International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Analysis of Effect Change of Side Entry Nozzle Angle on Friction Coefficient of Fluid Flow in Pipes

Natsir Thamrin[1], Nasaruddin Salam[2], Rustan Tarakka[3]

[1] Postgraduate Student of Mechanical Engineering Department Engineering Faculty Hasanuddin University, South Sulawesi 90245, Indonesia

[2, 3] Lecturer of Mechanical Engineering Department Engineering Faculty Hasanuddin University, Sulawesi Selatan 90245, Indonesia

Abstract: ***The use of nozzles in the pipeline flow is used to determine the type of pipes that are good for the industry. This study aims to analyze the effect of changes in the inlet side nozzle angle to the friction coefficient of the fluid flow in the pipe with the nozzle angle of 250, 350, and 450. The experiment uses experimental method using nose-angle variation on the coefficient of friction experimentally and theoretically with rotation variation And the opening of the fluid flow valve in the pipe. The result of the research is at the angle of 25 º 0 nos of opening of 100% valve of 125 rpm rotation coefficient value (feks) = 0,00228, theoretical friction coefficient (fb) = 0,00465, velocity distribution (U / U *) = 24,7737, the average velocity (Ū) = 14.925 m / s, at an angle of 350, the 100% opening valve 125 rpm coefficient of friction (0.00) is 0.00177, theoretical friction coefficient (fb) = 0.0045, The speed velocity (Ū) = 16.970 m / s, whereas at the 450 angle, the coefficient of friction value is 0.00113, the theoretical friction coefficient (fb) = 0 , 00436, velocity distribution (U / U *) = 24.3594, average velocity (Ū) = 19.353 m / s. The results show that the mean velocity relation to the coefficient of friction experimentally and theoretically is inversely proportional, whereas the coefficient of friction coefficient experimentally and theoretically to the velocity distribution is straight and the coefficient of friction is theoretically tends to be higher than the coefficient of friction in experiment.***

Keywords: nozzle,friction coefficient,fluid flow

1. Introduction

Science and technology will develop when accompanied by conducting research, testing and analysis on various disciplines of science. Fluid mechanics as part of science is one example that needs attention because of its widespread application. At all times we are all always in contact with the fluid almost involuntarily. Many beautiful and wonderful natural phenomena, such as deep hills and canyons, occur due to the forces generated by the fluid flow. All fluids have or exhibit characteristics or characteristics that are important in the world of engineering.

The development of fluid mechanics science from time-to-time increasing rapidly. Likewise, the application of the science of fluid mechanics, both in the industrial world, the maritime world and in daily life. In the industry many use piping installation that serves to drain the fluid to the destination.

In the piping installation, many connections are used to deflect, dividing the stream into branching and combining the flow. Separation of the fluid flow in branching is unavoidable thus reducing the performance of a system (Arifin S, et al., 2013).

The government currently focuses on the industrial sector, so the industrial world mostly uses pipes with varying nozzle angles as a means to distribute the production from the industry, for example: mining industry in the form of gas or liquid, hydroelectric power industry, water supply industry and others.

The fluid to be streamed or which will be produced by an industry, it is necessary to do a prior planning in accordance with the existing theories. The purpose of planning is done and is intended to select the nozzle angle and to know the type of flow that occurs in each nozzle change that will be channeled somewhere through the pipe. Flow in a channel (internal flow), insofar as there is no obstacle, will have boundary layer characteristics and certain vorticity values that are only influenced by fluid viscosity with a smooth solid surface. Only in the thin region adjacent to the solid surface, the viscosity effect is so important. In this region there is friction between the fluid layer adjacent to the solid surface itself (Setyo Pratomo, 2002).

The type of fluid that flows through the pipe will experience a head loss and pressure change, this is caused by friction of the pipe and the change of velocity or flow direction. These two kinds of losses are generally called major losses (major losses). Major losses are a continuous head loss that occurs along the pipeline due to friction in the pipeline. And these losses are what causes a loss of energy, so should be cultivated to occur as small as possible.

