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Flow Induced Vibration for Different Support Pipe and Liquids: A review

Ansam Adil Mohammed[1], Ayad Mohammed Salman[2], Mustafa Saad Ayoub[3]

Authors affiliations:
1) Mechanical Eng. Dept., Engineering Collage, Al-Nahrian University, Baghdad, Iraq.
ansamadil@gmail.com

2) Mechanical Eng. Dept., Engineering Collage, Al-Nahrian University, Baghdad, Iraq.
ayadmohammeds78@gmail.com

3) Department of Prosthectics and Orthotics Engineering, Al-Nahrian University, Baghdad, Iraq.
mustafa.saad@nahrainuniv.edu.iq

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Abstract

This study aims to review flow-induced vibration one of the repercussions of vibrations is caused by fluid movement. In general, the investigation of the structure of the systems affects the efficiency of the components that construct those systems. This review examined the influence of generated vibrations and internal pressure on fluid transport pipes using theoretical calculations, practical tests, and numerical analysis to identify and test the dynamic behavior of static fluid transport pipes. The experimental study considered the natural frequencies caused by the fluid pressure effect under various stability situations. The flow of all liquids, such as oil, water, gas, air, and vapors, through the pipes, was tested, and the mathematical models were correctly adjusted. All empirical, theoretical, numerical, and analytical research agrees that several approaches exist to develop, modify, and improve these metrics. However, one factor affecting rheological measurements is vibration, which was addressed as needed in the middle of the 20th century due to major discoveries that damage could be rooted in vibration. Established on the determinations, they provided mathematical models paired with pressure and velocity measurements of moving fluids and the influence of produced or uninduced vibration. This study demonstrates that additional empirical investigations, particularly more detailed analytical methodologies, are urgently required to produce better findings.

Keywords: Flow Induced Vibration, Natural Frequency, Forced Vibration, Cooling Liquid, Different Supported Pipes.

الاهتزاز المستحث بالتدفق لأنابيب الدعم المختلفة: مراجعة

انسام عادل محمد ، اياد محمد سلمان ، مصطفى سعد ايوب

الخلاصة:

تهدف هذه الدراسة إلى مراجعة الاهتزاز الناجم عن التدفق، وهو أحد تداعيات الاهتزازات الناتجة عن حركة السوائل. بشكل عام، يؤثر التحقيق في بنية الأنظمة على كفاءة المكونات التي تنشئ تلك الأنظمة. فحصت هذه المراجعة تأثير الاهتزازات المتولدة والضغط الداخلي على أنابيب نقل السوائل باستخدام الحسابات النظرية والاختبارات العملية والتحليل العددي لتحديد واختبار السلوك الديناميكي لأنابيب نقل السوائل الثابتة. درست الدراسة التجريبية الترددات الطبيعية الناتجة عن تأثير ضغط المائع في حالات الاستقرار المختلفة. تم اختبار تدفق جميع السوائل، مثل النفط والماء والغاز والهواء والأبخرة عبر الأنابيب، وتم تعديل النماذج الرياضية بشكل صحيح. تتفق جميع الأبحاث التجريبية والنظرية والرقمية والتحليلية على وجود عدة طرق لتطوير هذه المقاييس وتعديلها وتحسينها. ومع ذلك، فإن أحد العوامل التي تؤثر على القياسات الانسيابية هو الاهتزاز، والذي تمت معالجته حسب الحاجة في منتصف القرن العشرين بسبب الاكتشافات الرئيسية التي يمكن أن يكون الضرر متجذرًا في الاهتزاز. بناءً على التحديدات، قدموا نماذج رياضية مقترنة بقياسات الضغط والسرعة للسوائل المتحركة وتأثير الاهتزاز الناتج أو غير المستحث. توضح هذه الدراسة أن التحقيقات التجريبية الإضافية ، ولا سيما المنهجيات التحليلية الأكثر تفصيلاً ، مطلوبة بشكل عاجل لإنتاج نتائج أفضل.

1. Introduction

The effects resulting from external vibrations will directly or indirectly affect the movement and properties of fluids inside the pipes through these media, especially their impact on the flow and pressure of fluids, as well as the impact of vibration on the pipes from shocks and deviations, which are used in many applications such as heat exchangers[1,2,&3],Systems used in the concentration of sunlight [4, 5] and underground water networks that will be Discussing them in this research and answering as much as possible some of the questions that may arise in our minds about this topic, albeit briefly, as the calculations will be discussed according to the theory used in the research. The past few decades have seen intense research into new types of transmission fluids. Studies, research and experiments on the subject of the effects of vibrations and fluid movement and the relationship between them began since the fifties of the last century or before that, but what was found from the research on the above subject was since the year 1950, when Ashley & Haviland [6] noticed many problems of oil pipeline vibrations, which encouraged him On the initiation of work in the field of vibrations involving transverse fluids, an investigation of the treadle dynamics of fluid flow flexible tubing to explain the vibrations observed in pipeline operation across the Arabian Peninsula. . However, their formulation of this problem was incorrect as demonstrated in 1951 by the researcher Feodos Yiv [7] who in his study showed the correct relation of a tube containing a flowing liquid to do so by studying the case of the tube fixed at its ends. Subsequently, Hausner [8] in 1952 studied the same subject, but in a different way, in which he discovered that a pipe could bend sufficiently at high flow rates due to its instability. The maximum velocities of the fluids in the tubes were detected. . This was followed by several studies, including Niordson, [9], which examined who discovered a similar relationship of movement and, more importantly, converging conclusions regarding the stability of tubes fixed on both sides.

