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The Effect of Changing the Particles Diameter on Pressure Drop in Flow of Three-Phase (Air-Water-Gasoil).

Dr. Esam M. Abed[1], Amall H. Aliwi[2]
[1, 2] Babylon University College of Engineering Mechanic Department

Abstract: Due to investigate numerically and experimentally the effect particles diameter on pressure drop along vertical pipe of internal diameter of 1.25 inches and length of 2 meter. The mixture flow of three –phase is air –water –gasoil. This study performed for different temperature of water –phase 35Cº, 40 Cº, and 45 Cº. Numerically, the volume of fluid (VOF) used as model to simulate the solution. Experimentally all experiments carried out of system design in laboratory. The results showed that pressure values along pipe depended on particles, it observed the particles of 2mm have a higher values comparison with 6mm and 10mm, because its depended on porosity .When increasing water-phase temperature, it observed that the pressure values increased because the natural of relationship between temperature and pressure .The deviation between the Numerical part and Experimental part is very good .The study have agreement with other studies.
Keyword: Three–phase air –water –gasoil, VOF, Porosity, Temperature, Pressure

I. INTRODUCTION

The increasing of study packed bed is to solve a many problems in several industries such as chemical ,biochemical ,and absorption towers , in more types of Reactors such as CO_2 Sequestion ,filtration of water by sand bed ,catalytic fixed bed Reactor .The packed bed studied a lot of for several years [1] .To solve problem of pressure drop through packed bed ,it should understand a some papers and find a solutions .

A. The pressure drop Depended on Liquid phase Friction Losses in bed [2].

Bed porosity changed with particles diameter , shape and distribution of particles [3] .The pressure drop across packed bed is depended on flow rate ,viscosity ,the physical properties [4]. In a vertical flow the pressure drop analyzed into the sum of components due to acceleration ,gravity and friction in wall [5] .The relationship between the inlet pressure and flow rate ,as a slop for two values [6] . Any changing in porosity lead to increase or decrease the pressure through packed bed [7] . For packing with single-size spheres the size of porosity is the same as in all bed [8].

B. Experimental Description

The system of experiments build laboratory of Mechanic Engineering of Fluid Babylon . The important components of system are: compressor (8) is to compressed the atmospheric air to store in reservoir (9) for stability. Centrifugal pump (3) is to provide water from tank (1) . Gasoil pump(16) is pumped from tank (15). The air flow rate is controlled such as flow meter (11) , check valve (13) , gate valve(12) . The water flow rate is controlled such as flow gate valve(4), check valve(5) and flow meter(6) .The gasoil flow rate is controlled such as flow gate valve (17) and check valve (18) .The three-phase admitted to mixing pipe (14), and then introduced to Perspex pipe (20) . Perspex pipe (20) was described of (1.25)in as diameter and (2)m as long and found in position about 0.33cm from beginning a porous media (30) of 20 cm height and packed with particles (chrome–steel) of (2 ,6 and10) mm in separately experiments. High speed camera(29) fixed near test pipe to clear view for process .Five pressure transducers(23) fixed on test pipe to know pressure in specific points (0.33-0.66-0.99-1.32-1.65) m ,and connected in interface device (24) to personal computer (26).Ten thermocouples fixed along testpipe(0.165,0.33,0.495,0.66,0.825,0.99,1.155,1.32,1.485,1.65) cm as shown in figure (1).