2. Materials and Methodology

The research was conducted in Fluid Mechanics Laboratory of Mechanical Engineering Department of Hasanuddin University. Equipment used in research: 1) Suction Blower, 2) Electrical Control, 3) Handtaco Meter, 4) Valve, 5) Manometer, 6) Pitot Tubes, 7) Barometer, 8) Nozzle. The materials used in this research are: 1) Teflon with 46 cm thickness and 3 inner diameter.

3. Research Methods

The research method used is experimental method by testing on nozzle with angle 250, 350, and 450. The research was conducted at Fluid Mechanics Laboratory, Department of Mechanical, Faculty of Engineering, Hasanuddin University. Testing is done 3 times with different nozzle angle that is

250, 350, and 450 with variation of rotation and valve opening at every corner of nozzle. The data collection begins with the specimen in pairs at the end of the test line pipe, with three different specimen shapes having 250, 350, and 450 different angles.

The pitot tube is installed after the airflow passes through the specimen. Electrical control switch ON, wait for about 5 minutes then apply valve setting at 10%, 50% and 100% position. The electric motor runs at 25 rpm, 50 rpm, 75 rpm, 100 rpm and 125 rpm, allow about 10 minutes as heating. The power control is set to the desired rotation. Electrical control rotation is measured using handtaco meter.

After a stable state, then made a simultaneous observation of the manometer, barometer and thermometer. The position of the fixed pitot tube and the probe is changed from 18 mm, 20 mm, 22 mm, 24 mm, 26mm, 28 mm and 30 mm along the nozzle. The test is repeated for the next level of data accuracy. After the data retrieval is complete, the opened nozzle is replaced with a nozzle with different angles, then repeats like above steps. After the above points are completed, the control switch is returned to the OFF position.

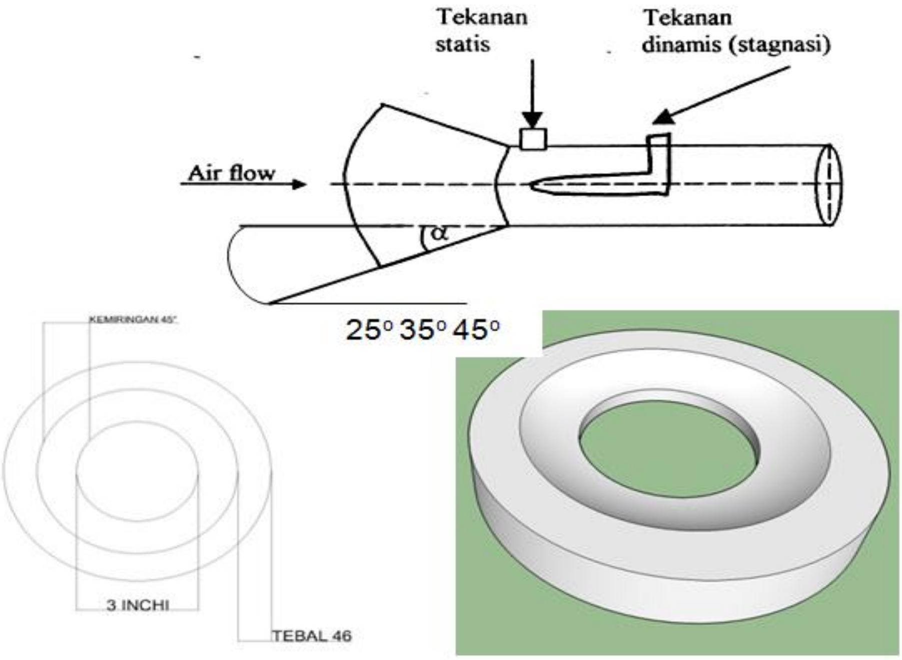

Figure 1: Dimension of nozzle

Air type mass

$$\rho_{ud} = \frac{Pa}{RT} \quad (kg/m^3) \qquad (1)$$

Average velocity of flow in pipes ($\bar{U}$)

