

**WATER HAMMER ANALYSIS ON HIGH PRESSURE DUE TO  
STOPPING PUMP**

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**RESEARCH REPORT SUBMITTED TO THE FACULTY OF  
ENGINEERING, UNIVERSITY OF MALAYA IN PARTIAL  
FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF  
MASTER OF MECHANICAL ENGINEERING**

**2019**

# UNIVERSITY OF MALAYA

## ORIGINAL LITERARY WORK DECLARATION

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Title of Project Paper/Research Report/Dissertation/Thesis ("this Work"):

Water Hammer Analysis on High Pressure Due To Stopping Pump

Field of Study: Water Surge

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## DEDICATION

This thesis is dedicated to:

Who their true love and support were behind my success;

My dear mother, Norijah Mohd Ali

&

My beloved sister, Nur Zarina.

Last but not least,

To my dedicated supervisor, Prof. Madya Ir. Dr. Nik Nazri, for his endless supervision and guidance throughout the whole progress of producing this research report.

Not to forget to all my supportive friends for their encouragement.

Thank you so much.

## **ACKNOWLEDGEMENT**

In preparing this project, the author was in contact with many people, academicians and practitioners; I wish to express my sincere gratitude, appreciation and indebtedness to my project supervisor, Prof. Madya Ir. Dr. Nik Nazri for his germinal ideas, encouragement, guidance, assistance and constant support in making this project possible during this study. Without his continued support and interest, this study would not have been the same as presented here.

In addition, special thanks to my fellow friends for all the support and as well to my colleagues. Last but not least, my sincere appreciation also extends to all my family especially my mother Norijah Mohd Ali and my sister Nur Zarina, for their sacrifices, patience and understanding which were inevitable to make this work possible. This research report means a lot to gain invaluable knowledge throughout my completion.

## ABSTRACT

In such restricted framework for water pipeline, a sudden relocation of stream that causes expansive weight destabilize or back weight is called water hammer. The called is given because of the sound that happens amid the reverse of water. It is generally imperative thought of numerous water powered plan structure because of outrageous variety of weight cause by the pump. The compressibility of water and the flexibility of channels, weight waves will at that point spread in the pipe until the point when they are diminished at certain speed, which is subject to the pipe material and divider thickness. Through the impacts of the water hammer changing, go from slight changes in weight and speed to adequately high weight or vacuum through to disappointment of fittings, and burst channels. Figure 1 indicates burst mellow steel pipe because of water hammer weight. This pipe thickness and pipe material is not adequate to support the water hammer weight. In this way, pipe burst and reasonable numerical displaying of the diverse fixing in pressure driven framework is important to get, valuable outcomes, which help satisfy these goals. In this paper numerical demonstrating were used to create PC program to reproduce the water powered transient in straightforward pipe. There was no compelling reason to think about instances of precarious stream, either in open diverts or in shut funnels and conductors. The activity of waves on shore lines, in sounds and ports, and along channels, was the main problem similar to water-hammer known in early occasions, and the numerical and physical learning in those days was not able adapt to this issue with the exception of by development of barriers for assurance of harbors and shipping. This part of hydraulics, now assigned as beach front building, which bargains with tidal and surface waves, has turned into an essential field, especially in this twentieth century. As a result of the fast stream changes, a weight wave is proliferated while a negative down flood goes down the

pipeline to the release outlet where it is reflected. The reflected wave will thusly makes a positive flood along the pipeline. Not at all like some part of the framework conduct that are traditionalist when dismissed, can't this marvel be ignored as it builds the seriousness of water hammer. Segment partition is the irregularity in the water segment caused by inordinate strain when the weight is diminished to the vapor weight of water. Expansive breadth thin walled pipelines are especially powerless against shell crumple under this condition. On the other case, if the unfriendly weight isn't adequate, appropriate flood concealment gadget will be prescribed to constrain the weight to adequate dimensions.

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## ABSTRAK

Dalam rangka kerja yang terhad untuk saluran paip air, relokasi aliran secara tiba-tiba yang menyebabkan berat badan yang kestabilan atau berat badan kembali dipanggil tukul air. Yang dipanggil diberikan kerana bunyi yang berlaku di tengah-tengah air yang terbalik. Ia secara umum pemikiran pelbagai struktur pelan berkuasa air kerana pelbagai jenis berat yang menyebabkan keterlaluan oleh pam. Kebolehgawal selia air dan fleksibiliti saluran, gelombang berat akan pada titik itu tersebar di dalam paip sehingga titik apabila mereka berkurang pada kelajuan tertentu, yang tertakluk kepada bahan paip dan ketebalan pembahagi. Melalui kesan tukul air yang berubah-ubah, pergi dari sedikit perubahan dalam berat badan dan kelajuan kepada berat badan yang cukup tinggi atau hampa melalui kekecewaan kelengkapan, dan saluran pecah. Rajah 1 menunjukkan paip keluli yang lembap kerana berat tukul air. Ketebalan paip dan bahan paip ini tidak mencukupi untuk menyokong berat tukul air. Dengan cara ini, pecah paip dan paparan berangka yang munasabah bagi penetapan pelbagai dalam rangka kerja tekanan adalah penting untuk mendapatkan, hasil yang berharga, yang membantu memenuhi matlamat ini. Dalam kertas kerja ini menunjukkan secara numerik digunakan untuk membuat program PC untuk menghasilkan semula fana bertenaga air dalam paip lurus. Tidak ada sebab yang kuat untuk memikirkan tentang aliran tidak menentu, sama ada dalam pengalihan terbuka atau dalam corong tertutup dan konduktor. Kegiatan ombak di pantai lin, dalam bunyi dan pelabuhan, dan saluran along, adalah masalah utama yang berkaitan dengan tukul air yang diketahui pada masa-masa awal, dan pembelajaran berangka dan fizikal pada masa-masa itu tidak dapat menyesuaikan diri dengan masalah ini dengan pengecualian dengan membangunkan halangan untuk jaminan pelabuhan dan perkapalan. Bahagian hidrauka ini, yang kini ditugaskan sebagai bangunan depan pantai, yang ditawarkan dengan tidal dan gelombang

permukaan, telah berubah menjadi medan penting, terutama pada abad kedua puluh ini. Akibat perubahan aliran pantas, gelombang berat akan meningkat sementara banjir turun ke bawah turun saluran paip ke saluran keluarnya yang dicerminkan. Gelombang yang dipantulkan akan membuat banjir positif sepanjang saluran paip. Sama sekali tidak seperti sebahagian daripada tingkah laku kerangka yang tradisionalis apabila diberhentikan, tidak boleh mengagumkan ini kerana tidak membina keseronokan tukul air. Pemisahan segmen adalah ketidakteraturan dalam segmen air yang disebabkan oleh ketegangan yang luar biasa apabila beratnya berkurang pada berat uap air. Jalur lebar berdinding nipis yang luas meluas terutamanya tanpa daya terhadap crumple shell di bawah keadaan ini. Dalam kes yang lain, jika berat tidak mesra tidak mencukupi, alat penyembunyian banjir yang sesuai akan ditetapkan untuk mengekang berat ke dimensi yang mencukupi.



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# CHAPTER 1

## INTRODUCTION

### 1.1. BACKGROUND

In order of understanding the correlation of water hammer occurrence, it is easily to understand that is normally perceived by a slamming or pounding in water lines. In spite of the fact that it may appear to be a smooth stream, the water inside the pipe really stirs and tumbles as it travels through. The ordinary sound of water traveling through funnels is a consistent, even solid. The most ideal approach to realize what it sounds like is to go turn the bath water on maxing out, at that point go to different rooms of the house and tune in.

Water hammer in an arrangement of water pipeline, are transient spill out of one change to consistent state in liquid stream framework. This transient happens inside and unconfined framework. With this, it permitted by an unsettling influence to the liquid stream. In such restricted framework for water pipeline, a sudden dislodging of stream that causes extensive weight destabilize or back weight is called water hammer. The name produced because of the sound that happens amid the reverse of water. It is most imperative thought of numerous water powered plan structure because of extraordinary variety of weight cause by the pump. For instance, the expanding weight in the channeling framework join with high weight wave, there are the negative wave which are probably going to be missed yet can cause contaminant interruption. It will apply to pressure and cause harming the current

on funnels, joint and valve and the clamor that activated can be told. Refer to figure 1.1 that illustrate on occurrence of water hammer in pipeline.

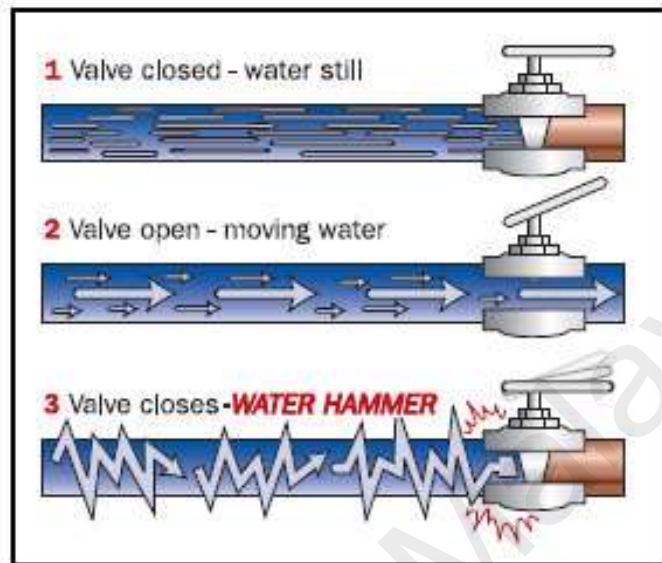


Figure 1.1: Figure of water hammer occurrence

(Source: <http://www.plumbingmart.com/water-hammer-information.html>)

### 1.1.1 Identifying Water Hammer

Water hammer can be a major pound that shakes the house, or a progression of slamming clamors beginning with a blast pursued by a few "echoes". Quickly shutting or opening a valve causes weight homeless people in pipelines. The impact of water hammer on channeling framework can change the weight and coming about of quick changes in stream. On the off chance that the commotion happens when you open a valve or a fixture, it is presumably air in the channels. On the off chance that it happens when a valve closes or the washer changes cycles, it is likely water pound. In the event that it happens when a pump starts, it could be water hammer, air in the funnels, or both. Although opening valves can make water hammer, this ordinarily just happens with valves bigger than 3" in size and, after its all said and done it is sensibly uncommon.



By and large happen in a pipe framework after crisis pump cut-off or typical working pump stop, despite the fact that it might likewise amid the pump begin or at valve opening or shutting. The compressibility of water and the flexibility of funnels, weight waves will at that point spread in the pipe until the point when they are diminished at certain speed, which is subject to the pipe material and divider thickness. Through the impacts of the water pound changing, extend from slight changes in weight and speed to adequately high weight or vacuum through to disappointment of fittings, and burst channels. Pipe thickness and pipe material isn't adequate to continue the water hammer weight. In this manner, pipe burst and appropriate numerical demonstrating of the distinctive fixing in pressure driven framework is important to get, valuable outcomes, which help satisfy to achieve this phenomenon.

### **1.1.2 The Source of Water Hammer**

The main variable is the length of the pipe the water is going through. We can't do much about the length of funnels or water channel, accepting that we can't draw housing area nearer and directly to the water source. Be that as it may, it is a vital factor in profound of water hammer, so it is helpful to investigate it, particularly as it identifies with the pipe measure. For instance, in a few circumstances of compelling a high rate of move through a little pipe without issues, gave the length of the pipe is short. The shorter the pipe, the littler it tends to be. Realizing this helps when endeavor to distinguish the wellspring of the water hammer. So remember that a little pipe may not be an issue on the off chance that it is a short length.

In the bigger field of hydraulic engineering, early improvement depended on issues of transportation of water, and on the estimation of stream for water system and for residential use in the focuses of populace. This involved gadgets for pumps, for conveyance along channels and courses, and for the estimation of amounts utilized by people. The hypothesis and structures had to do with hydrostatic weights, grinding misfortunes, and release coefficients, the vast majority of which could be taken care of by test ponders. There was no compelling reason to think about instances of flimsy stream, either in open directs or in shut channels and conductors. The activity of waves on shore lines, in sounds and ports, and along waterways, was the main problem similar to water-hammer known in early occasions, and the scientific and physical learning in those days was not able adapt to this issue with the exception of by development of sea walls for assurance of harbors and dispatching. This part of hydraulics, now assigned as beach front building, which manages tidal and surface waves, has turned into a vital field, especially in this twentieth century.

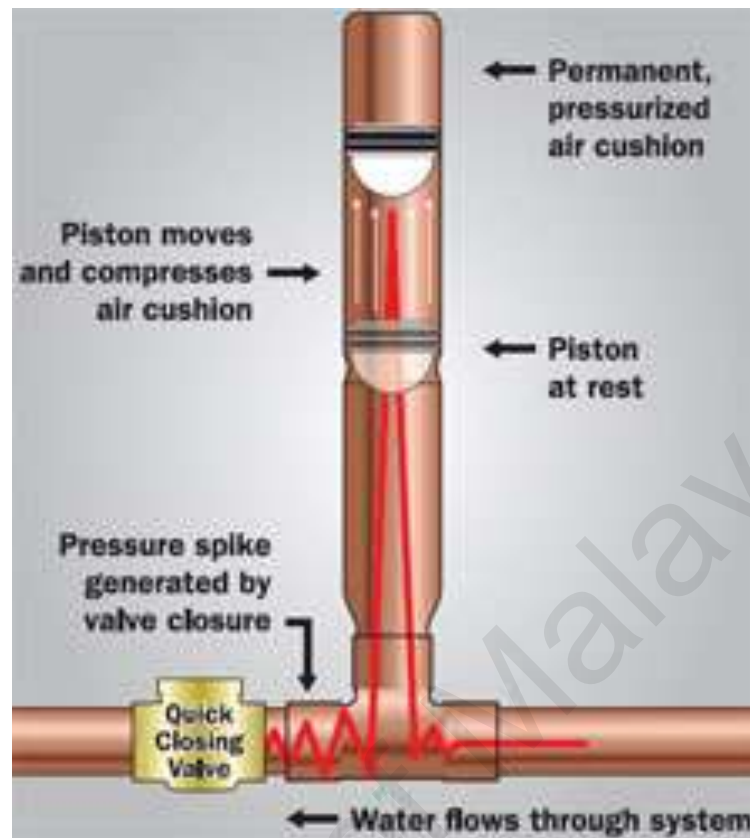


Figure 1.2: illustration of water hammer in moving piston

(Source: <http://www.plumbingmart.com/water-hammer-information.html>)

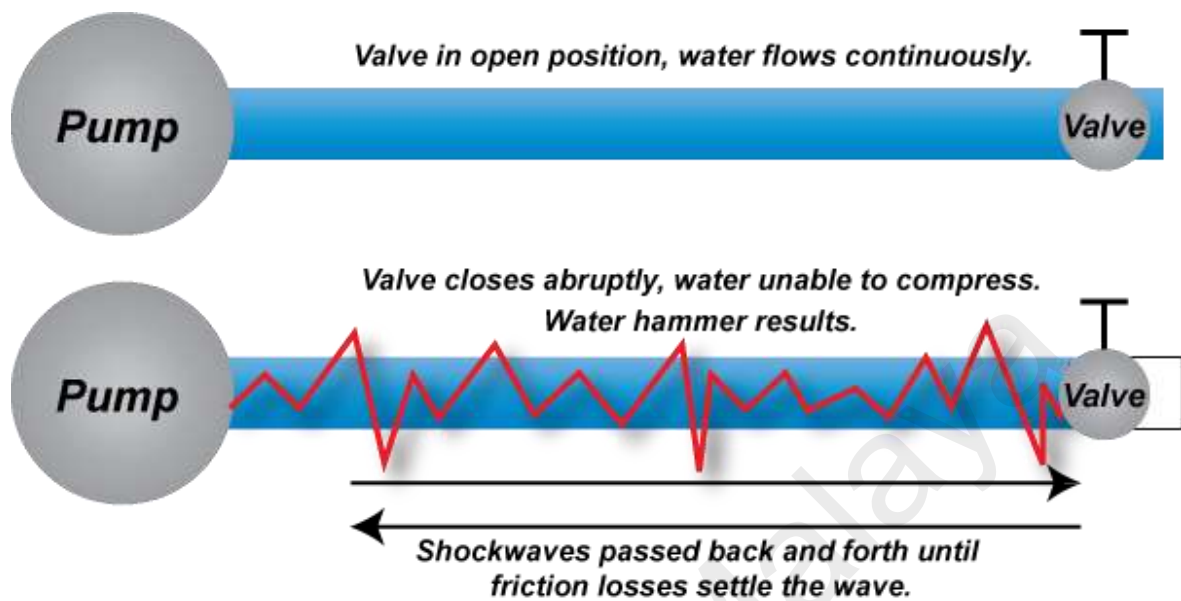
In reference to figure 1.2, the figure shows the piston moves and compresses the air cushion within the pipe causing the pressure to spike that is generated by the valve closure. As we can see that the upper part of the pipe is a stagnant, pressurized air cushion whereas the bottom part is where water flows through the system in horizontal manner.

