Study Of the design And Simulation Work For An Artificial Heart

Mohammed Eltayeb Salih Elamin

University Of Khartoum, Faculty Of Engineering Department Of Mechanical Engineeing.

Abstract-

This study discuss the concept of the artificial heart using engineering concepts, of the fluid mechanics and the characteristics of the non- newtonian fluid .

A pump was designed in order to pump blood to the human body and taking into account all the factors that allows it to replace the human heart, in order to work at the same characteristics and the efficiency of the human heart.

The pump was designed on the idea of the diaphragm pump.

Three models of blood obtained from the blood real characteristics and all of these models were simulated in order to study the effect of the pumping work on the fluid.

the properties of this pump was studied by using ansys15 software to simulate blood flow inside the pump and the amount of stress that blood will goes under.

The 3D geometries modeling was done using SOLID WORKS and the geometries then imported to ansys design modeler which is used during the pre-processing procedure.

The solver used throughout the study is Ansys FLUENT.

Design criteria

design criteria are perhaps the most difficult to achieve without losing the integrity of the other requirements, as maximization of stroke volume without exceeding anatomical limits is somewhat contradictory.

To design a low profile pump that delivers a large stroke volume.

This approach has, however, three rather serious drawbacks.

1. Material fatigue.

Ellipsoidal shaped baseplates require the diaphragm to flex through a somewhat larger angle, measured at the diaphragm pump housing junction, during cycling.

Consequently, high stress concentrations are predominant at this location, resulting in a lower diaphragm cycle life than if the diaphragm were cycled through a smaller angle.

Also, as baseplates of this type force the diaphragm through an equatorial plane during transition, severe deformation yielding immoderate stresses may be expected.

2. Anatomical fit.

With baseplates of the ellipsoidal type, the two pumps may contact each other at only one point, resulting in a very inefficient volumetric use of the limited space provided by the pericardial sac.

3. Stress design.

Diaphragm deformation during pumping is somewhat random, so that no adequate reinforcing or design elimination of the stress concentrations in the diaphragm can be reasonably attempted.