2. Literature Review

2.1 Flow Induced Vibration / Experimental Approach

The interaction phenomena between bodies and the movement of fluid flow are considered one of the toughest issues in the discipline of fluid dynamics. Haitham & Ansam [10] studied, analysed, and derived equations for one of these problems through a model of pipes that transport fluids, and then analysed the resulting vibration on the model for straight and curved pipes installed from both ends or more than one place.

Research, studies, and experiments on the topics of vibrations and flow and the relationship between them have continued throughout those years to this day. Ansam [11] studied and conducted a practical experiment on the dynamics theories of flexible pipes that transport fluids that have applications in numerous fields, including the design of fuel lines, pump discharge lines, cranes on offshore platforms, and components of reactor systems. Dana Giacobbi, et al.[12] studied the dynamics of thinness and flexibility of the cantilevered suction tube, which swallows the liquid at its unfixed end and pushes it towards the fixed end from the other end. Because of the wide applications that exist, especially in the seas and in mining operations in particular, the problem had to be studied and reviewed. From the previous research on this topic - which extended for relatively long periods, and which showed a contradiction in the results, it was found that the system is moving away from stability due to vibration at relatively low flow velocities. These results were reviewed and the study was in-depth by exploring and analysing the problem in three ways Experimental and analytical. And my number.

Thaer,.[13] investigated how struts affected the critical velocity and natural frequency values in a straight tube containing a fluid that flowed steadily in theory. The study's objective was to introduce a novel analytical technique for analyzing the vibrational behavior of a tube based on a variety of vacancies. with changing ambient conditions, taking into account that the bearing consists of a ductile material that can be geometrically represented by two types of linear and rotational springs. This method describes both full (simple, narrow, sliding) and elastic datums, A computer program in MATLAB was designed for this purpose. The conclusion drawn from the theoretical side in general is that the value and location of the datum have a clear influence on the dynamic properties of the tube, as it was shown that the tube is divided into 20 spaces and depends on an average datum at the end of each space that behaves like a tube based on the Winkler.

Attia Khalifa, et al. [14] studied the interaction of amphipods as an important source of vibrations and high-pressure waves for high-capacity pumps. The aim of the study was to establish equations to relate pressure field to pumping vibration and to select effective solutions to reduce vibration caused by two-flow screw pumps. In order to assess the distribution of pressure variations inside the pump and pump vibration under various operating conditions, experiments were conducted on a typical boiler feed pump stage.

R. Virabandi , et al.[15]. Experimental Studied of Graphical Analysis of Calculations Resulting from the Performance Index Measurement Index. In this setup, the main components of the actuating elements are an angular type valve. The study and study were conducted respectively with one effect showing the effect of gas in the mathematical model of the fluid carrier for threaded pipes. The motion equation that governs the true copyright transmission fluid has been derived.

Nosherwan Shoaib, et al [16] reviewed the spread of electromagnetic waves in the pipelines that transport oil underground. The study of electromagnetic waves in pipeline networks is the goal of this effort. generated by oil medium under high temperatures. The work includes making a model at the bottom of the well for oil pipelines. The simulation focuses on calculating the scattering variables (S variables) of the electromagnetic waves spread throughout the network of oil-filled pipelines at incompatible temperatures. These findings will be helpful to verify the oil pipeline's comprehensive wireless capabilities.

Etim S Udoetok .[17]studied and examined the vibrations caused by the flow of fluids through them and used the development of equations for the purpose of showing the flow of fluids inside the tubes and its influence of the vibrations on the natural frequency and displacement of the tubes. Use practical experiments and compare their results with what was reached through engineering analyzes and reach new and simple equations that can be used in wide in several places with the intention of decreasing vibration brought on by fluid flow inside pipes.

Qianli Zhao.[18] relied on the Laplace transform in order to find a new method that enables it to analyze the vibration resulting from the movement of the transmission fluid in curved pipes. The accuracy of the assumed method for calculating the critical velocity of flow was verified for three cases, including a pipe fixed on one side and flexible and curved pipes fixed on one side.

