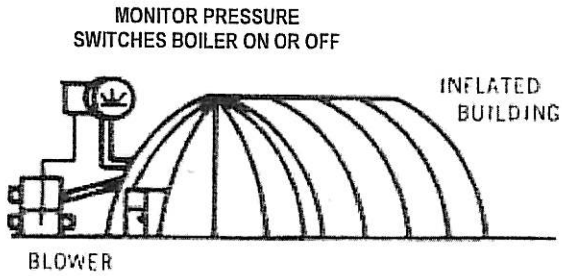

Figure 5.12 Control pressure

5.5.3 To control material weight

On paper making or textile machinery, a pressure switch/gage controls weight of material gathered by sensing pressure changes caused by changes in permeability and thickness of the material.

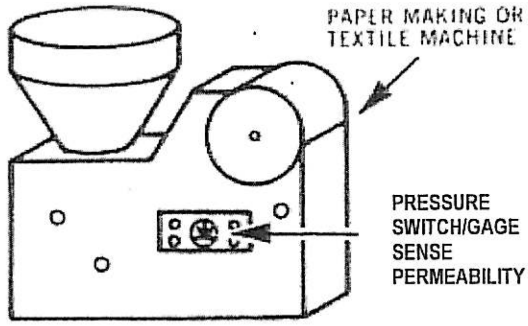

Figure 5.13 Control weight

5.5.4 Monitor air conditioning systems

Adjustments in air flow due to seasonal changes may require resetting the control points on a regular basis. A pressure gage can monitor pressures through the gage portion and permits accumulation of operating data. This is useful in adjusting operation of variable pressure and volume systems and in making system changes when necessary.

Figure 5.14 shows the pressure gage used to monitor air conditioning systems.

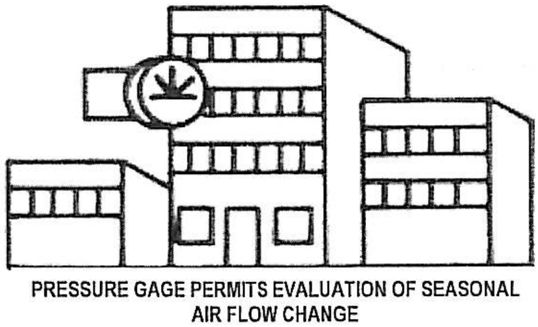

Figure 5.14 Monitor air conditioning systems

5.5.5 For life support or kidney machines

A pressure switch/gage controls pressure on circulating system of machine and alarms in event of too high or low pressure.

Figure 5.15 shows the pressure gage used for life support or kidney machines.

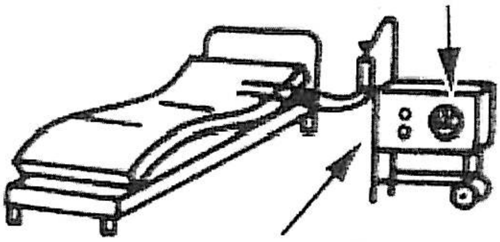

Figure 5.15 Life support machines

CHAPTER VI

HARDWARE DESIGN

6.1 Project Overview

This chapter will discuss on the hardware design of the water pressure increaser device. Some assumptions need to make for this project. As to ensure the water pressure value increase, some equipment is use to measure the value of pressure and flow of the water.

The basic of designing water pressure increaser device is shown in block diagram below, Figure 6.1:

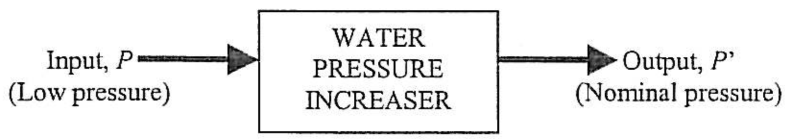

Figure 6.1 Block diagram of basic water pressure increaser

Assume that:

Nominal pressure level = 3 psi

Minimum pressure required = 2 psi
for water to reach the tank

The input of the device receive low water pressure and by using a measuring tool, when P is lower than 2 psi, the device will turn on and increase the water pressure to a nominal pressure level of 3 psi. Now the water distributing should satisfy the consumer. But when the water pressure at the input, P is higher than 2.5 psi, the device should be off.

As the basic design of the water pressure increaser in Figure above, the design for the necessary connectors is needed. This project will discussed the design of the connector in order to connect between pipelines and an additional force, the compressor and the measurement instruments that used.

Figure 6.2 shows the block diagram of water pressure increaser design system.

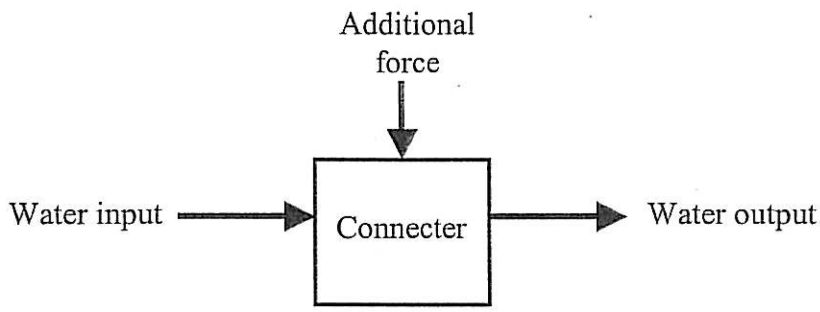

Figure 6.2 Block diagram of water pressure increaser design system

The above figure shows the block diagram of the design system used for the water pressure increaser device. The connector is design to connect the pipeline and the additional force. A force is use to push the water and create a low pressure area in order to increase the flow of the water.

This project consists with four main parts; the Y junction, the air compressor and the measurement instruments, flowmeter and pressure gauge.

The Y junction is used in this project as to connect between pipeline transmission and the air compressor. The Y junction has a various pipe diameter size at the output of the water transmission and the air compressor connector.

An air compressor is used to give a force in order to increase the flow rate of the water transmission. The air compressor is connected to the Y junction.

Flowmeter and pressure gauge are used in this project to measure the value of flow and pressure of the water. These two instruments are placed at the input and the output of the water transmission.

6.2 The Y junction

By using the flow equation between in and out of a junction as discussed in the previous chapter:

Total inflow to junction = Total outflow from junction,

$$\rho_1 Q_1 + \rho_2 Q_2 = \rho_3 Q_3$$

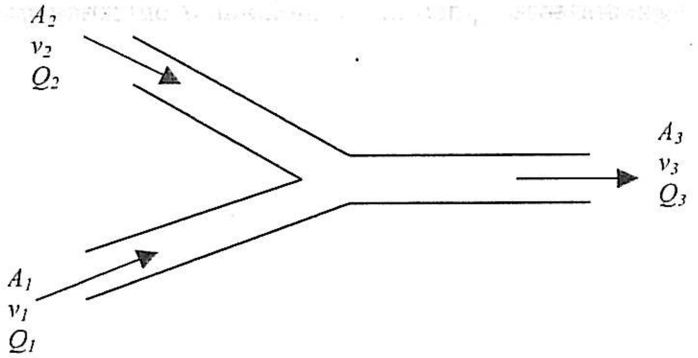

Figure 6.3 Continuity of flow junction

With:

$$Q = Av$$

It became:

$$\rho_1 A_1 v_1 + \rho_2 A_2 v_2 = \rho_3 A_3 v_3$$

Assume that the mass density, $\rho_1 = \rho_2 = \rho_3$

$$Q_1 + Q_2 = Q_3$$

$$A_1 v_1 + A_2 v_2 = A_3 v_3$$

The equation above shows that the flow rate, Q of the junction is proportional with the area, A of the junction and the velocity, v out of the junction.

Figure 6.4 shows the design of the Y junction pipe using the equation above.

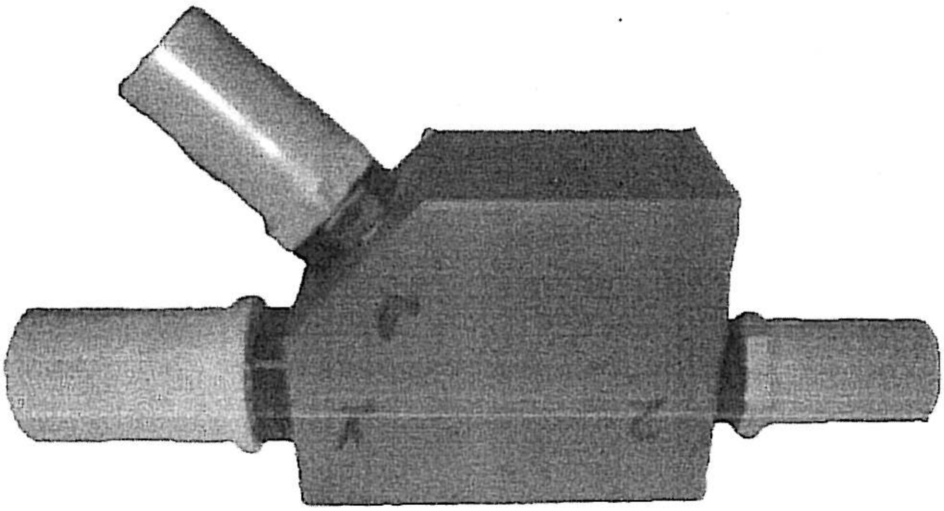

Figure 6.4 Design of the Y junction

Figure 6.5 shows the diameter of pipe, *B* and at the output, *C* is varies.

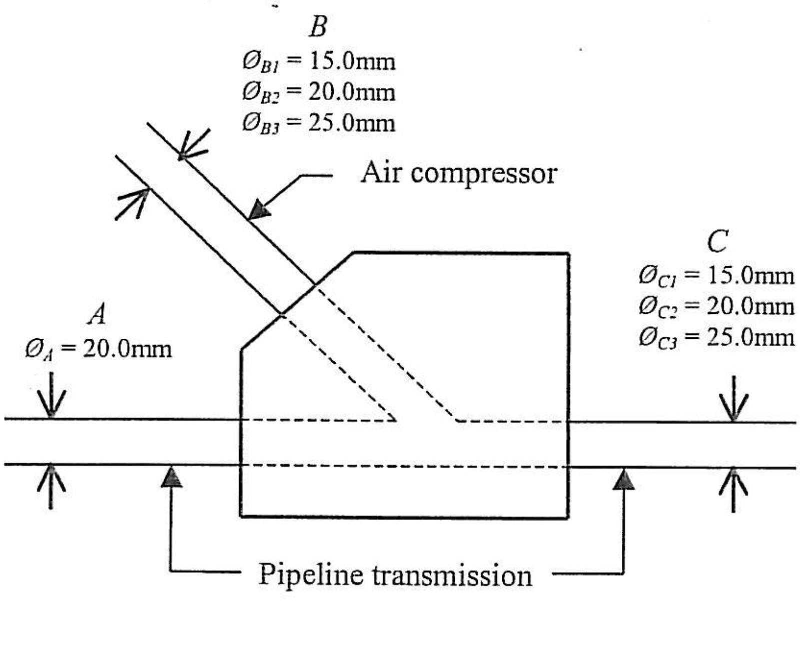

Figure 6.5 Variable sizes for the Y junction

The Y junction is used to connect the pipeline transmission and the air compressor that used in this project. As shown in Fig. 6.5, the input of the water transmission, *A* is fixed with:

$Ø_A = 20.0\text{mm}$

The fixed diameter at *A* is to show and assume that the end user of the water pipeline is the one that use the water pressure increaser device.

As shown in Fig. 6.5, the pipe diameter for *B* is varies in size:

$Ø_{B1} = 15.0\text{mm}$,
$Ø_{B2} = 20.0\text{mm}$ and
$Ø_{B3} = 25.0\text{mm}$.