The second factor is the time, or explicitly how quick the water is being halted. At the point when an end valve is causing water pound, time is to what extent it takes for the valve to close. Most water system valves take a few seconds to close. Hypothetically this would not cause an issue, as a few seconds is moderate when managing water hammer. The valve may take a couple of moments to go from full open to full shut, however it tends to snap shut.

Sensibly the genuine shutting time of a run of the mill water system solenoid valve is around 1/2 to 1 second. Be that as it may, it fluctuates incredibly, notwithstanding when testing a similar valve. For instance, a water system valve closes a lot quicker if there is higher water weight present. It additionally closes quicker as you increment the course through the valve (expanding the stream makes a more noteworthy weight differential over the valve, which makes it close quicker.) So a valve that would not cause a water hammer issue at a low stream and low weight, will cause a wide range of issues on the off chance that increment the move through the valve or potentially the water weight.

In water supply pump plans including exchanging of water from suction tank to lifted store, usually expected that sudden power inability to the pump engines will deliver the greatest and least transient in the pipeline. On the off chance that there are numerous pump in the station, it is accepted that the extraordinary transient created will be caused by all pump failing simultaneously. In larger cases, the weight caused by concurrent power inability to numerous pump is the primary thought that administers the plan of the pipeline.

In pump plans where check valve is introduced at the downstream of the pump, when control supply falls flat, the main vitality accessible to drive the pump the forward way is the dynamic vitality of the turning mass of the pump, engine and the entrained water in the pump. Since the vitality is typically little contrasted with the vitality required to keep up the stream against the release head, the pump speed backs off rapidly bringing about a quick decrease in the pump release. Due to the fast stream changes, a weight wave is proliferated while a negative down flood heads out down the pipeline to the release outlet where it is reflected. The reflected wave will thusly makes a positive flood along the pipeline.



*Figure 1.3: water hammer in pumping pipe line*

*(Source: Carne Engineering.com)*

As we look closely on figure 1.3, when water hammer took place in pumping pipeline, the water channel with continuously vibrates by the shockwaves which will goes back and forth until the friction in the water channel reduces to the limit to neutralize with the wave within the pipe.

The third factor that impacts water pound is the speed of the water. The quicker the water is going in the pipe, the more prominent the water pound. It is this last factor which is least demanding for us to address in a sprinkler framework, so the greater part of the proposed answers for water sledge will be gone for diminishing the water speed. A different aspect from the system, in conduction that are moderate when dismissed, this occurrence can't be ignored as it builds the seriousness of water hammer. Segment division is the irregularity in the water segment caused by unreasonable strain when the weight is lessened to the vapor

weight of water. A huge distance across of the thin walled pipelines is especially defenseless against shell crumple under this condition.

### 1.1.3 Water Hammer in Hydropower Plant

Water hammer—or hydraulic shock —is a well-suited depiction of the sudden effect of a mass of quick moving water on a channeling part, for example, a valve or an elbow. It for the most part happens in longer steam lines and is caused by the opening of a stop valve or the blending of steam from one pipe with condensate from another. The inquiries and load cases managed incorporate the start-up of the plant from a stop to full load activity, the guide vane crisis shutdown of the two turbines, the concurrent load dismissal of the two turbines, the intermittent task of the plant in light of the flood chamber motions and the restart of the plant to full load after a crisis shutdown or a heap dismissal.

1997 – Lapino HPP (2.3MW) Poland



Adamkowski A. (2001): *Case Study: Lapino Powerplant Penstock Failure.* J. Hydr. Eng. 127(7), 547-555.

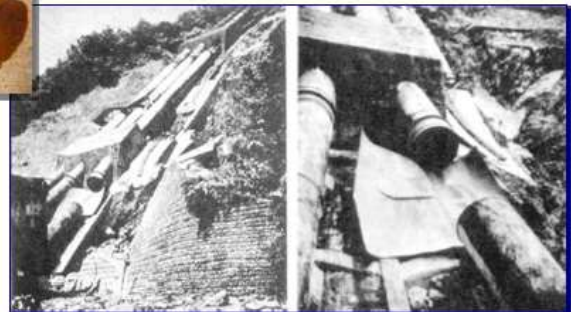
2011 - Mississippi River Power Corp. (4.6MW) Canada ([millstonenews.com](http://millstonenews.com))



2009 - Bear Creek Hydroelectric Project (5MW) California ([deereault.com](http://deereault.com))



1950 - Oigawa Hydropower Station (68.2MW) Japan



Bonin, C. C. (1960): *Water-Hammer Damage to Oigawa Power Station,* J. Eng. Power 82(2), 111-116

Figure 1.4: collage of penstock destruction

(Source: Research-Gate Hydropower Development: Europe 2015)

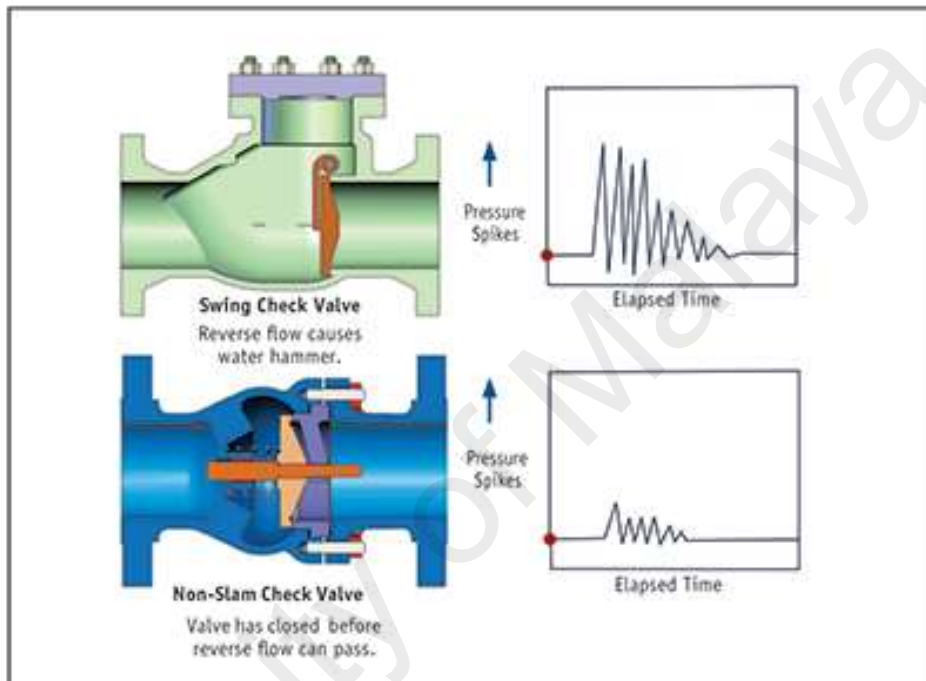
Referring to the collage photos above, this shows the mass destruction and after effect that caused by water hammer or known to be hydraulic shock that cannot be withstand by pipeline system that have been built for the convenient of the community and society.

As this power plant venture is still in its arranging stage, moreover to the matters mentioned charges the most extreme inward weights inside the channels not out of the ordinary are of significance so as to have the capacity to accurately measurement these funnels and/or their divider thickness.

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## 1.2. PROBLEM STATEMENT

In the home, a water mallet may happen when a dishwasher, clothes washer or latrine stop water stream. The outcome might be heard as a noisy blast, tedious slamming (as the stun wave goes forward and backward in the pipes framework), or as some shivering.



*Figure 1.5: how usage of check valve effect the pressure spike*

*(Source: Research-Gate Hydropower Development: Europe 2015)*

As illustrated in figure 1.5, differential of valve use correlate and brings effect to how the water pressure may behave within the pipeline or water channel. This also helps in the time frame of occurrence making it behalf in the life span of the pipes.

It happens as the displaying the flood executions of a pipeline, crest positive weights are one of the key perspectives to audit. The evaluated weight of pipeline is a greatest weight which the pipe can be liable to, as indicated by the pipe producer. As rising mains are liable to changing degrees of water pound, usually practice to structure a pipeline with the goal



that the typical working weight is well underneath that of the evaluated weight of the pipe material utilized. If explicit water pound displaying isn't done, the water powered specialist can't be sure of the size of pinnacle weights inside the pipeline. If the appraised weight be surpassed, the rising principle's valuable life could be lessened, prompting disappointment.

Then again, when an upstream valve in a pipe closes, water downstream of the valve endeavors to keep streaming making a vacuum that may make the pipe fall or implode. This issue can be especially intense if the pipe is on a declining incline. To keep this, air and vacuum alleviation valves or air vents are introduced only downstream of the valve to enable air to enter the line to keep this vacuum from happening.

Different reasons for water pound are pump disappointment and check valve pummel (because of sudden deceleration, a check valve may hammer close quickly, contingent upon the dynamic normal for the check valve and the mass of the water between a check valve and tank). To lighten this circumstance, it is prescribed to introduce non-pummel check valves as they don't depend on gravity or liquid stream for their conclusion. For vertical channels, different recommendations incorporate putting in new funnelling that can be intended to incorporate air chambers to lighten the conceivable shockwave of water because of overabundance water stream.

Negative weights inside a pipeline cause clasping of the pipeline as well as cavitation. A pipeline can clasp if the negative weights experienced inside the line are more noteworthy than the structure of the pipe can endure, and the pipe will crumple in on itself. This generally just happens with high negative weight and moderately thin walled funnels. In the event that flood demonstrating of a pipeline demonstrates that critical negative weights are likely, it is judicious to lead an explicit clasping computation.

### **1.3. OBJECTIVES**

- To apply the analysis and fundamental phenomenon of water hammer occurrence in pump stopping
- To understand the analysis on pressure arising in pump
- To simulate the analysis using computer program
- To analyze water hammer in a high pressure of pump stopping systems
- To evaluate the result and discussion for near future recommendation

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## 1.4. RESEARCH REPORT STRUCTURE

In this research report project, it is presented in predictable/occurring research based manner. The order shall be from the literature review, methodology, result and discussions, and concluded with the conclusion section. The reference of overall thesis is also listed at the end of the thesis along with the appendices.

In the literature review, most of the water hammer issues, let it be in hydropower plant system or common hydro engineering, have been researched in the view of its conduct, processed and mechanism thus it is applied in the discussion. The view from the researcher and methodology of past journal was also observed and the researched gap is identified. In the methodology section, it is presentation of the Hytran software thus the overview of thesis conduct on this researched based project.



*Figure 1.6: Hytran software logo*

*(Source: accutech2000.com)*

In the result and discussion section, the data of water hammer analysis, Hazen-William equation, figures and graphs of analytical method are shown in the calculation in mathematical mannerly and is projected orderly to their sequences of calculation. The discussion shall show the challenge and answer to the unclear statement. Conclusion will be the last part of the project to roll up the entire thesis project thus few recommendations are given for future acknowledgement.

# CHAPTER 2

## LITERATURE REVIEW

### 2.1. INTRODUCTION

In this chapter, there are some introductions of the water hammer analysis in general. The general view for water hammer occurrence, the aftermath of system and analysis review of some past journal.

### 2.2. AN ANALYSIS OF PLUMBING SYSTEMS, INTRUSION, AND PUMP OPERATION

Transient stream is the progress starting with one unfaltering state then onto the next enduring state in a liquid stream framework. Transient stream happens in all liquids, bound and unconfined. A progress is caused by an aggravation to the stream. In a kept framework, for example, a water pipeline, an unexpected change to the stream that causes extensive weight vacillations is called water pound. The name originates from the pounding sound the occasionally happens amid the wonder.

The water pound wonder is a critical thought in plan in numerous water driven structures because of outrageous varieties in weight it causes. For instance, the emotional weight rise can make funnels burst. Going with the high weight wave, there is a negative wave, which is frequently ignored, can cause low weights prompting the likelihood of contaminant interruption. Water pound is a typical yet difficult issue in private pipes frameworks. It puts conceivably harming additional anxiety on funnels, joints, and installations. The commotion related with water sledge can be an aggravation also. So as to demonstrate the

water pound marvel in courses it is required to illuminate an arrangement of force and congruity conditions.

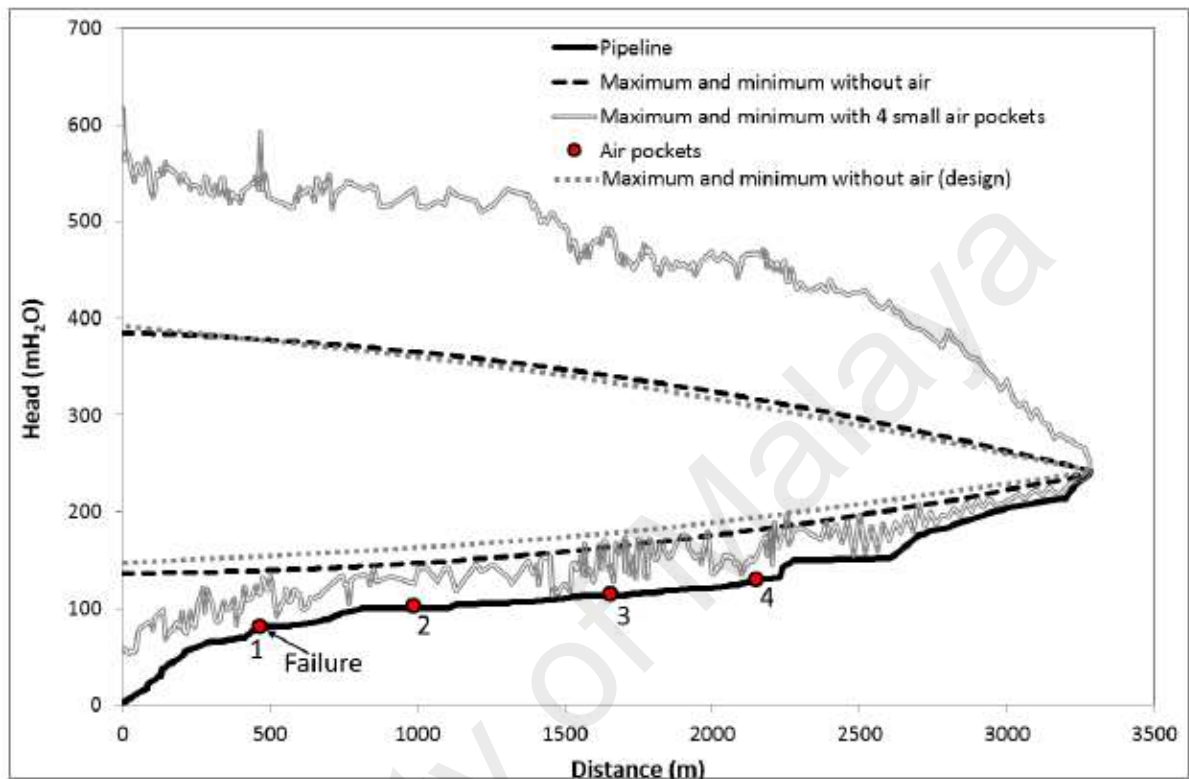


Figure 2.1: comparison of maximum and minimum head envelopes with and without air in pipelines.

