TECHNICAL REPORT ON SIMULATION RESULTS

1. Introduction

The purpose of this report is to analyze, evaluate and compare the flow simulation results between the OEM water pump and the NO BRAND water pump kit, for three different operating scenarios. **3000 rpm**, **6000 rpm**, and **9000 rpm**.
The study focuses on comparing key parameters such as inlet and outlet velocities, volume flow rates, and operating pressures.

2. Results Analysis for the OEM water pump by Operating Scenario

2.1. 3000 rpm Operating Scenario

In the 3000 rpm scenario, the key flow characteristics are as follows:

- **Inlet Velocity:** The inlet velocity averaged **1.73 m/s**
- **Outlet Velocity Av:** The average outflow velocity was recorded at **3.72 m/s**
- **Volume Flow Rate:** The inlet and outlet flow rates balance at approximately **63.58 l/min** and **63.60 l/min** respectively, demonstrating mass convergence validity.
- **Pressures:** The inlet total pressure was maintained at **102367 Pa (1.02 bar)**, while the outlet pressure reached **109498 Pa (1.09 bar)**.

2.2. 6000 rpm Operating Scenario

By doubling the rotational speed to 6000 rpm, the following changes are observed:

- **Inlet Velocity:** Increased noticeably to **3.35 m/s** scaling proportionally relative to the 3000 rpm case.
- **Outlet Velocity:** The average outflow velocity rose to **7.62 m/s**
- **Volume Flow Rate:** The flow rate doubled, approximating **123.26 l/min** at the inlet and **124.06l/min** at the outlet.
- **Pressures:**The outlet pressure increased significantly to **132872Pa (1.31 bar)**

2.3. 9000 rpm Operating Scenario

In the highest evaluated scenario at 9000 rpm:

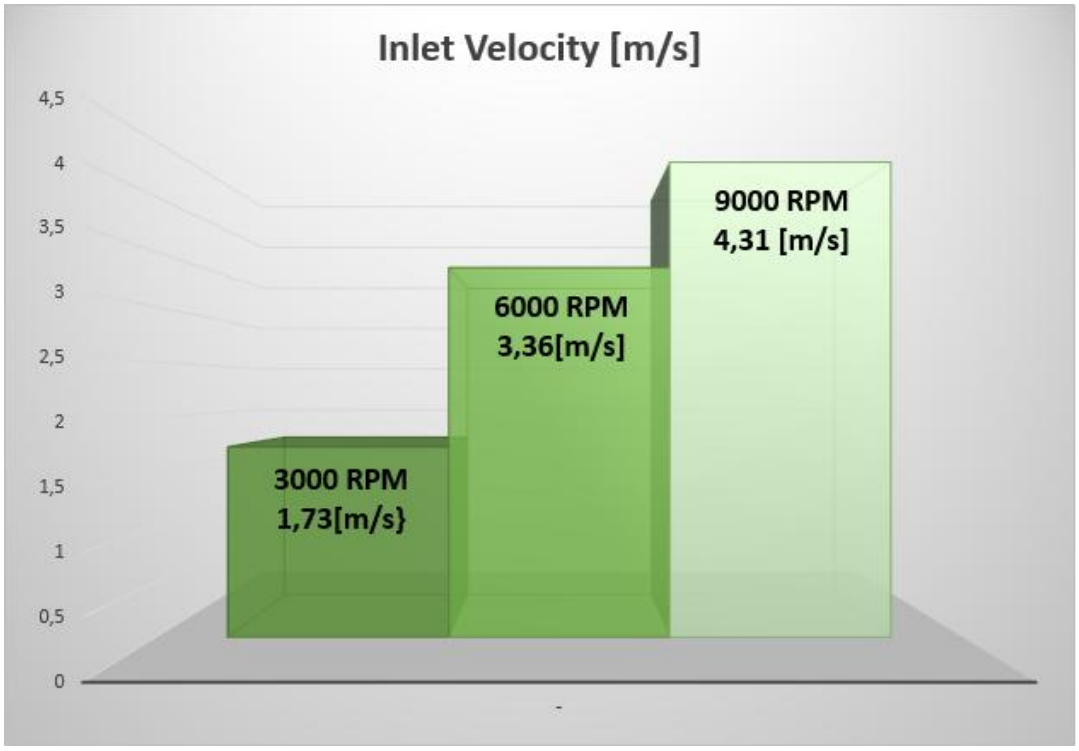
- **Inlet Velocity:** Reached **4.33 m/s**
- **Outlet Velocity:** The average outflow velocity was at **8.17 m/s**
- **Volume Flow Rate:** The flow increased to **159.00 l/min** (inlet) and **159.45 l/min** (outlet).
- **Pressures:** The outlet pressure settled at **139069 Pa (1.39 bar)**

3. Comparative Summary for the OEM pump and Conclusions

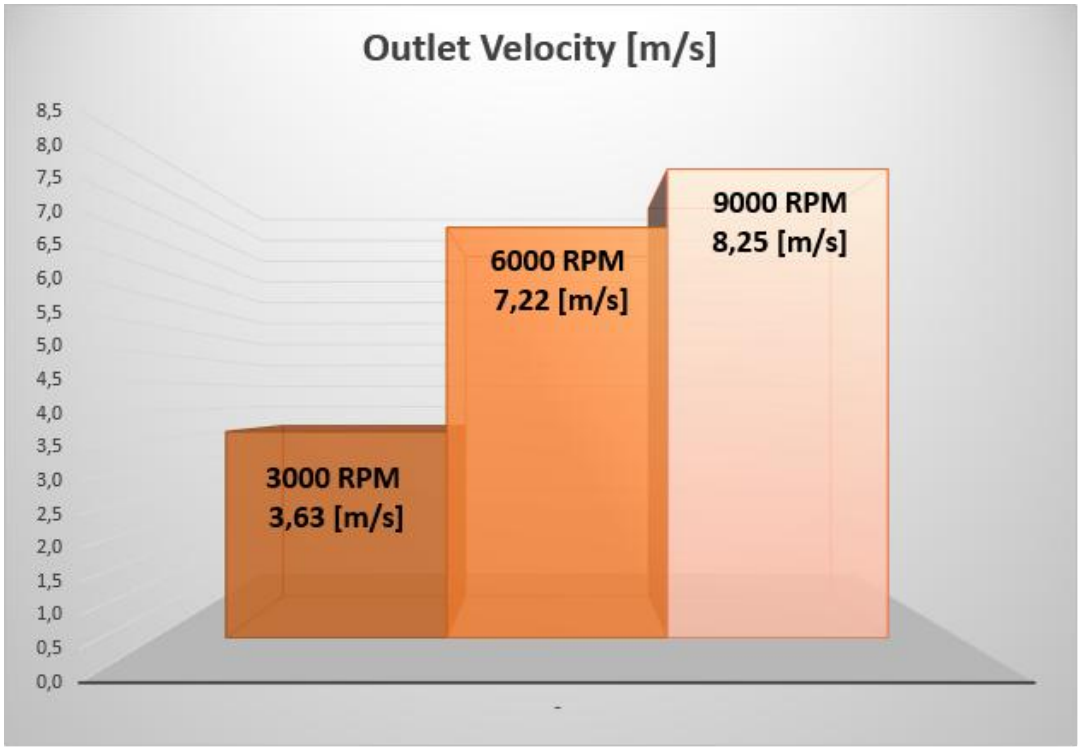
Scenario [rpm]	Inlet Velocity [m/s]	Outlet Velocity [m/s]	Outlet Pressure [Pa]	Inlet Volume Flow Rate [l/min]	Outlet Volume Flow Rate [l/min]
3000	1.73	3.72	109498 (1.09 bar)	63.58	63.60
6000	3.35	7.62	132872 (1.35 bar)	123.26	124.06
9000	4.33	8.17	139069 (1.39bar)	159.00	159.45