Pipe *B* is connected to the air compressor. A few size of the pipe is used to see the effect in using the air compressor to push the water and increased the water flow.

The pipe diameter for the output, *C* is also varies in size:

$Ø_{C1} = 15.0\text{mm}$,
$Ø_{C2} = 20.0\text{mm}$ and
$Ø_{C3} = 25.0\text{mm}$.

6.3 Air compressor

From the continuity of flow equation:

$$Q_1 + Q_2 = Q_3$$

And,

$$A_1v_1 + A_2v_2 = A_3v_3$$

The above equation shows that the flow, Q will increase or decrease by the change in area, A and the velocity, v. If the velocity at the second junction, v_2 increases with a constant value, the flow rate at the third junction, Q_3 will increase. So, in order to increase the velocity, v_2 an additional force is needed. This will directly increase the flow rate at the output.

Air compressor is a device that gives a compressed air at its output. It is suitable to give an additional force in this project system. So, it is use to push and give a compressed air to the water flow. in order to increase the flow rate at the output. This project used the basic vacuum concept in science in order to create low pressure area which will suck the water.

Figure 6.6 shows the air compressor is connected to the upper side of the Y junction, at B.

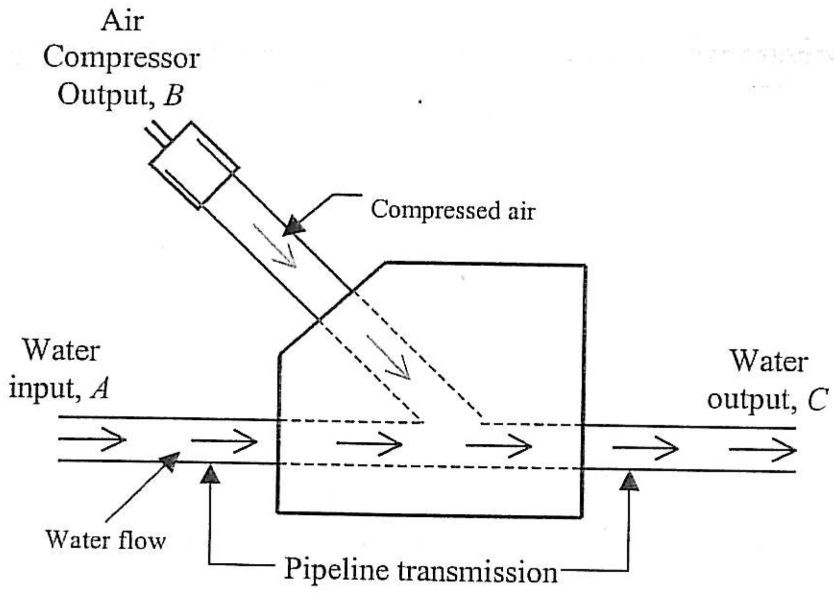

Figure 6.6 Connection for the air compressor at the Y junction

Figure 6.7 shows the air compressor that used for the water pressure increaser device.

Figure 6.7 Air compressor that use for the device

Figure 6.8 shows the flow meter that use for the device.

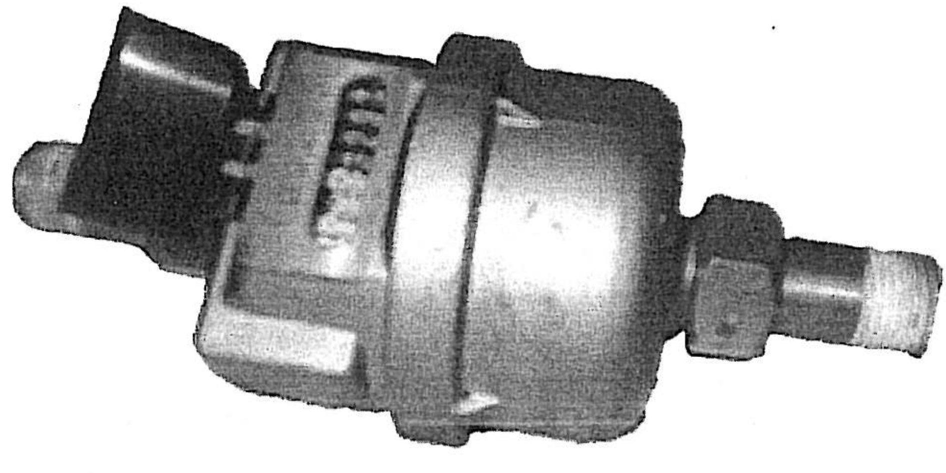

Figure 6.8 Flowmeter for this project

6.4 Flowmeter

To measure the water flow in this project, flowmeter is used. The sight flowmeter is chosen to use for this project in order to measure the value of the water flow rate. It is a bit difficult to use as the indicator spins. The value of the water flow is measured as the water pressure increaser device is switch off and on.

The value of the flow rate of the water is shown at the flowmeter. The unit is measured in cubic meter per hour (m^3/h).

The flowmeter is placed at the input, *A* and the output, *C* of the pipeline transmission. At the air compressor side, *B* is not measured because the main objective of this project is to ensure the water pressure increaser device increase the water transmission. The air compressor is assumed as the flow rate and the pressure does not change.

Figure 6.9 shows the flowmeter and the pressure gauge is placed to measure the value of flow and pressure.

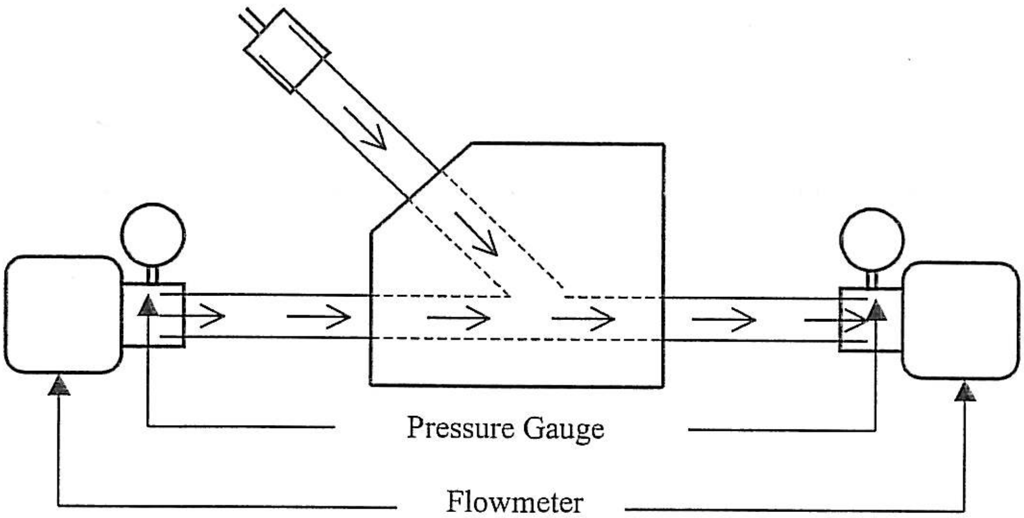

Figure 6.9 Where flowmeter and pressure gauge is placed at the device

6.5 Pressure Gauge

Pressure gauge is used in this project to measure the value of the water pressure before and after the water increaser device is on. The pressure gauge shows the water pressure at the time the water flow inside the pipeline transmission. It is easy to use and easy to take the value of the pressure. The pressure gauge that used in this project can be in psi unit or kPa unit.

The value of the water pressure is taken in psi unit; this is because the value is too small and the differential between two value can easily recognized.

The pressure gauge is placed at the input, *A* and the output, *C* of the pipeline transmission just like the flow meter. At the upper side of the Y junction, *B* also is not measured just like the flow meter.

Figure 6.10 shows the pressure gauge that use in this project.

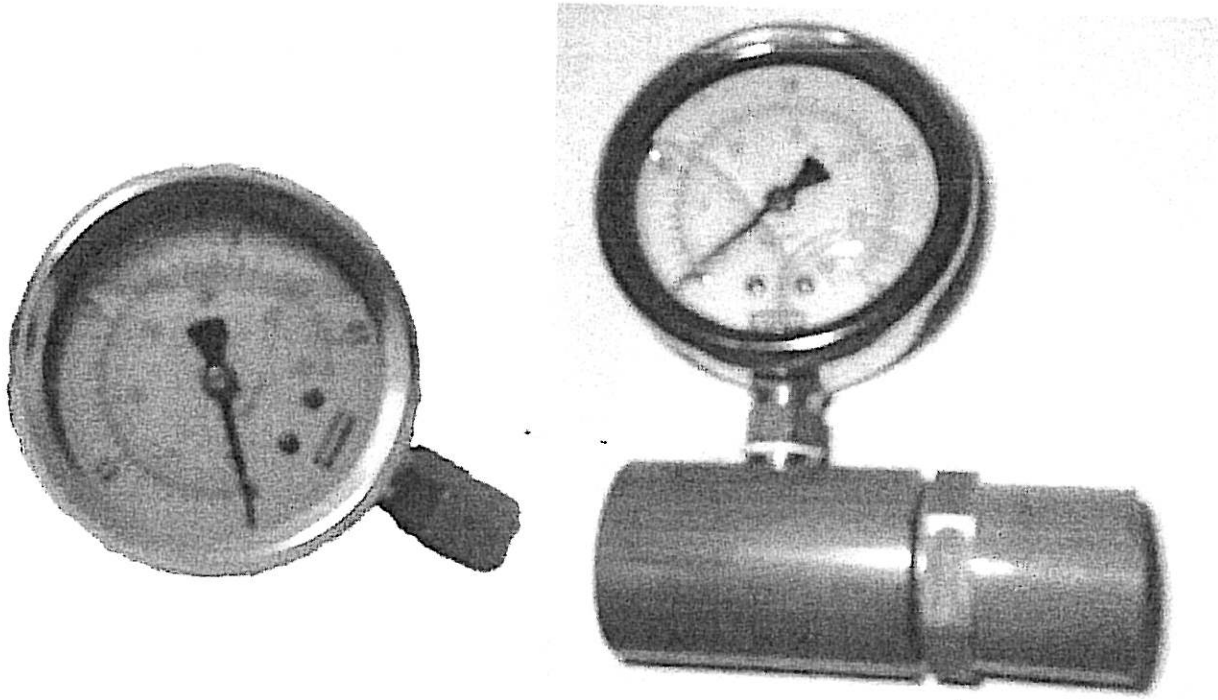

Figure 6.10 Pressure gauge for this project

Figure 6.11 shows all of the hardware that use in this project is assembles for the measuring procedure.

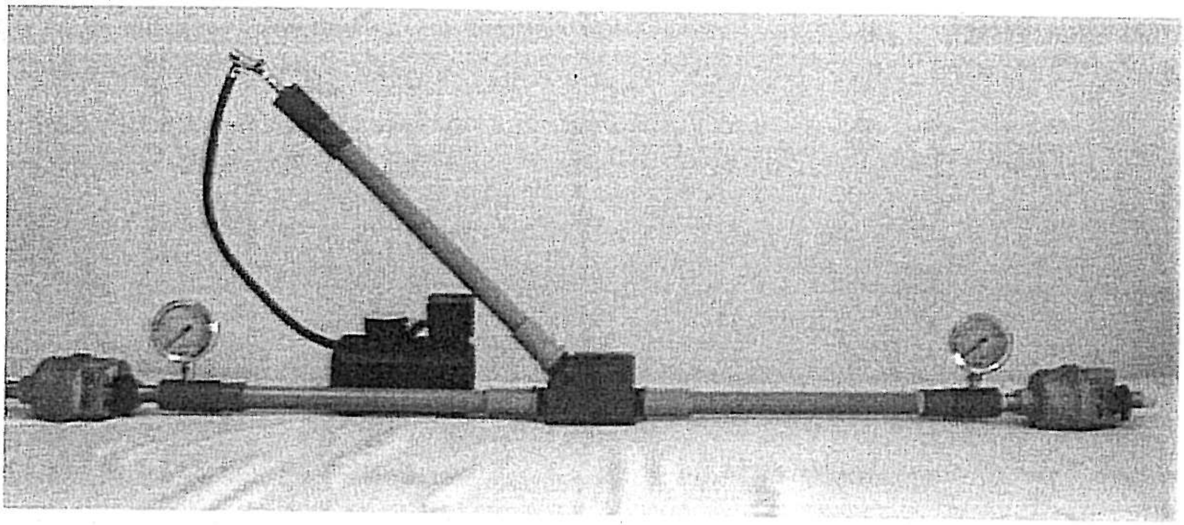

Figure 6.11 All the hardware is assemble.

