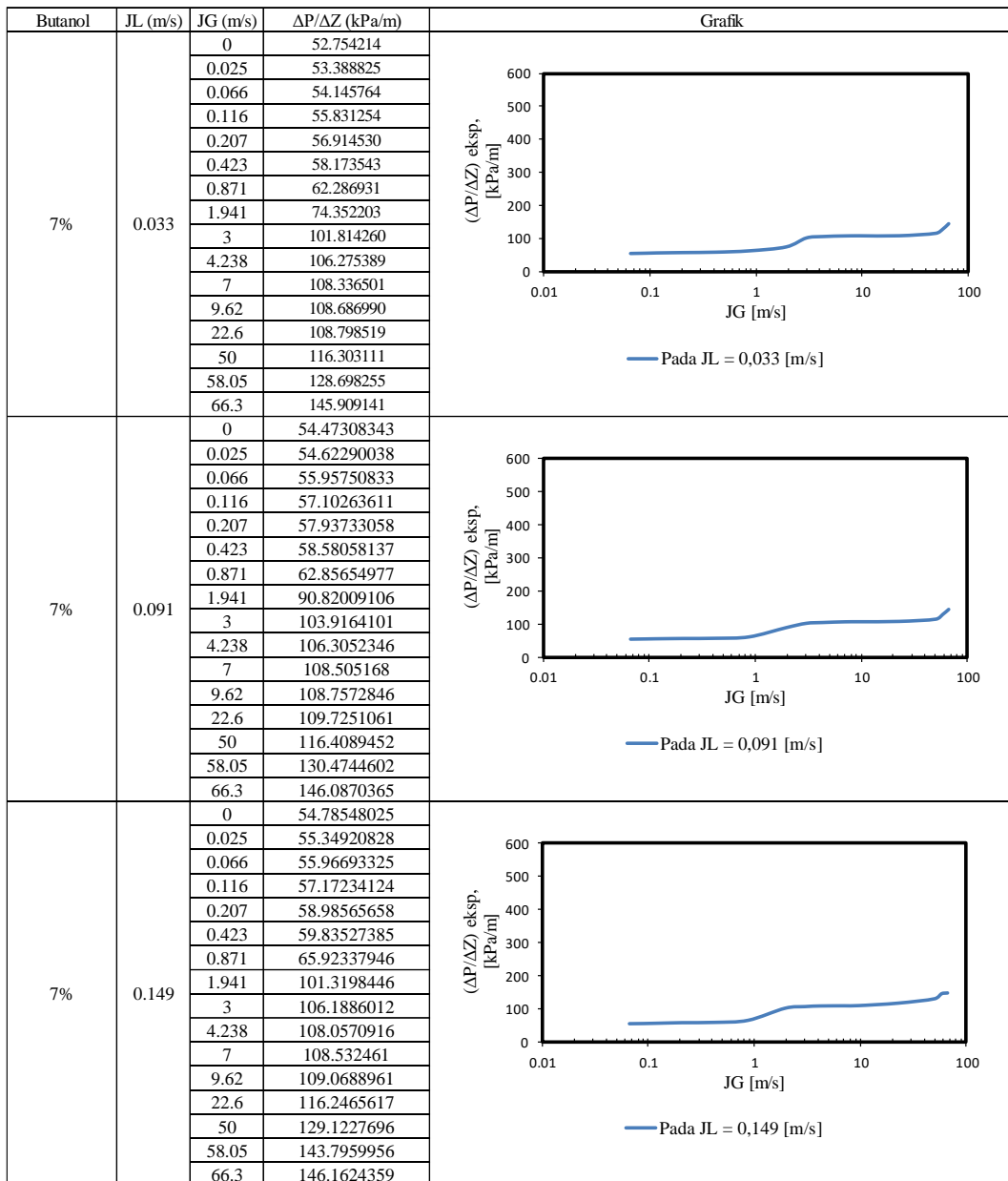