(Source: Failure Analysis of a Water Supply Pumping Pipeline System journal)

The force and progression conditions shape an arrangement of non-direct, hyperbolic, fractional differential conditions which can't be understood by hand. A numerical strategy with an underlying condition and two limit conditions are required. For a water circulation framework, there are a lot more parameters required for taking care of the water pound issue. In a water circulation framework, each part of the framework requires an extra limit condition. Outer limit conditions go up against the type of a driving head, or a stream leaving the framework. Inside limit conditions emerge as nodal progression, vitality

misfortune between focuses, head crosswise over valves, pump and that's just the beginning.

When modeling the problem of water hammer in a complex system, an understanding of the mathematics of the fundamental equations, the numerical method, and the computer model is needed. (Batterton, 2006)

This work gives the strategies to breaking down water pound on the littler scale home pipes frameworks. Before transient examination can start, consistent stream conditions must be created. Unflinching stream conditions created by utilizing the vitality condition and the congruity condition coordinated the enduring stream conditions created by utilizing the force condition and the coherence condition. This work demonstrates why this occurs. Amid transient occasions, pump can work in unordinary and strange way. Understanding the conduct of pump in every one of the methods of activity is important so as to precisely anticipate the conduct of the framework amid drifters. This issue is inspected by making a model like a genuine test mechanical assembly used to examine interruption in the program and running different re-enactments and dissecting the outcomes.

## 2.3. WATER HAMMER PHENOMENA IN THERMAL POWER STATION FEED WATER SYSTEMS

The event of an uncommon breakdown or disappointment requires an examination into specific conditions, as well as some of the time, as a result of decent variety of structure, the examination must be reached out, to pick up a full comprehension of the issue, from which both general arrangements and explicit answers for specific plants might be created. An ongoing increment in the quantity of weight part disappointments in liquid frameworks, together with one deadly release from a broke cast press valve in a kettle feed pump suction arrangement of a plant that was inert yet cooling, prompted an explicit examination and to a looking investigation into weight part disappointments actuated by water pound.

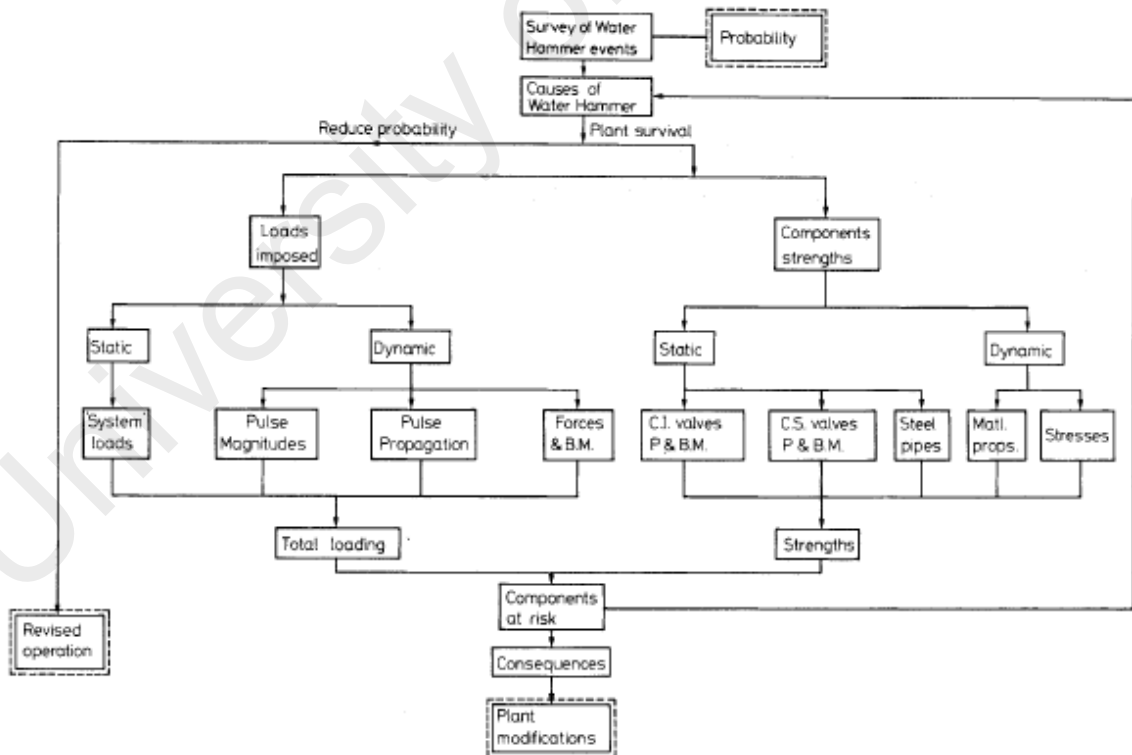


Figure 2.2: Logic diagram of investigation

(Source: D. H. WILKINSON AND L. M. DARTNELL journal)

An outline of the methods used to obtain these objectives is shown as a logic diagram in Figure 2.1. Experiential and theoretical work has revealed the magnitude of such pressure pulses and also revealed that steel pressure parts will not fail when subjected to the forces arising from thermodynamically induced water hammer, because steel pipes limit transient hydraulic pressures by dilating and steel valves are sufficiently strong. (WILKINSON, D. H.;L. M. DARTNELL, 1980)

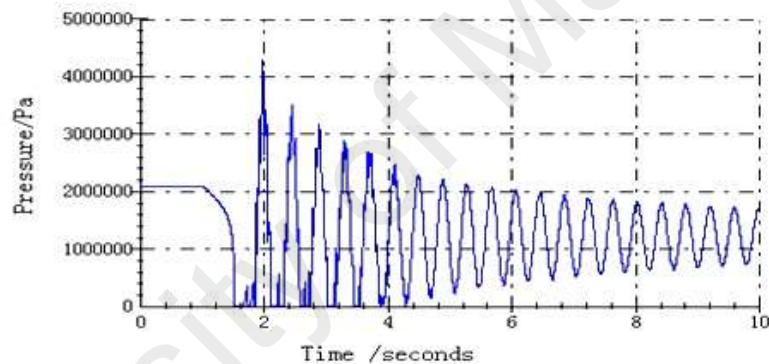
'Established' water pound because of sudden valve conclusion or fast pump shutdown is a surely knew highlight of water driven frameworks and weight beat extents and their spread through inflexible, chilly water pipework frameworks can be anticipated numerically, with great exactness. Anyway the occurrence that prompted the examinations gave off an impression of being water pound caused by steam developed from heated water, with the ensuing breakdown of a steam hole permitting the water segments each side of the cavity to impact, creating a water pound weight beat which at that point spread through the funnels and burst the cast press valve.

The itemized clarification of this occasion is portrayed in this. As there had been numerous other water pound occasions, in spite of the fact that not as genuine, an expansive modified of work was planned to take a gander at all parts of water pound wonders in power station feed water frameworks.

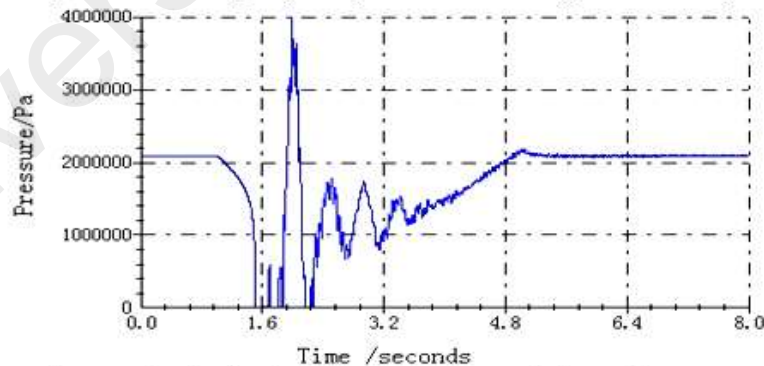


## 2.4. WATER-HAMMER CALCULATION AND PROTECTION OF CONDENSATE PUMP SYSTEM

In the nuclear power station, water pound marvel broadly exists in the optional circle particularly on the condensate pump. The condensate pump's capacity is to remove the condensate water from the condenser. The water goes through seal cooler, low weight radiator and channel to oxygen remover. The fundamental feed pump supply with the water in oxygen remover for the reuse. Little measure of buildup water is sent to the zone required for condensate to be cooled. In an atomic power station or a warm power station, condensate pump framework does not enable the water to reflow.



**Figure 1. A single pump runs and stops suddenly**



**Figure 2. A single pump stops and the other one starts**

*Graph 2.3: single pump run and other stops immediately (a) single pump stops and other starts*

*(Source Protection of Condensate Pump System Journal)*

The condensate pump is furnished with a check valve, which may cause to more noteworthy water pound when task states of condensate pump move. Since a specific atomic power station put into activity, its condensate pump vibration caution has happened ordinarily, moment blackout sound having related with water pound within proper limits valve. In the meantime, the pipelines have in some degree influenced. The vibration of pump is little in typical task condition, however the intemperate vibration will trig vibration alert when the pump stops and its working condition shifts. After the move of activity condition reaches an end, the vibration will re-establish to its unique. The principle reason is that when the pump stops, the fast conclusion under tight restraints valve causes weight beat. It will deliver an expansive vibration and even harm to pipeline. More consideration ought to be paid to this circumstance.

#### **2.4.1 Pump Boundary Conditions during Sudden Stop**

Amid fluid progress caused by sudden stop of pump, the limit condition relies upon the total trademark bends of pump, pump head harmony condition and the unit idleness condition. During pump stopping, rotating speed of pump rotor reduces and the reducing rating depends on moment of inertia and transient torque of pump. The equation of present pump torque and speed variations is unit inertia equation. It is another characteristic equation of pump boundary conditions. (Jin Jiang; Xiaohong Weng; Xinhua Zhang; Xuefei Jiang, 2010)

The check valves of condensate pump cause higher water pound weight and exceptional vibration and even the channels to shake. The vibration may not cause the harm to pumps and valve, yet it would stir the vibration caution. Also, the maximum water-pound weight does not surpass the structure weight, given condensate pump is safe as indicated by the plan. Be that as it may, after a long activity what's more, pipe maturing, the pipe execution would debase. Subsequently, the assurance measure ought to be taken to lessen water-pound weight and vibration. The aggregators turn out to be powerful on decrease of the mischief.

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## **2.5. WATER HAMMER AND OTHER PIPE TRANSIENT FLOW PROBLEMS**

Hammering and unsteady flow in funnelling frameworks is a typical event and regularly results in minor or real harm. Ordinary channelling structure procedures will regularly neglect to foresee circumstance which will prompt the issue, and its appropriate analysis and fix in a working plant can at times be troublesome. In spite of the fact that in like manner utilization any type of 'slamming' or 'bouncing' in pipework amid transient conditions is alluded to as 'water pound' this term ought to entirely just be connected to issues identified with the excessively quick shutting of a valve downstream of a streaming segment of fluid, or pump beginning or halting upstream.

In the event that fluid is vented to a line or vessel in which sooner or later the framework weight is lower than the vapor weight of the fluid, blazing is probably going to happen. In a few frameworks the arrangement and consequent crumple of vapor air pockets can bring about slamming in the low weight some portion of the framework (usually saw in tanks warmed with direct steam yet without satisfactory blending, likewise downstream of confining valves taking care of hot fluid). (ROSS PATTERSON ;GEOFF COVEY, 2014)

Gravitational impacts can be a genuine issue. An exemplary issue is rattling channels in a pumped high temp water radiator framework. In the upper floors it is very simple to produce cavitating stream conditions.

### **2.5.1 Rapidly filling pipe**

This happens when a valve opens (or a pump begins) into an at first void pipe – especially if there is a tightening at the release of the pipe, yet not a completely shut release end.

At first the fluid enters the pipe at rapid thus a considerable force is built up. At that point when the fluid methodologies the tightening there is a sudden deceleration, like that in established water pound as it is impeded by an end valve. This offers ascend to stun waves and fast weight variances in the pipe.

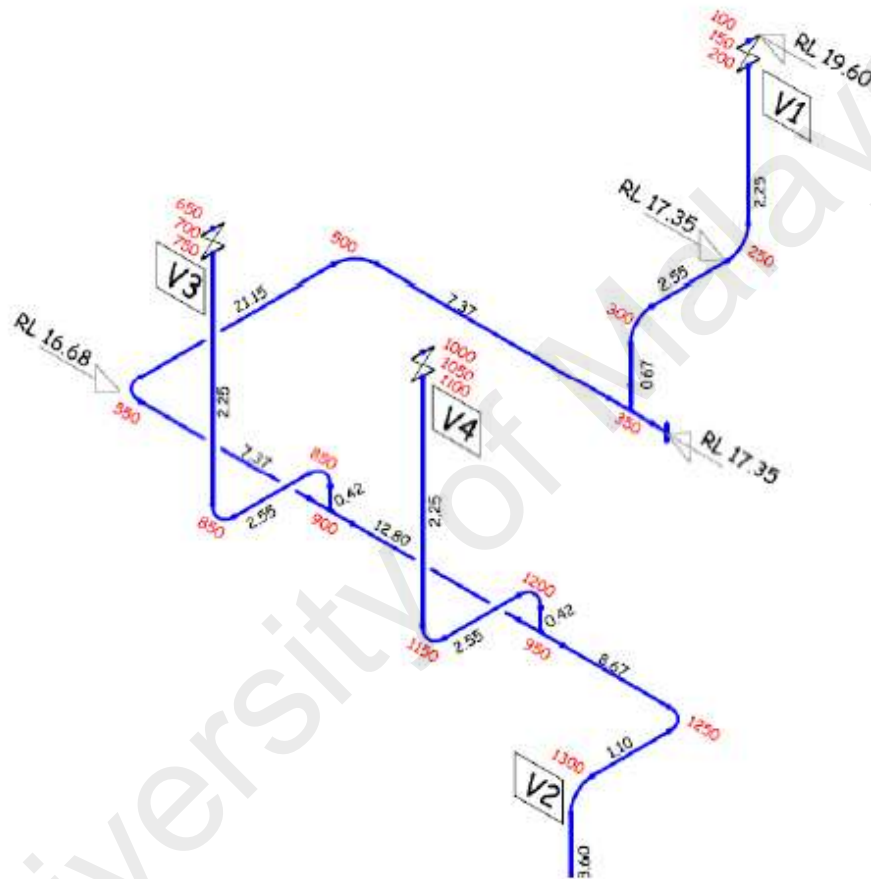


Figure 2.4: Logic diagram of investigation

(Source: Water hammer and other pipe transient flow problems journal)

On the off chance that the release end of the pipe is fixed (or almost so) air caught in the pipe will pad the deceleration and the stun will be constricted. On the other hand, if there is just a minor tightening at the release end, the stream won't be altogether impeded and again there won't be expansive stuns.

## **2.6. EFFECT OF AIR POCKETS ON PIPELINE SURGE PRESSURE**

Air pockets can develop in a pipeline by air pocket Presentation entrainment through the activity of pump suction what's more, via air release from arrangement as the water weight decreases. The previous can emerge from poor suction (wet) well plan and through activity cycling which licenses extreme drawdown before pump exchanging or shut depends on the weight decrease and other down. The measure of air discharge from arrangement factors, yet water at standard conditions may contain about 2% broke up air by volume.

