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Effect of Retarding Force on Mass Flow Rates of Fluid at Different Temperatures Using Software Visualization Technique

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Review Article

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Abstract

The designer of pipes normally faces the problems of how to design and prevent the pipes from leakage when used. To eradicate of reduces this problems, effects of retarding force on mass flow rate must take into consideration by compare the retarding force, mass flow rate of fluid at different temperature and with pipes of different radius. The fluid flow always takes place in a particular medium and pipe is one of the most common among the entire medium. During the flow process, retarding force has effect on the mass flow rates and always caused nagative effect by reduce the expected delivery product in term of mass flow rates. Main focus of this paper is to develop a mathematical model and software visualization to view the effect of retarding forces on the mass flow rate in term of visualization. Software Visualization (SV) is engaged in computer science by using computer graphics for communicating the structure and behavior of software or algorithms. It is mostly used for complex software. Application of this concept to real life complex situations has no boundary. Spillage of underground pipes has caused serious problems ranging from environmental pollution or degradation to economic shortage. It is caused by many factors either deliberate or unintended. C-sharp (C#) is the chosen program and this enable us to determine the mass flow rates patterns in relation to retarding force in form of graphical representation such as tables and graphics at different temperatures.

Keywords: Temperature, fluids, software, visualization, force, retarding force, etc.

1 Introduction

Software is one of the components of computer system, which has been in existence since the early 60's when the computer age started. It is the component that brings life to computer system. It has occupied strategic importance in Information Technology [1].

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Fluid is defined as a substance, which cannot withstand a Shear force or stress without moving when compared with solid [2]. Fluid can also be defined as a substance which continously deform when a force is applied [3]. [2] Further classified fluid as liquids or gases. A liquid has intermolecular forces which hold it together so that it possesses volume but no definite shape while gas consist of intermolecules in motion which collide with each other tending to disperse it so that a gas has no set volume or shape. They also classified fluid by the types of their flow into laminar and turbulent flow.

[2] Classified fluid by the types of their flow and this may be laminar or turbulent flow. The term laminar flow means a fluid flow which flows in laminas or layers, it can also be describe as a type of fluid flow in which the fluid travels smoothly or in regular paths or a fluid flow in which individual particles of the fluid follow paths which do not cross those of the neighbouing particles. Laminar flow is not normally found except in neighbourhood of a solid boundary [4]. While the turbulent flow is one for which the velocity component have random turbulent fluctuations imposed upon their mean values [4], further discuss that turbulent flow are the type in which individual particles of fluid are no longer everywhere straight but are sinuous.
Furthermore, the flow can also be classified into external and internal flow.

- External flow is the flow region around an object such as flow in open Channels, Rivers and Streams.
- Internal flow is the flow inside objects such as pipes, closed channels, nozzles and in fluid machinery where the flow of the fluid is confined by walls.

The flow of fluids in pipes and channels is of importance to civil engineers. The study of fluid machinery such as pumps, compressors, heat exchangers, jet and rocket engines, and the likes, makes fluid mechanics of importance to mechanical engineers. The flow of air over objects is of fundamental interest to aeronautical and space engineers in the design of aircrafts, missiles and rockets.

In order for fluid to be useful, it must flow from a region to another and the major medium is through pipes. [5,6] Explained that pipeline system ranges from simple ones to complex ones. The main function of pipe is to convey fluid from one location to another.

The designer of pipes always faces different problems especially during the design stage.

The problem ranges from the type of materials used for the length and radius of the pipe. In order to understand the phenomenuum of fluid flow in pipe software visualization is highly needed.

The word Software Visualization simply put as (SV), is the use of visual representations to enhance the understanding and comprehension of the different aspects of a software system [7]. gave a more precise definition of software visualization as the combination of utilizing graphic design and animation combined with technologies in human-computer interaction to reach the ultimate goal of enhancing both the understanding of software systems as well as the effective use of these systems. The need to visualize software systems evolved from the fact that such systems are not as tangible and visible as physical objects in the real world, [8]. SV is a broad field that is concerned with visualizing aspects of software engineering as a practice and software systems as evolving products. Some of these aspects include design models and patterns, software architecture, development processes, code history, database schemes, network interactions, web services, parallel processing, process execution and many others [8]. Since visualization cannot act alone, it must be visualized to a particular phenomenon and fluid is the choosen substance.

In this paper we are more concern about visualization of retarding force on mass flow rate by compare the retarding foce and mass flow rate in the selected fluid, which are fresh water, 30weight of oil, mercury and honey in form of 2D representation and tabular representation respectively. This will enables both designer and user of pipes to prepare for the losses that normaly occur due to retarding force effect during the fluid flow in pipes.

The literature review will not be complete without focus on those past works that are related to fluid especially those dealing with fluid flow in pipes.

[5] studied the thermal problem of transition-point heat transfer, for force laminar convection in heated horizontal elliptic ducts, using the concept of scale analysis. Results he obtained indicate that in the neighborhood of the eccentricity, e = 0.866, optimal result are predicted for the generalized transition point with nusselt number based on the major diameter. [9] Investigated laminar forced convective heat transfer in an inclined elliptic duct using scale and perturbation technique for hydrodynamic entrance problems and fully developed regions respectively. He predicted optimal heat transfer at critical aspect ratio of 0.50 (e = 0.866) and that perturbation result indicate a considerable effect of inclination on circular ducts and elliptic geometry of e = 0.433 while inclination effect is negligible for e = 0.866. [9,10] also presents heuristic scale technique to study fluid flow and heat transfer in the entrance region of elliptic ducts starting with conservation laws of mass, momentum and energy transport.

[6] studied a two-phase flow through helical coils. He also studied wall temperature fluctuations and compared the results to straight tube experiments. [9] Used approximate solution and steam functions to determine the flow pattern for steady laminar of an incompressible viscous fluid in curved pipes. Results showed that the flow rate depended on two independent variables, the Reynold number and the true curvature of the pipe. [10,11] performed numerical studies to determine the characteristics of the flow for fully developed laminar flow.

The results showed that as the axial velocity was increased the maximum value of the axial velocity moved forward the outer wall. And vortices also migrated to the outer wall.

[12], predicted unsteady flow resulting from a sinusoidal pressure gradient. Results showed that the flow could be in the opposite direction compared to steady pressure gradient. Predictions were validated with experimental work.

[11], studied helical coils in a separation technique for the petroleum industry. More than four flow patterns were observed. Correlations to predict the pressure drop were presented. Two phase air-water mixture flows were studied in helically coiled tubes by [12]. The thickness of the water film on the wall of the tubes was measured at different points around the circumference of the tube. The wave height and its characterics were discussed.

Despite the success of these related work in fluid as given above, the representation of their findings were not properly resented in virtual form and this makes it very difficult for the other especially those that are not expert in fluid flow which is the major concern of this study.

For the fact that there are great contributions towards the behavior of the fluid in pipes, they did not use visualization techniques for proper representation of fluid flow patterns and these make it difficult for users to understand their work fully especially those that have no knowledge on fluid.

2 Materials and Methods

This work was developed for Visualization process model and each stage of the taxonomy [13] is developed as follow:

Data generation: - For this work, the model equation to be Visualized shall be based on Heagen's equation

From [14] the derivation is as follows from Equation 1 below and the assumptions before the model include:

1. Flow starts from rest
2. The flow is taken place inside the boundary wall
3. Parameters A and B are constants
4. The flow is taking place
5. at a particular temperature e.g 20^0C

The Heagen equation which is given as:

$$u = \frac{pr^2}{4k} + ALog_e r + B \tag{1}$$

Where:

P = Pressure of pipe (bar)
u = Velocity of flow (m/s)
r = radius of the pipe (m)
A, B= parameter constant

The Equation (1) above is modified with the following boundary conditions [3]:
When u = 0, r = e, parameter constant A = 0

$$\text{Then } 0 = \frac{pe^2}{4k} + B$$

$$B = -\frac{pe^2}{4k}, \text{where o} < e < r$$

$$B = \frac{-pe^2}{4k} \tag{2}$$

Substitute Eq 2 into Eq 1 to get

$$u = \frac{pr^2}{4k} + 0 - \frac{pe^2}{4k}$$

$$u = \frac{P}{4k}(r^2 - e^2) \tag{3}$$

The mass flow rate can be determined according to Patrick and David (1999) from eq. (3).

$$M= \rho u.Area \tag{4}$$

But u.Area = Q,

Where ρ= density of the fluid

where area = πe^2 for a single duct

So equation 4 can be rewritten as M= ℓQ, where total mass flow rate is given as:

$$= \ell \pi e^{2} \sum_{i=1}^{1=r} \frac{pe_i^2}{4k}\left(1 - \frac{r^2}{e_i^2}\right) \tag{5}$$

With respect [8]: Retarding force (R) can also be given as
$R = \pi dL.T$ Where T = Shear stress, D= diameter of the pipe, l=length of the pipe and π = constant.