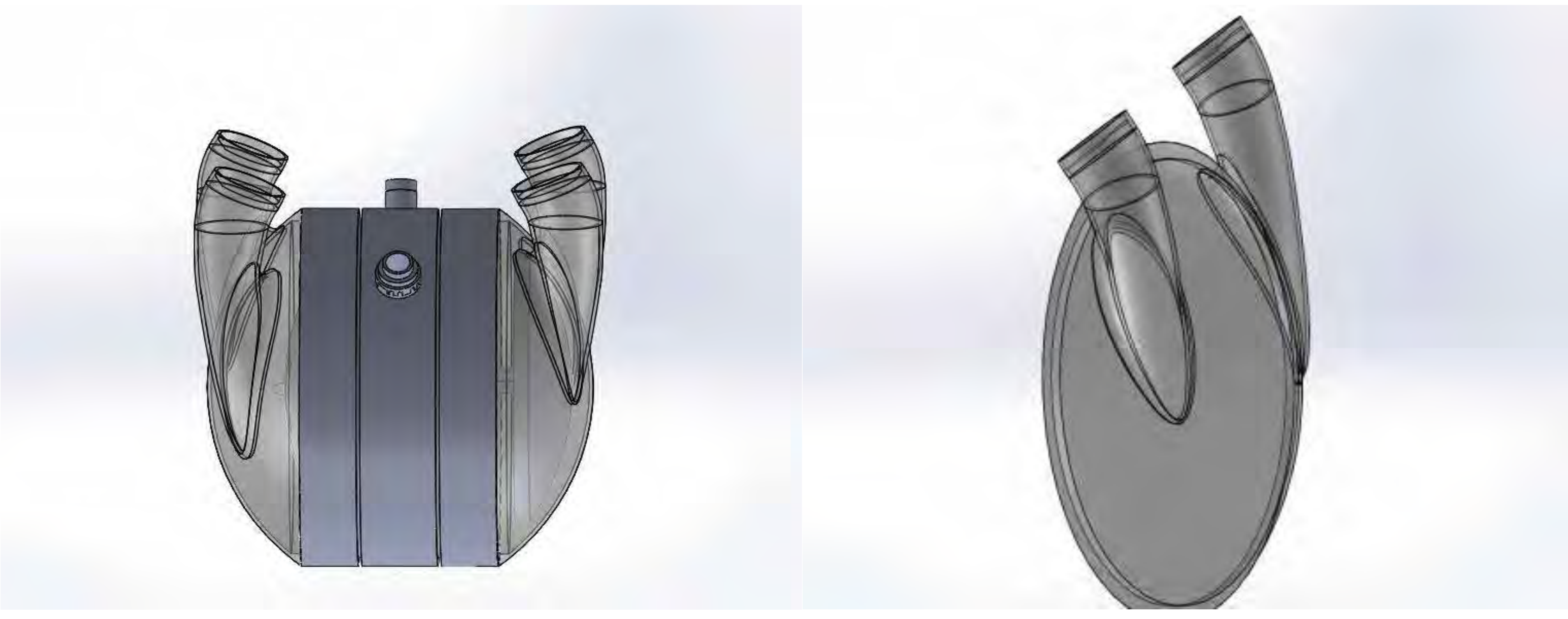

Fig. 1 the final assembly of the artificial heart pump front view and the blood chamber.

Pre-Processing

With the assistance of the solid work Workbench, the designing of the geometry was constructed with less complication.

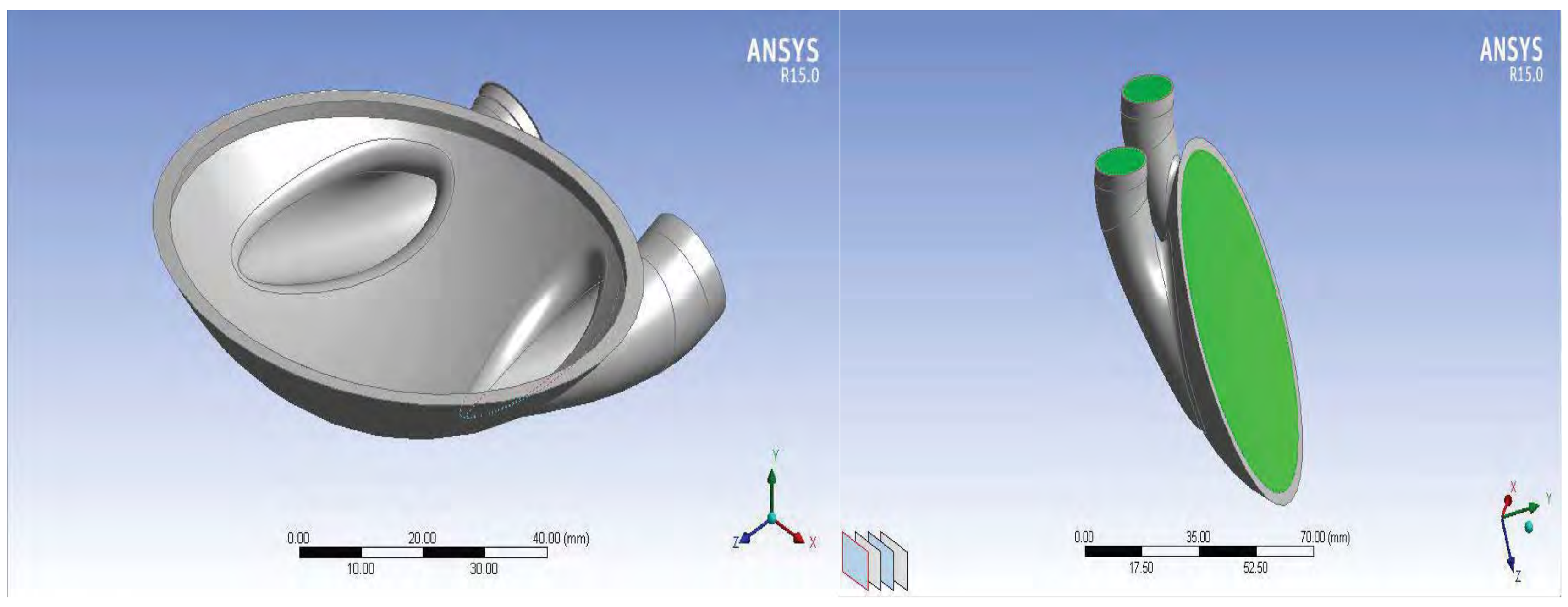

Fig. 2 isometric view of the blood chamber and the blood chamber is fully fill with the fluid

The diaphragm will move forward ,the parameter will control the movement of the diaphragm is the one in the z coordinate and the others will remain constant.

In the figure below the yellow lines shows the state of working in the diaphragm.

