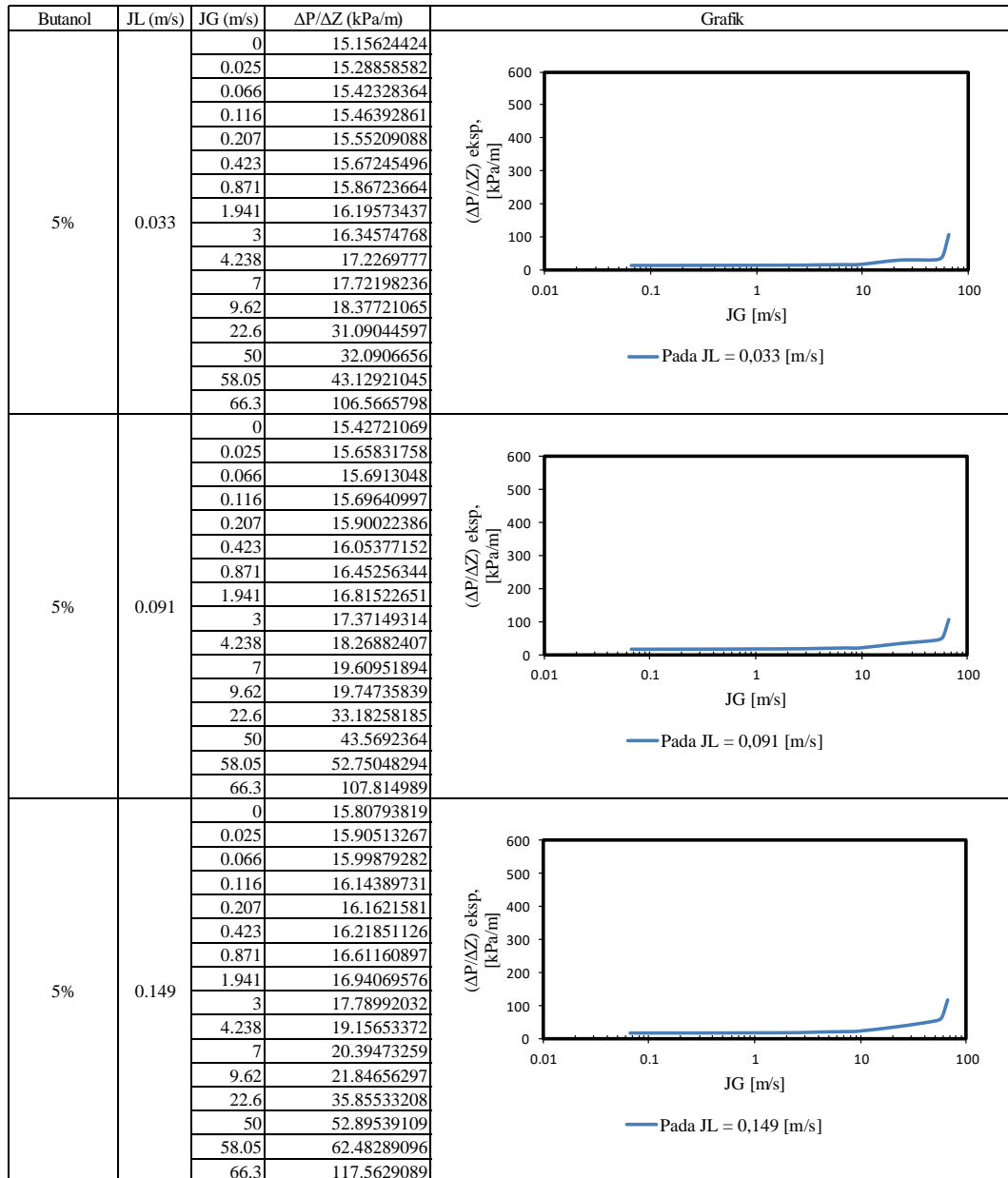
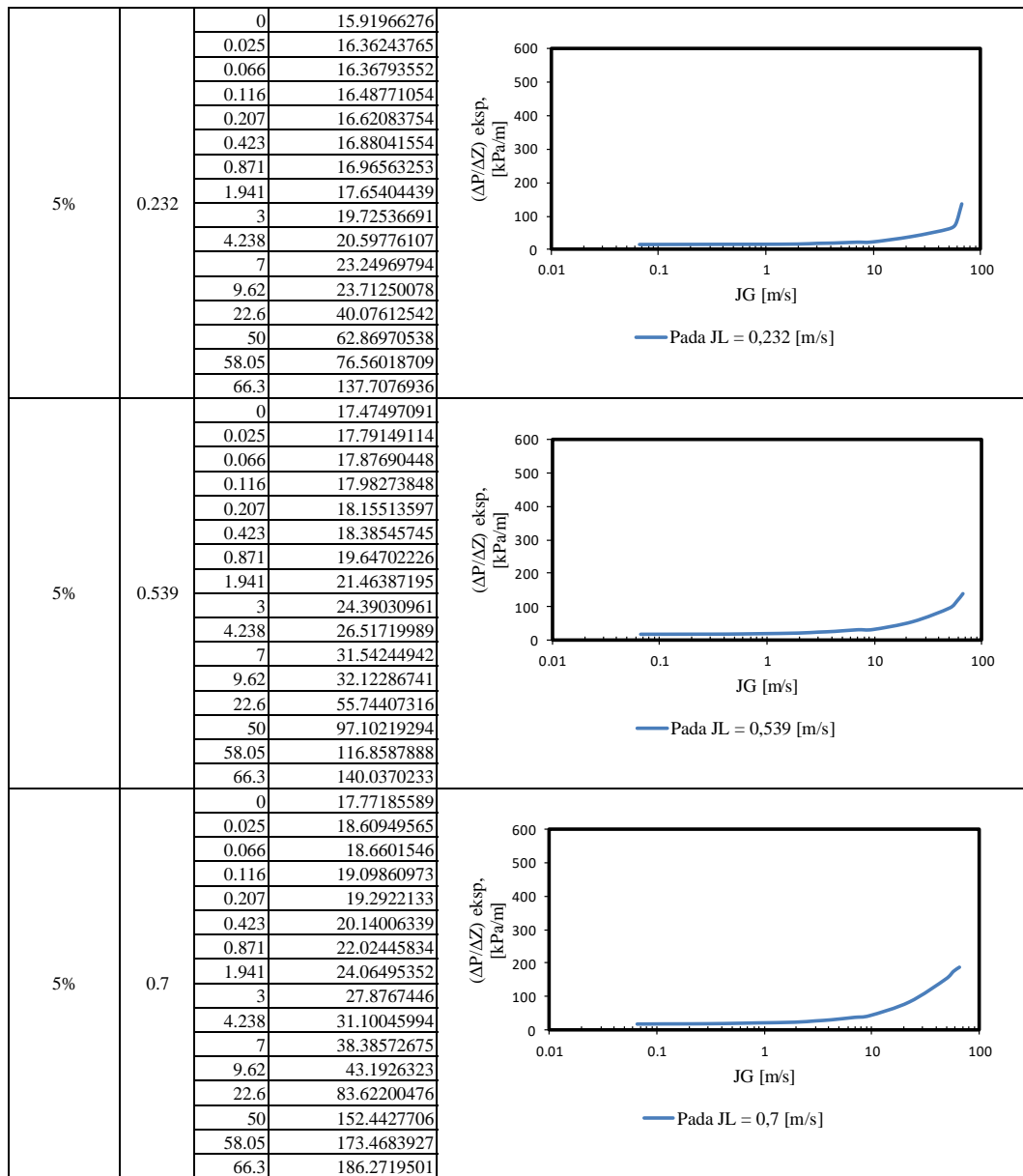
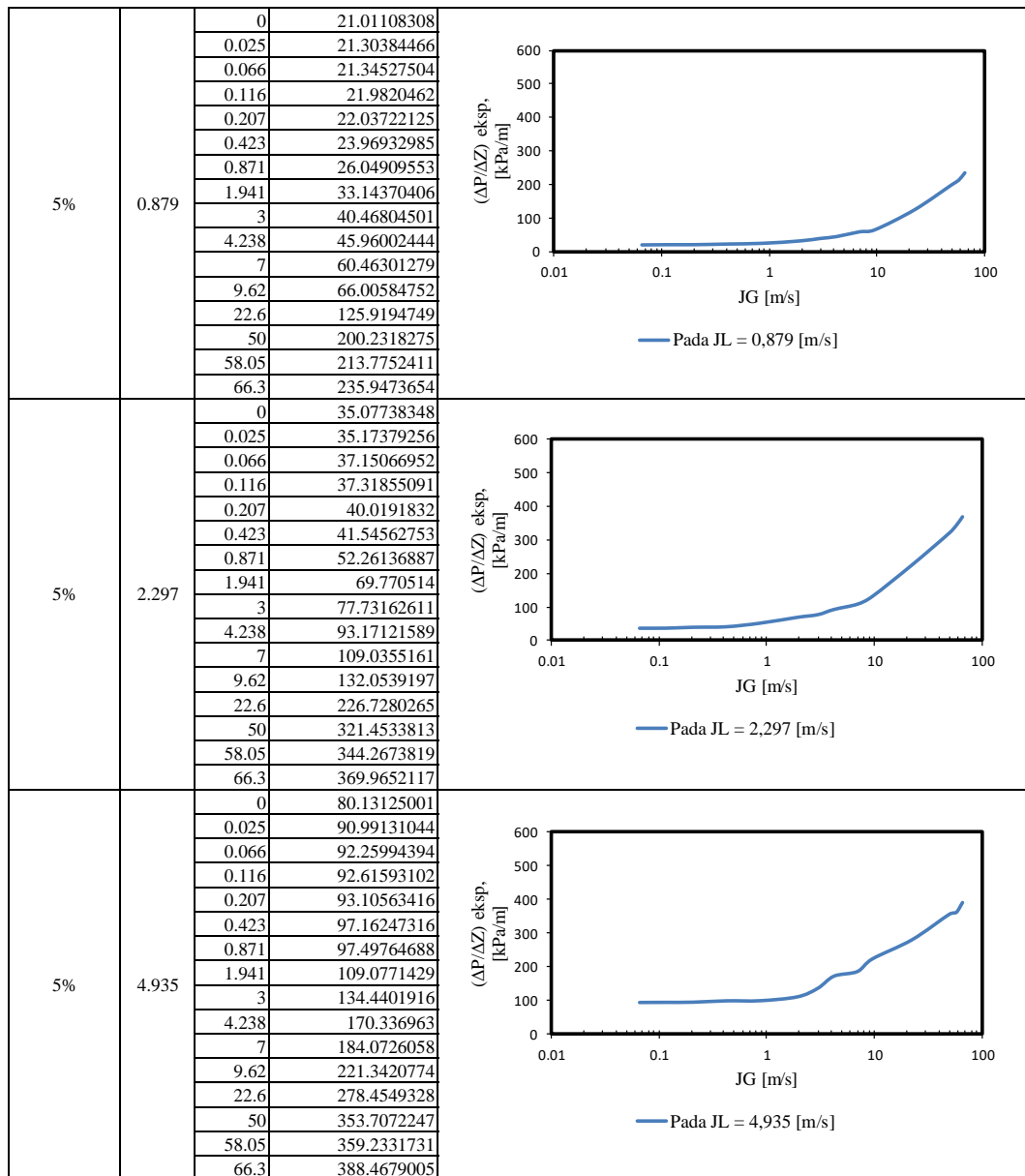


## LAMPIRAN

Lampiran 1 Tabel Variasi Kecepatan Superfisial Gas ( $J_G$ ) Terhadap Gradien Tekanan pada Butanol 5%

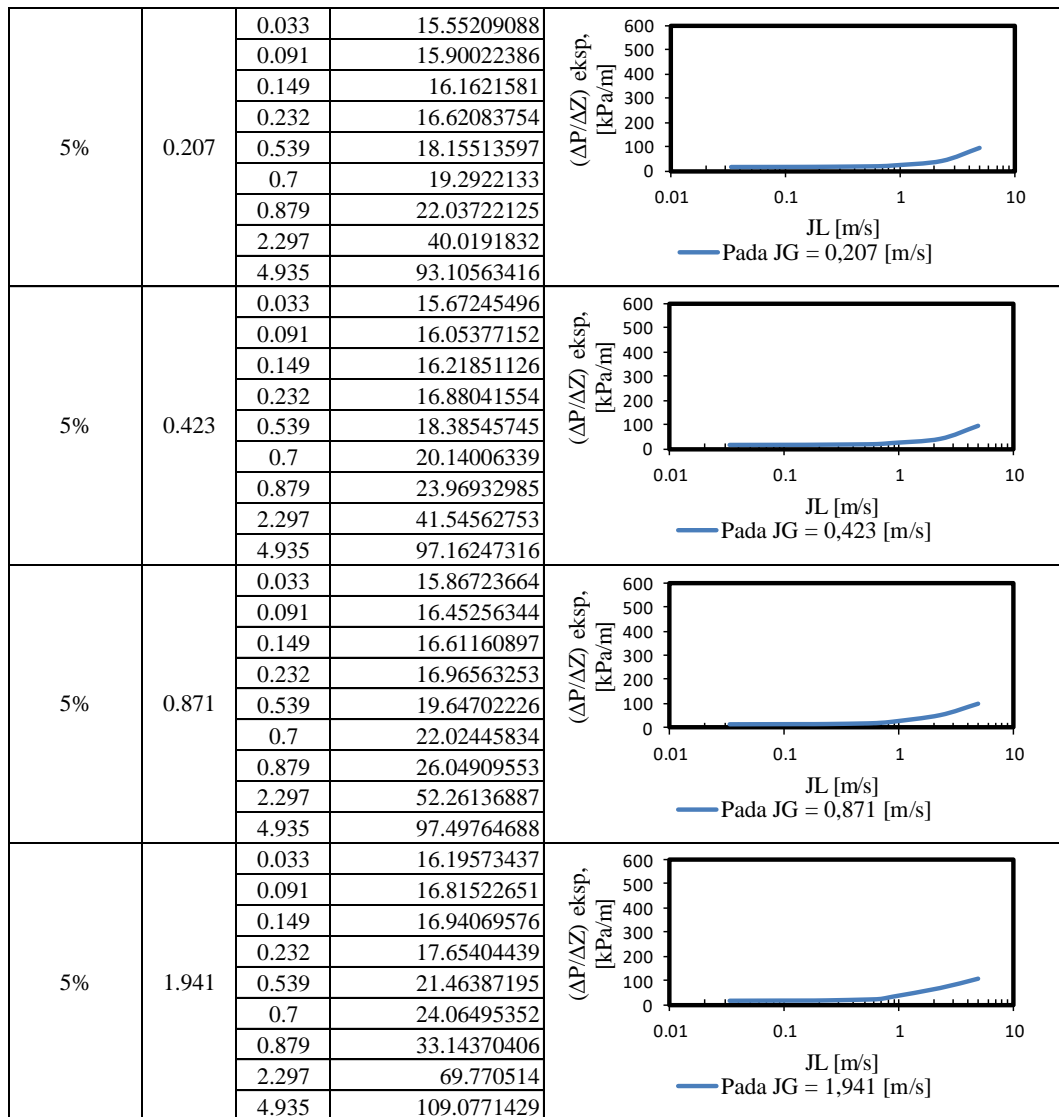






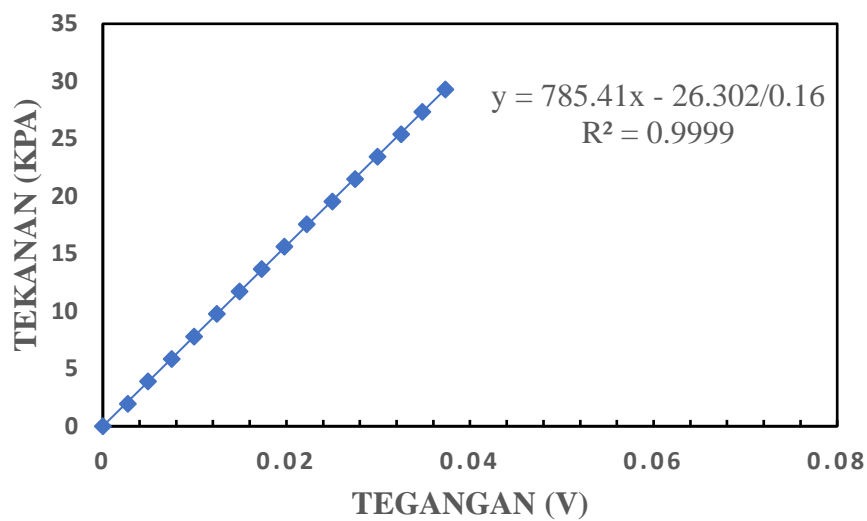
Lampiran 2 Tabel Variasi Kecepatan Superfisial *Liquid* ( $J_L$ ) Terhadap Gradien Tekanan Pada Butanol 5%

| Butanol | JG (m/s)    | $J_L$ (m/s) | $\Delta P/\Delta Z$ (kPa/m) | Grafik                   |
|---------|-------------|-------------|-----------------------------|--------------------------|
| 5%      | 0           | 0.033       | 15.15624424                 | <p>Pada JG = 0 [m/s]</p> |
|         |             | 0.091       | 15.42721069                 |                          |
|         |             | 0.149       | 15.80793819                 |                          |
|         |             | 0.232       | 15.91966276                 |                          |
|         |             | 0.539       | 17.47497091                 |                          |
|         |             | 0.7         | 17.77185589                 |                          |
|         |             | 0.879       | 21.01108308                 |                          |
|         |             | 2.297       | 35.07738348                 |                          |
|         |             | 4.935       | 80.13125001                 |                          |