4. OEM Charts

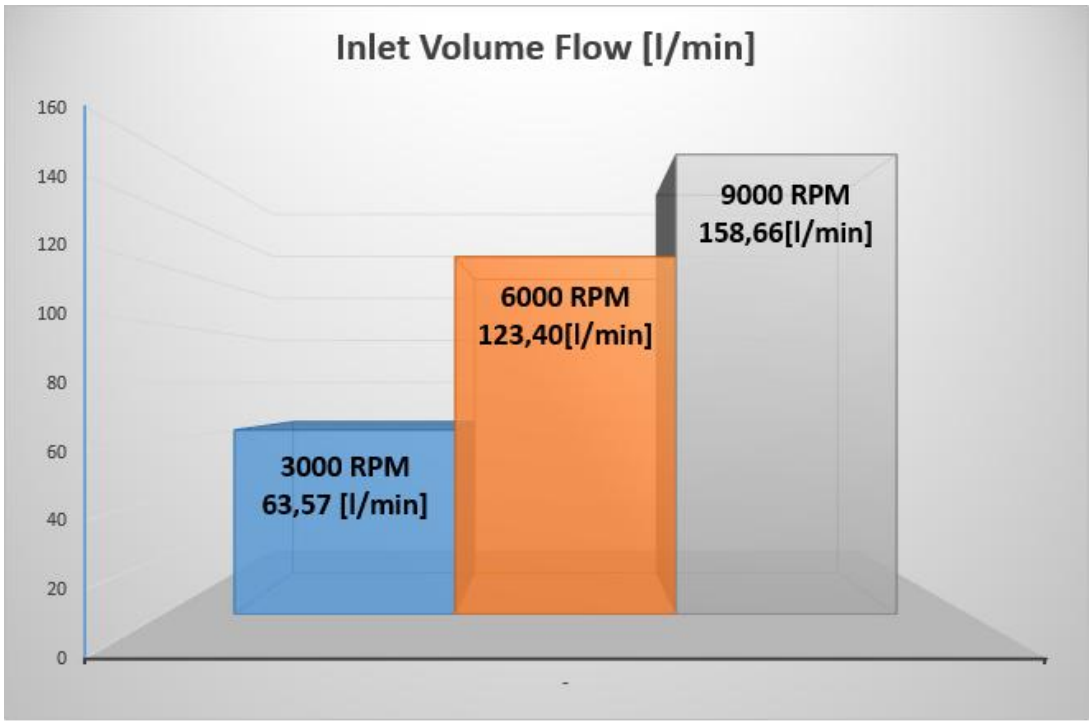
4.1. Inlet velocity chart



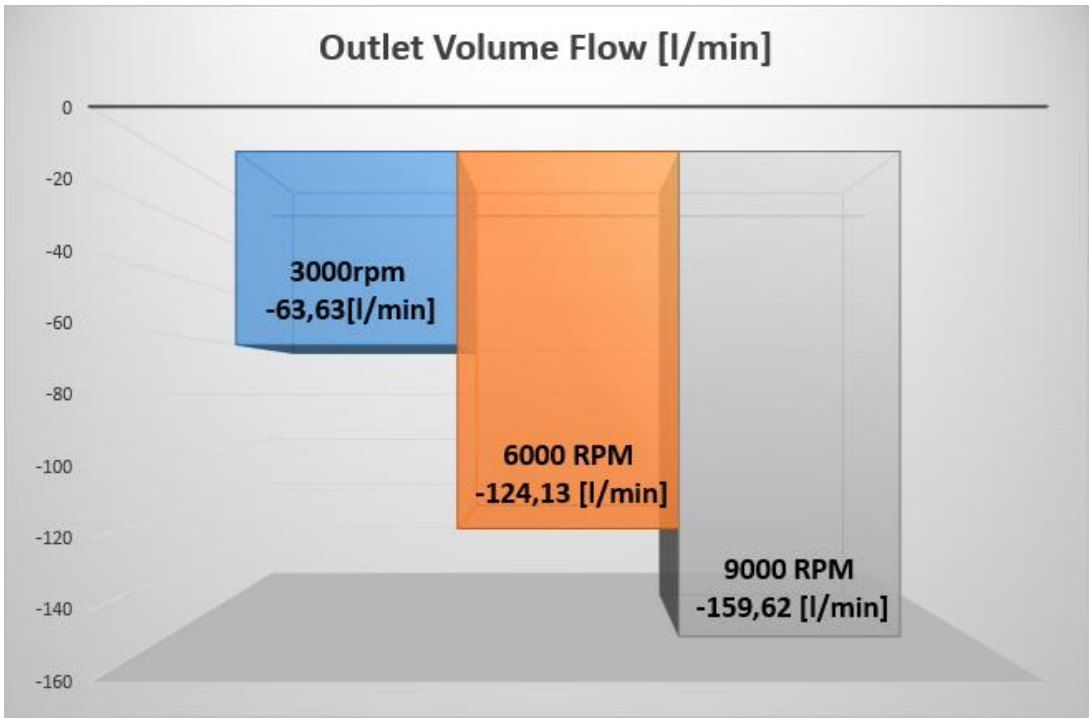
4.2. Outlet velocity chart



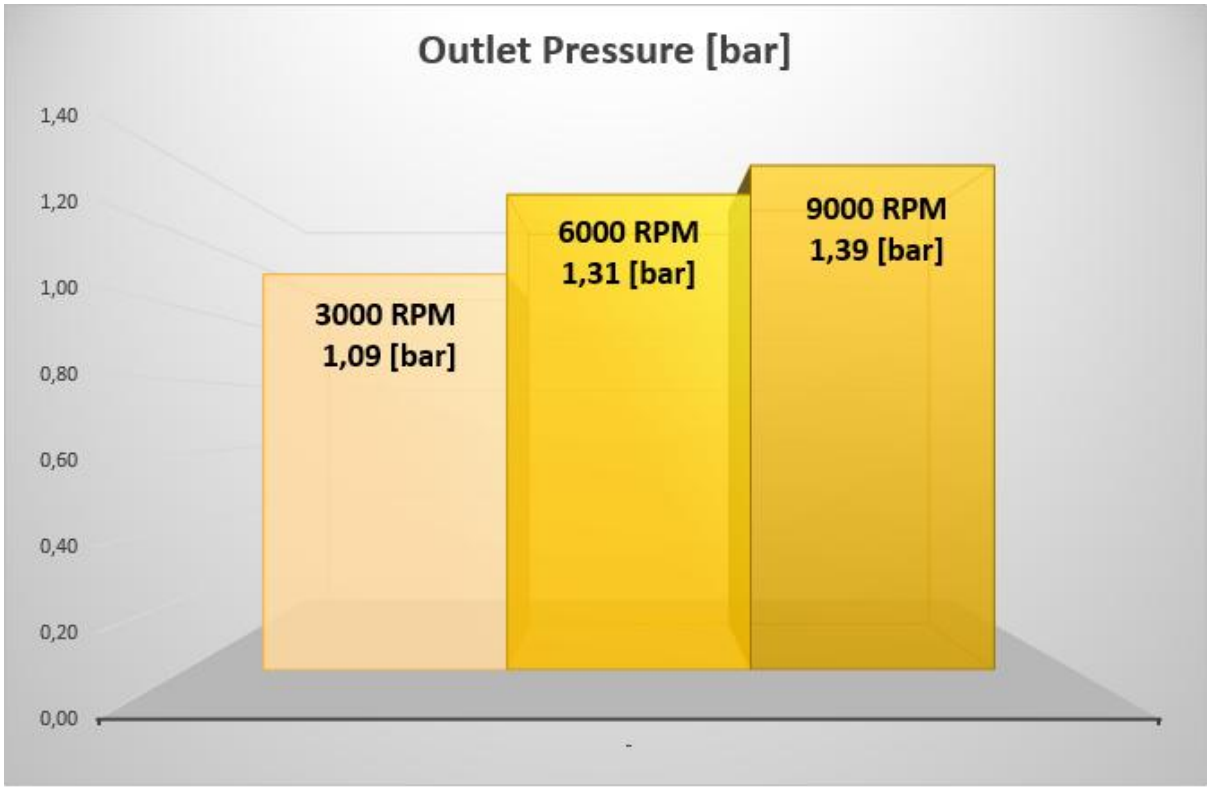
4.3. Inlet Volume Flow chart



4.4. Outlet Volume Flow chart

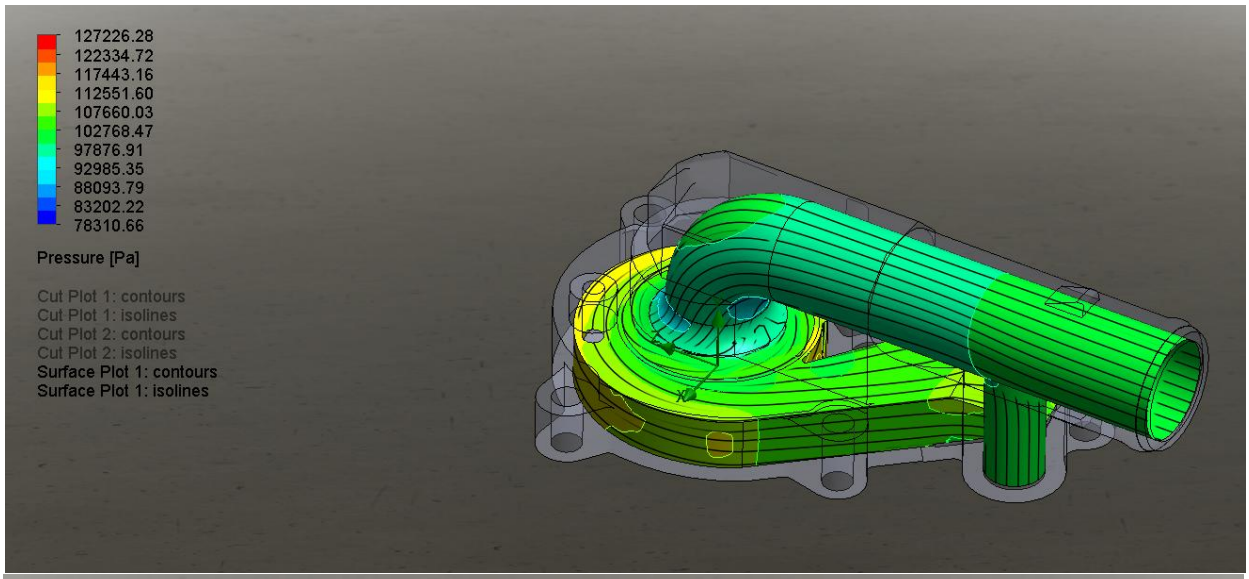


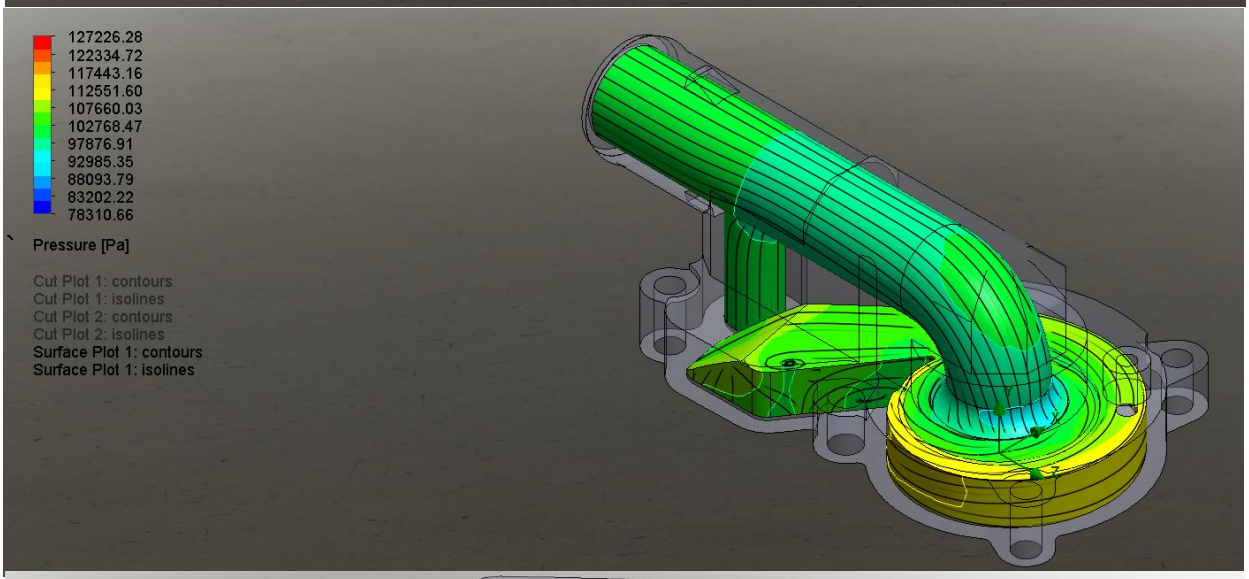
4.5. Outlet Pressure chart

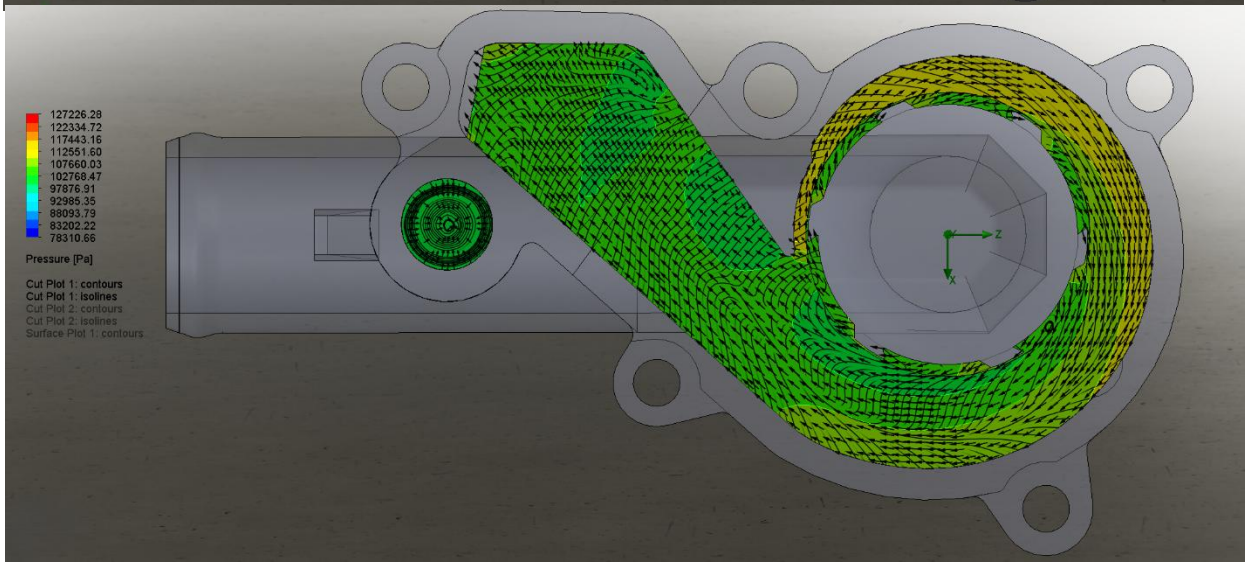


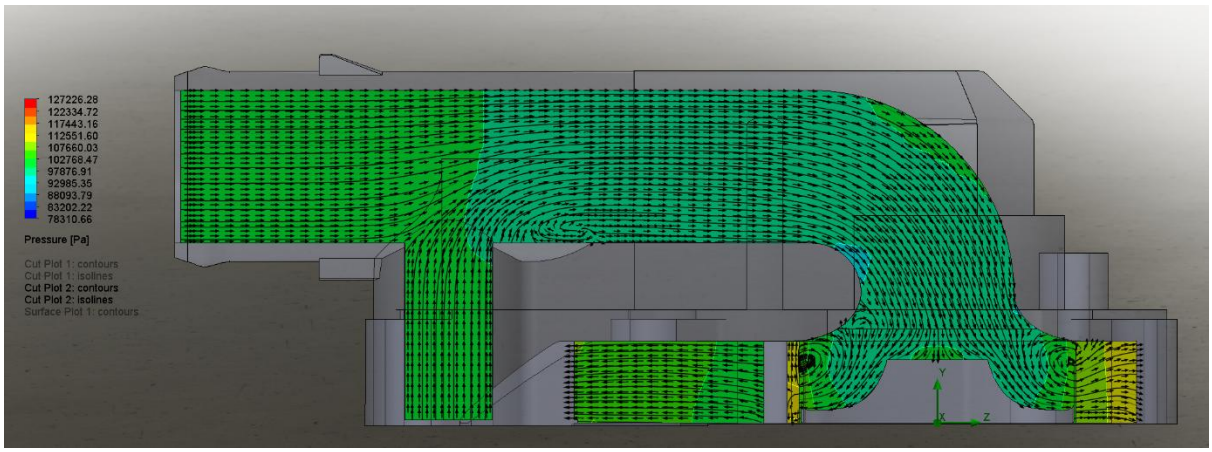
5. OEM Plots

5.1. Pressure plots 3000 RPM

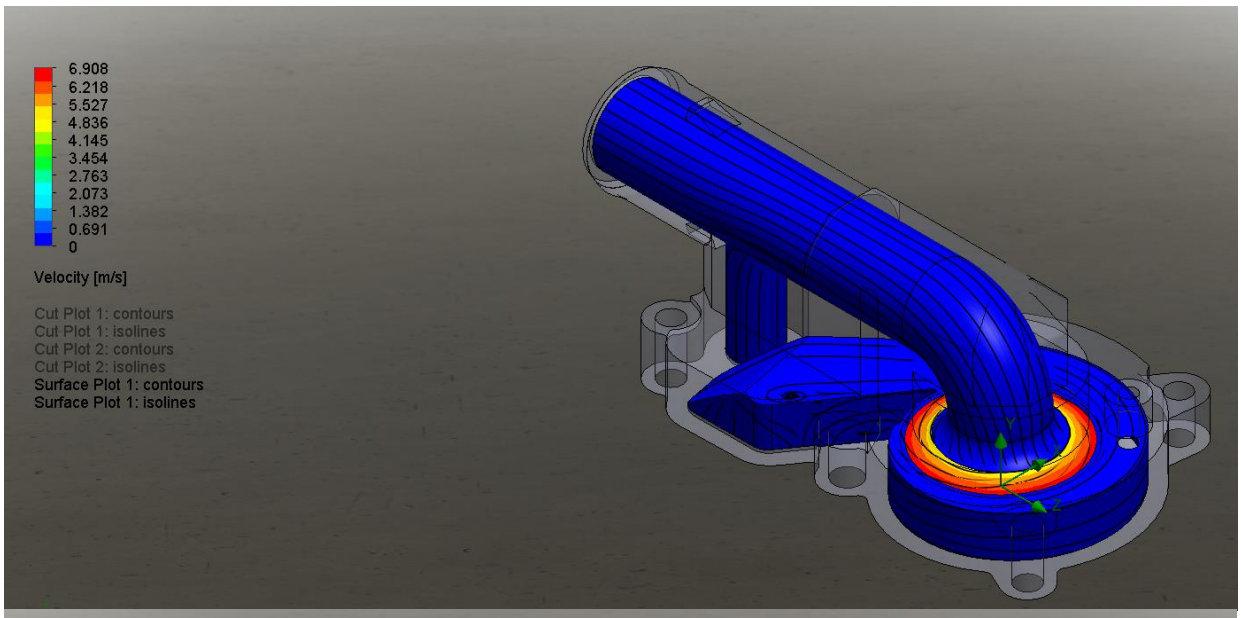


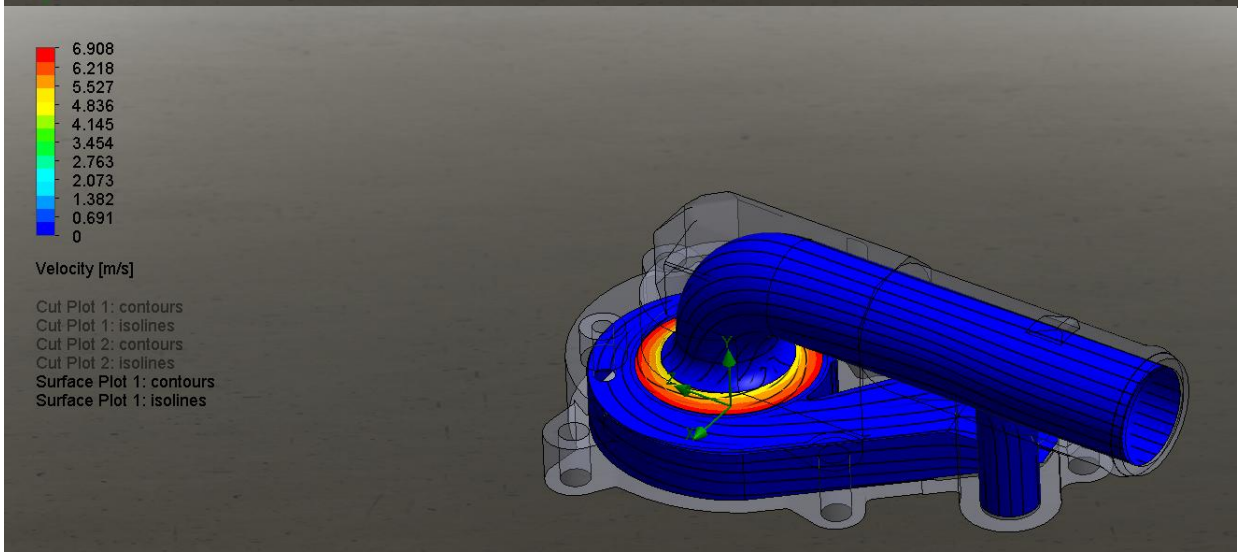




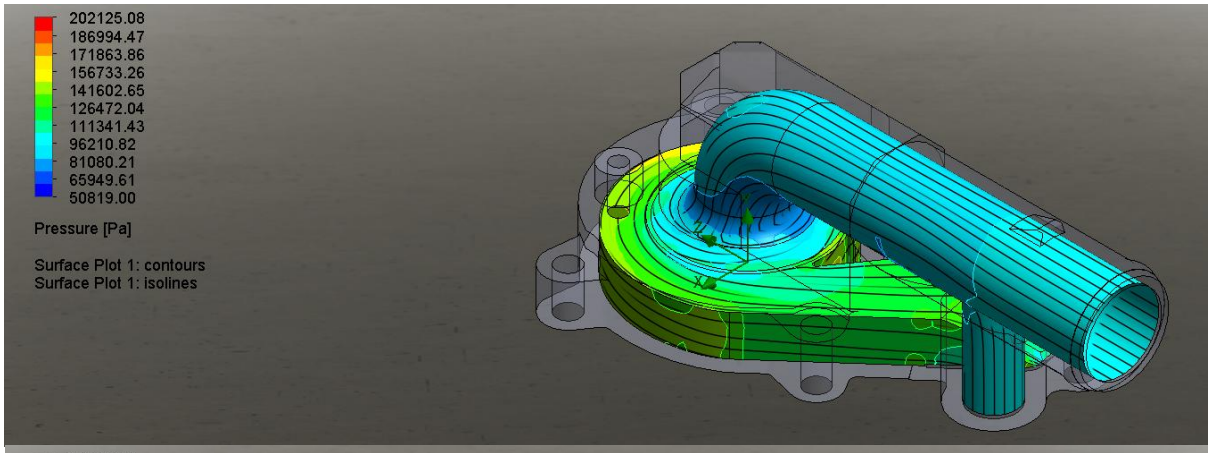


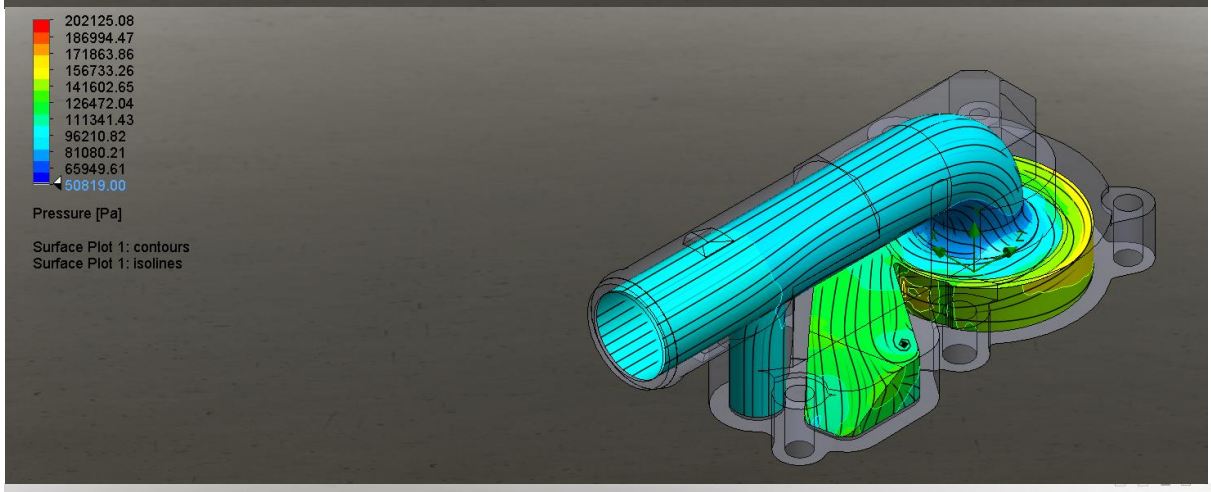
5.2. Velocity plots 3000 RPM

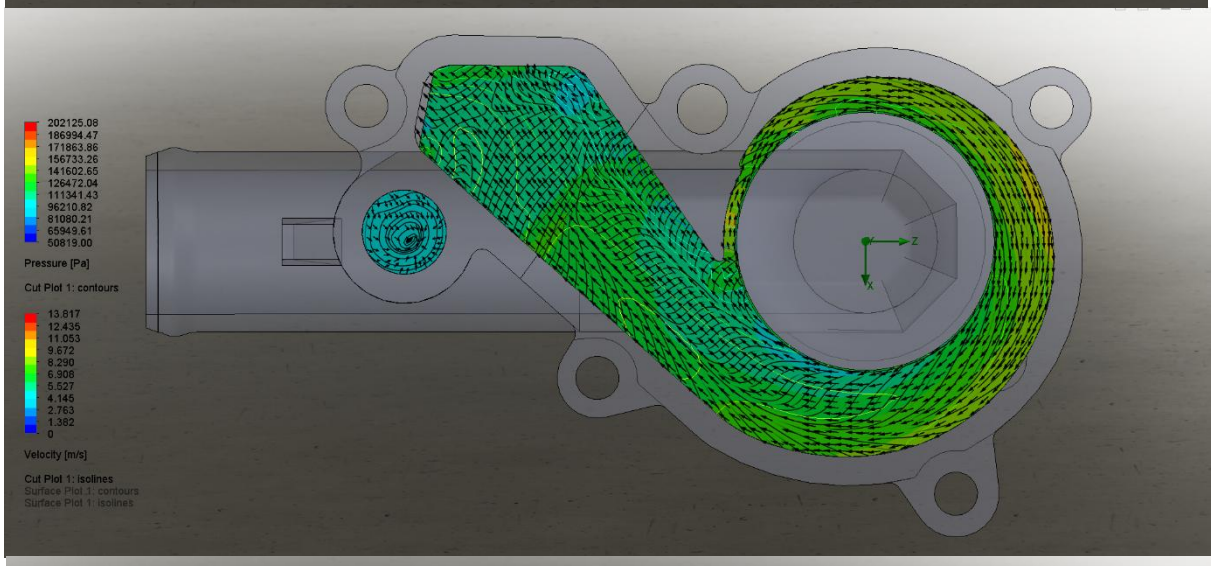


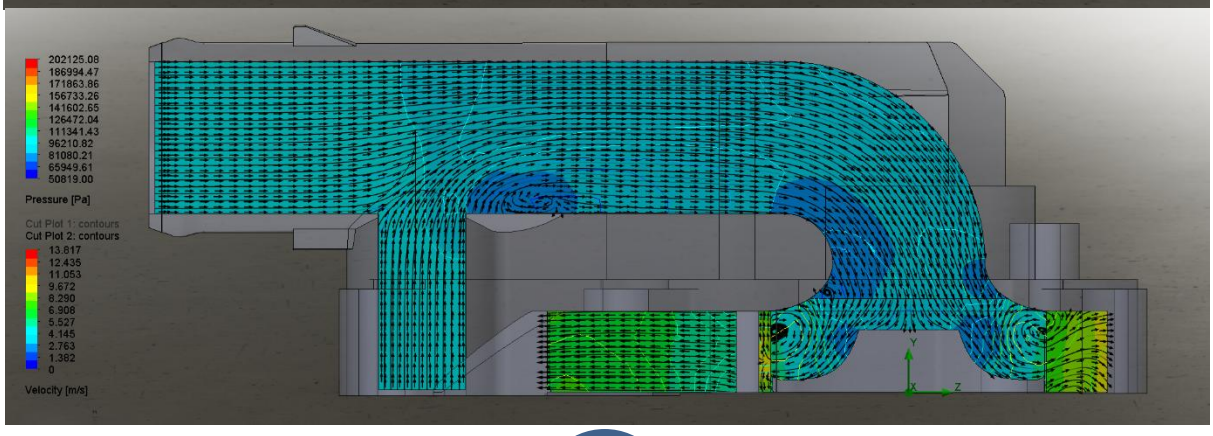


5.3. Pressure plots 6000 RPM

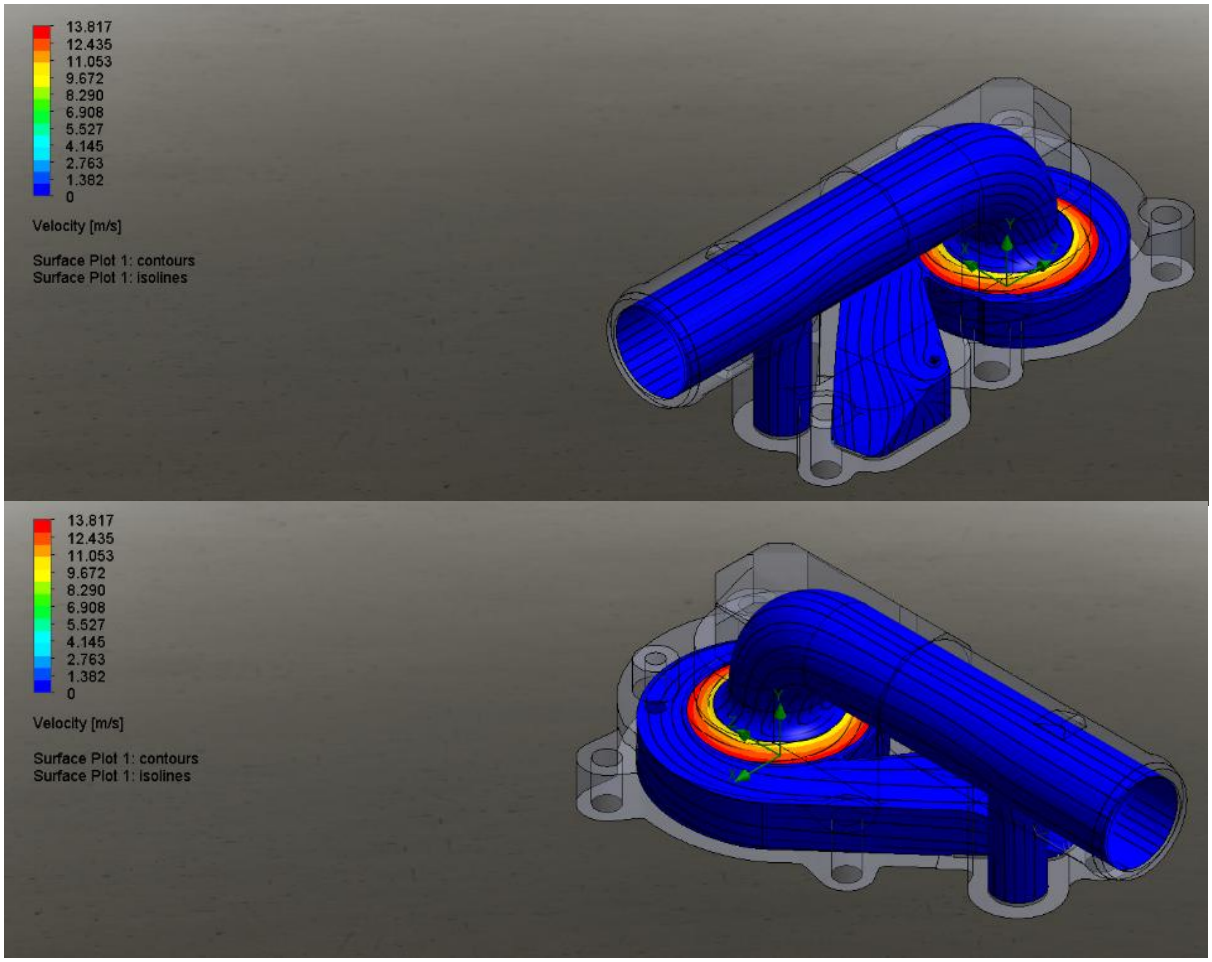




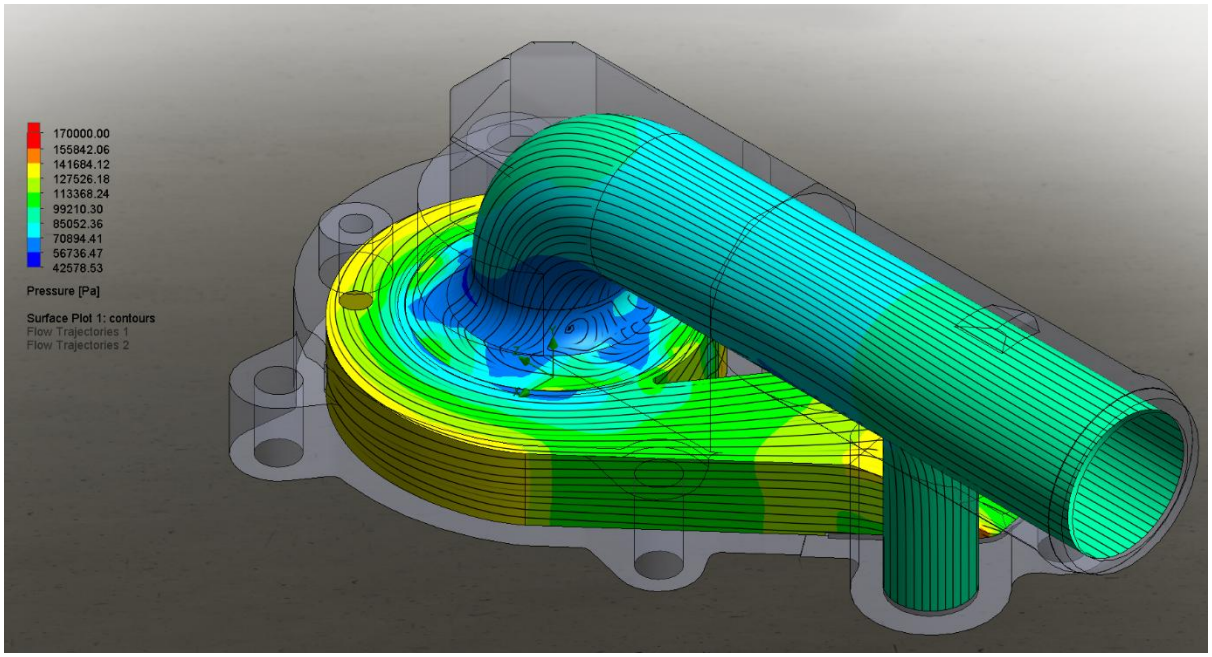


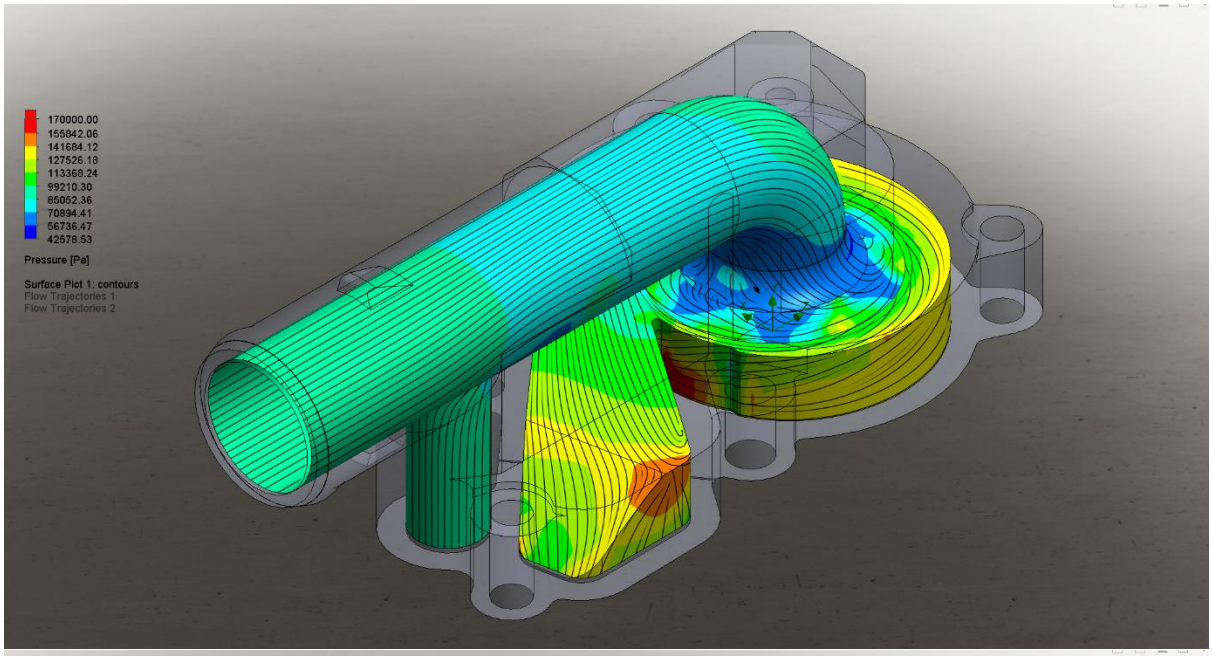


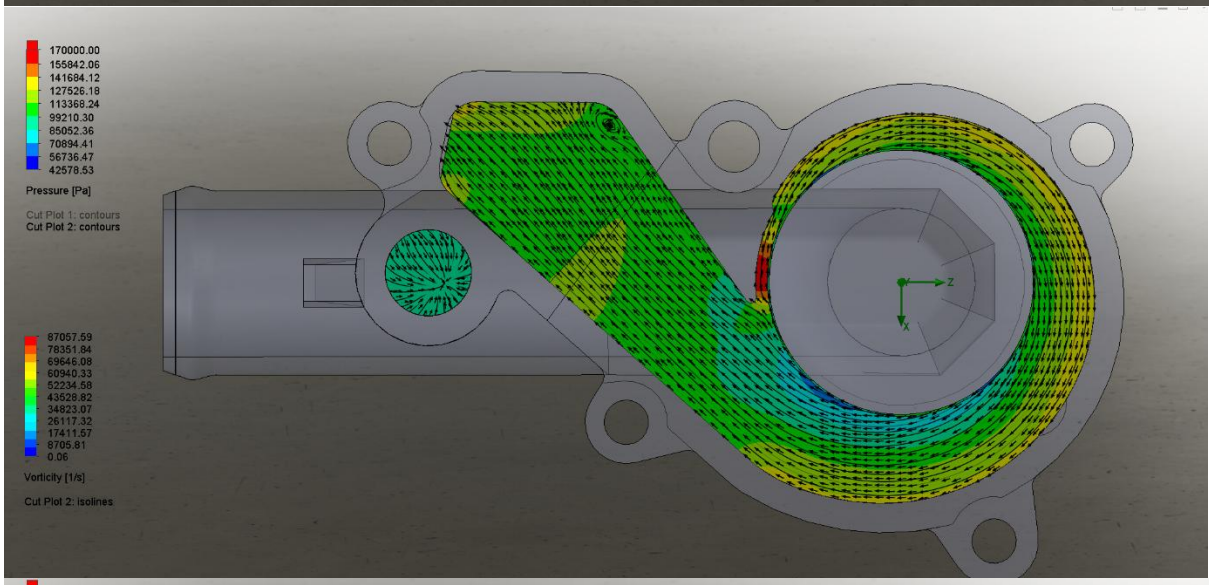
5.4. Velocity plots 6000 RPM

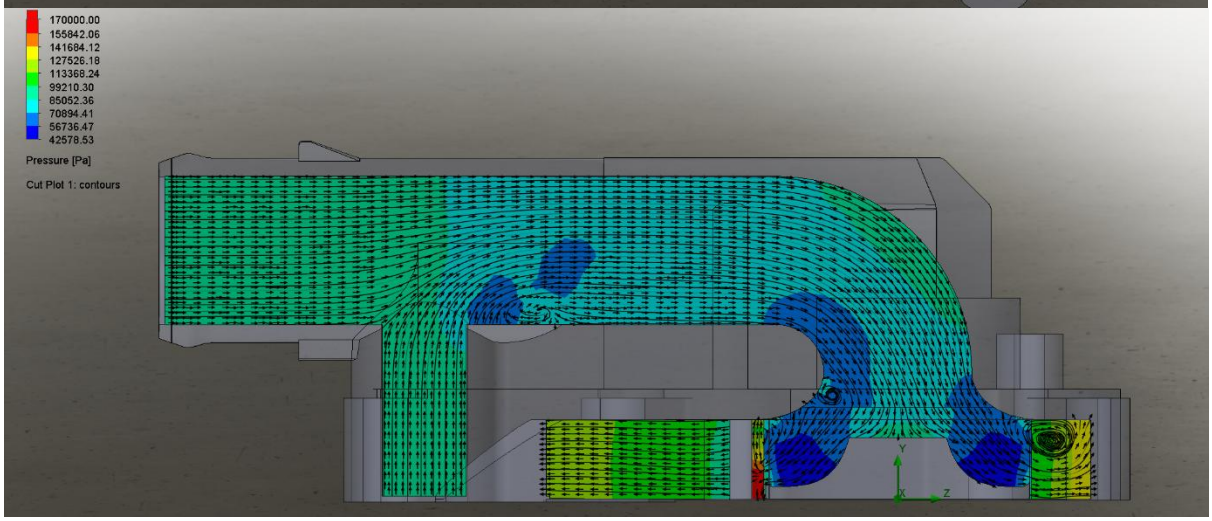


5.5. Pressure plots 9000 RPM

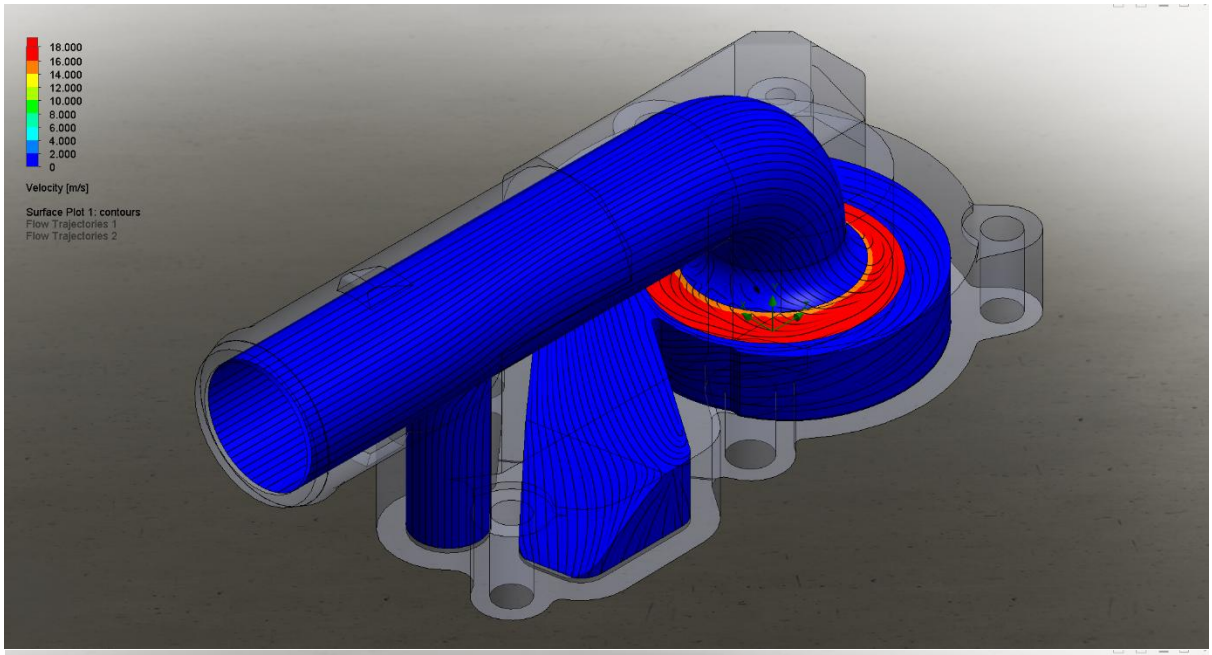


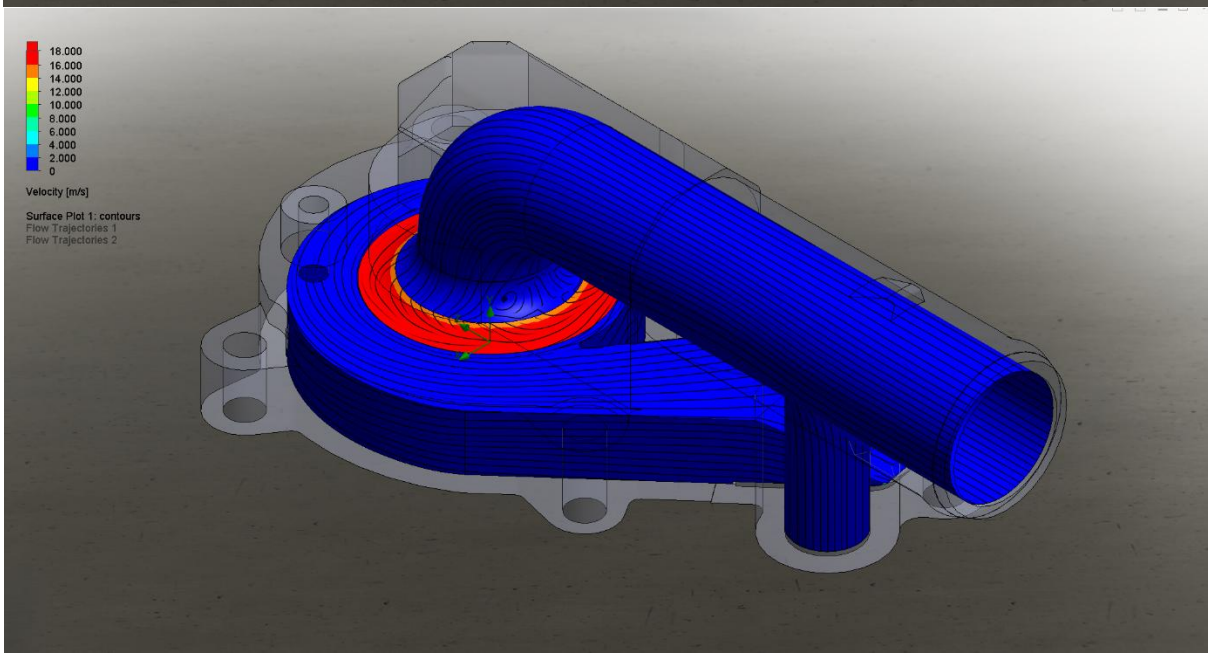

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141684.12
127526.18
113368.24
99210.30
85052.36
70894.41
56736.47
42578.53
Pressure [Pa]
Surface Plot 1: contours
Flow Trajectories 1
Flow Trajectories 2


170000.00
155842.06
141684.12
127526.18
113368.24
99210.30
85052.36
70894.41
56736.47
42578.53
Pressure [Pa]
