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

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ABSTRACT
Modeling some real life situations in visualized form has been a very challenging task. Software visualization (SV) uses computer graphics to communicate the structure and behavior of computer software and algorithms. In the same spirit, this work is to develop software visualization for porous media with Graphical User Interface (GUI) application. The proposed model is based on modified Heagen equation to determine different mass flow rate at different temperature. The visual pipe for representation of different mass flow rate is developed using Autodesk Mayer and embedded in C# program for easy visualization. With this software visualization, easy visualization of mass flow partterns can be examined and viewed.

KEYWORDS: 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 (Jawadekar, 2006; Raisinghania, 2003). Software is not like hardware components because it is not physical product that has specification like dimensions, weight, and height and so on.

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 described as the formation of mental visual images, the act or process of interpreting in visual term. Simple illustration of visualization process is given in Figure.

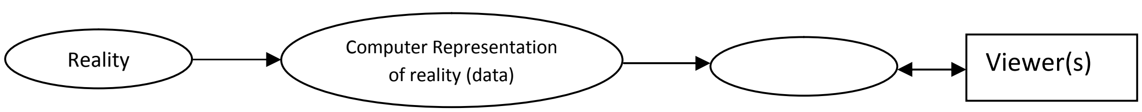

FIGURE 1: Visualization Process

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 (Bruce, John and Peter (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 (Bruce, John and Peter (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.

Fluid is classified by their types of flow which can either be laminar and turbulent flow Bruce, John and Peter (2009); Patankar, 1974). 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 (Levlin, 1992; Ovri and Ofeke). The main function of pipe is to convey fluid from one location to another (Bruce, John and Peter (2009 ; Reisherg, 1997).

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.

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

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

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.

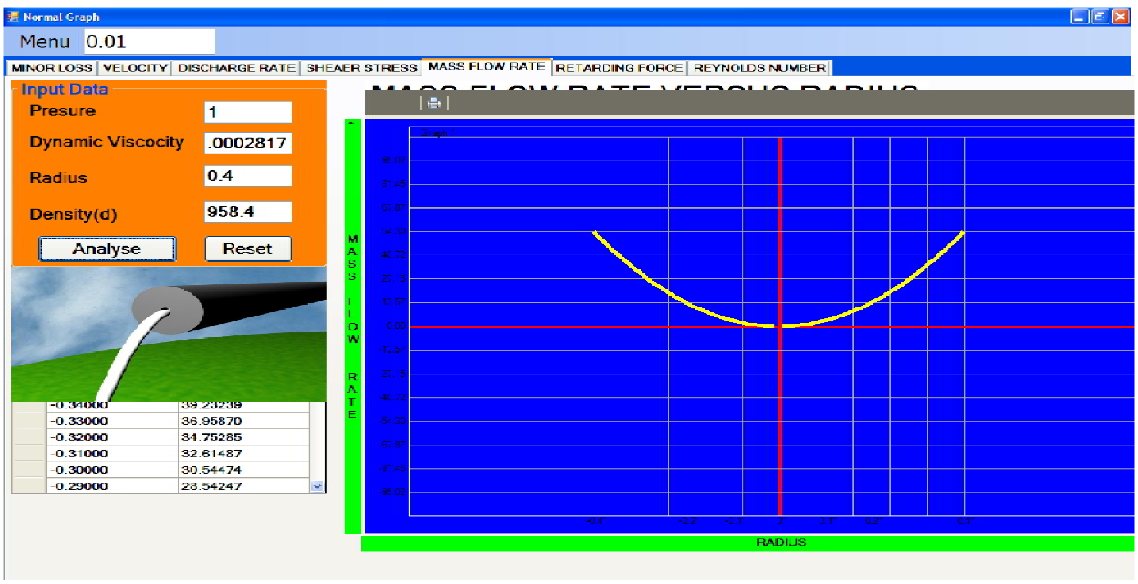

FIGURE 2: Mass flow rate of water at 0 degree with radious of 0.4m at presseure of 100bar

