

## DAFTAR PUSTAKA

- Affam. C.A dan Adlan. N.M. 2013. Operational Performnce Of Vertical Upflow Roughing Filter For Pretreatment Of Leachate Using Limestone Filter Media, *Journal of Urban and Environmental Engineering* , Vol. 7, No. 1 (January to June 2013), pp. 117-125
- Arie Herlambang.2010. Teknologi Penyediaan Air Minum Untuk Keadaan Tanggap Darurat. *Jurnal Air Indonesia*, Vol.6, No.1.
- Al-layla, M.A. 1980. *Water Supply Engineering Design* Michigan: Ann Arbor Science, Publisher Inc
- Andrie, Fatmawati S dan Tehuayo. H. 2016. Rancangan Sistem Penjernihan Air baku Dengan Sistem *Slow Sand Filter* di Desa Lekopancing Kabupaten Maros Sulawesi Selatan. *Jurnal Iptek*. Vol 11 (21) 1523 – 1530
- American Public Health Association, APHA. 1998. *Standard methods for examination of water and wastewater*, 20th ed. Washington, D.C. USA
- American Public Health Association, APHA. 1992. *Standard methods for examination of water and wastewater*, 19th ed. Washington, D.C. USA.
- Amin, K.N., Aziz, S.Q. 2002. Pressure distribution in filter media in conventional filters. *Journal of Dohuk University*, Vol.5, No.2, 56-59.
- Artiyani A dan Firmansyah.H.N. 2016. Kemampuan filtrasi *upflow* pengolahan filtrasi *upFlow* dengan media pasir,zeolit dan arang aktif dalam menurunkan kadar Fosfat dan deterjen air limbah domestik. *Jurnal Industri Inovatif* . Vol.6.1, 8-15
- Asmadi., Khayan., & Heru, SK. 2011. Teknologi Pengolahan Air Minum. Yogyakarta: Gosyen Publishing.
- Awwal R. 2016 , Efektifitas Pengolahan *Greywater* dengan menggunakan *Rapid Sand Filter* (RSF) dalam menurunkan kekeruhan TSS,BOD dan COD *Tugas Akhir* Fakultas Teknik sipil dan perencanaan Universitas Islam Indonesia.

- Aziz, H. A., Salina A., Mohd. N. A., Faridah, Asaar i A.H., Zahari, M.S. (2006) Colour removal from landfill leachate by coagulation and flocculation processes, *Bioresource Technology* 98, 218–220.
- Aziz, H.A., Yusoff M.S., Mohd N.A., Adnan N.H., Salina, A. (2004) Physico-chemical removal of iron from semi-aerobic landfill leachate by limestone filter. *Waste Management* 24, 353–358
- Badan Standardisasi nasional 2008. *Perencanaan Instalasi Saringan Pasir Lambat*. SNI – 3981.
- Badan Standarisasi Nasional , 2008 Tata cara perencanaan unit paket instalasi pengolahan air, Standar Nasional Indonesia (SNI) 6774:
- Baker, RW. 2004. *Membran Technology And Application* (2 ed). California: John Wiley & Son Ltd.
- Bambang B, Marry.S, RN.Hamdani, M.Ihsan, Y.Arai, 2019. The Effectiveness of PAC and Chitosan Usage in Jeneberang River Raw Water Treatment. Systems. *IOP Conference Series: Material Science and Engineering* 679 (1),012028
- Bambang B, A Sumakin, Y. Widiyari, 2020. Distribution pattern of Water Salinity Analysis in Jeneberang river estuary using ArcGis. *IOP-Conference Series* 419 (1),012116
- Bambang Triatmodjo. 2015. *Hidraulika I*. Penerbit Beta Offset. Yogyakarta
- Barrett, J.M. 1989. Improvement of slow sand filtration of warm water by using coarse sand. *Thesis*, University of Colorado, USA.
- Bear, J. and A. Verruijt, 1990, *Modelling Groundwater Flow and Pollution*: Reidel Publishing Company, Dordrecht, the Netherland, 412 p.
- Boller, M.A., Kavanaugh, M.C. 1995. Particle characteristics and headloss increase in granular media filtration. *Water Research*, Vol. 29, Issue 4, 1139-1149.
- Boller, M. 1993. Filter mechanisms in roughing filters. *Journal of Water Supply Research and Technology - Aqua*, Vol. 42, 174185.
- Bouwer, Herman, 1978. *Groundwater Hydrology*. Int. Student Ed., McGraw-Hill Kogakusha Ltd.

- Chatib B.1992, Diktat pengolahan air Minum, ITB, Bandung
- Cheremisinoff, N.P. 2002, *Handbook of Water and Wastewater Treatment Technologies*; Butterworth-Heinemann: Oxford, UK
- Cheryan. M. 1998. *Ultrafiltration and Microfiltration Handbook*, Bassel Technomic Publishing Co.
- Collins, M.R., Westersund C., Cole J., Roccaro J. 1994. *Evaluation of roughing filtration design variables*. AWWARF and AWWA, Denver, USA. 77- 88.
- Cooney, D.O. 1999 *Adsorption design for wastewater treatment*. CRC Press LLC, Florida, USA.
- Darsono dan Teguh Sutomo. 2002. Pengaruh Diameter dan Ketebalan Pasir dalam Saringan Pasir Lambat terhadap Penurunan Kadar Besi. *Jurnal Teknologi Industri* 6 (4), 213 – 224
- Deni Maryani , Ali Masduqi dan Atiek Moesriati. 2014. Pengaruh Ketebalan Media dan Rate filtrasi pada Sand Filter dalam Menurunkan Kekeruhan dan Total Coliform. *JURNAL TEKNIK POMITS* Vol. 3, No.2, (2014) ISSN: 2337-3539 (2301-9271 Print)
- Desviani. 2012. Evaluasi Pemberian Dosis Koagulan Alumunium Sulfat Cair dan Bubuk pada Sistem Dosing Koagulan di Instalasi Pengolahan Air Minum PT. Krakatau Tirta Industri. *Skripsi*. IPB-Bogor.
- Dewi Hendrayani, Nurina Fitriani dan Wahyono Hadi. 2013. Pengaruh Ketebalan Media Geotekstil dan Arah Aliran Terhadap Penyisihan Kekeruhan dan Total Coli pada Slow Sand Filter Rangkaian Seri. *JURNAL TEKNIK POMITS* Vol. 3, No. 1, (2013) ISSN: 2337-3539
- Dini, 2016. Filtrasi Sand Filter, <http://akrantauans.blogspot.com>.
- Effendi, Hefi. 2003 *Telaah Kualitas Air*, Kanicius, Yogyakarta
- Ellis, K.V.1987. Slow sand filtration as a technique for the tertiary treatment of municipal sewages. *Water Research*, Vol. 21, 403410

- Elystia, S., Indah & Helard, D. 2012. Efisiensi Metode Multi Soil Layering (MSL) dalam Penyisihan COD dari Limbah Cair Hotel (Studi Hotel X Padang). *Jurnal Teknik Lingkungan*. Universitas Andalas. Padang.
- Eri Rustanti Iva dan Hadi Wahyono, 2009. Kajian Pengolahan Air Gambut Menjadi Air Bersih dengan Kombinasi Proses Upflow Anaerobic Filter dan Slow Sand Filter. *Skripsi* (online) Jurusan Teknik Lingkungan FTSP- ITS, diakses 27 Juni 2021
- Fatehah. 2007. *Semiconductor Wastewater treatment with Natural Starch as Coagulant Using Response Surface Methodology*. University Techonolgy Malaysia
- Fardiaz, Srikandi, 1992 *Polusi Udara dan Air*, Kanicius, Yogyakarta  
Filtrasi. (online), [http://bhupalaka.files.wordpress.com/2010/12/filter cepat.pdf](http://bhupalaka.files.wordpress.com/2010/12/filter%20cepat.pdf), diakses 15 oktober 2020.
- Galvis, G., Visscher, J.T., Latorre J. 1998 *Multi-stage filtration and innovation water treatment technology*. International reference centre for community water supply and sanitation, The Hague, Netherlands and Universidad del valle instituto Cinara, Cali, Colombia.
- Ghaly, A.E., Kamal, M.A., Mahmoud, N.S., Cote. R. 2007. Treatment of landfill leachate using limestone/sandstone filters under aerobic batch conditions. *American Journal of Environmental Sciences* 3 (2), 43-53.
- Greenlee, L, F. Lawyer, D. F., Freeman, B. D, Marrot., B., Moulin, P. 2009. *Reverse osmosis Desalination: Wastewater Resources, Technology And Todays Challenges*. Wastewater Research 43.
- Hafni. 2012. Proses Pengolahan Air Bersih Pada PDAM, 13(2).
- Hardiyatmo, H.C. 2002, *Mekanika Tanah I*. Yogyakarta, Gadjah Mada University Press
- Hay, R. L. 1966. *Zeolites and Zeolitic Reactions in Sedimentary Rocks, Dept. Geology And Geophysics*. California: University of California Berkeley.
- Howkes dan Huisman, L, 1993, *Small Community Water Supplies*, John Wiley &sons, New york, Brisbane Toronto Singapore

- Huisman, L., 1974, *Rapid Filtration, part I*, Delft University of Technology, Dep. Of Civil Engineering Div of Sanitary, Netherlands
- Huisman, L.1994. *Slow Sand Filtration*. Lecture Notes. IHE Delt Netherlands.
- Idaman, NS. 2012. Pengolahan Air Payau menjadi Air Minum dengan Metode Kombinasi Elektrokoagulasi dan Adsorpsi menggunakan Karborsil. *Skripsi*. Universitas Lampung.Lampung.
- Joko, T. 2010. *Unit Produksi dalam Sistem Penyediaan Air Minum*, Graha Ilmu.
- Kardo, Syarfi Daud, Shinta Elystia. 2017. Pre-Treatment Air Payau Dengan Koagulan Tepung Jagung dan Filtrasi Dengan Membran Ultrafiltrasi Sistem Aliran Crossflow. *Jom F TEKNIK Volume 4 No.1*
- Kemala Sari Lubis. 2007. Keterhantaran Hidrolik dan Permeabilitas. *Usu Repository*
- Khambhammettu. 2006. *Full Scale Evaluation of Upflow Filter A Catch Areas*.
- Kissan, M.Rauf, M.Selintung, B Bakri 2021, Sistem Informasi Geografis Kualitas Air Sumur di Kota Makassar Journal of Applied Civil and Environmental 1: 78 -85
- Kusnaedi. 2010. *Mengolah Air Gambut dan Air Kotor Untuk Air Minum*. Cetakan Pertama.Penerbit Penebar Swadaya. Jakarta.
- Masduqi, A., & Selamat, A. (2012). *Unit Operasi & Proses Pengolahan Air* Surabaya Indonesia: ITS Press.
- Metcalf & Eddy. 2003. *Wastewater Engineering : Treatment, Disposal, Reuse, Revised* by Geo Tchobanoglous. Tata Mc Graw-Hil Publising Company LTD. New Delhi.
- Mulia. 2005. *Kesehatan Lingkungan*. Penerbit graha ilmu, Yogyakarta
- Muh Nurul Ma'arif, Mary Selintung, Bambang Bakri. 2017, Analisis Kualitas Air Minum Isi Ulang di Kota Makassar, *Jurnal Program Studi Teknik Lingkungan Universitas Hasanuddin*

- Mudiat, T. 1996. Desalinasi Air Laut dengan Destilasi. Jakarta: PLTU/PLTG Sektor Priok
- Mulder. 1996. Basic Principles of Membrane Technology (2ed). Hetherland Academic Publisher.
- Notodarmodjo, S & Anne. D. 2004. Penurunan Zat Organik dan Kekeruhan menggunakan Teknologi Membran Ultrafiltrasi Sistem Aliran Dead And. Proceeding. ITB Sains & Teknologi. Vol36 A. No I. 2004. Hal 63-82.
- Nurandani Hardyanti, Nurmeta Diana Fitri. 2006 Studi Evaluasi Instalasi Pengolahan Air Bersih Untuk Kebutuhan Domestik dan Non Domestik ( Studi Kasus Perusahaan Tekstil Bawen Kabupaten Semarang ) *Jurnal Presipitasi* 1(1), 37 - 42
- Osada. Y, Nakagawa. T. 1992. Membrane Science and Technology. New York: Marcel Dekker, Inc.
- Ozacar, M. & Sengil, I.A. 2003. Evaluation of Tanin as A Coagulant Aid for Coagulant of Colloidal Particle, Colloid And Surfaces A, Physicochem. Eng. Aspects, Vol 229. Hal 85-96.
- Pallu, M.S. 1999. Studi Karakteristik Pasir Untuk Saringan Penjernihan Air. *Hi – Tech*. Edisi 03:84 -88
- Paraturan Pemerintah Republik Indonesia Nomor 82 tahun 2001 Tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air
- Peraturan Pemerintah Republik Indonesia Nomor 16 Tahun 2005 Tentang Pengembangan Sistem Penyediaan Air Minum
- Peraturan Menteri Kesehatan . Nomor 416 Tahun 1990 tentang Persyaratan Air Bersih
- Peraturan Menteri Kesehatan Republik Indonesia Nomor: 32/Menkes/Per/IX/2017 Tentang Baku Mutu Air
- Pinem, J.A, Ginting, MS. & Paratenta, M. 2014. Pengolahan Air Lindi TPA Muara Fajar dengan Membran Ultrafiltrasi. *Jurnal Teknobiologi*.Vol 5. Hal 43-46.