Cut Plot 1: contours
Cut Plot 2: contours
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78351.84
69646.08
60940.33
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Vorticity [1/s]
Cut Plot 2: isolines

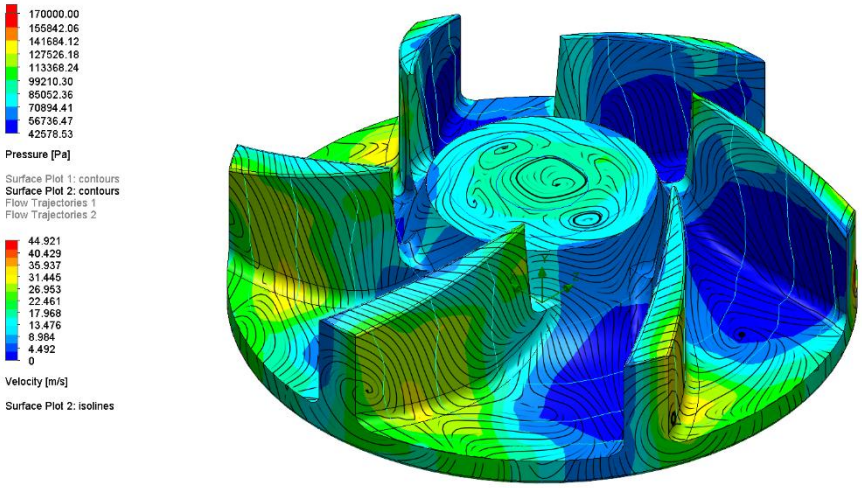

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127526.18
113368.24
99210.30
85052.36
70894.41
56736.47
42578.53
Pressure [Pa]
Cut Plot 1: contours

5.6. Velocity plots 9000 RPM





5.6. Impeller Pressure/ Velocity plot 9000 RPM



6. Results Analysis for the NO BRAND water pump kit by Operating Scenario

6.1. 3000 rpm Operating Scenario

In the 3000 rpm scenario, the key flow characteristics are as follows:

- **Inlet Velocity:** The inlet velocity averaged **2.76 m/s**
- **Outlet Velocity Av:** The average outflow velocity was recorded at **4.09 m/s**
- **Volume Flow Rate:** The inlet and outlet flow rates balance at approximately **101.51 l/min** and **101.93 l/min** respectively, demonstrating mass convergence validity.
- **Pressures:** The inlet total pressure was maintained at **101325 Pa (1.01 bar)**, while the outlet pressure reached **109647 Pa (1.10 bar)**.

6.2. 6000 rpm Operating Scenario

By doubling the rotational speed to 6000 rpm, the following changes are observed:

- **Inlet Velocity:** Increased noticeably to **5.54 m/s** scaling proportionally relative to the 3000 rpm case.
- **Outlet Velocity:** The average outflow velocity rose to **8.20 m/s**