So, we can model the retarding force along the horizontal axis as:

$$R=\pi dL.-\sum\left(-\frac{r2}{e}\right)\frac{pe_i}{4}\left(1-\frac{r2}{e_i}\right) \tag{6}$$

3 Discussion of Results

The pattern of flow of fluid in related to mercury, honey, 30weight of oil and fresh water were compared as shown in Figures and Tables below.

3.1 Discussion on Retarding Force Output Figures at 25-degree celcius

Frictional force resists the movement of fluid. The retarding force that occur in 25degree celcius with radius of 0.4m mercury, honey, 30weight of oil and fresh water is shown in Figs. 3.1, 3.2, 3.3 and 3.4 respectively. The retarding force decreases towards the centre of the pipe and this leads to increase in velocity towards the centre of the pipe because of the low retarding force that resists the flow of fliud. Each figure consists of three windows namely the input window, the graph window and the animation window. The input window is used to input the radius of 0.4m, the animation window display the pipe of 0.4m radius while the graph window display the graph of retarding force for the selected fluids.

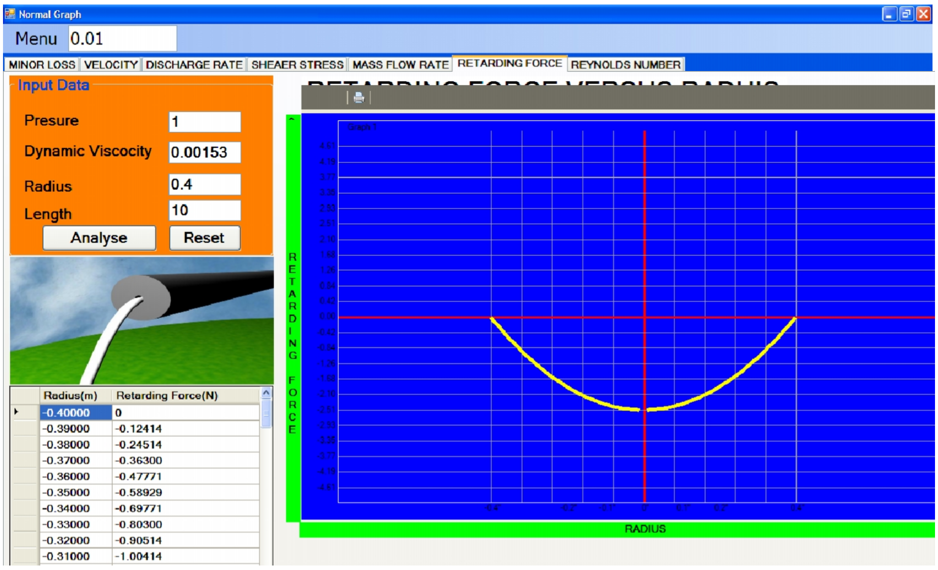

Fig 3.1. Displays retarding force produce a Sino cider shape of mercury at 25degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.00153. The retarding force is very high at the wall of the pipe and reduces toward the center of the pipe, this gives the opportunity for the velocity to be higher at the center of the pipe and reduce at the wall of the pipe

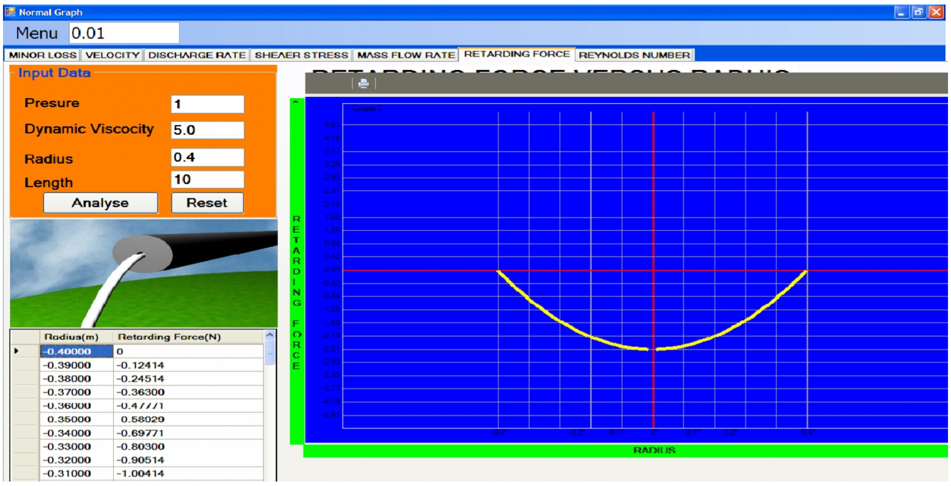

Fig 3.2. Displays retarding force produce a Sino cider shape of mercury at 25degree Celsius with radius of 0.4m at pressure of one bar and dynamic viscosity of 5.0. The retarding force is very high at the wall of the pipe and reduces toward the center of the pipe, this gives the opportunity for the velocity to be higher at the center of the pipe and reduce at the wall of the pipe

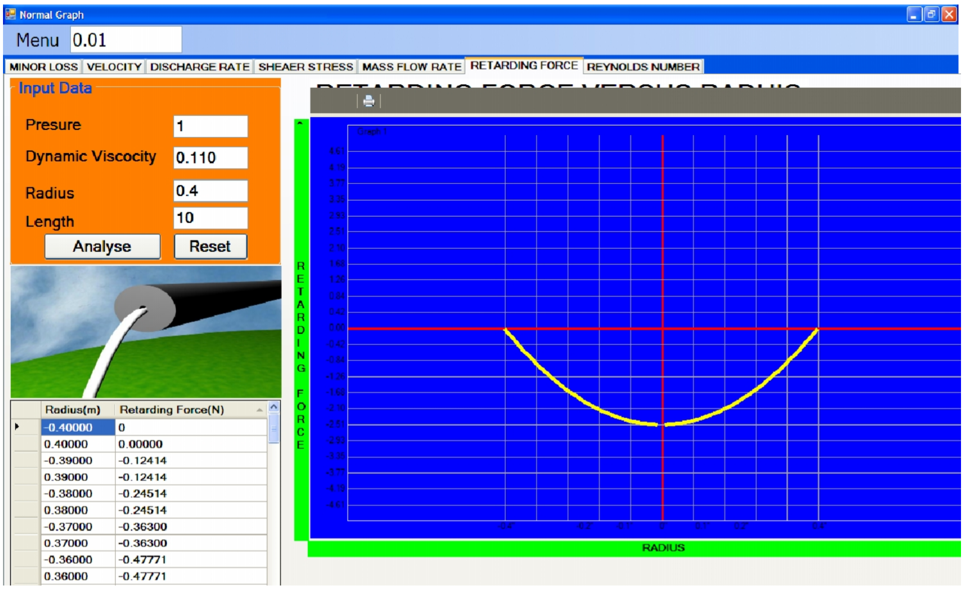

Fig 3.3. Retarding force of 30weight of oil at 25degree celcius with radius of 0.4m at pressure of one bar

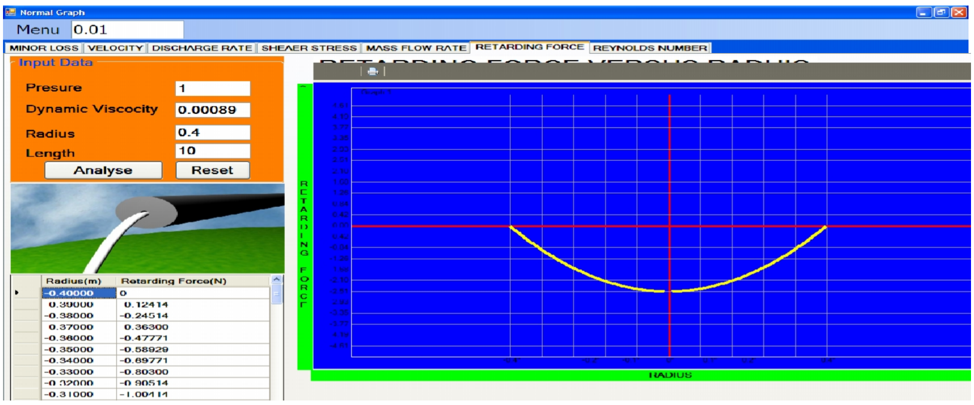

Fig 3.4. Displays retarding force produce a Sino cider shape of mercury at 25degree Celsius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.00089. The retarding force is very high at the wall of the pipe and reduces toward the center of the pipe, this gives the opportunity for the velocity to be higher at the center of the pipe and reduce at the wall of the pipe

3.2 Discussion on Retarding Force Output Figures at 100-degree celcius

This frictional force resists the movement of fluid. The retarding force that occur in one hundered degree celcius with radius of 0.4m in mercury, honey, 30weight of oil and fresh water as shown in Figs. 3.5, 3.6, 3.7 and 3.8 respectively. The retarding force reduces towards the centre of the pipe and increase towards the wall of the pipe. Each figure consists of three windows namely the input window, the graph window and the animation window. The input window is used to input the radius of 0.4m, the animation window display the pipe of 0.4m radius while the graph window display the graph of retarding force for the selected fluids.