$$\bar{U} = 233{,}75\sqrt{\frac{ht.T}{Pa}} \qquad (2)$$

Experimental swipe coefficient (fex)

$$9{,}81\ h = 4f\frac{L}{d}\frac{\rho\, U^{-2}}{2} \qquad (3)$$

$$f_e = 9{,}81 . \frac{d}{L} . \frac{h}{\rho_{ud} . U^{-2}}$$

or

$$f_e = 4{,}905 . \frac{d}{L} . \frac{h}{\rho_{ud} . U^{-2}}$$

Empirical Strength Coefficient (Theoretical)

$$fb = 0{,}079\ (Re)^{-1/4} \qquad (4)$$

Speed At cross section (m / s)

$$U = 237{,}7\sqrt{\frac{ht.T}{Pa}} \qquad (5)$$

Friction speed (U *)

$$U^* = U.\sqrt{\frac{fe}{2}} \qquad (6)$$

Speed distribution For semi-empirical equations

$$\frac{U}{U^*} = 5{,}75 \log\frac{U^*_n . Y}{\upsilon} + 5{,}5 \qquad (7)$$

4. Discussion

Based on the experimental results, the result of the average velocity relationship (Ū) to the coefficient of friction (feks) at the nozzle angle 250 valve opening 100% rotation 125 rpm coefficient of friction (feks) = 0.00228, at nozzle 35 0 angle, valve opening 100% round 125 rpm, coefficient of friction (feks) = 0,00177, while at nozzle 450 angle coefficient value friction (feks) = 0,00113. The speed distribution value is the nozzle angle of 250, the valve opening 100% rotation 125 rpm, the velocity distribution value (U / U *) = 24,7737, at the nozzle nose 350, the 100% valve opening round 125 rpm, the speed distribution value (U / U *) = 24.5873, at the nozzle 450 angle, 100% valve opening round 125 rpm, the speed distribution value (U / U *) = 24.3594. The speed distribution is at the nozzle angle of 250, the opening of the 100% valve of 125 rpm rotation, the value of the experimental friction coefficient (fx) = 0.00228, the theoretical friction coefficient (fb) = 0.00465, at the nozzle 350 angle, valve opening 100% Rpm, the value of the experimental friction coefficient (fx) = 0.00177, the theoretical friction coefficient (fb) = 0.0045, while at the nozzle 450 angle, 100% valve opening of 125 rpm, the experimental friction coefficient (fex) = 0.00113 , Theoretical friction coefficient (fb) = 0.00436.

From the results of the above discussion, a graph of the relationship (Ū) with (feks), relationship (Ū) with (fb), and the relations (feks) and (fb) to (U / U *) as shown Figure 2. The relationship between the average speed of the coefficient of friction by Experiment at any change of nossel angle 25 ¬, 350 and 450, where the higher the average velocity value value at each change of nosel angle then the coefficient value of friction decreased at the nossel angle 250 100% rotation valve opening 125 rpm coefficient value of friction (feks) = 0,00228, at nozzle angle 35 0, 100% rotation valve opening 125 rpm, coefficient of friction (feks) = 0,00177, while at nozzle 450 value coefficient of friction (Feks) = 0.00113.

This is because the average velocity is inversely proportional to the coefficient of friction in accordance with the friction coefficient equation.