|         |             | 5%          | 0.025                       |                          |
| 0.091   | 15.65831758 |             |                             |                          |
| 0.149   | 15.90513267 |             |                             |                          |
| 0.232   | 16.36243765 |             |                             |                          |
| 0.539   | 17.79149114 |             |                             |                          |
| 0.7     | 18.60949565 |             |                             |                          |
| 0.879   | 21.30384466 |             |                             |                          |
| 2.297   | 35.17379256 |             |                             |                          |
| 4.935   | 90.99131044 |             |                             |                          |
| 5%      | 0.066       |             |                             | 0.033                    |
|         |             | 0.091       | 15.6913048                  |                          |
|         |             | 0.149       | 15.99879282                 |                          |
|         |             | 0.232       | 16.36793552                 |                          |
|         |             | 0.539       | 17.87690448                 |                          |
|         |             | 0.7         | 18.6601546                  |                          |
|         |             | 0.879       | 21.34527504                 |                          |
|         |             | 2.297       | 37.15066952                 |                          |
|         |             | 4.935       | 92.25994394                 |                          |
|         |             | 5%          | 0.116                       | 0.033                    |
| 0.091   | 15.69640997 |             |                             |                          |
| 0.149   | 16.14389731 |             |                             |                          |
| 0.232   | 16.48771054 |             |                             |                          |
| 0.539   | 17.98273848 |             |                             |                          |
| 0.7     | 19.09860973 |             |                             |                          |
| 0.879   | 21.9820462  |             |                             |                          |
| 2.297   | 37.31855091 |             |                             |                          |
| 4.935   | 92.61593102 |             |                             |                          |



Lampiran 3 Hasil Kalibrasi *Pressure Transducer MPX System*

| No. | h (m) | Beda Tekanan (Volt) | Tekanan (Pa) | Tekanan (Kpa) | $\rho$ (g/cm <sup>3</sup> ) | g (m/s <sup>2</sup> ) |
|-----|-------|---------------------|--------------|---------------|-----------------------------|-----------------------|
| 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 |
|--------------|--------------|----|----------|----------|----------|----------|----------|---------|----------|----------|----------|