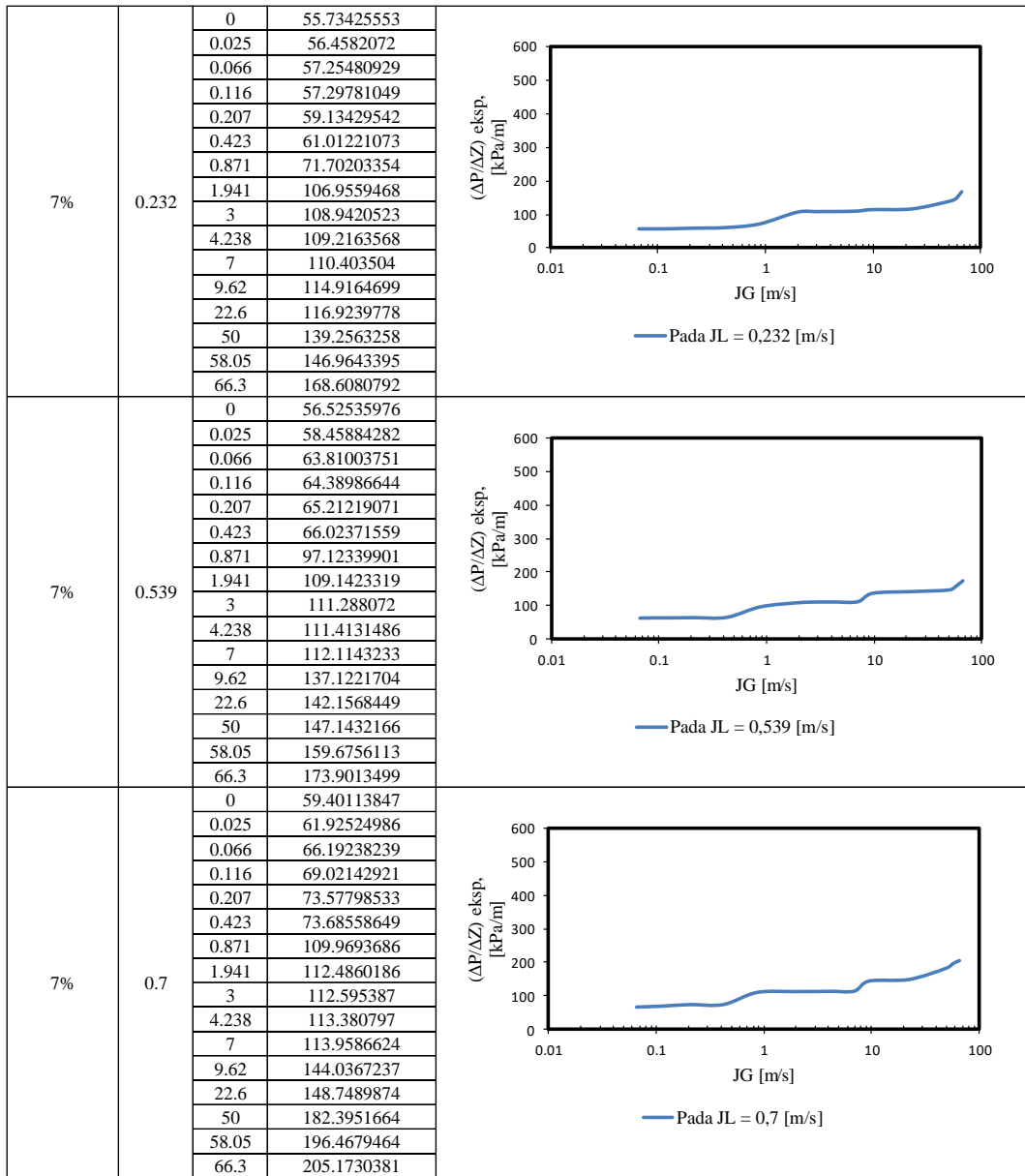