MJ Brennan, et al [19] Vibration of the research sample tube was measured on both sides of the suspected leak. However, PVC pipes may cause problems due to the close interaction of water, pipe, and earth. which in turn affects leakage noise spreading inside the pipe. Numerical and experimental analysis was used in the research and showed the influence of soil characteristics on leaky noise propagation underground water pipes made of plastic The analytical model enables a thorough analysis of the physical impacts of the soil on noise (wave) propagation in a tube, specifically regarding wave velocity and wave attenuation. The findings demonstrated that the shear stiffness of the soil might have a substantial impact on the wave velocity in the tube in addition to the stiffness of the tube collar.

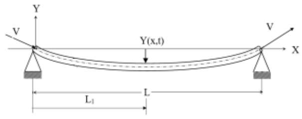
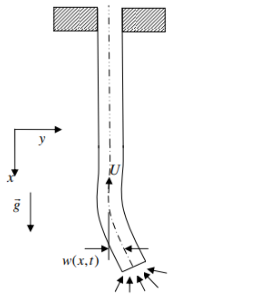
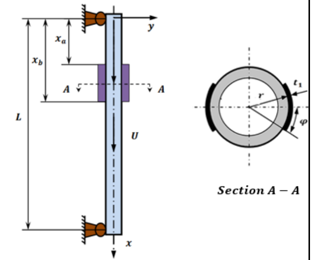
Haitham [20] The experimental forced vibration test was conducted on a model consisting of two circular tubes of 1.6 m each and two different diameters (one of them is 15 mm and the other is 35 mm). The tube was installed in a tank with dimensions (0.6 m wide, 0.6 m high, and 1.2 m long) horizontally at a height of 0.4 m. two distinct stimulation frequencies for forced vibration (10 and 15 Hz) was imposed on all test points which were five points distributed on the model with a distance between two points (0.2 m), five different Reynolds types were tested and tested in two different environments, one adrift The influence of vibrations caused by fluid flow was observed to increase to a maximum deviation when the flow velocity increased, and the other is submerged in water. It was also discovered that the effect of vibration was reduced by 33–46% by the water around the pipes. Where there is a 4–7% effect differential between excitation frequencies.

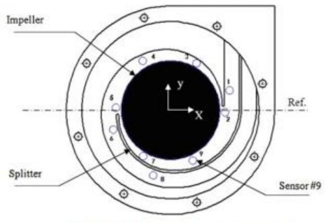
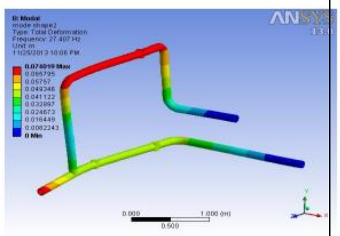
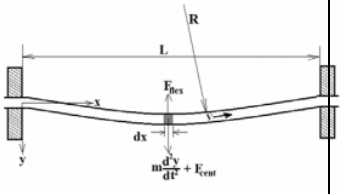
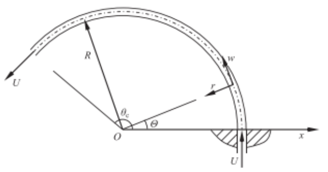
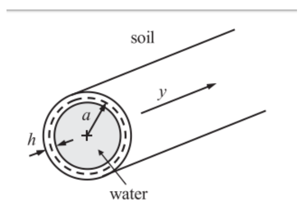
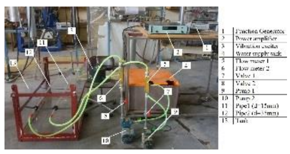
Eman. [21] obtained vibration equations for cracked and cracked FG tubes using Hamiltonian principle based on Euler-Bernoulli model with different boundary conditions. The failure appears as a massless torsion fountain. The effective numerical procedures were developed by the differential quadrature (GDQ) method Utilizing the Galerkin method to determine the stability and normal frequencies of the FG tubes that are not cracked and that are cracked, respectively. Effects of fissure location, fissure depth, gradient index, and baseline parameters on the natural frequencies of FG tubules transporting fluids at a given flow velocity on the frequencies. The findings showed that as dimensionless flow velocity increased, the first vibration frequency decreased.. The amount of decrease in this frequency for the cantilever tube is (6.73%), for the cantilever tube (3%), and for the simply supported end conditions, the amount of decrease is (11.33%). The outcomes further demonstrated that by raising the first frequency of the non-dimensional vibration the gradient coefficient k (that is, the percentage increase is 46.5%) for C-F while the percentage of C-C increase is 42.2%. For SS, the amount of reduction is 50.4%.