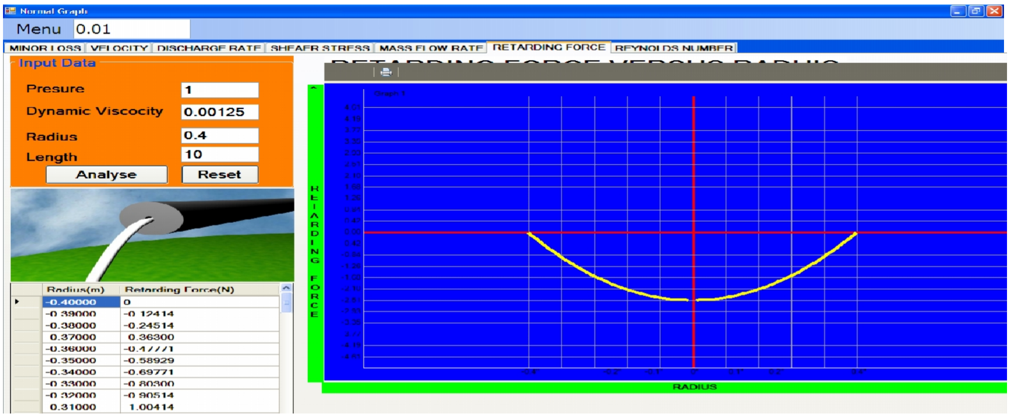

Fig 3.5. Displays retarding force produce a Sino cider shape of mercury at 100degree Celsius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.00125. The retarding force is very high at the wall of the pipe and reduces toward the center of the pipe, this gives the opportunity for the velocity to be higher at the center of the pipe and reduce at the wall of the pipe. The shape of retarding force at 100 degrees is the same to that of 25 degrees, but the output generated are different

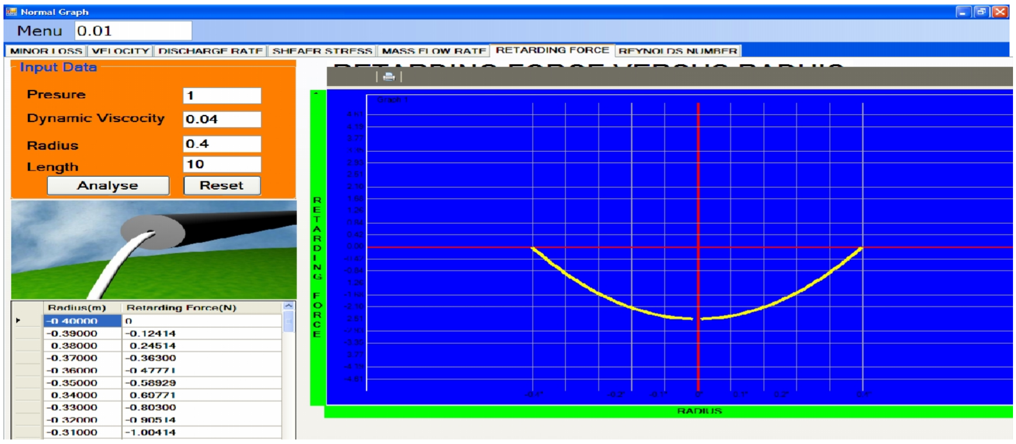

Fig 3.6. Displays retarding force produce a Sino cider shape of mercury at 100degree Celsius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.04. The retarding force is very high at the wall of the pipe and reduces toward the center of the pipe, this gives the opportunity for the velocity to be higher at the center of the pipe and reduce at the wall of the pipe. The shape of retarding force at 100 degrees is the same to that of 25 degrees, but the output generated are different

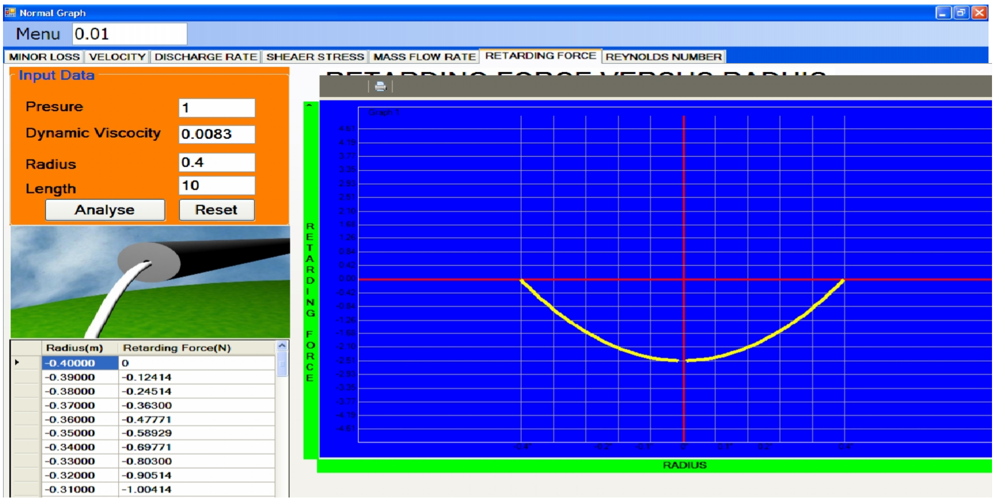

Fig 3.7. Display retarding force rate of 30weight of oil at 100degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.0083. The retarding force produces a Sino cider shape. The retarding force is very high at the wall of the pipe and reduces toward the center of the pipe, this gives the opportunity for the velocity to be higher at the center of the pipe and reduce at the wall of the pipe. The shape of retarding force at 100 degrees is the same to that of 25 degrees, but the output generated are different

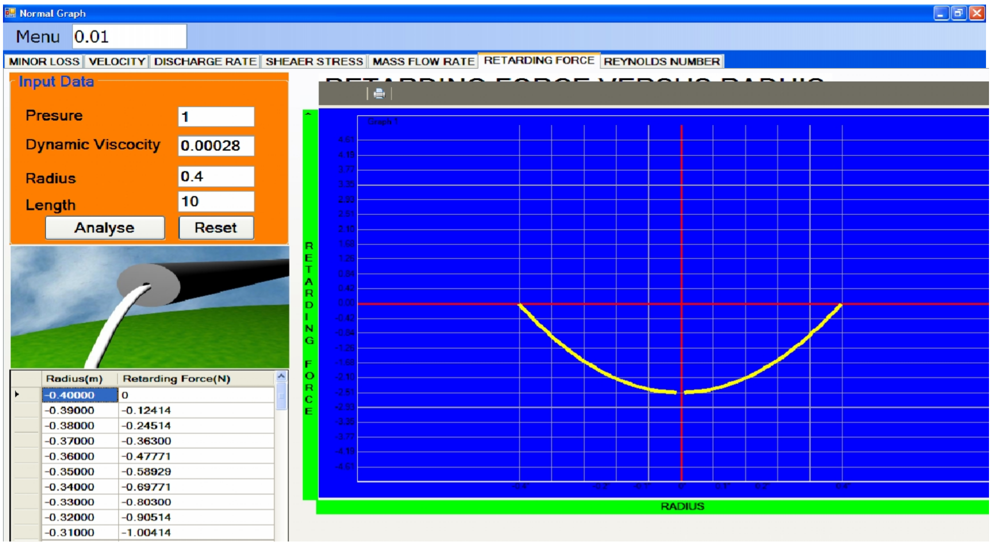

Fig 3.8. Retarding force of fresh water at 100degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.0028. The retarding force produces a Sino cider shape. The retarding force is very high at the wall of the pipe and reduces toward the center of the pipe, this gives the opportunity for the velocity to be higher at the center of the pipe and reduce at the wall of the pipe. The shape of retarding force at 100 degrees is the same to that of 25 degrees, but the output generated are different

3.3 Discussion on Mass Flowrate Output Figures at 25 degree Celcius

This is the mass of flowrate that passes through a particular point at a given time. The mass flowrate of mercury, honey, 30weight of oil and fresh water are shown below in Figs. 3.9, 3.10, 3.11 and 3.12 respectively. The reason for this is that as tempertaure increases the molecules of fluid that are already bonded together continue to move and because of this it becomes lighter and the bond binding them together become more loose and oocupy more space.