- Prihatingningtyas & Efendi. Aplikasi Koagulan Alami dari Koagulan Tepung Jagung dalam Pengolahan Air Bersih. *Jurnal ITB Sains & Teknologi*. Vol 2 Hal 71-158.
- Qasim, Syed R, Edward M. Motley, dan Guang Zhu, *Water Works Engineering: Planning, Design dan Operation*, Prentice Hall PTR, Upper Saddle River, NJ 07458, 2000.
- Quddus, R. 2014. Teknik Pengolahan Air Bersih dengan Sistem Saringan Pasir Lambat (*downflow*) yang bersumber dari Sungai Musi. *Jurnal Teknik Sipil Dan Lingkungan*, 2(4), 669–675
- Rahman, 2012. Pemanfaatan Rouging filter Aliran Horizontal Dalam Menurunkan Keketuhan Dan Kesadahan Pada Air Sungai Dengan Media Filter Batu Kapur, Zeolit Dan Batu Kerikil. *Skripsi Jurusan Teknik Lingkungan ITN Malang*.
- Rahmawati, S.Pallu, M. Selintung, F.Maricar. 2017, Studi Kualitas dan kuantitas air Sungai Karajae sebagai Sumber Air Bersih untuk Kota Parepare. *Proiding Konteks 11, Teknik Sipil Universitas Tarumanegara, Jakarta*
- Ratnayaka, D.D.; Brandt, M.J.; Johnson, K.M. 2009 *Twort's Water Supply*, 6th ed.; Butterworth-Heinemann: Oxford, MA, USA
- Reynolds, Tom D. dan Richards, Paul A., 1996. *“Unit Operations and Processes in Environmental Engineering, 2nd edition”* PWS Publishing Company, Boston.
- Rozy Medi Wilian, Laili Fitria dan Hendri Sutrisno. 2019 Pengaruh Susunan Multimedia Filter dalam Kolom Filtrasi terhadap Penurunan Parameter Zat Organik. *Jurnal Teknologi Lingkungan Lahan Basah*, Vol. 07, No. 2, 2019: 045 – 054.
- Said Nusa Idaman, Indriatmoko, Robertus Haryoto, Raharjo, P. Nugro, dan Herlambang, Arie. 2005 “Aplikasi teknologipengolahan air sederhana untuk masyarakat pedesaan”. *Jurnal Air Indonesia*, Vol.1, No.2
- Sri Widystuti & Antik Sepdian Sari, 2011: Kinerja Pengolahan Air Bersih Dengan Proses Filtrasi Dalam Mereduksi Kesadahan *Jurnal Teknik WAKTU* Volume 09 Nomor 01 ISSN : 1412 – 1867

- Sukmasari Antaria, Mary Selintung, Muh Saleh Pallu, Mukhsan Putra Hatta. 2015 Test Of Bio Activator Model With Natural Zeolite form South Sulawesi As Filter Media and Adsorbent Heavy Metal Pb, Ni and Cu. *IPTEK Journal of Proceeding Series 1*
- Syahrir.S, M.Selintung, S.Pallu, A.Thaha. 2015 Studi Model Efektifitas karakteristik Pasir Kuarsa Malimpung sebagai filtrasi Single Medium .*Disertasi*, Program Pascasarjana Universitas Hasanuddin
- Syahrir.S, Sugianto. Irwan,I. 2018. Studi Penurunan Kadar Mangan (MN) Pada Air Melalui Media Filter Pasir Kuarsa Malimpung. Makalah disajikan dalam *Seminar Nasional Hasil Penelitian & Pengabdian Kepada Masyarakat (SNP2M)*
- Sudiyo utomo, Tri. M. W. Sir, Albert Sonbay. 2012 Desain Saringan Pasir Lambat Pada Instalasi Pengolahan Air Bersih ( IPAB) Kolhua Kota Kupang , *Jurnal Teknik Sipil Vol 1. No. 4 September 2012*, Universitas Nusa Cendana
- Suprihatin & Ono Suparno. 2013. *Teknologi Proses Pengolahan Air*. Bogor: IPB Press.
- Sutrisno, C. 1987. Teknik Penyediaan Air Bersih. PT Bina Angkasa. Jakarta.
- Tjokrokusumo, 1998. *Pengantar Enjinerig Lingkungan*, STTL "YLH". Yogyakarta.
- Triwardani, 2011. Pemakaian Cangkang Kerang dan Batu Apung dan Arang Aktif Tempurung Kelapa Sebagai Media Pada Roughing Filter Aliran Horizontal Dalam Menurunkan Kadar Kekeruhan dan Kesadahan Pada Air Sungai Brantas. *Skripsi Jurusan Teknik Lingkungan ITN Malang*.
- Utaberta, N, dan Aisyah N, H, 2014. *Filter wells as an alternative sustainable innovation of greywater treatment system for water management in Journal of Islamic Architecture Vol 3 1 june* : Malaysia.
- Wiharyanto Oktiawan, Krisbiantoro. 2007 Efektifitas Penurunan Fe 2+ Dengan Unit Saringan Pasir Cepat Media Pasir Aktif,*Jurnal Presipitasi Volume 2 No.1 Maret 2007 ISSN 1907-187X*



Widyastuti, Sri dan Antik Sepdian S. 2011 "Kinerja Pengolahan Air Bersih Dengan Proses Filtrasi Dalam Mereduksi Kepadatan" *Jurnal Teknik WAKTU Vol. 09, No. 01*.

Yolly Adriati, MS Pallu, M.Selintung, B.Bakri. 2020 Relevance Between Filtration Rate and Filter Media Thickness in Downflow Filter Systems. *IOP Conference Series: Earth and Environmental Science* 419 (1),012130

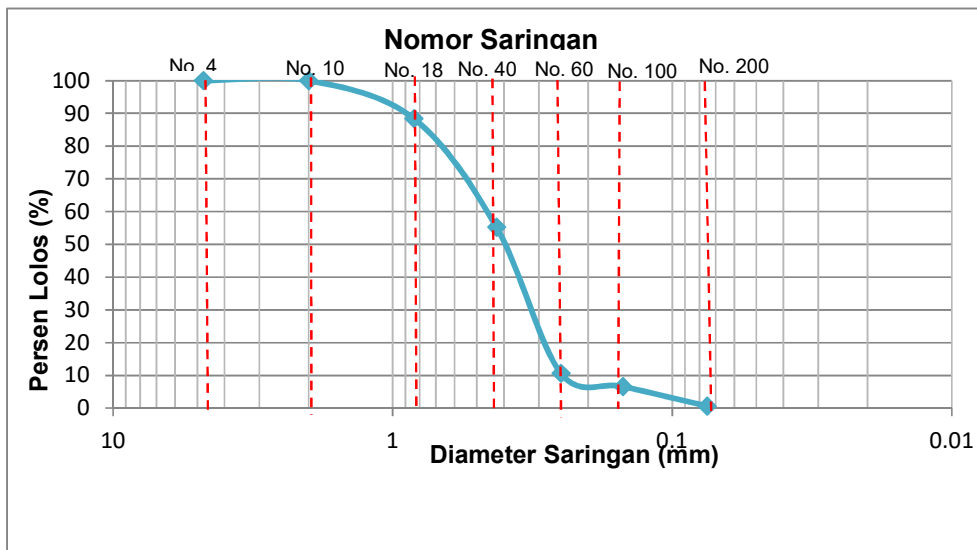
**LAMPIRAN - LAMPIRAN**

**LABORATORIUM MEKANIKA TANAH**  
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### Lampiran 1 . Analisa Saringan Pasir Pantai

|                                | Sebelum | Sesudah |
|--------------------------------|---------|---------|
| Berat tanah kering + Container | -       |         |
| Berat Container                | -       |         |
| Berat tanah Kering             | 500     |         |

| Saringan No. | Diameter (mm) | Berat Tertahan (gram) | Berat Kumulatif (gram) | Persen (%) |       |
|--------------|---------------|-----------------------|------------------------|------------|-------|
|              |               |                       |                        | Tertahan   | Lolos |
| 4            | 4.75          | 0                     | 0                      | 0          | 100   |
| 10           | 2             | 0                     | 0                      | 0          | 100   |
| 20           | 0.84          | 58                    | 58                     | 11.6       | 88.4  |
| 40           | 0.425         | 166                   | 224                    | 44.8       | 55.2  |
| 60           | 0.25          | 223                   | 447                    | 89.4       | 10.6  |
| 100          | 0.15          | 20                    | 467                    | 93.4       | 6.6   |
| 200          | 0.075         | 30                    | 497                    | 99.4       | 0.6   |
| Pan          | 0             | 3                     | 500                    | 100        | 0     |



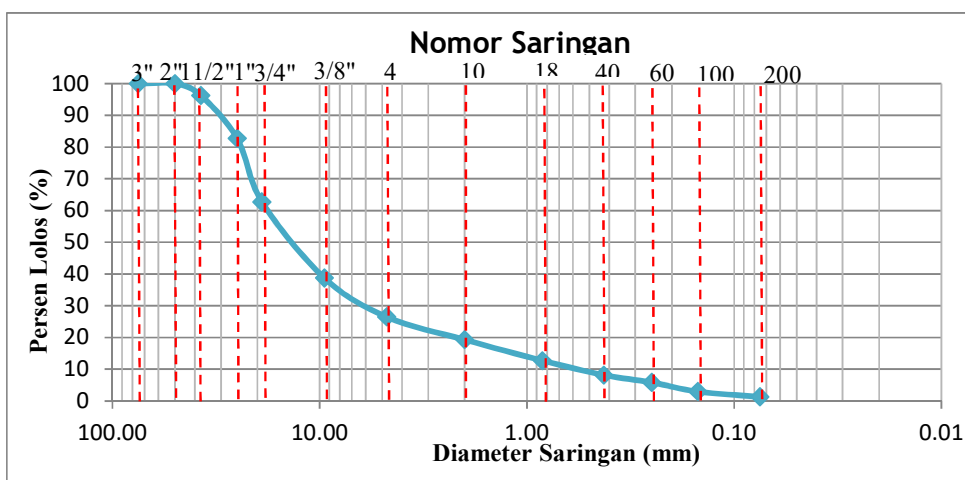
**Gambar 26 . Grafik Analisa Saringan Pasir Pantai**

