

## DAFTAR PUSTAKA

- Adji, Surjo W. 2009. *Resistance & Propulsion Modul 1: Introduction to Ship Resistance*. Surabaya : ITS.
- Baital, Muh. Sawal. 2016. *Analisa Pengaruh Penempelan Marine Biofouling Terhadap Power Kapal Dengan Simulasi CFD*. Surabaya : ITS.
- Baso, S., Ardianti, A., Rosmani, A. Ade Anggriani. (2021). *An Extended Validation of Free CFD Application to Ship Resistance Prediction for Using In Preliminary Design Stage*. Journal of Engineering Science and Technology, 16(3), 2544-2561.
- Callow, Maureen E dan James A Callow. 2002. *Marine Biofouling : a sticky problem*. University of Birmingham, UK.
- Curtin, Mary Ellen. 1985. *Trying to Solve the Biofouling Problem*. Nature Biotechnology.
- Djabbar M.A. & Rosmani. 2011. *Hibah Penulisan Buku Ajar Tahanan Kapal*. Departemen Teknik Perkapalan, Universitas Hasanuddin. Makassar.
- Harvald, Sv. Aa. 1992. *Tahanan dan Propulsi Kapal*. Surabaya : Aerlangga University Press.
- Iswadi, Agung dan Gadang Priyotomo. 2020. *Biofouling dan Korosi pada Infrastruktur Energi Laut di Indonesia: Analisis Bibliometrik*. Jakarta Selatan : Universitas Nasional.
- L.D. Chambers; et al. 2006. *Modern approaches to marine antifouling coatings*. Surface and Coatings Technology.
- Lilik, Puspitasari. 2015. *Biofouling dan Teknologi Antifouling*. Yogyakarta : Universitas Gadjah Mada.
- Nurrohman, Muhammad Nizar. 2017. *Analisis Lapisan Batas Untuk Mengetahui Pertumbuhan Marine Fouling Pada Lambung Kapal Dibawah Garis Air Dengan Menggunakan Program CFD*. Surabaya : ITS.
- Pakka, Zetrawan Natal. 2018. *Prediksi Tahanan Kapal Perikanan Berdasarkan Analisis CFD*. Makassar : Universitas Hasanuddin.
- Peraturan Menteri Perhubungan No. PM 26 Tahun 2022 Tentang Pengawasan Kapal Niaga.

- Prasetio, F. A., Chrismianto, D., & Iqbal, M. 2017. *Analisa Pengaruh Variasi Bulbous Bow Terhadap Hambatan Total Pada Kapal Katamaran Penyeberangan Kepulauan Seribu Dengan Parameter Non-Linear Menggunakan CFD*. Jurnal Teknik Perkapalan, 5(1).
- Prastianto, Rudi W. 2006. *Apa itu "Vortex shedding ?"*. Surabaya.
- Ramadhani, Hendra Marta. 2016. *Studi Pengaruh Variasi Kedalaman Air Laut Tropis Terhadap Penempelan Biofouling Pada Material Bambu Laminasi*. Surabaya : ITS.
- Sardjadi, Djoko. 2003. *Mekanika Fluida*. Bandung.
- Simanjuntak, H. F. P., Manik, P., & Santosa, A. W. B. 2017. *Analisa Pengaruh Panjang, Letak dan Geometri Lunas Bilga Terhadap Arah dan Kecepatan Aliran (Wake) Pada Kapal Ikan Tradisioal (Studi Kasus Kapal Tipe Kragan)*. Jurnal Teknik Perkapalan, 5(1).
- Sv. Aa. Harvald, 1983, *Resistance and Propulsion*.
- Tumanggor, Meika Pestaria. 2022. *Jadwal Kapal Pelni KM Wilis dan Tiket 14-25 Oktober 2022, 11 Rute Mulai Makassar-Labuan Bajo*, [Pelni KM Wilis Ship Schedule and Ticket Prices 14-25 October 2022, 11 Makassar - Labuan Bajo Starting Routes - Pos-kupang.com \(tribunnews.com\)](#), diakses 16 Desember 2022.
- Verde, S. W. R. U. M. 2009. *Secretary of the Navy Environmental Award Winners Recognized New Hull Coatings Cut Fuel Use, Protect Environment*. Currents. Woods Hole Oceanographic Institution. 1952. *Marine fouling and Its Prevention Chapter 2*. United States Naval Institute, Annapolis Maryland.
- Yusim, Adi Kurniawan. 2016. *Studi Eksperimental Pengaruh Pertumbuhan Biofouling Pada Lambung Kapal Terhadap Skin Friction Drag*. Surabaya : ITS.

# LAMPIRAN

Lampiran 1. Tabel offset *lines plan* kapal KM. Wilis







WL	Draft	-0,86	-0,43	0,00	3,52	7,05	10,57
		Section a	Section b	Section 0	Section 1	Section 2	Section 3
WL0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
WL1	0,48	0,00	0,00	0,00	0,00	1,20	3,73
WL2	0,95	0,00	0,00	0,00	0,00	3,14	4,92
WL3	1,43	0,00	0,00	0,00	0,41	4,07	5,54
WL4	1,90	0,00	0,00	0,00	2,70	4,82	6,01
WL5	2,38	0,00	0,00	0,00	3,71	5,42	6,35
WL6	2,85	0,00	0,00	1,20	4,35	5,83	6,59
H	6,00	3,38	3,63	3,87	5,71	6,92	7,27


WL	Draft	14,10	17,62	21,15	24,67	28,19	31,72
		Section 4	Section 5	Section 6	Section 7	Section 8	Section 9
WL0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
WL1	0,48	5,00	5,94	6,52	6,79	6,87	6,75
WL2	0,95	5,88	6,51	6,91	7,11	7,20	7,16
WL3	1,43	6,30	6,76	7,05	7,20	7,28	7,28
WL4	1,90	6,59	6,93	7,13	7,23	7,29	7,31
WL5	2,38	6,79	7,05	7,18	7,24	7,29	7,33
WL6	2,85	6,94	7,13	7,23	7,26	7,30	7,35
H	6,00	7,38	7,43	7,47	7,48	7,48	7,52


WL	Draft	35,24	38,77	42,29	45,81	49,34	52,86
		Section 10	Section 11	Section 12	Section 13	Section 14	Section 15
WL0	0,00	0,00	0,00	0,00	0,00	0,00	0,00
WL1	0,48	6,62	6,49	6,22	5,58	4,63	3,60
WL2	0,95	7,12	7,07	6,85	6,34	5,56	4,62
WL3	1,43	7,27	7,26	7,08	6,68	6,07	5,22
WL4	1,90	7,33	7,33	7,18	6,91	6,45	5,71
WL5	2,38	7,35	7,37	7,25	7,06	6,74	6,09
WL6	2,85	7,37	7,40	7,30	7,18	6,95	6,39
H	6,00	7,55	7,59	7,60	7,60	7,58	7,48


WL	Draft	56,39	59,91	63,43	66,96	68,72	69,78	70,48
		Section 16	Section 17	Section 18	Section 19	Section 19.5	Section 19.8	Section 20
WL0	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
WL1	0,48	1,62	0,93	0,93	0,44	0,20	0,06	0,00
WL2	0,95	2,33	1,40	1,40	0,65	0,30	0,09	0,00
WL3	1,43	2,87	1,80	1,80	0,82	0,38	0,12	0,00
WL4	1,90	3,38	2,19	2,19	0,99	0,46	0,15	0,00
WL5	2,38	3,83	2,56	2,56	1,19	0,56	0,19	0,00
WL6	2,85	4,23	2,93	2,93	1,43	0,71	0,28	0,00
H	6,00	6,42	5,30	5,30	3,60	2,45	1,74	1,26

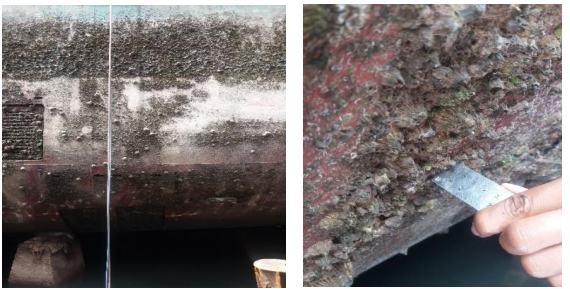
**Lampiran 2.** Data hasil pengukuran ketebalan *biofouling* pada lambung kapal

Section	Waterline	Ketebalan Biofouling		Dokumentasi	
		Portside (mm)	Starboard (mm)		
<b>10</b>	WL 0	1	1		
	WL 1	3	13		
	WL 2	5	10		
	WL 3	8	18		
	WL 4	11	11		
	WL 5	13	11		
	WL 6	20	20		
<b>9</b>	WL 0	5	8		
	WL 1	8	7		
	WL 2	7	7		
	WL 3	4	4		
	WL 4	4	12		
	WL 5	12	13		
	WL 6	10	11		
<b>8</b>	WL 0	9	9		
	WL 1	5	5		
	WL 2	6	6		
	WL 3	6	6		
	WL 4	7	7		
	WL 5	12	10		
	WL 6	15	12		
<b>7</b>	WL 0	3	3		
	WL 1	2	2		
	WL 2	3	3		
	WL 3	2	2		
	WL 4	6	9		
	WL 5	12	12		
	WL 6	13	13		


Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>6</b>	WL 0	6	7	
	WL 1	6	6	
	WL 2	3	3	
	WL 3	6	6	
	WL 4	10	10	
	WL 5	14	14	
	WL 6	16	15	


Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>5</b>	WL 0	3	3	
	WL 1	5	5	
	WL 2	5	5	
	WL 3	8	8	
	WL 4	10	10	
	WL 5	14	12	
	WL 6	16	14	


Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>4</b>	WL 0	4	4	
	WL 1	8	8	
	WL 2	5	5	
	WL 3	8	8	
	WL 4	8	10	
	WL 5	14	12	
	WL 6	16	18	


Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>3</b>	WL 0	8	8	
	WL 1	10	10	
	WL 2	8	7	
	WL 3	8	8	
	WL 4	10	10	
	WL 5	14	12	
	WL 6	16	18	




Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>2</b>	WL 0	4	7	
	WL 1	7	4	
	WL 2	8	8	
	WL 3	10	10	
	WL 4	13	13	
	WL 5	13	13	
	WL 6	11	10	

Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>1</b>	WL 0	3	3	
	WL 1	9	9	
	WL 2	7	7	
	WL 3	9	9	
	WL 4	13	13	
	WL 5	14	14	
	WL 6	13	13	

Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>0</b>	WL 0	-	-	
	WL 1	-	-	
	WL 2	-	-	
	WL 3	-	-	
	WL 4	18	18	
	WL 5	20	20	
	WL 6	20	20	

Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>b</b>	WL 0	-	-	
	WL 1	-	-	
	WL 2	-	-	
	WL 3	-	-	
	WL 4	-	-	
	WL 5	20	20	
	WL 6	18	18	

Section	Waterline	Ketebalan Biofouling		Dokumentasi
		Portside (mm)	Starboard (mm)	
<b>a</b>	WL 0	-	-	
	WL 1	-	-	
	WL 2	-	-	
	WL 3	-	-	
	WL 4	-	-	
	WL 5	-	-	
	WL 6	18	18	



**Lampiran 3.** Penentuan nilai kecepatan model kapal ( $V_m$ )

Berdasarkan persamaan 2.17 dimana  $\frac{Vm}{\sqrt{g.Lm}} = \frac{Vs}{\sqrt{g.Ls}}$  maka dalam menentukan kecepatan model kapal sebagai berikut.

**a. Kecepatan 5 knot**

$$\begin{aligned} Fn_s &= \frac{Vs}{\sqrt{g.Ls}} \\ &= \frac{2,572}{\sqrt{9,81 \times 71,41}} \\ &= 0,097 \end{aligned}$$

$$Fn_s = Fn_m = 0,097$$

Maka,

$$\begin{aligned} Fn_m &= \frac{Vm}{\sqrt{g.Lm}} \\ 0,097 &= \frac{Vm}{\sqrt{9,81 \times 1,79}} \\ V_m &= 0,407 \text{ m/s} \end{aligned}$$

**b. Kecepatan 7 knot**

$$\begin{aligned} Fn_s &= \frac{Vs}{\sqrt{g.Ls}} \\ &= \frac{3,601}{\sqrt{9,81 \times 71,41}} \\ &= 0,136 \end{aligned}$$

$$Fn_s = Fn_m = 0,136$$

Maka,

$$\begin{aligned} Fn_m &= \frac{Vm}{\sqrt{g.Lm}} \\ 0,136 &= \frac{Vm}{\sqrt{9,81 \times 1,79}} \\ V_m &= 0,569 \text{ m/s} \end{aligned}$$

**c. Kecepatan 9 knot**

$$\begin{aligned} Fn_s &= \frac{Vs}{\sqrt{g.Ls}} \\ &= \frac{4,630}{\sqrt{9,81 \times 71,41}} \\ &= 0,175 \end{aligned}$$

$$F_{n_s} = F_{n_m} = 0,175$$

Maka,

$$F_{n_m} = \frac{Vm}{\sqrt{g.Lm}}$$

$$0,175 = \frac{Vm}{\sqrt{9,81 \times 1,79}}$$

$$V_m = 0,732 \text{ m/s}$$

#### d. Kecepatan 11 knot

$$F_{n_s} = \frac{Vs}{\sqrt{g.Ls}}$$

$$= \frac{5,658}{\sqrt{9,81 \times 71,41}}$$

$$= 0,214$$

$$F_{n_s} = F_{n_m} = 0,214$$

Maka,

$$F_{n_m} = \frac{Vm}{\sqrt{g.Lm}}$$

$$0,214 = \frac{Vm}{\sqrt{9,81 \times 1,79}}$$

$$V_m = 0,895 \text{ m/s}$$

#### e. Kecepatan 13 knot

$$F_{n_s} = \frac{Vs}{\sqrt{g.Ls}}$$

$$= \frac{6,687}{\sqrt{9,81 \times 71,41}}$$

$$= 0,253$$

$$F_{n_s} = F_{n_m} = 0,253$$

Maka,

$$F_{n_m} = \frac{Vm}{\sqrt{g.Lm}}$$

$$0,253 = \frac{Vm}{\sqrt{9,81 \times 1,79}}$$

$$V_m = 1,057 \text{ m/s}$$

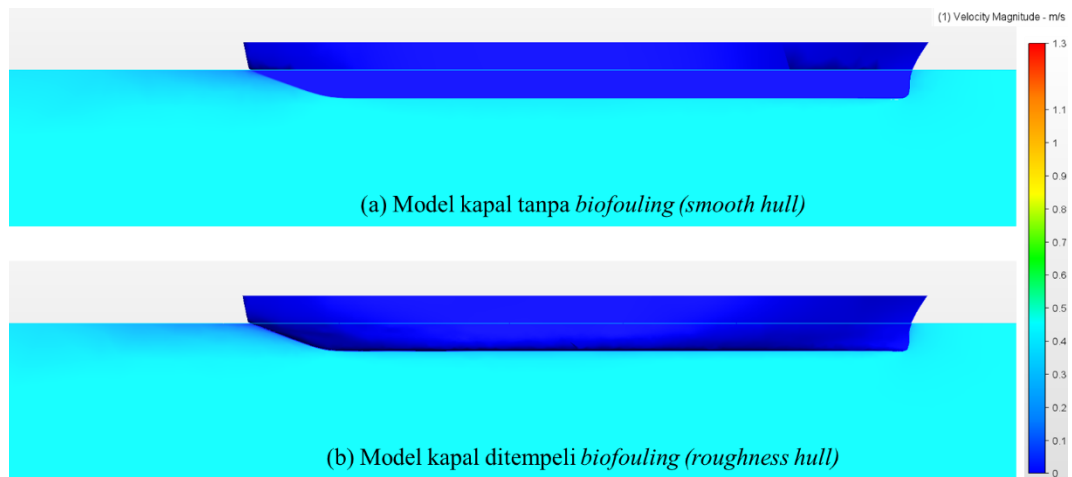
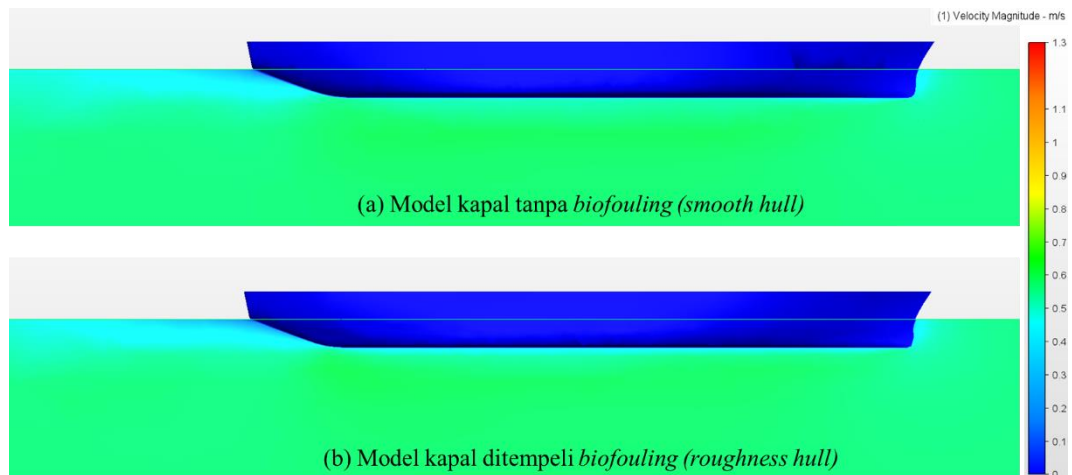
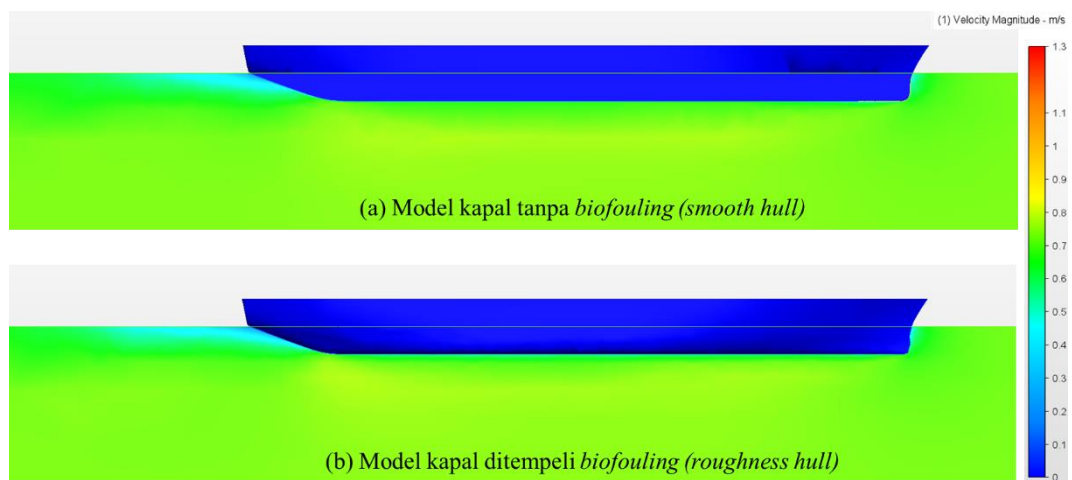
**f. Kecepatan 15 knot**