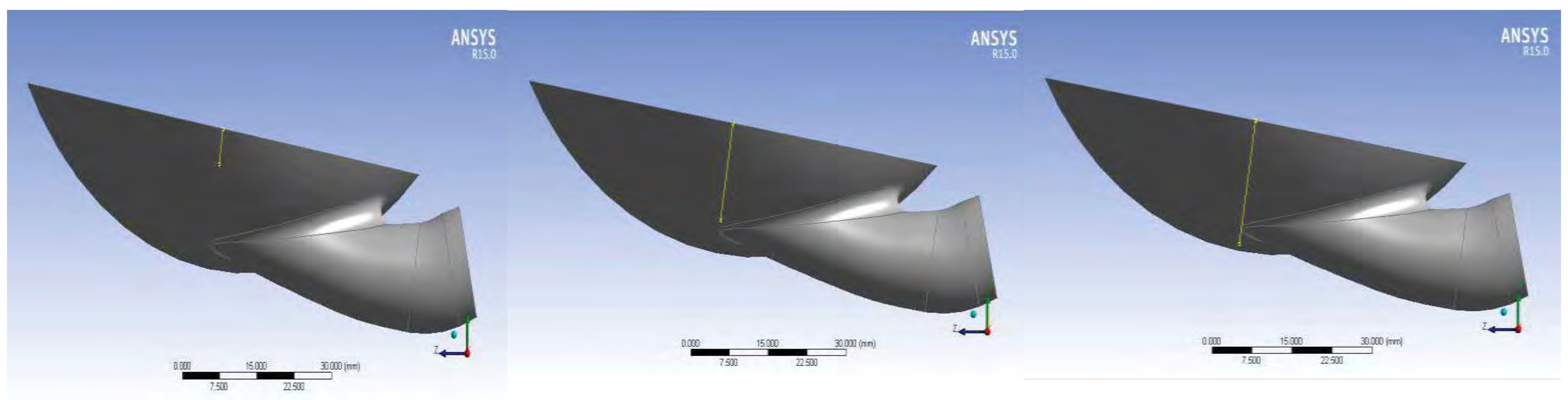

Fig.3 three state of diaphragm work 5mm,10mm,19mm respectively represented by the yellow line.

Result and Discussion

A. Comparison of non-Newtonian model with the Newtonian ones for steady flow condition, under 5 mm state of work for the diaphragm.

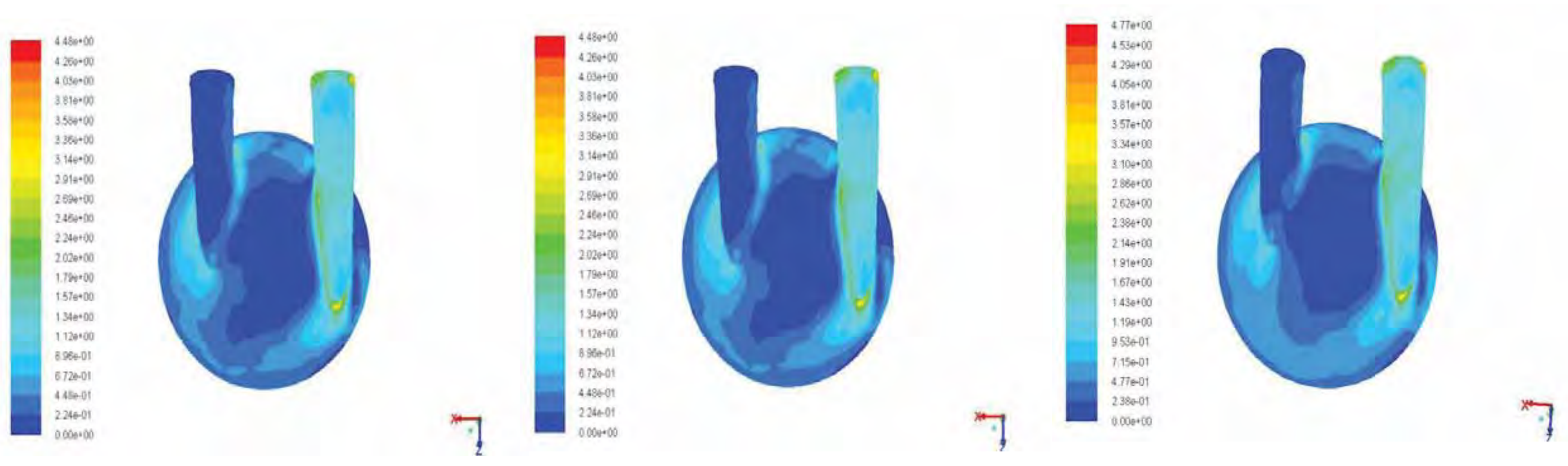

Fig.4 shows the variation of wall shear stress in the Newtonian model, power law model and the Carreau model respectively under 5mm state of work for the diaphragm.