Figure 6.12 shows the assembled Y junction with the water pipeline.

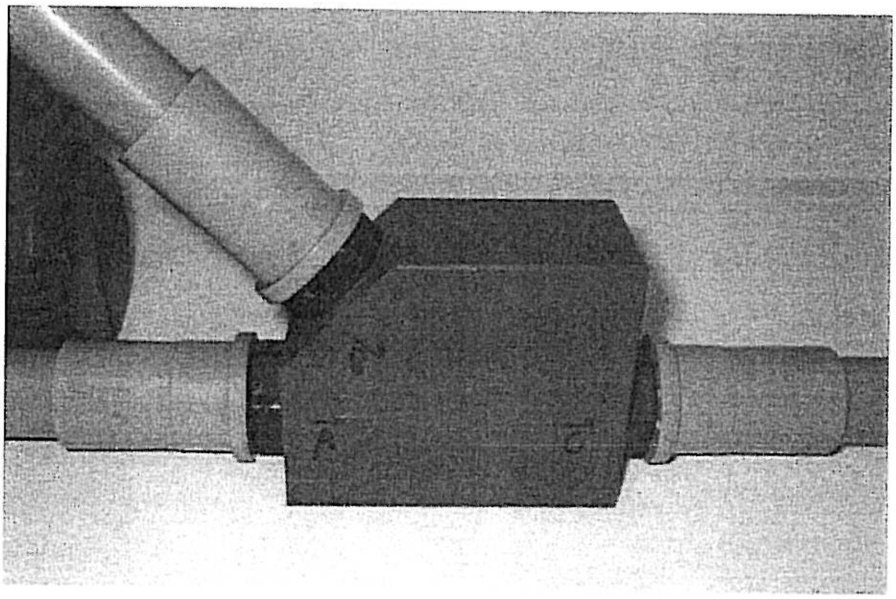

Figure 6.12 Assembled Y junction

Figure 6.13 shows the air compressor is connected at the upper side of the junction.

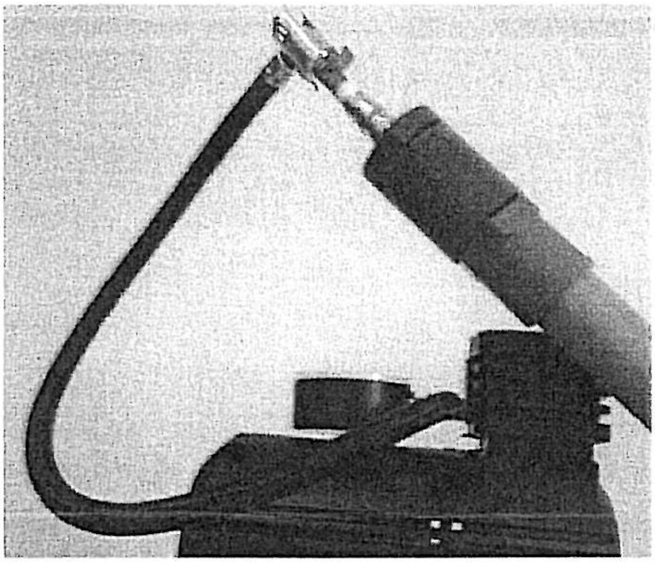

Figure 6.13 Air compressor connected to the upper side of the Y junction

Figure 6.14 shows the flowmeter and the pressure gauge at the input of the device.

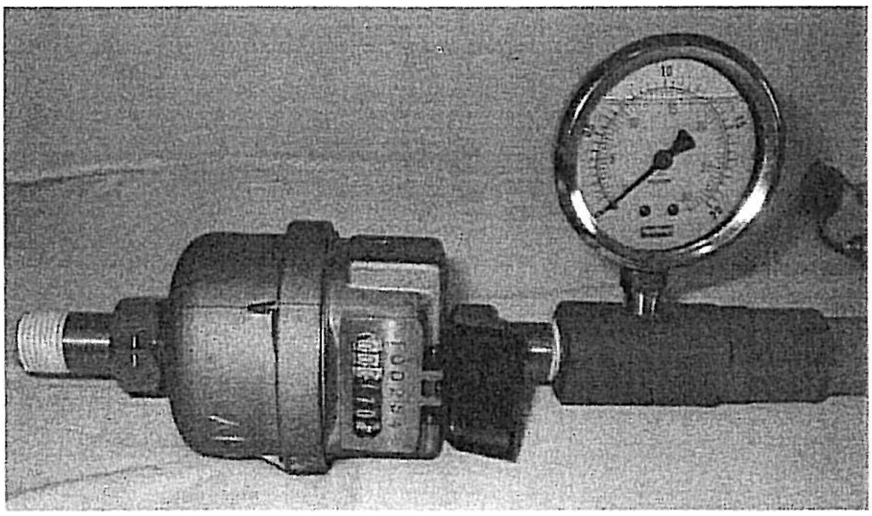

Figure 6.14 Flowmeter and pressure gauge at the input of the water supply

Figure 6.15 shows the flowmeter and the pressure gauge at the output of the device.

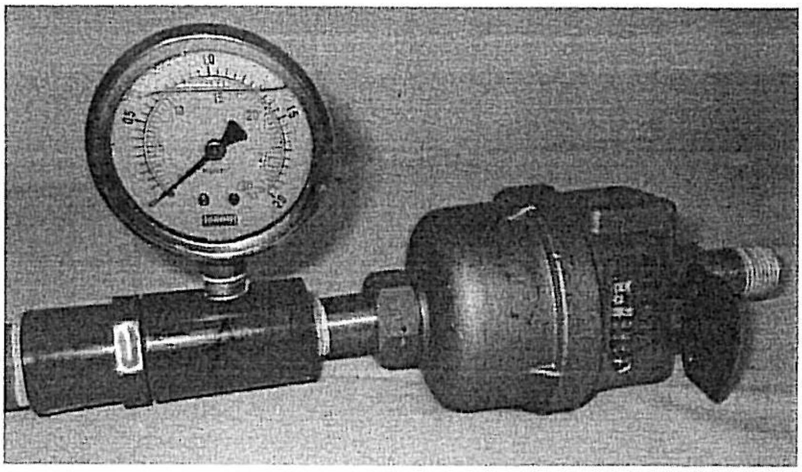

Figure 6.15 Flowmeter and pressure gauge at the output of the water supply

CHAPTER VII

SOFTWARE DEVELOPMENT

7.1 Database

Database is use to put and collect all data and put it in one source for a purpose. The data can be stored in many ways. The collected data also can be call in many methods. The easy way to use a database is by using integrated software. The most basic of database software is *Visual Basic*. This software is used by a lot of people that use a database such as designers, engineers, developers and students.

Visual Basic is a compiled language totally different from its predecessor - the *Basic* language, which is an interpreted language.

Interpreted language's *exe* will be translated into machine code only when the program is run. On the other hand, the output of compiled language is an *exe* that contains instructions that are native to the processor.

Visual Basic combined the ease of *Basic* and a visual interface to design the appearance and the coding of an application.

In this project, the measured data is placed and stored in other database software. The basic of the language is the same, but the developer of the software is different. This project use a web base to stored the measured data. The web base is simpler than other database. The internet now is widely use and more global and easy to access.

Macromedia Dreamweaver is one of the web bases that easy to develop and it is easy to interact. *Macromedia Dreamweaver MX* is a professional *HTML* editor for designing, coding, and developing websites, web pages, and web applications. Whether you enjoy the control of hand-coding *HTML* or prefer to work in a visual editing environment, *Dreamweaver* provides you with helpful tools to enhance your web creation experience.

The visual editing features in *Dreamweaver* let you quickly create pages without writing a line of code. If you prefer to code by hand, however, *Dreamweaver* also includes many coding-related tools and features. And *Dreamweaver* helps you to build dynamic database-backed web applications using server languages such as *ASP, ASP.NET, ColdFusion Markup Language* (*CFML*) and *JSP*.

As a web designer, this software allow the easy access to tools such as the *CSS* styles panel, the *HTML* styles panel and the behaviors panel to made a webpage. This software also gives coder to access the tools easily such as *Tag* inspector, the *Snippets* panel and the Reference panel. And as a web application developer, this software gives an easy access to tools such as the *Binding* panel, the *Server Behavior* panel, and the *Database* panel.

This software is use in this project to store the measured value and to ease the use of the measured value and easy to interact with the data.

Figure 7.1 below shows the interface of the design web base or web site:

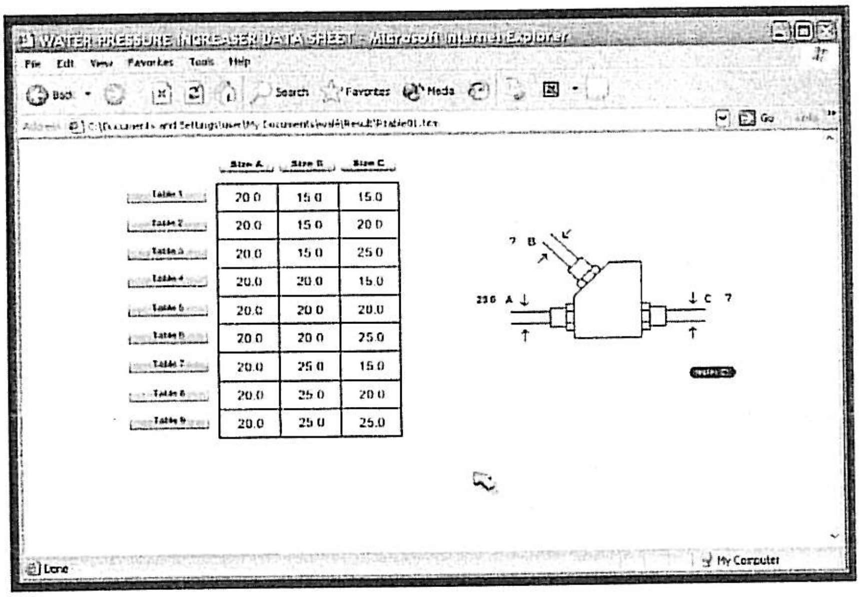

Figure 7.1 Main site of the web base

Figure 7.2 shows one of the measured values at the web base.