- **Volume Flow Rate:** The flow rate doubled, approximating **203.6 l/min** at the inlet and **205.3 l/min** at the outlet.
- **Pressures:** The outlet pressure increased significantly to **134737 Pa (1.35bar)**, reflecting the system's increased energy.

6.3. 9000 rpm Operating Scenario

In the highest evaluated scenario at 9000 rpm:

- **Inlet Velocity:** Reached **8.31 m/s**
- **Outlet Velocity:** The highest average outflow velocity was recorded at **12.26 m/s**
- **Volume Flow Rate:** The flow increased to **305.42 l/min** (inlet) and **307 l/min** (outlet).
- **Pressures:** The outlet pressure settled at **176053 Pa** (**1.76 bar**)

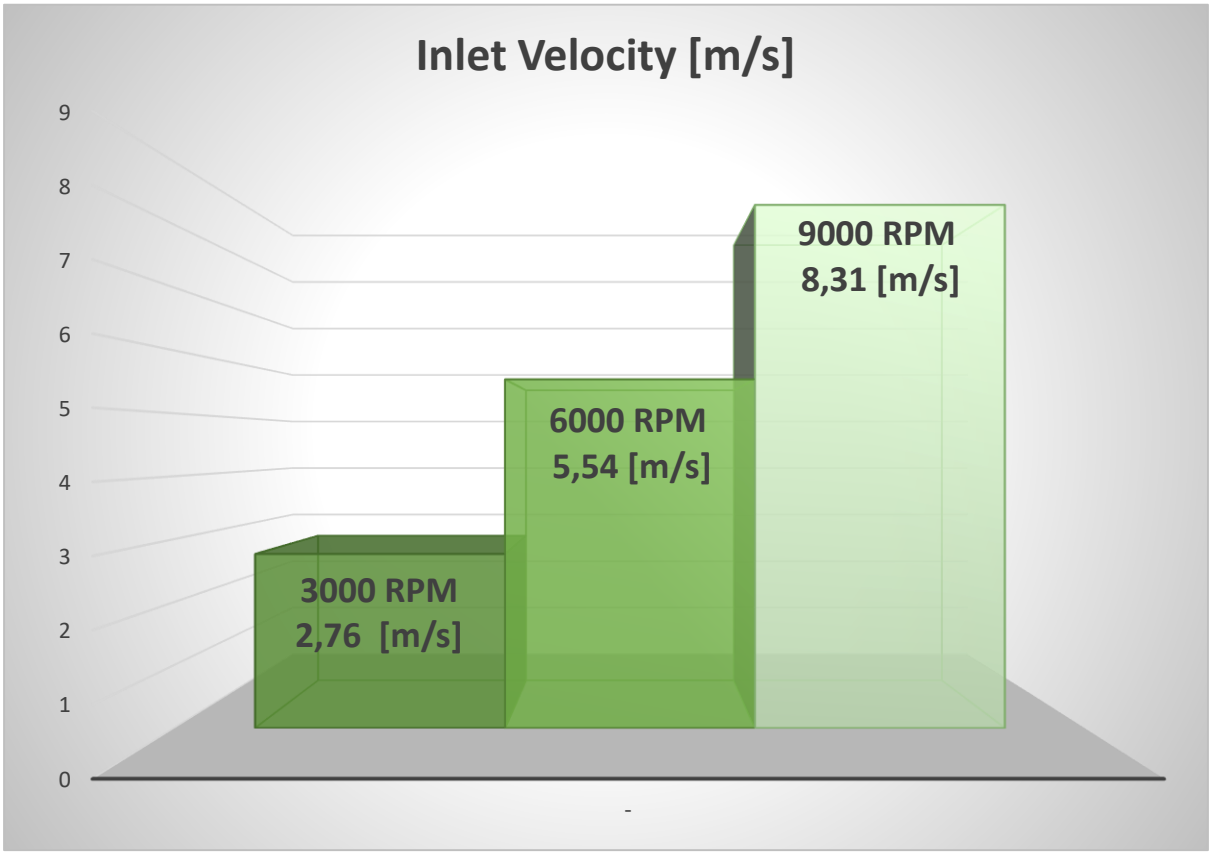
7. Comparative Summary for the NO BRAND water pump kit

Scenario [rpm]	Inlet Velocity [m/s]	Outlet Velocity [m/s]	Outlet Pressure [Pa]	Inlet Volume Flow Rate [l/min]	Outlet Volume Flow Rate [l/min]
3000	2.76	4.09	109647 (1.10 bar)	101.51	101.93
6000	5.54	8.20	134737 (1.35 bar)	203.6	205.3
9000	8.31	12.26	176053 (1.76bar)	305.42	307

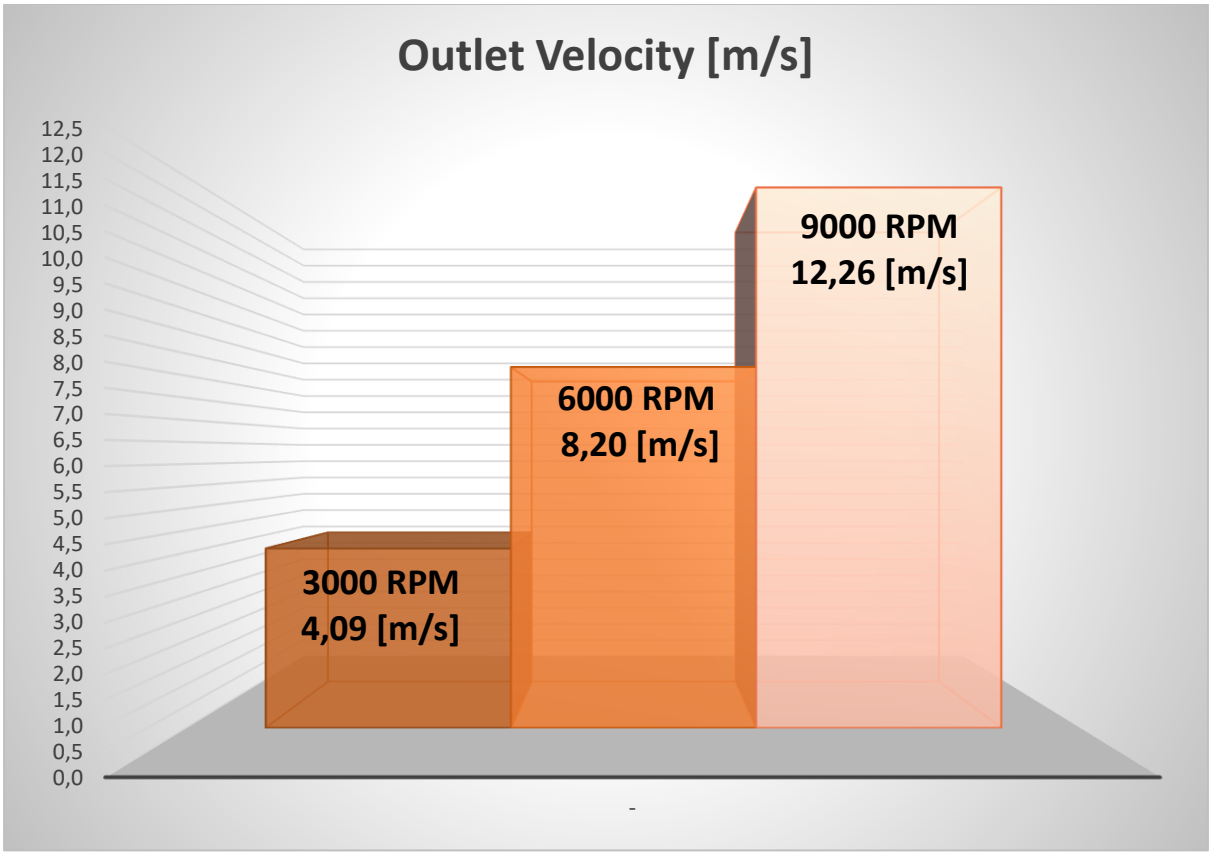
1. **Flow Linearity:** The volume flow rate exhibits a highly predictable increase proportional to the rpm rise, confirming the consistent hydraulic behavior of the model.
2. **Simulation Convergence:** All parameters reached 100% progress with successful convergence, ensuring data reliability.
3. **Volume Build-up:** Higher rotational speeds lead to a corresponding rise in Outlet Volume Flow rate, a critical factor for the cooling efficiency of the heat exchanger.