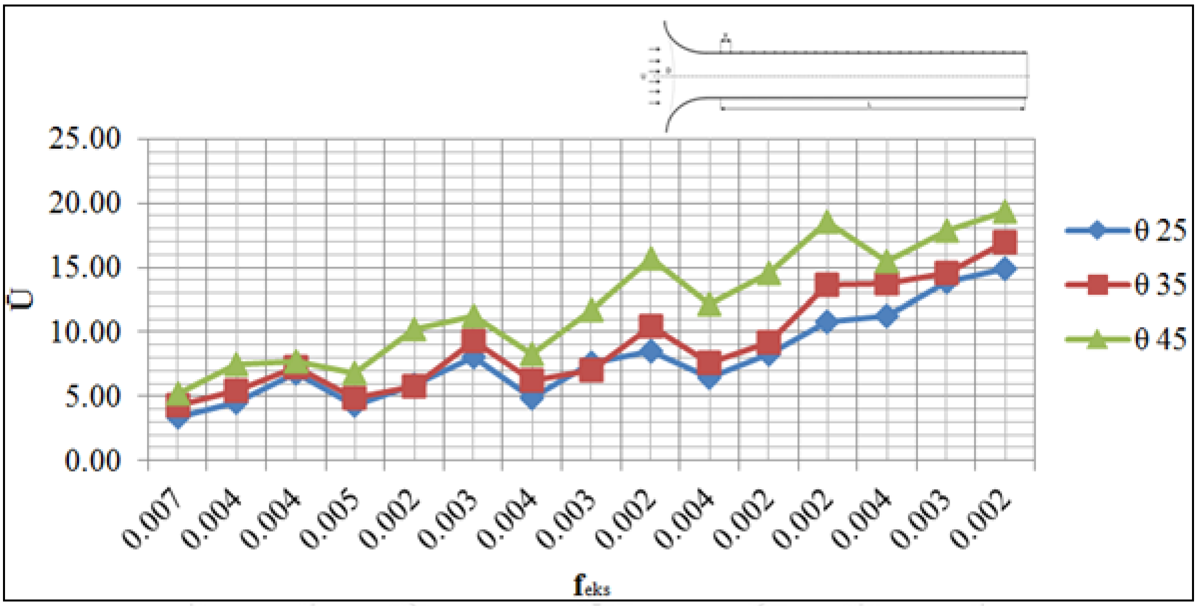

Figure 2: The relationship of mean velocity to the experimental friction coefficient.

Table 1: Average velocity and friction coefficient rates experimentally at 100% valve opening at each nozzle angle change.

Sudut	Kecepatan Rata-rata (Ū)					Koefisien Gesek Eksperimen (feks)				
Nossel	N=25 rpm	N=50rpm	N=75rpm	N=100rpm	N=125rpm	N=25 rpm	N=50rpm	N=75rpm	N=100rpm	N=125rpm
θ = 25°	9,44523029	15,22997622	19,8124822	22,74712677	25,69380425	0,003682351	0,002606974	0,00237571	0,002176759	0,002289545
θ = 35°	8,438499628	10,96644273	12,29307877	15,91178749	19,86983468	0,003273201	0,002907119	0,002313519	0,000920588	0,001771071
θ = 45°	9,071114535	13,22330812	18,31584287	21,71536386	22,66033517	0,002832578	0,002665956	0,000694783	0,000988551	0,001134777

Table 1 shows the minimum value of the friction coefficient experimentally at each change of nozzle angle occurs at the largest nozzle angle that is θ = 450, while the maximum value of coefficient of friction is experimentally at nozzle angle θ = 250.

The relationship between the average velocity to the coefficient of friction theoretically at any change of nozzle angle 25 ¬, 350 and 450, where the higher the average velocity value value at each nosel angle change the coefficient value of the-theoretical friction decrease at the nossel angle 250 valve opening 100% rotation 125 rpm theoretical friction coefficient value (fb) = 0,00465, at nozzle angle 35 0, 100% rotation valve opening 125 rpm, coefficient of friction (fb) = 0,0045, while at nozzle angle 450 value The coefficient of friction (fb) = 0.00436. This is because the Reynolds number is influenced by the average velocity of the theoretical friction coefficient, according to the theoretical friction coefficient equation.