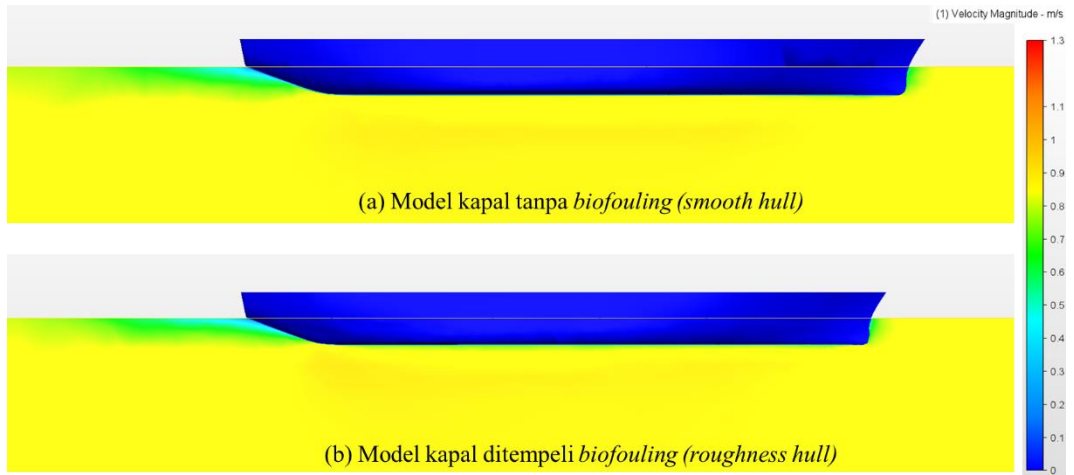
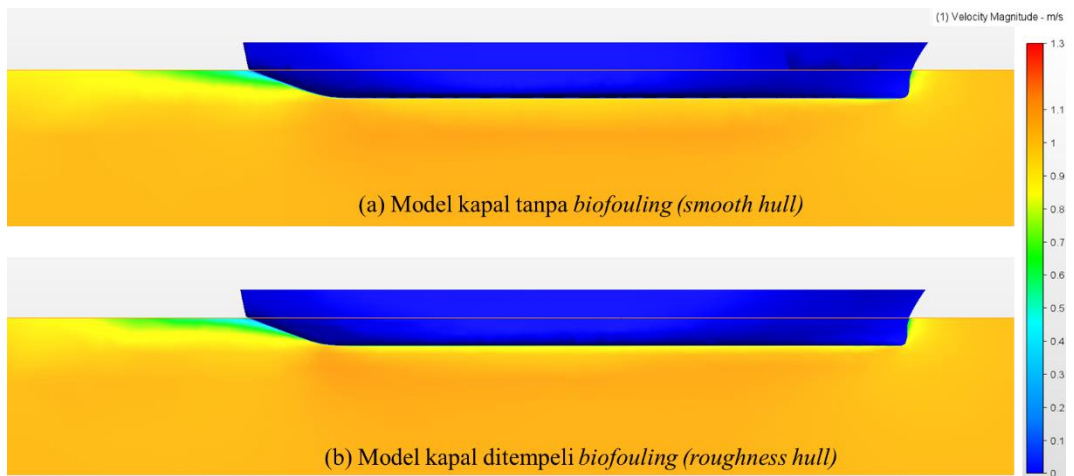
$$\begin{aligned}Fn_s &= \frac{Vs}{\sqrt{g.Ls}} \\ &= \frac{7,716}{\sqrt{9,81 \times 71,41}} \\ &= 0,292\end{aligned}$$

$$Fn_s = Fn_m = 0,292$$

Maka,

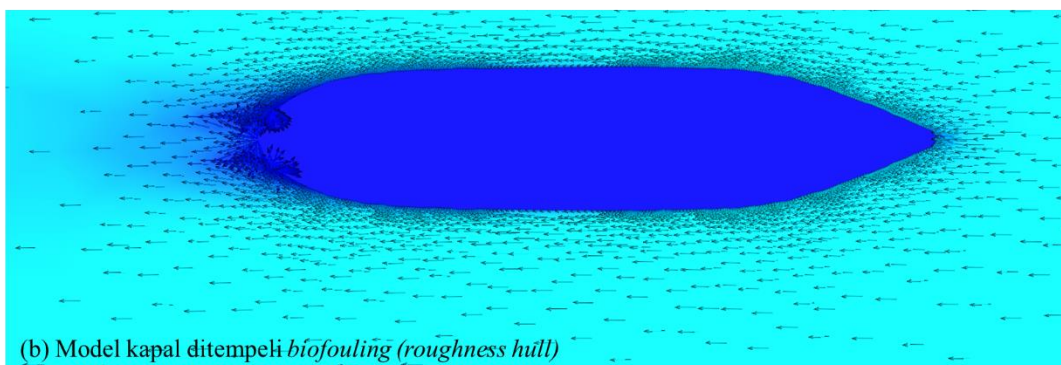
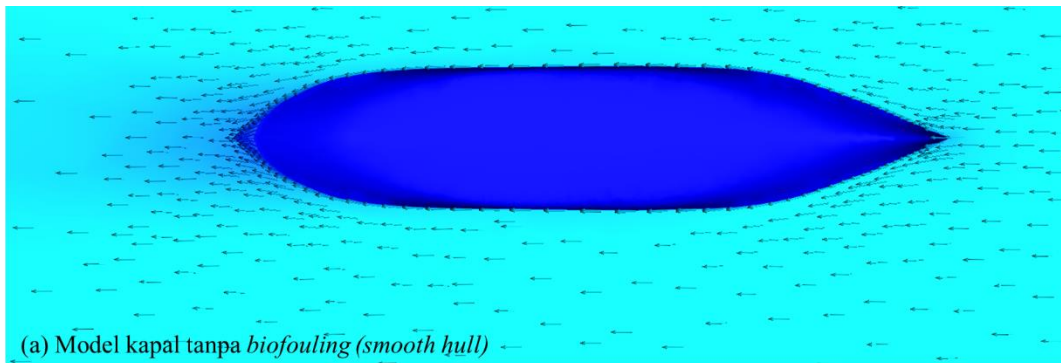
$$\begin{aligned}Fn_m &= \frac{Vm}{\sqrt{g.Lm}} \\ 0,292 &= \frac{Vm}{\sqrt{9,81 \times 1,79}} \\ V_m &= 1,220 \text{ m/s}\end{aligned}$$

**Lampiran 4.** Visualisasi *velocity magnitude* pada setiap kecepatan**a. Kecepatan 0,407 m/s****b. Kecepatan 0,569 m/s****c. Kecepatan 0,732 m/s**

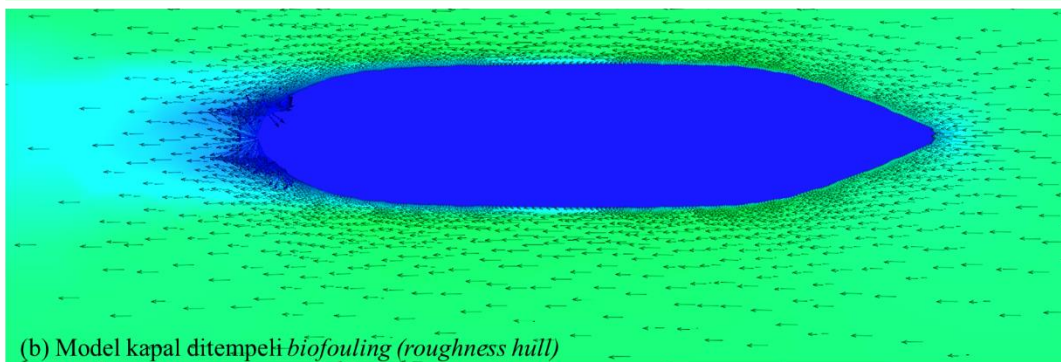
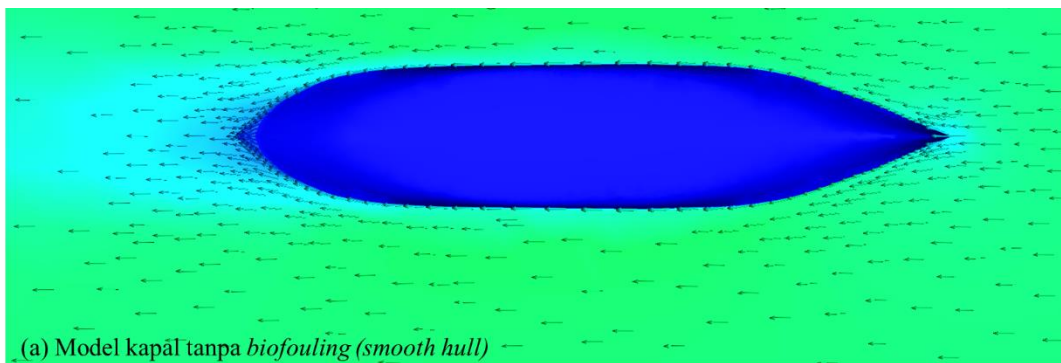
**d. Kecepatan 0,895 m/s****e. Kecepatan 1,057 m/s**