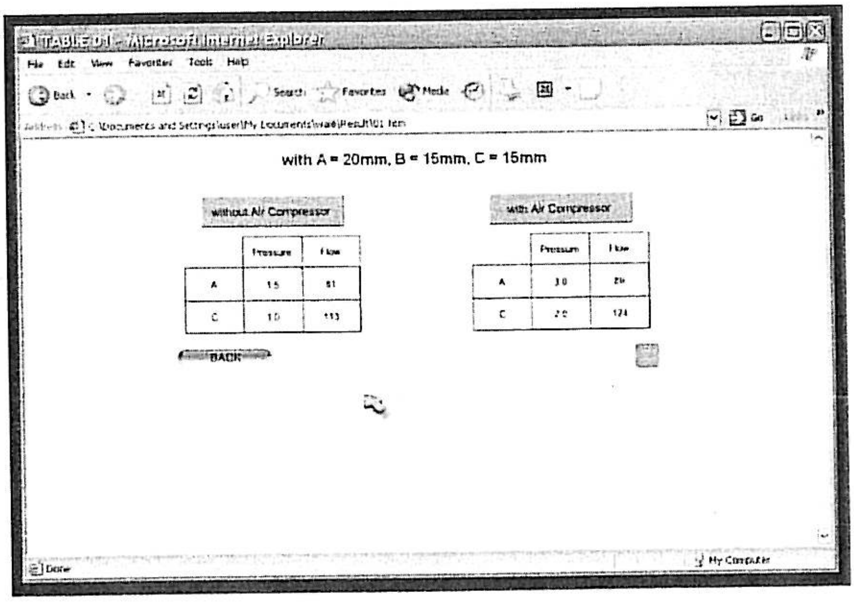

Figure 7.2 One of the table from the measured value

Figure 7.3 shows the description of the project without using an air compressor at the web base.

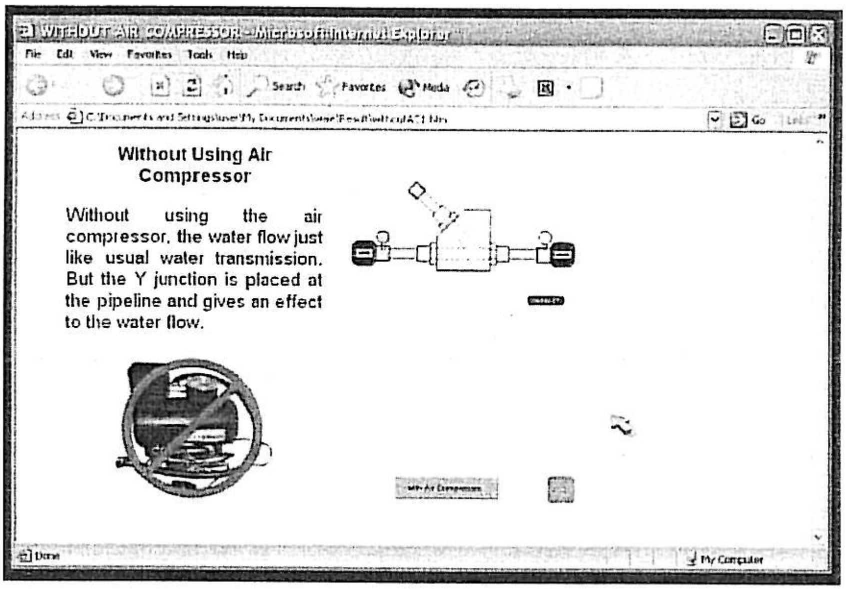

Figure 7.3 Description of the project - without using an air compressor

Figure 7.4 shows the description of the project using an air compressor at the web base.

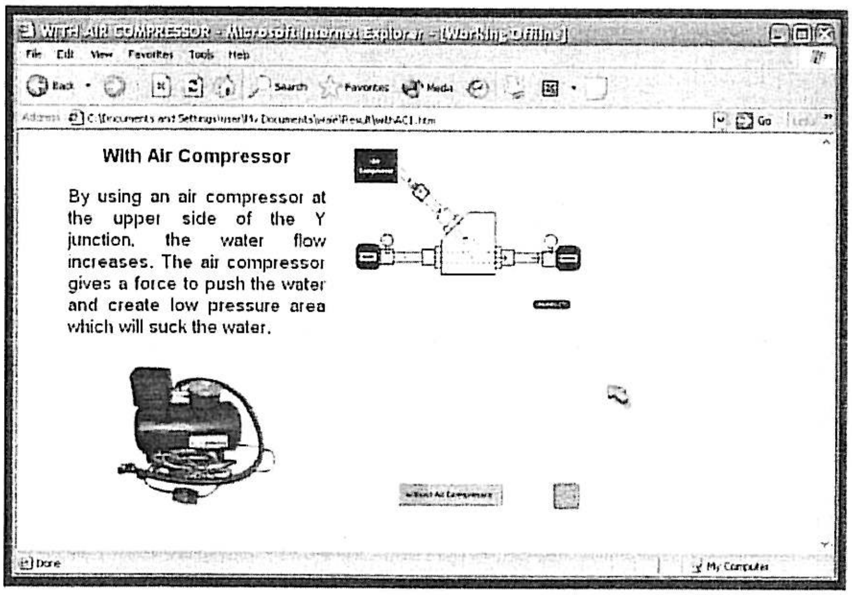

Figure 7.4 Description of the project – by using an air compressor

Figure 7.5 shows the description of pipe *A* at the web base.

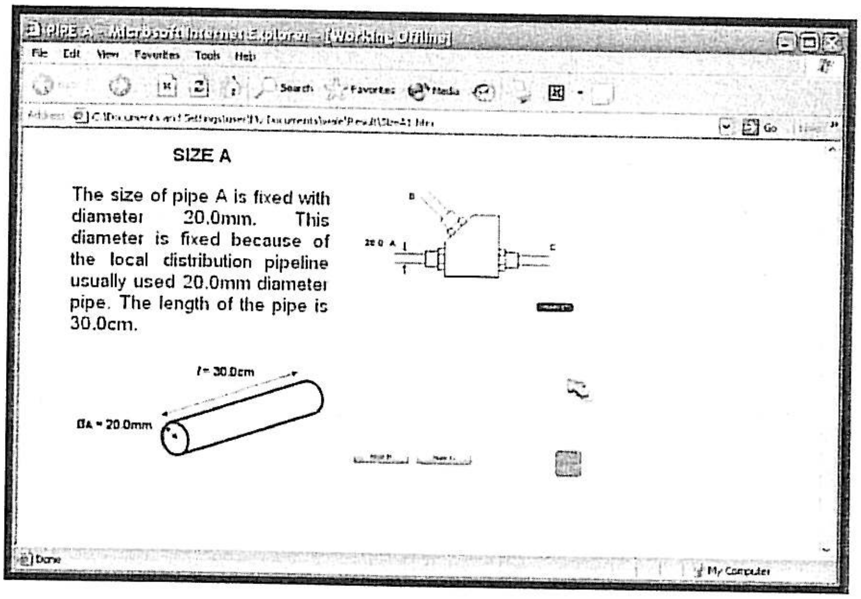

Figure 7.5 Description of pipe at the input, *A*

Figure 7.6 shows the description of pipe *B* at the web base.

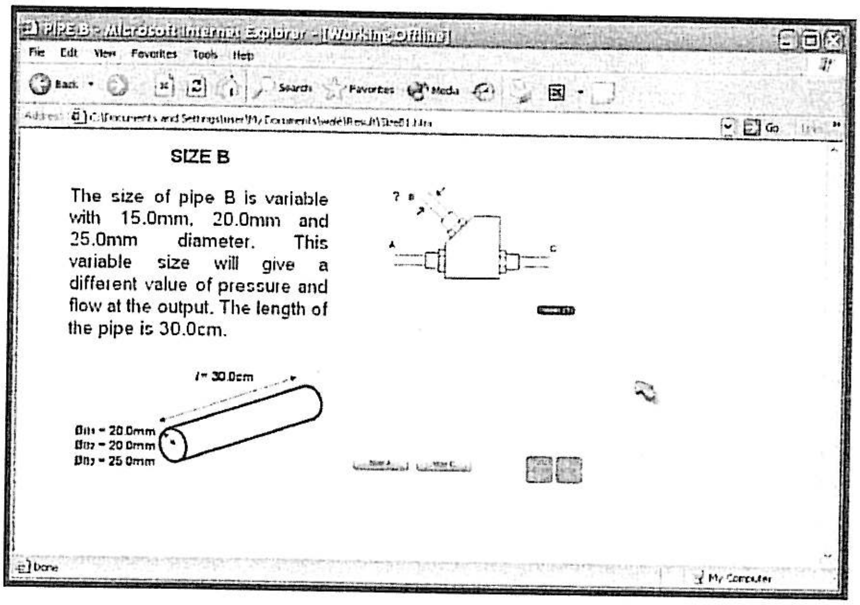

Figure 7.6 Description of pipe at the upper side of the Y junction, *B*

Figure7.7 shows the description of pipe C at the web base.

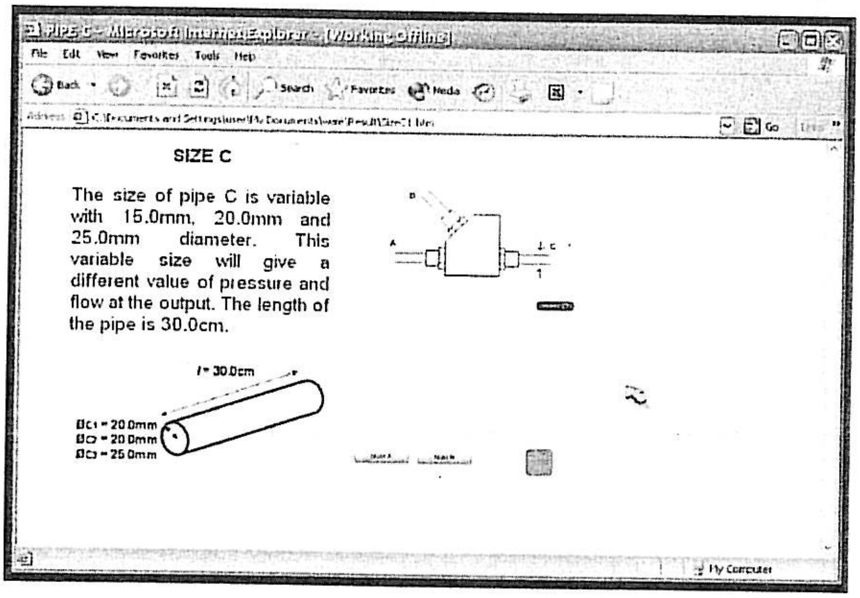

Figure 7.7 Description of pipe at the output, C

CHAPTER VIII

RESULTS

The water pressure increaser device was completely developed. The end user of the water transmission can use the water pressure increaser device to increase their water supply that being distributed to their house. Besides, they also can control either to use the device or not by just turning the air compressor switch on and off. When they had a problem with their water pressure, they can switch the air compressor on and increase the water transmission. A simple, economical price and capable to increase water pressure device was developed and able to serve for the end user of water transmission that having problem with their water supply.

The value of water pressure and flow rate for the device is measured with all the variable pipe diameter size and all the instruments are assembled as shown on figure-below.