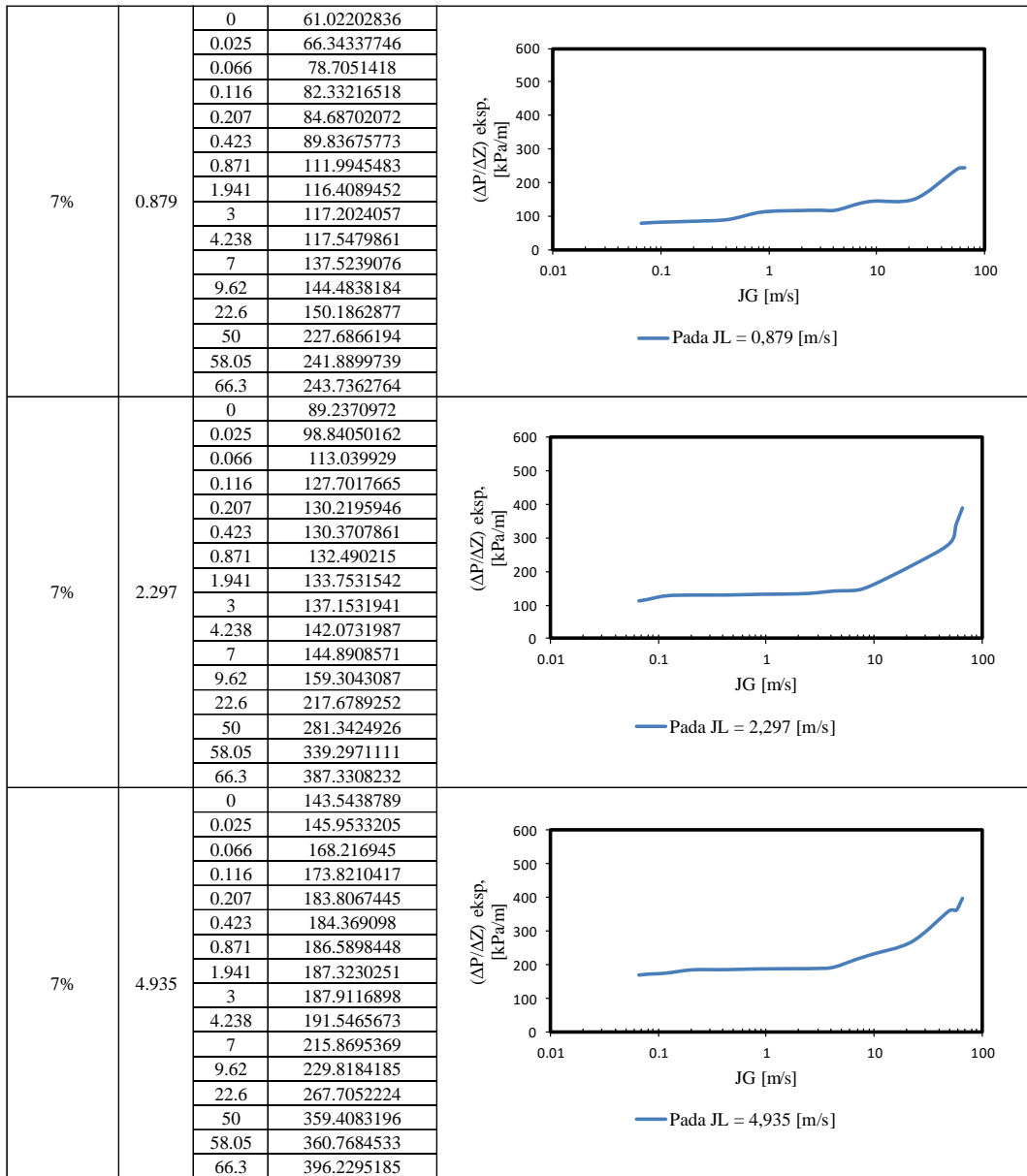