**Lampiran 5.** Visualisasi *velocity vector* pada setiap kecepatan

**a.** Kecepatan 0,407 m/s

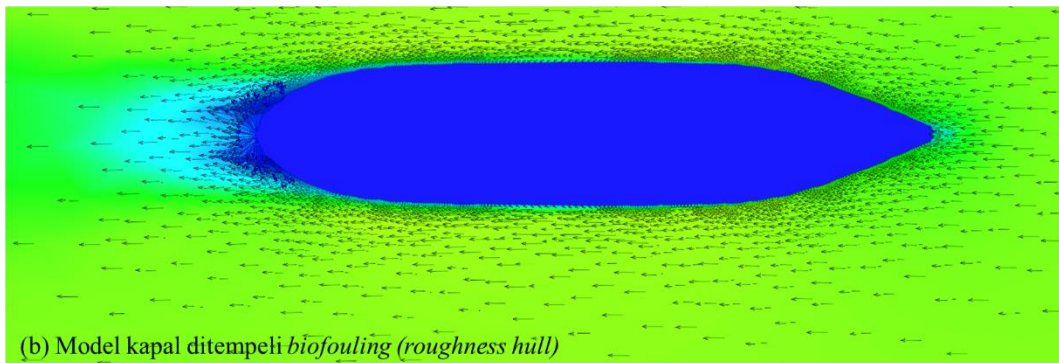
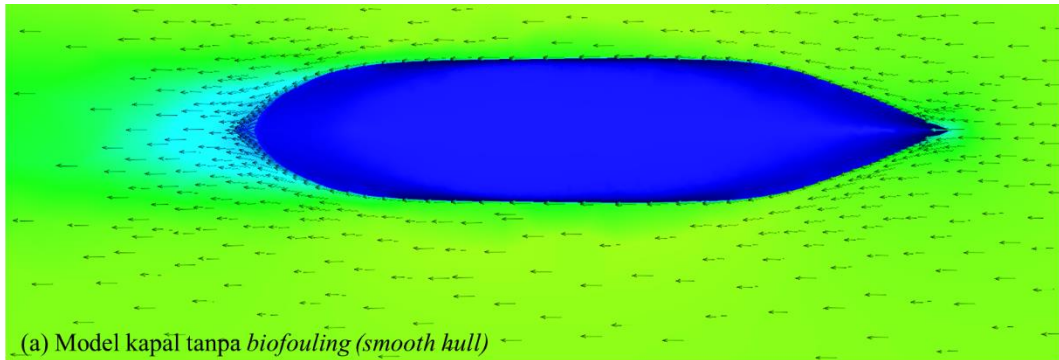


**b.** Kecepatan 0,569 m/s

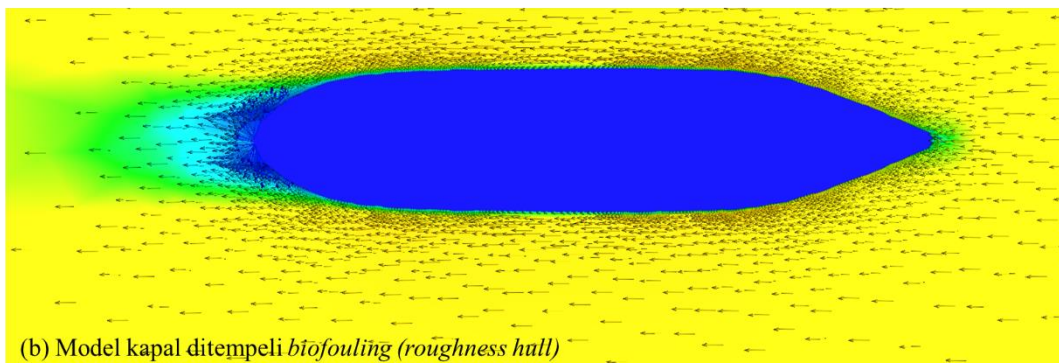
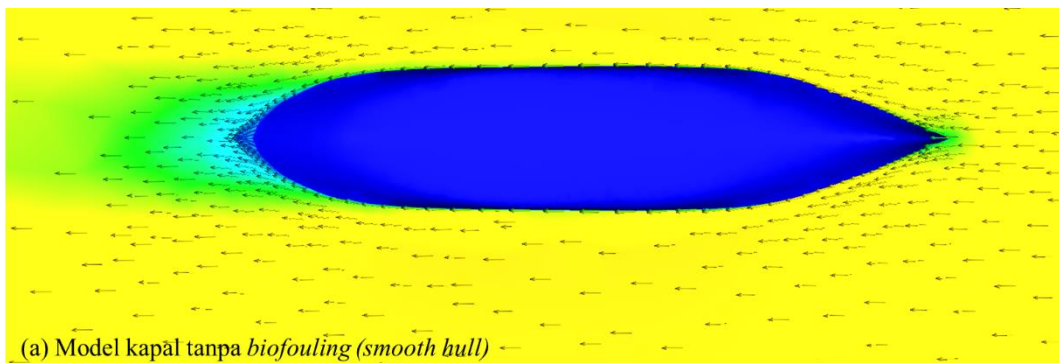




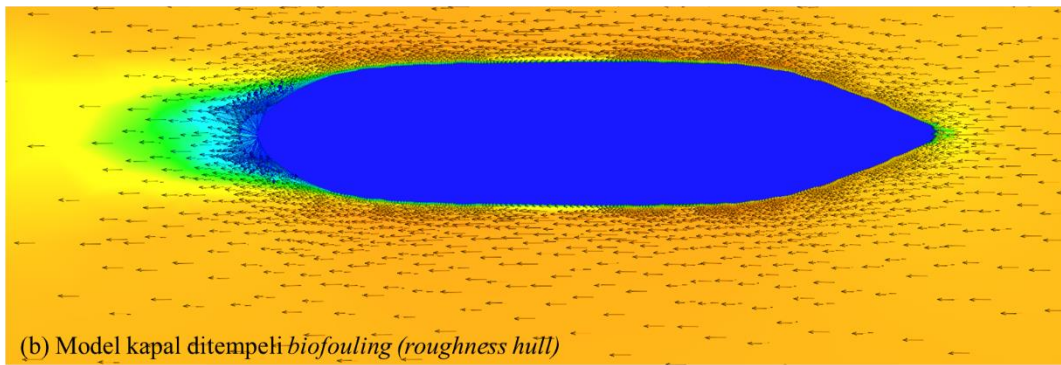
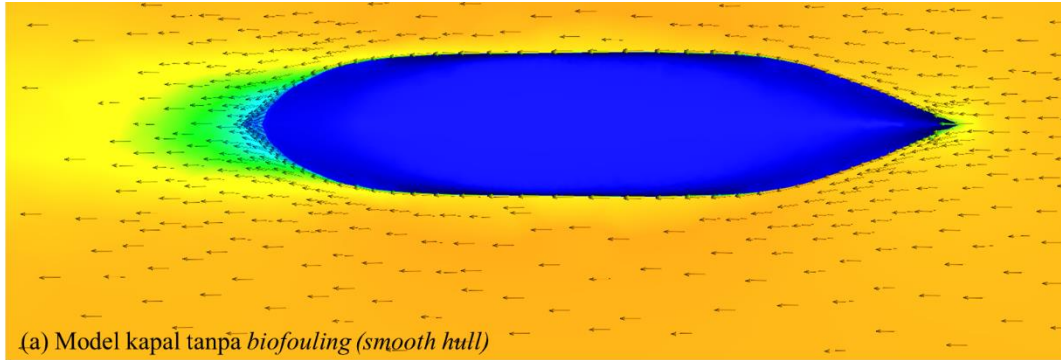
Kecepatan 0,732 m/s