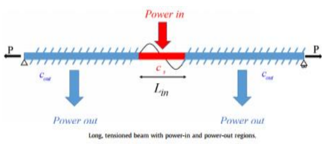
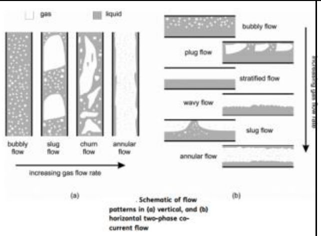
J. Kim Vandevere.[22] How the reduction modulates worldwide vibrations caused by vortices (VIV) is studied. Flexible response. The general behavior changes from standing waves to waves traveling on infinite cylinders. Structural damping controls the Radial damping controls the VIV response on extremely long cylinders in the standing wave condition. First, due to the balance of forces at play, the equation expresses the stability of the structure. It is clear that the arms representing the square root response in the excitation region VIV are an excellent predictor of the general response due to its relationship to energy flow. Under steady-state circumstances, the energy flux quotient should be zero, which leads directly to the 3D independent damping parameters when the radiative damping problems illustrate the overall effects of damping on the response. Uncontrollable causes frequently manifest as graphic anomalies that provide fresh perspectives on VIV. The conclusions are supported by data from numerical models and experimentation.

Samuel Gabrimariam Haile [23] The study was focused on the phenomenon known as flow-induced vibration (FIV), which is frequently seen in inflows in technological systems such as process plants, nuclear power plants, oil pipelines, and heat exchangers. FIV is more challenging to forecast and analyze for two-stage internal flows when compared to single-stage flows. As a result, experimental studies for biphasic flow are often carried out first in the laboratory using a prototype of the original structure, and experimental data and analysis tools are restricted to certain aspects or situations. In addition to experimental studies, computational fluid dynamics (CFD) has gained popularity as a method for FIV assessment. To complete them as an empirical database, CFD models and methodologies must, however, be further developed. CFD is additionally.

Table 1: Vibration of Pipes Conveying Fluid (Experimental Work)

No	Name	Year	Theory	working fluid	Type	Fig.	Fluid or/and vibration	Conclusion
10	Haitam and ansam	2020	analyzed the resulting vibration on the model for straight and curved pipes installed from both ends or more than one place.	Water	Fixed supported		F&v	The phenomenon of interaction between bodies and the motion of fluid flow is one of the toughest issues in the discipline of fluid dynamics.
11	Ansam	2006	studied and conducted a practical experiment on the dynamic theories of flexible tubes that transport fluids, which have many applications	Water	Fixed supported	 Testing rig for vibration test	F&v	The Tiomoshenko beam theory was used to analyze the dynamics of fluid-conveying pipes. Despite being a straightforward extension of prior theory, the solution of the equations of motion required the application of a fair treatment of the variation principle, which turned out to be a very effective analytical technique..
12	Dana Giacobbi	2010	studied the dynamics of thinness and flexibility of the cantilevered suction tube, which swallows the liquid at its unfixed end and pushes it towards the fixed end from the other end	Air	flexible elastomer pipe.	 Schematic of an instantaneously deformed aspirating cantilevered pipe.	F&v	it was found that the system is moving away from stability due to vibration at relatively low flow velocities.
13	Thaer	2016	studied the dynamics of thinness and flexibility of the cantilevered suction tube, which swallows the liquid at its unfixed end and pushes it towards the fixed end from the other end	water	Simple supported	 Pinned at both ends of pipes conveying fluid model	F&v	it was found that the system is moving away from stability due to vibration at relatively low flow velocities.

14	Attia Khalifa	2011	studied the interaction of amphipods as an important source of vibrations and high-pressure waves for high-capacity pumps.	Water	Pump	 Locations of distributed sensors inside the pump	F&v	establish equations to relate pressure field to pumping vibration and to select effective solutions to reduce vibration caused by two-flow screw pumps.
15	R.Veerapandi	2014	The study were conducted respectively with one effect showing the effect of gas in the mathematical model of the fluid carrier for threaded pipes.	Gas	Rocket engine	 Deformation of Mode shape 2	F&v	The motion equation that governs the true copyright transmission fluid has been derived
17	Etim S Udoetok	2018	Use practical experiments and compare their results with what has been reached through engineering analyses	Water	Clamped & simple supported	 . Schematic of vibrating pipe section	F&v	Coming up with new and simple equations that can be widely used in many fields in order to lessen the vibrations brought on by the fluid flow inside the pipes.
18	Qianli Zhao	2018	relied on the Laplace transform to find a new way to analyze the vibrations caused by the motion of transmission fluid in curved tubes.	Fluid	cantilevered, clamped-elastically supported, and periodic cantilevered curved	 Mechanical model of cantilevered curved pipe conveying fluid.	F&v	The assumed method for calculating the critical flow velocity was validated for three cases, including a tube fixed on one side and flexible and curved tubes fixed on one side
19	MJ Brennan	2018	The vibration of the research sample tube was measured on both sides of the suspected leak. Numerical and experimental analysis were used in the research	Water	Plastic pipe	 Schematic diagram of the buried pipe showing the pipe geometry.	F&v	It was shown how soil characteristics affected the way noise from leaking plastic water pipes spread underground.
20	Haitham	2019	Five different types of Reynolds were tested and tested in two different environments, One is submerged in water; the other is in the air.	water	Fixed supported		F&v	It was found that the effect of vibrations caused by the fluid flow increases to the maximum deviation when the flow velocity increases. Also, it was discovered that the water around the pipes reduced the vibration's impact by 33–46%. where there is a 4–7% effect differential between excitation frequencies.