8. NO BRAND Charts

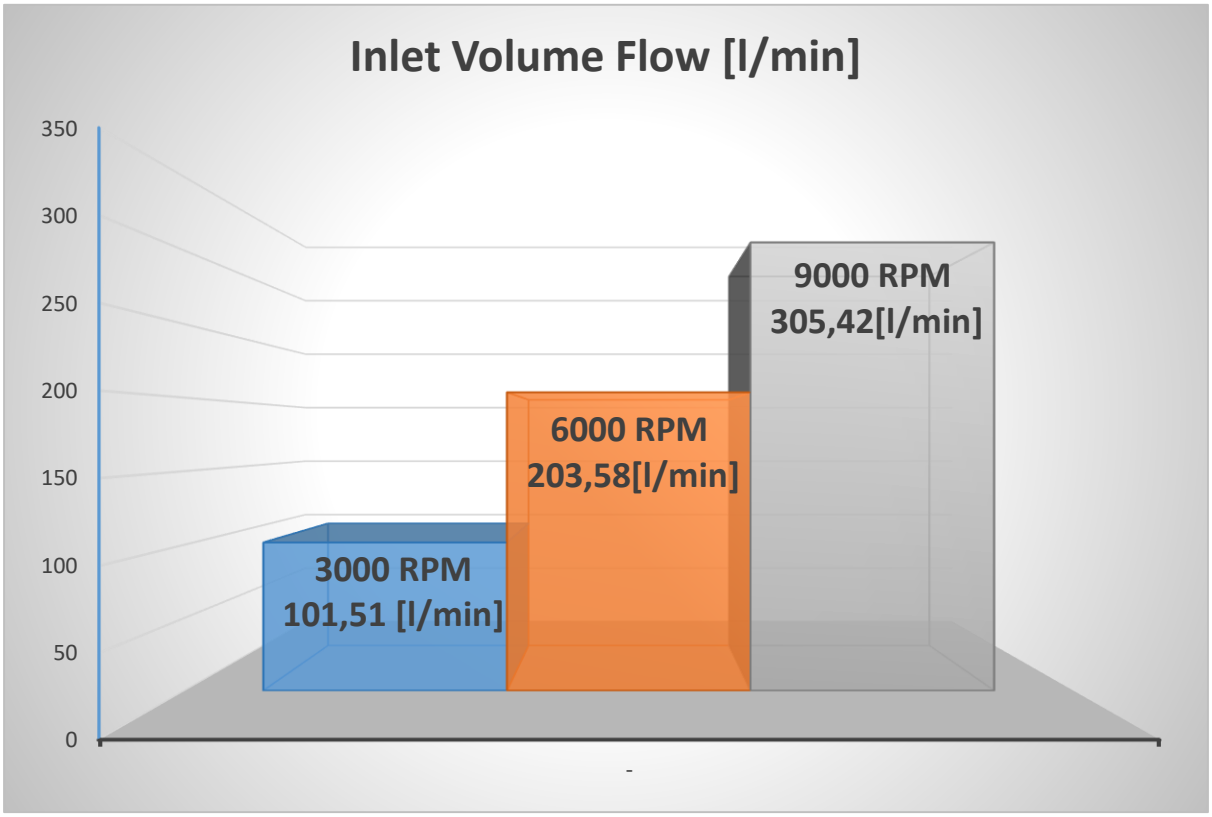
8.1. Inlet velocity chart



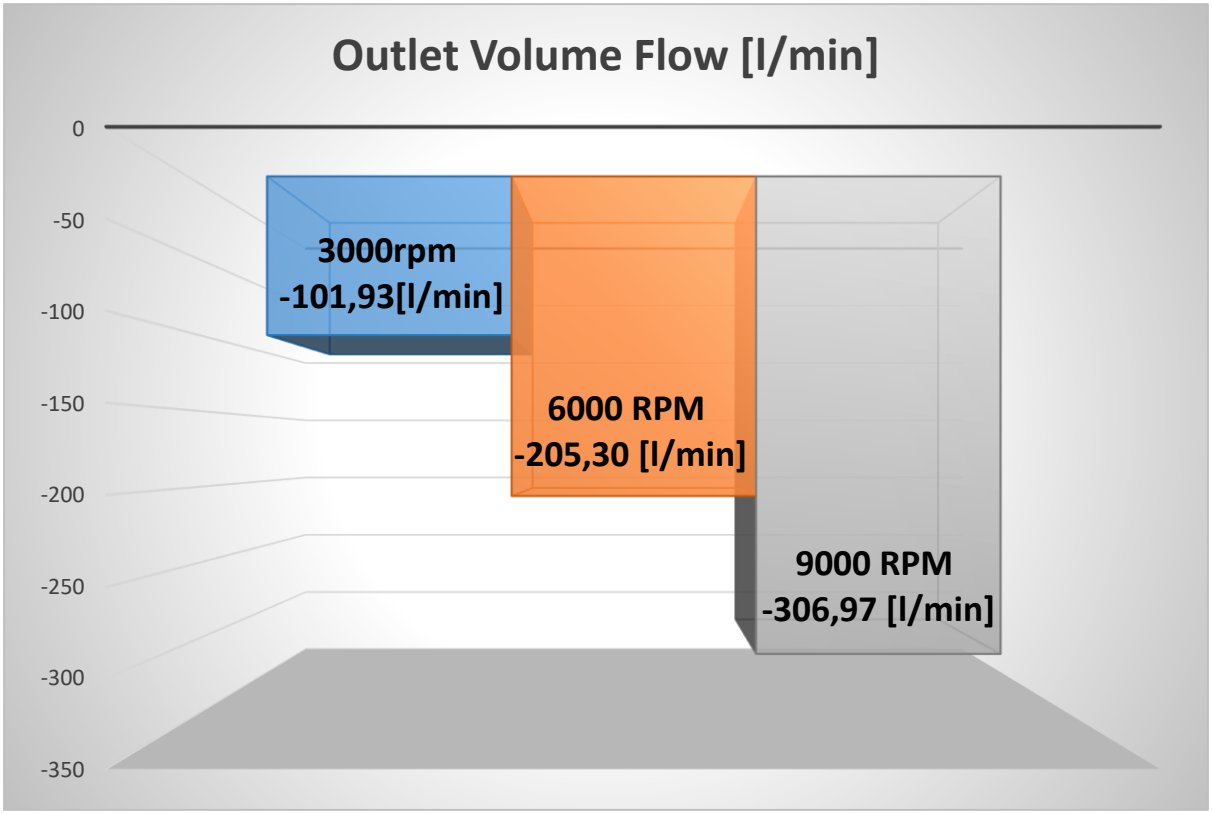
8.2. Outlet velocity chart



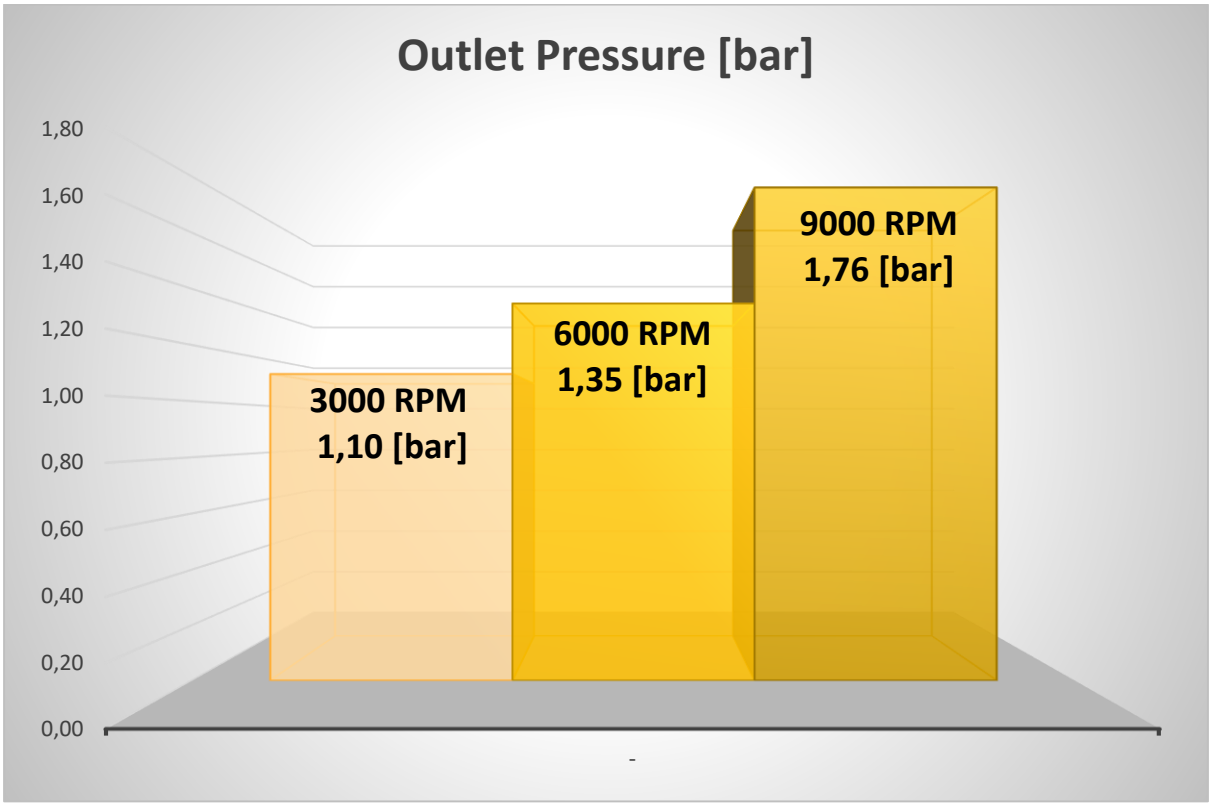
8.3. Inlet Volume Flow chart



8.4. Outlet Volume Flow chart

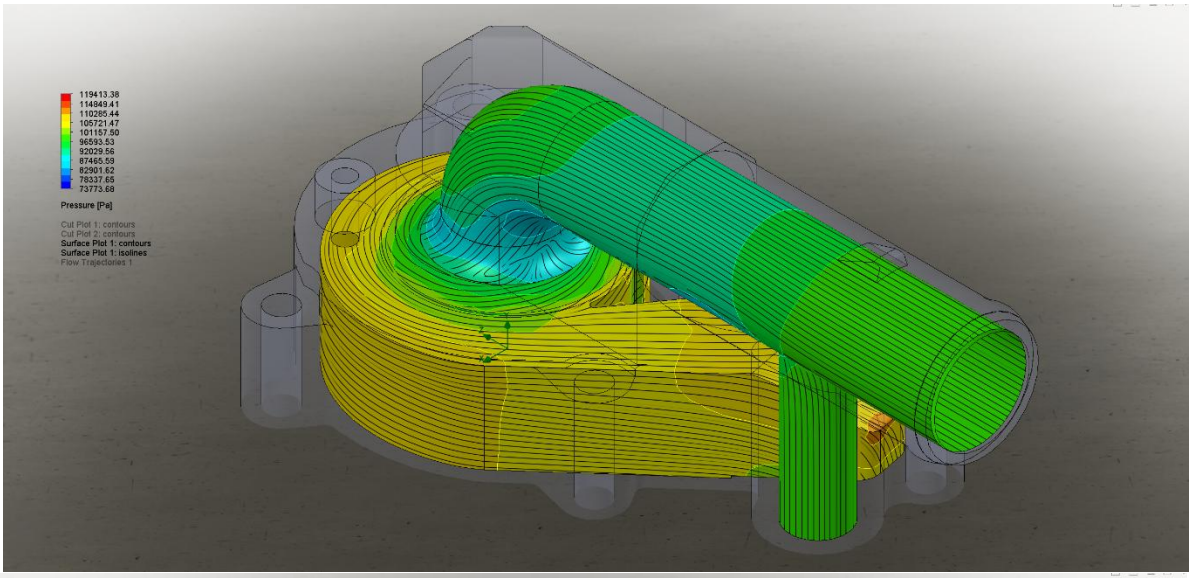


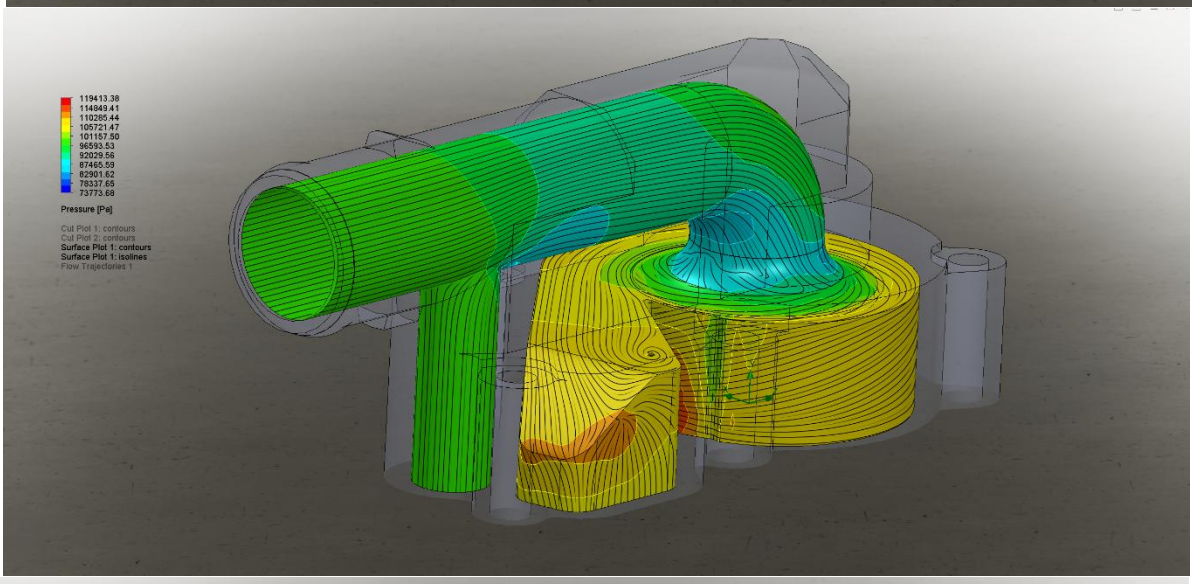
8.5. Outlet Pressure chart

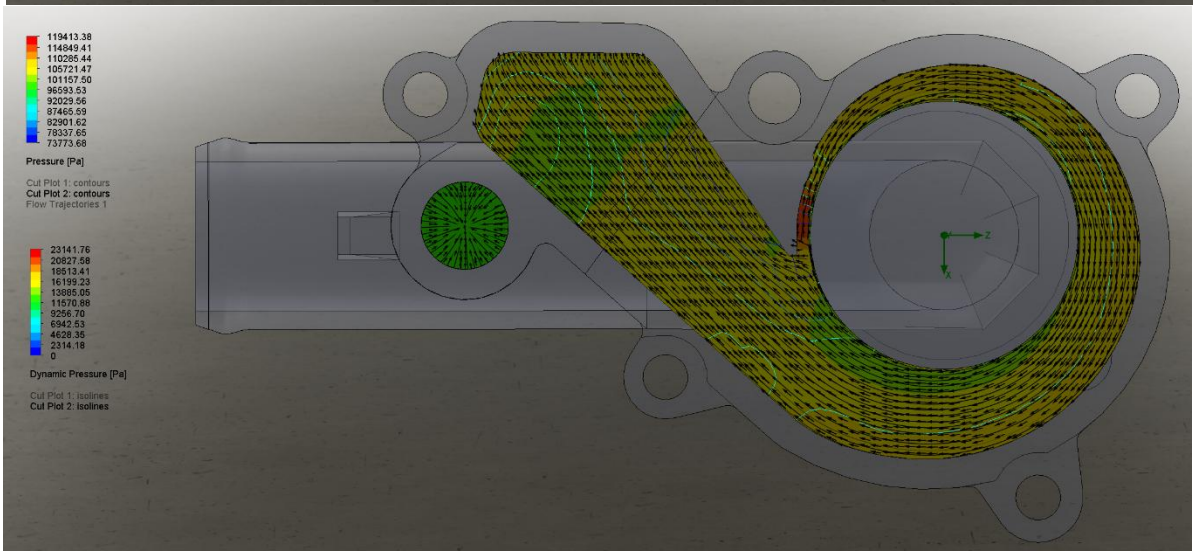


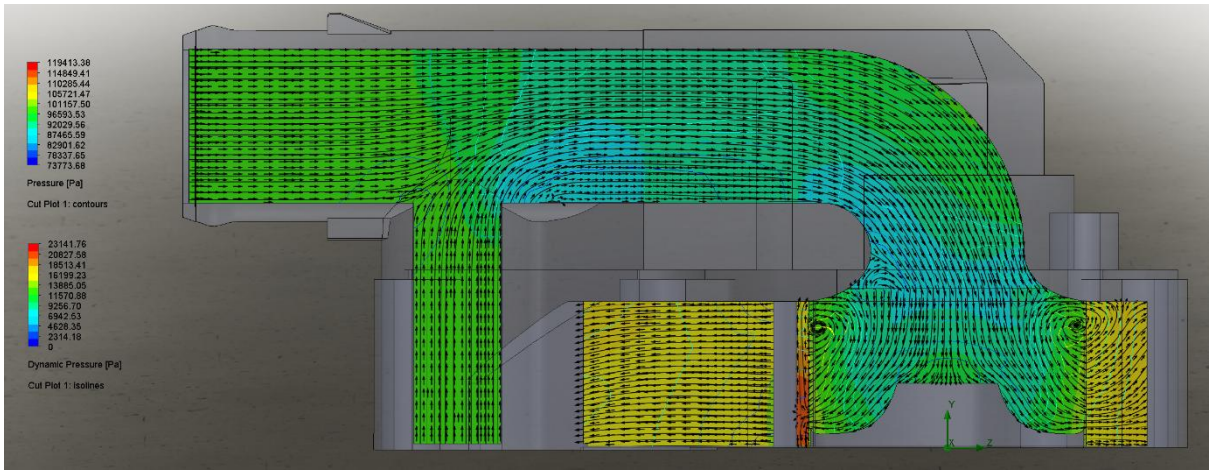