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### Lampiran 2. Analisa Saringan Zeolit

|                                | Sebelum | Sesudah |
|--------------------------------|---------|---------|
| Berat tanah kering + Container | -       |         |
| Berat Container                | -       |         |
| Berat tanah Kering             | 3500    |         |

| Saringan No. | Diameter (mm) | Berat Tertahan (gram) | Berat Kumulatif (gram) | Persen (%) |        |
|--------------|---------------|-----------------------|------------------------|------------|--------|
|              |               |                       |                        | Tertahan   | Lolos  |
| 3"           | 75.00         | 0                     | 0                      | 0.00       | 100.00 |
| 2"           | 50.00         | 0                     | 0                      | 0.00       | 100.00 |
| 1 1/2"       | 37.50         | 131                   | 131                    | 3.74       | 96.26  |
| 1"           | 25.00         | 475                   | 606                    | 17.31      | 82.69  |
| 3/4"         | 19.00         | 698                   | 1304                   | 37.26      | 62.74  |
| 3/8"         | 9.500         | 839                   | 2143                   | 61.23      | 38.77  |
| 4            | 4.750         | 430                   | 2573                   | 73.51      | 26.49  |
| 10           | 2.000         | 251                   | 2824                   | 80.69      | 19.31  |
| 20           | 0.840         | 231                   | 3055                   | 87.29      | 12.71  |
| 40           | 0.425         | 159                   | 3214                   | 91.83      | 8.17   |
| 60           | 0.250         | 81                    | 3295                   | 94.14      | 5.86   |
| 100          | 0.150         | 101                   | 3396                   | 97.03      | 2.97   |
| 200          | 0.075         | 59                    | 3455                   | 98.71      | 1.29   |
| Pan          | -             | 45                    | 3500                   | 100.00     | 0.00   |



**Gambar 27 . Grafik Analisa Zeolit**

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Dari analisa saringan dapat dihitung  $D_{10}$  dan  $D_{60}$  untuk mencari Nilai  $E_s$  dan  $C_u$

$$D_{10} = 0,25 \text{ mm}$$

$$D_{60} = 0.50 \text{ mm}$$

$E_s = D_{10} = 0,25$  (syarat SNI 03-3981-2008 adalah 0,2 – 0,4 mm)

$$C_u = \frac{D_{60}}{D_{10}}$$


$$C_u = \frac{0,50}{0,25}$$

$C_u = 2$  ( Syarat SNI 03-3981-2008 adalah 2- 3 )

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**Pekerjaan** : Penelitian Mahasiswa S3  
**No Sampel** :  
**Lokasi** : Laboratorium Mekanika Tanah Teknik Sipil FT Unhas  
**Tanggal Percobaan** : Juni 2019  
**TESTING METHOD** : ASTM D 854-58(72)

**Lampiran 3 Berat Jenis Media Filtrasi**

| SPECIFIC GRAVITY TEST RESULTS  |   |                         |               |  |
|--|---|-------------------------|---------------|--|
|  | PROJECT   | : Disertasi S3          |               |  |
|  | LOCATION  | :                       |               |  |
|  | TESTING METHOD                                  | : ASTM D 854-58(72)     |               |  |
|  | LABORATORY                                      | : HASANUDDIN UNIVERSITY |               |  |
| Bore Hole No. / Type   | -   |                         |               |  |
| Sample   | -   | <b>Pasir</b>            | <b>Zeolit</b> |  |
| Sample Depth & Inclination   | -   | <b>4</b>                | <b>1</b>      |  |
| Number of Volumetric Flask   | -   | 1                       | 1             |  |
| Weight of Vol. Flask + Soil (W2)   | Gram  | 47.2                    | 54.1          |  |
| Weight of Vol. Flask (W1)  | Gram  | 22.21                   | 29.12         |  |
| Weight of Dry Soil (Ws=W2-W1)  | Gram  | 25.00                   | 25.00         |  |
| Temperature, T (oC)  | Degree  | 28                      | 28            |  |
| Weight of Vol. Flask+Water at T (W4)   | Gram  | 76.53                   | 76.83         |  |
| Weight of Vol. Flask+Water+Soil (W3)   | Gram  | 92.15                   | 92.50         |  |
| Unit Weight of Water at T, $\gamma_T$  | Gram/Cm <sup>3</sup>                            | 0.9963                  | 0.9963        |  |
| Temp. Corr. Coefficient, $\alpha = \gamma_T / \gamma_{20}^{oC}$                    | -   | 0.9980                  | 0.9980        |  |
| Weight of Soil (Wu=(Ws+W4-W3))   | Gram  | 9.4                     | 9.3           |  |
| Specific Gravity of Soil ( $G_s = \alpha * W_s / W_u$ )                            | -   | 2.660                   | 2.674         |  |
| Remarks:   | Unit Weight of W $\gamma_{w,20}^{oC} = 0.99823$ |                         |               |  |

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**Pekerjaan** : Penelitian Mahasiswa S3  
**No Sampel** :  
**Lokasi** : Laboratorium Mekanika Tanah Teknik Sipil FT Unhas  
**Tanggal Percobaan** : Juni 2019  
**TESTING METHOD** : ASTM D698/ D 1557

**Constan Head**

Diameter buret (d) : 1 cm

Diameter sampel (D) : 6.35 cm

**Lampiran 4 . Permeabilitas Media Filtrasi**

| Sampel  |                    | Pasir  | Zeolit |
|---|--------------------|--------|--------|
| Luas potongan melintang buret ( $a=1/4\pi d^2$ )  | cm <sup>2</sup>    | 0.785  | 0.785  |
| Luas potongan melintang sampel ( $A=1/4\pi D^2$ ) | cm <sup>2</sup>    | 31.669 | 31.669 |
| Ketinggian hidrolik ( h )                         | cm                 | 108.7  | 108.7  |
| Panjang sampel (L)                                | cm                 | 6      | 6      |
| Waktu pengujian (t)                               | detik              | 31     | 28     |
| Temperatur (T)                                    | °C                 | 28     | 28     |
| Volume air yang terkumpul (Q)                     | (cm <sup>3</sup> ) | 100    | 100    |
| Koefisien permeabilitas (Q.L/ h.A.t)              | (cm/det)           | 0.0056 | 0.0062 |

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**Lampiran 5 . Data Porositas Pasir Pantai**

| Ring/ Container Number                                | Satuan               | Lolos saringan<br>20 |
|---|----------------------|----------------------|
| Weight of Ring (1)                                    | gram                 | 60                   |
| weight of Container (2)                               | gram                 | 10                   |
| Weight of Ring + Container + Wet Soil<br>(3)          | gram                 | 169.85               |
| Weigh of Wet Soil (4) = (3)-(2)-(1)                   | gram                 | 99.85                |
| Volume of Soil (5)                                    | cm <sup>3</sup>      | 65.25                |
| Weight of Ring + Container + Dry Soil<br>(6)          | gram                 | 168.8                |
| Weigh of Dry Soil (7) = (6)-(2)-(1)                   | gram                 | 98.8                 |
| Weigh of water (8) = (4)-(7)                          | gram                 | 1.05                 |
| Spesific Gravity, G <sub>s</sub>                      |                      | 2.66                 |
| Volume of Dry Soil (9) = (7)/G <sub>s</sub>           | cm <sup>3</sup>      | 37.14                |
| Volume of Pore (10) = (5)-(9)                         | cm <sup>3</sup>      | 28.11                |
| Wet Density, Y <sub>wet</sub> = (4)/(5)               | gram/cm <sup>3</sup> | 1.53                 |
| Water Content, w = (8)/(7)*100%                       | %                    | 1.06                 |
| Dry Density. Y <sub>d</sub> = Y <sub>wet</sub> /(1+w) | gr/cm <sup>3</sup>   | 0.74                 |
| Porosity n = (10)/(5) *100%                           | %                    | 43.08                |



**Lampiran 6** Data Kapasitas Filter ( Debit dan Kecepatan Filtrasi) Media Pasir Pantai Konsentrasi 50 NTU

| No               | Ketebalan (D) | Luas (A) | Porosi tas | Debit masuk (Qin) | Debit filtrasi (Q out) |            | Ratio Debit  |              | Flow Rate , va= Qout/A |             | Kecepatan Filtrasi  |                      |
|------------------|---------------|----------|------------|-------------------|------------------------|------------|--------------|--------------|------------------------|-------------|---------------------|----------------------|
|                  |               |          |            |                   | Downflow               | Kombinasi  | Downflow     | Kombinasi    | Downflow               | Kombinasi   | Downflow (cm/detik) | Kombinas i(cm/detik) |
|                  | cm            | (cm2)    | € 1        | (cm3/dtk)         | (cm3/det)              | (cm3/det)  | (%)          | (%)          | cm/dtk                 | cm/dtk      | V=Va/E1             | V=Va/E1              |
| 1                | 10            | 2500     | 0.43       | 597               | 399                    | 230        | 66.79        | 38.56        | 0.16                   | 0.09        | 0.37                | 0.21                 |
|                  |               |          |            |                   | 386                    | 219        | 64.63        | 36.68        | 0.15                   | 0.09        | 0.36                | 0.20                 |
|                  |               |          |            |                   | 373                    | 213        | 62.45        | 35.68        | 0.15                   | 0.09        | 0.35                | 0.20                 |
|                  |               |          |            |                   | 368                    | 218        | 61.67        | 36.58        | 0.15                   | 0.09        | 0.34                | 0.20                 |
|                  |               |          |            |                   | 360                    | 195        | 60.38        | 32.74        | 0.14                   | 0.08        | 0.34                | 0.18                 |
|                  |               |          |            |                   | 354                    | 191        | 59.35        | 31.92        | 0.14                   | 0.08        | 0.33                | 0.18                 |
| <b>Rata Rata</b> |               |          |            |                   | <b>373</b>             | <b>211</b> | <b>62.54</b> | <b>35.36</b> | <b>0.15</b>            | <b>0.08</b> | <b>0.35</b>         | <b>0.20</b>          |
| 2                | 20            | 2500     | 0.43       | 597               | 353                    | 168        | 59.08        | 28.14        | 0.14                   | 0.07        | 0.33                | 0.16                 |
|                  |               |          |            |                   | 345                    | 167        | 57.82        | 27.91        | 0.14                   | 0.07        | 0.32                | 0.16                 |
|                  |               |          |            |                   | 342                    | 153        | 57.23        | 25.56        | 0.14                   | 0.06        | 0.32                | 0.14                 |
|                  |               |          |            |                   | 341                    | 140        | 57.05        | 23.49        | 0.14                   | 0.06        | 0.32                | 0.13                 |
|                  |               |          |            |                   | 343                    | 128        | 57.40        | 21.46        | 0.14                   | 0.05        | 0.32                | 0.12                 |
|                  |               |          |            |                   | 338                    | 126        | 56.55        | 21.17        | 0.14                   | 0.05        | 0.31                | 0.12                 |
| <b>Rata Rata</b> |               |          |            |                   | <b>343</b>             | <b>147</b> | <b>57.52</b> | <b>24.62</b> | <b>0.14</b>            | <b>0.06</b> | <b>0.32</b>         | <b>0.14</b>          |
| 3                | 30            | 2500     | 0.43       | 597               | 282.15                 | 142.00     | 47.26        | 23.79        | 0.11                   | 0.06        | 0.26                | 0.13                 |
|                  |               |          |            |                   | 280.15                 | 138.95     | 46.93        | 23.27        | 0.11                   | 0.06        | 0.26                | 0.13                 |
|                  |               |          |            |                   | 279.30                 | 126.50     | 46.78        | 21.19        | 0.11                   | 0.05        | 0.26                | 0.12                 |
|                  |               |          |            |                   | 278.21                 | 120.23     | 46.60        | 20.14        | 0.11                   | 0.05        | 0.26                | 0.11                 |
|                  |               |          |            |                   | 275.70                 | 102.89     | 46.18        | 17.23        | 0.11                   | 0.04        | 0.26                | 0.10                 |
|                  |               |          |            |                   | 273.45                 | 108.40     | 45.80        | 18.16        | 0.11                   | 0.04        | 0.25                | 0.10                 |
| <b>Rata Rata</b> |               |          |            |                   | <b>278</b>             | <b>123</b> | <b>46.59</b> | <b>20.63</b> | <b>0.11</b>            | <b>0.05</b> | <b>0.26</b>         | <b>0.11</b>          |