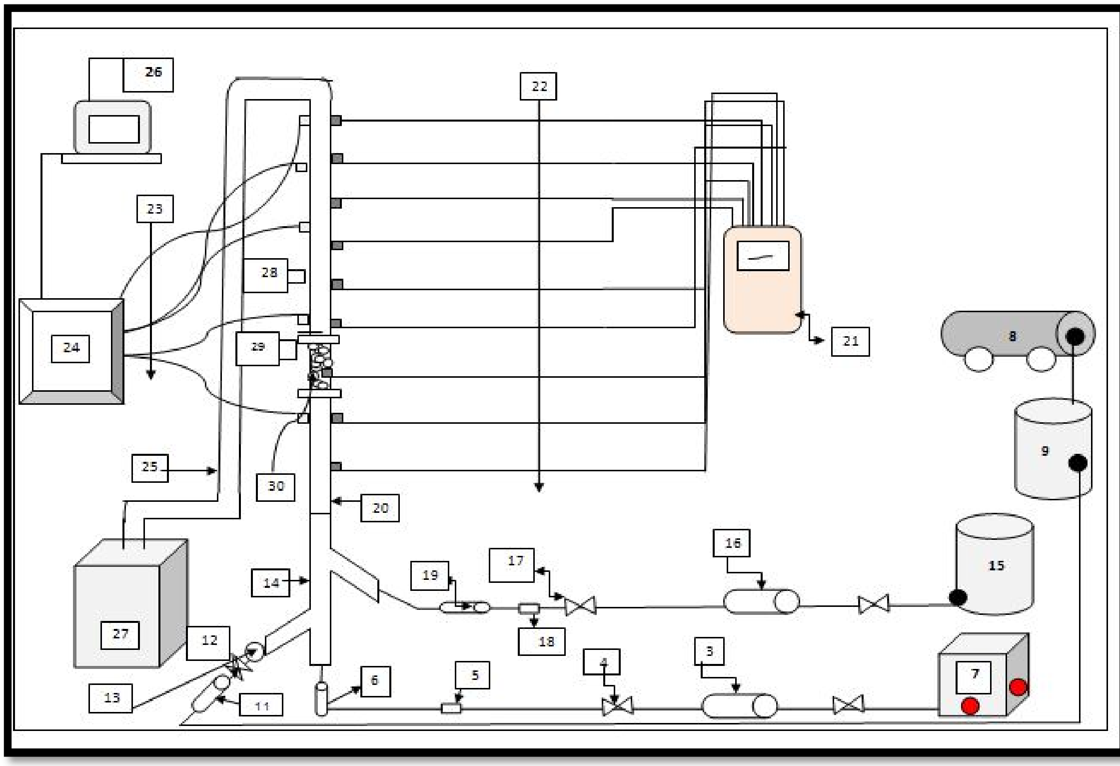

Fig (1):Diagram of Experiment system.

1-water tank.	16-Oil pump.
2-Thermometer.	17-Gate valve
3-Centrifugal pump.	18-Check valve
4-water gate valve	19-Gasoil flow meter
5-water check valve	20-Perspex pipe (ID=1.25in,L=2m)
6-water flow meter	21-Temperature recorder device.
7-Heaters	22-10Channels Temperature recorder device .
8-Compressor.	23-5 Pressure sensors.
9-Reservior	24-Interface device.
10-Pressure regular	25-Circulation Pipe.
11-Air flow meter	26-Personal Computer.
12-Gate valve	27-Accumulation tank.
13-Check valve.	28-Ordinary Video Camera
14-Mixing pipe	29-High Speed Camera.
15-Gasoil tank	30-Porous media