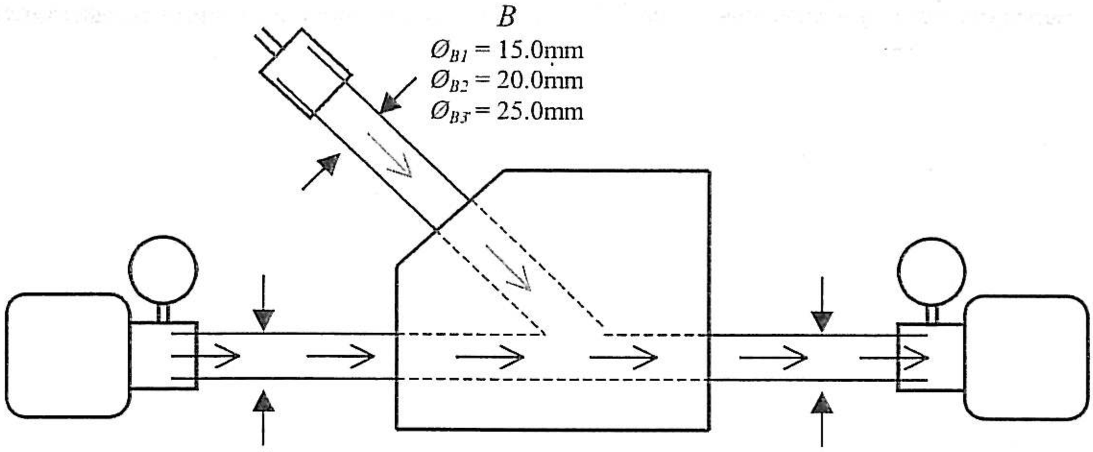

Figure 8.1 Variable of pipe size

The measured values for the tables below show the pipe diameter, *A*, *B*, and *C* in unit mm the pressure in unit psi and the flow rate in unit m^3/h:

Table 8.1 Pipe dimensions with $A = 20$, $B = 15$, $C = 15$

without Air Compressor

	PRESSURE	FLOW
A	1.5	81
C	1	113

with Air Compressor

	PRESSURE	FLOW
A	3	89
C	2	124

Table 8.2 Pipe dimensions with $A = 20$ $B = 20$, $C = 15$

without Air Compressor

	PRESSURE	FLOW
A	1.5	73
C	1	102

with Air Compressor

	PRESSURE	FLOW
A	3	74
C	2	111

Table 8.3 Pipe dimensions with $A = 20, B = 25, C = 15$

without Air Compressor

	PRESSURE	FLOW
A	1.5	75
C	1	108

with Air Compressor

	PRESSURE	FLOW
A	3	78
C	2	108

Table 8.4 Pipe dimensions with A=20, $B = 15, C = 20$

without Air Compressor

	PRESSURE	FLOW
A	2	75
C	1.5	81

with Air Compressor

	PRESSURE	FLOW
A	3	78
C	2	114

Table 8.5 Pipe dimensions with $A = 20, B = 20, C = 20$

without Air Compressor

	PRESSURE	FLOW
A	1	77
C	1	80

with Air Compressor

	PRESSURE	FLOW
A	2	81
C	1.5	118

Table 8.6 Pipe dimensions with $A = 20, B = 25, C = 20$

without Air Compressor

	PRESSURE	FLOW
A	1	73
C	1	82

with Air Compressor

	PRESSURE	FLOW
A	2	75
C	1.5	110

Table 8.7 Pipe dimensions with $A = 20, B = 15, C = 25$

without Air Compressor

	PRESSURE	FLOW
A	1.5	92
C	1.5	92

with Air Compressor

	PRESSURE	FLOW
A	2.5	97
C	2	117

Table 8.8 Pipe dimensions with $A = 20$, $B = 20$, $C = 25$

without Air Compressor

	PRESSURE	FLOW
A	1.5	92
C	1.5	101

with Air Compressor

	PRESSURE	FLOW
A	2.5	95
C	2.5	112

Table 8.9 Pipe dimensions with $A = 20$, $B = 25$, $C = 25$

without Air Compressor

	PRESSURE	FLOW
A	2	80
C	1.5	101

with Air Compressor

	PRESSURE	FLOW
A	3	84
C	2.5	115

The tables below show the same measured value with proper of the pipe diameter matrix. For the pipe diameter, *B* and *C* unit is in mm, the flow rate in m^3/h unit and the pressure in psi unit:

Table 8.10 Pressure (psi) at *A* and *C* without using an air compressor

Pressure *A*

*A**C*	15	20	25
15	1.5	2	1.5
20	1.5	1	1.5
25	1.5	1	2

Pressure *C*

*A**C*	15	20	25
15	1	1.5	1.5
20	1	1	1.5
25	1	1	1.5

Table 8.11 Pressure (psi) at *A* and *C* by using an air compressor

Pressure *A*

*A**C*	15	20	25
15	3	3	2.5
20	3	2	2.5
25	3	2	3

Pressure *C*

*A**C*	15	20	25
15	2	2	2
20	2	1.5	2.5
25	2	1.5	2.5

Table 8.12 Flow rate (m^3/h) at *A* and *C* without using an air compressor

Flow *A*

*A**C*	15	20	25
15	81	75	92
20	73	77	92
25	75	73	80

Flow *C*

*A**C*	15	20	25
15	113	81	92
20	102	80	101
25	108	82	101

Table 8.13 Flow rate (m^3/h) at *A* and *C* by using an air compressor

Flow *A*

*A**C*	15	20	25
15	89	78	97
20	74	81	95
25	78	75	84

Flow *C*

*A**C*	15	20	25
15	124	114	117
20	111	118	112
25	108	110	115

To ease an analysis in mathematical method and the differences of the measured value, a chart is use.

Figure 8.2 shows the pressure value at pipe *A* without using an air compressor in the device.

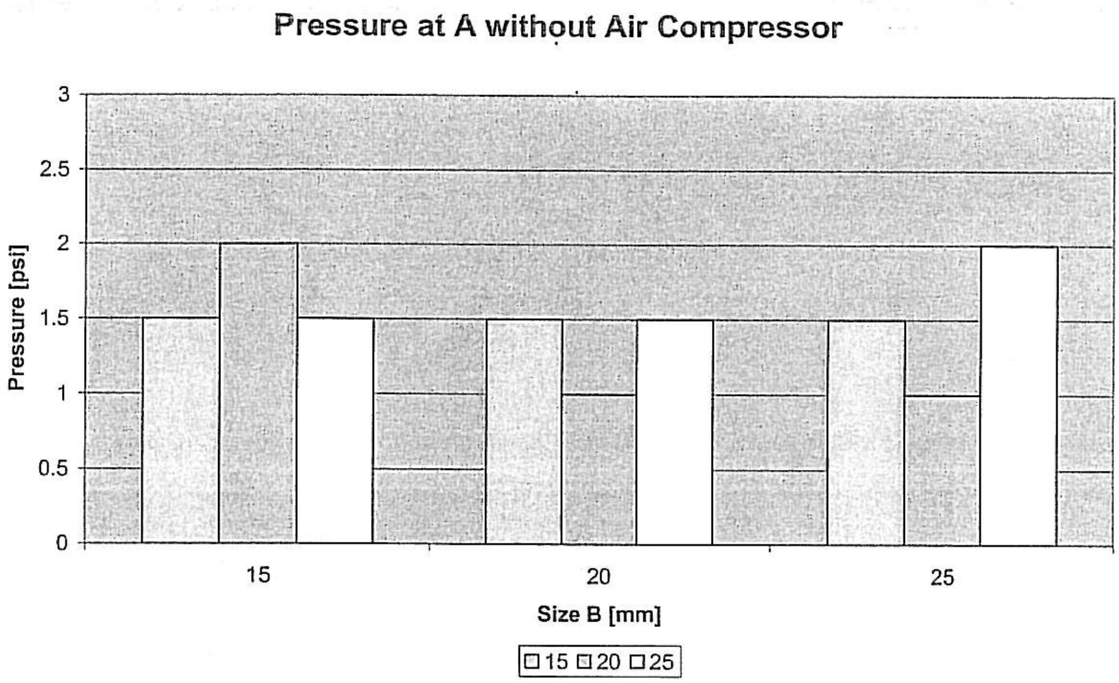

Figure 8.2 Pressure at A without air compressor

Figure 8.3 shows the pressure value at pipe A by using an air compressor in the device.

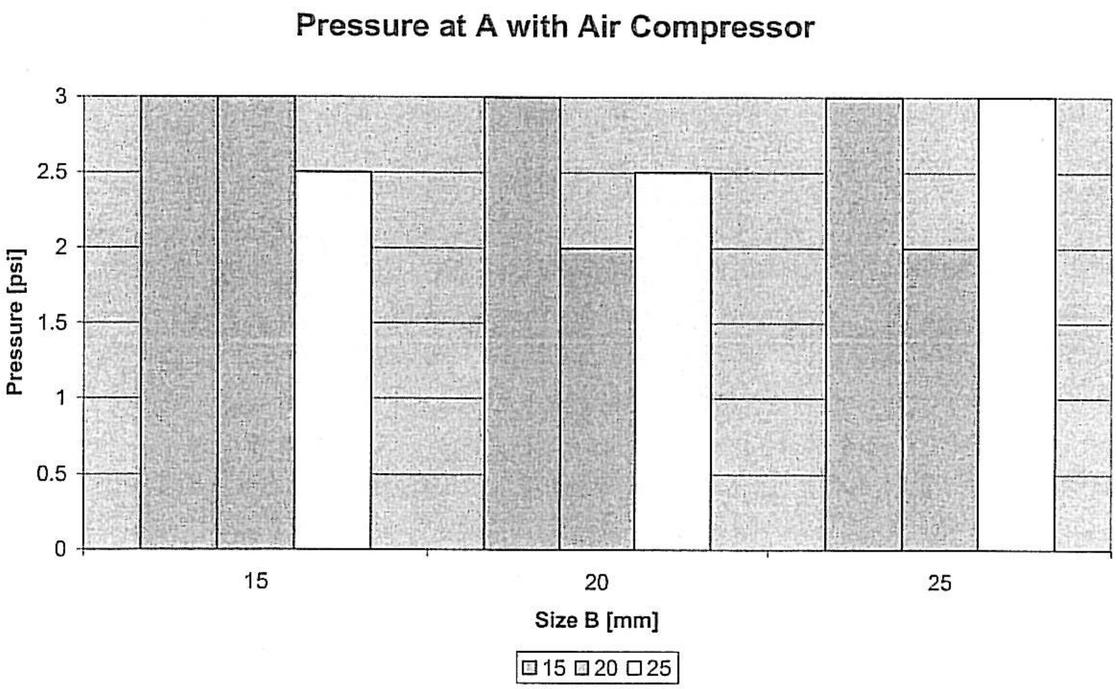

Figure 8.3 Pressure at *A* with air compressor

Figure 8.4 shows the pressure value at pipe *C* without using an air compressor in the device.

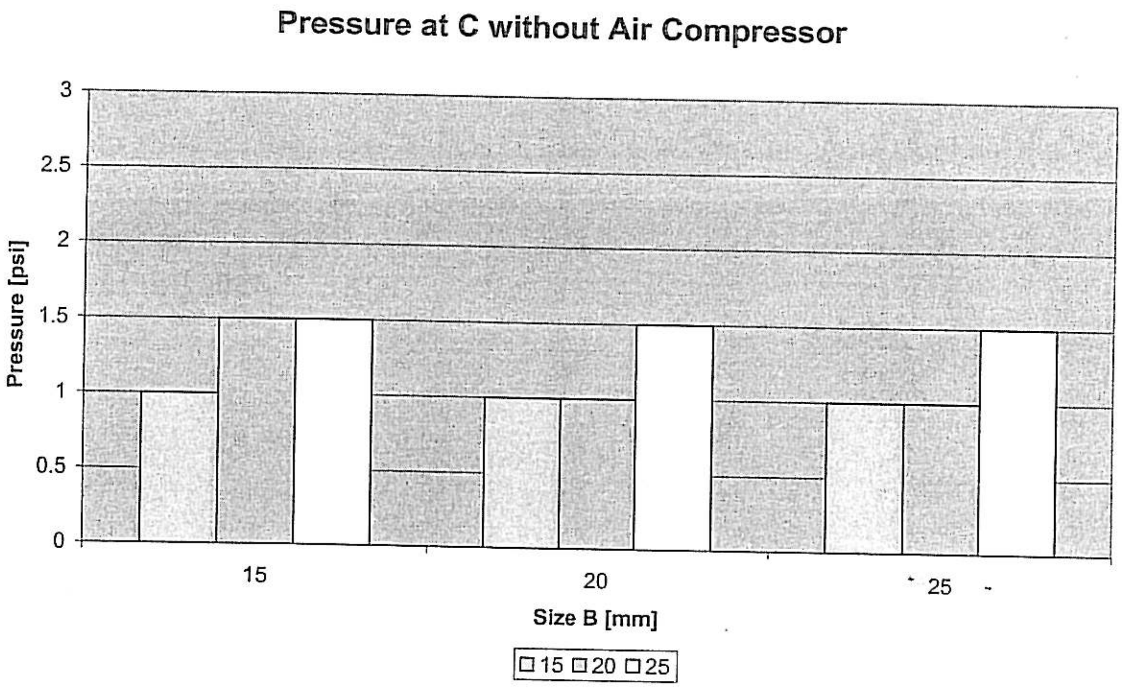

Figure 8.4 Pressure at *C* without air compressor

Figure 8.5 shows the pressure value at pipe *C* by using an air compressor in the device.