LAMPIRAN

Lampiran 1 Tabel Variasi Kecepatan Superfisial Gas (J_G) Terhadap Gradien Tekanan Pada Butanol 7%







Lampiran 2 Tabel Variasi Kecepatan Superfisial cairan (J_L) Terhadap Gradien Tekanan Pada Butanol 7%

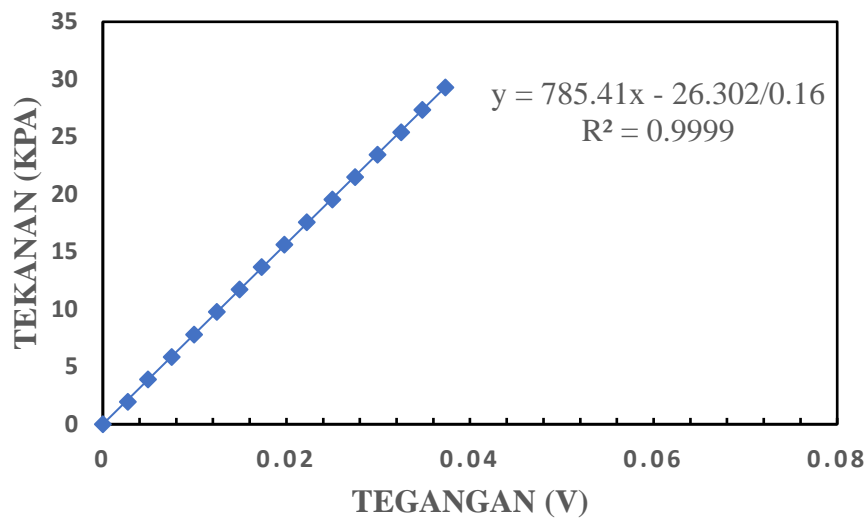
| Butanol | JG (m/s) | J_L (m/s) | $\Delta P/\Delta Z$ (kPa/m) | Grafik |
|---------|----------|-------------|-----------------------------|--------------------------------------------------------------------------------------------------------------------|
| 7% | 0 | 0.033 | 52.75421364 | <p>$(\Delta P/\Delta Z)$ eksp. [kPa/m]</p> <p>J_L [m/s]</p> <p>— Pada JG = 0 [m/s]</p> |
| | | 0.091 | 54.47308343 | |
| | | 0.149 | 54.78548025 | |
| | | 0.232 | 55.73425553 | |
| | | 0.539 | 56.52535976 | |
| | | 0.7 | 59.40113847 | |
| | | 0.879 | 61.02202836 | |
| | | 2.297 | 89.2370972 | |
| | | 4.935 | 143.5438789 | |
| 7% | 0.025 | 0.033 | 53.38882492 | <p>$(\Delta P/\Delta Z)$ eksp. [kPa/m]</p> <p>J_L [m/s]</p> <p>— Pada JG = 0,025 [m/s]</p> |
| | | 0.091 | 54.62290038 | |
| | | 0.149 | 55.34920828 | |
| | | 0.232 | 56.4582072 | |
| | | 0.539 | 58.45884282 | |
| | | 0.7 | 61.92524986 | |
| | | 0.879 | 66.34337746 | |
| | | 2.297 | 98.84050162 | |
| | | 4.935 | 145.9533205 | |
| 7% | 0.066 | 0.033 | 54.14576381 | <p>$(\Delta P/\Delta Z)$ eksp. [kPa/m]</p> <p>J_L [m/s]</p> <p>— Pada JG = 0,066 [m/s]</p> |
| | | 0.091 | 55.95750833 | |
| | | 0.149 | 55.96693325 | |
| | | 0.232 | 57.25480929 | |
| | | 0.539 | 63.81003751 | |
| | | 0.7 | 66.19238239 | |
| | | 0.879 | 78.7051418 | |
| | | 2.297 | 113.039929 | |
| | | 4.935 | 168.216945 | |
| 7% | 0.116 | 0.033 | 55.83125367 | <p>$(\Delta P/\Delta Z)$ eksp. [kPa/m]</p> <p>J_L [m/s]</p> <p>— Pada JG = 0,116 [m/s]</p> |
| | | 0.091 | 57.10263611 | |
| | | 0.149 | 57.17234124 | |
| | | 0.232 | 57.29781049 | |
| | | 0.539 | 64.38986644 | |
| | | 0.7 | 69.02142921 | |
| | | 0.879 | 82.33216518 | |
| | | 2.297 | 127.7017665 | |
| | | 4.935 | 173.8210417 | |
| 7% | 0.207 | 0.033 | 56.91453041 | <p>$(\Delta P/\Delta Z)$ eksp. [kPa/m]</p> <p>J_L [m/s]</p> <p>— Pada JG = 0,207 [m/s]</p> |
| | | 0.091 | 57.93733058 | |
| | | 0.149 | 58.98565658 | |
| | | 0.232 | 59.13429542 | |
| | | 0.539 | 65.21219071 | |
| | | 0.7 | 73.57798533 | |
| | | 0.879 | 84.68702072 | |
| | | 2.297 | 130.2195946 | |
| | | 4.935 | 183.8067445 | |