|              | JL           | JG | 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 terbentuknya pola aliran *plug*, *bubbly* dan *slug-annular*

| PLUG |       |       | BUBBLY       |       |       |
|------|-------|-------|--------------|-------|-------|
| No.  | JG    | JL    | No.          | JG    | JL    |
| 10   | 0.025 | 0.033 | 17           | 0.025 | 2.297 |
| 11   | 0.025 | 0.091 | 18           | 0.025 | 4.935 |
| 12   | 0.025 | 0.149 | 26           | 0.066 | 2.297 |
| 13   | 0.025 | 0.232 | 27           | 0.066 | 4.935 |
| 14   | 0.025 | 0.539 | 34           | 0.116 | 0.879 |
| 15   | 0.025 | 0.7   | 35           | 0.116 | 2.297 |
| 16   | 0.025 | 0.879 | 36           | 0.116 | 4.935 |
| 19   | 0.066 | 0.033 | 42           | 0.207 | 0.7   |
| 20   | 0.066 | 0.091 | 43           | 0.207 | 0.879 |
| 21   | 0.066 | 0.149 | 44           | 0.207 | 2.297 |
| 22   | 0.066 | 0.232 | 45           | 0.207 | 4.935 |
| 23   | 0.066 | 0.539 | 51           | 0.423 | 0.7   |
| 24   | 0.066 | 0.7   | 52           | 0.423 | 0.879 |
| 25   | 0.066 | 0.879 | 53           | 0.423 | 2.297 |
| 28   | 0.116 | 0.033 | 54           | 0.423 | 4.935 |
| 29   | 0.116 | 0.091 | 60           | 0.871 | 0.7   |
| 30   | 0.116 | 0.149 | 61           | 0.871 | 0.879 |
| 31   | 0.116 | 0.232 | 62           | 0.871 | 2.297 |
| 32   | 0.116 | 0.539 | 63           | 0.871 | 4.935 |
| 33   | 0.116 | 0.7   |              |       |       |
| 37   | 0.207 | 0.033 | SLUG ANNULAR |       |       |
| No.  | JG    | JL    | No.          | JG    | JL    |