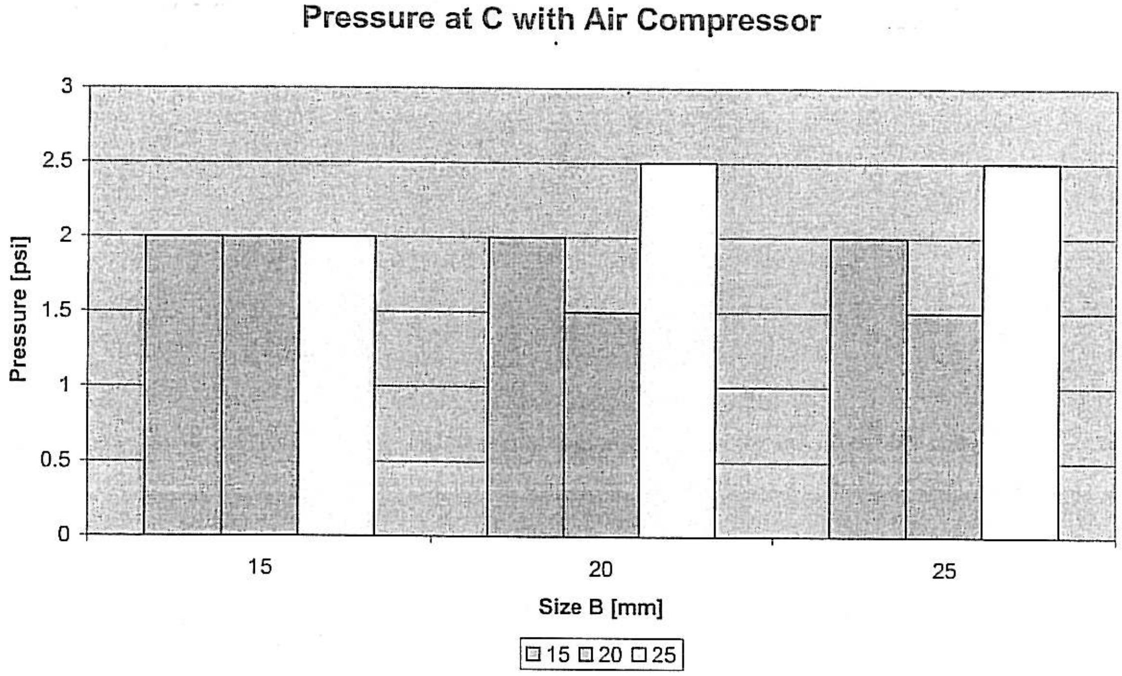

Figure 8.5 Pressure at C with air compressor

Figure 8.6 shows the flow rate at pipe A without using an air compressor in the device.

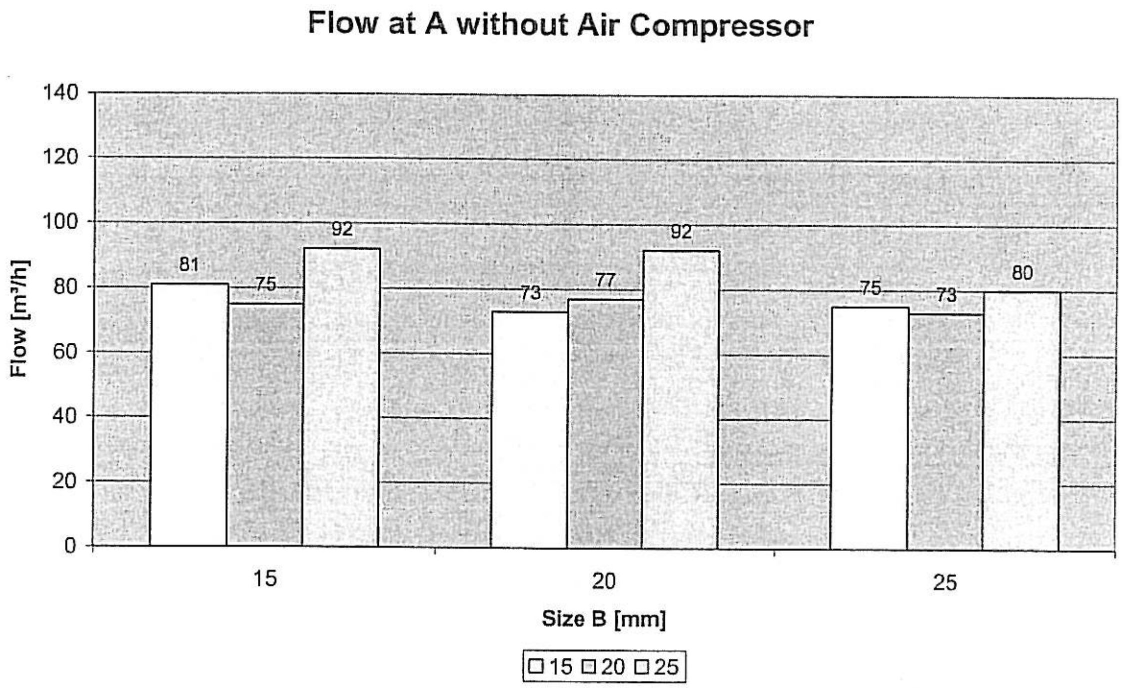

Figure 8.6 Flow at *A* without air compressor

Figure 8.7 shows the flow rate at pipe *A* by using an air compressor in the device.

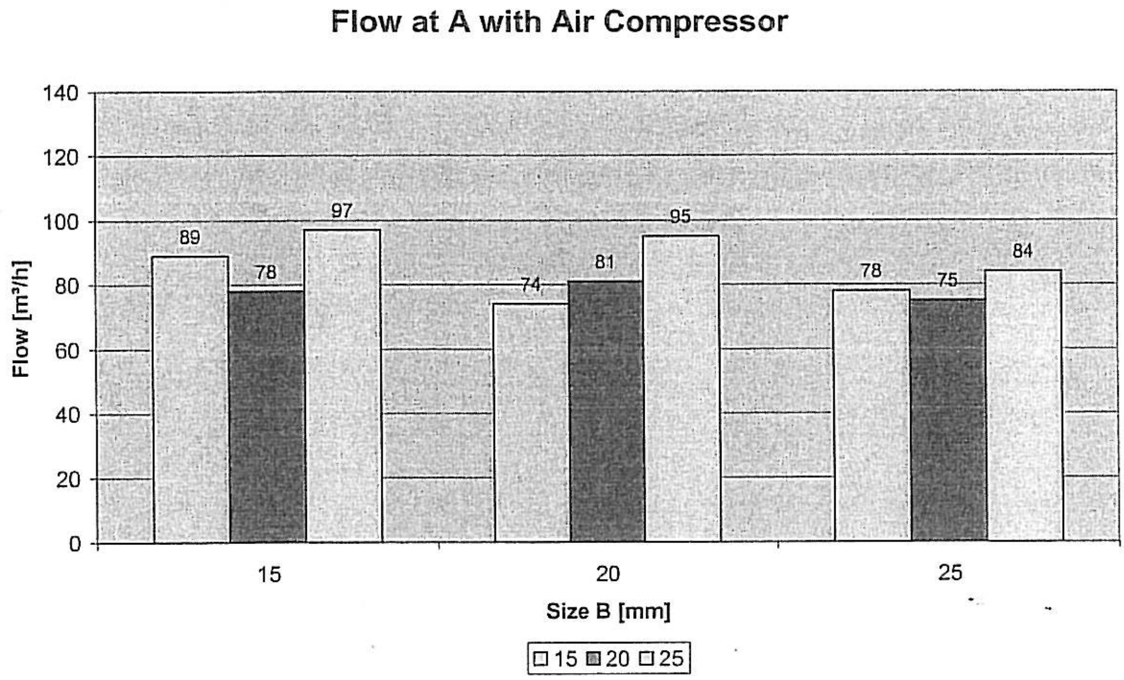

Figure 8.7 Flow at *A* with air compressor

Figure 8.8 shows the flow rate at pipe *C* without using an air compressor in the device.

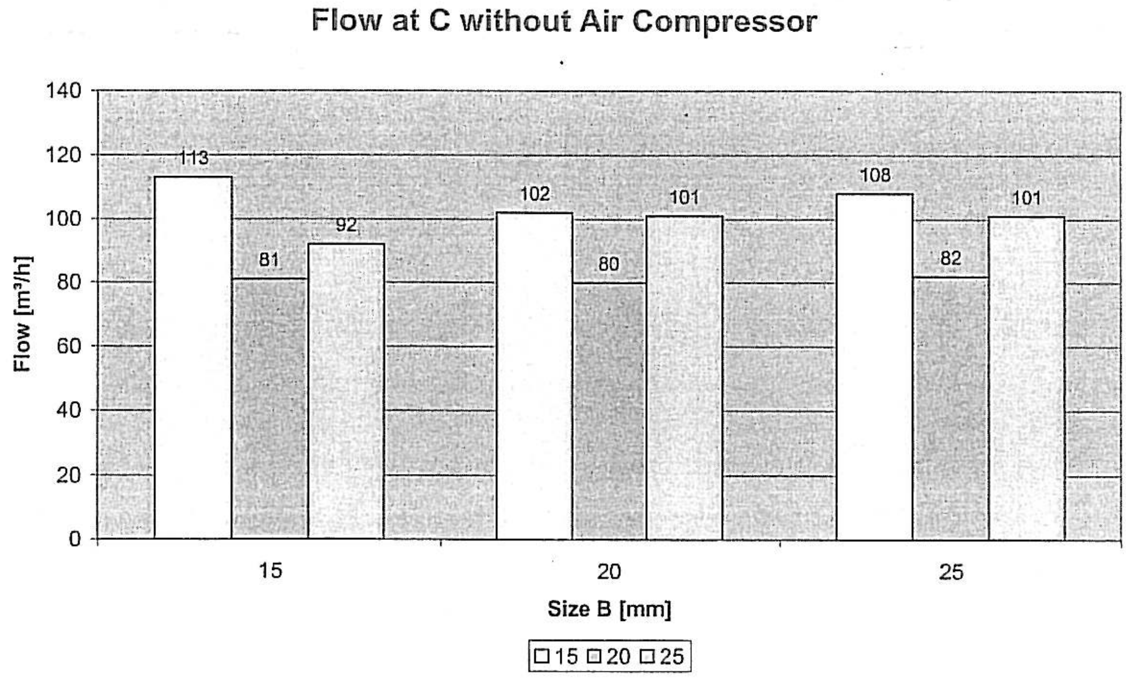

Figure 8.8 Flow at *C* without air compressor

Figure 8.9 shows the flow rate at pipe *C* by using an air compressor in the device.

