CHAPTER 3

TEMPERATURE ANALYSIS IN A CENTRIFUGE USING NUMERICAL TECHNIQUE

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3.1 INTRODUCTION

The laboratory centrifuge is a piece of machinery in which centrifugal forces are used to isolate liquids depending on their densities as in Figure 3.1. This rotation-based method induces the aggregation of denser substances at the bottom, whereas less dense substances climb to the peak. Its rotational speed was insufficient for biomedical science the year before, as biomolecules are far smaller and lighter, and different types of biomolecules needed faster speeds to be distinguished from each other. Sophisticated technologies such as temperature monitoring, user-programmed acceleration or deceleration speeds, automated distortion is still present in modern centrifuges today [1]. A temperature increase may affect a circuit's performance and characteristics**.**

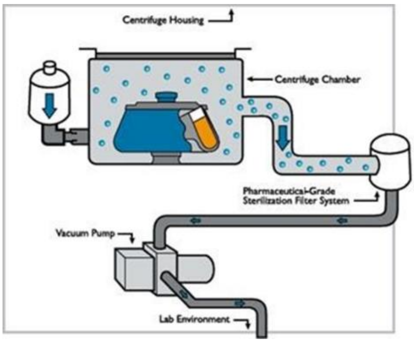


Figure 3.1: Schematic diagram [2].

The component most influenced by a temperature increase include semiconductors, resistors, capacitors, and inductor. All this component has an embedded device temperature dependency parameter to adjust component and eventual circuit activity when conducting a temperature sweep. Using the default nominal temperature of 25°C, which is set in the simulation profile under the tab options, an AC, DC, or transient analysis is normally run. The nominal temperature minimum and the temperature at which model parameters were measure. To carry out a transient study at a specific temperature, the simulation temperature must be defined by choosing temperature and entering a single simulation temperature for the set [3]. This study is focusing analysis on the temperature of the centrifuge which may cause the sample to be used in the damage centrifuge and using parameters in temperature is degree Celsius and speed velocity in revolutions per minute (rpm) is a measure of the rotation frequency, specifically the number of rotations in one minute around a fixed axis.

This analysis is based on the construction of a programmable centrifuge that is used in laboratories, the refrigerator uses the numerical technique used in revolution per minute (rpm) and more data can be shown on each measurement unit by radian/second (rad/sec). A systematic system for collecting specimens is key to precise and consistent measurement of coagulation [4]. Effort was made to define the most suitable methods for obtaining, processing, and preserving specimens for coagulation research, including a guideline for centrifuge samples at room temperature. However, there is no conclusive proof that centrifugation at alternative temperatures could substantially affect coagulation test result. In both instances, the venous accesses were clear, and no hemolyzed or lipemic specimens were detected. Growing patient's tubes were carefully combined, pooled, and eventually separated into three similar 4-ml aliquots

Refrigerated centrifuges to control the temperature inside. The compressors are normally either on or off, resulting in cooling or not cooling, and may result in large temperature differences in the rotor, and therefore the sample test. Centrifuge that controls the temperature around the set point by regulating the compressor function, provide higher consistency in the temperature and protect your samples from temperature fluctuations. Continuous cooling can ensure the samples remain at the correct temperature until they are able to be collected after the run is done. Other centrifuge use air temperature instead of sample temperature, which speed up cooling down but does not reflect the sample temperature inside [5].

For refrigerator centrifuge, temperature is lower than current temperature shown by centrifuge. To centrifuge reduced temperature samples in storage in the external refrigerator, the centrifuge chamber, rotor, and centrifuge container must e pre-cooling to the predetermined temperature. It causes minimalization of temperature differences. Initial cooling may be activated by cooling system automatically set proper parameters to obtain demanded temperature the fastest way. The power of the cooling system, the shape of the rotor, the rotor speed, ambient temperature, and the accuracy of the temperature stability of ± 1ºc is determined by the installation place of the temperature sensor. Centrifugation is an exothermic process in which heat is produced by friction with the air in the centrifuge chamber and the different parts of the rotor. This heat depends on multiple factors such as the type of rotor or its speed. Therefore, centrifugation cycles can be affected by temperature changes. Centrifuges are designed to minimize temperature increase inside the chamber by means of three different systems: in the case of non-refrigerated centrifuges using a forced ventilation system to remove the heat from the centrifuge chamber and suck in ambient temperature air.