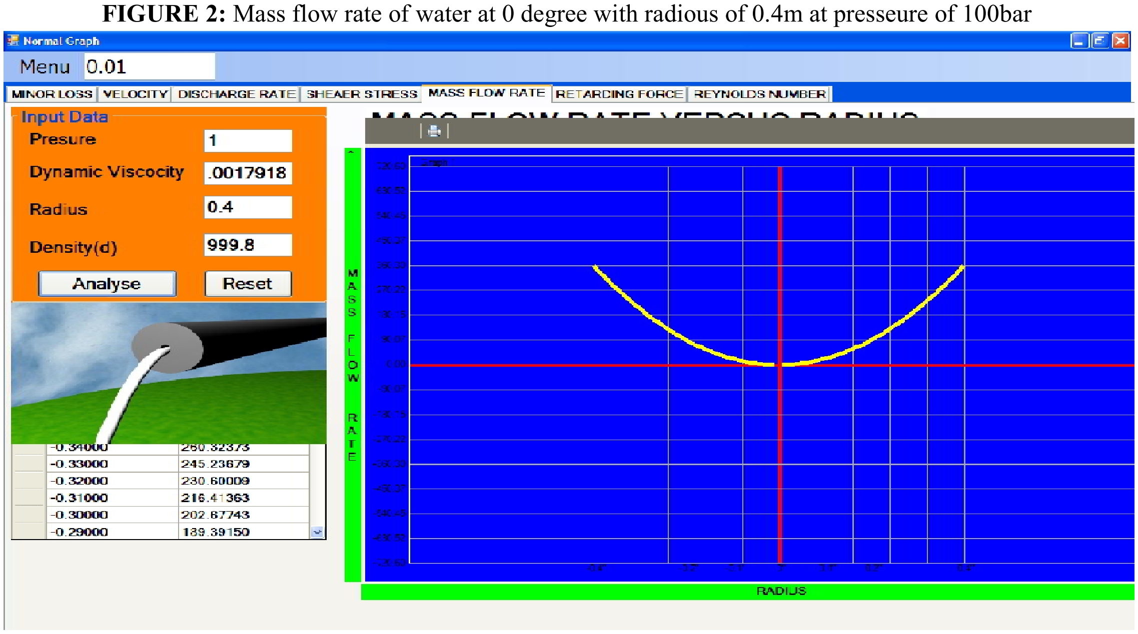

FIGURE 3: Mass flow rate of water at 0 degree with radius of 0.4m at pressure of One bar

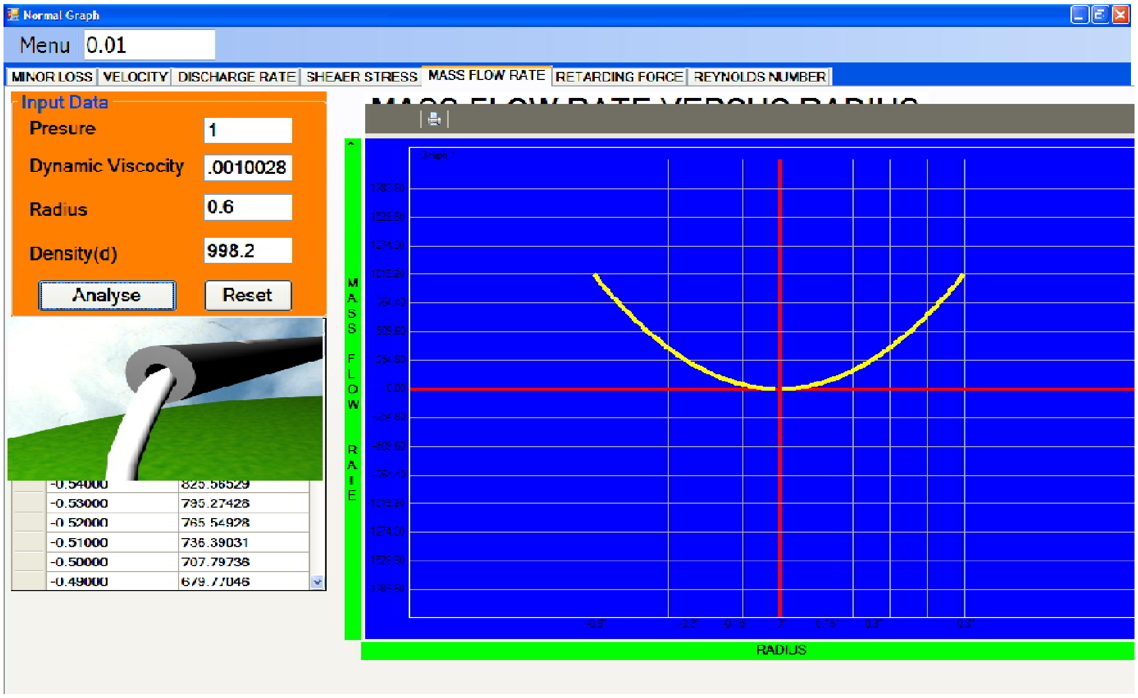

FIGURE 4: Mass flow rate of water at 100 degree with radious of 0.4m at presseure of 100bar