Clearly the pipe profile as pockets and there is additionally dependably a probability of air gathering at a change of angle in the pipeline. It is normal practice in water supply frameworks to give programmed venting to avoid unnecessary sewerage, be that as it may, the support issue and significant stream narrowing. In has prompted visit oversight of air valves in support of the arrangement of 'sluicing' office as it were. (R. Burrows,D. Q. Qiu,, 1996)

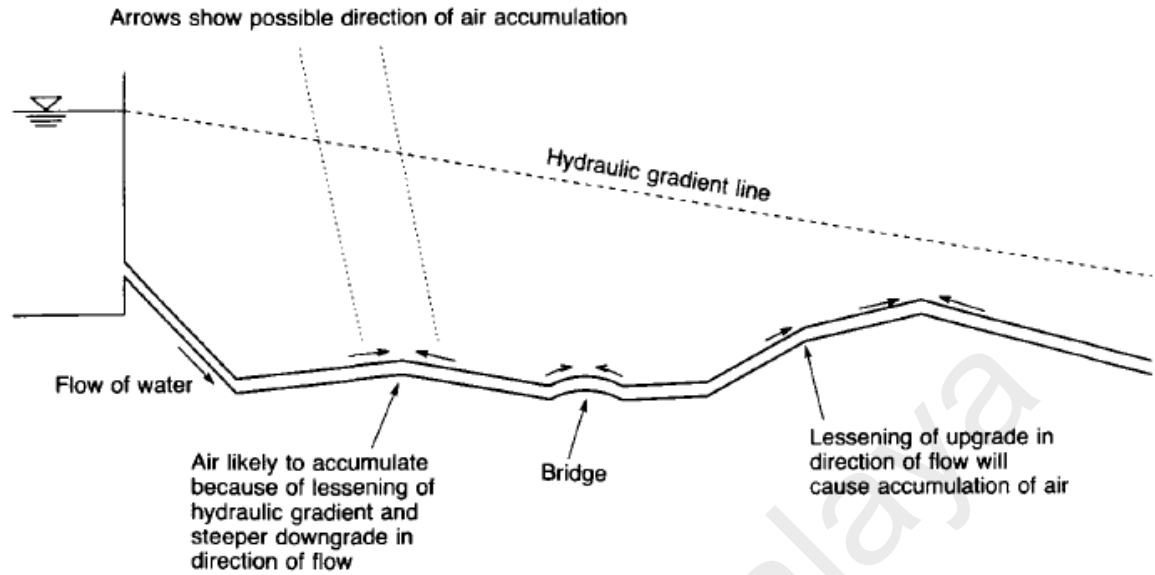


Figure 2.5: Position of air accumulations

(Source: *Effect of air pockets on pipeline surge pressure journal*)

Air aggregations in the pipeline are both unintended and baseless and, as a outcome, their potential effect on weight drifters isn't given thought, either at structure stagier in post-disappointment request. Circumstances where serious drifters ay emerge incorporate framework breakdown, transitory activity amid upkeep and repairer even amid typical pump trip-out has demonstrated that perception of weight motions inside a pipeline can be utilized to distinguish the likely area of gas pockets.

## **2.7. ANALYSIS OF WATER HAMMER WITH DIFFERENT CLOSING VALVE LAWS ON TRANSIENT FLOW OF HYDROGEN-NATURAL GAS MIXTURE**

Most examination of stream in pipelines and systems has expected the stream to be at consistent state conditions. This implies that the flow does not change with time at any area in the pipeline framework. With the presumption of uniform stream, the investigation winds up less complex and arrangements are anything but difficult to acquire. Concentrate on transient condition is vital in light of the fact that pipeline streams are every now and again in insecure state because of the sudden opening and shutting of valves.

Every single transient stream are changes, regardless of whether in long or brief length. Transient stream can be characterized as the stream change when the speed and weight of a liquid or on the other hand gas stream change after some time because of changes in the framework. Relating explicitly to weight, they are at times called dynamic weight changes or weight homeless people. It isn't achievable to anticipate weight transient when working a funnelling framework, yet this circumstance can be controlled.

The primary driver of transient stream conditions are shutting or opening of valves in the funnelling framework, turning off the control supply, or a power disappointment or potentially gear disappointment. The sudden conclusion of a control valve, halting of a pump, also, variety of release because of pipeline burst lead to overabundance weight in a pipeline. (Norazlina Subani ;Norsarahaida Amin, 2015)



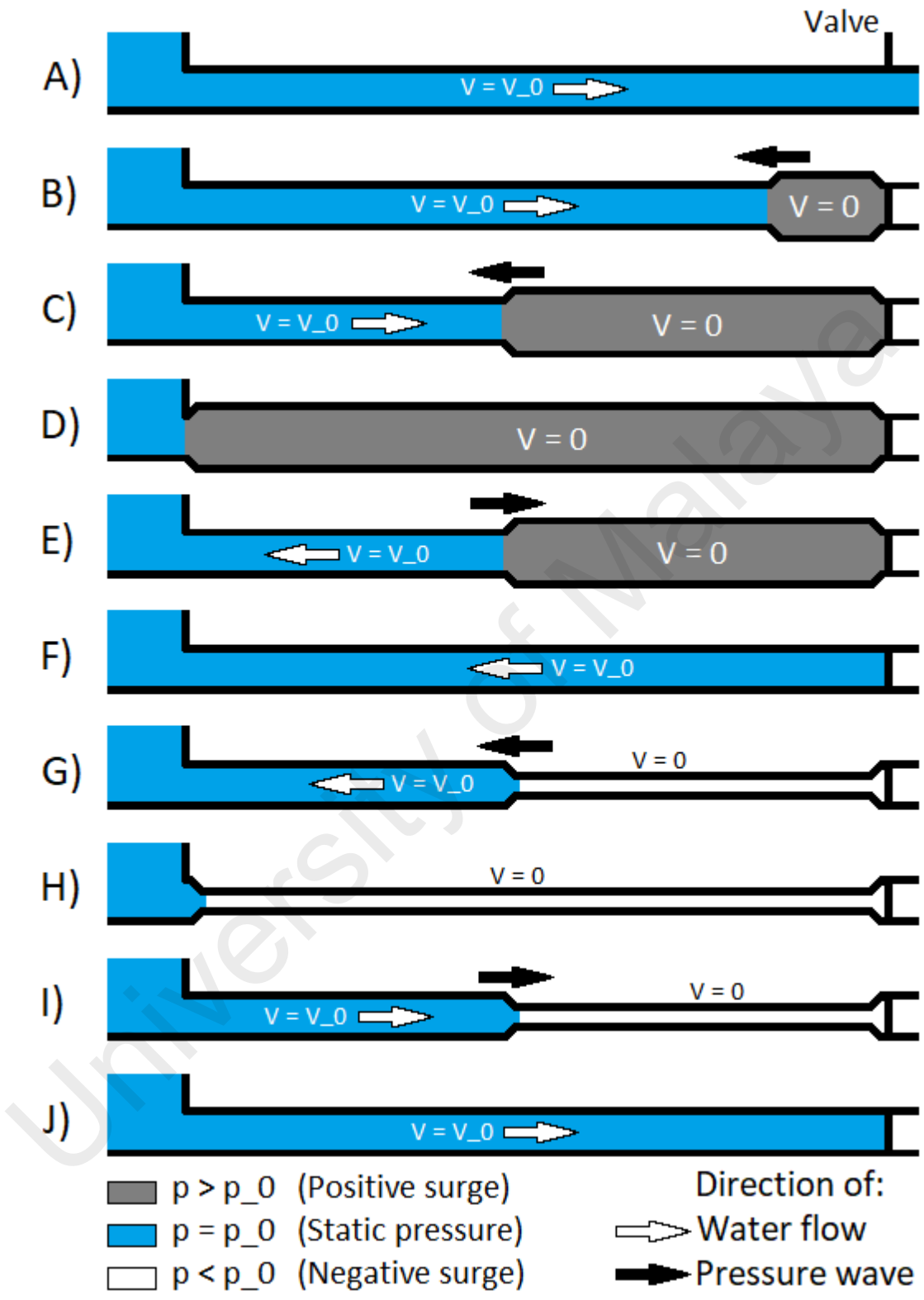


Figure 2.6: Water hammer illustration with instantaneous valve closure.

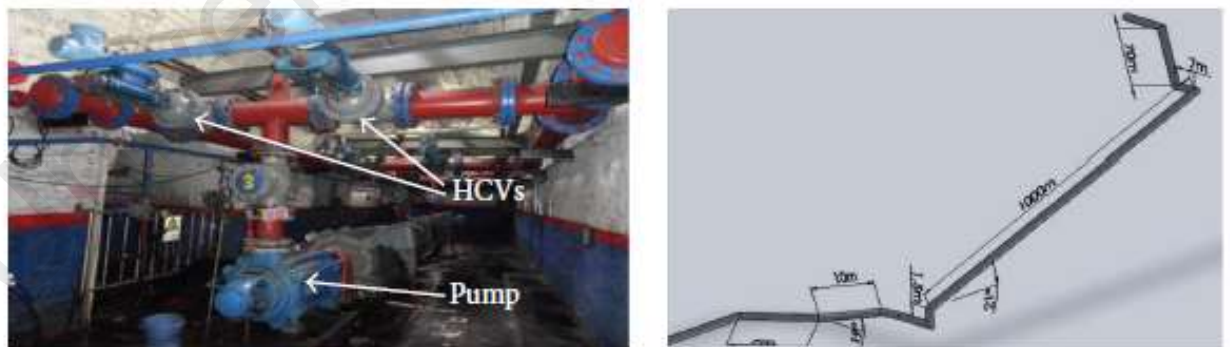
(Source: Modelling of a Two Phase Water Hammer)

There are four methods which can be utilized to modify the activity of the valve (conclusion law), most ordinarily alluded to as curved, inward, straight, furthermore, prompt shutting law. These kinds of shutting valve laws speak to a scientific capacity that depicts the speed variety of the flow as it is closing. These kinds of valve conclusion rely upon the rate at which valves can be closed. The valve conclusion rate assumes an imperative job in controlling the water pound marvel.

Valve conclusion times are additionally a wellspring of hazard when we investigate the water pound marvel. In this way, a few endeavors have been exhausted to advance the time conclusion of control valves, considering a few sorts of limitations. It is exhibited a general history and presentation of the water hammer wonder. Inspected by the utilization of air chambers and security valves for controlling water hammer, back in the mid 19th century, a few analysts endeavored to create articulations identifying with weight and speed changes in a pipe.

## 2.8. A WATER HAMMER PROTECTION METHOD FOR MINE DRAINAGE SYSTEM BASED ON VELOCITY ADJUSTMENT OF HYDRAULIC CONTROL VALVE

Mine waste framework is an imperative part in the security creation of coal mine. Because of the constrained space and the mind-boggling expense of hardware changing, water pound is a normal marvel in mine waste framework and its damage is limitless. The minor wounds of water mallet can cause serious stun or even pipes breaking, and the major wounds can cause gear harming, pumping station flooding, or even wounds to underground staff. There are a few conventional water pound insurance techniques such as introducing vacuum valves, debilitate valve, and weight tank. (Yanfei Kou; Jieming Yang,; Ziming Kou, 2015) Be that as it may, when these water pound insurance techniques are used to mine waste framework, the first channelling plan must be changed on the grounds that extra hardware is required. It is unenforceable to do this in this constrained mine space and the expense is too high. In this circumstance, controlling the time and speed of valve-shutting is a compelling means o secure water pound in mine waste framework.



*Figure 2.7: Diagram of drain pipes.*

*(Source: Water Hammer Protection Method for Mine Drainage journal)*

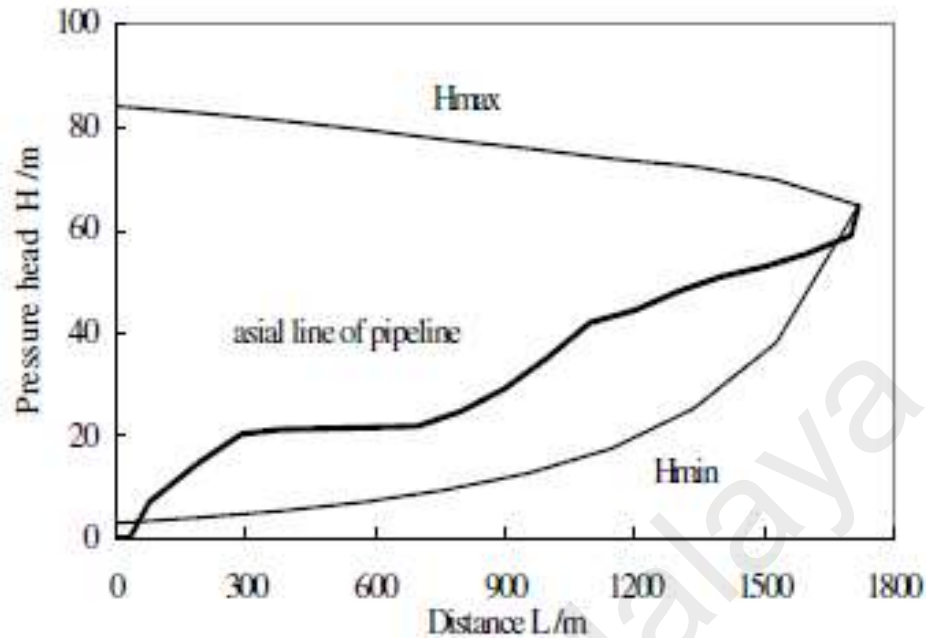
A water pound is effortlessly to be shaped in pipeline if the valve-shutting is fast. On the opposite, the ability of pumps is wasteful if the valve-shutting is too moderate since pumps in mine waste framework are centrifugal. This wasteful activity has harm for pumps, since power given by pumps is changed over into warmth. Consequently, it is critical for us to look into the basic valve-shutting speed for Hydraulic Control Valve (HCV). Examines of hypothetical framework and building applications for water pound assurance of pipeline liquid conveyance regions are progressively enhanced. Be that as it may, it is still a troublesome issue in mine seepage framework as a result of the constrained mine space.

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## **2.9. STUDY ON WATER HAMMER PREVENTION IN PUMPING WATER SUPPLY SYSTEMS BY MULTI-VALVES**

Air valves are generally utilized in water supply frameworks for their basic structure, minimal effort and simple establishment. Many water pound examines had demonstrated that so as to successfully ensuring water pound, air valve ought to have both huge air inflow zone and little surge zone, i.e. the air inflow speed is quick while outpouring moderate. Be that as it may, inquire about on the best way to execute that thought can barely be found. In light of a genuine pumping water supply framework, a water pound assurance strategy utilizing trademark technique for water pound figuring, and the idea of air valve set proposed.

The estimation results appear that region proportion between air valve delta and outlet has incredible impact on water pound insurance impact, and the proportion has an ideal esteem. Utilizing both air valve set and butterfly valve two-stage shutting methodology can viably forestall water pound in pumping water supply frameworks. In a pumping framework, opening/shutting of release valves and beginning/shutting of pumps can cause sudden change of water speed inside, and thus sharp change in water weight. While water speed and weight change, parameters of pump, similar to limit, head, transformation and torque and so on likewise momentarily change.



*Graph 2.7: Maximum and minimum pressure envelop curves of water hammer prevention by butterfly valves.*

*(Source: Water Hammer Prevention in Pumping Water Supply Systems journal)*

This momentary change is called water powered transient of pumping stations, or pumping station water pound. Water mallet of pumping stations has incredible effect on typical and safe task of pumping offices, and many pumping stations were genuinely harmed by water pound. Along these lines look into on water driven transient has been focal point of numerous considers. (Manlin Zhu, Xiaohong Zhang, Yanhe Zhang, Tao Wang, 2006)

## 2.10. TWO-PHASE WATER HAMMER

Air valves are generally utilized in water supply frameworks for their basic structure, minimal effort and simple establishment. Many water pound ponders had demonstrated that so as to adequately securing water pound, air valve ought to have both extensive air inflow territory and little outpouring zone, i.e. the air inflow speed is quick while outpouring moderate. In any case, investigate on the best way to execute that thought can scarcely be found. In view of a genuine pumping water supply framework, this paper introduced a water pound security strategy utilizing trademark strategy for water pound figuring, and the idea of air valve set proposed. (Beuthe, 2001).