Each figure consists of three windows namely the input window, the graph window and the animation window. The input window is used to input the radius of 0.4m, Dynamic Viscosity, Density and Pressure. The animation window display the pipe of 0.4m radius while the graph window display the graph of massflow rate for the selected fluids.

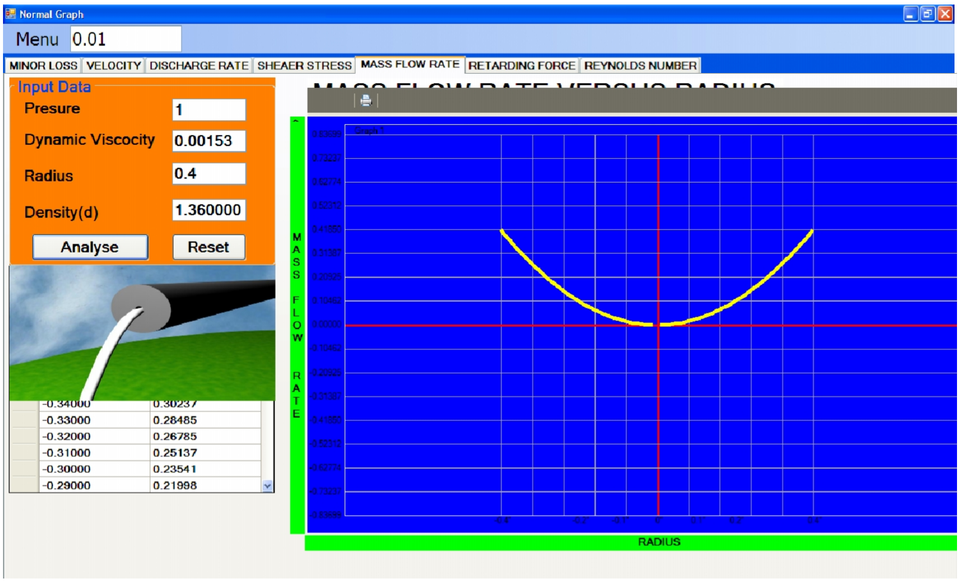

Fig 3.9. Massflow of mercury at 25degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.0153. This also produces a Sino cider shape, in which the generate value is total different at different temperature. The mass flow rate increases at the center pipe while it reduces toward the wall of the pipe

3.4 Discussion on Mass Flowrate Output Figures at 100-Degree Celcius

This is the mass of flowrate that passes through a particular point at a given time. The mass flowrate of mercury, honey, 30weight of oil and fresh water are as shown below in Figs. 3.13, 3.14, 3.15 and 3.16 respectively. The reason for this is that as tempertaure increases the molecules of fluid thet are already bonded together continue to move and because of this it become lighter and the bond binding them together become more loss and occupy more space. Each figure consists of three windows namely the input window, the graph window and the animation window. The input window is used to input the radius of 0.4m, the animation window display the pipe of 0.4m radius while the graph window display the graph of massflow rate for the selected fluids.

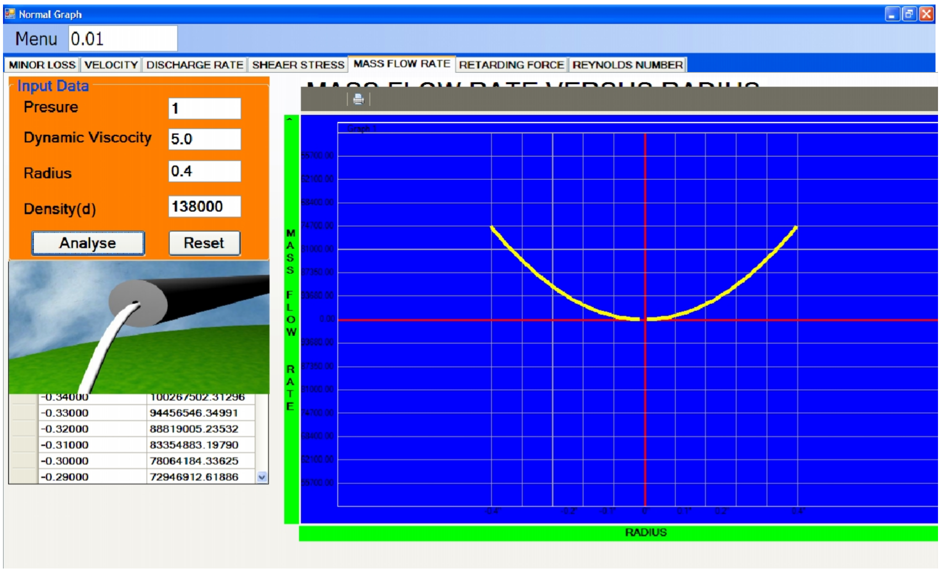

Fig 3.10. Mass flow of honey at 25-degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 5.0. This also produces a Sino cider shape, in which the generate value is total different at different temperature. The mass flow rate increases at the center pipe while it reduces toward the wall of the pipe. This generated a highest value as the radius changes.

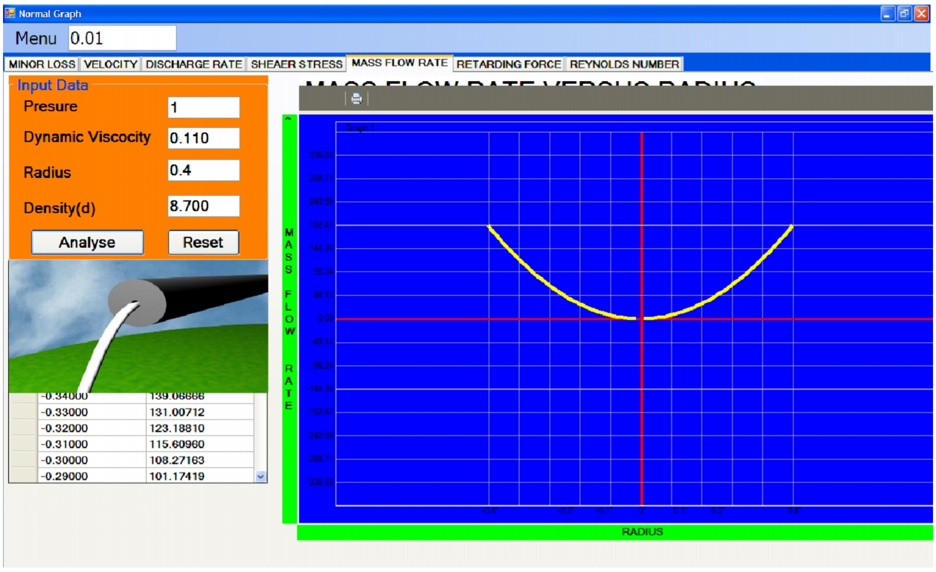

Fig 3.11. Mass flow rate of 30weight of oil at 25-degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.110. This also produces a Sino cider shape, in which the generate value is total different at different temperature. The mass flow rate increases at the center pipe while it reduces toward the wall of the pipe