**Lampiran 7 Data Kapasitas Filter ( Debit dan Kecepatan Filtrasi) Media Pasir Pantai Konsentrasi 200 NTU**

| No | Ketebalan (D) | Luas (A)        | Porositas | Debit masuk (Qin)    | Debit filtrasi (Q out) |                      | Ratio Debit |           | Flow Rate , va= Qout/A |           | Kecepatan Filtrasi V=Va/E |             |
|----|---------------|-----------------|-----------|----------------------|------------------------|----------------------|-------------|-----------|------------------------|-----------|---------------------------|-------------|
|    |               |                 |           |                      | Downflow               | Kombinasi            | Downflow    | Kombinasi | Downflow               | Kombinasi | Downflow                  | Kombinasi   |
|    | cm            | cm <sup>2</sup> | € 1       | cm <sup>3</sup> /dtk | cm <sup>3</sup> /det   | cm <sup>3</sup> /det | (%)         | (%)       | cm/dtk                 | cm/dtk    | (cm/detik)                | ( cm/detik) |
| 1  | 10            | 2500            | 0.43      | 597                  | 352                    | 199                  | 58.91       | 33.33     | 0.14                   | 0.08      | 0.33                      | 0.19        |
|    |               |                 |           |                      | 345                    | 180                  | 57.86       | 30.17     | 0.14                   | 0.07      | 0.32                      | 0.17        |
|    |               |                 |           |                      | 344                    | 178                  | 57.60       | 29.89     | 0.14                   | 0.07      | 0.32                      | 0.17        |
|    |               |                 |           |                      | 339                    | 166                  | 56.74       | 27.85     | 0.14                   | 0.07      | 0.32                      | 0.15        |
|    |               |                 |           |                      | 330                    | 169                  | 55.32       | 28.26     | 0.13                   | 0.07      | 0.31                      | 0.16        |
|    |               |                 |           |                      | 322                    | 160                  | 53.99       | 26.83     | 0.13                   | 0.06      | 0.30                      | 0.15        |
|    | Rata Rata     |                 |           |                      | 338.73                 | 175                  | 56.74       | 29.39     | 0.14                   | 0.07      | 0.32                      | 0.16        |
| 2  | 20            | 2500            | 0.43      | 597                  | 328                    | 155                  | 55.01       | 26.00     | 0.13                   | 0.06      | 0.31                      | 0.14        |
|    |               |                 |           |                      | 325                    | 150                  | 54.46       | 25.17     | 0.13                   | 0.06      | 0.30                      | 0.14        |
|    |               |                 |           |                      | 322                    | 136                  | 53.99       | 22.77     | 0.13                   | 0.05      | 0.30                      | 0.13        |
|    |               |                 |           |                      | 320                    | 132                  | 53.65       | 22.13     | 0.13                   | 0.05      | 0.30                      | 0.12        |
|    |               |                 |           |                      | 318                    | 125                  | 53.31       | 21.02     | 0.13                   | 0.05      | 0.30                      | 0.12        |
|    |               |                 |           |                      | 305                    | 128                  | 51.11       | 21.51     | 0.12                   | 0.05      | 0.28                      | 0.12        |
|    | Rata Rata     |                 |           |                      | 319.93                 | 138                  | 53.59       | 23.10     | 0.13                   | 0.06      | 0.30                      | 0.13        |
| 3  | 30            | 2500            | 0.43      | 597                  | 265                    | 113                  | 44.43       | 18.93     | 0.11                   | 0.05      | 0.25                      | 0.11        |
|    |               |                 |           |                      | 256                    | 115                  | 42.90       | 19.28     | 0.10                   | 0.05      | 0.24                      | 0.11        |
|    |               |                 |           |                      | 246                    | 111                  | 41.14       | 18.54     | 0.10                   | 0.04      | 0.23                      | 0.10        |
|    |               |                 |           |                      | 240                    | 105                  | 40.23       | 17.56     | 0.10                   | 0.04      | 0.22                      | 0.10        |
|    |               |                 |           |                      | 233                    | 102                  | 39.10       | 17.14     | 0.09                   | 0.04      | 0.22                      | 0.10        |
|    |               |                 |           |                      | 231                    | 100                  | 38.63       | 16.78     | 0.09                   | 0.04      | 0.21                      | 0.09        |
|    | Rata Rata     |                 |           |                      | 245                    | 108                  | 41.07       | 18.04     | 0.10                   | 0.04      | 0.23                      | 0.10        |

**Lampiran 8** Data Kapasitas Filter ( Debit dan Kecepatan Filtrasi) Media Pasir Pantai Konsentrasi 1000 NTU

| No | Ketebalan (D) | Luas (A)        | Porositas | Debit masuk (Qin)    | Debit filtrasi (Q out) |                      | Ratio Debit |           | Flow Rate , $v_a = Q_{out}/A$ |           | Kecepatan Filtrasi $V = V_a/E1$ |             |
|----|---------------|-----------------|-----------|----------------------|------------------------|----------------------|-------------|-----------|-------------------------------|-----------|---------------------------------|-------------|
|    |               |                 |           |                      | Downflow               | Kombinasi            | Downflow    | Kombinasi | Downflow                      | Kombinasi | Downflow                        | Kombinasi   |
|    | cm            | cm <sup>2</sup> | € 1       | cm <sup>3</sup> /dtk | cm <sup>3</sup> /det   | cm <sup>3</sup> /det | (%)         | (%)       | cm/dtk                        | cm/dtk    | cm/detik                        | ( cm/detik) |
| 1  | 10            | 2500            | 0.43      | 597                  | 305                    | 137                  | 51.12       | 23.03     | 0.12                          | 0.05      | 0.28                            | 0.13        |
|    |               |                 |           |                      | 300                    | 128                  | 50.31       | 21.44     | 0.12                          | 0.05      | 0.28                            | 0.12        |
|    |               |                 |           |                      | 292                    | 112                  | 48.94       | 18.76     | 0.12                          | 0.04      | 0.27                            | 0.10        |
|    |               |                 |           |                      | 291                    | 114                  | 48.66       | 19.10     | 0.12                          | 0.05      | 0.27                            | 0.11        |
|    |               |                 |           |                      | 285                    | 110                  | 47.71       | 18.47     | 0.11                          | 0.04      | 0.26                            | 0.10        |
|    |               |                 |           |                      | 278                    | 103                  | 46.62       | 17.18     | 0.11                          | 0.04      | 0.26                            | 0.10        |
|    | Rata Rata     |                 |           |                      | 292                    | 117                  | 48.90       | 19.66     | 0.12                          | 0.05      | 0.27                            | 0.11        |
| 2  | 20            | 2500            | 0.43      | 597                  | 301                    | 106                  | 50.42       | 17.76     | 0.12                          | 0.04      | 0.28                            | 0.10        |
|    |               |                 |           |                      | 280                    | 101                  | 46.93       | 16.95     | 0.11                          | 0.04      | 0.26                            | 0.09        |
|    |               |                 |           |                      | 272                    | 102                  | 45.58       | 17.09     | 0.11                          | 0.04      | 0.25                            | 0.09        |
|    |               |                 |           |                      | 260                    | 100                  | 43.62       | 16.75     | 0.10                          | 0.04      | 0.24                            | 0.09        |
|    |               |                 |           |                      | 252                    | 98                   | 42.25       | 16.46     | 0.10                          | 0.04      | 0.23                            | 0.09        |
|    |               |                 |           |                      | 240                    | 97                   | 40.21       | 16.18     | 0.10                          | 0.04      | 0.22                            | 0.09        |
|    | Rata Rata     |                 |           |                      | 268                    | 101                  | 44.84       | 16.86     | 0.11                          | 0.04      | 0.25                            | 0.09        |
| 3  | 30            | 2500            | 0.43      | 597                  | 249                    | 70                   | 41.66       | 11.80     | 0.10                          | 0.03      | 0.23                            | 0.07        |
|    |               |                 |           |                      | 242                    | 75                   | 40.50       | 12.56     | 0.10                          | 0.03      | 0.22                            | 0.07        |
|    |               |                 |           |                      | 233                    | 72                   | 39.05       | 12.06     | 0.09                          | 0.03      | 0.22                            | 0.07        |
|    |               |                 |           |                      | 231                    | 68                   | 38.67       | 11.39     | 0.09                          | 0.03      | 0.21                            | 0.06        |
|    |               |                 |           |                      | 228                    | 71                   | 38.22       | 11.88     | 0.09                          | 0.03      | 0.21                            | 0.07        |
|    |               |                 |           |                      | 228                    | 71                   | 38.21       | 11.87     | 0.09                          | 0.03      | 0.21                            | 0.07        |
|    | Rata Rata     |                 |           |                      | 235                    | 71                   | 39.38       | 11.93     | 0.09                          | 0.03      | 0.22                            | 0.07        |