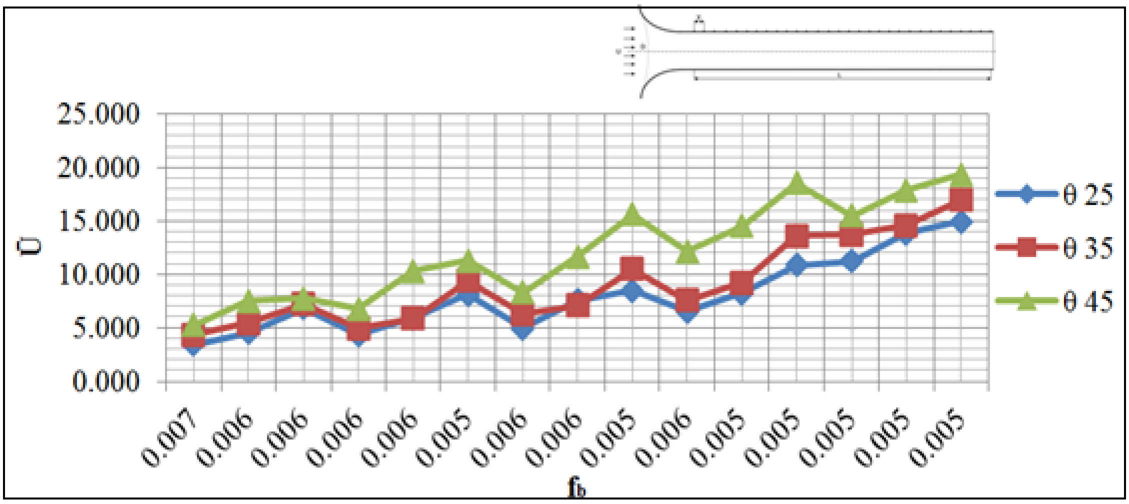

Figure 3: The relationship of mean velocity to the theoretical friction coefficient

Table 2: The mean velocity and coefficient of friction theoretically at 100% opening of the valve at each nozzle angle change.

Nossel	Average Velovity (?)					Theoritical Friction Coefficient				
Angle	N=25 rpm	N=50rpm	N=75rpm	N=100rpm	N=125rpm	N=25 rpm	N=50rpm	N=75rpm	N=100rpm	N=125rpm
?=25°	9,44523025	15,2299762	19,8124822	22,7471267	25,69380425	0,00567	0,00542	0,00536	0,005	0,00465
?=35°	8,43849962	10,9664427	12,2930787	15,9117874	19,86983468	0,00558	0,0052	0,00508	0,00476	0,0045
?=45°	9,07111455	13,2233081	18,3158428	21,7153638	22,66033517	0,00548	0,0049	0,0046	0,0044	0,00436

Table 2 shows the minimum value of the coefficient of friction theoretically at each change of nozzle angle occurs at the largest nozzle angle is 450, while the maximum coefficient of friction theoretically at nozzle angle 250. The existence of variation of slope of nozzle angle in test specimens shows that the greatest coefficient of friction occurs at A specimen with a slope angle of 250, when compared to a specimen with an angle of 350 and 450.

The relationship between the friction coefficient experimentally and the coefficient of friction theoretically to the speed distribution at each change of nozzle angle 25 ¬, 350 and 450, where the higher the coefficient of friction value experimentally and theoretically at each change of nosel angle then the value of the higher speed distribution at the smallest-nozzle corner change. Where at the nozzle angle of 250, the opening of the valve 100% rotation 125 rpm, the value of the experimental friction coefficient (feks) = 0.00228, theoretical friction coefficient (fb) = 0.00465, at nozzle 350 angle, 100% Value of experimental friction coefficient (fex) = 0.00177, theoretical friction coefficient (fb) = 0.0045, while at nozzle 450 angle, 100% rotation valve opening 125 rpm, experimental friction coefficient (fex) = 0.00113, coefficient Theoretical friction (fb) = 0.00436. This is because the velocity distribution is influenced by the coefficient of friction experiment where the coefficient of friction determines the reynolds number to calculate the velocity distribution value according to the speed distribution equation. From the graph above can be seen that the test results are equal to the theoretical results.