B. Comparison of non-Newtonian model with the Newtonian ones for steady flow condition, under 10 mm state of work for the diaphragm.

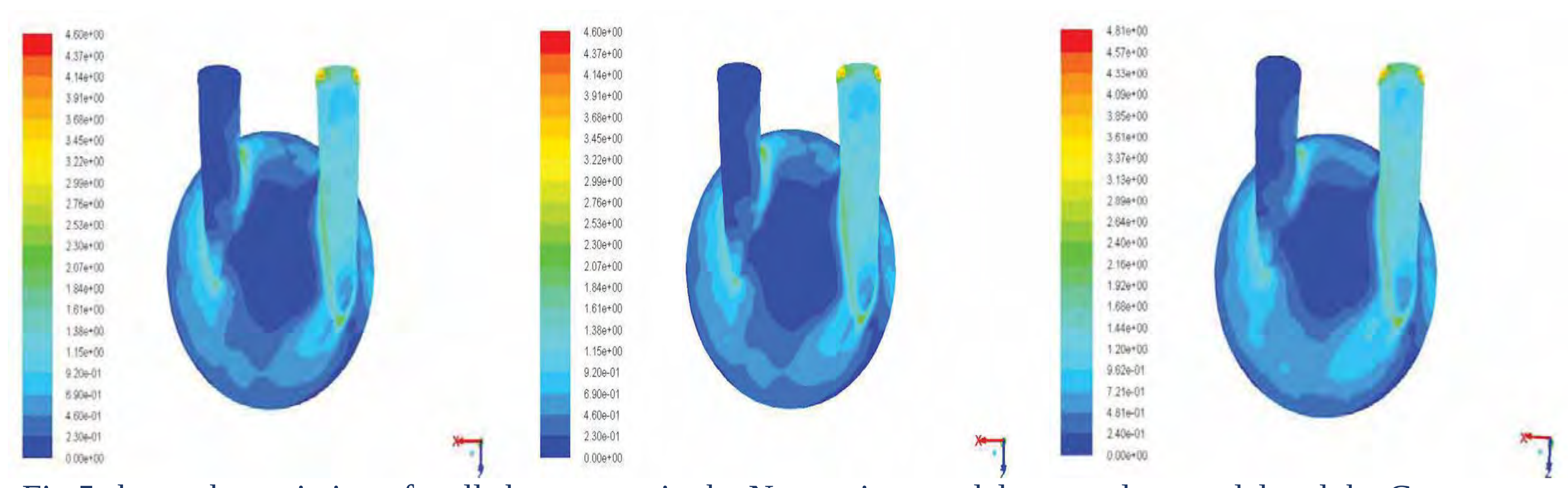

Fig.5 shows the variation of wall shear stress in the Newtonian model, power law model and the Carreau model respectively under 10mm state of work for the diaphragm.

C. Comparison of non-Newtonian model with the Newtonian ones for steady flow condition, under 19 mm state of work for the diaphragm.