21	Eman	2019	Efficient numerical procedures were developed by the differential squared method (GDQ) and Galerkin's method to find the normal and invariant frequencies of uncracked and cracked FG tube, respectively.	water	Fixed, Clamped & cantilever	---------	F&v	The findings showed that when the velocity of the dimensionless flow increases, the frequency of the first vibration decreases.. The amount of decrease at this frequency for the cantilever tube is (6.73%), for the cantilever pipe (3%), and for the simply supported final condition the amount of decrease is (11.33%). The results also showed that the first frequency of non-dimensional vibration by increasing the gradient coefficient k (i.e. the percentage increase is 46.5%) for C-F while the percentage increase for C-C is 42.2%. For SS, the reduction amount is 50.4%
22	J. Kim Vandevere	2018	How down sampling modulates global vortex-induced vibration (VIV) is studied.	Water	Flexible cylinder		F&v	that the arms representing the square root response in the VIV excitation region are an excellent predictor of the overall response due to its relationship to energy flow.
23	samuel	2022	focused on the topic of flow-induced vibration (FIV)	Gas & liqui	Under sea pipeline		F&v	The work that follows offers an analysis of two-stage flows related to various structural components in FIV research.

2.2 Flow Induced Vibration / Theoretical Approach

HL Day, et al. [24] indicated the vibrations caused by the vortex of a moving fluid inside the articulated tube, by looking at the internal velocities of the fluids encompassing subcritical and supercritical areas. Galerkin's four-mode approach was used to estimate the coupled nonlinear kinematic equations. When the coil's internal fluid velocity is in the subcritical area, according to numerical calculations and schematics,, the tube shows different dynamic behavior about the post-bending modulation such as the inverted period doubling of the dendrites.

M. SIBA, et al. [25]. Proving that flow-induced vibration is an empirical topic, and there have been numerical and theoretical studies. Its purpose is to implement the best flow control applications using aperture technology. The orifice becomes the flowmeter after controlling the flow. Each fluid's ability to flow through an orifice has been examined, including water, oil, gas, and vapors. Mathematical models have been created to support the study and research. These extensive investigations' principal focus was the requirement for highly accurate flow measurements through the orifices. All analytical, numerical, theoretical, and experimental research agreed that there were multiple ways to create, improve, and adjust these metrics.

Nosherwan Shoaib, et al [16] examined the propagation of electromagnetic waves in oil transport pipelines underground. This paper's objective is to examine electromagnetic waves in pipeline networks generated by oil medium under high temperatures. The work includes making a model at the bottom of the well for oil pipelines. The simulation focuses on calculating the scattering variables (S variables) of the electromagnetic waves spread throughout the network of oil-filled pipelines at incompatible temperatures. These findings will be helpful to verify the oil pipeline's comprehensive wireless capabilities.

Bhagwat b. Kedar. [26] showed in his study that high flow, acoustic vibrations, and metal fatigue in the system can result from pipe networks modified to handle fluids like steam, diverse processes, and hydrocarbon gases by pressure reduction under high velocity and pressure settings. Carucci and Mueller introduced the technique for determining the tubules' sensitivity to AIV stress failure roughly 35 years ago. There have been reported several developments. Unfortunately, the finite element technique with respect to the AIV phenomenon was not mentioned in any publications. Based on actual operating circumstances, this research suggests a technique to lessen acoustic vibrations brought on by flow in a piping system. Prioritizing countermeasures to reduce tube failure brought on by AIV and FIV might benefit from this type of assessment of AIV and FIV.

Shuai Meng. [27] studied focused on the application of the proposal to collect and store carbon dioxide and to show that the tube installed on one side can gain energy losses due to the internal flow. Fixed at one end to drain the liquid.

Gbeminiyi M. Sobamowo.[28] The Galerkin differential transformation approach proved the nonlinear equations of heat and flow-induced vibration in fluid transport structures. In this study, the analysis reveals that the large disparity in the length and aspect ratio of the structure's details results in a decrease in the structure's unstable vibration frequencies, as opposed to what is seen when fluid flow velocity increases due to an increase in nonlinear frequencies, while an increase in slip coefficient results in a decrease in the structure's vibration frequency and speed. both important to the transferred substance and infrequent.