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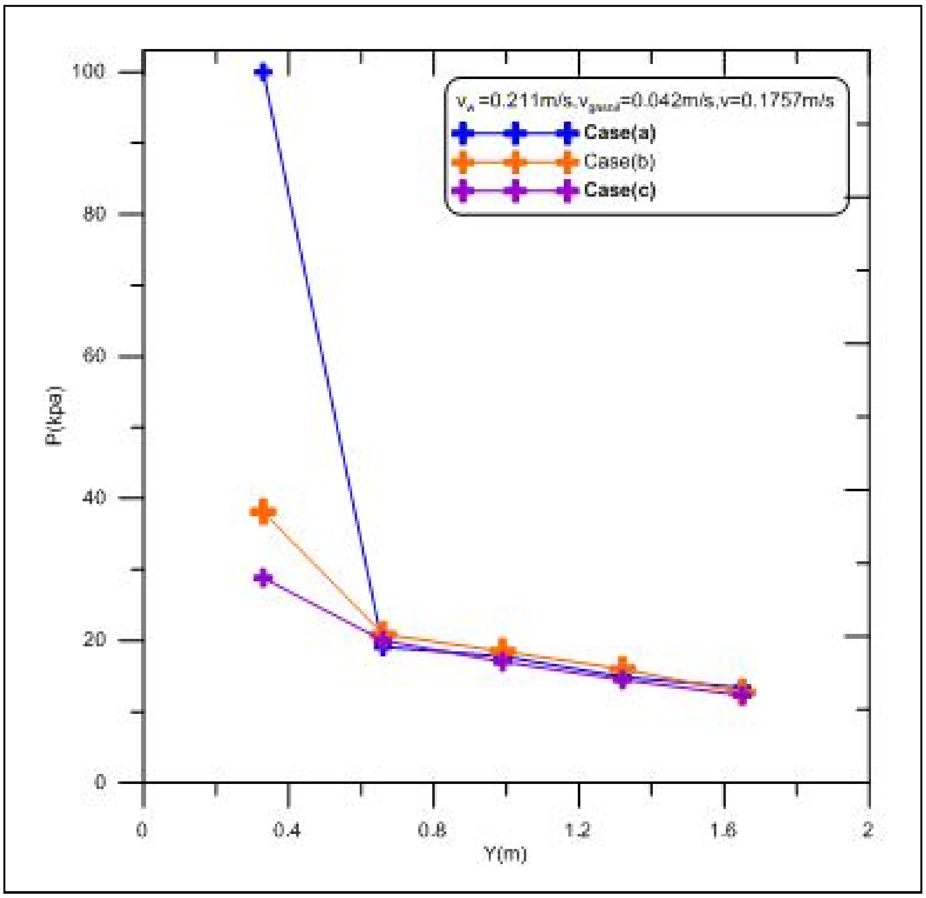
II. EXPERIMENTAL SOLUTION

A. Pressure Gradient

The pressure gradient is very clear behavior when changing the diameter of particles (case (a),case (b),case (c)) for mixture of three-phases flow at temperature 35C° and at same flow rate for three cases through porous media in pipe ,also every point on curve represent a sensor of pressure . Figure **(2)** represent the pressure drop for three cases due the finding porous media .

The blue line represents the pressure drop for case (a) ,it observed the pressure value is very high in comparison with other cases ,and the drop between sensor (1) and (2) is very sharp due to the porosity smallness .

The orange line represents the pressure drop for case (b) ,it observed the pressure value is lower than case(a) in comparison with other cases ,and the drop between sensor (1) and (2) is lower than case (a) due to the porosity is higher previous case. The purple line represents the pressure drop for case (c) ,it observed the pressure value is lower than case(a), case (b) in comparison with other cases ,and the drop between sensor (1) and (2) is lower than case (a), case (b) due to the porosity is higher previous cases.



Figure(2):Pressure drop for three particles at temperature 35C°.

B. Numerical Solution

In order to understand the behavior of pressure for three-phase flow when changing the particles diameter ,its carried out the simulation the rig pipe in several diameters (2,6, and 10) mm separaty .

C. Pressure Gradient

In order to understand the behavior of pressure when changing the particles diameter ,its showed simulation the rig pipe in several diameters **(**2,6, and 10)mm .Fig(2) explain the pressure gradient behavoir with changing the particles diameter at water temperature about 35C°,when observed the pressure values is maximum in case (a) in comparison with other cases (6 and 10)mm because the porosity in case (a) is smallness . Fig(3) explain the behavior of pressure gradient at water temperature about 35C° ,when increasing the gasoil flow rate from (0.042 to 0. 105) m/s .It observed the pressure graidient behavior is increased with increasing gasoil flow rate with remain the pressure values for case (a) is maximum because the porosity in case (a) is smallness .