| 38   | 0.207 | 0.091 | 73           | 3     | 0.033 |
| 39   | 0.207 | 0.149 | 74           | 3     | 0.091 |
| 40   | 0.207 | 0.232 | 75           | 3     | 0.149 |
| 41   | 0.207 | 0.539 | 76           | 3     | 0.232 |
| 46   | 0.423 | 0.033 | 82           | 4.238 | 0.033 |
| 47   | 0.423 | 0.091 | 83           | 4.238 | 0.091 |
| 48   | 0.423 | 0.149 | 84           | 4.238 | 0.149 |
| 49   | 0.423 | 0.232 | 85           | 4.238 | 0.232 |
| 50   | 0.423 | 0.539 | 91           | 7     | 0.033 |
| 55   | 0.871 | 0.033 | 92           | 7     | 0.091 |
| 56   | 0.871 | 0.091 | 93           | 7     | 0.149 |
| 57   | 0.871 | 0.149 | 94           | 7     | 0.232 |
| 58   | 0.871 | 0.232 | 100          | 9.62  | 0.033 |
| 59   | 0.871 | 0.539 | 101          | 9.62  | 0.091 |
| 64   | 1.941 | 0.033 | 102          | 9.62  | 0.149 |
| 65   | 1.941 | 0.091 | 103          | 9.62  | 0.232 |
| 66   | 1.941 | 0.149 |              |       |       |
| 67   | 1.941 | 0.232 |              |       |       |
| 68   | 1.941 | 0.539 |              |       |       |



Lampiran 6 Tabel terbentuknya pola aliran *annular* dan *churn*

| ANNULAR |       |       | CHURN |       |       |
|---------|-------|-------|-------|-------|-------|
| No.     | JG    | JL    | No.   | JG    | JL    |
| 109     | 22.6  | 0.033 | 69    | 1.941 | 0.7   |
| 110     | 22.6  | 0.091 | 70    | 1.941 | 0.879 |
| 111     | 22.6  | 0.149 | 71    | 1.941 | 2.297 |
| 112     | 22.6  | 0.232 | 72    | 1.941 | 4.935 |
| 118     | 50    | 0.033 | 77    | 3     | 0.539 |