Talib EH. Elaikh, et al [29] Use FG transmission fluid, which can be used in many applications in accordance with the specifications and properties of this fluid. A nonvibrational analytical solution for the functional classification (FG) of a fine material transmission fluid is presented. He observed that the material's properties across the thickness of the microtubules are constantly changing and depend, in theory, on the power distribution law based on the theoretically modified Euler beam model and the linked stress. To find the equation of motion for the three sides of the boundary conditions, use Hamilton's principle (supported and immobilized microtubules). The equation of motion's solution as well as associated boundary conditions were obtained using the DT method. The vibration and stability of female vaginal fluids containing microtubules are affected by the fluid flow velocity, gradient index, and material length scale parameter. Results View As the measurement index rises, critical speeds and natural frequencies increase rapidly.

Chenghua Shi, et al. [30] studied on infrastructure and planning, he saw the importance of underground pipeline networks in providing the basic needs of the population, such as water, natural gas and oil. The pipeline networks used to transport crude oil and natural gas may be in grave danger due to the rapid development of highways and urbanization. One of these issues is explosion tunneling, which is regarded as the most serious threat to pipeline networks. Materials, wall thickness, and stress conditions of the pipeline vary depending on the pipelines, and each pipeline has a varied resistance to loading. As a result, separate pipelines should have different PPV control criteria. Various PPV control parameters are needed for various pipelines. A method should be developed to determine the PPV control standard of various pipelines buried beneath the adjacent tunnel blasting, where the influence factors, such as the material of the pipeline, the wall thickness, and the pressure condition of the pipeline, are known. This will help to ensure the safety of the pipeline under blasting loads. The acceleration vibration of the surrounding rock mass can be thought of as the excitation of the tube under the influence of the external seismic wave blast, which is simulated by the temporal acceleration function operating on the tube particles, based on the theory of structural dynamics.

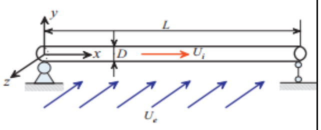
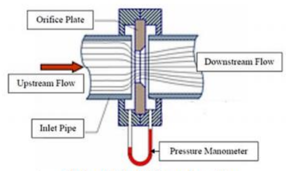
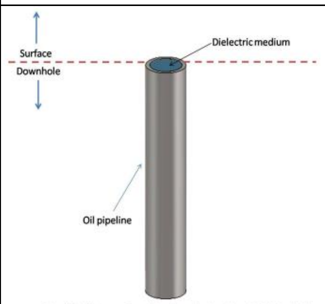
Enbin Liu, et al. [31] emphasized the proper handling of the pipelines of the natural gas station, as the abnormal vibrations of these pipelines pose a threat to them in case they are exposed to any problems and consequently huge economic losses. The transmitted gas's volume affects the vibration's intensity. Three different sorts of vibration reduction systems have been put forth and simulation-tested. The following are the primary conclusions: (1) The primary source of the anomalous vibration in the station is fluid pressure variation in the pipeline. (2) The pipeline system's vibration will worsen as the volume of gas being transported increases. (3) The best method for decreasing vibration in the system is to increase the pipe's diameter and install proper constraints.

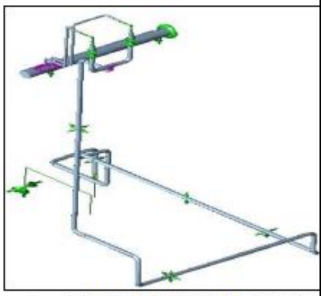
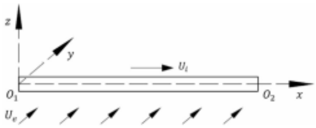
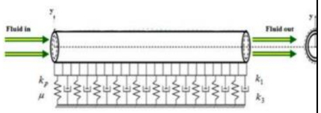
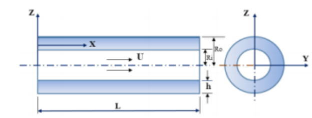
Dhurgham, et al.[32] researched, with a particular emphasis on the pipes used to carry fluids in all systems that depend on pressure and flow, including those used to convey water, oil derivatives, and all kinds of gases in industrial settings. Despite the fact that pipelines are so vital and important for moving fluids, they have significant issues. One of these issues is vibration, which, if not prevented, can completely collapse systems and result in significant economic losses. In his study, he studied the potential for decreasing these vibrations on the pipes as well as the issue of managing those vibrations that arise due to the movement of fluids inside the pipes. Thus, the researcher presented the effective control of the tube using the Nyquist method in this research after comparing with other studies and ensuring the control and fixation of the tube. Nyquist theory was used to study the dynamic behavior of conservative and non-conservative fluid-transporting tubes in the absence of hydraulic damping (active control) and to track each stage's reaction and stability. To undertake this analysis, differential equations for pipes and various fixations were derived. The general kinetic equation for pipeline transport fluids was pushed, its equation was solved using Galerkin technology, and stability was calculated using Nyquist techniques.