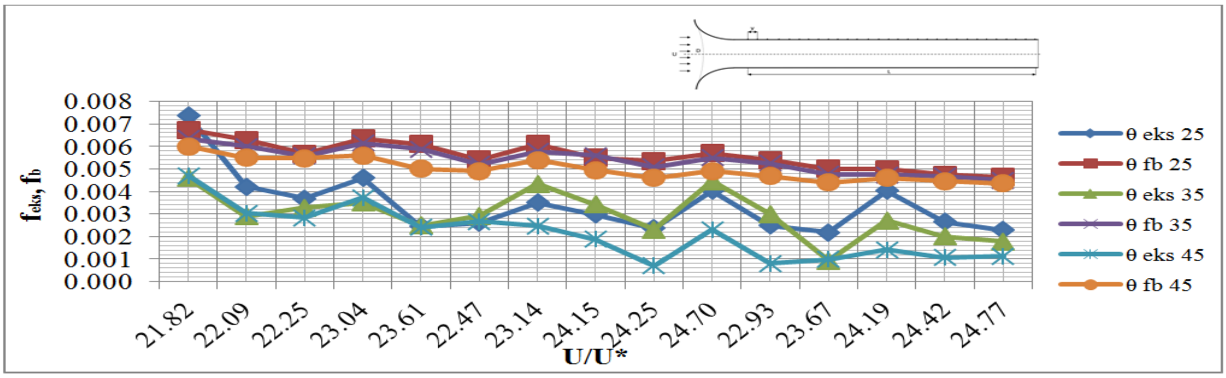

Figure 4: The Experimental And Theoretical Coefficient of Friction Against Speed Distribution.

The relationship between the friction coefficient experimentally and the coefficient of friction theoretically to the speed distribution at each change of nozzle angle 25 ¬, 350 and 450, where the higher the coefficient of friction value experimentally and theoretically at each change of nosel angle then the value of the higher speed distribution at

The smallest nozzle corner change. Where at the nozzle angle of 250, the opening of the valve 100% rotation 125 rpm, the value of the experimental friction coefficient (feks) = 0.00228, theoretical friction coefficient (fb) = 0.00465, at nozzle 350 angle, 100% value of experimental friction coefficient (fex) = 0.00177, theoretical friction coefficient (fb) = 0.0045, while at nozzle 450 angle, 100% rotation valve opening 125 rpm, experimental friction coefficient (fex) = 0.00113, coefficient Theoretical friction (fb) = 0.00436. This is because the velocity distribution is influenced by the coefficient of friction experiment where the coefficient of friction determines the reynolds number to calculate the velocity distribution value according to the speed distribution equation. From the graph above can be seen that the test results are equal to the theoretical results.

Table 3: The velocity distribution value, the experimental and theoretical coefficient of friction on the opening of 100% valves at each nozzle angle change.

Sudut	Distribusi Kecepatan (U/U*)					Koefisien Gesek Eksperimen (f_{eks})					Koefisien Gesek Teoritis (f_b)				
Nossel	N=25 rpm	N=50rpm	N=75rpm	N=100rpm	N=125rpm	N=25 rpm	N=50rpm	N=75rpm	N=100rpm	N=125rpm	N=25 rpm	N=50rpm	N=75rpm	N=100rpm	N=125rpm
θ = 25°	22,9276068	23,6655897	24,1895487	24,417897	24,7736598	0,003682351	0,002606974	0,00237571	0,002176759	0,002289545	0,00567	0,00542	0,00536	0,005	0,00465
θ = 35°	23,0056668	24,3774414	24,4051652	23,6044677	24,5872566	0,003273201	0,002907119	0,002313519	0,000920588	0,001771071	0,00558	0,0052	0,00508	0,00476	0,0045
θ = 45°	23,32120846	24,0171172	23,1557097	23,9111379	24,3593507	0,002832578	0,002665956	0,000694783	0,000988551	0,001134777	0,00548	0,0049	0,0046	0,0044	0,00436