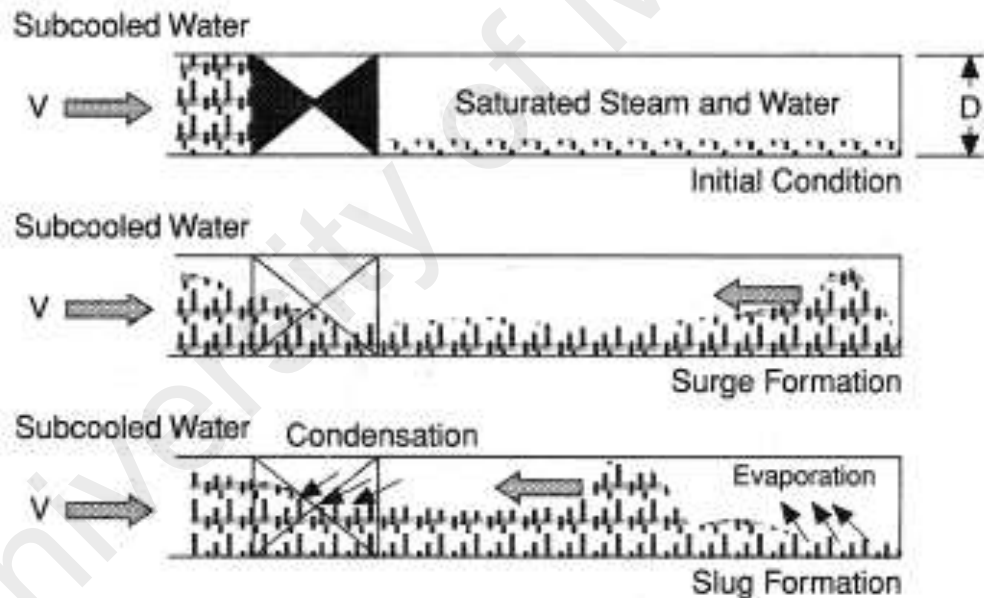


Figure 2.8: Sequence of events leading to a steam bubble collapse induced water hammer when a short, horizontal steam pipe is filled with cold water with Froude Number less than

1.

(Source: thermopedia.com)

The figuring results appear that territory proportion between air valve bay and outlet has extraordinary impact on water pound assurance impact, and the proportion has an ideal esteem. Utilizing both air valve set and butterfly valve two-stage shutting method can adequately avoid water pound in pumping water supply frameworks. In a pumping framework, opening/shutting of release valves and beginning/shutting of pumps can cause sudden change of water speed inside, and thus sharp change in water weight. While water speed and weight change, parameters of pump, similar to limit, head, unrest and torque and so on additionally immediately change. This prompt change is called water powered transient of pumping stations, or pumping station water pound. Water sledge of pumping stations has extraordinary effect on ordinary and safe task of pumping offices, and many pumping stations were truly harmed by water pound. Consequently examine on water powered transient has been focal point of numerous ponders.



## 2.11. CONCLUSION

The study of water hammer essence phenomena is very important for ménage employment and industriousness especially for industriousness which related to tube line such as gas and crude industry and tobacco pipe manufacturing industry. The model experimentation of water hammer burden is built in order to investigate the water hammer event. From the study, it can be conclude that there is some argument s influencing water hammer phenomena. The obvious parametric quantities are textile of pipe and the pressure in the pipe. The pipe material gives chronicle into friction component. The friction factor is most likely the parameter to determine the water hammer outcome. From the result of the experiment, get the water hammer effect in blade pipe. Another important parameter that will affect the water hammer effect is the pressure in the pipe. The pressure in pipeline is directly influence by the initial velocity. From the literature result, the high pressure pipeline occur more water hammer effect. This is due to the inverter pump is setting more initial velocity of fluid. Beside these two parametric quantities, there are parameters like inlet diameter and length of the pipe also influence the water hammer effect. The bar method of water hammer effect which install the bypass pipe with non-return valve had proven that the method is successfully to reduce the water hammer effect in the pipeline. From the research, the pressure in the pipe with prevention method is lower compare to the pipe that without prevention method. The mean pressure is reducing about 33.33% after installing the prevention method.

# CHAPTER 3

## METHODOLOGY

### 3.1. INTRODUCTION

To play out the proposed task, there need a strategy or venture to guarantee that there will be no oversight amid playing out the investigation. These are the progression and clarification on what is the progression required.

In water supply pumping plans including exchanging of water from suction tank to water stockpiling tank, usually expected that sudden power inability to the pump engines will create the most extreme and least transient in the pipeline. On the off chance that there are various pumps in the station, it is expected that the outrageous homeless people created will be caused by all pumps flopping all the while. In greater part of the cases, the weight caused by concurrent power inability to different pumps is the fundamental thought that oversees the structure of the pipeline.

In pumping plans, where check valves are introduced at the downstream of the pumps. At the point when control supply fizzles, the main vitality accessible to drive the pump the forward way is the dynamic vitality of the pivoting mass of the pump, engine and the entrained water in the pump. Since this vitality is typically little contrasted with the vitality required to keep up the stream against the release head, the pump speed backs off rapidly bringing about a fast decrease in the pump release. Because of the quick stream changes, a weight wave is spread while a negative down flood heads out down the pipeline to the release outlet where it is reflected. The reflected wave will thus make a positive flood along the pipeline.

### 3.2.PROJECT CONDUCT

Following chart shows the flows of conducting this project:

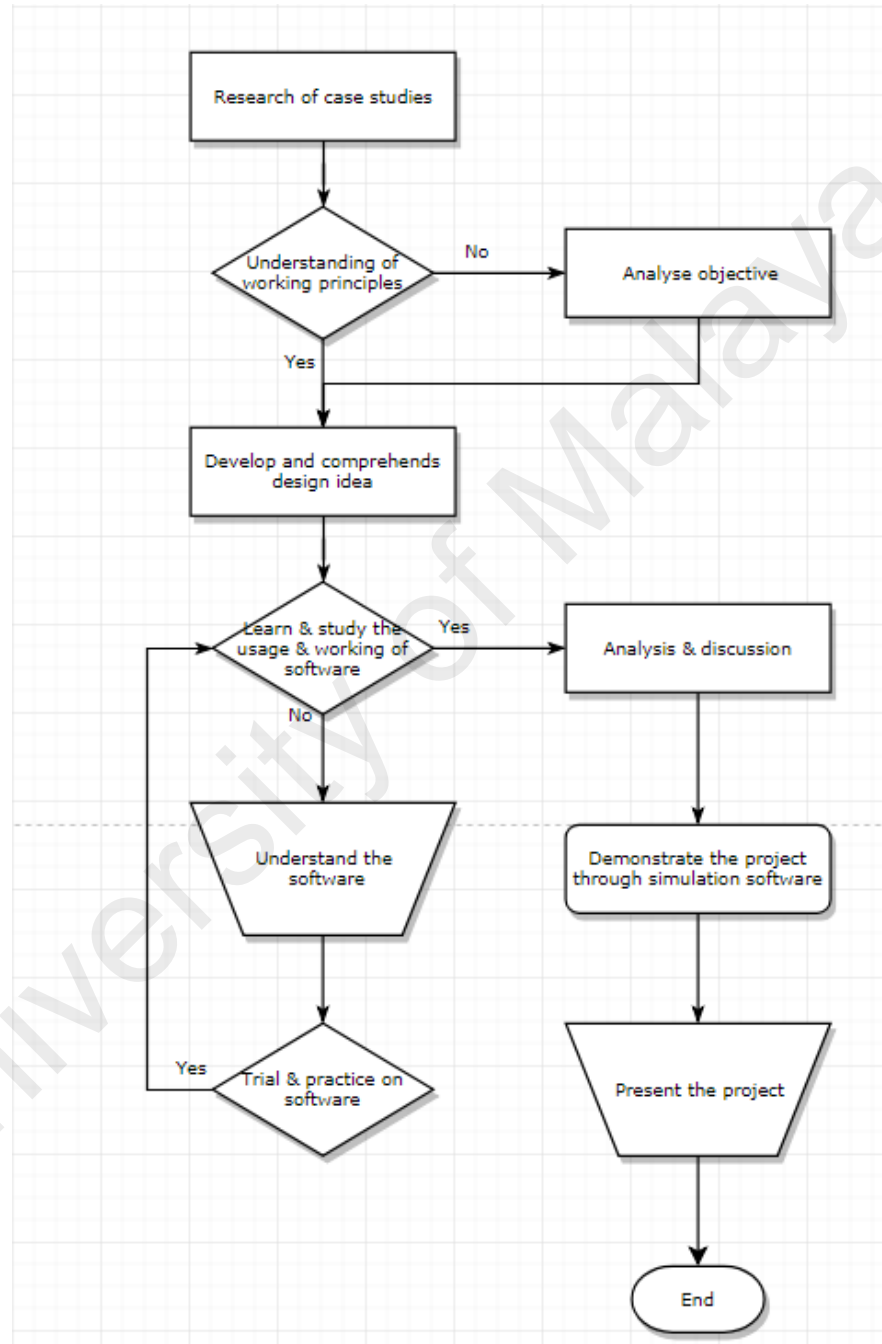


Chart 3.1: Flow Chart of Methodology Conduction of Project

Amid this transient cycle, the weight may fall underneath environmental weight and in the event that it further drops to the vapor weight of water anytime in the pipeline, cavitation will happen shaping a vacuum by then. Not at all like some part of framework conduct that are traditionalist when ignored, can't marvel to dismissed as it builds the seriousness of water pound. Section partition is the intermittence in the water segment caused by over the top strain when the weight is diminished to the vapor weight of water. Substantial width thin walled pipelines are especially helpless against shell fall under this condition.

It is the motivation behind this flood investigation to uncover if there is any unfavorable weight (Maximum or least) happens amid transient, if no antagonistic weights are experienced, no flood concealment gadget is required. Then again, if the antagonistic weights are not adequate, appropriate flood concealment gadget will be prescribed to confine the weights to satisfactory dimensions.

### **3.3.SURGE ANALYSIS**

In conduction of water hammer analysis for the pressure arising on pump stopping, this methodology is conducted by using the software of HYTRAN WATER HAMMER SOLUTION

### **3.4.ASSUMPTION**

#### **3.4.1 One—Dimensional flow is assumed, thus it follows that :-**

- A common pressure is assumed at pipeline section
- An average velocity is assumed for each pipe section

**3.4.2 The pipe is full and remains full during the transient**

**3.4.3 The pipe wall and fluid are assumed to behave linearly elastically**

**3.4.4 Unsteady viscous losses may be approximately by steady state losses**

**3.4.4.1 Pipes:-**

Modulus of elasticity of steel	200Mpa
Poisson Ratio	0.27
Conduit condition	thin wall elastic conduit
Friction Factor	C 110

*Table 3.2: Table of pipe data sheet*

**3.4.4.2 Fluid:-**

Media	Water
Bulk Modulus	2.19 Gpa
Density	1000 kg/m <sup>3</sup>
Operating Temperature	Ambient

*Table 3.3: Table of fluid data sheet*

### 3.5. SIMULATION OF HYTRAN

Analytical method was conducted with system analysis of water hammer using the software HYTRAN; provide the data specification are used as assumption made in table 3.1 and table 3.2. Pipeline analyzed for 2 transient cases such that when the pump is on operated whereas the other act as standby. This was conducted to ascertain that pressure of transient induced in pipelines during power failure at level of acceptance.

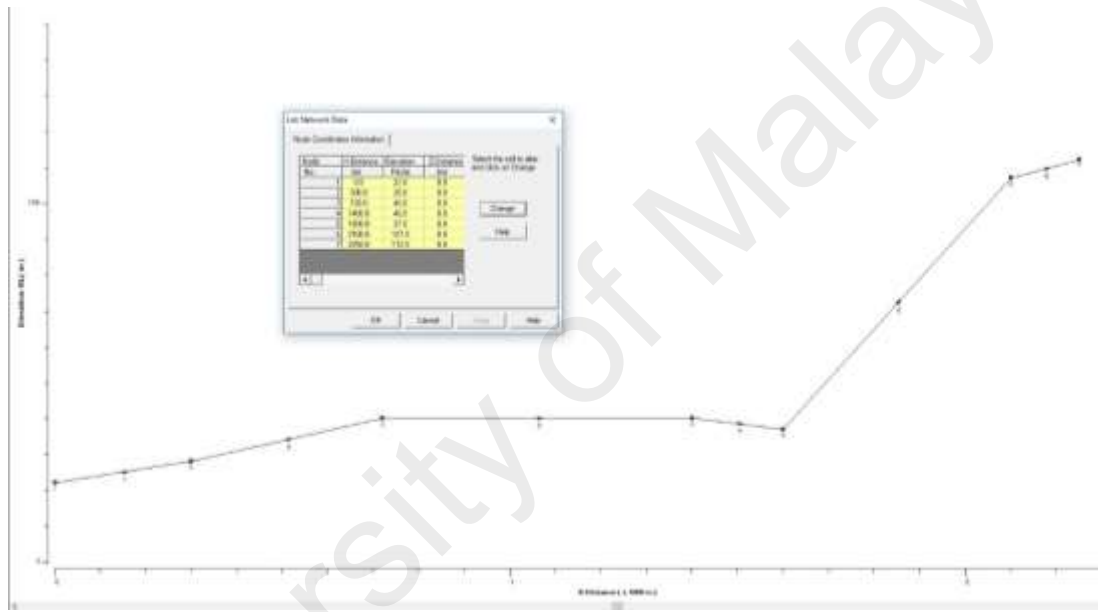


Figure 3.1: Drawing of pipes

The pipe is draw with 6 pipeline point haphazardly as it not should have been precise on location base reason the length and rise can be change after the outline is finished. The hubs that been feature is the most basic way, as it the real number of length and rise that are essentially increment from the DATUM. In spite of the fact that the length of the pipeline is about 2250m, there are just required 7 nodes to run the recreation and enter the most significant way.

The first elevation is at the starting point node 1 where the pump house is and the highest point elevation is at the node 7 where the reservoir are place. Most of water distribution reservoirs are place in high places so that it can distribute to consumer by gravity. It doesn't required pump to distribute to the housing area near the location radius.

After the sketch is completed, then it is time to select the pipe node position. The length and elevation are choose at most critical path were it needed to most drastically increase. It can indicate that in the beginning node 1, the start point at the pump house elevation RL (m) is 22.0 as from DATUM level was taken. At the node7, where the reservoir are is at distance 2,250m from the pump house and increasing of elevation profile at 112.0m from DATUM level.

The screenshot shows a software dialog box titled "List Network Data". It contains a table with the following data:

Node No	X-Distance (m)	Elevation RL(m)	Z-Distance (m)
1	0.0	22.0	0.0
2	300.0	28.0	0.0
3	720.0	40.0	0.0
4	1400.0	40.0	0.0
5	1600.0	37.0	0.0
6	2100.0	107.0	0.0
7	2250.0	112.0	0.0

Below the table, there are buttons for "Change" and "Help". At the bottom of the dialog box, there are buttons for "OK", "Cancel", "Apply", and "Help".

Figure 3.2: Nodes, distance and elevation

The pump structure of even multi organize information are taken from the provider. These pumps figure are just expected to put one (1) pump cause the pump house theory is one (1) pump running and (1) pump reserve. The most extreme pumping running hours is at 10 hours out of each day and it will pivot to the pump on the backup mode to work one more hour. The pumping will stop amid the supply at full limit and the two pumps one (1) and two (2) will on backup mode.