c. Kecepatan 0,895 m/s

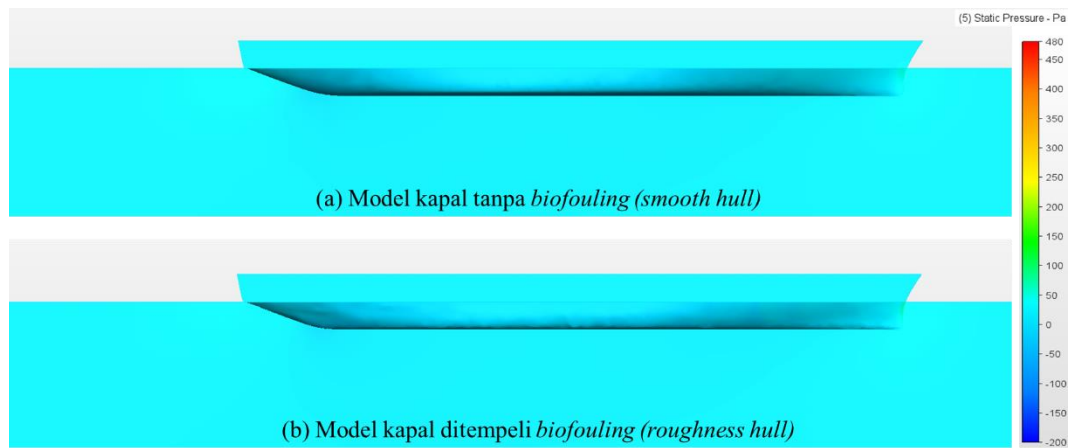


d. Kecepatan 1,057 m/s

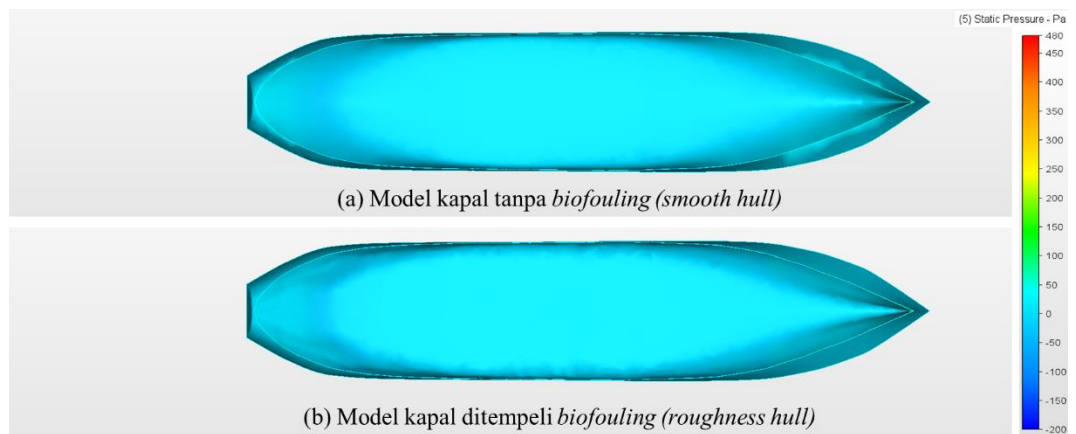


**Lampiran 6.** Visualisasi *static pressure* pada setiap kecepatan

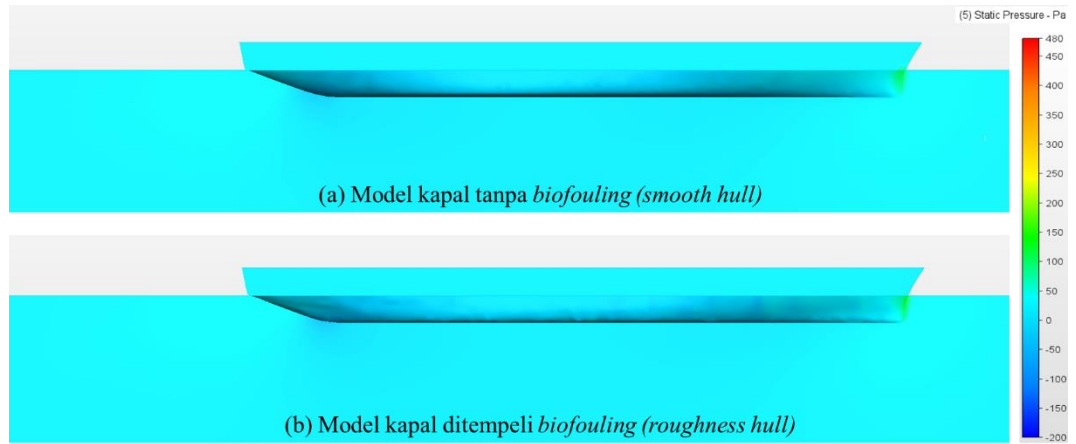
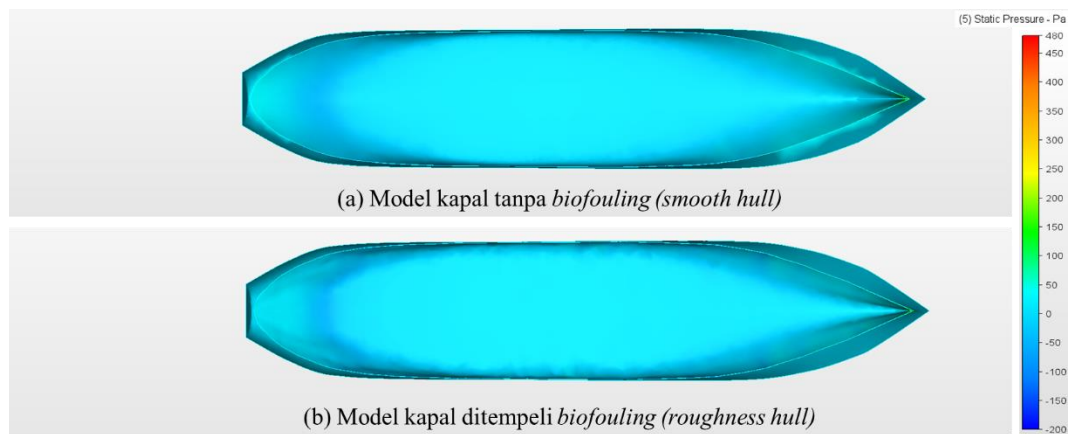
**a.** Kecepatan 0,407 m/s



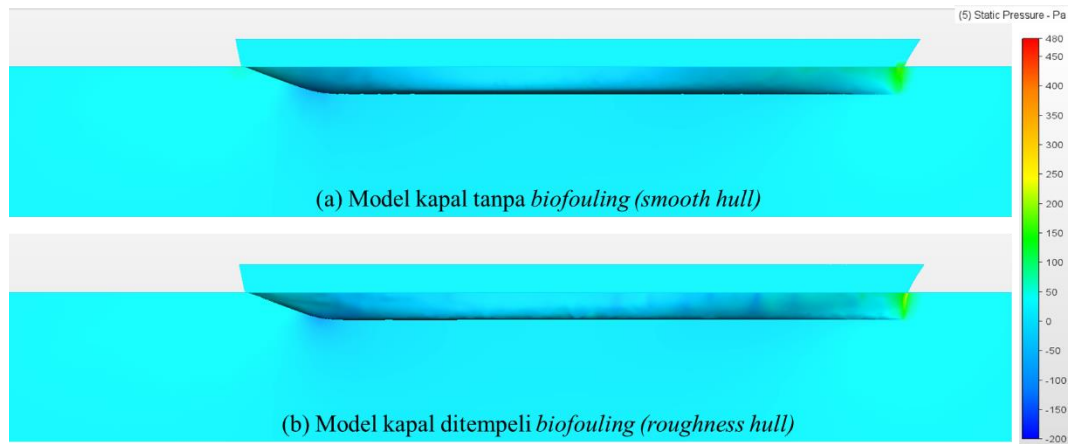
Gambar 1. Visualisasi *static pressure* model kapal pada kecepatan 0,407 m/s tampak samping



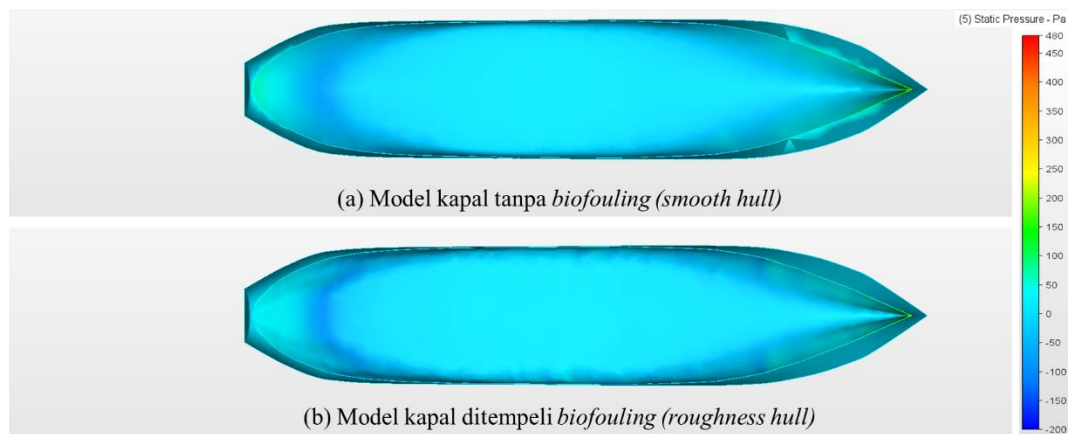
Gambar 2. Visualisasi *static pressure* model kapal pada kecepatan 0,407 m/s tampak bawah

**b. Kecepatan 0,569 m/s**Gambar 1. Visualisasi *static pressure* model kapal pada kecepatan 0,569 m/s tampak sampingGambar 2. Visualisasi *static pressure* model kapal pada kecepatan 0,569 m/s tampak bawah

