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SOFTWARE VISUALIZATION OF POROUS MEDIA WITH EMPHASIS ON MASS FLOW RATE DETERMINATON AS TEMPERATURE CHANGES

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ABSTRACT

Background: *Software development has been in existence since the last three decades, when the computer age started, as the software developments became more complex, so does the task of understanding them. Even some time, it is very difficult for the developers to interpret the source and object codes to the users.*

Objective*: Based on the problems mentioned above, this work is developed software visualization for porous media with Graphical User Interface (GUI) application. Software visualization (SV) uses computer graphics to communicate the structure and behavior of computer software and algorithms.*

Fluid, which comprise both liquid and gases play very vital roles in human life and machines performances. This fluid always becomes useful when it tranfers or move from one point to another and this normally possible through pipe. The quantity or mass of fluid that passes through the pipe need to be determined especialy by the designers of pipe and the end users of the fluid.

Method: *Inorder to develop the software visualization for this work, the model which based on modified Heagen equation was modified to determine different mass flow rate at different temperature. The visual pipe for representation of different mass flow rate was developed with Autodesk Mayer and embedded in C# program for easy visualization.*

Results: *With this software visualization, easy visualization of mass flow partterns can be examined and viewed.*

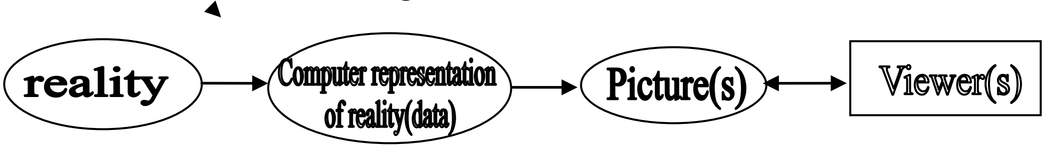
Conclution: *This work will definitely assist the experts in fluid, pipes designers, and end users of fluid to determine at ease and at safe cost series of mass flow rate at different temperature.*

Key Words: Software visualization, Porous media, Mass flow rate, Temperature changes.

INTRODUCTION

Determination of mass flow rate of fluid is very important for any designer of pipe, so in other to know the quantity of fluid that can pass through the pipe at any given time before the actual design. Software visualization has a great role to play in determination of mass flow rate in graphical forms.Software is defined as a set of instruction designed to perform certain processing on the inputs to produce certain results (Raisinghania, 2003; Jawadekar, 2006). Software is not like hardware components because it is not physical product that has specification like dimensions, weight, Height and so on. It is referred to as an invisible component of computer system. Visualization is the systematic and focuses visual display of information in form of tables, diagrams and graphs (Turfle, 2001). The classical definition of visualization is describe as the formation of mental visual images, the act or process of interpreting in visual term
Simple illustration of visualization process is given below:

Figure-1. Visualisation Process



For software visualization to be meaningfull, it must be related to an object or substance which is a visualized object or substance. Fluid can be described in many forms as given below

Fluid is defined as a substance which cannot withstand a shear force or stress without moving when compared with solid, (John *et al.*, 2009). Fluid can also be defined as a substance which continously deform when a shear stress is appled.It is further classified fluids as liquids or gases,. (John *et al.*, 2009) It is as well regarded a liquid which has intermolecular forces which hold it together so that it possesses volume but no definite shape, (Raisinghania, 2003). They also classified fluid by the types of their flow into laminar and turbulent flow. Classified fluid by the types of their flow into laminar and turbulent flow (Patankar, 1974; Raisinghania, 2003; John *et al.*, 2009) The term laminar flow means a fluid flow which flows in laminas or layers as opposed to the turbulent flow in which the velocity component have random turbulent fluctuations imposed upon their means values. Since we know that fluid cannot flow without pass through an object and the most common object is pipe Pipeline system ranges from simple ones to complex ones (Ovri and Ofeke, 1998).(Bruce, 2009) And (Reisherg, 1997) describe that 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 to the length and radius of the pipe.
The solution to these problems must be provided in order to achieve the objectives of the designers so that the design pipes can allow the flow of fluid to undergo expected trends, with these in mind,

visualization is hereby proposed as method of determining the trends and patterns of fluid flow in pipe.

METHODOLOGY

The material for this study was collected using observation and interview method.
The object oriented programing language was used to analyse and visualize the mass flow rate in graphical and in tabular form.
This was based on the mathematical model that was developed as follow:
The equation 1 below is the Heagen Postullate equation which serves as the basis for the model that needs to be developed.