| 119     | 50    | 0.091 | 78    | 3     | 0.7   |
| 120     | 50    | 0.149 | 79    | 3     | 0.879 |
| 121     | 50    | 0.232 | 80    | 3     | 2.297 |
| 127     | 58.05 | 0.033 | 81    | 3     | 4.935 |
| 128     | 58.05 | 0.091 | 86    | 4.238 | 0.539 |
| 129     | 58.05 | 0.149 | 87    | 4.238 | 0.7   |
| 130     | 58.05 | 0.232 | 88    | 4.238 | 0.879 |
| 136     | 66.3  | 0.033 | 89    | 4.238 | 2.297 |
| 137     | 66.3  | 0.091 | 90    | 4.238 | 4.935 |
| 138     | 66.3  | 0.149 | 95    | 7     | 0.539 |
| 139     | 66.3  | 0.232 | 96    | 7     | 0.7   |
|         |       |       | 97    | 7     | 0.879 |
|         |       |       | 98    | 7     | 2.297 |
|         |       |       | 99    | 7     | 4.935 |
|         |       |       | 104   | 9.62  | 0.539 |
|         |       |       | 105   | 9.62  | 0.7   |
|         |       |       | 106   | 9.62  | 0.879 |
|         |       |       | 107   | 9.62  | 2.297 |
|         |       |       | 108   | 9.62  | 4.935 |
|         |       |       | 113   | 22.6  | 0.539 |
|         |       |       | 114   | 22.6  | 0.7   |
|         |       |       | 115   | 22.6  | 0.879 |
|         |       |       | 116   | 22.6  | 2.297 |
|         |       |       | 117   | 22.6  | 4.935 |
|         |       |       | 122   | 50    | 0.539 |
|         |       |       | 123   | 50    | 0.7   |
|         |       |       | 124   | 50    | 0.879 |
|         |       |       | 125   | 50    | 2.297 |
|         |       |       | 126   | 50    | 4.935 |
|         |       |       | 131   | 58.05 | 0.539 |