| | | | | |
|----|-------|-------|-------------|--------------------------------|
| 7% | 0.423 | 0.033 | 58.17354264 | <p>— Pada JG = 0,423 [m/s]</p> |
| | | 0.091 | 58.58058137 | |
| | | 0.149 | 59.83527385 | |
| | | 0.232 | 61.01221073 | |
| | | 0.539 | 66.02371559 | |
| | | 0.7 | 73.68558649 | |
| | | 0.879 | 89.83675773 | |
| | | 2.297 | 130.3707861 | |
| | | 4.935 | 184.369098 | |
| 7% | 0.871 | 0.033 | 62.28693116 | <p>— Pada JG = 0,871 [m/s]</p> |
| | | 0.091 | 62.85654977 | |
| | | 0.149 | 65.92337946 | |
| | | 0.232 | 71.70203354 | |
| | | 0.539 | 97.12339901 | |
| | | 0.7 | 109.9693686 | |
| | | 0.879 | 111.9945483 | |
| | | 2.297 | 132.490215 | |
| | | 4.935 | 186.5898448 | |
| 7% | 1.941 | 0.033 | 74.35220323 | <p>— Pada JG = 1,941 [m/s]</p> |
| | | 0.091 | 90.82009106 | |
| | | 0.149 | 101.3198446 | |
| | | 0.232 | 106.9559468 | |
| | | 0.539 | 109.1423319 | |
| | | 0.7 | 112.4860186 | |
| | | 0.879 | 116.4089452 | |
| | | 2.297 | 133.7531542 | |
| | | 4.935 | 187.3230251 | |
| 7% | 3 | 0.033 | 101.8142602 | <p>— Pada JG = 3 [m/s]</p> |
| | | 0.091 | 103.9164101 | |
| | | 0.149 | 106.1886012 | |
| | | 0.232 | 108.9420523 | |
| | | 0.539 | 111.288072 | |
| | | 0.7 | 112.595387 | |
| | | 0.879 | 117.2024057 | |
| | | 2.297 | 137.1531941 | |
| | | 4.935 | 187.9116898 | |
| 7% | 4.238 | 0.033 | 106.275389 | <p>— Pada JG = 4,238 [m/s]</p> |
| | | 0.091 | 106.3052346 | |
| | | 0.149 | 108.0570916 | |
| | | 0.232 | 109.2163568 | |
| | | 0.539 | 111.4131486 | |
| | | 0.7 | 113.380797 | |
| | | 0.879 | 117.5479861 | |
| | | 2.297 | 142.0731987 | |
| | | 4.935 | 191.5465673 | |
| 7% | 7 | 0.033 | 108.3365012 | <p>— Pada JG = 7 [m/s]</p> |
| | | 0.091 | 108.505168 | |
| | | 0.149 | 108.532461 | |
| | | 0.232 | 110.403504 | |
| | | 0.539 | 112.1143233 | |
| | | 0.7 | 113.9586624 | |
| | | 0.879 | 137.5239076 | |
| | | 2.297 | 144.8908571 | |
| | | 4.935 | 215.8695369 | |