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

Where:
P = Pressure of pipe (bar)
u = Velocity of pipe (m/s)
r = radius of the pipe
A, B= parameter constant
when equation 1 above is subjected to the following conditions
u = 0, r = e, parameter constant A = 0
The equation 2 below is generated which is the total velocity

$$-\sum_{e_i=-r}^{e_i=r} \frac{pe_i^2}{4k}\left(1-\frac{r^2}{e_i^2}\right) \qquad \text{Eq2}$$

The Mass flow rate can be calculated as M=ℓ.Q

Where

ℓ = Density of the fluid

Q = Discharge rate of the fluid which is Area of the pipe multiplied with velocity of the fluid.
The Total Mass flow rate will be given as:

$$\ell\pi e^2 \sum_{e_i=-r}^{e_i=r} \frac{pe_i^2}{4k}\left(1-\frac{r^2}{e_i^2}\right) \qquad \text{Eq3}$$

RESULTS

For clear presentaion of result of findings, the results were presented in graphical form as follow using C# which is an object oriented programming language according to (Harold, 2002).

Discussion on Mass Flowrate Output figures

The figures 2, 3 and 4 below show the effect of temperature at 0°, 20° and 100° respectively on mass flow rate of water.

Fig-2. Mass flow rate of water at 0 degree with radious of 0.4m at presseure of 100bar

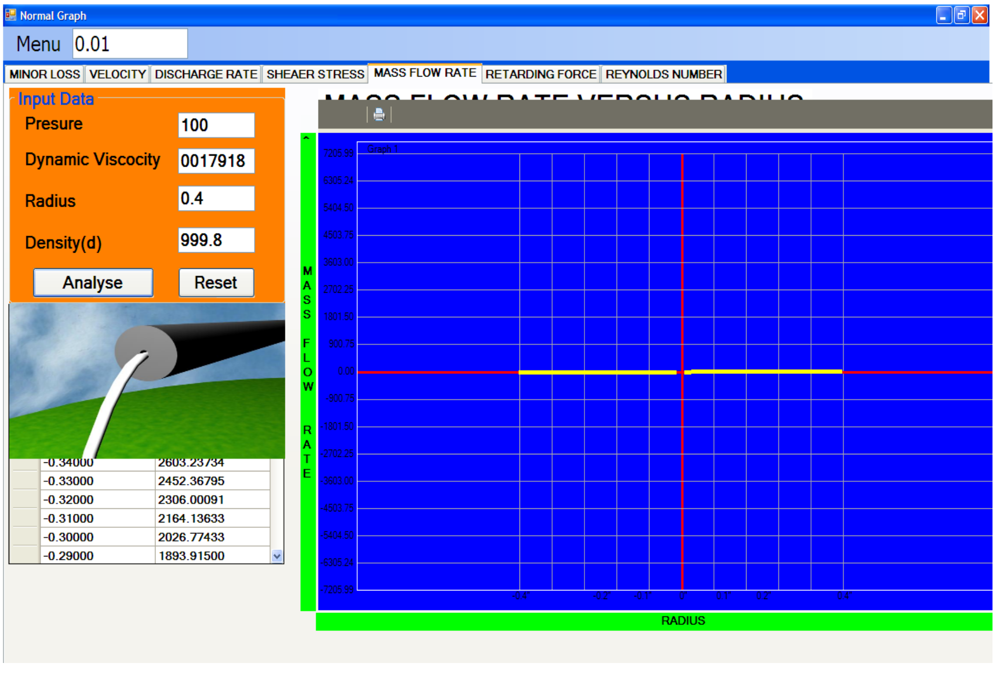


Fig-3. Mass flow rate of water at 20 degree with radious of 0.6m at presseure of 100bar