TABLE 1: Mass flow rate of water at 0 degree with radious of 0.4m at presseure of One bar

Mass flow rate at 0 degree Celsius

Radius(m)	Mass Flow Rate(Kg/s)
-0.40000	54.29938
-0.39000	51.61860
-0.38000	49.00567
-0.37000	46.46058
-0.36000	43.98333
-0.35000	41.57394
-0.34000	39.23239
-0.33000	36.95870
-0.32000	34.75285
-0.31000	32.61487
-0.30000	30.54474
-0.29000	28.54247
-0.28000	26.60805
-0.27000	24.74150
-0.26000	22.94281
-0.25000	21.21199
-0.24000	19.54903
-0.23000	17.95393
-0.22000	16.42671
-0.21000	14.96735
-0.20000	13.57586
-0.19000	12.25225
-0.18000	10.99650
-0.17000	9.80863
-0.16000	8.68863
-0.15000	7.63651
-0.14000	6.65226
-0.13000	5.73589
-0.12000	4.88739
-0.11000	4.10677
-0.10000	3.39403
-0.09000	2.74917
-0.08000	2.17218
-0.07000	1.66308
-0.06000	1.22186
-0.05000	0.84851
-0.04000	0.54305
-0.03000	0.30546
-0.02000	0.13576
-0.01000	0.03394
0.00000	0.00000
0.01000	0.03394
0.02000	0.13576
0.03000	0.30546
0.04000	0.54305
0.05000	0.84851
0.06000	1.22185
0.07000	1.66308
0.08000	2.17218
0.09000	2.74917
0.10000	3.39403
0.11000	4.10677
0.12000	4.88739
0.13000	5.73588
0.14000	6.65226
0.15000	7.63650
0.16000	8.68863
0.17000	9.80863
0.18000	10.99650
0.19000	12.25224
0.20000	13.57586
0.21000	14.96735
0.22000	16.42670
0.23000	17.95393
0.24000	19.54902
0.25000	21.21198
0.26000	22.94281

0.27000	24.74150
0.28000	26.60805
0.29000	28.54246
0.30000	30.54473
0.31000	32.61486
0.32000	34.75285
0.33000	36.95869
0.34000	39.23238
0.35000	41.57393
0.36000	43.98333
0.37000	46.46057
0.38000	49.00566
0.39000	51.61859
0.40000	54.29937

Mass flow rate at 20 degree Celsius

Radius(m)	Mass Flow Rate(Kg/s)
-0.40000	360.29966
-0.39000	342.51156
-0.38000	325.17362
-0.37000	308.28585
-0.36000	291.84827
-0.35000	275.86090
-0.34000	260.32373
-0.33000	245.23679
-0.32000	230.60009
-0.31000	216.41363
-0.30000	202.67743
-0.29000	189.39150
-0.28000	176.55585
-0.27000	164.17048
-0.26000	152.23541
-0.25000	140.75064
-0.24000	129.71619
-0.23000	119.13206
-0.22000	108.99826
-0.21000	99.31480
-0.20000	90.08168
-0.19000	81.29891
-0.18000	72.96651
-0.17000	65.08447
-0.16000	57.65280
-0.15000	50.67150
-0.14000	44.14059
-0.13000	38.06006
-0.12000	32.42993
-0.11000	27.25019
-0.10000	22.52085
-0.09000	18.24191
-0.08000	14.41337
-0.07000	11.03525
-0.06000	8.10754
-0.05000	5.63024
-0.04000	3.60336
-0.03000	2.02689
-0.02000	0.90084
-0.01000	0.22521
0.00000	0.00000
0.01000	0.22521
0.02000	0.90084
0.03000	2.02688
0.04000	3.60335
0.05000	5.63023
0.06000	8.10753
0.07000	11.03524
0.08000	14.41336
0.09000	18.24189
0.10000	22.52083
0.11000	27.25017
0.12000	32.42991
0.13000	38.06004
0.14000	44.14057
0.15000	50.67148
0.16000	57.65277
0.17000	65.08444
0.18000	72.96648
0.19000	81.29889
0.20000	90.08165
0.21000	99.31477
0.22000	108.99823
0.23000	119.13203
0.24000	129.71615
0.25000	140.75061
0.26000	152.23537
0.27000	164.17044
0.28000	176.55581
0.29000	189.39146
0.30000	202.67739
0.31000	216.41359
0.32000	230.60005
0.33000	245.23675
0.34000	260.32369
0.35000	275.86085
0.36000	291.84823
0.37000	308.28580
0.38000	325.17357
0.39000	342.51151
0.40000	360.29961