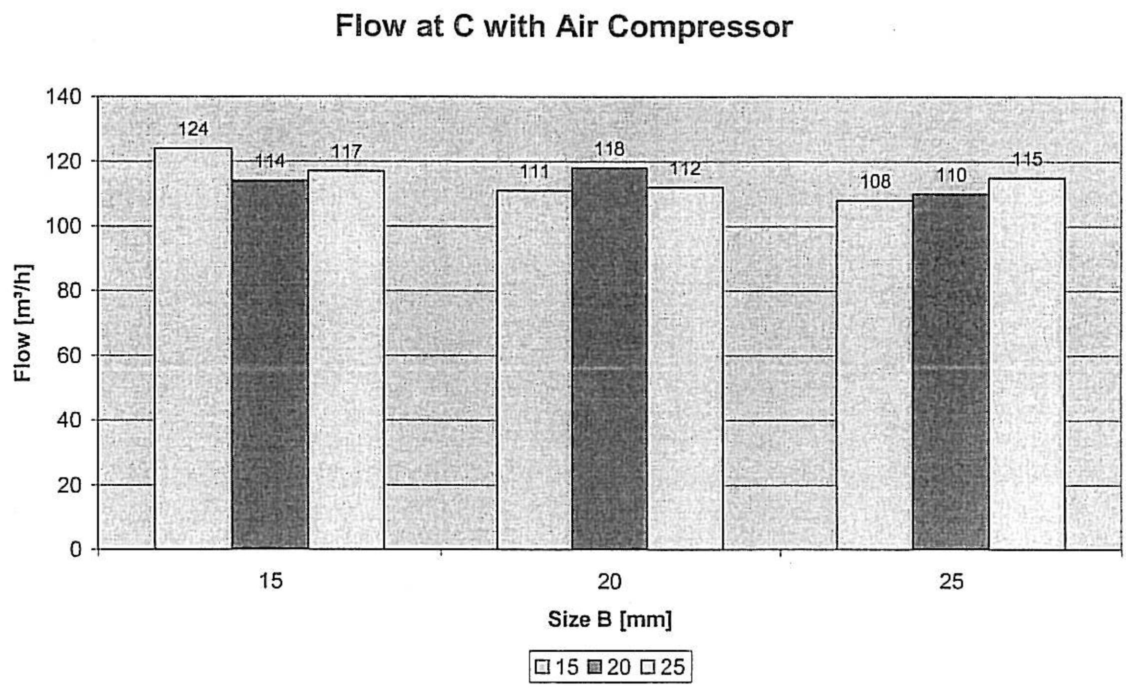

Figure 8.9 Flow at *C* with air compressor

The pressure value and the flow rate differences at the output of the water transmission, at *C* by using an air compressor and without using an air compressor is shown in the table below. The pipe diameter is in unit mm, the pressure unit is in psi and the flow unit is m^3/h:

Table 8.14 Pressure (psi) and flow (m^3/h) difference at the output, *C*

Pressure *C*

A\C	15	20	25
15	1	0.5	0.5
20	1	0.5	1
25	1	0.5	1

Flow *C*

A\C	15	20	25
15	11	33	25
20	9	38	11
25	0	28	14

For the differences table above, Figure 8.10 below shows the pressure differences chart at pipe *C*.

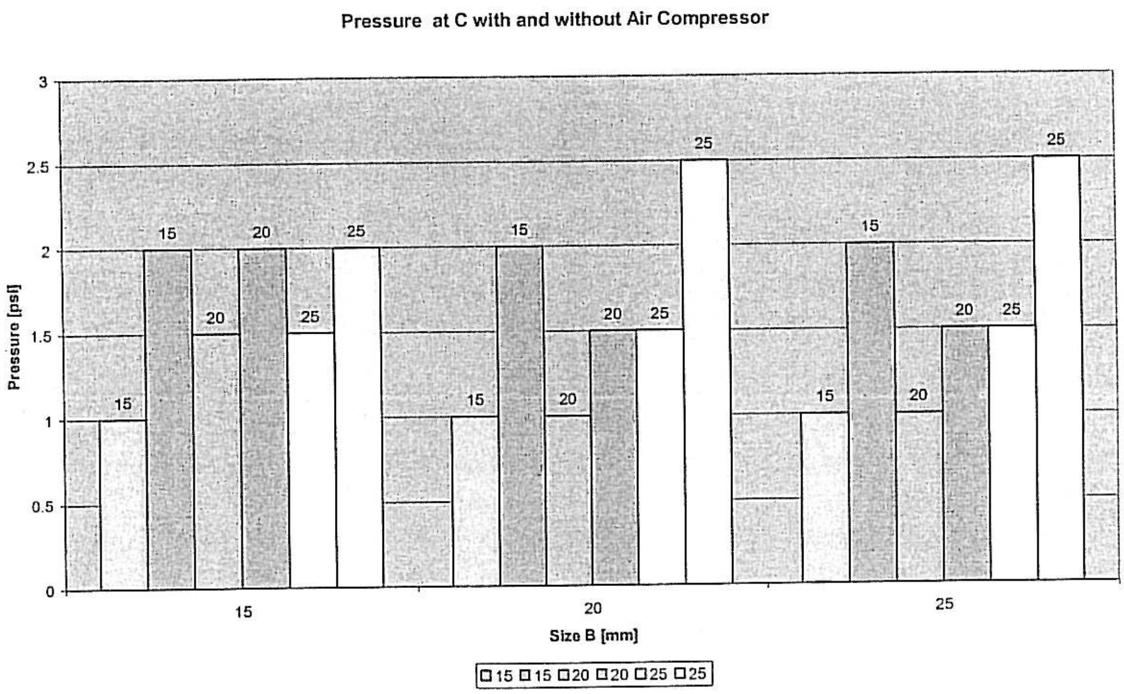

Figure 8.10 Pressure differences at *C*

Figure 8.11 shows the flow differences chart at pipe *C*.

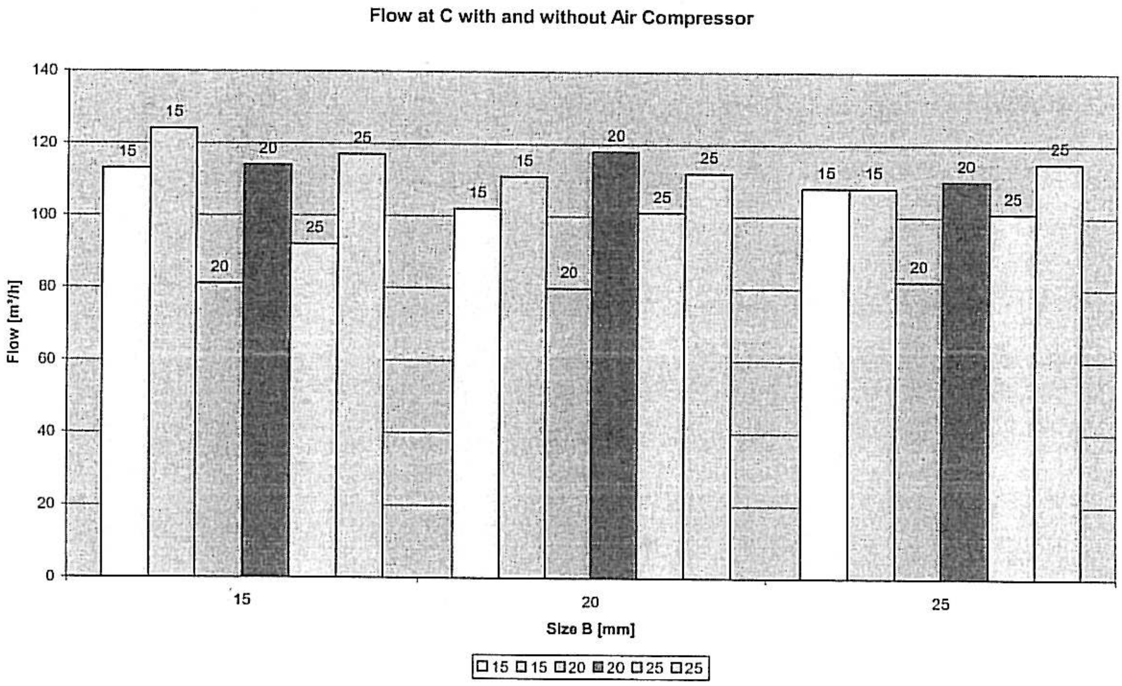

Figure 8.11 Flow differences at *C*

CHAPTER IX

CONCLUSIONS

Through this project, a simple economic water pressure increaser device was developed. The design and construction of the device is a new concept implemented. The project is a pioneer project to provide a water pressure increaser device rather than using pumps. This prototype can work well as to increase the water pressure and flow rate in pipeline transmission. The water pressure increaser device is operating manually and with further development it can be upgraded to be an automatic water pressure increaser device.

9.1 Water Pressure Increaser Device Accomplishments

Through this project, a water pressure increaser device was built. The device is based on basic vacuum concept in science. As the results show, the water pressure increaser device had an ability to increase water pressure in the pipeline transmission.

The best result to increase the water pressure and flow as with the matrix $Ø_A$ = 20.0mm, $Ø_{B2}$ = 20.0mm and $Ø_{C2}$ = 20.0mm. This matrix of pipe diameter can increase the pressure up to 0.5psi and the flow rate increase with $38m^3/h$.

The water pressure increaser device meets the objective of this project. This project increases the water pressure and flow. The design for the device is also economical and suitable for the use at the end consumer.

9.2 Problems

Every project must through a lot of difficulties and problems. This project also has its own difficulties. The main problem in this project is to get the required information to implement the project. The only information that refers to this project is pump, not much about invention to create another water pressure increaser device. So this project is the first invention as a water pressure increaser device and the project is succeeded.

The result of this project is not a satisfactory. As shown in previous chapter, the flow rate and the pressure value at the output is not equivalent. The flow rate and the pressure value at the input and the output without using an air compressor should be the same. This problem occurs because the water flow through pipe *B* and moving opposite direction and affects the measured value. This problem can be solved by using a valve at pipe *B* that will close the water path into it.

The flowmeter that used to measure the value of water flow in this project is quite difficult to take. It also needs to be subtracting the early value and the last value of the water flow. The indicator for the flow value is not showing the right value. This will gives an inaccurate value of flow. For more accurate and high precision of the flow value, a better flow meter should be used.

The connector at the output of the air compressor need to be assembles correctly. If not, the water will flow through the upper side of the Y junction and affect the flow rate for the water output. A valve or a one-direction junction should be used at the upper side of the Y junction for a better solution.

9.3 Future Development and Recommendation

The problem of low water pressure happens at the highland area and especially at the end user. The water pressure increaser device is a need towards this lack of water supply in pipeline transmission.

The device can be used not only at the end user of the water transmission but to anyone who need to increase their water supply in any purpose such as for private use or for industrial use. The application of the device can be develop in so many ways. More research should be done on the various fields to increase the ability of the device.

The result of the water pressure increaser device is not satisfactory. The measured value of the flow is not for the water only, it include the air flow from the air compressor that create turbulent flow. By using a valve or better connector, the result should be more satisfy and convenient with less disturbance for the water transmission.

The design of this project should be more variable in range such as the phase at the connector (as this project used 45°), pipe diameter, pipe type (this project used only

PVC pipe type), and the air compressor. Simulation using software should be helpful to design a better device with a lesser cost.