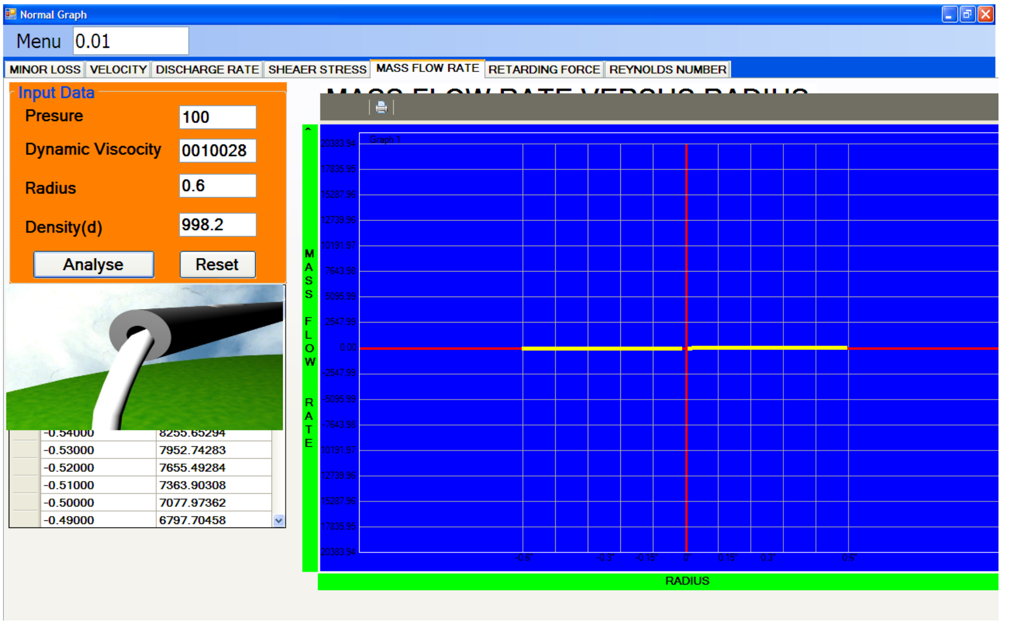
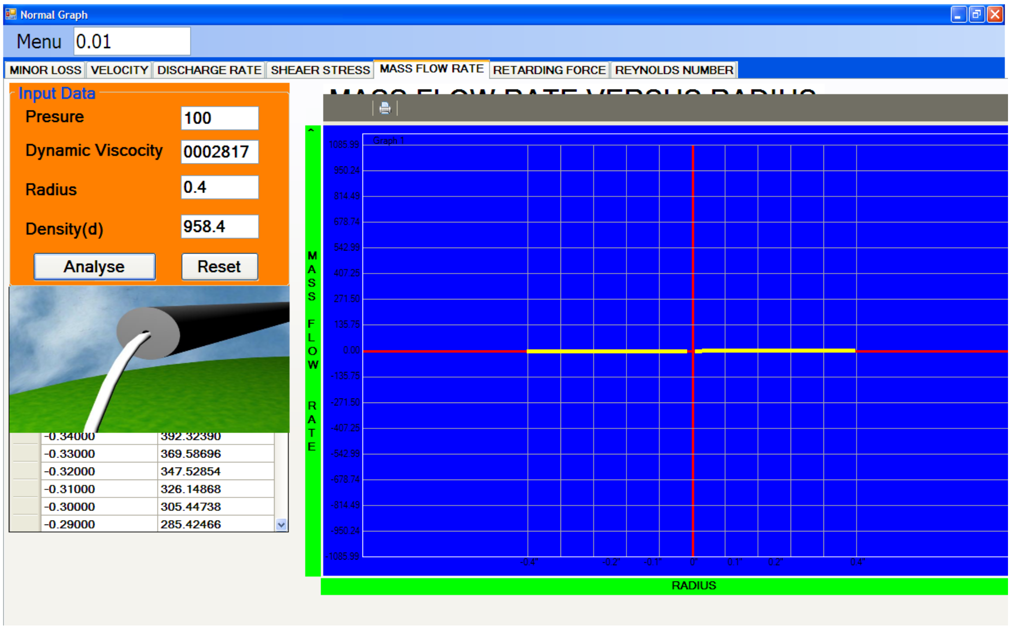


Fig-4. Mass flow rate of water at 100 degree with radious of 0.4m at presseure of 100bar



DISCUSSIONS

With reference to the figures 2,3,4 above it implies that the higher the temperature the lower the mass flow rate and vice versa as illustrated at point 0.33000 radius with 369.58696 and 2452.36796 at zero and hundred degree respectively. The reason this for pheneomenum 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 loss and occupy less weight.

This is the mass of flow that passes through a particular point at a given time. The mass flowrate of water at 0, 20 and 100 degree as shown above in Tables 1, 2 and 3 respectively. The chosen radii were .8, .6 and .4 m respectively. It can also be deduced from the tables that as the point in the radius increases, the mass flow rate reduces. Also, as the temperature increases, the mass flow rate increases. The effidence can be found by comparing the values in the tables 1 and 3 above.