| | | | | |
|----|-------|-------|-------------|--------------------------------|
| 7% | 9.62 | 0.033 | 108.6869904 | <p>— Pada JG = 9,62 [m/s]</p> |
| | | 0.091 | 108.7572846 | |
| | | 0.149 | 109.0688961 | |
| | | 0.232 | 114.9164699 | |
| | | 0.539 | 137.1221704 | |
| | | 0.7 | 144.0367237 | |
| | | 0.879 | 144.4838184 | |
| | | 2.297 | 159.3043087 | |
| | | 4.935 | 229.8184185 | |
| 7% | 22.6 | 0.033 | 108.7985187 | <p>— Pada JG = 22,6 [m/s]</p> |
| | | 0.091 | 109.7251061 | |
| | | 0.149 | 116.2465617 | |
| | | 0.232 | 116.9239778 | |
| | | 0.539 | 142.1568449 | |
| | | 0.7 | 148.7489874 | |
| | | 0.879 | 150.1862877 | |
| | | 2.297 | 217.6789252 | |
| | | 4.935 | 267.7052224 | |
| 7% | 50 | 0.033 | 116.3031112 | <p>— Pada JG = 50 [m/s]</p> |
| | | 0.091 | 116.4089452 | |
| | | 0.149 | 129.1227696 | |
| | | 0.232 | 139.2563258 | |
| | | 0.539 | 147.1432166 | |
| | | 0.7 | 182.3951664 | |
| | | 0.879 | 227.6866194 | |
| | | 2.297 | 281.3424926 | |
| | | 4.935 | 359.4083196 | |
| 7% | 58.05 | 0.033 | 128.6982555 | <p>— Pada JG = 58,05 [m/s]</p> |
| | | 0.091 | 130.4744602 | |
| | | 0.149 | 143.7959956 | |
| | | 0.232 | 146.9643395 | |
| | | 0.539 | 159.6756113 | |
| | | 0.7 | 196.4679464 | |
| | | 0.879 | 241.8899739 | |
| | | 2.297 | 339.2971111 | |
| | | 4.935 | 360.7684533 | |
| 7% | 66.3 | 0.033 | 145.9091412 | <p>— Pada JG = 66,3 [m/s]</p> |
| | | 0.091 | 146.0870365 | |
| | | 0.149 | 146.1624359 | |
| | | 0.232 | 168.6080792 | |
| | | 0.539 | 173.9013499 | |
| | | 0.7 | 205.1730381 | |
| | | 0.879 | 243.7362764 | |
| | | 2.297 | 387.3308232 | |
| | | 4.935 | 396.2295185 | |

Lampiran 3 Hasil Kalibrasi *Pressure Transducer MPX System*

| No. | h (m) | Beda Tekanan (Volt) | Tekanan (Pa) | Tekanan (Kpa) | ρ (g/cm ³) | g (m/s ²) |
|-----|-------|---------------------|--------------|---------------|-----------------------------|-----------------------|
| 1 | 0 | 0,033494959 | 0 | 0 | 996 | 9,81 |
| 2 | 0,2 | 0,036206748 | 1954,152 | 1,954152 | 996 | 9,81 |
| 3 | 0,4 | 0,038415708 | 3908,304 | 3,908304 | 996 | 9,81 |
| 4 | 0,6 | 0,04096836 | 5862,456 | 5,862456 | 996 | 9,81 |
| 5 | 0,8 | 0,043403393 | 7816,608 | 7,816608 | 996 | 9,81 |
| 6 | 1 | 0,045901646 | 9770,76 | 9,77076 | 996 | 9,81 |
| 7 | 1,2 | 0,048378447 | 11724,912 | 11,724912 | 996 | 9,81 |
| 8 | 1,4 | 0,05076496 | 13679,064 | 13,679064 | 996 | 9,81 |
| 9 | 1,6 | 0,053245502 | 15633,216 | 15,633216 | 996 | 9,81 |
| 10 | 1,8 | 0,055694268 | 17587,368 | 17,587368 | 996 | 9,81 |
| 11 | 2 | 0,058473666 | 19541,52 | 19,54152 | 996 | 9,81 |
| 12 | 2,2 | 0,060975207 | 21495,672 | 21,495672 | 996 | 9,81 |
| 13 | 2,4 | 0,063400916 | 23449,824 | 23,449824 | 996 | 9,81 |
| 14 | 2,6 | 0,065966688 | 25403,976 | 25,403976 | 996 | 9,81 |
| 15 | 2,8 | 0,068292817 | 27358,128 | 27,358128 | 996 | 9,81 |
| 16 | 3 | 0,070786566 | 29312,28 | 29,31228 | 996 | 9,81 |