9. NO BRAND Plots

9.1. Pressure plots 3000 RPM

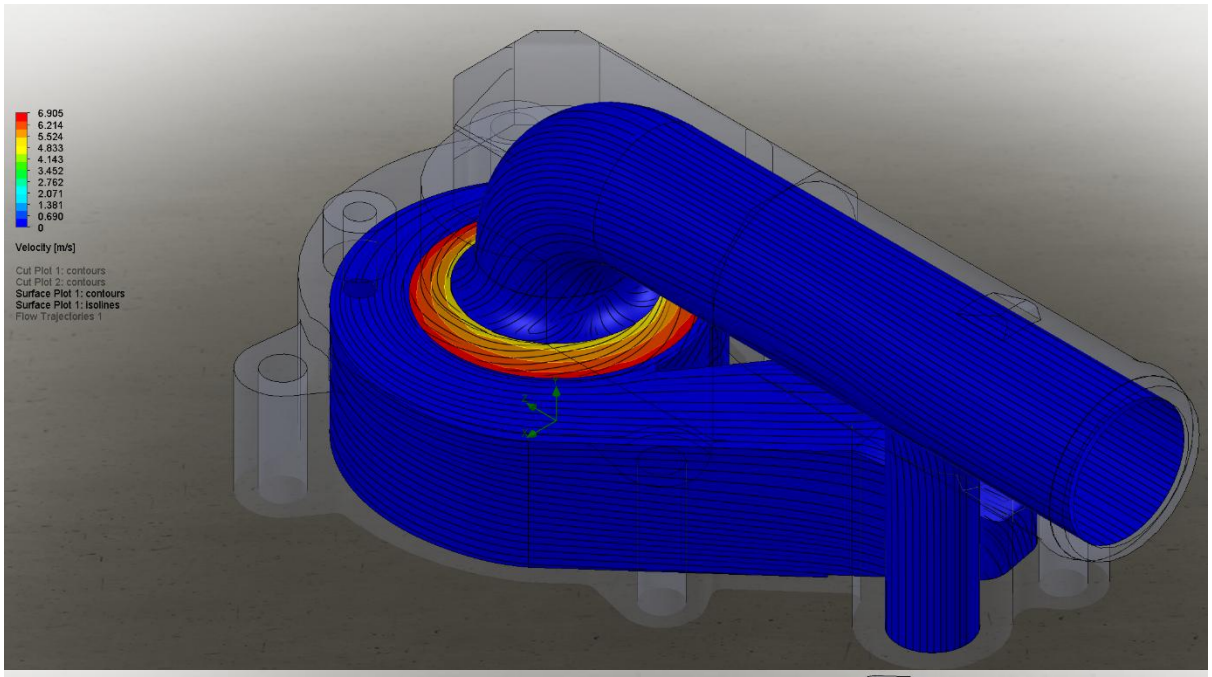


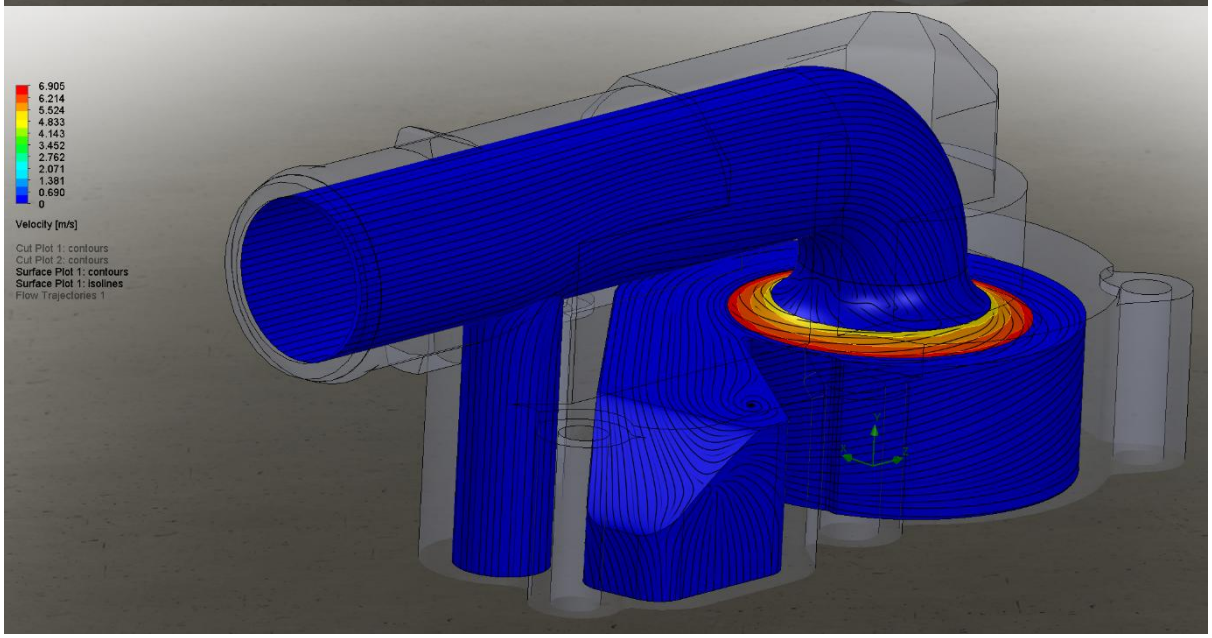




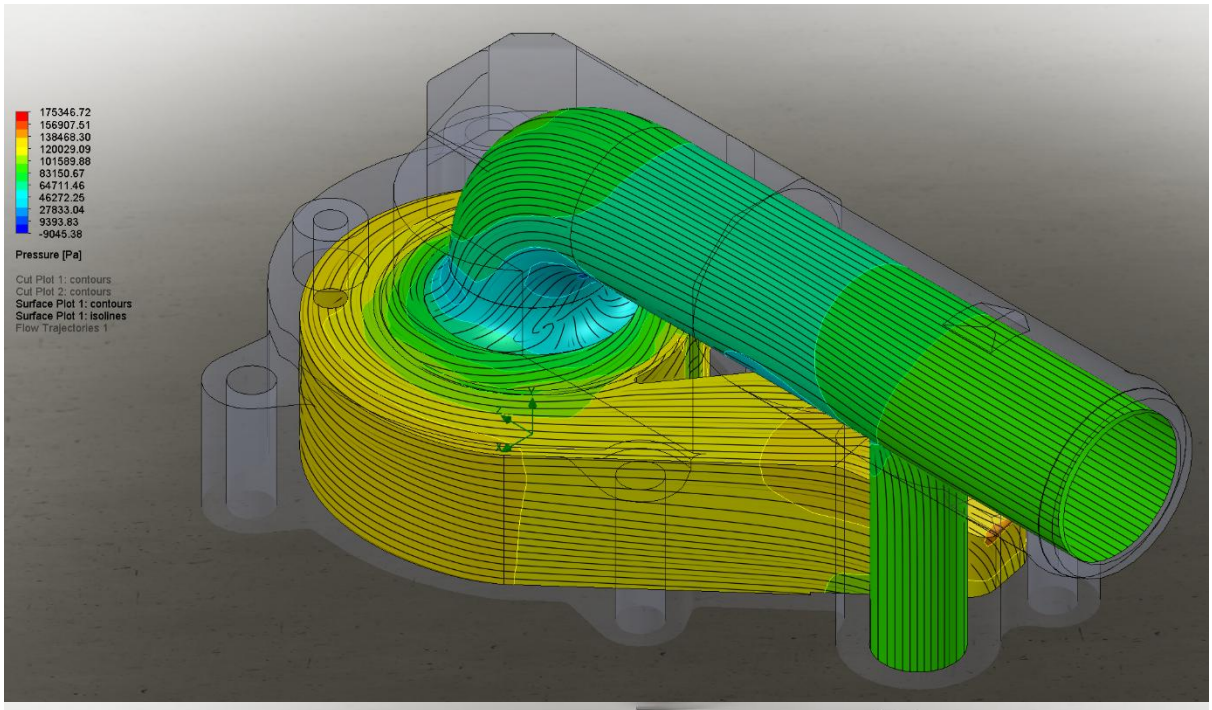


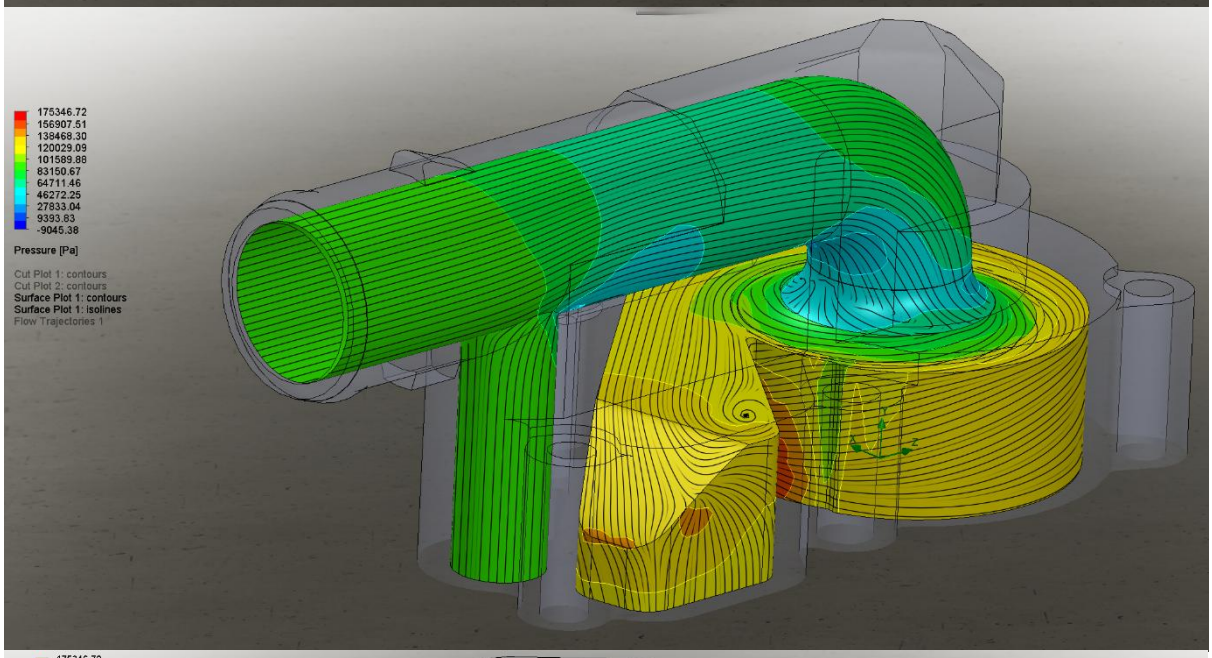
9.2. Velocity plots 3000 RPM

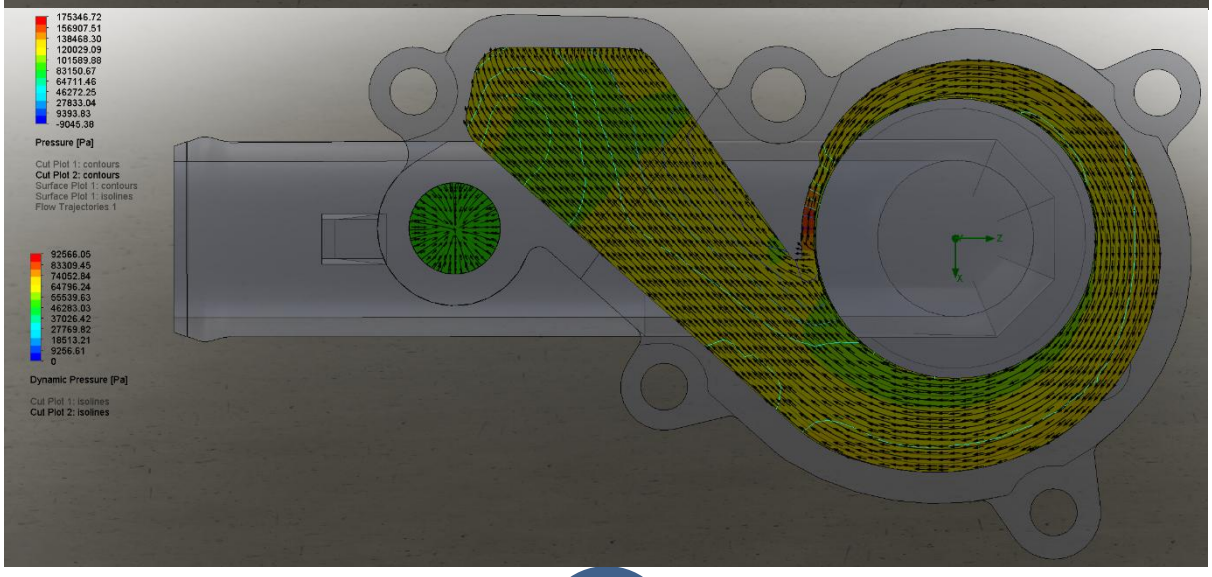


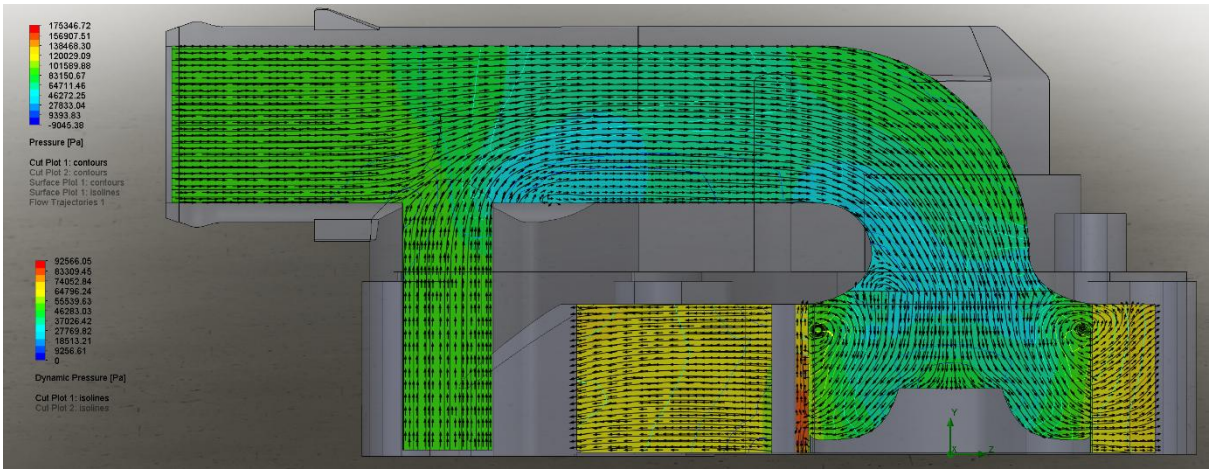


9.3. Pressure plots 6000 RPM

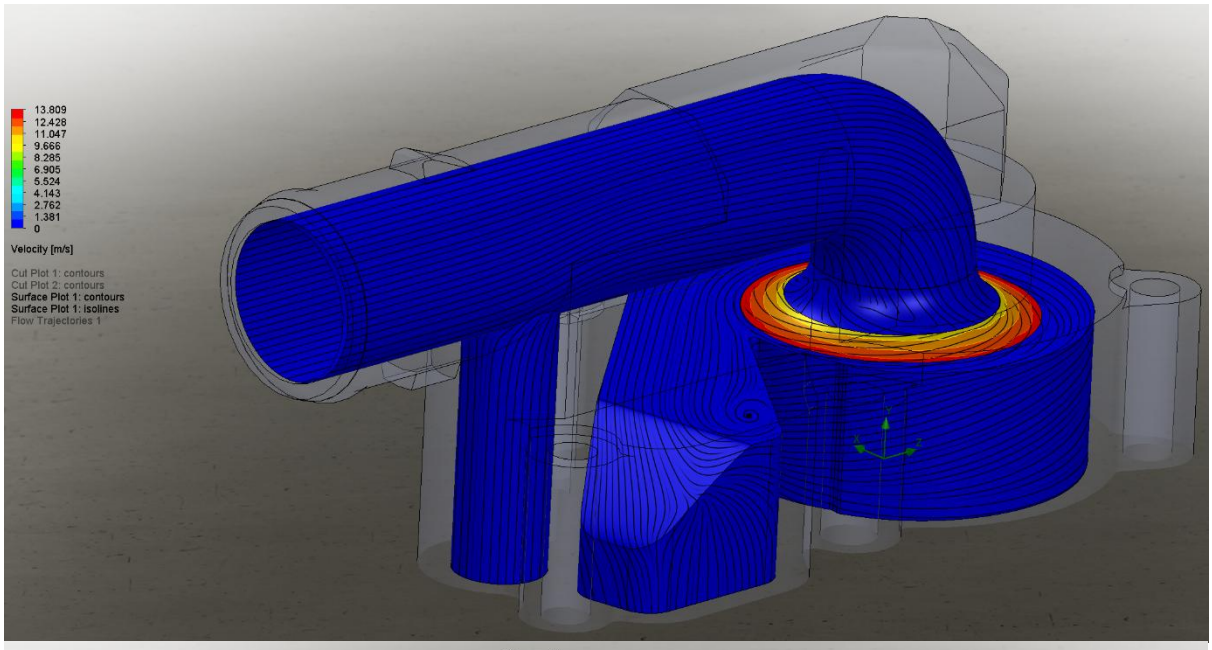


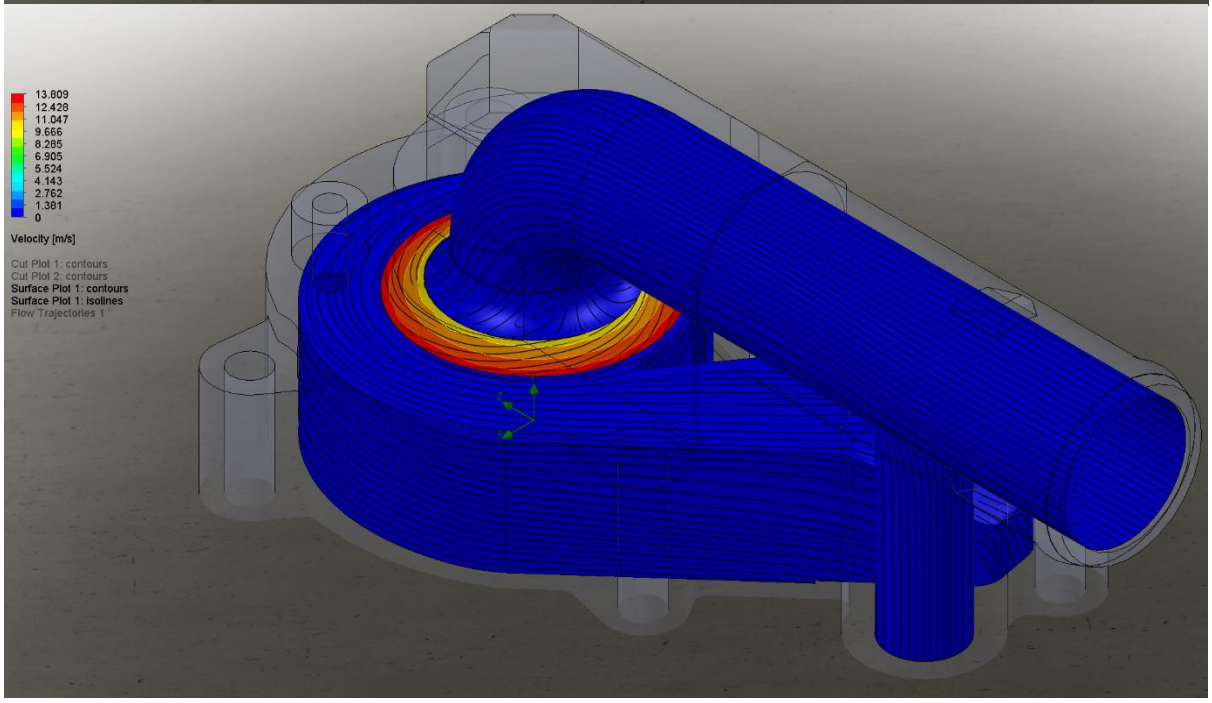