CONCLUSION AND RECOMMADATIONS

This work has clearly shown that the temprature play a vital role in mass of fluid that passes through a pipe at given time. With the results of the findings, the recommendations are as follow:

i, designer of the pipe must consider the environmental temperature.

ii, the radius of pipe must be in proportional to amount of fluid needed by end users to avoid spillage

Table-1. Mass flow rate of water at 0 degree with radious of 0.4m at presseure of 100bar

Radius(m)	Mass Flow Rate(Kg/s)
-0.40000	3602.99663
-0.39000	3425.11559
-0.38000	3251.73618
-0.37000	3082.85852
-0.36000	2918.48275
-0.35000	2758.60898
-0.34000	2603.23734
-0.33000	2452.36795
-0.32000	2306.00091
-0.31000	2164.13633
-0.30000	2026.77433
-0.29000	1893.91500
-0.28000	1765.55845
-0.27000	1641.70477
-0.26000	1522.35406
-0.25000	1407.50639
-0.24000	1297.16187
-0.23000	1191.32057
-0.22000	1089.98257
-0.21000	993.14796
-0.20000	900.81679
-0.19000	812.98914
-0.18000	729.66508
-0.17000	650.84466
-0.16000	576.52795
-0.15000	506.71501
-0.14000	441.40588
-0.13000	380.60062
-0.12000	324.29926
-0.11000	272.50186
-0.10000	225.20845
-0.09000	182.41907
-0.08000	144.13374
-0.07000	110.35251
-0.06000	81.07538
-0.05000	56.30239

-0.04000	36.03356
-0.03000	20.26889
-0.02000	9.00840
-0.01000	2.25210
0.00000	0.00000
0.01000	2.25209
0.02000	9.00838
0.03000	20.26885
0.04000	36.03350
0.05000	56.30233
0.06000	81.07530
0.07000	110.35241
0.08000	144.13364
0.09000	182.41895
0.10000	225.20832
0.11000	272.50172
0.12000	324.29910
0.13000	380.60044
0.14000	441.40569
0.15000	506.71481
0.16000	576.52774
0.17000	650.84443
0.18000	729.66483
0.19000	812.98888
0.20000	900.81652
0.21000	993.14767
0.22000	1089.98228
0.23000	1191.32026
0.24000	1297.16155
0.25000	1407.50606
0.26000	1522.35371
0.27000	1641.70441
0.28000	1765.55808
0.29000	1893.91461
0.30000	2026.77393
0.31000	2164.13591
0.32000	2306.00048

0.33000	2452.36750
0.34000	2603.23689
0.35000	2758.60851
0.36000	2918.48226
0.37000	3082.85802
0.38000	3251.73567
0.39000	3425.11506
0.40000	3602.99609

Table-2. Mass flow rate of water at 20 degree with radious of 0.6m at presseure of 100bar

Radius(m)	Mass Flow Rate(Kg/s)
-0.60000	10191.97031
-0.59000	9855.10167
-0.58000	9523.89252
-0.57000	9198.34296
-0.56000	8878.45311
-0.55000	8564.22306
-0.54000	8255.65294
-0.53000	7952.74283
-0.52000	7655.49284
-0.51000	7363.90308
-0.50000	7077.97362
-0.49000	6797.70458
-0.48000	6523.09605
-0.47000	6254.14811
-0.46000	5990.86086
-0.45000	5733.23438
-0.44000	5481.26876
-0.43000	5234.96409
-0.42000	4994.32044
-0.41000	4759.33790
-0.40000	4530.01654
-0.39000	4306.35645
-0.38000	4088.35769
-0.37000	3876.02034
-0.36000	3669.34446
-0.35000	3468.33014
-0.34000	3272.97743
-0.33000	3083.28640
-0.32000	2899.25711
-0.31000	2720.88963
-0.30000	2548.18401
-0.29000	2381.14032
-0.28000	2219.75860
-0.27000	2064.03891
-0.26000	1913.98131
-0.25000	1769.58584
-0.24000	1630.85255