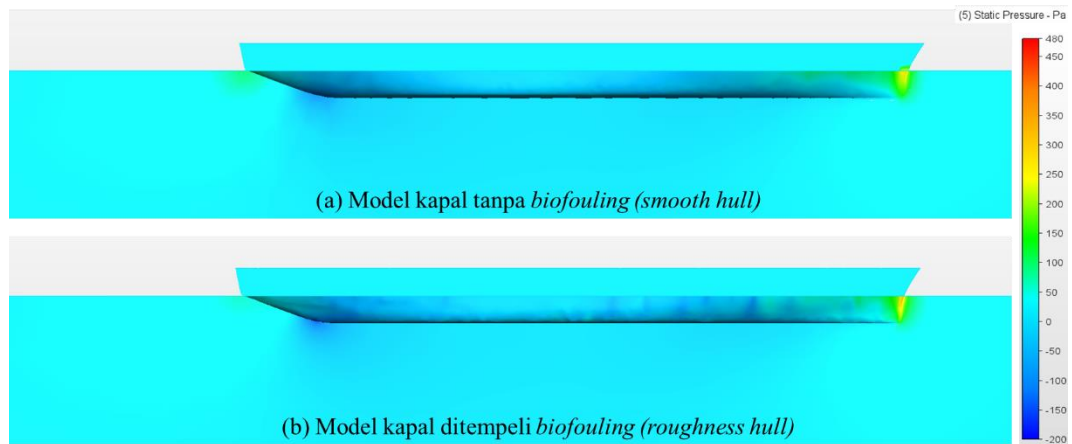
c. Kecepatan 0,732 m/s



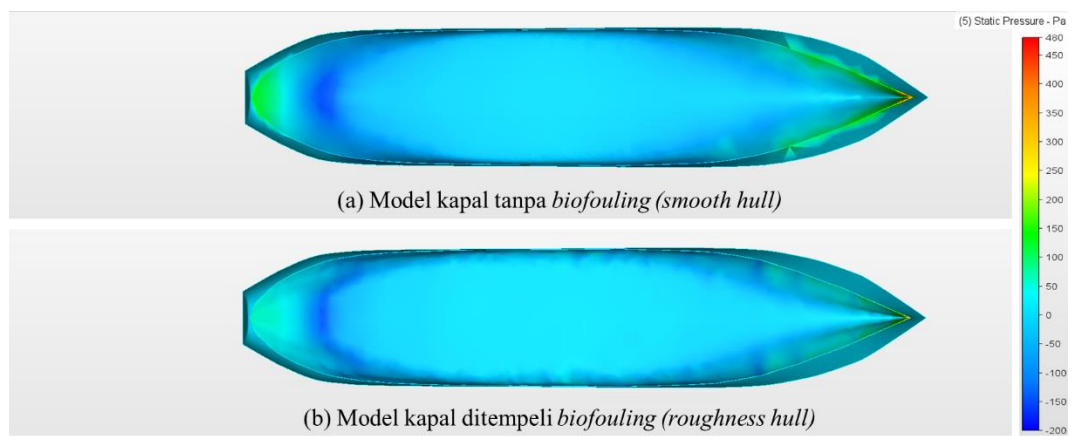
Gambar 1. Visualisasi *static pressure* model kapal pada kecepatan 0,732 m/s tampak samping



Gambar 2. Visualisasi *static pressure* model kapal pada kecepatan 0,732 m/s tampak bawah

**d. Kecepatan 0,895 m/s**

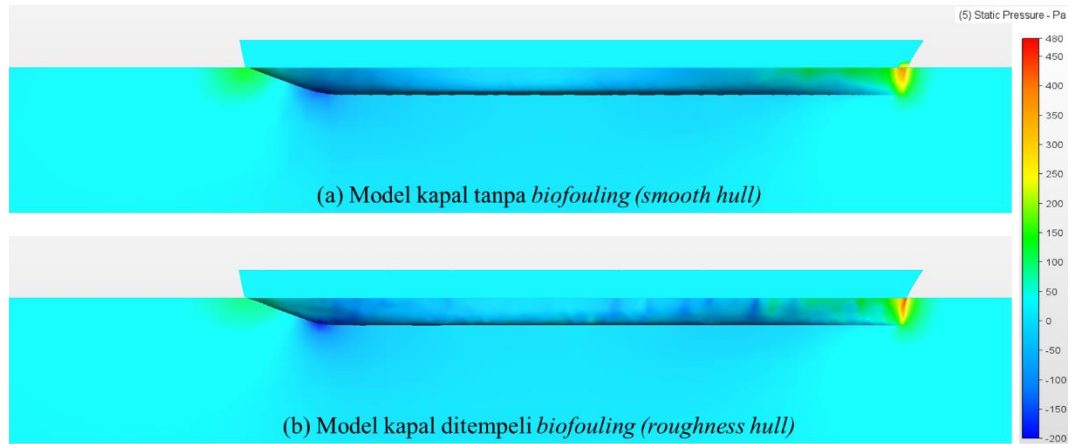
Gambar 1. Visualisasi *static pressure* model kapal pada kecepatan 0,895 m/s tampak samping



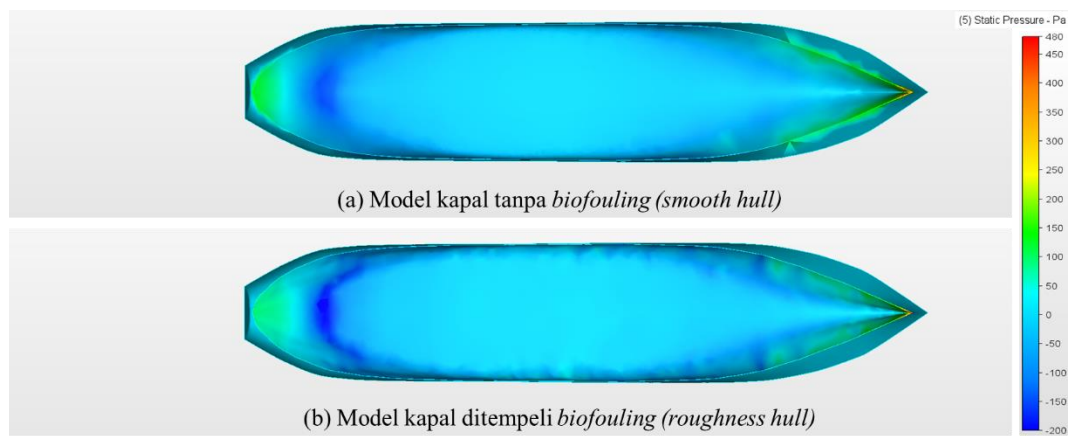
Gambar 2. Visualisasi *static pressure* model kapal pada kecepatan 0,895 m/s tampak bawah



e. Kecepatan 1,057 m/s



Gambar 1. Visualisasi *static pressure* model kapal pada kecepatan 1,057 m/s tampak samping



Gambar 2. Visualisasi *static pressure* model kapal pada kecepatan 1,057 m/s tampak bawah

**Lampiran 7.** Data nilai rata-rata *static pressure* pada setiap *surface*

**1. Data menu wall calculator model kapal tanpa biofouling (smooth hull)**

Tabel 1. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 0,407 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,333	4,153
2	2	0,333	4,167
3	3	0,526	0,174
		1,193	2,831

Tabel 2. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 0,569 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,333	8,179
2	2	0,333	8,185
3	3	0,526	0,349
		1,193	5,571

Tabel 3. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 0,732 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,333	13,594
2	2	0,333	13,694
3	3	0,526	0,592
		1,193	9,293

Tabel 4. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 0,895 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,333	20,426
2	2	0,333	20,695
3	3	0,526	0,925
		1,193	14,015

Tabel 5. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 1,057 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,333	28,606
2	2	0,333	28,937
3	3	0,526	1,310
		1,193	19,617

Tabel 6. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 1,220 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,333	38,137
2	2	0,333	38,612
3	3	0,526	1,751
		1,193	26,167

## 2. Data menu *wall calculator* model kapal ditemplei *biofouling (roughness hull)*

Tabel 7. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 0,407 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,341	4,374
2	2	0,341	4,335
3	3	0,533	0,022
		1,215	2,910

Tabel 8. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 0,569 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,341	8,778
2	2	0,341	8,696
3	3	0,533	0,043
		1,215	5,839

Tabel 9. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 0,732 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,341	14,750
2	2	0,341	14,590
3	3	0,533	0,072
		1,215	9,804

Tabel 10. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 0,895 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,341	22,199
2	2	0,341	21,970
3	3	0,533	0,109
		1,215	14,759

Tabel 11. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 1,057 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,341	31,071
2	2	0,341	30,760
3	3	0,533	0,153
		1,215	20,661

Tabel 12. Nilai rata-rata *static pressure* setiap *surface* pada kecepatan 1,220 m/s

No	Surface	Area	Avg. Static Pressure
		(m <sup>2</sup> )	(Pa)
1	1	0,341	41,531
2	2	0,341	41,151
3	3	0,533	0,204
		1,215	27,629

## Lampiran 8. Hasil perhitungan *wall calculator* tahanan model kapal

### 1. Data menu *wall calculator* model kapal tanpa *biofouling* (*smooth hull*)

#### a) Kecepatan 0,407 m/s

Summary

-----

Total area, 11412.9, cm<sup>2</sup>  
 TOTAL FX, -0.433605, Newton  
 TOTAL FY, 0.00406867, Newton  
 TOTAL FZ, -2.40025, Newton  
 Center of Force about X-Axis (Y-Z), 47322.7, 273.647, cm  
 Center of Force about Y-Axis (X-Z), 42897.1, 276.185, cm  
 Center of Force about Z-Axis (X-Y), 42847.5, 47322.8, cm

#### b) Kecepatan 0,569 m/s

Summary

-----

Total area, 11412.9, cm<sup>2</sup>  
 TOTAL FX, -0.802782, Newton  
 TOTAL FY, 0.00376803, Newton  
 TOTAL FZ, -4.71341, Newton  
 Center of Force about X-Axis (Y-Z), 47322.7, 273.649, cm  
 Center of Force about Y-Axis (X-Z), 42906.4, 280.431, cm  
 Center of Force about Z-Axis (X-Y), 42847.7, 47322.8, cm