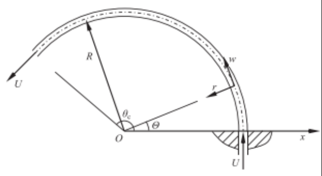
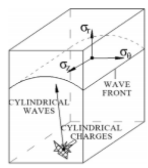
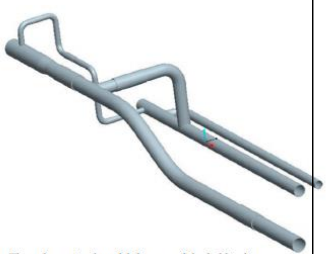
Stephanie Rinaldi .[33] An analytical model of the optimized linear dynamics of a cantilever cylinder, subject to axial flow, and whose free end is directed toward the grating, is presented. A precise analysis is done of the forces at the free end of the cylinder. According to theoretical analysis, the cylinder may become unstable at a flow velocity that is somewhat lower due to vibration than at a flow velocity that is higher due to static deviation.

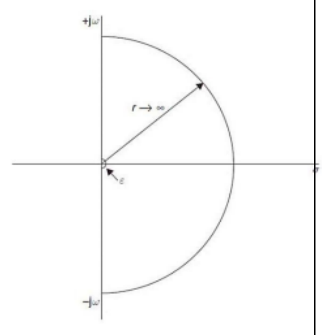
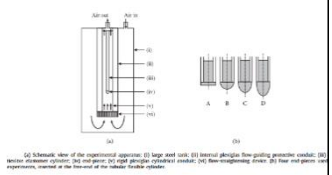
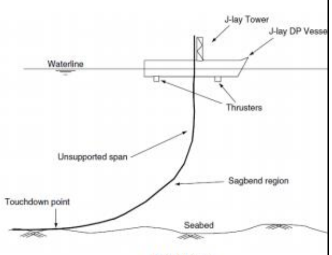
Duha B. Saber, et al. [34] studied the applications of pipeline networks that will be installed in the seas, which may be affected by a variety of factors, including waves and currents that come from opposite directions, the movement of barges, interactions with the sea floor, and other factors. The purpose of this work was to construct a dynamic analysis of the suspended subsurface J-mode pipeline during installation while taking into account the effects of sea state, wave direction, and water depth. The dynamic analysis of the pipeline revealed that the influence of wave direction on the bending moment first occurs at a depth of 2 meters (m) below the water's surface and subsequently diminishes until it vanishes at a depth of 100 meters (m). Whereas the impact of wave height first manifests itself at a depth of 2 m, steadily diminishes, and finally vanishes at a depth of 120 m.

Table 2: Vibration of Pipes Conveying Fluid (Theoretical Work)

No	Name	Year	Theory	working fluid	Type	Fig.	Fluid or/and vibration	Conclusion
24	H.L. Dai	2013	The Galerkin four-mode technique was used to evaluate the coupled nonlinear kinetic equations. based on computer calculations and schematics,	Water	Fixed pipe	 Schematic of a pipe conveying fluid subjected to VIV.	F&v	It turns out that the tube exhibits unusual dynamic behavior at the post-bending modulation when the internal fluid velocity of the coil is in the subcritical region.
25	m. siba	2016	Each fluid's ability to flow through an orifice has been examined, including water, oil, gas, and vapors. Mathematical models have been created to support the study and research.	Water	Orifice plate	 . Orifice plate instalation and operation	F&v	Proving that flow-induced vibration is an empirical topic
16	Nosherwan Shoaib	2016	View the propagation of electromagnetic waves in underground oil transportation pipelines.	Oil	underground oil pipelines	 Simplified diagram of an oil well consisting of a cylindrical pipeline.	F&v	analyzed electromagnetic waves in pipeline networks generated by oil medium under high temperatures