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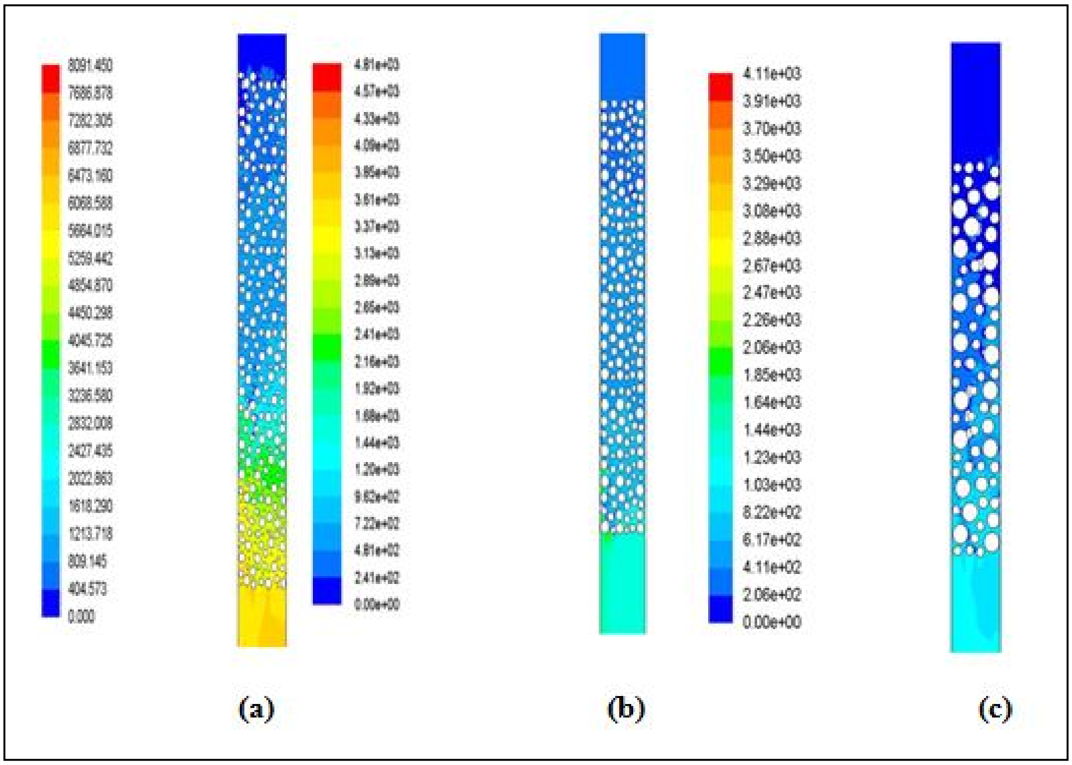


Fig.(2):The pressure distribution at T=35C^o,v_w=0.211m/s ,v_{gasoil}=0.042m/s ,w_{air}=0.1757m/s for particles (a)2mm(b)6mm(c)10mm.