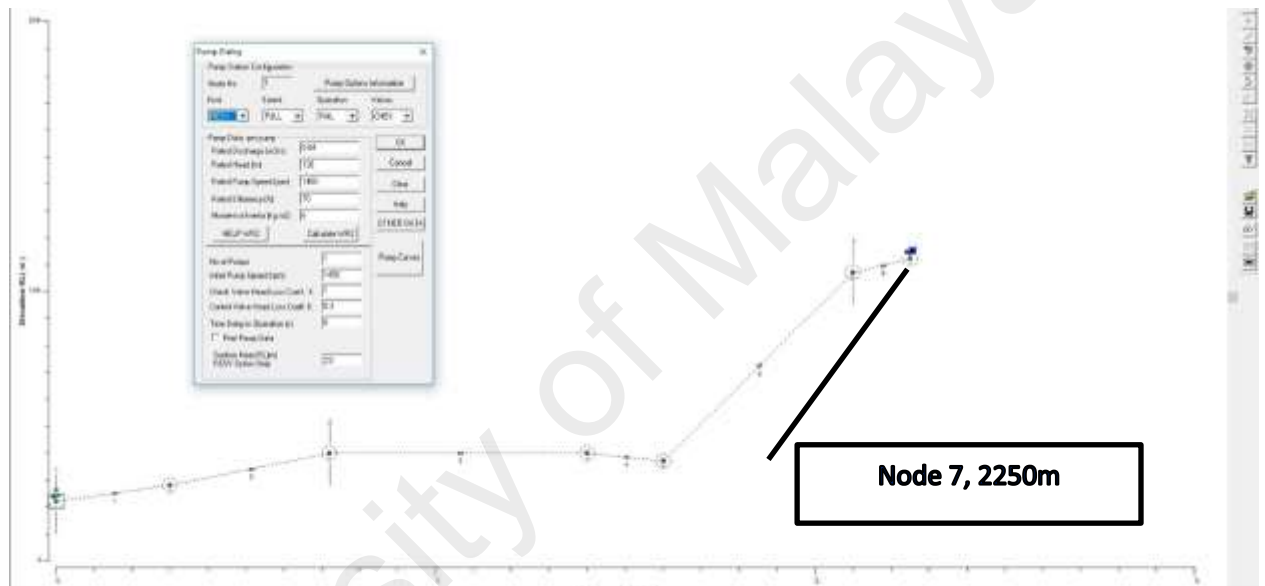


Figure 3.3: Insert of data

The pump information discourse is put in the reenactment. The snapshot of latency (kg.m<sup>2</sup>) is based pump bends, Hytran programming utilizes a moderate condition tending to bring down esteem. This reproduction is determined to "task" method of bomb in case there are control disturbance on the pump house. The suction head RL (m) RESV choice just is the water level from which the water is pumped for the repository.



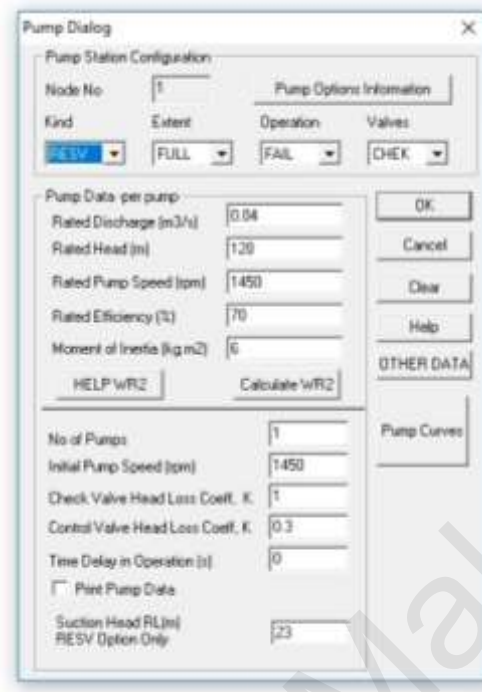


Figure 3.4: Pump Dialog

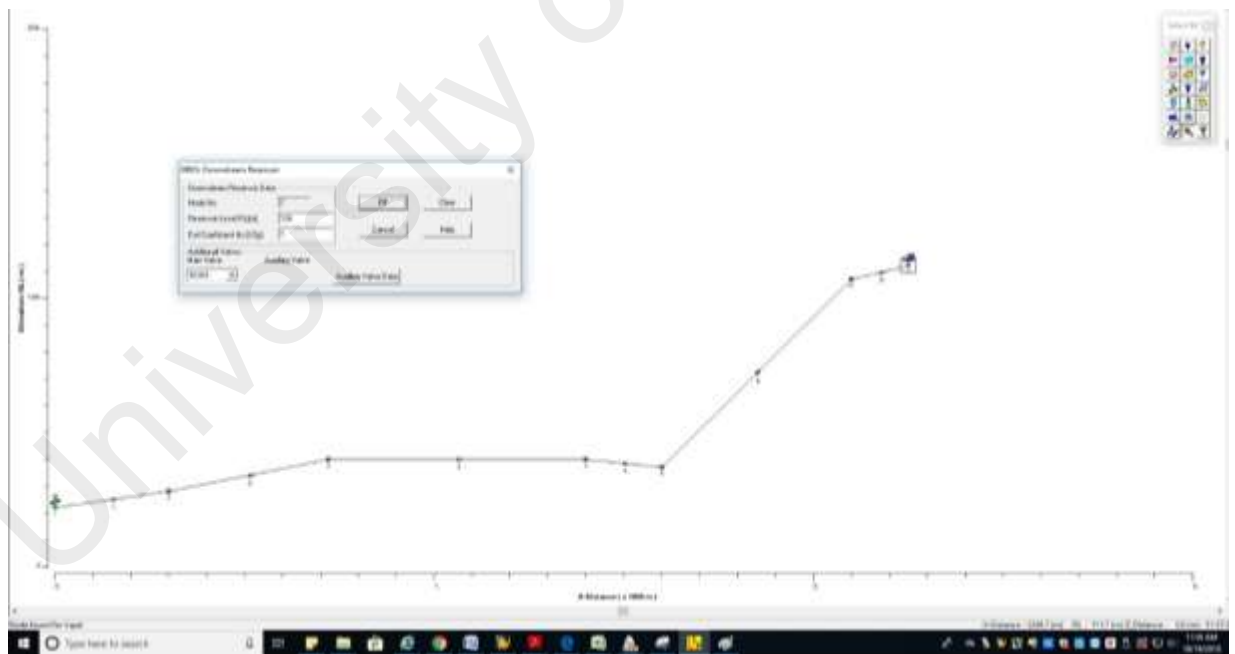


Figure 3.5: Downstream Reservoir

The reservoir data is placed at the node 7 where the end of node. As the elevation level is at peak with 125m from DATUM. The exit coefficient ( $kv^2/2g$ ) is equal to one (1) is based on the Hytran software minimum of pressure outlet.

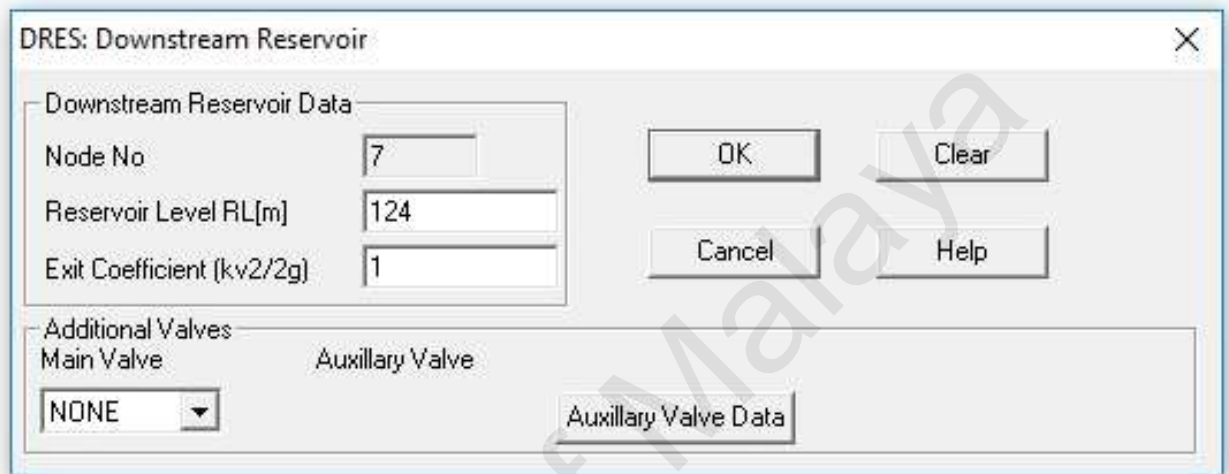


Figure 3.6: Data for Downstream Reservoir

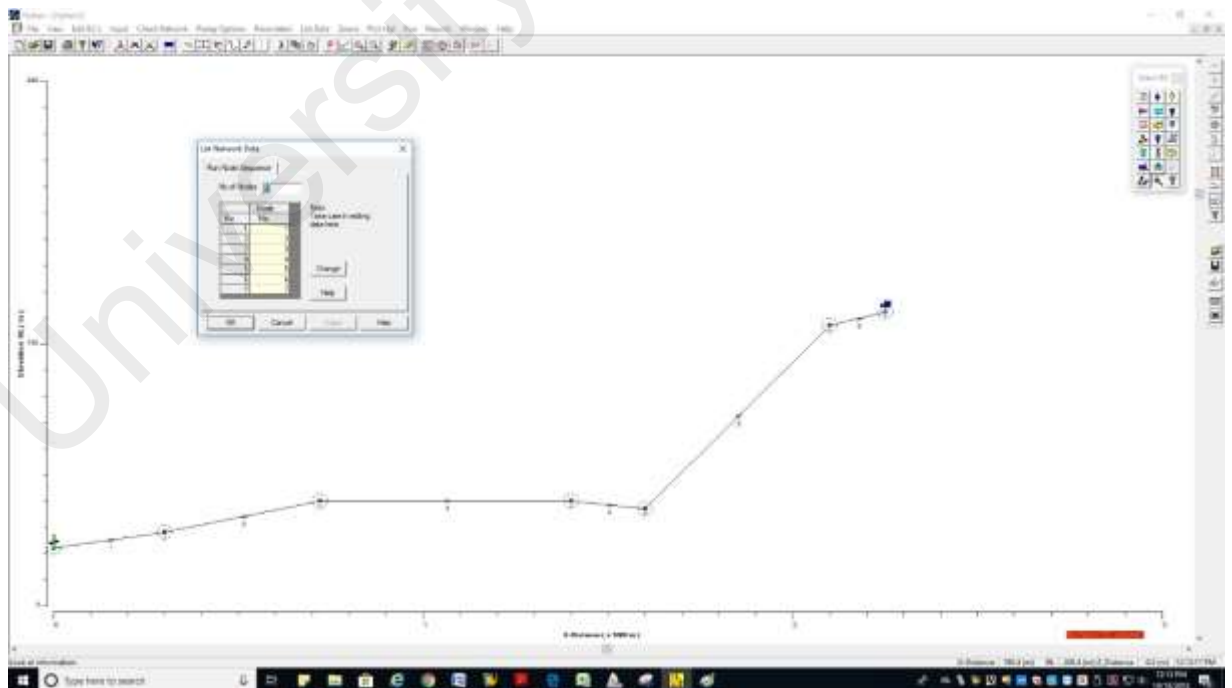


Figure 3.7: List of network data

From figure above, we select the number of node to comprehend by the software thus select the option of let the computer select for automation data selection by the programmed.

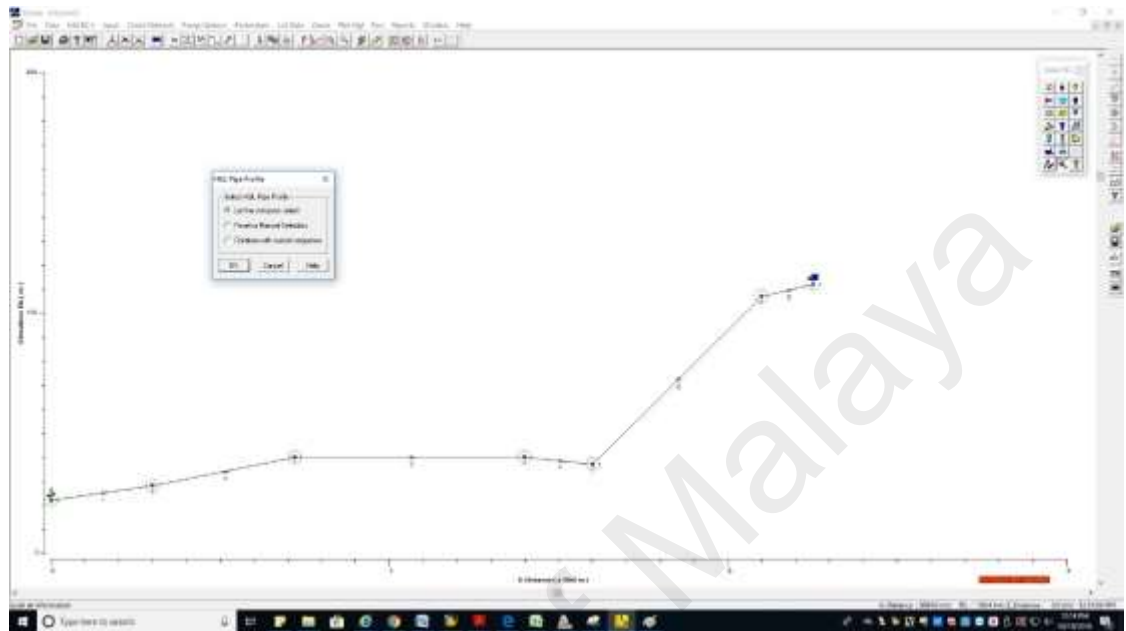


Figure 3.8: Pipe profile

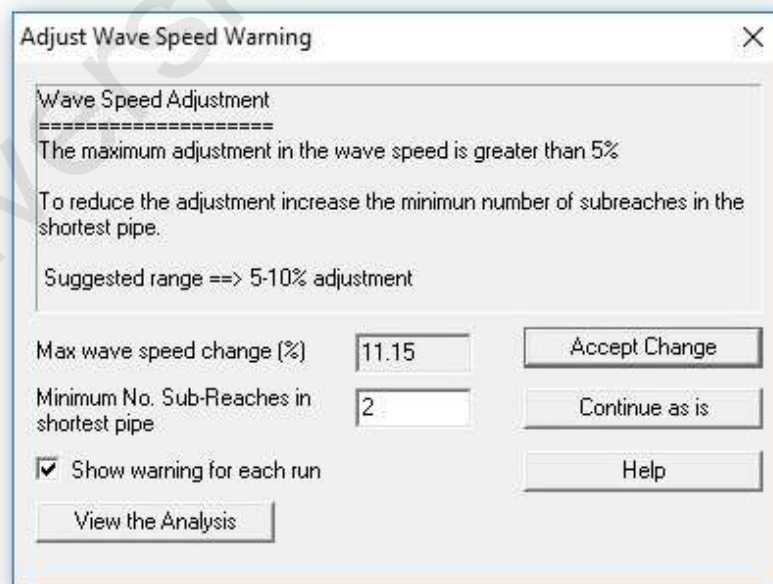


Figure 3.9: Adjust wave speed

We are to adjust the wave speed warning accordingly to achieve the desired and expected outcome that we set to design. We let the max of wave speed change to be 11.15% as shown in figure 3.9 and set the minimum number of sub-reached in shortest pipe to be 2.

Air valve is regularly used to discharge air in the pipeline to climatic strain to limit weight in the pipe. The air valve are as of now put with two (2) units along the pipeline when on location visit. These air valve is optional in ensure framework activity including start-up, shutdown and basic condition, for example, control disappointments or line breaks.