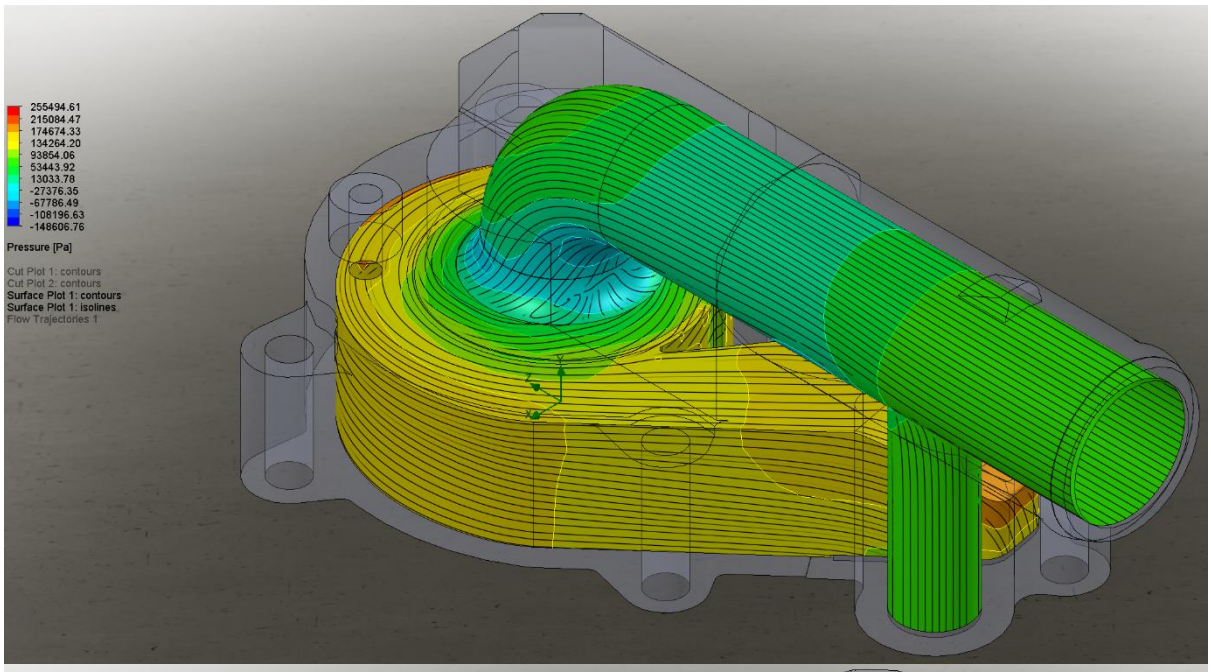


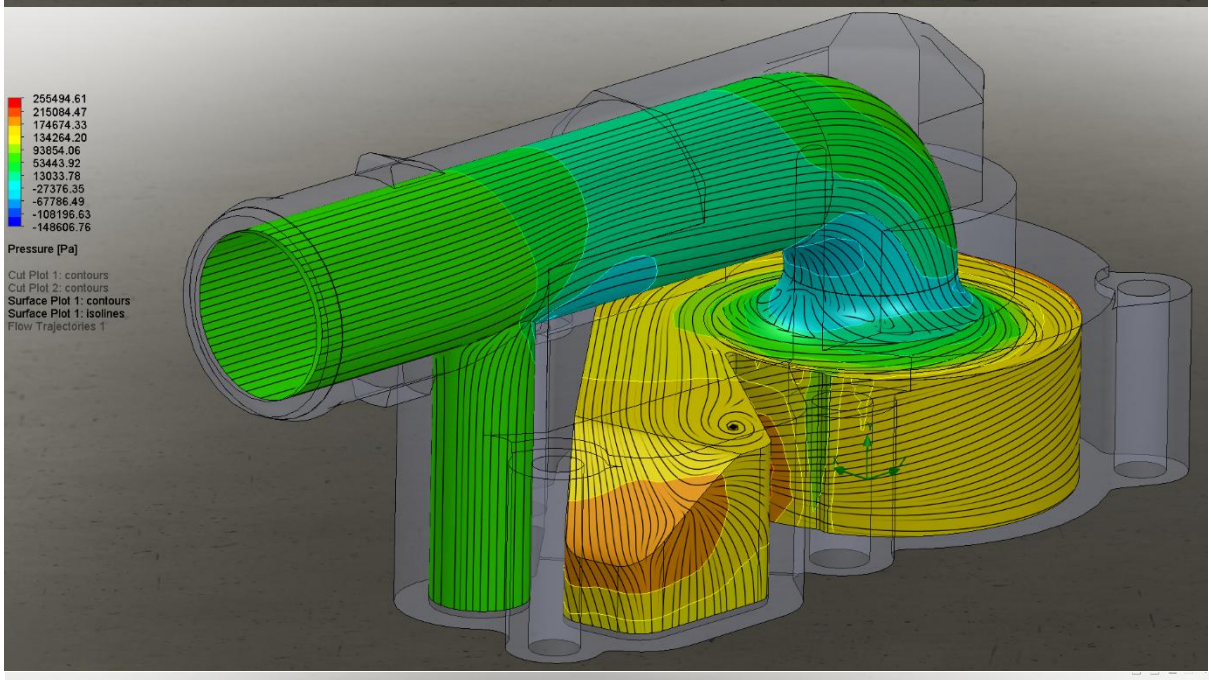
9.4. Velocity plots 6000 RPM

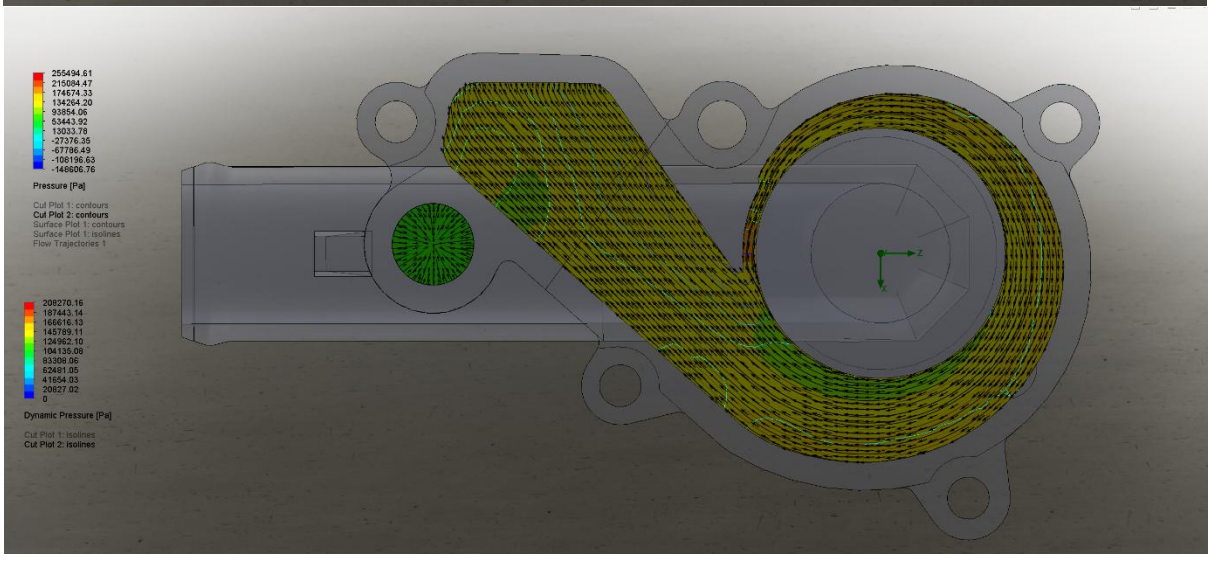


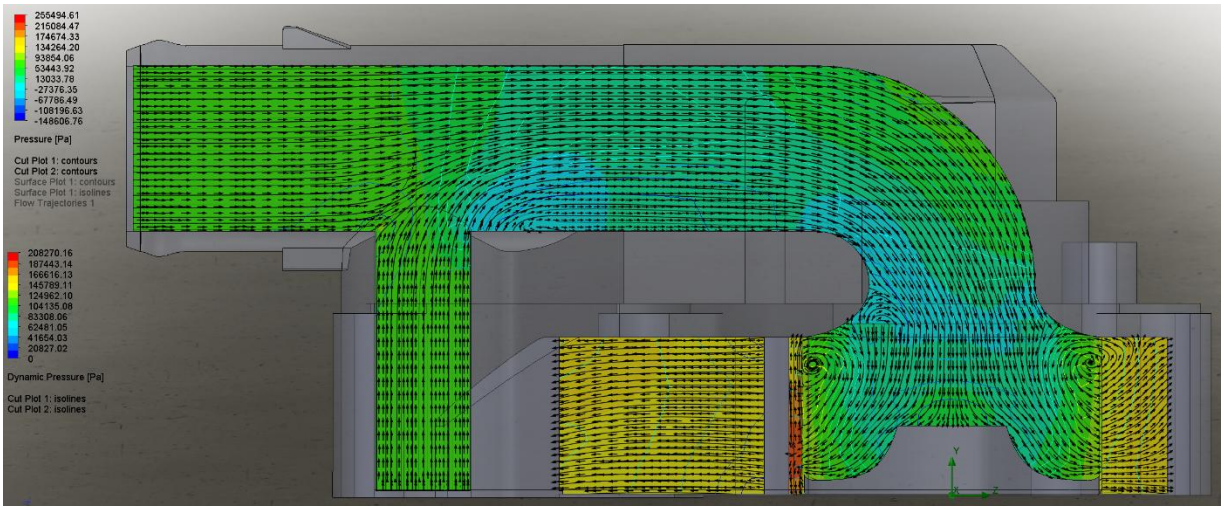


9.5. Pressure plots 9000 RPM

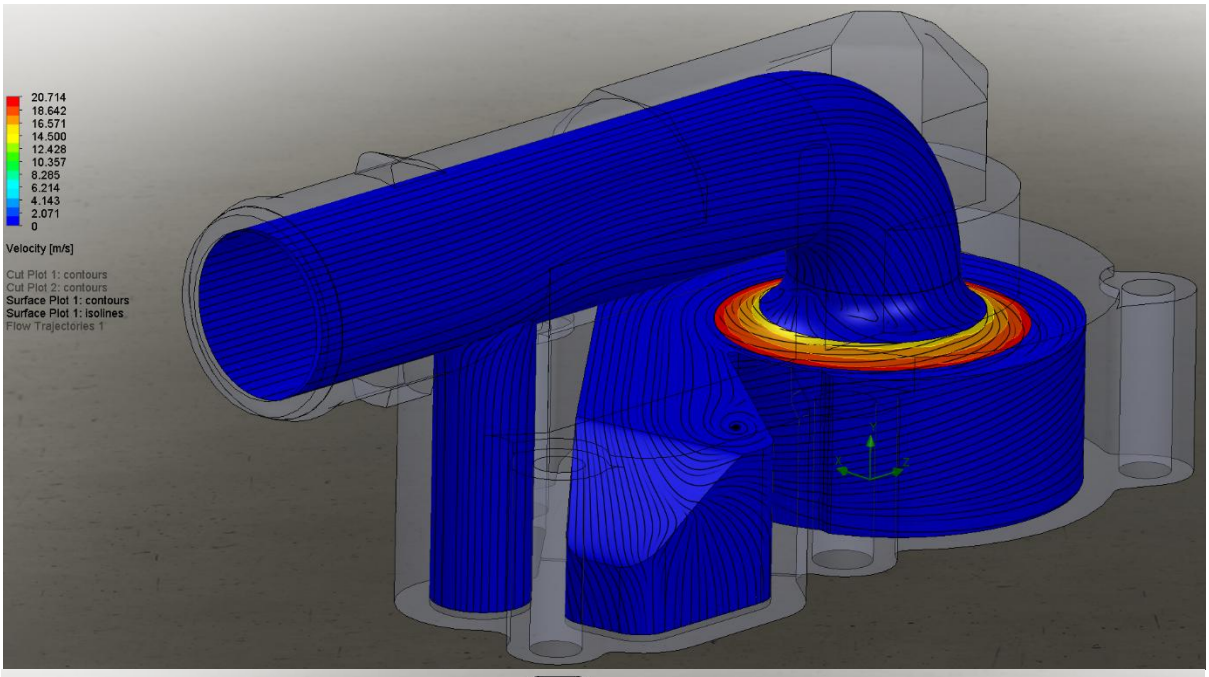


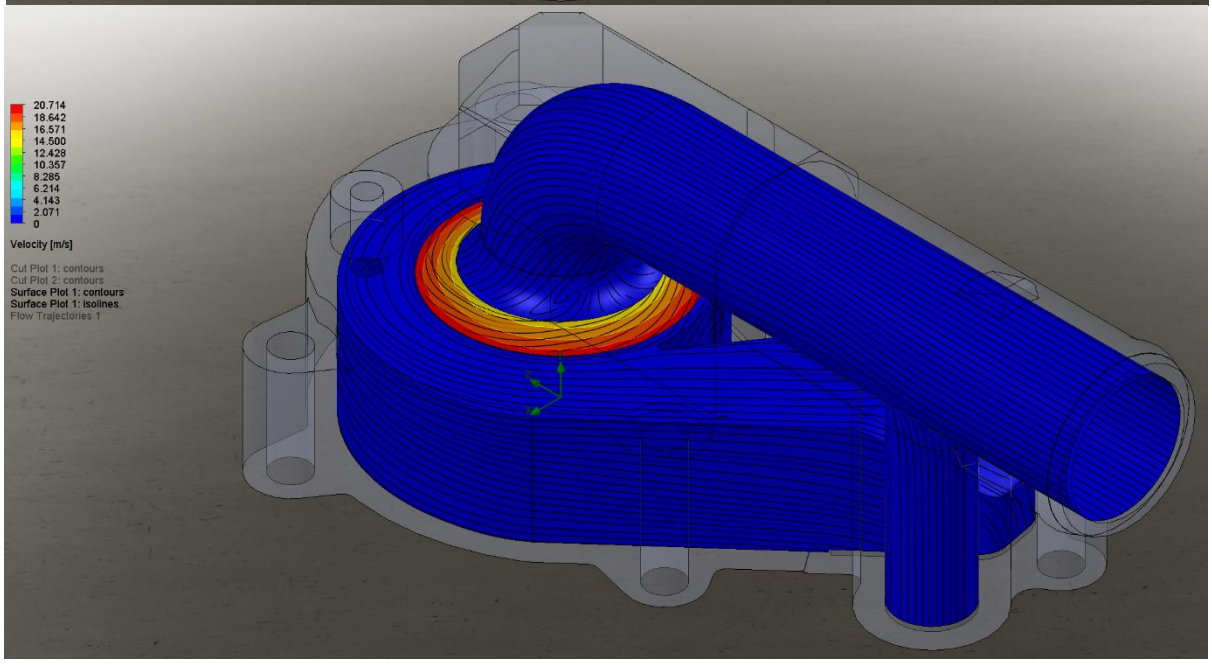




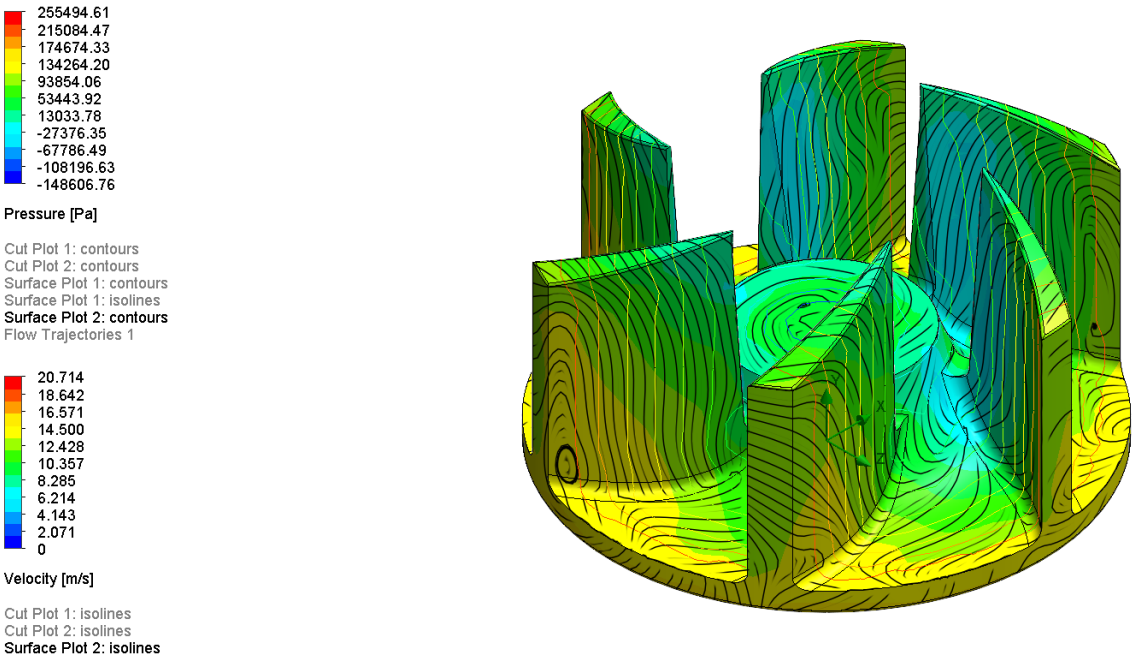


9.6. Velocity plots 9000 RPM





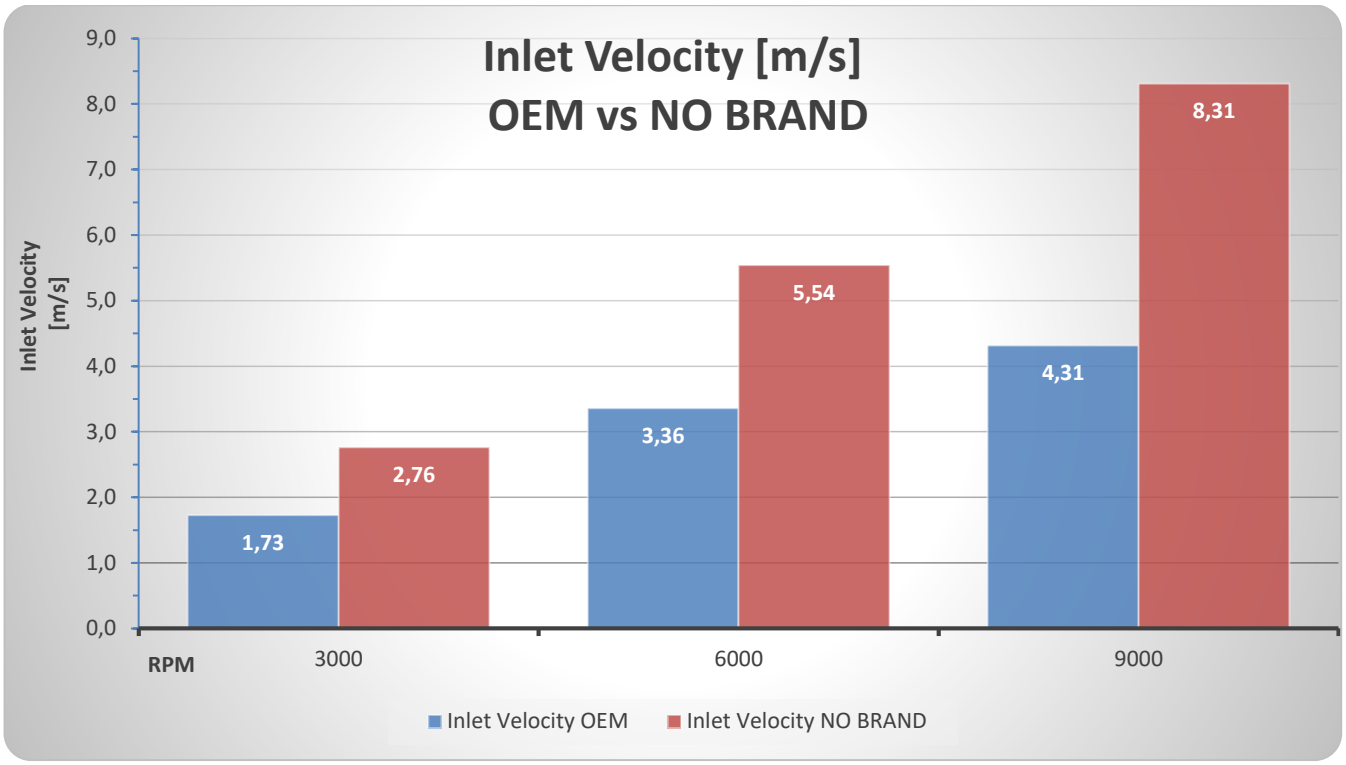
9.6. Impeller Pressure/ Velocity plot 9000 RPM