**Lampiran 9** Data Kapasitas Filter ( Debit dan Kecepatan Filtrasi) Media Gabungan Konsentrasi 50 NTU

| No | Ketebalan (D) | Luas (A) | Porositas |      | Debit masuk (Qin) | Debit filtrasi (Q out) |           | Ratio Debit |           | Flow Rate , va= Qout/A |          | Kecepatan Filtrasi   |         |             |                       |         |             |
|----|---------------|----------|-----------|------|-------------------|------------------------|-----------|-------------|-----------|------------------------|----------|----------------------|---------|-------------|-----------------------|---------|-------------|
|    |               |          |           |      |                   | Downflow               | Kombinasi | Downflow    | Kombinasi | Downflow               | Kmbinasi | Downflow ( cm/detik) |         |             | kombinasi ( cm/detik) |         |             |
|    | cm            | (cm2)    | € 1       | € 2  | cm3/dtk           | cm3/det                | cm3/det   | (%)         | (%)       | cm/dtk                 | cm/dtk   | V=Va/E1              | V=Va/E2 | V rata rata | V=Va/E1               | V=Va/E2 | V rata rata |
| 1  | 10            | 2500     | 0.43      | 0.41 | 597               | 362                    | 250       | 60.64       | 41.88     | 0.14                   | 0.10     | 0.34                 | 0.35    | 0.34        | 0.23                  | 0.24    | 0.24        |
|    |               |          |           |      |                   | 363                    | 246       | 60.80       | 41.21     | 0.15                   | 0.10     | 0.34                 | 0.35    | 0.35        | 0.23                  | 0.24    | 0.23        |
|    |               |          |           |      |                   | 348                    | 215       | 58.29       | 36.01     | 0.14                   | 0.09     | 0.32                 | 0.34    | 0.33        | 0.20                  | 0.21    | 0.20        |
|    |               |          |           |      |                   | 358                    | 206       | 59.97       | 34.51     | 0.14                   | 0.08     | 0.33                 | 0.35    | 0.34        | 0.19                  | 0.20    | 0.20        |
|    |               |          |           |      |                   | 320                    | 204       | 53.60       | 34.17     | 0.13                   | 0.08     | 0.30                 | 0.31    | 0.30        | 0.19                  | 0.20    | 0.19        |
|    |               |          |           |      |                   | 318                    | 202       | 53.27       | 33.84     | 0.13                   | 0.08     | 0.30                 | 0.31    | 0.30        | 0.19                  | 0.20    | 0.19        |
|    | Rata Rata     |          |           |      |                   | 345                    | 221       | 57.76       | 36.93     | 0.14                   | 0.09     | 0.32                 | 0.34    | 0.33        | 0.21                  | 0.22    | 0.21        |
| 2  | 20            | 2500     | 0.43      | 0.41 | 597               | 294                    | 177       | 49.25       | 29.65     | 0.12                   | 0.07     | 0.27                 | 0.29    | 0.28        | 0.16                  | 0.17    | 0.17        |
|    |               |          |           |      |                   | 264                    | 167       | 44.22       | 27.97     | 0.11                   | 0.07     | 0.25                 | 0.26    | 0.25        | 0.16                  | 0.16    | 0.16        |
|    |               |          |           |      |                   | 270                    | 169       | 45.23       | 28.31     | 0.11                   | 0.07     | 0.25                 | 0.26    | 0.26        | 0.16                  | 0.16    | 0.16        |
|    |               |          |           |      |                   | 255                    | 166       | 42.71       | 27.81     | 0.10                   | 0.07     | 0.24                 | 0.25    | 0.24        | 0.15                  | 0.16    | 0.16        |
|    |               |          |           |      |                   | 240                    | 121       | 40.20       | 20.27     | 0.10                   | 0.05     | 0.22                 | 0.23    | 0.23        | 0.11                  | 0.12    | 0.12        |
|    |               |          |           |      |                   | 242                    | 109       | 40.54       | 18.26     | 0.10                   | 0.04     | 0.23                 | 0.24    | 0.23        | 0.10                  | 0.11    | 0.10        |
|    | Rata Rata     |          |           |      |                   | 261                    | 152       | 43.69       | 25.38     | 0.10                   | 0.06     | 0.24                 | 0.25    | 0.25        | 0.14                  | 0.15    | 0.14        |
| 3  | 30            | 2500     | 0.43      | 0.41 | 597               | 239                    | 127       | 40.03       | 21.27     | 0.10                   | 0.05     | 0.22                 | 0.23    | 0.23        | 0.12                  | 0.12    | 0.12        |
|    |               |          |           |      |                   | 237                    | 118       | 39.70       | 19.77     | 0.09                   | 0.05     | 0.22                 | 0.23    | 0.23        | 0.11                  | 0.12    | 0.11        |
|    |               |          |           |      |                   | 239                    | 107       | 40.03       | 17.92     | 0.10                   | 0.04     | 0.22                 | 0.23    | 0.23        | 0.10                  | 0.10    | 0.10        |
|    |               |          |           |      |                   | 229                    | 102       | 38.36       | 17.09     | 0.09                   | 0.04     | 0.21                 | 0.22    | 0.22        | 0.09                  | 0.10    | 0.10        |
|    |               |          |           |      |                   | 230                    | 83        | 38.53       | 13.90     | 0.09                   | 0.03     | 0.21                 | 0.22    | 0.22        | 0.08                  | 0.08    | 0.08        |
|    |               |          |           |      |                   | 222                    | 85        | 37.19       | 14.24     | 0.09                   | 0.03     | 0.21                 | 0.22    | 0.21        | 0.08                  | 0.08    | 0.08        |
|    | Rata Rata     |          |           |      |                   | 233                    | 104       | 38.97       | 17.36     | 0.09                   | 0.04     | 0.22                 | 0.23    | 0.22        | 0.10                  | 0.10    | 0.10        |

**Lampiran 10** Data Kapasitas Filter ( Debit dan Kecepatan Filtrasi) Media Gabungan Konsentrasi 200 NTU

| No | Ketebalan D | Luas A | Porositas |      | Debit masuk (Qin) | Debit filtrasi (Qout) |         | Ratio Debit |        | Flow Rate , va |         | Kecepatan Filtrasi v = ( cm/detik) |             |         |          |             |      |
|----|-------------|--------|-----------|------|-------------------|-----------------------|---------|-------------|--------|----------------|---------|------------------------------------|-------------|---------|----------|-------------|------|
|    |             |        | € 1       | € 2  |                   | cm3/dtk               | cm3/dtk | Dwnflow     | Kom    | Dwnflow        | Kombin  | Downflow                           |             |         | Kombnasi |             |      |
|    | cm          | cm     |           |      | cm3/dtk           | cm3/dtk               | %       | %           | cm/dtk | cm/dtk         | V=Va/E1 | V=Va/E2                            | V rata rata | V=Va/E1 | V=Va/E2  | V rata rata |      |
| 1  | 10          | 2500   | 0.43      | 0.41 | 597               | 305                   | 207     | 51.09       | 34.67  | 0.12           | 0.08    | 0.28                               | 0.30        | 0.29    | 0.19     | 0.20        | 0.20 |
|    |             |        |           |      |                   | 338                   | 202     | 56.62       | 33.84  | 0.14           | 0.08    | 0.31                               | 0.33        | 0.32    | 0.19     | 0.20        | 0.19 |
|    |             |        |           |      |                   | 302                   | 196     | 50.59       | 32.83  | 0.12           | 0.08    | 0.28                               | 0.29        | 0.29    | 0.18     | 0.19        | 0.19 |
|    |             |        |           |      |                   | 310                   | 201     | 51.93       | 33.67  | 0.12           | 0.08    | 0.29                               | 0.30        | 0.30    | 0.19     | 0.20        | 0.19 |
|    |             |        |           |      |                   | 290                   | 198     | 48.58       | 33.17  | 0.12           | 0.08    | 0.27                               | 0.28        | 0.28    | 0.18     | 0.19        | 0.19 |
|    |             |        |           |      |                   | 295                   | 195     | 49.41       | 32.66  | 0.12           | 0.08    | 0.27                               | 0.29        | 0.28    | 0.18     | 0.19        | 0.19 |
|    | Rata Rata   |        |           |      |                   | 307                   | 200     | 51.37       | 33.47  | 0.12           | 0.08    | 0.29                               | 0.30        | 0.29    | 0.19     | 0.19        | 0.19 |
| 2  | 20          | 2500   | 0.43      | 0.41 | 597               | 234                   | 169     | 39.20       | 28.31  | 0.09           | 0.07    | 0.22                               | 0.23        | 0.22    | 0.16     | 0.16        | 0.16 |
|    |             |        |           |      |                   | 223                   | 166     | 37.35       | 27.81  | 0.09           | 0.07    | 0.21                               | 0.22        | 0.21    | 0.15     | 0.16        | 0.16 |
|    |             |        |           |      |                   | 222                   | 134     | 37.19       | 22.45  | 0.09           | 0.05    | 0.21                               | 0.22        | 0.21    | 0.12     | 0.13        | 0.13 |
|    |             |        |           |      |                   | 213                   | 126     | 35.68       | 21.11  | 0.09           | 0.05    | 0.20                               | 0.21        | 0.20    | 0.12     | 0.12        | 0.12 |
|    |             |        |           |      |                   | 206                   | 113     | 34.51       | 18.93  | 0.08           | 0.05    | 0.19                               | 0.20        | 0.20    | 0.11     | 0.11        | 0.11 |
|    |             |        |           |      |                   | 203                   | 108     | 34.00       | 18.09  | 0.08           | 0.04    | 0.19                               | 0.20        | 0.19    | 0.10     | 0.11        | 0.10 |
|    | Rata Rata   |        |           |      |                   | 217                   | 136     | 36.32       | 22.78  | 0.09           | 0.05    | 0.20                               | 0.21        | 0.21    | 0.13     | 0.13        | 0.13 |
| 3  | 30          | 2500   | 0.43      | 0.41 | 597               | 204                   | 100     | 34.17       | 16.75  | 0.08           | 0.04    | 0.19                               | 0.20        | 0.19    | 0.09     | 0.10        | 0.10 |
|    |             |        |           |      |                   | 200                   | 99      | 33.50       | 16.58  | 0.08           | 0.04    | 0.19                               | 0.20        | 0.19    | 0.09     | 0.10        | 0.09 |
|    |             |        |           |      |                   | 198                   | 97      | 33.17       | 16.25  | 0.08           | 0.04    | 0.18                               | 0.19        | 0.19    | 0.09     | 0.09        | 0.09 |
|    |             |        |           |      |                   | 193                   | 95      | 32.33       | 15.91  | 0.08           | 0.04    | 0.18                               | 0.19        | 0.18    | 0.09     | 0.09        | 0.09 |
|    |             |        |           |      |                   | 195                   | 97      | 32.66       | 16.25  | 0.08           | 0.04    | 0.18                               | 0.19        | 0.19    | 0.09     | 0.09        | 0.09 |
|    |             |        |           |      |                   | 195                   | 92      | 32.66       | 15.41  | 0.08           | 0.04    | 0.18                               | 0.19        | 0.19    | 0.09     | 0.09        | 0.09 |
|    | Rata Rata   |        |           |      |                   | 198                   | 97      | 33.08       | 16.19  | 0.08           | 0.04    | 0.18                               | 0.19        | 0.19    | 0.09     | 0.09        | 0.09 |