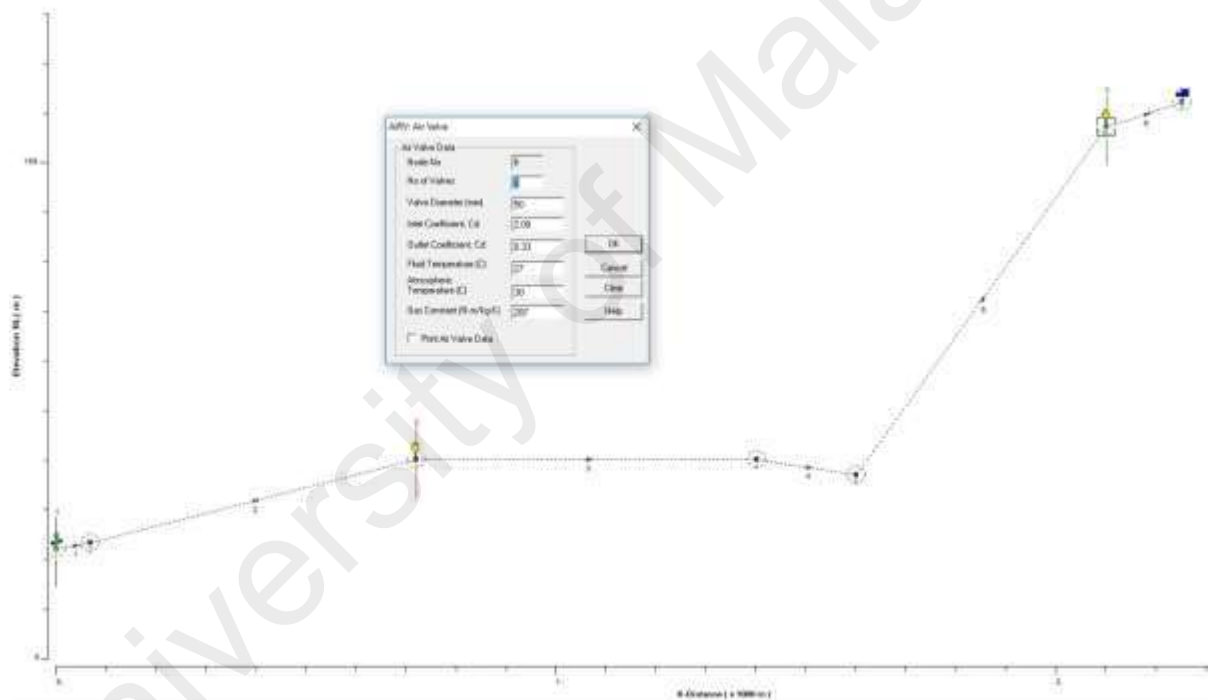


Figure 3.10: air valve

Below Air valve exchange is embedded as the information is get from the provider. The size that been introduced nearby is 50mm distance across and the brand is AVK air discharge valves that can be fitted to any crest on a pipeline where the weight is more prominent than 0.1 bar and up to the most extreme working weight. The high inflow rate is to keep harming vacuum weight from creating. At the point when water in pipeline is

depleted, air goes into pipe rapidly in such a way that it won't make vacuum. It is suggested that twofold air valve will be utilized for most extreme proficiency.

The image shows a software dialog box titled "AIRV: Air Valve". It contains several input fields and buttons. The fields are: Node No (6), No of Valves (1), Valve Diameter (mm) (50), Inlet Coefficient, Cd (2.08), Outlet Coefficient, Cd (0.33), Fluid Temperature (C) (27), Atmospheric Temperature (C) (30), and Gas Constant (N.m/kg.K) (287). There is also a checkbox for "Print Air Valve Data" which is currently unchecked. On the right side, there are four buttons: "OK", "Cancel", "Clear", and "Help".

Parameter	Value
Node No	6
No of Valves	1
Valve Diameter (mm)	50
Inlet Coefficient, Cd	2.08
Outlet Coefficient, Cd	0.33
Fluid Temperature (C)	27
Atmospheric Temperature (C)	30
Gas Constant (N.m/kg.K)	287

Figure 3.11: data of air valve

The format pipe that been drawn from the design of the pump house to the supply is the separations about 2,250m. The pipe type is gentle steel (MS) that fabricated utilizing low carbon (under 0.25%) steel. This sort of pipe is effectively welded and framed in different shapes and sizes. In clean water dispersion industry, these kind of new pipe is utilized as opposed to cast press. The MS pipe is covered with powder to build its quality and obstruction when underground.

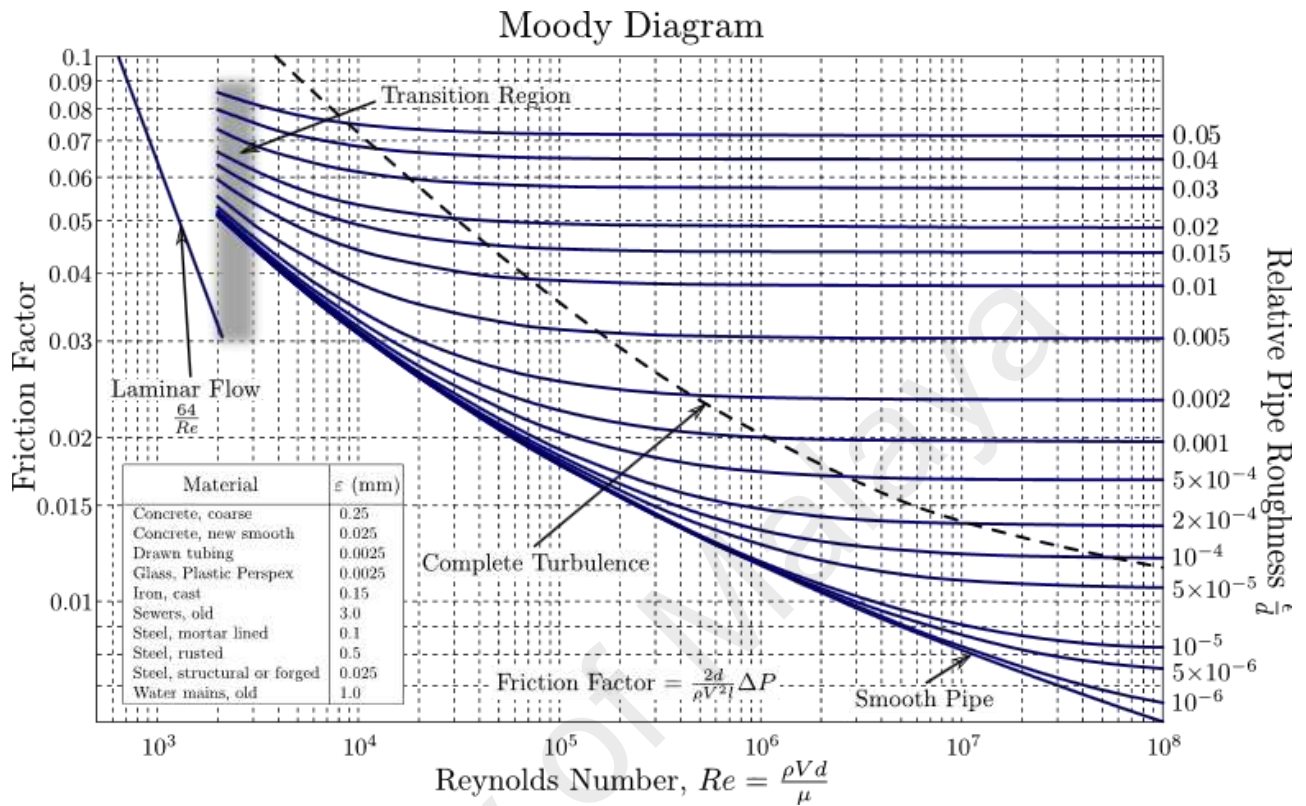


Figure 3.12: moody diagram

The vast majority of the MS pipe subtleties are ordinarily utilized by numerous makes. The information that been set is from the make of all the fabrication of pipes. The pipe database holds the pipe versatility and divider unpleasantness. The grating factor that been utilized in this reenactment is Hazen as it Hazen – Williams condition that evidence exact relationship that related the stream of water in a pipe with physical properties of the pipe and the weight drop cause by grinding.

The esteem that put is "100" as it institutionalizes in the Hytran Software reenactment that determined utilizing the Moody outline. The grumpy outline portrays the erosion misfortune in the funneling framework. It is demonstrated the harshness pipe arrangement materials. The wave speed section are set to default as Hytran will determined dependent on the pipe versatility, divider thickness and port. This all info pipe database are actualizing on all hubs funnels.

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# CHAPTER 4

## OBSERVATION & RESULT (DATA & ANALYSIS)

### 4.1.INTRODUCTION

In this project, the data analysis is based on pump use for data in Hytran software. Calculation are done in sequence of default data schedule that can be achieved thus it is used in calculated for research based of this project only.

Overall of the data collection have been completed, then to run the simulation using Hytran software to see the water surge during normal pumping flow to sudden stop. This section reports the water hammer transients caused by the following scenarios or pumping configuration.

Recreation has been done with flood valve with 75mm distance across delta pipe recommended to be introduced at the pumping station to decrease the flood affect amid water hammer happen along the pipeline, the establishment detail is as below



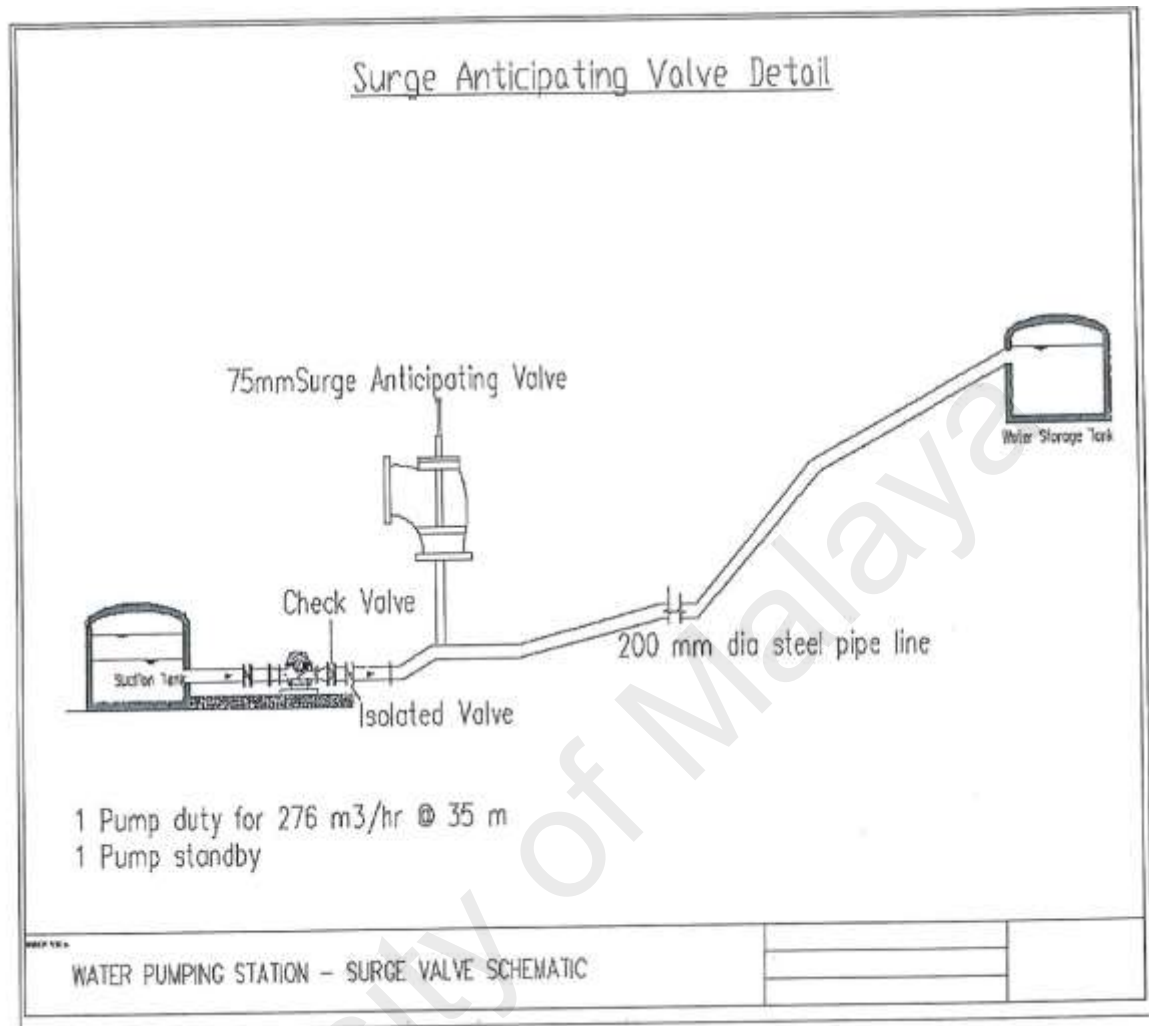
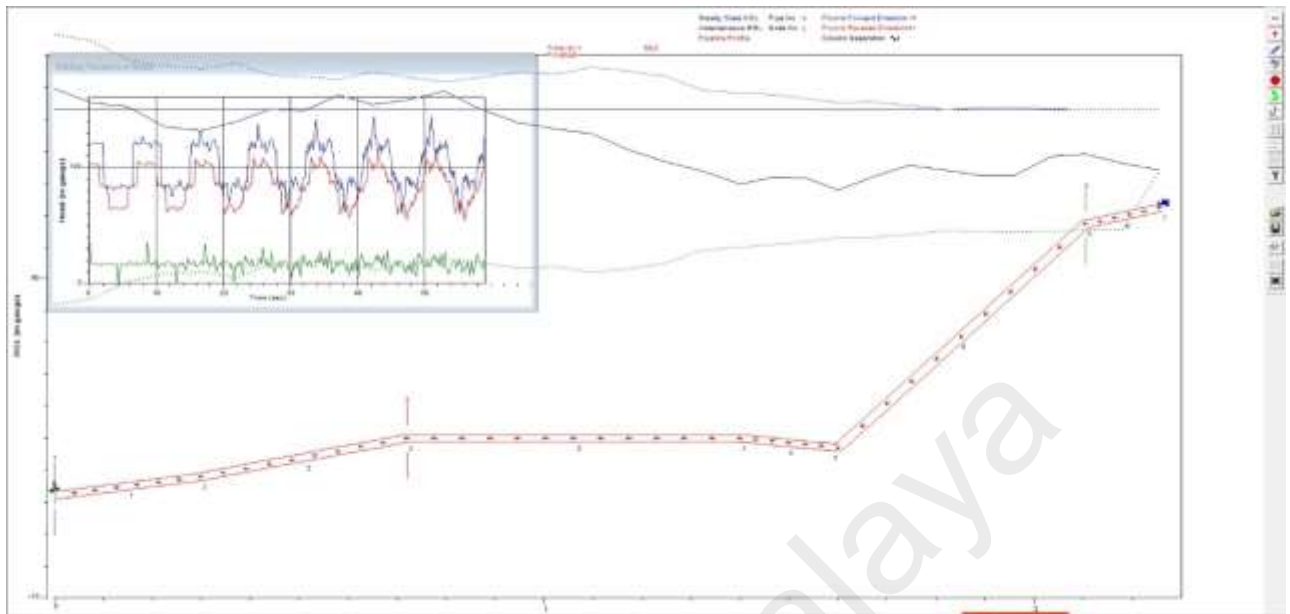


Figure 4.1: detail of pump station

#### 4.2. Steady state condition

After the recreation was kept running for 30s, it demonstrates the ebb and flow wave of the water stream. The red arrow shown down flood water which is invert heading that streaming back to the pump house amid the pump stop or power disturbance. The blue bolt as forward way from the pump house to the supply. The darker the shading the more prominent the relative speed.



*Figure 4.2: The result during steady state analysis*

The figure demonstrates that the full run time 30s recreation was played out, the blue line is the unfaltering state HGL (water driven Grade Line) for the pipeline profile. The run time that Hytran begin with the most minimal upstream hub number and works downstream hub is distinguished. It is demonstrated that the amid this transient, the water flood consistent increment at its pinnacle which is at head 170m and it coherence can cause pipe burst for a significant lot of time.