#### c) Kecepatan 0,732 m/s

Summary

-----

Total area, 11412.9, cm<sup>2</sup>  
 TOTAL FX, -1.27579, Newton  
 TOTAL FY, 0.0183007, Newton  
 TOTAL FZ, -7.84635, Newton  
 Center of Force about X-Axis (Y-Z), 47322.7, 273.645, cm  
 Center of Force about Y-Axis (X-Z), 42902.1, 276.108, cm  
 Center of Force about Z-Axis (X-Y), 42847.9, 47322.8, cm

#### d) Kecepatan 0,895 m/s

Summary

-----

Total area, 11412.9, cm<sup>2</sup>  
 TOTAL FX, -1.84151, Newton  
 TOTAL FY, 0.0545465, Newton  
 TOTAL FZ, -11.7946, Newton  
 Center of Force about X-Axis (Y-Z), 47322.7, 273.633, cm  
 Center of Force about Y-Axis (X-Z), 42891.9, 275.175, cm  
 Center of Force about Z-Axis (X-Y), 42848.1, 47322.8, cm

## e) Kecepatan 1,057 m/s

Summary

-----

Total area, 11412.9, cm<sup>2</sup>  
 TOTAL FX, -2.50635, Newton  
 TOTAL FY, 0.0707688, Newton  
 TOTAL FZ, -16.485, Newton  
 Center of Force about X-Axis (Y-Z), 47322.7, 273.627, cm  
 Center of Force about Y-Axis (X-Z), 42885.5, 274.563, cm  
 Center of Force about Z-Axis (X-Y), 42848.2, 47322.8, cm

## f) Kecepatan 1,220 m/s

Summary

-----

Total area, 11412.9, cm<sup>2</sup>  
 TOTAL FX, -3.2802, Newton  
 TOTAL FY, 0.100759, Newton  
 TOTAL FZ, -21.9806, Newton  
 Center of Force about X-Axis (Y-Z), 47322.6, 273.631, cm  
 Center of Force about Y-Axis (X-Z), 42888.3, 274.302, cm  
 Center of Force about Z-Axis (X-Y), 42848.3, 47322.8, cm

**2. Data menu *wall calculator* model kapal ditempel *biofouling* (*roughness hull*)**

## g) Kecepatan 0,407 m/s

Summary

-----

Total area, 12151.9, cm<sup>2</sup>  
 TOTAL FX, -0.542797, Newton  
 TOTAL FY, -0.00545225, Newton  
 TOTAL FZ, -2.62084, Newton  
 Center of Force about X-Axis (Y-Z), 47310.6, 273.059, cm  
 Center of Force about Y-Axis (X-Z), 44007, 273.976, cm  
 Center of Force about Z-Axis (X-Y), 43991.4, 47310.6, cm

## h) Kecepatan 0,569 m/s

Summary

-----

Total area, 12151.9, cm<sup>2</sup>  
 TOTAL FX, -0.934639, Newton  
 TOTAL FY, -0.0129384, Newton  
 TOTAL FZ, -5.23378, Newton  
 Center of Force about X-Axis (Y-Z), 47310.6, 273.034, cm  
 Center of Force about Y-Axis (X-Z), 43979.3, 274.441, cm  
 Center of Force about Z-Axis (X-Y), 43991.5, 47310.6, cm



## i) Kecepatan 0,732 m/s

## Summary

-----

Total area, 12151.9, cm<sup>2</sup>  
 TOTAL FX, -1.44044, Newton  
 TOTAL FY, -0.0258716, Newton  
 TOTAL FZ, -8.76454, Newton  
 Center of Force about X-Axis (Y-Z), 47310.6, 273.022, cm  
 Center of Force about Y-Axis (X-Z), 43999.7, 274.232, cm  
 Center of Force about Z-Axis (X-Y), 43991.6, 47310.6, cm

## j) Kecepatan 0,895 m/s

## Summary

-----

Total area, 12151.9, cm<sup>2</sup>  
 TOTAL FX, -2.08773, Newton  
 TOTAL FY, -0.0372079, Newton  
 TOTAL FZ, -13.1754, Newton  
 Center of Force about X-Axis (Y-Z), 47310.6, 272.996, cm  
 Center of Force about Y-Axis (X-Z), 44001.5, 274.308, cm  
 Center of Force about Z-Axis (X-Y), 43991.6, 47310.6, cm

## k) Kecepatan 1,057 m/s

## Summary

-----

Total area, 12151.9, cm<sup>2</sup>  
 TOTAL FX, -2.85206, Newton  
 TOTAL FY, -0.0526734, Newton  
 TOTAL FZ, -18.4317, Newton  
 Center of Force about X-Axis (Y-Z), 47310.6, 272.985, cm  
 Center of Force about Y-Axis (X-Z), 44007.7, 274.149, cm  
 Center of Force about Z-Axis (X-Y), 43991.6, 47310.6, cm

## l) Kecepatan 1,220 m/s

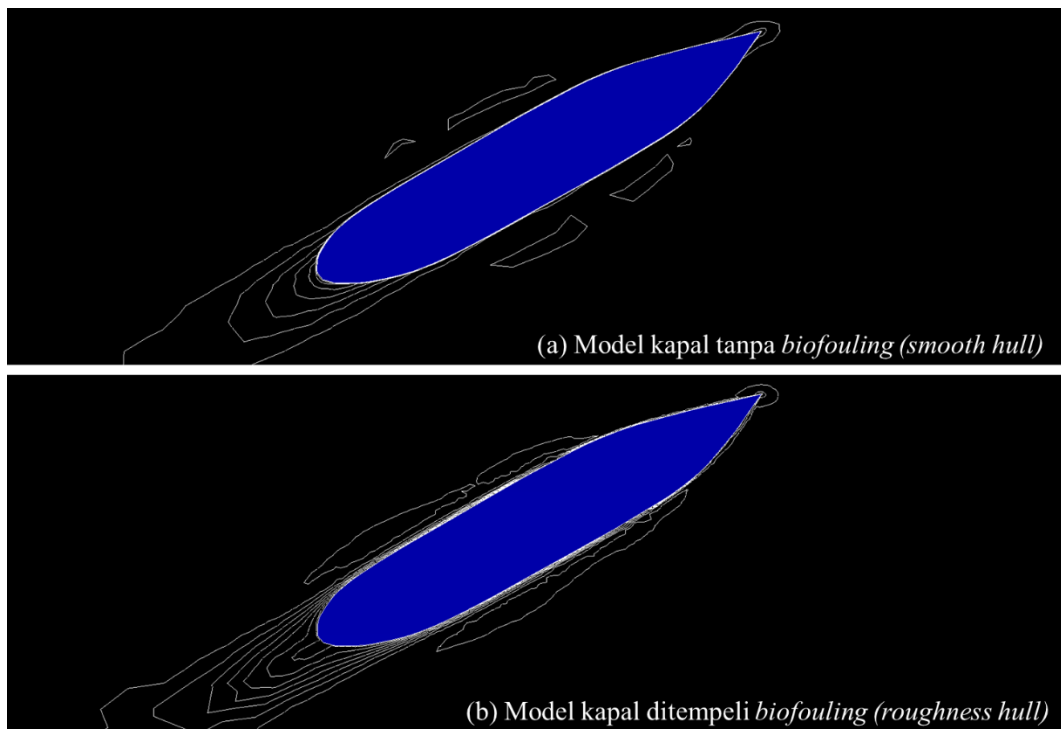
## Summary

-----

Total area, 12151.9, cm<sup>2</sup>  
 TOTAL FX, -3.7394, Newton  
 TOTAL FY, -0.0612394, Newton  
 TOTAL FZ, -24.6287, Newton  
 Center of Force about X-Axis (Y-Z), 47310.6, 272.976, cm  
 Center of Force about Y-Axis (X-Z), 43998.7, 274.455, cm  
 Center of Force about Z-Axis (X-Y), 43991.6, 47310.6, cm

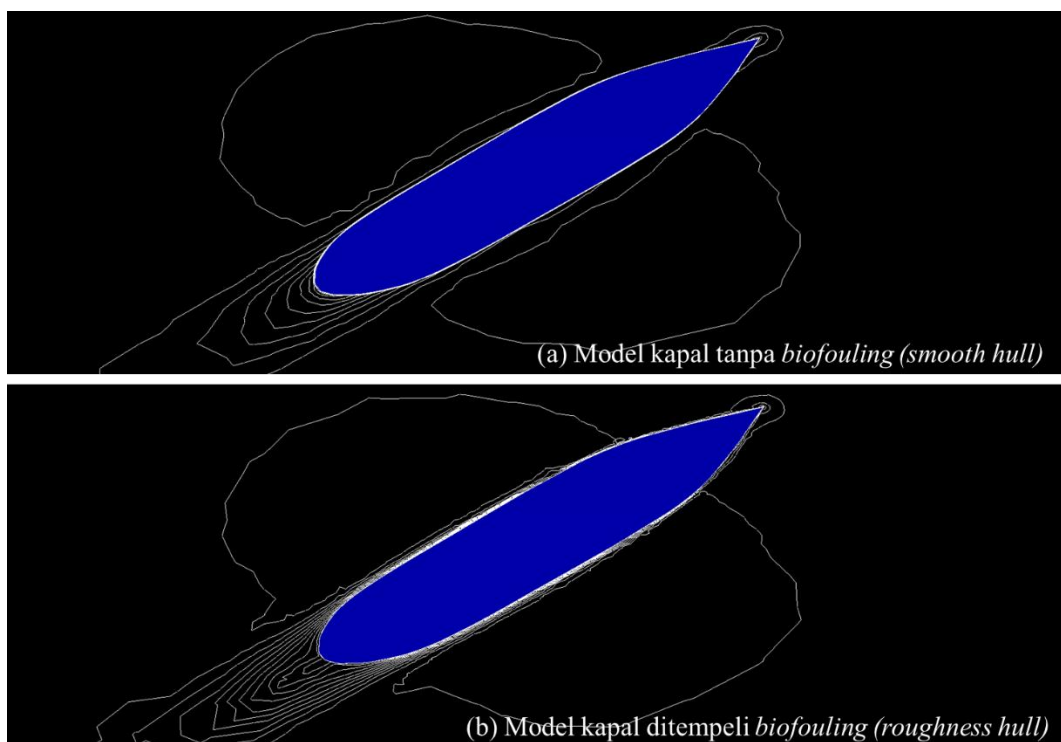
**Lampiran 9.** Visualisasi pola aliran fluida pada setiap kecepatan