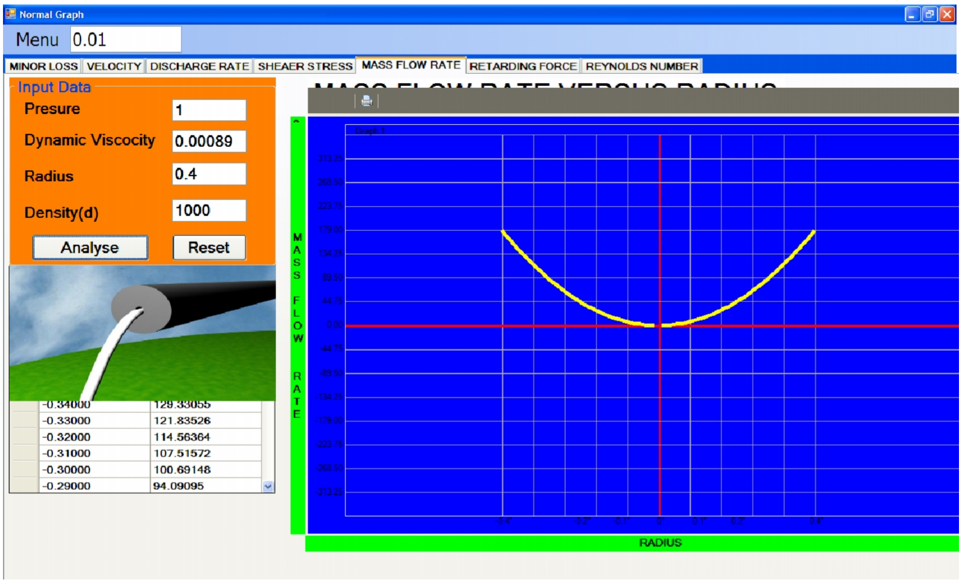

Fig 3.12. Massflow rate of fresh water at 25-degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.00089. This also produces a Sino cider shape, in which the generate value is total different at different temperature. The mass flow rate increases at the center pipe while it reduces toward the wall of the pipe

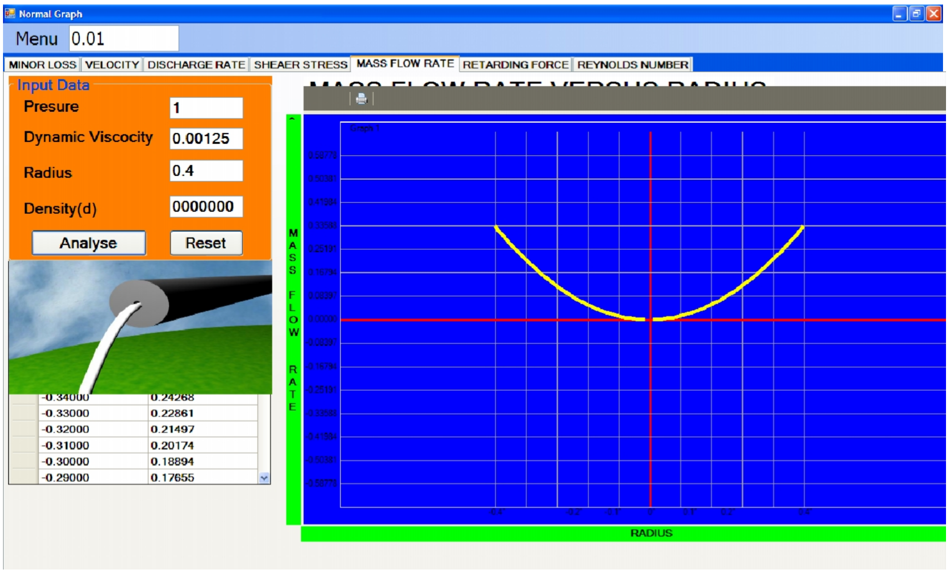

Fig 3.13. Massflow rate of mercury at 100degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.00125. This also produces a Sino cider shape, in which the generate value is total different at different temperature. The mass flow rate increases at the center pipe while it reduces toward the wall of the pipe

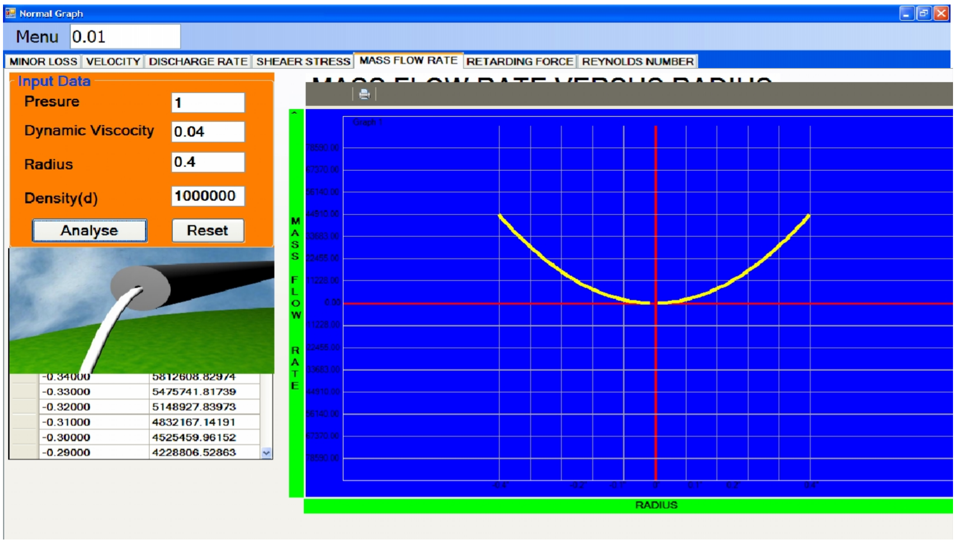

Fig 3.14. Massflow of honey at 100degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.04. This also produces a Sino cider shape, in which the generate value is total different at different temperature. The mass flow rate increases at the center pipe while it reduces toward the wall of the pipe

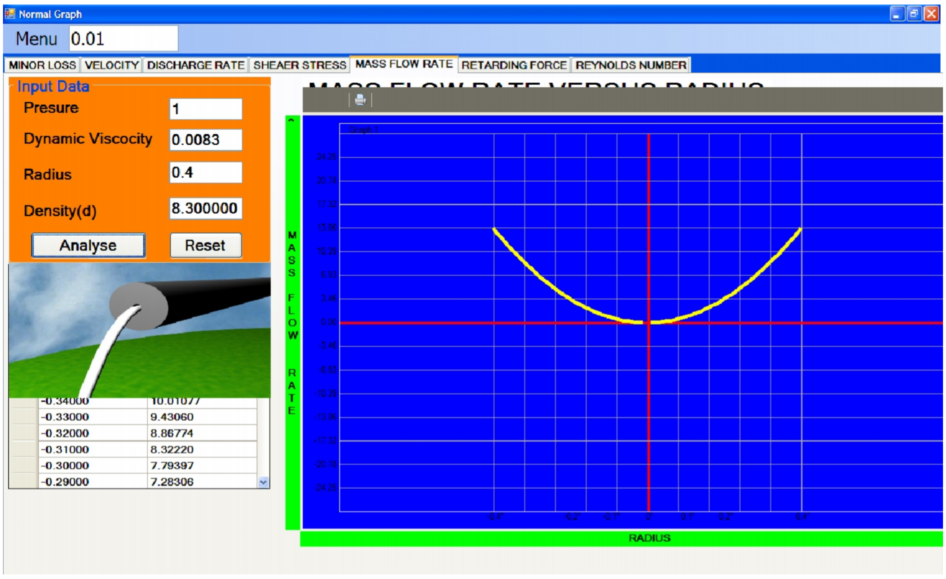

Fig 3.15. Mass flow rate of 30weight of oil at 100degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.0083. This also produces a Sino cider shape, in which the generate value is total different at different temperature. The mass flow rate increases at the center pipe while it reduces toward the wall of the pipe

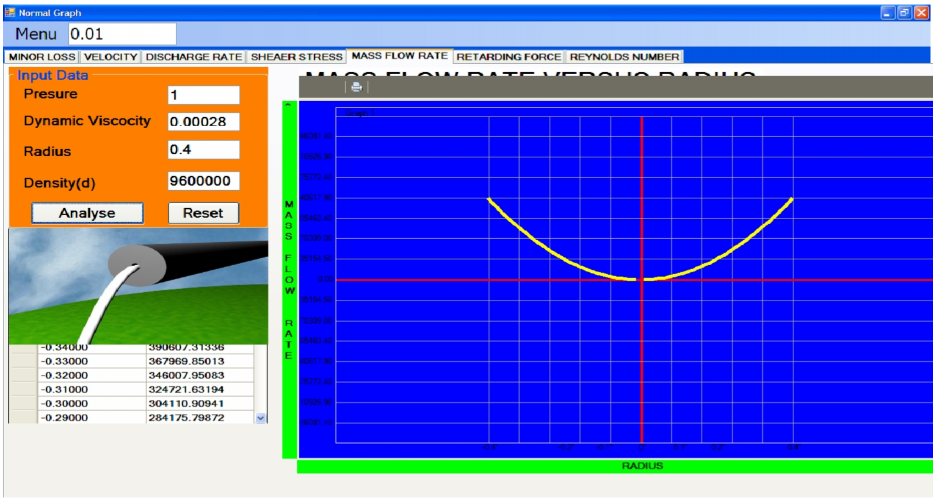

Fig 3.16. Massflow of fresh water at 100degree celcius with radius of 0.4m at pressure of one bar and dynamic viscosity of 0.00028. This also produces a Sino cider shape, in which the generate value is total different at different temperature. The mass flow rate increases at the center pipe while it reduces toward the wall of the pipe

3.5 Comparism of Retarding Force of Selected fluid at 25 and 100 Degree Celcius:

The Tables 3.1 and 3.2 below compare the retarding force of selected fluid at different degree celcius. Based on the result generated, temperature has no effect on the reatrding force and remains the same in any given fluid.