-0.23000	1497.78149
-0.22000	1370.37270
-0.21000	1248.62622
-0.20000	1132.54210
-0.19000	1022.12037
-0.18000	917.36107
-0.17000	818.26424
-0.16000	724.82991
-0.15000	637.05811
-0.14000	554.94886
-0.13000	478.50220
-0.12000	407.71816
-0.11000	342.59674
-0.10000	283.13799
-0.09000	229.34191
-0.08000	181.20853
-0.07000	138.73786
-0.06000	101.92991
-0.05000	70.78470
-0.04000	45.30223
-0.03000	25.48253
-0.02000	11.32558
-0.01000	2.83141
0.00000	0.00000
0.01000	2.83136
0.02000	11.32550
0.03000	25.48240
0.04000	45.30207
0.05000	70.78449
0.06000	101.92965
0.07000	138.73756
0.08000	181.20819
0.09000	229.34153
0.10000	283.13757
0.11000	342.59628
0.12000	407.71765
0.13000	478.50165
0.14000	554.94827

0.15000	637.05747
0.16000	724.82924
0.17000	818.26353
0.18000	917.36032
0.19000	1022.11957
0.20000	1132.54125
0.21000	1248.62533
0.22000	1370.37177
0.23000	1497.78052
0.24000	1630.85154
0.25000	1769.58478
0.26000	1913.98021
0.27000	2064.03777
0.28000	2219.75742
0.29000	2381.13909
0.30000	2548.18275
0.31000	2720.88832
0.32000	2899.25576
0.33000	3083.28501
0.34000	3272.97599
0.35000	3468.32866
0.36000	3669.34294
0.37000	3876.01878
0.38000	4088.35608
0.39000	4306.35480
0.40000	4530.01486
0.41000	4759.33617
0.42000	4994.31867
0.43000	5234.96228
0.44000	5481.26691
0.45000	5733.23248
0.46000	5990.85892
0.47000	6254.14613
0.48000	6523.09403
0.49000	6797.70252
0.50000	7077.97152
0.51000	7363.90092
0.52000	7655.49065

0.53000	7952.74060
0.54000	8255.65066
0.55000	8564.22074
0.56000	8878.45074
0.57000	9198.34056
0.58000	9523.89007
0.59000	9855.09918
0.60000	10191.96778

Table-3. Mass flow rate of water at 100 degree with radious of 0.6m at presseure of 100bar

Radius(m)	Mass Flow Rate(Kg/s)
-0.40000	542.99379
-0.39000	516.18602
-0.38000	490.05667
-0.37000	464.60577
-0.36000	439.83333
-0.35000	415.73937
-0.34000	392.32390
-0.33000	369.58696
-0.32000	347.52854
-0.31000	326.14868
-0.30000	305.44738
-0.29000	285.42466
-0.28000	266.08053
-0.27000	247.41502
-0.26000	229.42813
-0.25000	212.11988
-0.24000	195.49028
-0.23000	179.53935
-0.22000	164.26709
-0.21000	149.67351
-0.20000	135.75864
-0.19000	122.52247
-0.18000	109.96502
-0.17000	98.08630
-0.16000	86.88631
-0.15000	76.36507
-0.14000	66.52259
-0.13000	57.35886
-0.12000	48.87390
-0.11000	41.06771
-0.10000	33.94030
-0.09000	27.49168
-0.08000	21.72184
-0.07000	16.63080
-0.06000	12.21856
-0.05000	8.48512
-0.04000	5.43048

-0.03000	3.05465
-0.02000	1.35762
-0.01000	0.33941
0.00000	0.00000
0.01000	0.33940
0.02000	1.35762
0.03000	3.05464
0.04000	5.43047
0.05000	8.48511
0.06000	12.21855
0.07000	16.63079
0.08000	21.72183
0.09000	27.49166
0.10000	33.94028
0.11000	41.06769
0.12000	48.87387
0.13000	57.35883
0.14000	66.52256
0.15000	76.36504
0.16000	86.88628
0.17000	98.08627
0.18000	109.96499
0.19000	122.52243
0.20000	135.75860
0.21000	149.67347
0.22000	164.26704
0.23000	179.53930
0.24000	195.49024
0.25000	212.11983
0.26000	229.42808
0.27000	247.41497
0.28000	266.08048
0.29000	285.42460
0.30000	305.44732
0.31000	326.14861
0.32000	347.52848
0.33000	369.58689
0.34000	392.32383

0.35000	415.73930
0.36000	439.83325
0.37000	464.60569
0.38000	490.05660
0.39000	516.18594
0.40000	542.99370

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