3.2 METHODOLOGY

3.2.1 Design Process

The centrifuge temperature analysis software is designed for the important purposes of numerical simulation, a step at the point of selection at the samples performed using a centrifuge. Initially, the program must read the information on the parameters need for using the geometry model. Geometric shapes are analysing at a different temperature which can be distinguished at different temperature and under normal conditions. The design process of this project relied heavily on the research of exiting centrifuge as in Figure 3.2, Figure 3.3 and Figure 3.4. This design for rotor has buckets that start off a vertical position, but during acceleration of the rotor swing out to a horizontal position so that during centrifugation, the tube and the solution aligned perpendicular to the axis of rotation and parallel to the applied centrifugal field, the tube returning to its original position during deceleration of the rotor. The tube is in a hole rotor body set at a fixed angle between 22℃ - 40℃ to the vertical axis. Another rotor is designed to minimize the wall effect that is encountered in swinging-bucket and fixed-angle rotors and to increase the sample size. The centrifuge architecture has a normal frequency which is unique to its geometry and properties. Therefore, to ensure that the natural frequency did not interfere with the rotor's then frequency, it became important to calculate the natural frequency of the device, such that we can realize the speed limit we could comfortably use the centrifuge. However, this proved much too difficult as the centrifuge structure is complicated when it comes to measuring natural frequency. Therefore, decide to use Ansys to assess the centrifuges to normal frequency.

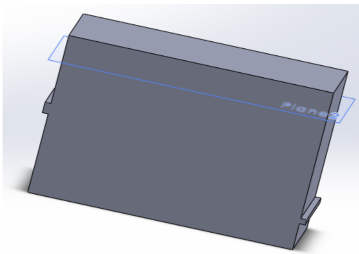


Figure 3.2: 3D image after using the SolidWorks

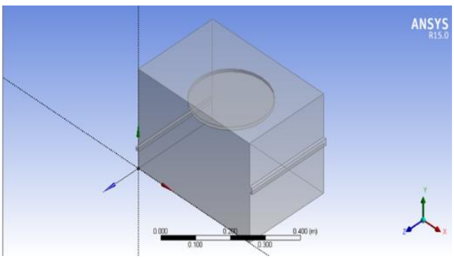


Figure 3.3: 3D design in Ansys Workbench

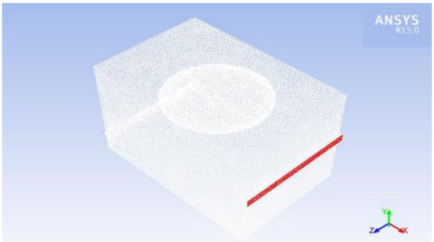


Figure 3.4: Design after apply Mesh for this model

After modelling the frame in Ansys, setting the appropriate material properties and fixed support, and generating a mesh for the system and can view more details on each measurement unit rad/sec.

3.2.2 Numerical Modelling

Numerical modelling was performed using Ansys software to know high-risk temperature to affect the sample. Refrigerated centrifuge the temperature and rotor swing are different value depends on the size centrifuge. The following procedure for the separation of the nuclear, membrane and cytoplasmic cell fractions using a centrifuge in brief.

3.2.3 System Block Diagram

The block diagram from Figure 3.5 shows how the system of the project will be works. Initially, as the primary part of the project, the project begins with the starting block. In addition, SolidWork will be attached to the starting block for 3D design temperature in the centrifuge. After that, the 3D design of the SolidWork will be imported into the ANSYS software and the ANSYS will be in the analysis block 3D for the inflow and outflow temperature centrifuge, so the analysis data will be obtained there in the form of geometry design. Basically, the ANSYS is al methods for interacting with the ANSYS solver functionality. Lastly, the geometry data will be sent into the computer software known as ANSYS to do color image mapping from the data received.

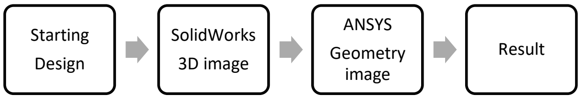


Figure 3.5 Block diagram proses analysis.

3.2.4 Table of 3 Simulation

The intended outcome of this research, to determine the refrigeration effect on the tube during rotation of centrifuge that benefits biomedical engineering. Also, the expected result will be affected by the simulation and effect of the result through this research to determine the optimum operating condition. This project is supposed to generate temperature analysis, hoping that biomedical engineering centrifuges are designed to last. The durability is strengthened by the reduced chamber environment provided by the FRS, which reduces stress on the cooling compressor, the drive train, and the rotor. Lastly, this proposes y using the software called ANSYS on the computer. This mapping will be vital for temperature analysis in the centrifuge. This analysis uses the three simulations for three-speed rotation and four temperature to know effect at rotor in the centrifuge. The cooling system can help speed rotation in good condition. This analysis can be referred to base on the Table 3.1 below.