Table 3.1. Retarding force at 25 degree celcius with radius of 0.4m at pressure of one bar

Retarding force(N) at 25 degree celcius with radius of 0.4m				
Radius	**Fresh water**	**Honey**	**Mercury**	**30weight of oil**
-0.4	0	0	0	0
-0.39	-0.12414	-0.12414	-0.12414	-0.12414
-0.38	-0.24514	-0.24514	-0.24514	-0.24514
-0.37	-0.363	-0.363	-0.363	-0.363
-0.36	-0.47771	-0.47771	-0.47771	-0.47771
-0.35	-0.58929	-0.58929	-0.58929	-0.58929
-0.34	-0.69771	-0.69771	-0.69771	-0.69771
-0.33	-0.803	-0.803	-0.803	-0.803
-0.32	-0.90514	-0.90514	-0.90514	-0.90514
-0.31	-1.00414	-1.00414	-1.00414	-1.00414
-0.3	-1.1	-1.1	-1.1	-1.1
-0.29	-1.19271	-1.19271	-1.19271	-1.19271
-0.28	-1.28229	-1.28229	-1.28229	-1.28229
-0.27	-1.36871	-1.36871	-1.36871	-1.36871
-0.26	-1.452	-1.452	-1.452	-1.452

-0.25	-1.53214	-1.53214	-1.53214	-1.53214
-0.24	-1.60914	-1.60914	-1.60914	-1.60914
-0.23	-1.683	-1.683	-1.683	-1.683
-0.22	-1.75371	-1.75371	-1.75371	-1.75371
-0.21	-1.82129	-1.82129	-1.82129	-1.82129
-0.2	-1.88571	-1.88571	-1.88571	-1.88571
-0.19	-1.947	-1.947	-1.947	-1.947
-0.18	-2.00514	-2.00514	-2.00514	-2.00514
-0.17	-2.06014	-2.06014	-2.06014	-2.06014
-0.16	-2.112	-2.112	-2.112	-2.112
-0.15	-2.16071	-2.16071	-2.16071	-2.16071
-0.14	-2.20629	-2.20629	-2.20629	-2.20629
-0.13	-2.24871	-2.24871	-2.24871	-2.24871
-0.12	-2.288	-2.288	-2.288	-2.288
-0.11	-2.32414	-2.32414	-2.32414	-2.32414
-0.1	-2.35714	-2.35714	-2.35714	-2.35714
-0.09	-2.387	-2.387	-2.387	-2.387
-0.08	-2.41371	-2.41371	-2.41371	-2.41371
-0.07	-2.43729	-2.43729	-2.43729	-2.43729
-0.06	-2.45771	-2.45771	-2.45771	-2.45771
-0.05	-2.475	-2.475	-2.475	-2.475
-0.04	-2.48914	-2.48914	-2.48914	-2.48914
-0.03	-2.50014	-2.50014	-2.50014	-2.50014
-0.02	-2.508	-2.508	-2.508	-2.508
-0.01	-2.51271	-2.51271	-2.51271	-2.51271
0	-2.51429	-2.51429	-2.51429	-2.51429
0.01	-2.51271	-2.51271	-2.51271	-2.51271
0.02	-2.508	-2.508	-2.508	-2.508
0.03	-2.50014	-2.50014	-2.50014	-2.50014
0.04	-2.48914	-2.48914	-2.48914	-2.48914
0.05	-2.475	-2.475	-2.475	-2.475
0.06	-2.45771	-2.45771	-2.45771	-2.45771
0.07	-2.43729	-2.43729	-2.43729	-2.43729
0.08	-2.41371	-2.41371	-2.41371	-2.41371
0.09	-2.387	-2.387	-2.387	-2.387
0.1	-2.35714	-2.35714	-2.35714	-2.35714
0.11	-2.32414	-2.32414	-2.32414	-2.32414
0.12	-2.288	-2.288	-2.288	-2.288
0.13	-2.24871	-2.24871	-2.24871	-2.24871
0.14	-2.20629	-2.20629	-2.20629	-2.20629
0.15	-2.16071	-2.16071	-2.16071	-2.16071
0.16	-2.112	-2.112	-2.112	-2.112
0.17	-2.06014	-2.06014	-2.06014	-2.06014
0.18	-2.00514	-2.00514	-2.00514	-2.00514
0.19	-1.947	-1.947	-1.947	-1.947
0.2	-1.88571	-1.88571	-1.88571	-1.88571
0.21	-1.82129	-1.82129	-1.82129	-1.82129
0.22	-1.75371	-1.75371	-1.75371	-1.75371
0.23	-1.683	-1.683	-1.683	-1.683

0.24	-1.60914	-1.60914	-1.60914	-1.60914
0.25	-1.53214	-1.53214	-1.53214	-1.53214
0.26	-1.452	-1.452	-1.452	-1.452
0.27	-1.36871	-1.36871	-1.36871	-1.36871
0.28	-1.28229	-1.28229	-1.28229	-1.28229
0.29	-1.19271	-1.19271	-1.19271	-1.19271
0.3	-1.1	-1.1	-1.1	-1.1
0.31	-1.00414	-1.00414	-1.00414	-1.00414
0.32	-0.90514	-0.90514	-0.90514	-0.90514
0.33	-0.803	-0.803	-0.803	-0.803
0.34	-0.69771	-0.69771	-0.69771	-0.69771
0.35	-0.58929	-0.58929	-0.58929	-0.58929
0.36	-0.47771	-0.47771	-0.47771	-0.47771
0.37	-0.363	-0.363	-0.363	-0.363
0.38	-0.24514	-0.24514	-0.24514	-0.24514
0.39	-0.12414	-0.12414	-0.12414	-0.12414
0.4	0	0	0	0

The above Table shows that the increase in the radius changes the effect of the retarding force of fresh water, honey, mercury and 30 weight of oil at 25 degrees temperature.

Table 3.2. Retarding at 100 degree celcius with radius of 0.4m at pressure of one bar

Retarding force(n) at 100 degree celcius with radius of 0.4m				
Radius	**Fresh water**	**Honey**	**Mercury**	**30weight of oil**
-0.4	0	0	0	0
-0.39	-0.12414	-0.12414	-0.12414	-0.12414
-0.38	-0.24514	-0.24514	-0.24514	-0.24514
-0.37	-0.363	-0.363	-0.363	-0.363
-0.36	-0.47771	-0.47771	-0.47771	-0.47771
-0.35	-0.58929	-0.58929	-0.58929	-0.58929
-0.34	-0.69771	-0.69771	-0.69771	-0.69771
-0.33	-0.803	-0.803	-0.803	-0.803
-0.32	-0.90514	-0.90514	-0.90514	-0.90514
-0.31	-1.00414	-1.00414	-1.00414	-1.00414
-0.3	-1.1	-1.1	-1.1	-1.1
-0.29	-1.19271	-1.19271	-1.19271	-1.19271
-0.28	-1.28229	-1.28229	-1.28229	-1.28229
-0.27	-1.36871	-1.36871	-1.36871	-1.36871
-0.26	-1.452	-1.452	-1.452	-1.452
-0.25	-1.53214	-1.53214	-1.53214	-1.53214
-0.24	-1.60914	-1.60914	-1.60914	-1.60914
-0.23	-1.683	-1.683	-1.683	-1.683
-0.22	-1.75371	-1.75371	-1.75371	-1.75371
-0.21	-1.82129	-1.82129	-1.82129	-1.82129
-0.2	-1.88571	-1.88571	-1.88571	-1.88571
-0.19	-1.947	-1.947	-1.947	-1.947
-0.18	-2.00514	-2.00514	-2.00514	-2.00514