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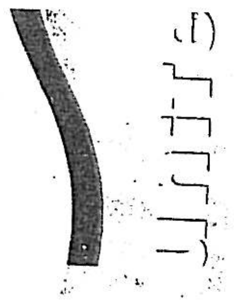
APPENDIX A

GB ▶ Air compressor with pressure gauge, 12 volts
F ▶ Compresseur d'air à manomètre 12 volts
I ▶ Compressore d'aria con manometro 12 volt
PL ▶ Kompresor z manometrem 12 Volt



D

Zubehör:
- 1 m 12 V-Kabel mit Universalstecker für den Zigarettenanzünder
- Druckgummischlauch mit Schnellverschluss-Ventil
- 2 Adapter + 1 Ventil zum Aufpumpen von Bällen

Gebrauchsanweisung:
1) Bitte lassen Sie den Kompressor nicht länger als 15 Minuten durchgehend laufen.
2) Bei längerem Betrieb als 15 Minuten Kleinkompressor nach 15 Minuten abstellen und ihn 5 Minuten abkühlen lassen.
3) Der Kompressor ist nicht geeignet für das Aufpumpen von Hochdruck-LKW-Reifen oder Traktorreifen. **Arbeitsvorgang des Aufpumpens nicht unbeaufsichtigt lassen.**

Aufpumpvorgang:
1) Stellen Sie den Wagen so, dass das Ventil des aufzupumpenden Reifens unten ist.
2) Bitte schließen Sie jetzt den Gummischlauch mit dem Schnellverschlussventil an das Ventil des Reifens an und drücken dann den Ventilverschluss herunter, so dass das Ventil fest mit dem Reifenventil verbunden ist.
3) Bitte beachten Sie, wenn der Reifen total luftleer ist, sollte der Wagen mit dem Wagenheber angehoben werden, so dass kein zusätzlicher Druck auf dem luftleeren Reifen lastet.
4) Stecken Sie jetzt den Stecker in den Zigarettenanzünder, damit der Kompressor mit Strom versorgt wird. Der Aufpumpvorgang kann jetzt beginnen, jedoch achten Sie darauf, dass der Luftdruck ständig kontrolliert wird, um nicht einen Überdruck zu erzeugen.
5) Bitte beachten Sie, dass je höher der Druck im aufzupumpenden Gegenstand ist, der Luftstrom geringer wird, da ein Gegendruck im aufzupumpenden Gegenstand entsteht. Bitte beachten Sie, dass die angegebenen Druckwerte nicht überschritten werden.

Druckkapazitäten:
1) Bitte beachten Sie immer die vom Hersteller angegebenen zulässigen Druckwerte, so dass kein Schaden durch einen zu hohen Druckwert entstehen kann.

Aufpumpen von Spielsachen und Bällen:
1) Bitte benutzen Sie die beigefügten Adapter, sofern Sie Bälle, Luftmatratzen oder andere Aufblasartikel aufpumpen möchten. Bitte lassen Sie bei jedem Aufpumpvorgang größte Sorgfalt walten und informieren Sie sich über die Maximaldruckangaben für diese Artikel.
2) Bitte beachten Sie hier auch, dass kleinere Artikel sehr schnell aufgeblasen werden können und daher sollten Sie den Aufpumpvorgang immer unter Beobachtung halten. Wenn Sie die o.a. Instruktionen befolgen, wird Ihnen der Kompressor lange zuverlässige Dienste leisten.

Wir wünschen viel Vergnügen mit diesem Artikel!

GB

Accessories:
- 1 m 12V wire with a universal plug for cigarette lighters
- Rubber pressure tubing with snap valve
- 2 adapters + 1 valve for inflating balls

Directions:
1) Please do not let the compressor operate continuously for more than 15 minutes.
2) If the small-capacity compressor is to be used for more than 15 minutes, switch it off after 15 minutes and let it cool down for 5 minutes.
3) The compressor is not suitable for inflating high-pressure lorry tyres or tractor tyres. Do not let anything be inflated without observing it.

Inflating:
1) Position the vehicle in such a way that the valve of the tyre to be inflated is at the bottom.
2) Now please connect the rubber tube having the snap valve to the tyre valve and then press the valve lock down so that it firmly locks onto the tyre valve.
3) Please note that if a tyre is completely void of air, the vehicle should be raised using a jack, so that no extra pressure will be exerted on the empty tyre.
4) Now put the plug into the cigarette lighter, so that the compressor is connected to the power supply. Now the inflating process can commence. But do observe the inflation pressure continuously in order to avoid excess pressure.
5) Please note that, the higher the pressure in the item being inflated, the lower the air flow, because counter-pressure is generated in the item being inflated. In addition, make sure that the specified pressure is not exceeded.

Pressure Capacity:
1) Please always adhere to the permissible pressure specified by the manufacturer, in order to avoid damage which may be caused by excess pressure.

Inflating Toys and Balls:
1) Please use the adapters provided, whenever you want to inflate balls, air mattresses or any other inflatable items. Be extremely careful whenever inflating anything and note the maximum pressure specified for it.
2) Moreover, take into consideration the fact that smaller items can be fully inflated very quickly. Thus always observe them while pumping. If you adhere to the aforesaid instructions, the compressor will serve you reliably for a long time to come.

We hope that you will enjoy using this item!

(F) **Accessoires:**

- Câble 12V de 1 m avec connecteur universel pour l'allume-cigares
- Flexible en caoutchouc avec valve à fermeture rapide
- 2 adaptateurs + 1 valve pour le gonflage des ballons

Mode d'emploi:

1) Ne pas laisser le compresseur fonctionner plus de 15 minutes sans interruption.
2) En cas d'utilisation longue durée, arrêter le compresseur au bout de 15 minutes pour le laisser refroidir pendant 5 minutes.
3) Le compresseur n'est pas conçu pour gonfler des pneus à haute pression de camions ou de tracteurs. Ne jamais laisser le compresseur sans surveillance pendant le gonflage.

Gonflage:

1) Placer la voiture de telle sorte que la valve du pneu à gonfler soit en bas.
2) Raccorder ensuite le flexible en caoutchouc à la valve du pneu au moyen de l'adaptateur et appuyer sur le levier de fermeture de celui-ci pour le relier fermement à la valve du pneu.
3) Si le pneu est entièrement plat, soulever la voiture au moyen du cric pour éviter toute pression supplémentaire sur le pneu.
4) Mettre ensuite la fiche du compresseur dans l'allume-cigare. Le gonflage peut commencer. Contrôler la pression en permanence pour éviter toute surpression.
5) Remarque : plus la pression dans l'objet à gonfler est élevée, plus le flux d'air devient faible, car il se produit une contre-pression dans l'objet à gonfler. Veiller à ne pas dépasser les pressions recommandées.

Pression recommandée:

1) Respecter toujours les valeurs admissibles indiquées par le constructeur pour éviter tout dommage éventuel dû à une surpression.

Gonflage de jouets et de ballons:

1) Veuillez utiliser l'adaptateur ci-joint pour gonfler les ballons, matelas pneumatiques ou autres articles gonflables. Renseignez-vous avec soin avant chaque gonflage sur les valeurs de pression maximales relatives à l'article que vous voulez gonfler..
2) Les petits articles étant très vite gonflés, surveillez leur gonflage en permanence. L'observation des instructions qui précèdent vous permettra de bénéficier pendant longtemps des bons services de votre compresseur.

Nous espérons que cet article vous donnera entière satisfaction!

(I) **Accessori:**

- Cavo 12V di 1 m con connettore universale per l'accendisigari
- Tubo flessibile di pressione con valvola a chiusura rapida
- 2 adattatori + 1 valvola per il pompaggio di palloni

Istruzioni per l'uso:

1) Non lasciare funzionare il compressore costantemente oltre 15 minuti.
2) Per un funzionamento di lunga durata, desinnestare il compressore ogni 15 minuti e fare raffreddare per 5 minuti.
3) Il compressore non è adatto per gonfiare pneumatici di camion ad alta pressione o di trattore. Non mai lasciare il compressore senza sorveglianza durante il gonfiaggio.

Gonfiaggio:

1) Posizionare la vettura a tal modo che la valvola del pneumatico da pompare sia in basso.
2) Collegare ora il tubo flessibile alla valvola del pneumatico e premere la chiusura della valvola del flessibile in modo di collegarla fortemente alla valvola del pneumatico.
3) Quando il pneumatico è totalmente vuoto, sollevare la vettura con il cricco, di modo che non vi sia nessuna pressione aggiuntiva sul pneumatico.
4) Inserire ora la spina nell'accendisigari, di modo che il compressore venga alimentato dalla corrente. Il pompaggio può ora iniziare, fare però attenzione che la pressione d'aria venga sempre controllata per non generare una sovrappressione.
5) Tenere presente che più è lata la pressione nell'oggetto da gonfiare, più ridotta la corrente d'aria, siccome avviene una contropressione nell'oggetto da gonfiare. Fare attenzione che i valori di pressione indicati non vengano superati.

Pressione raccomandata:

1) Attenersi sempre ai valori di pressione indicati dal produttore, per evitare un danno causato per via di una pressione troppo alta.

Pompaggio di giocattoli e palloni:

1) Se desiderate pompare palloni, materassini di gomma o altri articoli da pompare, si prega di usare l'adattatore allegato. Osservare per ogni processo di pompaggio la massima attenzione e informatevi sulle indicazioni della massima pressione per questi articoli.
2) Tenere anche conto che gli articoli piccoli vengono pompati molto velocemente, perciò osservare sempre il processo di pompaggio. Osservando le suindicate istruzioni, il compressore vi fornirà servizi affidabili per lungo tempo.

Vi auguriamo un buon divertimento con questo articolo!

(PL) **Wyposażenie**

- Przewód 12 V o długości 1 m z uniwersalnym wtykiem do gniazda zapalniczki,
- Wąż gumowy z końcówką
- 2 dodatkowe końcówki + 1 końcówka do pompowania piłek

Wskazówki użycia:

1) Kompresor nie powinien pracować dłużej niż 15 min.
2) W przypadku konieczności dłuższej pracy kompresora, wyłączyć go po 15 min i pozostawić na 5 min do ostygnięcia.
3) Kompresor nie jest przeznaczony do pompowania opon samochodów ciężarowych ani ciągników rolniczych. Pracujący kompresor nie może być pozostawiony bez nadzoru.

Wskazówki do pompowania:

1) Ustawić samochód tak, aby wentyl znajdował się w dolnej części koła.
2) Podłączyć wąż kompresora do wentyla i opuścić zamknięcie - wąż jest trwale połączony z wentylem.
3) W przypadku, gdy opona jest całkowicie opróżniona, samochód powinien być podniesiony przy pomocy podnośnika, aby opony nie były obciążone.
4) Podłączyć kompresor do gniazda zapalniczki. Pracujący kompresor należy pilnować aby zapobiec nadmiernemu napompowaniu przedmiotu.
5) Należy pamiętać, że im większe jest ciśnienie pompowanego przedmiotu, tym mniejszy strumień pompowanego powietrza. Uważać aby dopuszczalny poziom ciśnienia nie został przekroczony.

Uwaga:

1) Przekroczenie podanego przez producenta dopuszczalnego poziomu ciśnienia może spowodować uszkodzenie pompowanego przedmiotu.

Pompowanie piłek i zabawek:

1) Do pompowania piłek, materaców lub innych dmuchanych zabawek służą dołączone końcówki. Należy przestrzegać dopuszczalnego poziomu ciśnienia.
2) Należy pamiętać, że małe przedmioty pompuje się szybko, dlatego wymagany jest stały nadzór procesu pompowania. Przestrzeganie powyższych wskazówek umożliwi długie i niezawodne korzystanie z kompresora.

Życzymy Państwu wiele zadowolenia z zakupu kompresora!