**Lampiran 11** Data Kapasitas Filter ( Debit dan Kecepatan Filtrasi) Media Gabungan Konsentrasi 1000 NTU

| No | Ketebalan D<br>cm | Luas A<br>cm | Porositas |      | Debit masuk (Qin)<br>cm <sup>3</sup> /dtk | Debit filtrasi (Qout)      |                             | Ratio Debit |          | Flow Rate , va |               | Kecepatan Filtrasi v = ( cm/detik) |         |             |          |         |             |
|----|-------------------|--------------|-----------|------|---|----------------------------|-----------------------------|-------------|----------|----------------|---------------|------------------------------------|---------|-------------|----------|---------|-------------|
|    |                   |              | € 1       | € 2  |   | Df<br>cm <sup>3</sup> /dtk | Kom<br>cm <sup>3</sup> /dtk | Df<br>%     | Kom<br>% | Df<br>cm/dtk   | Kom<br>cm/dtk | Downflow                           |         |             | Kombnasi |         |             |
|    |                   |              |           |      |   |                            |                             |             |          |                |               | V=Va/E1                            | V=Va/E2 | V rata rata | V=Va/E1  | V=Va/E2 | V rata rata |
| 1  | 10                | 2500         | 0.43      | 0.41 | 597                                       | 182                        | 121                         | 30.49       | 20.27    | 0.07           | 0.048         | 0.17                               | 0.18    | 0.17        | 0.11     | 0.12    | 0.12        |
|    |                   |              |           |      |   | 178                        | 119                         | 29.82       | 19.93    | 0.07           | 0.048         | 0.17                               | 0.17    | 0.17        | 0.11     | 0.12    | 0.11        |
|    |                   |              |           |      |   | 180                        | 110                         | 30.15       | 18.43    | 0.07           | 0.044         | 0.17                               | 0.18    | 0.17        | 0.10     | 0.11    | 0.10        |
|    |                   |              |           |      |   | 176                        | 109                         | 29.48       | 18.26    | 0.07           | 0.044         | 0.16                               | 0.17    | 0.17        | 0.10     | 0.11    | 0.10        |
|    |                   |              |           |      |   | 168                        | 108                         | 28.14       | 18.09    | 0.07           | 0.043         | 0.16                               | 0.16    | 0.16        | 0.10     | 0.11    | 0.10        |
|    |                   |              |           |      |   | 140                        | 105                         | 23.45       | 17.59    | 0.06           | 0.042         | 0.13                               | 0.14    | 0.13        | 0.10     | 0.10    | 0.10        |
|    | Rata Rata         |              |           |      |   | 171                        | 112                         | 28.59       | 18.76    | 0.07           | 0.04          | 0.16                               | 0.17    | 0.16        | 0.10     | 0.11    | 0.11        |
| 2  | 20                | 2500         | 0.43      | 0.41 | 597                                       | 156                        | 103                         | 26.13       | 17.25    | 0.06           | 0.041         | 0.15                               | 0.15    | 0.15        | 0.10     | 0.10    | 0.10        |
|    |                   |              |           |      |   | 148                        | 98                          | 24.79       | 16.42    | 0.06           | 0.039         | 0.14                               | 0.14    | 0.14        | 0.09     | 0.10    | 0.09        |
|    |                   |              |           |      |   | 148                        | 97                          | 24.79       | 16.25    | 0.06           | 0.039         | 0.14                               | 0.14    | 0.14        | 0.09     | 0.09    | 0.09        |
|    |                   |              |           |      |   | 147                        | 98                          | 24.62       | 16.42    | 0.06           | 0.039         | 0.14                               | 0.14    | 0.14        | 0.09     | 0.10    | 0.09        |
|    |                   |              |           |      |   | 142                        | 96                          | 23.79       | 16.08    | 0.06           | 0.038         | 0.13                               | 0.14    | 0.14        | 0.09     | 0.09    | 0.09        |
|    |                   |              |           |      |   | 140                        | 95                          | 23.45       | 15.91    | 0.06           | 0.038         | 0.13                               | 0.14    | 0.13        | 0.09     | 0.09    | 0.09        |
|    | Rata Rata         |              |           |      |   | 147                        | 98                          | 24.60       | 16.39    | 0.06           | 0.04          | 0.14                               | 0.14    | 0.14        | 0.09     | 0.10    | 0.09        |
| 3  | 30                | 2500         | 0.43      | 0.41 | 597                                       | 135                        | 83                          | 22.61       | 13.90    | 0.05           | 0.033         | 0.13                               | 0.13    | 0.13        | 0.08     | 0.08    | 0.08        |
|    |                   |              |           |      |   | 132                        | 63                          | 22.11       | 10.55    | 0.05           | 0.025         | 0.12                               | 0.13    | 0.13        | 0.06     | 0.06    | 0.06        |
|    |                   |              |           |      |   | 122                        | 62                          | 20.44       | 10.39    | 0.05           | 0.025         | 0.11                               | 0.12    | 0.12        | 0.06     | 0.06    | 0.06        |
|    |                   |              |           |      |   | 120                        | 53                          | 20.10       | 8.88     | 0.05           | 0.021         | 0.11                               | 0.12    | 0.11        | 0.05     | 0.05    | 0.05        |
|    |                   |              |           |      |   | 108                        | 52                          | 18.09       | 8.71     | 0.04           | 0.021         | 0.10                               | 0.11    | 0.10        | 0.05     | 0.05    | 0.05        |
|    |                   |              |           |      |   | 108                        | 45                          | 18.09       | 7.54     | 0.04           | 0.018         | 0.10                               | 0.11    | 0.10        | 0.04     | 0.04    | 0.04        |
|    | Rata Rata         |              |           |      |   | 121                        | 60                          | 20.24       | 9.99     | 0.05           | 0.024         | 0.11                               | 0.12    | 0.12        | 0.06     | 0.06    | 0.06        |

**Lampiran 12** Efisiensi Kekeruhan pada Media filter Pasir Pantai

| No | Konsentrasi NTU | waktu (mnt) | Ketebalan 10 cm |                |                 |                | Ketebalan 20 cm |                |                 |                | Ketebalan 30 cm |                |                 |                |
|----|-----------------|-------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|-----------------|----------------|
|    |                 |             | Dowflow (NTU)   | Effisiensi (%) | Kombinasi (NTU) | Effisiensi (%) | Dowflow (NTU)   | Effisiensi (%) | Kombinasi (NTU) | Effisiensi (%) | Dowflow (NTU)   | Effisiensi (%) | Kombinasi (NTU) | Effisiensi (%) |
| 1  | 50              | 5           | 28              | 44             | 21              | 58.00          | 20              | 60.00          | 12              | 76.00          | 18              | 64.00          | 8               | 84.00          |
|    |                 | 10          | 22              | 56             | 18              | 64.00          | 16              | 68.00          | 10              | 80.00          | 10              | 80.00          | 7               | 86.00          |
|    |                 | 15          | 18              | 64             | 10              | 80.00          | 12              | 76.00          | 8               | 84.00          | 6               | 88.00          | 5               | 90.00          |
|    |                 | 20          | 12              | 76             | 8               | 84.00          | 9               | 82.00          | 6               | 88.00          | 5               | 90.00          | 3               | 94.00          |
|    |                 | 25          | 10              | 80             | 5               | 90.00          | 7               | 86.00          | 5               | 90.00          | 1               | 98.00          | 3               | 94.00          |
|    |                 | 30          | 8               | 84             | 4               | 92.00          | 5               | 90.00          | 3               | 94.00          | 1               | 98.00          | 0               | 100.00         |
|    |                 |             | 16.33           | 67.33          | 11.00           | 78.00          | 11.50           | 77.00          | 7.33            | 85.33          | 6.83            | 86.33          | 4.33            | 91.33          |
| 2  | 200             | 5           | 57              | 71.5           | 44              | 78.00          | 46              | 77.00          | 30              | 85.00          | 28              | 86.00          | 17              | 91.50          |
|    |                 | 10          | 52              | 74.0           | 25              | 87.50          | 40              | 80.00          | 26              | 87.00          | 21              | 89.50          | 12              | 94.00          |
|    |                 | 15          | 41              | 79.5           | 23              | 88.50          | 33              | 83.50          | 19              | 90.50          | 11              | 94.50          | 7               | 96.50          |
|    |                 | 20          | 30              | 85.0           | 20              | 90.00          | 17              | 91.50          | 10              | 95.00          | 11              | 94.50          | 5               | 97.50          |
|    |                 | 25          | 19              | 90.5           | 11              | 94.50          | 15              | 92.50          | 8               | 96.00          | 9               | 95.50          | 1               | 99.50          |
|    |                 | 30          | 17              | 91.5           | 8               | 96.00          | 10              | 95.00          | 6               | 97.00          | 5               | 97.50          | 1               | 99.50          |
|    |                 |             | 36.00           | 82.00          | 21.83           | 89.08          | 26.83           | 86.58          | 16.50           | 91.75          | 14.17           | 92.92          | 7.17            | 96.42          |
| 3  | 1000            | 5           | 78              | 92.2           | 66              | 93.40          | 60              | 94.00          | 49              | 95.10          | 48              | 95.20          | 44              | 95.60          |
|    |                 | 10          | 61              | 93.9           | 52              | 94.80          | 58              | 94.20          | 43              | 95.70          | 35              | 96.50          | 30              | 97.00          |
|    |                 | 15          | 54              | 94.6           | 40              | 96.00          | 42              | 95.80          | 34              | 96.60          | 28              | 97.20          | 19              | 98.10          |
|    |                 | 20          | 48              | 95.2           | 36              | 96.40          | 35              | 96.50          | 22              | 97.80          | 21              | 97.90          | 12              | 98.80          |
|    |                 | 25          | 32              | 96.8           | 22              | 97.80          | 28              | 97.20          | 16              | 98.40          | 16              | 98.40          | 9               | 99.10          |
|    |                 | 30          | 28              | 97.2           | 20              | 98.00          | 20              | 98.00          | 8               | 99.20          | 12              | 98.80          | 4               | 99.60          |
|    |                 |             | 50.17           | 94.98          | 39.33           | 96.07          | 40.50           | 95.95          | 28.67           | 97.13          | 26.67           | 97.33          | 19.67           | 98.03          |

**Lampiran 13. Efisiensi TSS pada Media filter Pasir Pantai**

| No | Konsentrasi NTU | waktu (menit)      | Ketebalan 10 cm |          |            |         | Ketebalan 20 cm |          |            |          | Ketebalan 30 cm |          |            |         |
|----|-----------------|--------------------|-----------------|----------|------------|---------|-----------------|----------|------------|----------|-----------------|----------|------------|---------|
|    |                 |                    | Df Mg/l         | Effi (%) | Kombi Mg/l | Eff (%) | Df Mg/l         | Effi (%) | Kombi Mg/l | Effi (%) | Df Mg/l         | Effi (%) | Kombi Mg/l | Eff (%) |
| 1  | 50              | 5                  | 22              | 56       | 16         | 68.0    | 18              | 64.0     | 10         | 80.0     | 10              | 80.00    | 5          | 90.00   |
|    |                 | 10                 | 19              | 62       | 11         | 78.0    | 13              | 74.0     | 8          | 84.0     | 8               | 84.00    | 4          | 92.00   |
|    |                 | 15                 | 16              | 68       | 7          | 86.0    | 10              | 80.0     | 6          | 88.0     | 4               | 92.00    | 2          | 96.00   |
|    |                 | 20                 | 9               | 82       | 4          | 92.0    | 5               | 90.0     | 4          | 92.0     | 3               | 94.00    | 2          | 96.00   |
|    |                 | 25                 | 8               | 84       | 4          | 92.0    | 5               | 90.0     | 3          | 94.0     | 1               | 98.00    | 1          | 98.00   |
|    |                 | 30                 | 5               | 90       | 0          | 100.0   | 2               | 96.0     | 1          | 98.0     | 0               | 100.00   | 0          | 100.00  |
|    |                 | <b>Rata - Rata</b> |                 |          | 13.17      | 73.67   | 7.00            | 86.0     | 8.83       | 82.3     | 5.33            | 89.33    | 4.33       | 91.33   |
| 2  | 200             | 5                  | 42              | 79.0     | 30         | 85.0    | 32              | 84.0     | 24         | 88.0     | 20              | 90.00    | 12         | 94.00   |
|    |                 | 10                 | 36              | 82.0     | 20         | 90.0    | 36              | 82.0     | 20         | 90.0     | 18              | 91.00    | 10         | 95.00   |
|    |                 | 15                 | 27              | 86.5     | 17         | 91.5    | 30              | 85.0     | 15         | 92.5     | 9               | 95.50    | 7          | 96.50   |
|    |                 | 20                 | 20              | 90.0     | 15         | 92.5    | 15              | 92.5     | 8          | 96.0     | 6               | 97.00    | 1          | 99.50   |
|    |                 | 25                 | 15              | 92.5     | 7          | 96.5    | 12              | 94.0     | 5          | 97.5     | 1               | 99.50    | 1          | 99.50   |
|    |                 | 30                 | 8               | 96.0     | 5          | 97.5    | 8               | 96.0     | 3          | 98.5     | 1               | 99.50    | 0          | 100.00  |
|    |                 | <b>Rata - Rata</b> |                 |          | 24.67      | 87.67   | 15.67           | 92.2     | 22.17      | 88.9     | 12.50           | 93.8     | 9.17       | 95.42   |
| 3  | 1000            | 5                  | 70              | 93.0     | 40         | 96.0    | 51              | 94.9     | 30         | 97.0     | 35              | 96.50    | 30         | 97.00   |
|    |                 | 10                 | 58              | 94.2     | 29         | 97.1    | 50              | 95.0     | 23         | 97.7     | 32              | 96.80    | 28         | 97.20   |
|    |                 | 15                 | 40              | 96.0     | 20         | 98.0    | 40              | 96.0     | 18         | 98.2     | 17              | 98.30    | 15         | 98.50   |
|    |                 | 20                 | 29              | 97.1     | 18         | 98.2    | 28              | 97.2     | 13         | 98.7     | 17              | 98.30    | 7          | 99.30   |
|    |                 | 25                 | 22              | 97.8     | 16         | 98.4    | 22              | 97.8     | 10         | 99.0     | 12              | 98.80    | 5          | 99.50   |
|    |                 | 30                 | 19              | 98.1     | 14         | 98.6    | 17              | 98.3     | 6          | 99.4     | 10              | 99.00    | 4          | 99.60   |
|    |                 | <b>Rata - Rata</b> |                 |          | 39.67      | 96.03   | 22.83           | 97.7     | 34.67      | 96.5     | 16.67           | 98.33    | 20.50      | 97.95   |