-0.17	-2.06014	-2.06014	-2.06014	-2.06014
-0.16	-2.112	-2.112	-2.112	-2.112
-0.15	-2.16071	-2.16071	-2.16071	-2.16071
-0.14	-2.20629	-2.20629	-2.20629	-2.20629
-0.13	-2.24871	-2.24871	-2.24871	-2.24871
-0.12	-2.288	-2.288	-2.288	-2.288
-0.11	-2.32414	-2.32414	-2.32414	-2.32414
-0.1	-2.35714	-2.35714	-2.35714	-2.35714
-0.09	-2.387	-2.387	-2.387	-2.387
-0.08	-2.41371	-2.41371	-2.41371	-2.41371
-0.07	-2.43729	-2.43729	-2.43729	-2.43729
-0.06	-2.45771	-2.45771	-2.45771	-2.45771
-0.05	-2.475	-2.475	-2.475	-2.475
-0.04	-2.48914	-2.48914	-2.48914	-2.48914
-0.03	-2.50014	-2.50014	-2.50014	-2.50014
-0.02	-2.508	-2.508	-2.508	-2.508
-0.01	-2.51271	-2.51271	-2.51271	-2.51271
0	-2.51429	-2.51429	-2.51429	-2.51429
0.01	-2.51271	-2.51271	-2.51271	-2.51271
0.02	-2.508	-2.508	-2.508	-2.508
0.03	-2.50014	-2.50014	-2.50014	-2.50014
0.04	-2.48914	-2.48914	-2.48914	-2.48914
0.05	-2.475	-2.475	-2.475	-2.475
0.06	-2.45771	-2.45771	-2.45771	-2.45771
0.07	-2.43729	-2.43729	-2.43729	-2.43729
0.08	-2.41371	-2.41371	-2.41371	-2.41371
0.09	-2.387	-2.387	-2.387	-2.387
0.1	-2.35714	-2.35714	-2.35714	-2.35714
0.11	-2.32414	-2.32414	-2.32414	-2.32414
0.12	-2.288	-2.288	-2.288	-2.288
0.13	-2.24871	-2.24871	-2.24871	-2.24871
0.14	-2.20629	-2.20629	-2.20629	-2.20629
0.15	-2.16071	-2.16071	-2.16071	-2.16071
0.16	-2.112	-2.112	-2.112	-2.112
0.17	-2.06014	-2.06014	-2.06014	-2.06014
0.18	-2.00514	-2.00514	-2.00514	-2.00514
0.19	-1.947	-1.947	-1.947	-1.947
0.2	-1.88571	-1.88571	-1.88571	-1.88571
0.21	-1.82129	-1.82129	-1.82129	-1.82129
0.22	-1.75371	-1.75371	-1.75371	-1.75371
0.23	-1.683	-1.683	-1.683	-1.683
0.24	-1.60914	-1.60914	-1.60914	-1.60914
0.25	-1.53214	-1.53214	-1.53214	-1.53214
0.26	-1.452	-1.452	-1.452	-1.452
0.27	-1.36871	-1.36871	-1.36871	-1.36871
0.28	-1.28229	-1.28229	-1.28229	-1.28229
0.29	-1.19271	-1.19271	-1.19271	-1.19271
0.3	-1.1	-1.1	-1.1	-1.1
0.31	-1.00414	-1.00414	-1.00414	-1.00414

0.32	-0.90514	-0.90514	-0.90514	-0.90514
0.33	-0.803	-0.803	-0.803	-0.803
0.34	-0.69771	-0.69771	-0.69771	-0.69771
0.35	-0.58929	-0.58929	-0.58929	-0.58929
0.36	-0.47771	-0.47771	-0.47771	-0.47771
0.37	-0.363	-0.363	-0.363	-0.363
0.38	-0.24514	-0.24514	-0.24514	-0.24514
0.39	-0.12414	-0.12414	-0.12414	-0.12414
0.4	0	0	0	0

The above Table shows that the increase in the radius changes the effect of the retarding force of fresh water, honey, mercury and 30 weight of oil at 100 degrees temperature.

3.6 Comparism of Mass Flowrate of Selected Fluid at 25 and 100 Degree Celcius

This is the mass of flow that passes through a particular point at a given time. The mass flowrate of selected fluid are compared at 25 degree celcius and 100 degree celcius respectively as shown below in Tables 3.3 and 3.4. The mass flow rate increases with increase in temperatue for all the seleced fluid.

Table 3.3. Mass flow rate at 25 degree celcius with radius of 0.4m at pressure of one bar

Mass flow rate(kg/s) at 25 degree celcius with radius of 0.4m				
Radius	**Fresh water**	**Honey**	**Mercury**	**30weight of oil**
-0.4	178.99925	138774696.7	0.4185	192.47447
-0.39	170.162	131923347.7	0.39783	182.97194
-0.38	161.5484	125245385.5	0.3777	173.7099
-0.37	153.15844	118740815.1	0.35808	164.68834
-0.36	144.99215	112409641.2	0.33899	155.90728
-0.35	137.04951	106251868.8	0.32042	147.36672
-0.34	129.33055	100267502.3	0.30237	139.06666
-0.33	121.83526	94456546.35	0.28485	131.00712
-0.32	114.56364	88819005.24	0.26785	123.1881
-0.31	107.51572	83354883.2	0.25137	115.6096
-0.3	100.69148	78064184.34	0.23541	108.27163
-0.29	94.09095	72946912.62	0.21998	101.17419
-0.28	87.71411	68003071.88	0.20507	94.3173
-0.27	81.56097	63232665.84	0.19069	87.70096
-0.26	75.63155	58635698.07	0.17682	81.32516
-0.25	69.92585	54212172.01	0.16349	75.18992
-0.24	64.44386	49962090.98	0.15067	69.29525
-0.23	59.18559	45885458.18	0.13837	63.64113
-0.22	54.15105	41982276.67	0.1266	58.22759
-0.21	49.34024	38252549.35	0.11536	53.05462
-0.2	44.75317	34696279.05	0.10463	48.12223
-0.19	40.38984	31313468.41	0.09443	43.43042
-0.18	36.25024	28104119.99	0.08475	38.97919

-0.17	32.33439	25068236.19	0.0756	34.76855
-0.16	28.64229	22205819.27	0.06697	30.79851
-0.15	25.17394	19516871.4	0.05886	27.06905
-0.14	21.92934	17001394.59	0.05127	23.58019
-0.13	18.90849	14659390.72	0.04421	20.33194
-0.12	16.1114	12490861.55	0.03767	17.32428
-0.11	13.53807	10495808.71	0.03165	14.55723
-0.1	11.1885	8674233.697	0.02616	12.03078
-0.09	9.0627	7026137.871	0.02119	9.74495
-0.08	7.16066	5551522.471	0.01674	7.69972
-0.07	5.48239	4250388.603	0.01282	5.8951
-0.06	4.02788	3122737.242	0.00942	4.3311
-0.05	2.79714	2168569.236	0.00654	3.00771
-0.04	1.79017	1387885.298	0.00419	1.92494
-0.03	1.00697	780686.0158	0.00235	1.08278
-0.02	0.44754	346971.8433	0.00105	0.48123
-0.01	0.11189	86743.10636	0.00026	0.12031
0	0	0	0	0
0.01	0.11189	86742.58933	0.00026	0.12031
0.02	0.44754	346970.8093	0.00105	0.48123
0.03	1.00697	780684.4647	0.00235	1.08278
0.04	1.79017	1387883.23	0.00419	1.92493
0.05	2.79714	2168566.651	0.00654	3.00771
0.06	4.02787	3122734.14	0.00942	4.3311
0.07	5.48238	4250384.984	0.01282	5.8951
0.08	7.16065	5551518.335	0.01674	7.69971
0.09	9.06269	7026133.218	0.02119	9.74494
0.1	11.1885	8674228.527	0.02616	12.03078
0.11	13.53806	10495803.03	0.03165	14.55722
0.12	16.11139	12490855.35	0.03767	17.32427
0.13	18.90848	14659384	0.04421	20.33193
0.14	21.92933	17001387.35	0.05127	23.58018
0.15	25.17393	19516863.65	0.05886	27.06904
0.16	28.64228	22205811	0.06697	30.79849
0.17	32.33438	25068227.4	0.0756	34.76854
0.18	36.25023	28104110.68	0.08475	38.97918
0.19	40.38982	31313458.59	0.09443	43.4304
0.2	44.75316	34696268.71	0.10463	48.12222
0.21	49.34023	38252538.5	0.11536	53.05461
0.22	54.15104	41982265.29	0.1266	58.22758
0.23	59.18558	45885446.29	0.13837	63.64112
0.24	64.44384	49962078.58	0.15067	69.29523
0.25	69.92583	54212159.08	0.16349	75.18991
0.26	75.63154	58635684.62	0.17682	81.32514
0.27	81.56096	63232651.88	0.19069	87.70094
0.28	87.71409	68003057.41	0.20507	94.31728
0.29	94.09093	72946897.63	0.21998	101.17417
0.3	100.69146	78064168.83	0.23541	108.27161
0.31	107.5157	83354867.17	0.25137	115.60957