|         |       |       | 132   | 58.05 | 0.7   |
|         |       |       | 133   | 58.05 | 0.879 |
|         |       |       | 134   | 58.05 | 2.297 |
|         |       |       | 135   | 58.05 | 4.935 |
|         |       |       | 140   | 66.3  | 0.539 |
|         |       |       | 141   | 66.3  | 0.7   |
|         |       |       | 142   | 66.3  | 0.879 |
|         |       |       | 143   | 66.3  | 2.297 |
|         |       |       | 144   | 66.3  | 4.935 |

## Lampiran 7 Hasil Uji Laboratorium Campuran Aquades dan Butanol

| <b>Fluida %</b>        | <b>SurfaceTension<br/>[mN/m]</b> | <b>Index</b> |
|------------------------|----------------------------------|--------------|
| Aquades                | 71,00                            | A            |
| Aquades + 1% Butanol   | 55,07                            | B1           |
| Aquades + 2% Butanol   | 46,03                            | B2           |
| Aquades + 3% Butanol   | 42,90                            | B3           |
| Aquades + 4% Butanol   | 36.50                            | B4           |
| Aquades + 5% Butanol   | 33.10                            | B5           |
| Aquades + 6% Butanol   | 30.85                            | B6           |
| Aquades + 7% Butanol   | 30.40                            | B7           |
| Aquades + 8% Butanol   | 26.57                            | B8           |
| Aquades + 10% Butanol  | 25.03                            | B10          |
| Aquades + 100% Butanol | 24.37                            | B100         |