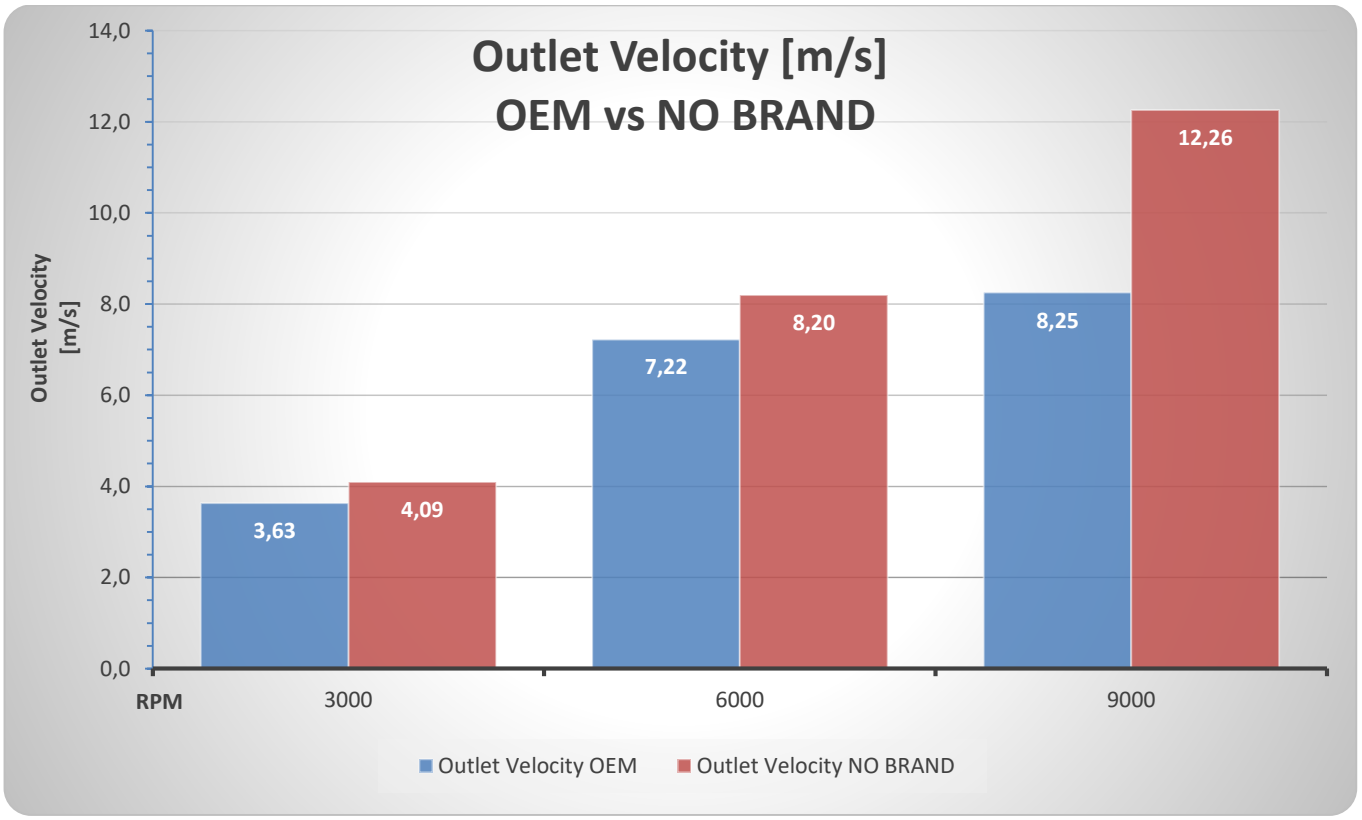
10. Comparison charts and conclusions

RPM	PARAMETER	NO BRAND	OEM	DELTA
3000	Inlet Velocity	2.76 [m/s]	1.73 [m/s]	+59.8%
	Outlet Velocity	4.09 [m/s]	3.63 [m/s]	+12.7%
	Inlet Volume Flow	101.51 [L/min]	63.57 [L/min]	+59.7%
	Outlet Volume Flow	101.93 [L/min]	63.63 [L/min]	+60.2%
	Outlet Pressure	1.10 [bar]	1.09 [bar]	+0.3%
6000	Inlet Velocity	5.54 [m/s]	3.36 [m/s]	+65.1%
	Outlet Velocity	8.2 [m/s]	7.22 [m/s]	+13.5%
	Inlet Volume Flow	203.58 [L/min]	123.40 [L/min]	+65%
	Outlet Volume Flow	205.30 [L/min]	124.13 [L/min]	+65.4%
	Outlet Pressure	1.35 [bar]	1.31 [bar]	+2.5%
9000	Inlet Velocity	8.31 [m/s]	4.31 [m/s]	+92.7%
	Outlet Velocity	12.26 [m/s]	8.25 [m/s]	+48.5%
	Inlet Volume Flow	305.42 [L/min]	158.66 [L/min]	+92.5%
	Outlet Volume Flow	306.97 [L/min]	159.62 [L/min]	+92.3%
	Outlet Pressure	1.76 [bar]	1.39 [bar]	+26.3%

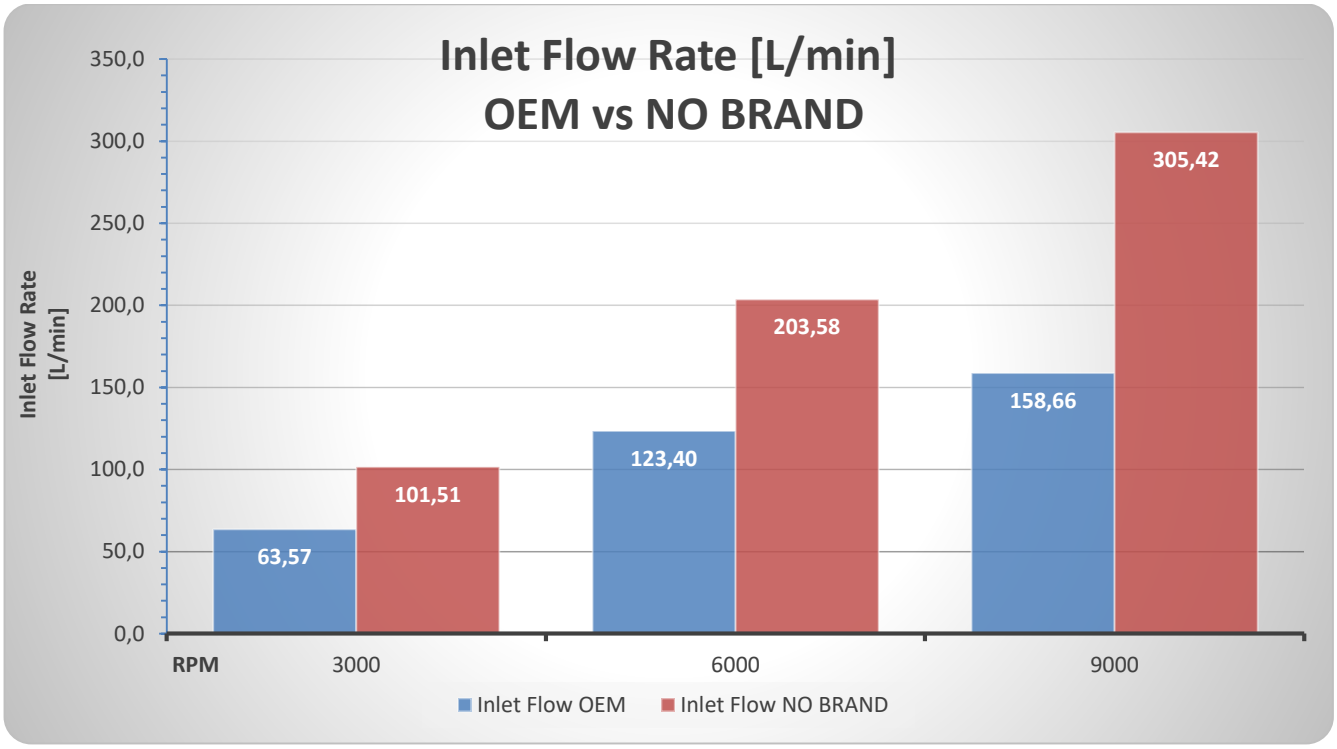
10.1. Inlet Velocity comparison



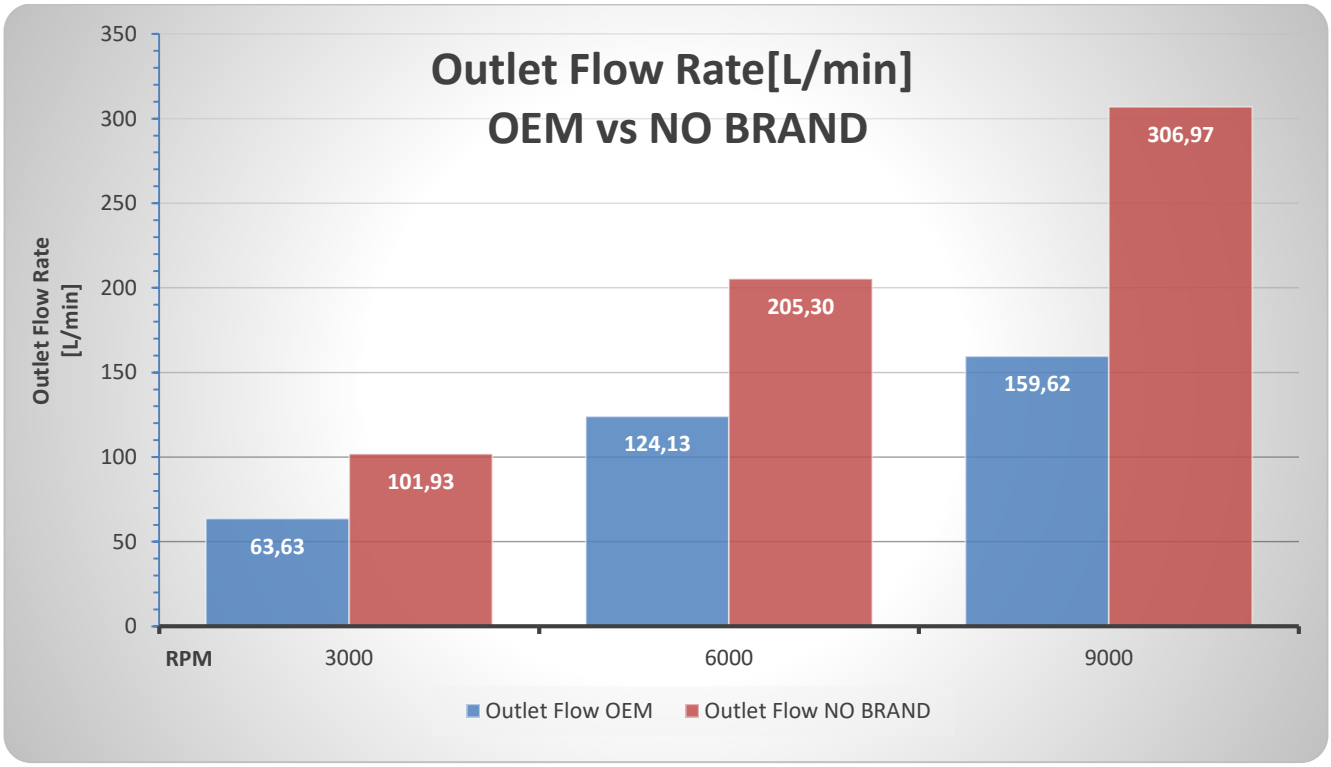
10.2. Outlet Velocity comparison



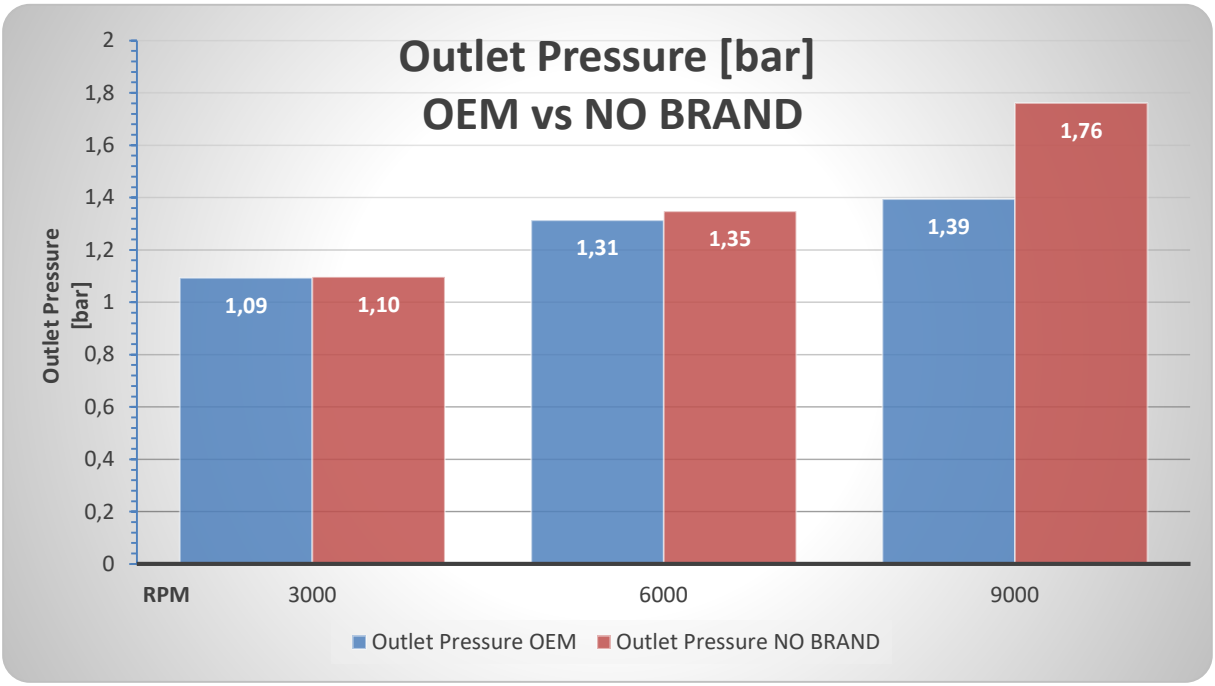
10.3. Inlet Flow Rate comparison



10.4. Outlet Flow Rate comparison



10.5. Outlet Pressure comparison



10.5. Conclusion

This study evaluated and compared the hydraulic performance between the genuine water pump (OEM) and the NO BRAND water pump kit across three rotational operating scenarios (3000 rpm, 6000 rpm, and 9000 rpm). From the analysis of critical parameters (flow velocities, volume flow rates, and discharge pressures), the following conclusions are drawn:

- **Performance of the NO BRAND Kit**
  The NO BRAND kit systematically demonstrates significantly higher volume flow rates and increased flow velocities across the entire operating range. Specifically:
  1. **Volume Flow Rate**: The NO BRAND kit delivers an increased flow rate of approximately +59.7% to +60.2% at 3000 rpm, scaling up to +92.3% to +92.5% at 9000 rpm compared to the OEM.
  2. **Flow Velocities:** Both inlet and outlet velocities are noticeably superior in the NO BRAND kit, indicating a better impeller geometrical design and modified flow cross section.

- **Behavior and Energy Balance**
  The outlet pressure increases stepwise for both systems with higher load. However, the NO BRAND kit develops a higher discharge pressure, peaking at 1.76 bar (176053 Pa) at 9000 rpm, versus 1.39 bar (139069 Pa) for the OEM. This variation indicates a greater transfer of hydraulic energy to the fluid.
- **Overall Evaluation**
  The NO BRAND kit clearly outperforms in terms of volumetric discharge and flow velocity per revolution, making it more effective for heat exchanger cooling under high load requirements.