26	Bhagwat b. Kedar	2017	It has been shown that pipe networks designed to handle fluids like steam, different process gases, and hydrocarbons by reducing pressure can result in high flow, acoustic vibrations, and metal fatigue in the system.	Water	Fixed pipe	 : CAESAR II model of the system	F&v	Based on the actual operating circumstances, this research suggests a technique to lessen the acoustic vibrations brought on by the flow in the piping system. Prioritizing countermeasures to reduce tube failure brought on by AIV and FIV might benefit from this type of assessment of AIV and FIV.
27	Shuai Meng	2017	The study focused on the application of the proposal for the capture and storage of carbon dioxide	Carbon dioxide	Cantilever	 Diagram of the cantilevered pipe undergoing VIV.	F&v	The study focused on the application of the proposal for the capture and storage of carbon dioxide
28	Gbeminiyi M. Sobamowo	2018	Nonlinear equations for heat and flow-induced vibration in fluid transport structures are provided by the Galerkin differential transformation.	water	Clamped-clamped &clamped –simple & cantilever	 Geometry and loading of the problem	F&v	Due to the significant variation in the length and aspect ratio of the structure's details, the analysis revealed a decrease in the structure's unstable vibration frequencies. In contrast, an increase in fluid flow velocity causes the nonlinear frequencies to rise, whereas an increase in slip coefficient causes a decrease in the vibration frequency and the structure's velocity.
29	Talib EH. Elaikh	2018	Use FG transmission fluid, which can be used in many applications depending on the specifications and characteristics of this fluid. A non-vibrational analytical solution to the functional classification (FG) of fine material transmission fluid is	Fluid	Simply supported, clamped-clamped and cantilever micro-pipes	 The Geometrical model of a fluid - conveying FGM micro-pipe.	F	saw that material properties across the thickness of microtubules were constantly changing and depended in principle on the energy distribution law.

			presentedBased on the coupled pressure model and the theoretically adjusted Euler beam model.					
18	Qianli Zhao	2018	relied on the Laplace transform to find a new way to analyze the vibrations caused by the motion of transmission fluid in curved tubes.	Fluid	cantilevered, clamped-elastically supported, and periodic cantilevered curved	 Mechanical model of cantilevered curved pipe conveying fluid.	F&v	The assumed method for calculating the critical flow velocity was validated for three cases, including a tube fixed on one side and flexible and curved tubes fixed on one side
30	Chenghua Shi	2019	saw the importance of underground pipe networks in providing the basic needs of the population, such as water, natural gas and oil.	Bangs	buried pipelines	 Stress distribution at any point in rock mass under cylindrical elastic seismic wave.	V	The temporal acceleration function acting on the tube particles simulates the acceleration vibration of the surrounding rock mass, which is how the tube is excited. Based on the structural dynamics theory
31	Enbin Liu	2020	emphasized good handling of the pipelines of the natural gas station, as the abnormal vibrations of these pipelines pose a danger to them in case they are exposed to any problems and thus huge economic losses.	Gas	Pipe network	 . Three-dimensional model diagram of the bobbin line.	F&v	The following are the primary conclusions: (1) The primary source of the anomalous vibration in the station is fluid pressure variation in the pipeline. (2) The pipeline system will vibrate more severely when the volume of gas being transported is high. (3) Increasing pipe diameter and installing suitable restrictions will have the greatest impact on reducing vibration..

32	Dhurgham	2020	Focused on fluid transport pipes used in all systems that depend on pressure and flow and used in all industrial fields In this research, the researcher introduced active tube control by the Nyquist method	Water	Cantilever , Clamped-Clamped , Clamped-Pinned & Pinned-Pinned Pipes.	 . S-Plane Nyquist Contour.	F&v	The analytical solution involved pushing the general kinetic equation of pipeline transport fluids, then applying the Galerkin method to solve its equation, and finally determining stability using Nyquist methods.
33	Stephanie Rinaldi	2010	An analytical model of the optimized linear dynamics of a cantilever cylinder, subject to axial flow, whose free end is directed toward the lattice, is presented.	Water	Cantilever		F&v	The cylinder is expected to lose stability at a fairly low flow velocity due to vibration, and then at a higher flow velocity due to static deflection.
34	Duha	2020	In this study, a dynamic analysis of a suspended J-mode undersea pipeline during installation was constructed, taking into account the effects of the sea's condition, wave direction, and water depth..	Oil	Under sea oil pipeline	 J-lay Method	V	The dynamic analysis of the pipeline revealed that the influence of the wave direction on the bending moment first appears at a depth of two meters below the water's surface, then rapidly diminishes until it vanishes at a depth of three meters (100 meters). While the influence of wave height first becomes apparent at a depth of (2 m), it then gradually vanishes at a depth of (120 m).

3. Conclusions

The illustrated studies discover a specific topic like pipe systems, fluid flow, vibrations, and the exchange of influences between them. Some discovered the maximum and critical speeds of fluid flow, and some found similar conclusions concerning the stability of the pipes installed from both. At the same time, they demonstrated that the pipe system loses stability at relatively modest speeds due to vibrations. In comparison, they proved that the support's value and location affect the dynamic facts of the pipe and its dependence on the average support at the end of each space. Others confirmed that high velocities with flow rates lead to large changes in the pressure inside the pumps. They finally proved that in the subcritical region, when the internal fluid velocity is, the tube shows a different dynamic behavior about adjusting the post-curvature of the tube.

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