Table 3 shows the comparison of the experimental and theoretical coefficient of frictional minimum values at each nosel angle change in the specimen. The minimum value of experimental and theoretical coefficient of friction occurs on the specimen with a slope angle of nozzle 450 with the difference of percentage ratio 1 - 4%. This is in line with research conducted by Nasir kurniawan, et al 2016, where the effect of the flow velocity on the coefficient of friction is inversely proportional as the greater the flow rate in. Then the plane of contact between the pipe and the fluid will be smaller, so it will result in friction factor or the coefficient of friction will be smaller.

5. Conclusions

From the results of the study at each change of nossel angle 25 ¬, 350 and 450, the higher the average velocity value value at each nosel angle change, the coefficient value of friction decreasing. While the coefficient correlation coefficient experimentally and the coefficient of friction theoretically to the speed distribution at each change of nossel angle 25 ¬, 350 and 450, where the higher value of velocity distribution at each change of nosel angle, the coefficient value of friction experimentally and theoretically higher on The smallest nozzle corner change. Seen from experimental test data is similar to the theoretical result that the theoretical value tends to be higher than experiment so the result of percentage ratio is 1 to 4 Percent.

For further research it is suggested to examine problems CFD (Dynamic Fluid Computerization) in order to compare the results of the research.

References

[1] Holman, J.P. 1989. Experimental Methods Enggineers
[2] James W. Daily, Donal R. F. Harleman.1965. Fluid Dinamika
[3] Laporan Praktikum Mekanika Fluida, 2015, Laboratorium Mekanika Fluida, Jurusan Mesin Fakultas Teknik, Universitas Hasanuddin
[4] Munson et al. 2005.Fluid Mechanics.Erlangga.
[5] Nasir kurniawan , Tabah Priangkoso, dan Darmanto, 2016. Analisis Pengaruh Kecepatan Aliran Udara Terhadap Kerugian Tekanan Pada Saluran Udara. Jurnal Pascasarjana Jurusan Teknik Mesin, Fakultas Teknik, Universitas Wahid Hasyim, Semarang, 2016.
[6] RidwanKaraeng, 2012. Tesis Analisis Pengaruh Kekasaran Sudut Entri α Terhadap Distribusi Kecepatan Fluida Dalam Pipa.
[7] Schlithing, H. 1979. Boundary-Layer Theory.McGraw-Hill.
[8] Setyo Pratomo., H.P., 2002. Studi Eksperimental Tentang Pengaruh Perubahan Diameter Lubang Orifice Terhadap Karakteristik Boundary Layer Aliran Hilir. Jurnal teknik mesin vol. 4, No.1.
[9] Sugiono Setiawan dan Yuli Setiyorini, 2013.Pengaruh VariasiSudut Nozzle dan Jarak Nozzle Pada Arc Spray Coating TerhadapKetahanan Abrasif Lapisan 13% Chrome Steel. JurnalTeknik POMITS Vol. 2, No. 1.
[10] Syamsul Arifin, Rustan Tarakka dan Mahbub Arfah, 2013. Analisis Rugi Energi Tekanan Pada Pemisahan Aliran Terhadap Variasi Sudut Sambungan Y. Proceeding Seminar Nasional Tahunan Teknik Mesin XII (SNTTM XII) Universitas Lampung, Bandar Lampung, 23 – 24 Oktober 2013.
[11] White, Frank M.1994. Fluid Mechanics.McGraw-Hill.
[12] White, Frank M.1991. Viscous Fluid Flow.McGraw-Hill.