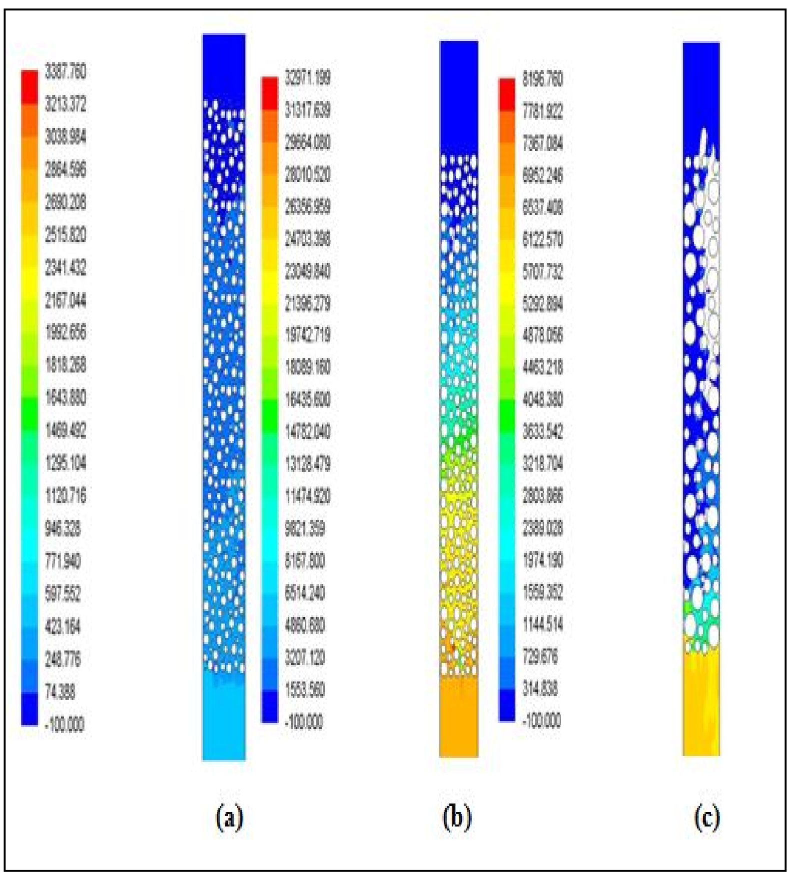
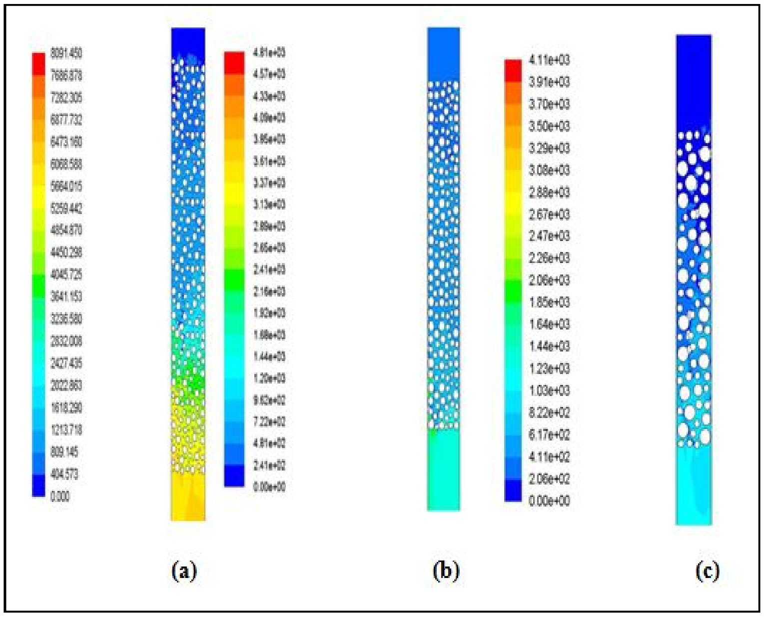


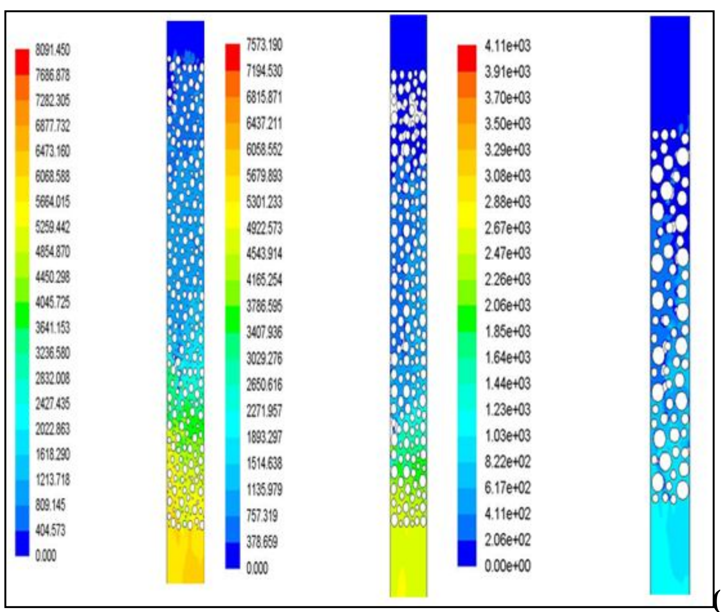
Fig. (3):The pressure distribution at T=35C^o, V_{water}=0.211m/s,V_{gasoil}=0.105m/s ,V_{air}=0.354m/s for particles (a)2mm(b)6mm(c)10mm.