Lampiran 4 Matriks Pengambilan Data Pola Aliran

| JG(ml/menit) | JL(ml/menit) | 3,979008 | 10,97242 | 17,96582 | 27,97363 | 64,99046 | 84,4032 | 105,9863 | 276,9631 | 595,0426 |
|--------------|--------------|----------|----------|----------|----------|----------|---------|----------|----------|----------|
| JG | JL | 0,033 | 0,091 | 0,149 | 0,232 | 0,539 | 0,7 | 0,879 | 2,297 | 4,935 |
| 0 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 3,0144 | 0,025 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 7,958016 | 0,066 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 13,98682 | 0,116 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| 24,95923 | 0,207 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 |
| 51,00465 | 0,423 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
| 105,0217 | 0,871 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 |
| 234,038 | 1,941 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 |
| 361,728 | 3 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 |
| 511,0011 | 4,238 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 844,032 | 7 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 |
| 1159,941 | 9,620 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 |
| 2725,018 | 22,6 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 |
| 6028,8 | 50 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 |
| 6999,437 | 58,05 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 |
| 7994,189 | 66,3 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 |

Lampiran 5 Tabel Kecepatan Superfisial Terbentuknya Pola Aliran

| No | <i>Annular</i> | | <i>Bubbly</i> | | <i>Slug annular</i> | |
|----|----------------|----------------|----------------|----------------|---------------------|----------------|
| | J _G | J _L | J _G | J _L | J _G | J _L |
| 1 | 50 | 0.033 | 0.025 | 0.879 | 1.941 | 0.033 |
| 2 | 50 | 0.091 | 0.025 | 2.297 | 1.941 | 0.091 |
| 3 | 50 | 0.149 | 0.025 | 4.935 | 1.941 | 0.149 |
| 4 | 50 | 0.232 | 0.066 | 0.879 | 3 | 0.033 |
| 5 | 58.05 | 0.033 | 0.066 | 2.297 | 3 | 0.091 |
| 6 | 58.05 | 0.091 | 0.066 | 4.935 | 3 | 0.149 |
| 7 | 58.05 | 0.149 | 0.116 | 0.879 | 3 | 0.232 |
| 8 | 58.05 | 0.232 | 0.116 | 2.297 | 4.238 | 0.033 |
| 9 | 66.3 | 0.033 | 0.116 | 4.935 | 4.238 | 0.091 |
| 10 | 66.3 | 0.091 | 0.207 | 0.879 | 4.238 | 0.149 |
| 11 | 66.3 | 0.149 | 0.207 | 2.297 | 4.238 | 0.232 |
| 12 | 66.3 | 0.232 | 0.207 | 4.935 | 7 | 0.033 |
| 13 | | | 0.423 | 0.897 | 7 | 0.091 |
| 14 | | | 0.423 | 2.297 | 7 | 0.149 |
| 15 | | | 0.423 | 4.935 | 7 | 0.232 |
| 16 | | | 0.871 | 0.897 | 9.62 | 0.033 |
| 17 | | | 0.871 | 2.297 | 9.62 | 0.091 |
| 18 | | | 0.871 | 4.935 | 9.62 | 0.149 |
| 19 | | | | | 9.62 | 0.232 |
| 20 | | | | | 22.6 | 0.033 |
| 21 | | | | | 22.6 | 0.091 |
| 22 | | | | | 22.6 | 0.149 |
| 23 | | | | | 22.6 | 0.232 |