0.32	114.56362	88818988.69	0.26785	123.18807
0.33	121.83523	94456529.29	0.28485	131.0071
0.34	129.33052	100267484.7	0.30237	139.06664
0.35	137.04949	106251850.7	0.32042	147.36669
0.36	144.99212	112409622.6	0.33899	155.90726
0.37	153.15842	118740795.9	0.35808	164.68832
0.38	161.54837	125245365.9	0.3777	173.70987
0.39	170.16197	131923327.6	0.39783	182.97192
0.4	178.99922	138774676	0.4185	192.47444

The above Table shows that the increase in the radius changes the effect of the mass flow rate of fresh water, honey, mercury and 30 weight of oil at 25 degrees temperature. Honey has the highest mass flow rate as the radius changes.

Table 3.4. Mass flow rate at 100 degree celcius with radius of 0.4m at pressure of one bar

Mass flow rate(m3/s) at 100 degree celcius with radius of 0.4m				
Radius	**Fresh water**	**Honey**	**Mercury**	**30weight of oil**
-0.4	540617.9489	8044909.954	0.33587	13.85535
-0.39	513927.4764	7647730.304	0.31929	13.1713
-0.38	487912.4584	7260602.059	0.30313	12.50457
-0.37	462572.9143	6883525.51	0.28739	11.85515
-0.36	437908.8632	6516500.94	0.27206	11.22304
-0.35	413920.3235	6159528.624	0.25716	10.60825
-0.34	390607.3134	5812608.83	0.24268	10.01077
-0.33	367969.8501	5475741.817	0.22861	9.4306
-0.32	346007.9508	5148927.84	0.21497	8.86774
-0.31	324721.6319	4832167.142	0.20174	8.3222
-0.3	304110.9094	4525459.962	0.18894	7.79397
-0.29	284175.7987	4228806.529	0.17655	7.28306
-0.28	264916.3148	3942207.066	0.16459	6.78947
-0.27	246332.4721	3665661.788	0.15304	6.31319
-0.26	228424.2846	3399170.902	0.14192	5.85422
-0.25	211191.7657	3142734.609	0.13121	5.41257
-0.24	194634.9284	2896353.101	0.12092	4.98824
-0.23	178753.7849	2660026.561	0.11106	4.58123
-0.22	163548.3474	2433755.169	0.10161	4.19153
-0.21	149018.6271	2217539.093	0.09258	3.81916
-0.2	135164.6349	2011378.496	0.08398	3.4641
-0.19	121986.3813	1815273.531	0.07579	3.12635
-0.18	109483.8761	1629224.347	0.06802	2.80593
-0.17	97657.12879	1453231.083	0.06067	2.50283
-0.16	86506.14813	1287293.871	0.05374	2.21704
-0.15	76030.94251	1131412.835	0.04724	1.94858
-0.14	66231.51979	985588.0921	0.04115	1.69743
-0.13	57107.88733	849819.7519	0.03548	1.4636
-0.12	48660.05197	724107.9162	0.03023	1.24709
-0.11	40888.02003	608452.6791	0.0254	1.04791
-0.1	33791.79736	502854.1274	0.02099	0.86604
-0.09	27371.38927	407312.3404	0.01701	0.70149

-0.08	21626.80058	321827.3896	0.01344	0.55427
-0.07	16558.0356	246399.3393	0.01029	0.42436
-0.06	12165.09813	181028.2459	0.00756	0.31178
-0.05	8447.99146	125714.1586	0.00525	0.21651
-0.04	5406.71838	80457.11875	0.00336	0.13857
-0.03	3041.28117	45257.16034	0.00189	0.07794
-0.02	1351.68162	20114.30976	0.00084	0.03464
-0.01	337.92097	5028.58588	0.00021	0.00866
0	0	0	0	0
0.01	337.91896	5028.5559	0.00021	0.00866
0.02	1351.67759	20114.24981	0.00084	0.03464
0.03	3041.27513	45257.07042	0.00189	0.07794
0.04	5406.71032	80456.99886	0.00336	0.13857
0.05	8447.98139	125714.0087	0.00525	0.21651
0.06	12165.08604	181028.0661	0.00756	0.31178
0.07	16558.0215	246399.1295	0.01029	0.42436
0.08	21626.78447	321827.1498	0.01344	0.55427
0.09	27371.37114	407312.0706	0.01701	0.70149
0.1	33791.77722	502853.8277	0.02099	0.86604
0.11	40887.99788	608452.3494	0.0254	1.04791
0.12	48660.0278	724107.5565	0.03023	1.24709
0.13	57107.86115	849819.3623	0.03548	1.4636
0.14	66231.49159	985587.6725	0.04115	1.69743
0.15	76030.9123	1131412.385	0.04724	1.94858
0.16	86506.1159	1287293.391	0.05374	2.21704
0.17	97657.09455	1453230.574	0.06067	2.50283
0.18	109483.8399	1629223.808	0.06802	2.80593
0.19	121986.343	1815272.962	0.07579	3.12635
0.2	135164.5946	2011377.896	0.08398	3.4641
0.21	149018.5848	2217538.464	0.09258	3.81916
0.22	163548.3031	2433754.51	0.10161	4.19153
0.23	178753.7386	2660025.872	0.11106	4.58123
0.24	194634.88	2896352.381	0.12092	4.98824
0.25	211191.7154	3142733.86	0.13121	5.41257
0.26	228424.2323	3399170.123	0.14192	5.85422
0.27	246332.4178	3665660.979	0.15304	6.31318
0.28	264916.2584	3942206.227	0.16459	6.78946
0.29	284175.7403	4228805.66	0.17655	7.28306
0.3	304110.849	4525459.062	0.18894	7.79397
0.31	324721.5695	4832166.213	0.20174	8.3222
0.32	346007.8864	5148926.881	0.21497	8.86774
0.33	367969.7837	5475740.828	0.22861	9.43059
0.34	390607.2449	5812607.811	0.24268	10.01076
0.35	413920.2531	6159527.575	0.25716	10.60825
0.36	437908.7907	6516499.861	0.27206	11.22304
0.37	462572.8398	6883524.402	0.28739	11.85515
0.38	487912.3819	7260600.92	0.30313	12.50457
0.39	513927.3979	7647729.135	0.31929	13.1713
0.4	540617.8684	8044908.755	0.33587	13.85534

The above Table shows that the increase in the radius changes the effect of the mass flow rate of fresh water, honey, mercury and 30 weight of oil at 25 degrees temperature..

4 Conclusion and Recommendation

Based on the results generated above, software visualization was developed using mathematical formulation to compare the effect of retarding force on mass flow rate of fluid flowing through a given a pipe at different temperature and radius. This study examines the effect of temperature changes and changes in radius on fluid flowing through a given pipe. We conclude that:

1. The region with high mass flow rate will have low retarding force.
2. The mass flow rate of fluid are very high at the center of the pipe while the retarding force is negligible.
3. The retarding force is higher at the wall of the pipe while the mass flow rate is low.
4. The velocity flow rate of the fluid in pipes is been determine by the radial of the pipe.
5. The flow in pipe takes place at both side of the pipe, (The physical and visual view).
6. The temperatures and the radial of the pipe have effect on the retarding force and mass flows rate of fluid.
7. Honey has the highest mass flows rate compare to fresh water and mercury. We hereby recommend that:

    1 The designer of the pipe needs to consider retarding force in order to avoid spillage in pipe.
    2 The retarding force in fluid at a particular temperature must also be considered in order to avoid over shortage in mass flow rate.
    3 The velocity flow rate must also be consider to avoid bursting of the pipes, since velocity play a major role in determining mass flow rate.
    4 During the construction of the pipe for usage, the visual view that is the part that is not view when the pipe in lay should be properly guided to avoid destruction of the actual shade of the pipe, since this will affect the flow of the fluid in pipes.

Competing Interests

Authors have declared that no competing interests exist.

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