Table 3.1: This table show 3 simulations in the analysis

No	Speed Rotation (RPM)	Temperature (ºC)	Result
1	2250RPM	22ºC	Result 1
		28 ºC	Result 2
		34 ºC	Result 3
		40 ºC	Result 4
2	4000RPM	22 ºC	Result 5
		28 ºC	Result 6
		34 ºC	Result 7
		40 ºC	Result 8
3	7500RPM	22 ºC	Result 9
		28 ºC	Result 10
		34 ºC	Result 11
		40 ºC	Result 12

3.2.5 Summary of Methodology

The analysis consists of design using software SolidWorks and ANYSY Workbench. Use 3D images in SolidWorks software and import them to Ansys. Using three simulation at three speed velocity at the solution is 2250rpm, 4000rpm, 7500 rpm and four temperature 22 °C,28 °C,34 °C,40 °C. In order, to see the comparison of velocity and temperature, twelve results must be produced. After that, to use the result add mesh to the 3d image. Detailed and justified methodology will guarantee reliable result and this result is presented and discussed in the following chapter.

3.3 RESULTS AND DISCUSSION

This project of temperature analysis in a centrifuge on the observation of the system's functionality by speed velocity data and some temperature to use geometry design. The capacity of the temperature analysis range measure in the centrifuge of this project can be evaluated by performing a repeated test. This analysis can use lowers the load on the refrigeration and drive, therefore improving the overall reliability of the system design. Advantages of the design, such as improved rotor speed, tube ability and volume of the rotor, as well as precise temperature control.

3.3.1 Result 1(R1) use 2250RPM in temperature 22 ºC

Result 1 temperature shows the same result, set to 22 ºC and get 22 ºC at speed velocity 2250rpm after the spin.The following Figure 3.6 shows the resulting R1 after the spin.

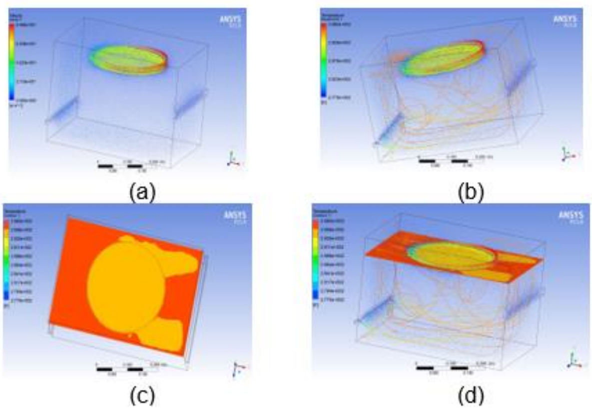


Figure 3.6: (a) Velocity vector by the magnitude of the velocity plotted at Rotor (cylinder); (b) Line of direction by absolute magnitude of temperature within the wall centrifuge; (c) Plotted convective heat flux contour on the Rotor plate; (d) Overview of the rotation process and temperature of within the centrifuge

3.3.2 Result 2 (R2) use 2250RPM in temperature 28 ºC

The set temperature is at 28 ºC at R2, the temperature change after the spin is 24 ºC, at speed velocity 2250rpm, so the temperature decreases by 4 ºC. The Figure 3.7 below shows a temperature drop of 4 degrees Celsius and the phase of rotation and temperature within the centrifuge. Table 1.2 to use the results after rotation to show the effect of 3 simulations and compare the 4 temperatures. Only one sample is used to working this centrifuge with a cooling system to control the temperature in rotor centrifuge the best solution. The samples are sensitive to temperature and a centrifuge with refrigeration and temperature control options is required. The centrifuge is used for processing blood bank samples so that the sample is not damaged, and the results on the table prove that some simulations cannot be used.