**Lampiran 14.** Efisiensi Kekeruhan pada Media filter gabungan

| No                 | Konsentrasi NTU | waktu (mnt) | Ketebalan 10 cm |              |              |             | Ketebalan 20 cm |             |             |              | Ketebalan 30 cm |              |             |              |
|--------------------|-----------------|-------------|-----------------|--------------|--------------|-------------|-----------------|-------------|-------------|--------------|-----------------|--------------|-------------|--------------|
|                    |                 |             | Df NTU          | Eff (%)      | Kom NTU      | Eff (%)     | Df NTU          | Eff (%)     | Kom NTU     | Eff (%)      | Df NTU          | Eff (%)      | Kom NTU     | Eff (%)      |
| 1                  | 50              | 5           | 20              | 60           | 15           | 70          | 16              | 68          | 9           | 82           | 10              | 80           | 6           | 88           |
|                    |                 | 10          | 16              | 68           | 10           | 80          | 12              | 76          | 6           | 88           | 8               | 84           | 6           | 88           |
|                    |                 | 15          | 9               | 82           | 6            | 88          | 9               | 82          | 4           | 92           | 4               | 92           | 2           | 96           |
|                    |                 | 20          | 7               | 86           | 4            | 92          | 5               | 90          | 4           | 92           | 1               | 98           | 0           | 100          |
|                    |                 | 25          | 5               | 90           | 2            | 96          | 4               | 92          | 2           | 96           | 1               | 98           | 0           | 100          |
|                    |                 | 30          | 4               | 92           | 2            | 96          | 3               | 94          | 2           | 96           | 1               | 98           | 0           | 100          |
| <b>Rata - Rata</b> |                 |             | <b>10.17</b>    | <b>79.67</b> | <b>6.50</b>  | <b>87.0</b> | <b>8.17</b>     | <b>83.7</b> | <b>4.50</b> | <b>91.00</b> | <b>4.17</b>     | <b>91.67</b> | <b>2.33</b> | <b>95.33</b> |
| 2                  | 200             | 5           | 40              | 80           | 25           | 88          | 36              | 82          | 15          | 93           | 10              | 95           | 6           | 97           |
|                    |                 | 10          | 30              | 85           | 18           | 91          | 20              | 90          | 9           | 96           | 8               | 96           | 6           | 97           |
|                    |                 | 15          | 26              | 87           | 15           | 93          | 13              | 94          | 7           | 97           | 6               | 97           | 3           | 99           |
|                    |                 | 20          | 17              | 92           | 9            | 96          | 7               | 97          | 5           | 98           | 4               | 98           | 1           | 100          |
|                    |                 | 25          | 10              | 95           | 7            | 97          | 6               | 97          | 2           | 99           | 4               | 98           | 0           | 100.0        |
|                    |                 | 30          | 8               | 96           | 3            | 99          | 5               | 98          | 1           | 100          | 1               | 100          | 0           | 100.0        |
| <b>Rata - Rata</b> |                 |             | <b>21.83</b>    | <b>89.08</b> | <b>12.83</b> | <b>93.6</b> | <b>14.50</b>    | <b>92.8</b> | <b>6.50</b> | <b>96.8</b>  | <b>5.50</b>     | <b>97.25</b> | <b>2.67</b> | <b>98.67</b> |
| 3                  | 1000            | 5           | 47              | 95.3         | 28           | 97.2        | 40              | 96          | 17          | 98.3         | 25              | 97.5         | 10          | 99           |
|                    |                 | 10          | 31              | 96.9         | 26           | 97.4        | 23              | 97.7        | 10          | 99           | 12              | 98.8         | 7           | 99.3         |
|                    |                 | 15          | 27              | 97.3         | 20           | 98          | 15              | 98.5        | 4           | 99.6         | 7               | 99.3         | 3           | 99.7         |
|                    |                 | 20          | 18              | 98.2         | 16           | 98.4        | 11              | 98.9        | 3           | 99.7         | 5               | 99.5         | 3           | 99.7         |
|                    |                 | 25          | 12              | 98.8         | 10           | 99          | 10              | 99          | 2           | 99.8         | 5               | 99.5         | 2           | 99.8         |
|                    |                 | 30          | 10              | 99           | 8            | 99.2        | 8               | 99.2        | 1           | 99.9         | 4               | 99.6         | 2           | 99.8         |
| <b>Rata - Rata</b> |                 |             | <b>24.17</b>    | <b>97.58</b> | <b>18.00</b> | <b>98.2</b> | <b>17.83</b>    | <b>98.2</b> | <b>6.17</b> | <b>99.38</b> | <b>10</b>       | <b>99</b>    | <b>4.50</b> | <b>99.55</b> |

**Lampiran 15. Efisiensi TSS pada Media filter gabungan**

| No | Konsentrasi NTU | waktu (mnt) | Ketebalan 10 cm |          |          |         | Ketebalan 20 cm |          |          |         | Ketebalan 30 cm |          |          |         |
|----|-----------------|-------------|-----------------|----------|----------|---------|-----------------|----------|----------|---------|-----------------|----------|----------|---------|
|    |                 |             | Df Mg/l         | Effi (%) | Kom Mg/l | Eff (%) | Df Mg/l         | Effi (%) | Kom Mg/l | Eff (%) | Df Mg/l         | Effi (%) | Kom Mg/l | Eff (%) |
| 1  | 50              | 5           | 12              | 76       | 8        | 84      | 10              | 80       | 7        | 86      | 7               | 86       | 2        | 96      |
|    |                 | 10          | 11              | 78       | 7        | 86      | 9               | 82       | 7        | 86      | 4               | 92       | 2        | 96      |
|    |                 | 15          | 7               | 86       | 3        | 94      | 7               | 86       | 3        | 94      | 1               | 98       | 1        | 98      |
|    |                 | 20          | 6               | 88       | 3        | 94      | 4               | 92       | 2        | 96      | 0               | 100      | 0        | 100     |
|    |                 | 25          | 4               | 92       | 2        | 96      | 2               | 96       | 1        | 98      | 0               | 100      | 0        | 100     |
|    |                 | 30          | 3               | 94       | 1        | 98      | 2               | 96       | 1        | 98      | 0               | 100      | 0        | 100     |
|    | Rata - Rata     |             | 7.17            | 85.67    | 4.00     | 92.0    | 5.67            | 88.7     | 3.50     | 93.00   | 2.00            | 96.00    | 0.83     | 98.33   |
| 2  | 200             | 5           | 37              | 82       | 20       | 90      | 33              | 84       | 10       | 95      | 9               | 96       | 5        | 98      |
|    |                 | 10          | 22              | 89       | 17       | 92      | 18              | 91       | 8        | 96      | 8               | 96       | 4        | 98      |
|    |                 | 15          | 21              | 90       | 11       | 95      | 12              | 94       | 4        | 98      | 6               | 97       | 3        | 99      |
|    |                 | 20          | 10              | 95       | 6        | 97      | 6               | 97       | 2        | 99      | 4               | 98       | 1        | 100     |
|    |                 | 25          | 8               | 96       | 4        | 98      | 5               | 98       | 0        | 100     | 4               | 98       | 0        | 100     |
|    |                 | 30          | 5               | 98       | 4        | 98      | 2               | 99       | 0        | 100     | 1               | 100      | 0        | 100     |
|    | Rata - Rata     |             | 17.17           | 91.42    | 10.33    | 94.8    | 12.67           | 93.7     | 4.00     | 98.0    | 5.33            | 97.33    | 2.17     | 98.92   |
| 3  | 1000            | 5           | 42              | 95.8     | 25       | 97.5    | 36              | 96.4     | 15       | 98.5    | 17              | 98.3     | 5        | 99.5    |
|    |                 | 10          | 30              | 97       | 18       | 98.2    | 20              | 98       | 10       | 99      | 7               | 99.3     | 5        | 99.5    |
|    |                 | 15          | 22              | 97.8     | 15       | 98.5    | 13              | 98.7     | 3        | 99.7    | 5               | 99.5     | 2        | 99.8    |
|    |                 | 20          | 17              | 98.3     | 9        | 99.1    | 7               | 99.3     | 3        | 99.7    | 5               | 99.5     | 2        | 99.8    |
|    |                 | 25          | 10              | 99       | 8        | 99.2    | 6               | 99.4     | 2        | 99.8    | 4               | 99.6     | 2        | 99.8    |
|    |                 | 30          | 7               | 99.3     | 5        | 99.5    | 5               | 99.5     | 1        | 99.9    | 4               | 99.6     | 2        | 99.8    |
|    | Rata - Rata     |             | 21.33           | 97.87    | 13.33    | 98.7    | 14.50           | 98.6     | 5.67     | 99.43   | 7.00            | 99.3     | 3.00     | 99.70   |

### Lampiran 16. Kehilangan Energi pada Media Filter Pasir

| Konsentrasi<br>NTU | Tebal Media (D)<br>(cm) | Diameter pasir (d)<br>(cm) | Kecepatan Filtrasi (Va) |                    | Faktor bentuk ( $\Psi$ ) | Viskositas kinematik | grafitasi (g) | Porositas $\epsilon$ | NRE      |           | f'       |           | Kehilangan Enrgi (hl) |           |
|--------------------|-------------------------|----------------------------|-------------------------|--------------------|--------------------------|----------------------|---------------|----------------------|----------|-----------|----------|-----------|-----------------------|-----------|
|                    |                         |                            | Df (cm/dtk)             | Kombinasi (cm/dtk) |                          |                      |               |                      | Downflow | Kombinasi | Downflow | Kombinasi | Downflow              | Kombinasi |
| 50                 | 10                      | 0.084                      | 0.15                    | 0.08               | 0.82                     | 0.00854              | 981           | 0.43                 | 1.2098   | 0.6810    | 72.42    | 127.29    | 1.729                 | 0.963     |
|                    | 20                      | 0.084                      | 0.14                    | 0.06               | 0.82                     | 0.00854              | 981           | 0.43                 | 1.1292   | 0.4742    | 77.47    | 182.04    | 3.222                 | 1.335     |
|                    | 30                      | 0.084                      | 0.11                    | 0.05               | 0.82                     | 0.00854              | 981           | 0.43                 | 0.8872   | 0.3973    | 98.12    | 216.93    | 3.779                 | 1.676     |
| 200                | 10                      | 0.084                      | 0.14                    | 0.07               | 0.82                     | 0.00854              | 981           | 0.43                 | 1.0928   | 0.5661    | 79.99    | 152.79    | 1.558                 | 0.799     |
|                    | 20                      | 0.084                      | 0.13                    | 0.06               | 0.82                     | 0.00854              | 981           | 0.43                 | 1.0322   | 0.4449    | 84.59    | 193.93    | 2.939                 | 1.252     |
|                    | 30                      | 0.084                      | 0.10                    | 0.04               | 0.82                     | 0.00854              | 981           | 0.43                 | 0.7911   | 0.3475    | 109.83   | 247.81    | 3.363                 | 1.464     |
| 1000               | 10                      | 0.084                      | 0.12                    | 0.05               | 0.82                     | 0.00854              | 981           | 0.43                 | 0.9418   | 0.3787    | 92.54    | 227.52    | 1.339                 | 0.532     |
|                    | 20                      | 0.084                      | 0.11                    | 0.04               | 0.82                     | 0.00854              | 981           | 0.43                 | 0.8636   | 0.3248    | 100.76   | 265.00    | 2.451                 | 0.912     |
|                    | 30                      | 0.084                      | 0.09                    | 0.03               | 0.82                     | 0.00854              | 981           | 0.43                 | 0.7586   | 0.2297    | 114.46   | 373.92    | 3.223                 | 0.966     |