| No | <i>Plug</i> | | <i>Churn</i> | |
|----|----------------|----------------|----------------|----------------|
| | J _G | J _L | J _G | J _L |
| 1 | 0.025 | 0.033 | 1.941 | 2.297 |
| 2 | 0.025 | 0.091 | 1.941 | 4.935 |
| 3 | 0.025 | 0.149 | 3 | 0.539 |
| 4 | 0.025 | 0.232 | 3 | 0.7 |
| 5 | 0.025 | 0.539 | 3 | 0.879 |
| 6 | 0.025 | 0.7 | 3 | 2.297 |
| 7 | 0.066 | 0.033 | 3 | 4.935 |
| 8 | 0.066 | 0.091 | 4.238 | 0.539 |
| 9 | 0.066 | 0.149 | 4.238 | 0.7 |
| 10 | 0.066 | 0.232 | 4.238 | 0.879 |
| 11 | 0.066 | 0.539 | 4.238 | 2.297 |
| 12 | 0.066 | 0.7 | 4.238 | 4.935 |
| 13 | 0.116 | 0.033 | 7 | 0.539 |
| 14 | 0.116 | 0.091 | 7 | 0.7 |
| 15 | 0.116 | 0.149 | 7 | 0.879 |
| 16 | 0.116 | 0.232 | 7 | 2.297 |
| 17 | 0.116 | 0.539 | 7 | 4.935 |
| 18 | 0.116 | 0.7 | 9.62 | 0.539 |
| 19 | 0.207 | 0.033 | 9.62 | 0.7 |
| 20 | 0.207 | 0.091 | 9.62 | 0.879 |
| 21 | 0.207 | 0.149 | 9.62 | 2.297 |
| 22 | 0.207 | 0.232 | 9.62 | 4.935 |
| 23 | 0.207 | 0.539 | 22.6 | 0.539 |
| 24 | 0.207 | 0.7 | 22.6 | 0.7 |
| 25 | 0.423 | 0.033 | 22.6 | 0.879 |
| 26 | 0.423 | 0.091 | 22.6 | 2.297 |
| 27 | 0.423 | 0.149 | 22.6 | 4.935 |
| 28 | 0.423 | 0.232 | 50 | 0.539 |
| 29 | 0.423 | 0.539 | 50 | 0.7 |
| 30 | 0.423 | 0.7 | 50 | 0.879 |
| 31 | 0.871 | 0.033 | 50 | 2.297 |
| 32 | 0.871 | 0.091 | 50 | 4.935 |
| 33 | 0.871 | 0.149 | 58.05 | 0.539 |
| 34 | 0.871 | 0.232 | 58.05 | 0.7 |
| 35 | 0.871 | 0.539 | 58.05 | 0.879 |
| 36 | 0.871 | 0.7 | 58.05 | 2.297 |
| 37 | 1.941 | 0.232 | 58.05 | 4.935 |

| | | | | |
|----|-------|-------|------|-------|
| 38 | 1.941 | 0.539 | 66.3 | 0.539 |
| 39 | 1.941 | 0.7 | 66.3 | 0.7 |
| 40 | 1.941 | 0.879 | 66.3 | 0.879 |
| 41 | | | 66.3 | 2.297 |
| 42 | | | 66.3 | 4.935 |

Lampiran 6 Hasil Uji Laboratorium Campuran Aquades dan Butanol

| Fluida % | SurfaceTension [mN/m] | Index |
|------------------------|----------------------------------|--------------|
| Aquades | 71.00 | A |
| Aquades + 1% Butanol | 55.07 | B1 |
| Aquades + 2% Butanol | 46.03 | B2 |
| Aquades + 3% Butanol | 42.9 | B3 |
| Aquades + 4% Butanol | 36.50 | B4 |
| Aquades + 5% Butanol | 33.10 | B5 |
| Aquades + 6% Butanol | 30.85 | B6 |
| Aquades + 7% Butanol | 30.4 | B7 |
| Aquades + 8% Butanol | 26.57 | B8 |
| Aquades + 10% Butanol | 25.03 | B10 |
| Aquades + 100% Butanol | 24.37 | B100 |