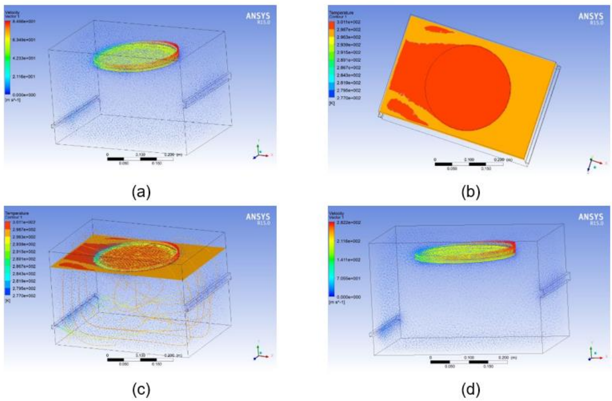


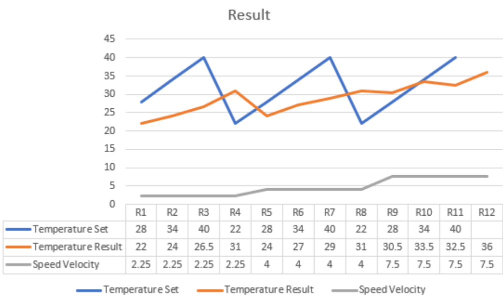
Figure 3.7 (a) Line of direction by absolute magnitude of temperature within the wall centrifuge; (b) Plotted convective heat flux contour on the Rotor plate; (c) Overview of the rotation process and temperature of within the centrifuge and (d) Velocity vector by the magnitude of the velocity plotted at Rotor (cylinder).

Table 3.2 Value result after Run.

No	Speed Velocity (RPM)	Set (ºC)	Result (ºC)
1	2250	22	22
		28	24
		34	26.5
		40	31
2	4000	22	24
		28	27
		34	29
		40	31
3	7500	22	30.5
		28	33.5
		34	32.5
		40	36

3.3.3 Graph for Result Simulation

This graph is using the increase and decreases the result from R1 to R12, the use of this analysis, the 3 lines at this graph perfectly fit for use understanding the result and making a comparison or showing relationships between the temperature and speed velocity. In addition, the three-line for the blue color is temperature set, the red color for the after temperature and the green color for speed velocity. on these lines, more able to understand than the given table. On these lines, better able to comprehend than the Figure 3.8. This graph shows all result temperature and 3 simulations



	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
Temperature Set	28	34	40	22	28	34	40	22	28	34	40	
Temperature Result	22	24	26.5	31	24	27	29	31	30.5	33.5	32.5	36
Speed Velocity	2.25	2.25	2.25	2.25	4	4	4	4	7.5	7.5	7.5	7.5

Figure 3.8: This graph shows all result temperature and 3 simulations.

The graphs in Figure 3.9 shows the increase and decrease of the previous temperature. To facilitate this analysis is studied, the graph below also according to the temperature at that speed. Based on the graph, on the x-axis is the value of speed velocity value while the y-axis is the temperature value. Therefore, at the temperatures 22ºC, 28 ºC, 34ºC and 40ºC, the graph is divided into four, followed by temperature values after this analysis is studied.

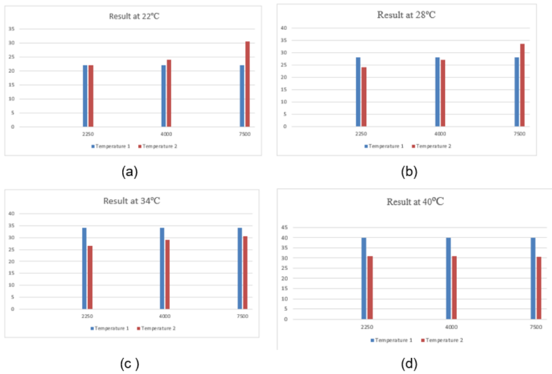


Figure 3.9 (a) This graph shows the resulting temperature at 22 ºC; (b) 28 ºC (c) 34 º C; (d) 40 º

3.4 CONCLUSION AND RECOMMENDATIONS

The summary of this study, the optimum starting temperature for this analysis is 22 degrees Celsius at a velocity of 2250 revolution per minute for the light spin and heavy spin at the maximum value is 40ºC at speed 7500 rpm. To find out the detailed geometry studied, the 3 Simulation and 4 temperature to analyze with the use of ANSYS Workbench software. The Ansys Workbench analysis software is used to simulate refrigerator centrifuge computer models to analyze strength, temperature distribution, speed velocity, pressure, fluid flow, and others. For the analysis of 12 results, this Ansys is very useful and can distinguish temperatures that cannot be used and can be used at 3 speeds. Therefore, the best temperature is R5 because that temperature the starting point for the sample to be separated by the light spin refrigerator centrifuge

3.5 ACKNOWLEDGEMENT

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