**Lampiran 18** Data Q Penelitian dan Q Darcy Untuk Media Filter Pasir

| Head<br>cm | luas (A)<br>cm <sup>2</sup> | ketebalan<br>cm | K<br>cm/dtik | J= h/D | Q Penelitian |         |          | Q Darcy<br>= K.A.J |
|------------|-----------------------------|-----------------|--------------|--------|--------------|---------|----------|--------------------|
|            |                             |                 |              |        | 50 NTU       | 200 NTU | 1000 NTU |                    |
| 50         | 2500                        | 10              | 0.023148     | 5      | 398.75       | 351.72  | 315.20   | 289.35             |
| 50         | 2500                        | 10              | 0.023148     | 5      | 385.86       | 345.45  | 325.35   | 289.35             |
| 50         | 2500                        | 10              | 0.023148     | 5      | 372.80       | 343.85  | 312.18   | 289.35             |
| 50         | 2500                        | 10              | 0.023148     | 5      | 368.15       | 338.75  | 310.50   | 289.35             |
| 50         | 2500                        | 10              | 0.023148     | 5      | 360.45       | 330.28  | 314.85   | 289.35             |
| 50         | 2500                        | 10              | 0.023148     | 5      | 354.30       | 322.30  | 305.35   | 289.35             |
| 60         | 2500                        | 20              | 0.023148     | 3      | 352.70       | 338.40  | 301.00   | 173.61             |
| 60         | 2500                        | 20              | 0.023148     | 3      | 345.20       | 325.12  | 280.20   | 173.61             |
| 60         | 2500                        | 20              | 0.023148     | 3      | 341.65       | 322.35  | 272.10   | 173.61             |
| 60         | 2500                        | 20              | 0.023148     | 3      | 340.57       | 320.28  | 260.40   | 173.61             |
| 60         | 2500                        | 20              | 0.023148     | 3      | 342.67       | 318.25  | 252.25   | 173.61             |
| 60         | 2500                        | 20              | 0.023148     | 3      | 337.60       | 315.15  | 240.05   | 173.61             |
| 70         | 2500                        | 30              | 0.023148     | 2.33   | 282.150      | 265.250 | 248.70   | 135.03             |
| 70         | 2500                        | 30              | 0.023148     | 2.33   | 280.150      | 256.100 | 241.80   | 135.03             |
| 70         | 2500                        | 30              | 0.023148     | 2.33   | 279.300      | 245.600 | 233.15   | 135.03             |
| 70         | 2500                        | 30              | 0.023148     | 2.33   | 278.210      | 240.200 | 230.85   | 135.03             |
| 70         | 2500                        | 30              | 0.023148     | 2.33   | 275.700      | 233.400 | 228.15   | 135.03             |
| 70         | 2500                        | 30              | 0.023148     | 2.33   | 273.450      | 230.650 | 228.10   | 135.03             |

## Lampiran 19. Analisa Dimensi

| Head | Diameter pasir | porositas<br>€ | ketebalan<br>(D) | Q<br>penelitian | Q/gt2v   | Kp | Kp/Ks | h/D  | d/gt2       | hd/Dgt2     | hE/D   | dE/Dgt2     | hdE/Dgt2    |
|------|----------------|----------------|------------------|-----------------|----------|----|-------|------|-------------|-------------|--------|-------------|-------------|
| 50   | 0.0085         | 0.43           | 10               | 398.75          | 0.000053 | 15 | 0.60  | 5.00 | 3.46585E-05 | 0.000173293 | 2.1500 | 1.49032E-05 | 7.45158E-05 |
| 50   | 0.0085         | 0.43           | 10               | 385.86          | 0.000013 | 10 | 0.40  | 5.00 | 8.66463E-06 | 4.33231E-05 | 2.1500 | 3.72579E-06 | 0.000018629 |
| 50   | 0.0085         | 0.43           | 10               | 372.80          | 0.000005 | 8  | 0.32  | 5.00 | 3.85095E-06 | 1.92547E-05 | 2.1500 | 1.65591E-06 | 8.27953E-06 |
| 50   | 0.0085         | 0.43           | 10               | 368.15          | 0.000003 | 7  | 0.28  | 5.00 | 2.16616E-06 | 1.08308E-05 | 2.1500 | 9.31448E-07 | 4.65724E-06 |
| 50   | 0.0085         | 0.43           | 10               | 360.45          | 0.000002 | 7  | 0.28  | 5.00 | 1.38634E-06 | 6.93170E-06 | 2.1500 | 5.96126E-07 | 2.98063E-06 |
| 50   | 0.0085         | 0.43           | 10               | 354.30          | 0.000001 | 4  | 0.16  | 5.00 | 9.62736E-07 | 4.81368E-06 | 2.1500 | 4.13977E-07 | 2.06988E-06 |
| 50   | 0.0085         | 0.43           | 10               | 351.72          | 0.000047 | 25 | 1.00  | 5.00 | 3.46585E-05 | 0.000173293 | 2.1500 | 1.49032E-05 | 7.45158E-05 |
| 50   | 0.0085         | 0.43           | 10               | 345.45          | 0.000011 | 18 | 0.72  | 5.00 | 8.66463E-06 | 4.33231E-05 | 2.1500 | 3.72579E-06 | 1.8629E-05  |
| 50   | 0.0085         | 0.43           | 10               | 343.85          | 0.000005 | 15 | 0.60  | 5.00 | 3.85095E-06 | 1.92547E-05 | 2.1500 | 1.65591E-06 | 8.27953E-06 |
| 50   | 0.0085         | 0.43           | 10               | 338.75          | 0.000003 | 12 | 0.48  | 5.00 | 2.16616E-06 | 1.08308E-05 | 2.1500 | 9.31448E-07 | 4.65724E-06 |
| 50   | 0.0085         | 0.43           | 10               | 330.28          | 0.000002 | 10 | 0.40  | 5.00 | 1.38634E-06 | 6.93170E-06 | 2.1500 | 5.96126E-07 | 2.98063E-06 |
| 50   | 0.0085         | 0.43           | 10               | 322.30          | 0.000001 | 8  | 0.32  | 5.00 | 9.62736E-07 | 4.81368E-06 | 2.1500 | 4.13977E-07 | 2.06988E-06 |
| 50   | 0.0085         | 0.43           | 10               | 305.20          | 0.000040 | 50 | 2.00  | 5.00 | 3.46585E-05 | 0.000173293 | 2.1500 | 1.49032E-05 | 7.45158E-05 |
| 50   | 0.0085         | 0.43           | 10               | 300.35          | 0.000010 | 30 | 1.20  | 5.00 | 8.66463E-06 | 4.33231E-05 | 2.1500 | 3.72579E-06 | 1.8629E-05  |
| 50   | 0.0085         | 0.43           | 10               | 292.18          | 0.000004 | 25 | 1.00  | 5.00 | 3.85095E-06 | 1.92547E-05 | 2.1500 | 1.65591E-06 | 8.27953E-06 |
| 50   | 0.0085         | 0.43           | 10               | 290.50          | 0.000002 | 20 | 0.80  | 5.00 | 2.16616E-06 | 1.08308E-05 | 2.1500 | 9.31448E-07 | 4.65724E-06 |
| 50   | 0.0085         | 0.43           | 10               | 284.85          | 0.000002 | 20 | 0.80  | 5.00 | 1.38634E-06 | 6.93170E-06 | 2.1500 | 5.96126E-07 | 2.98063E-06 |
| 50   | 0.0085         | 0.43           | 10               | 278.35          | 0.000001 | 18 | 0.72  | 5.00 | 9.62736E-07 | 4.81368E-06 | 2.1500 | 4.13977E-07 | 2.06988E-06 |

| head | O butir pasir | porositas | ketebalan | Q penelitian | Q/gt2v   | Kp | Kp/Ks | h/D | d/gt2       | hd/Dgt2     | hE/D | dE/Dgt2     | hdE/Dgt2    |
|------|---------------|-----------|-----------|--------------|----------|----|-------|-----|-------------|-------------|------|-------------|-------------|
| 60   | 0.085         | 0.43      | 20        | 352.70       | 0.000047 | 10 | 0.40  | 3   | 0.000346585 | 0.001039755 | 1.29 | 0.000149032 | 0.000447095 |
| 60   | 0.085         | 0.43      | 20        | 345.20       | 0.000046 | 9  | 0.36  | 3   | 8.66463E-05 | 0.000259939 | 1.29 | 3.72579E-05 | 0.000111774 |
| 60   | 0.085         | 0.43      | 20        | 341.65       | 0.000045 | 8  | 0.32  | 3   | 3.85095E-05 | 0.000115528 | 1.29 | 1.65591E-05 | 4.96772E-05 |
| 60   | 0.085         | 0.43      | 20        | 340.57       | 0.000045 | 7  | 0.28  | 3   | 2.16616E-05 | 6.49847E-05 | 1.29 | 9.31448E-06 | 2.79434E-05 |
| 60   | 0.085         | 0.43      | 20        | 342.67       | 0.000045 | 7  | 0.28  | 3   | 1.38634E-05 | 4.15902E-05 | 1.29 | 5.96126E-06 | 1.78838E-05 |
| 60   | 0.085         | 0.43      | 20        | 337.60       | 0.000045 | 3  | 0.12  | 3   | 9.62736E-06 | 2.88821E-05 | 1.29 | 4.13977E-06 | 1.24193E-05 |
| 60   | 0.085         | 0.43      | 20        | 328.40       | 0.000044 | 16 | 0.64  | 3   | 0.000346585 | 0.001039755 | 1.29 | 0.000149032 | 0.000447095 |
| 60   | 0.085         | 0.43      | 20        | 325.12       | 0.000043 | 16 | 0.64  | 3   | 8.66463E-05 | 0.000259939 | 1.29 | 3.72579E-05 | 0.000111774 |
| 60   | 0.085         | 0.43      | 20        | 322.35       | 0.000043 | 10 | 0.40  | 3   | 3.85095E-05 | 0.000115528 | 1.29 | 1.65591E-05 | 4.96772E-05 |
| 60   | 0.085         | 0.43      | 20        | 320.28       | 0.000042 | 12 | 0.48  | 3   | 2.16616E-05 | 6.49847E-05 | 1.29 | 9.31448E-06 | 2.79434E-05 |
| 60   | 0.085         | 0.43      | 20        | 318.25       | 0.000042 | 9  | 0.36  | 3   | 1.38634E-05 | 4.15902E-05 | 1.29 | 5.96126E-06 | 1.78838E-05 |
| 60   | 0.085         | 0.43      | 20        | 305.15       | 0.000040 | 5  | 0.20  | 3   | 9.62736E-06 | 2.88821E-05 | 1.29 | 4.13977E-06 | 1.24193E-05 |
| 60   | 0.085         | 0.43      | 20        | 301.00       | 0.000040 | 38 | 1.52  | 3   | 0.000346585 | 0.001039755 | 1.29 | 0.000149032 | 0.000447095 |
| 60   | 0.085         | 0.43      | 20        | 280.20       | 0.000037 | 30 | 1.20  | 3   | 8.66463E-05 | 0.000259939 | 1.29 | 3.72579E-05 | 0.000111774 |
| 60   | 0.085         | 0.43      | 20        | 272.10       | 0.000036 | 26 | 1.04  | 3   | 3.85095E-05 | 0.000115528 | 1.29 | 1.65591E-05 | 4.96772E-05 |
| 60   | 0.085         | 0.43      | 20        | 260.40       | 0.000035 | 24 | 0.96  | 3   | 2.16616E-05 | 6.49847E-05 | 1.29 | 9.31448E-06 | 2.79434E-05 |
| 60   | 0.085         | 0.43      | 20        | 252.25       | 0.000033 | 18 | 0.72  | 3   | 1.38634E-05 | 4.15902E-05 | 1.29 | 5.96126E-06 | 1.78838E-05 |
| 60   | 0.085         | 0.43      | 20        | 240.05       | 0.000032 | 15 | 0.60  | 3   | 9.62736E-06 | 2.88821E-05 | 1.29 | 4.13977E-06 | 1.24193E-05 |