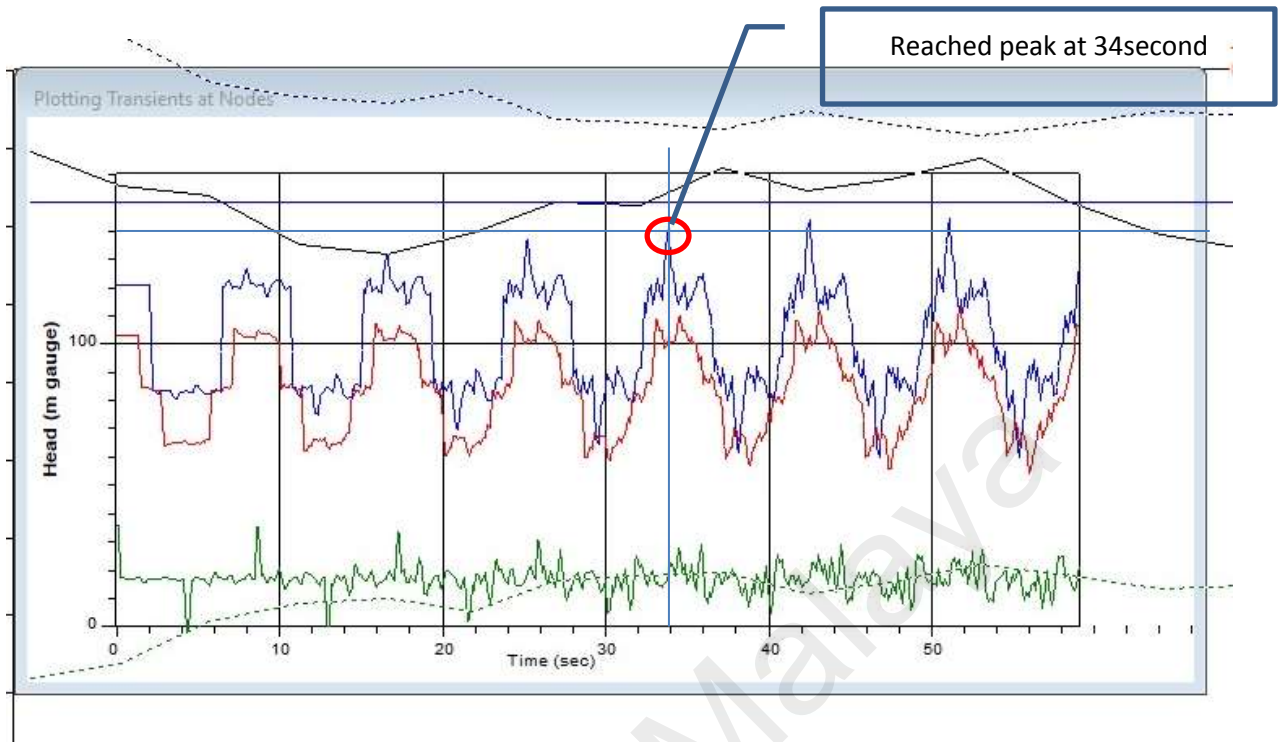


Figure 4.3: The Graph pattern on steady state

### 4.3. Transient state condition

**Pump Dialog**

Pump Station Configuration

Node No: 1 Pump Options Information

Kind: RESV Extent: FULL Operation: FAIL Valves: ANTI

---

Pump Data - per pump

Rated Discharge (m<sup>3</sup>/s): 0.04 OK

Rated Head (m): 120 Cancel

Rated Pump Speed (rpm): 1450 Clear

Rated Efficiency (%): 70 Help

Moment of Inertia (kg.m<sup>2</sup>): 6 OTHER DATA

HELP WR2 Calculate WR2 Pump Curves

---

No of Pumps: 1

Initial Pump Speed (rpm): 1450

Check Valve Head Loss Coeff. K: 1

Control Valve Head Loss Coeff. K: 0.3

Time Delay in Operation (s): 0

Print Pump Data

Suction Head RL(m) RESV Option Only: 23

**PUMP/ANTI: Pump with Surge Anticipator**

Pumping Station Configuration

Node No: 1 OK Clear

Kind: RESV Extent: FULL Operation: FAIL Valve: ANTI Cancel Help

---

Surge Anticipator Valve Data

Rated Discharge (m<sup>3</sup>/s): 0.02 Open Percent (% Rated Head): 90

Rated head (m): 120 ClosingTime (s): 3

Discharge Level RL(m): 23

---

Valve Operation Curve

No of Values: 4

Operation Curve (Full Open= 1, Closed= 0)

Start.....End

0	1	1	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

Start.....Times (s).....Finish

0	1	2	3	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

Figure 4.4: Surge anticipating data

Reproduction of water driven transient because of intensity disappointment were complete and the results incorporate plotting of least and greatest weight wrap along the pipeline and flood weight versus time plot at the pump end (Node 1), set apart as '1' in blue shading and at crests about 720m and 2100m far from the pump, checked as '2' and '3' in red shading in the plots. As appeared in the plot for case 1, the most extreme up flood at pump end (Node 1) is 175.28m head and least down flood is 0.00m. The plots likewise demonstrate that section division did not happen all through the pipeline.

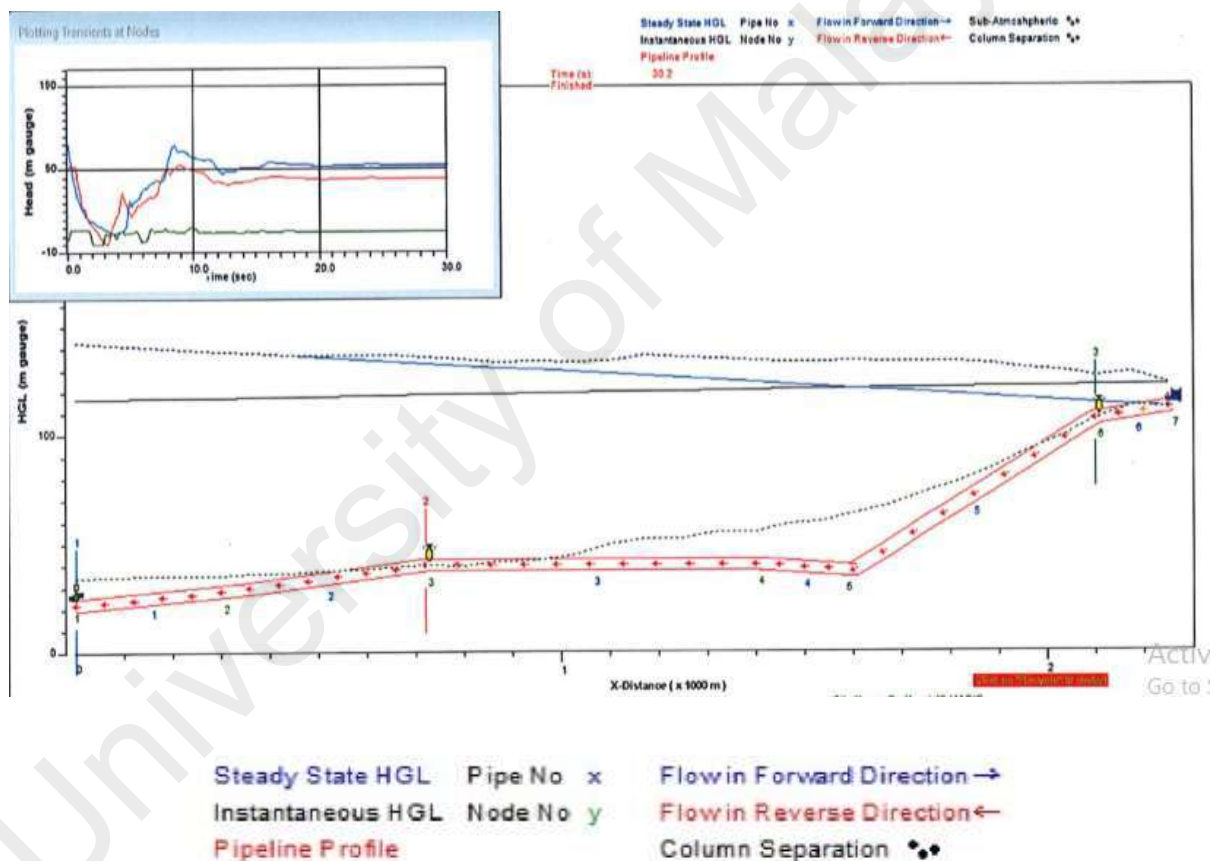


Figure 4.5: After Surge anticipating valve installed

The flood foreseeing valve will be introduced at the pump end to lessen and settle positive flood along the pipeline. After establishment of 80mm flood anticipator, the consistent state streams at typical pumping stream condition with flood anticipator valve when one (1) pump running. As appeared in figure over, the flood has been balance out and decreased to most extreme up flood of 120.81m head. Least down flood remains around the equivalent at - 0.14m. Size of the flood envisioning valve utilized will be DN 80 with suggested setting.

#### **4.4.Surge Anticipating Valve Calculation**

From the simulation, a rough calculation to determine which type of size that needed to the transient run. Here are the calculation bases on the data from the pump house;

Pump Flow Rate: 144 m<sup>3</sup>/h convert to l/s

Pump capacity: 40 l/s

Convert to US Gallon per Minutes (USGPM):  $40 \times 15.8503 = 634.012$

Sizing the valve is based on 50% of the maximum pumping capacity. The selected 50% maximum pumping capacity for better opening discharge, through the factory recommendation of 25% of pumping capacity 50% of the maximum pumping capacity;

$$\frac{50 \times 634.012}{100} = 317.006 \text{ USGPM}$$

Therefore, the recommended of surge anticipating are based on the graph curve that provided by the supplier on Flow vs Pressure Drop (Model 106 – Pilot vented downstream).

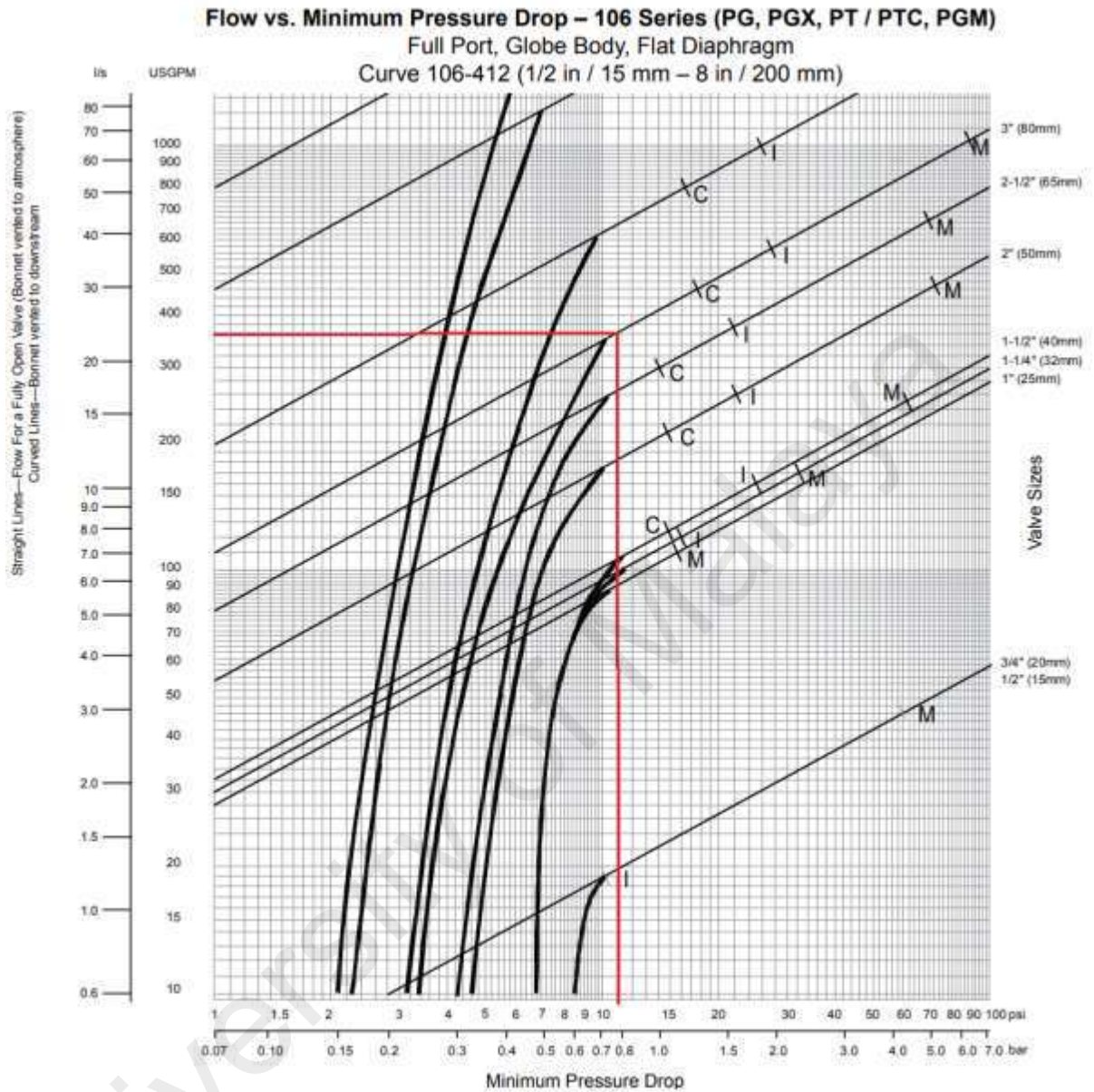


Figure 4.6: Flow vs Minimum Pressure Drop

From the above Flow vs Minimum pressure drop, it shown that a pressure drop is about 11.20 PSI is obtained when the horizontal line is across at 317.006 USGPM and intercept at 3" (80mm) diameter surge anticipating valve.

# CHAPTER 5

## CONCLUSION AND RECOMMENDATION

### 5.1. CONCLUSION

In light of the two cases, it is vital to perform investigation in counteract any water flood along the pipelines. Water flood is a genuine wonder that can cause staggering harm to the funnels and pump house. The purpose behind that few individuals mindful with it present and issue to see fast changes. Due to more critical is the impact weight amid transient on the hardware that introduce, prompting early discovery disappointment of joints as opposed to inability to the pumping framework. Harms to pipe bolster or vigorously break can bring out Non-Revenue Water (NRW) that can make misfortunes the organization water ventures and paid more cost to fix than counteractive action.

The proposed surge anticipating valve of 75mm inlet size is able to control the surge pressures occurred at the pumping system to prevent the pipeline damage. When the surge pressure occurs in the pipeline, the surge valve wills relief the water from the pipeline to reduce the surge impact. Form the plot, the maximum surge without the usage of surge tank is 62.32m. The presence of huge and fluctuating surge with high frequency will damage the pumping station. With the installation of surge anticipating valve, the huge and high frequency fluctuating surge can be eliminated. The surge is decreased to a tolerable 35.68m head which is within the tolerable safety factor of the pumping station. To conclude, surge anticipating valve is recommended to be installed at the pumping station.

## 5.2. RECOMMENDATION

In numerous creation plant or circulation plant for pumping framework, it required flood assurance relying upon the sort and limit of pump. In these cases, the pump and channeling size are middle and doesn't required substantial water flood assurance.

In a few businesses, there are utilizing greater pumps and the channeling size is more than 900mm distance across in this way it utilizes substantial flood assurance framework and more than one. In the event that the framework carryout more load, the flood framework is normally are flood vessel that kept running with air also, water proportion in their counterweight tank. Flood vessel fundamental intention is to keep up the right weight while water is transmitted to the mains systems. Uncontrolled floods can cause a few issues to water organizations, from spillages and water quality issues to foundation and system disappointments.

These are some recommendation can take to improve in the future;

To be done by water hammer, another check valve that performs programming control can be utilized. Other than expense, the valve structure is somewhat muddled and its use lessens framework unwavering quality. On the off chance that the control framework is out of request and makes pump invert runaway, the auxiliary harm will be finished. The air vessel is associated with the primary pipeline by a short pipeline. In this examination the lumped dormancy demonstrates, including erosion is utilized in the connector. Similarity condition is connected to the connector.



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