**a. Kecepatan 0,407 m/s**



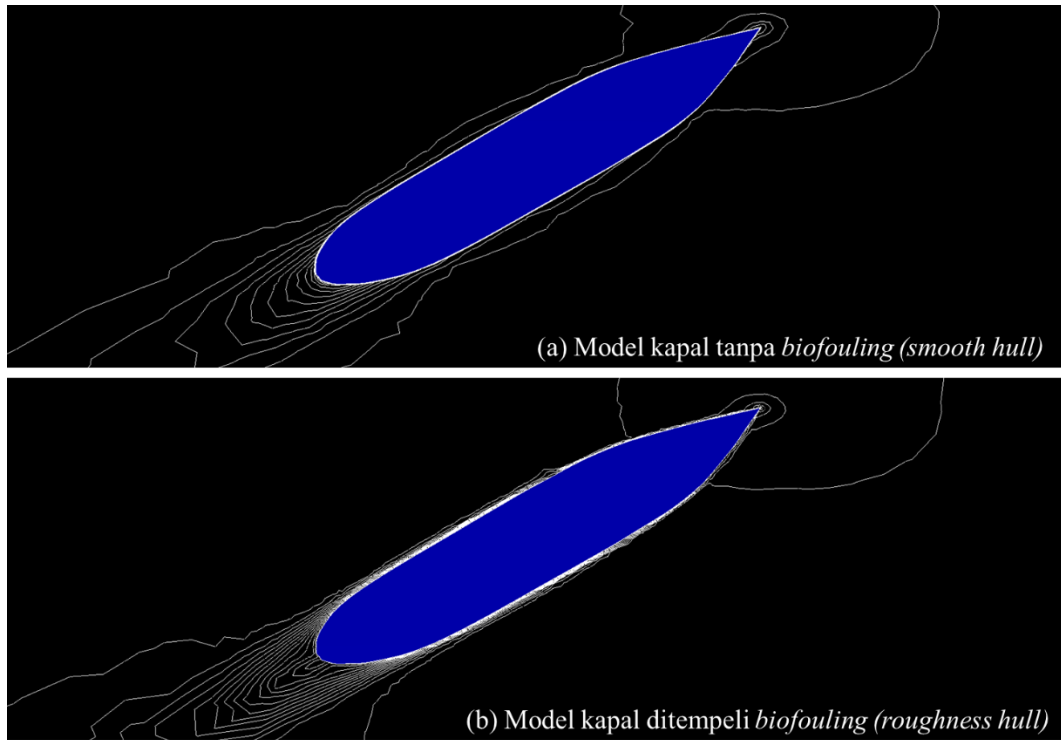
Gambar 1. Visualisasi pola aliran fluida model kapal pada kecepatan 0,407 m/s

**b. Kecepatan 0,569 m/s**



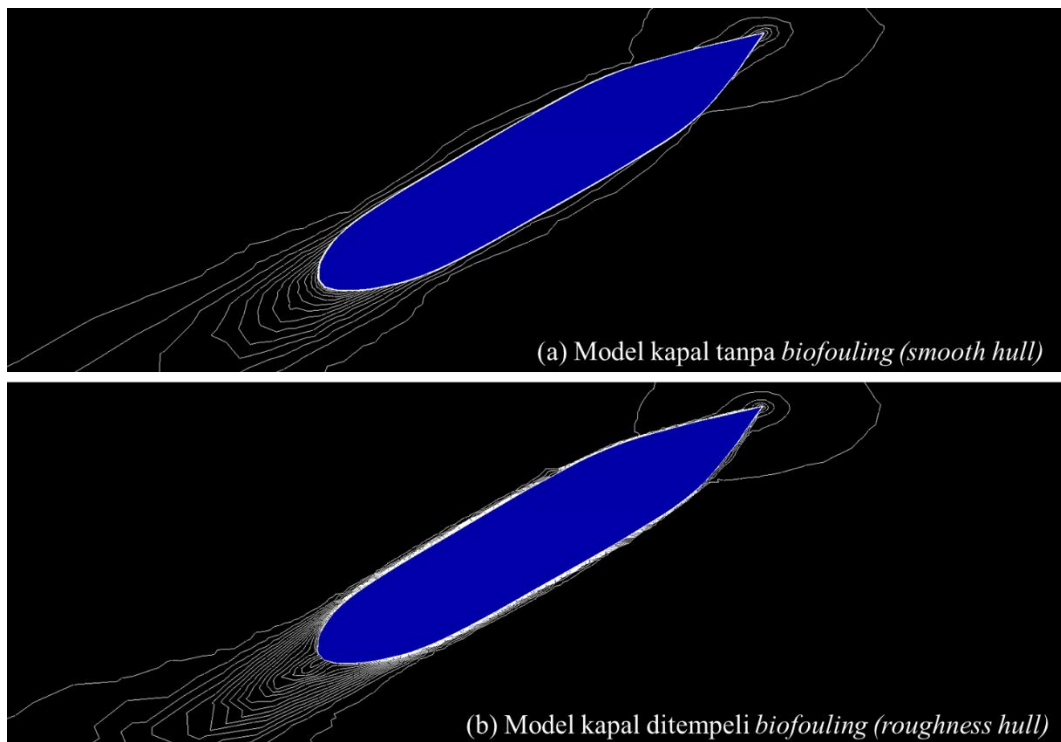
Gambar 1. Visualisasi pola aliran fluida model kapal pada kecepatan 0,569 m/s

**c. Kecepatan 0,732 m/s**



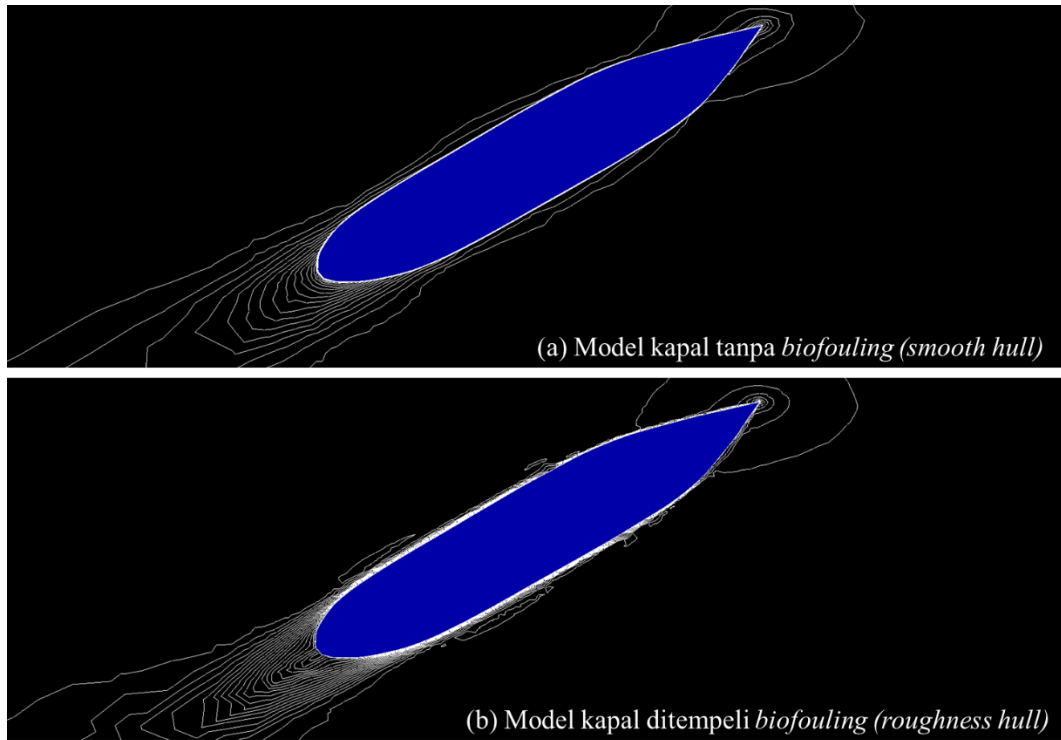
Gambar 1. Visualisasi pola aliran fluida model kapal pada kecepatan 0,732 m/s

**d. Kecepatan 0,895 m/s**



Gambar 1. Visualisasi pola aliran fluida model kapal pada kecepatan 0,895 m/s

e. Kecepatan 1,057 m/s



Gambar 1. Visualisasi pola aliran fluida model kapal pada kecepatan 1,057 m/s