Table 2: Mass flow rate of water at 20 degree with radious of 0.4m at presseure of One bar

Mass flow rate at 100 degree Celsius

Radius(m)	Mass FlowRate(Kg/s)
-0.60000	1019.19703
-0.59000	985.51017
-0.58000	952.38925
-0.57000	919.83430
-0.56000	887.84531
-0.55000	856.42231
-0.54000	825.56529
-0.53000	795.27428
-0.52000	765.54928
-0.51000	736.39031
-0.50000	707.79736
-0.49000	679.77046
-0.48000	652.30960
-0.47000	625.41481
-0.46000	599.08609
-0.45000	573.32344
-0.44000	548.12688
-0.43000	523.49641
-0.42000	499.43204
-0.41000	475.93379
-0.40000	453.00165

-0.39000	430.63564
-0.38000	408.83577
-0.37000	387.60203
-0.36000	366.93445
-0.35000	346.83301
-0.34000	327.29774
-0.33000	308.32864
-0.32000	289.92571
-0.31000	272.08896
-0.30000	254.81840
-0.29000	238.11403
-0.28000	221.97586
-0.27000	206.40389
-0.26000	191.39813
-0.25000	176.95858
-0.24000	163.08525
-0.23000	149.77815
-0.22000	137.03727
-0.21000	124.86262
-0.20000	113.25421
-0.19000	102.21204
-0.18000	91.73611
-0.17000	81.82642
-0.16000	72.48299
-0.15000	63.70581
-0.14000	55.49489
-0.13000	47.85022
-0.12000	40.77182
-0.11000	34.25967
-0.10000	28.31380
-0.09000	22.93419
-0.08000	18.12085
-0.07000	13.87379
-0.06000	10.19299
-0.05000	7.07847
-0.04000	4.53022
-0.03000	2.54825
-0.02000	1.13256
-0.01000	0.28314
0.00000	0.00000
0.01000	0.28314
0.02000	1.13255
0.03000	2.54824
0.04000	4.53021
0.05000	7.07845
0.06000	10.19297
0.07000	13.87376
0.08000	18.12082
0.09000	22.93415
0.10000	28.31376
0.11000	34.25963
0.12000	40.77176
0.13000	47.85017
0.14000	55.49483
0.15000	63.70575
0.16000	72.48292
0.17000	81.82635
0.18000	91.73603
0.19000	102.21196
0.20000	113.25413
0.21000	124.86253
0.22000	137.03718
0.23000	149.77805
0.24000	163.08515
0.25000	176.95848
0.26000	191.39802
0.27000	206.40378
0.28000	221.97574
0.29000	238.11391
0.30000	254.81827
0.31000	272.08883
0.32000	289.92558
0.33000	308.32850
0.34000	327.29760
0.35000	346.83287
0.36000	366.93429
0.37000	387.60188
0.38000	408.83561
0.39000	430.63548
0.40000	453.00149
0.41000	475.93362
0.42000	499.43187
0.43000	523.49623
0.44000	548.12669
0.45000	573.32325
0.46000	599.08589
0.47000	625.41461
0.48000	652.30940
0.49000	679.77025
0.50000	707.79715
0.51000	736.39009
0.52000	765.54907
0.53000	795.27406
0.54000	825.56507
0.55000	856.42207
0.56000	887.84507
0.57000	919.83406
0.58000	952.38901
0.59000	985.50992
0.60000	1019.19678

TABLE 3: Mass flow rate of water at 100 degree with radious of 0.6m at presseure of One bar

DISCUSSION

With reference to the figures 3,4,5 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 36.95869 and 308.32864 at zero and hundred degree respectively. The reason this for pheneomenum is that as temperature 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 later 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. In addition, as the temperature increases, the mass flow rate increases. The evidence 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.

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