D. Heating of water-Phase

When heating water-phase to several temperature 35Cº,40 Cº,and 45 Cº ,and with same flow rates of water, air and gasoil ,it observed changing the pressure of mixture. It increased with increasing temperature of water .Fig(4) ,Fig(5) and Fig(6) show the pressure of mixture increased with increasing temperature 35Cº , 40 Cº and 45 Cº respectively ,they explained pressure values for case (a) case(b) ,and case(c) are maximum for water temperature 45 Cº because the pressure values increased with increasing temperature of mixture . Fig(4) explain the pressure in case (1) ,case (2) ,and case (3) ,it's find case (1) have maximum in comparison with other cases due to porosity increased with increasing particles diameter . Fig(5), explain the pressure in case (1) ,case (2) ,and case (3) increased in comparison with Fig(4) due to increasing temperature from 35Cº to 40Cº. Fig(6) explain the pressure in case (1) ,case (2) ,and case (3) increased in comparison with Fig(4) and Fig(5) ,due to increasing temperature from 35Cº to40 Cº and then 45Cº.



Fig(4): The pressure distribution at T=35Cº, V_{water}=0.211m/s,V_{gasoil}=0.042m/s ,V_{air}=0.354m/s for particles (a)2mm(b)6mm(c)10mm.



a) (b) (c)

Fig(5): The pressure distribution at T=40Cº,V_{water}=0.211m/s,V_{gasoil}=0.042m/s ,V_{air}=0.1757m/s for particles (a)2mm (b)6mm,(c)10mm.

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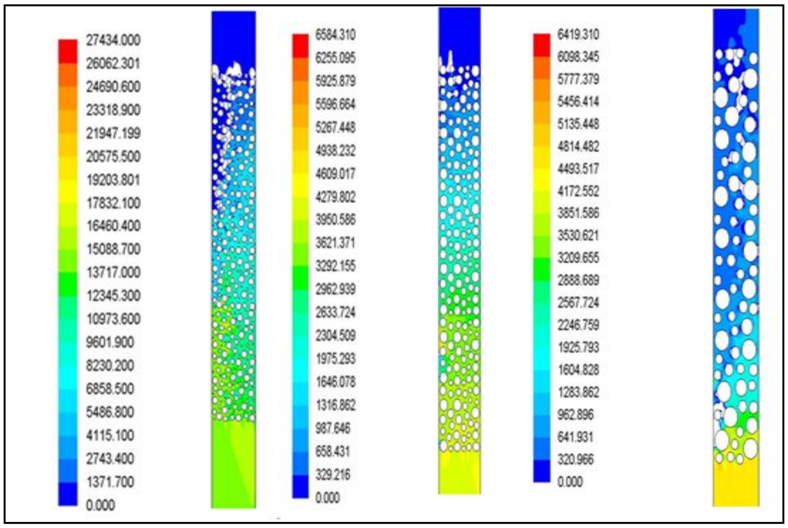

(a) (b) (c)

Fig(6): The pressure distribution at T=45Cº, V_{water}=0.211m/s,V_{gasoil}=0.042m/s ,V_{air}=0.1757m/s for particles (a)2mm(b)6mm(c)10mm.

III. CONCLUSION

A. The pressure value for case (a) is very high in comparison with other cases**.**
B. The drop for case (a) between sensor (1) and (2) is very sharp due to the porosity smallness .
C. The pressure value for case (b) is lower than case(a) .
D. The drop for case (b) between sensor (1) and (2) is lower than case (a) due to the porosity is higher previous case.
E. The pressure value is lower than case(a), case (b) in comparison with other cases .
F. The drop between sensor (1) and (2) is lower than case (a), case (b) due to the porosity is higher previous cases.
G. The pressure drop for three cases due the finding porous media
H. .It observed the pressure graidient behavior is increased with increasing gasoil flow rate with remain the pressure values for case (a) is maximum because the porosity in case (a) is smallness .
I. Pressure values for case (a) case(b) ,and case(c) are maximum for water temperature 45 Cº because the pressure values increased with increasing temperature of mixture

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A. Nomenclat Ure

VOF**:** Volume of fluid model
V_{water},V_{gasoil},V_{air}: superficial velocity of water, gasoil, air respectively (m /s).
Case (a):represent particles of 2mm Case (b):represent particles of 6mm. Case (c):represent particles of 10mm.