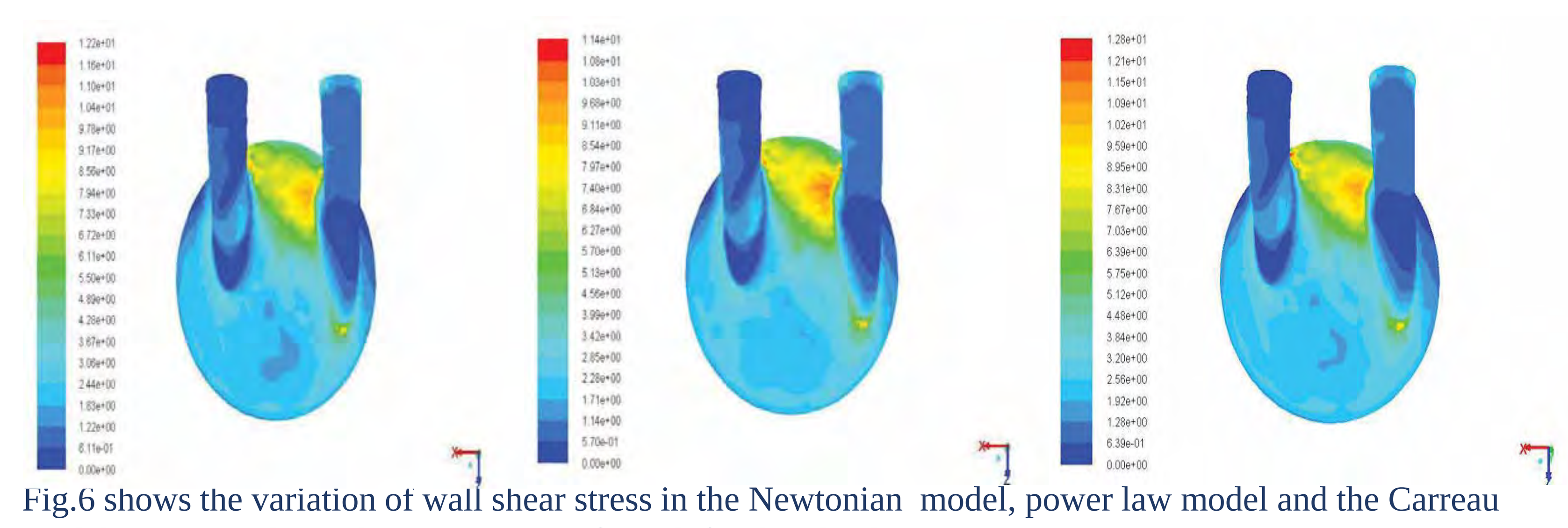

Fig.6 shows the variation of wall shear stress in the Newtonian model, power law model and the Carreau model respectively under 19mm state of work for the diaphragm.

Theoretically these three results are very ideal for blood flow in the artificial heart, the range roughly starting from 0.00319329 Pascal as minimum value and 12.7497 Pascal as maximum value. It was also noted that the power law model shows a difference in terms of the values of stresses that the values are not directly proportional to the amount of pressure represented on it by the diaphragm unlike the carreau model, which showed a positive correlation with the values of the pressure that when we increased the pressure values this results in an increased rate of stress.

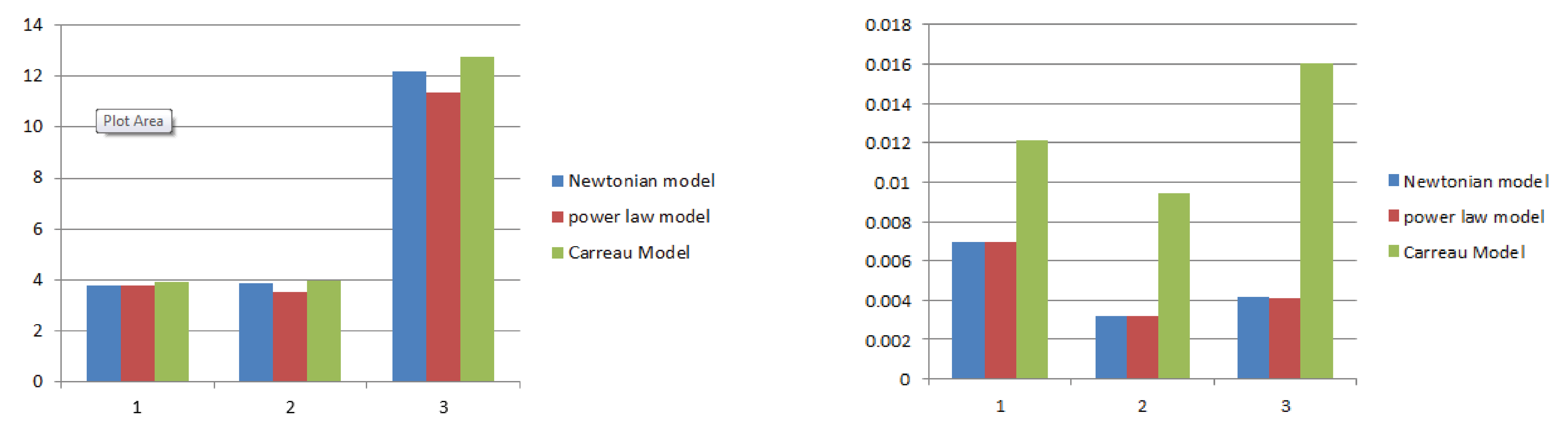

Fig. 18 shows the maximum and minimum values of wall shear stress in the three models under the three stat of the diaphragm work