The modern Heart-lung machine can perform the following tasks:

- 1- Oxygenation of blood
- 2- Controlling the patient body temperature.
- 3- Adding medication and anesthetic drugs to the blood through the machine during the surgery.
- In spite of these advantages, there are some substantial disadvantages in this machine, some of these are:
- 1- Formation of blood clots which may lead to a stroke, heart attack or kidney failure.
- 2- This machine can also trigger inflammatory process that can damage many body systems and organs.
- 3- In rare cases, memory loss may occur.

Because of these disadvantages, biomedical engineers are developing the surgical tool, imaging and robotics technologies for what is known "minimal invasive surgery" instead of open heart surgery, and thus elimination the need for this machine.

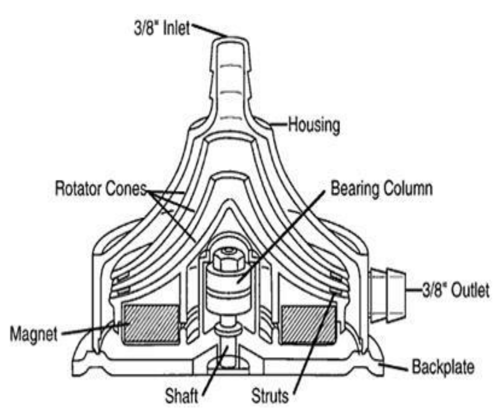
- **The Heart Lung Machine is composed of three main parts:**
- 1- The Pumps: these pumps are required to circulate the blood between the body and the machine.
- 2- Oxygenator: this part is required to oxygenate the blood.
- 3- Heat Exchanger: this part is necessary to regulate the temperature of the blood and thus the temperature of the body.

- **Design Aspects of Heart-Lung Machine**
- To serve the natural function of heart and lung, the machine should be able to arterialize up to 5 liters per minute of venous blood from 65% oxygen saturation to more than 95%, the carbon dioxide must be adequate. It should cause the least trauma and damage to the blood particles.
- **<u>Pumps design,</u>**
- Peristaltic pumps are used for providing flow through the systemic line back into the patient. **The pump must be designed to have flow rate up to 5 liters per minute with a pressure head up to 200mm Hg.** The roller occludes the tube and displaces the fluid. The pump should be double roller that has a wide flow range which is varied by varying the speed of rotation.
- The pump rotation speed should be variable from 0-180rprn. The pump has two heads and each head is driven by 1/8 hp single phase AC motor. Speed

variation can be accomplished by Voltage/frequency speed variation principle.

- Complications associated with roller pumps includes: malocclusion, miss calibration, or miscalculation including setting the wrong tube size into the pump controller; fracture of the pump tubing; loss of power; spallation; and pumping of large amounts of air.
- If the outflow becomes occluded, pressure in the line will progressively rise until the tubing in the pump ruptures or connectors and tubing separate. This can be avoided by use of a pressure-regulated shunt between the outflow and inflow lines of the roller pump or use of servo-regulation of the pump to arterial line pressure so that it turns off when excessive pressures are detected.
- If inflow becomes limited, the roller pumps will develop high negative pressures producing cavitation, and microbubbles.
- Centrifugal pumps consist of a nest of smooth plastic cones or a vaned impeller located inside a plastic housing. When rotated rapidly (2,000 to 3,000 rpm), these *pumps generate a pressure differential that causes the movement of fluid.*
- Unlike roller pumps, they are totally nonocclusive and afterload dependent (i.e., an increase in downstream resistance or pressure decreases forward flow delivered to the patient if no adjustment is made in the rpm). This has both favorable and unfavorable consequences.
- Flow is not determined by rotational rate alone, and therefore a flowmeter must be incorporated in the outflow line to quantitate pump flow. Furthermore, when the pump is connected to the patient's arterial system but

- is not rotating, blood will flow backward through the pump and out of the patient unless the CPB systemic line is clamped. This can cause exsanguination of the patient or aspiration of air into the arterial line. Thus, whenever the centrifugal pump is not running, the arterial line must be clamped, or a check valve is used to prevent this problem .
- On the other hand, if the arterial line becomes occluded, these pumps will not generate excessive pressure (the maximum is only about 700 to 900 mm Hg) and will not rupture the systemic flow line. Likewise, they will not generate as much negative pressure and hence as much cavitation and microembolus production as a roller pump because the maximum is only about –500 mm Hg if the inflow becomes occluded.
- A reputed advantage of centrifugal pumps over roller pumps is less risk of passing massive air emboli into the arterial line. This is because they will become deprimed and stop pumping if more than approximately 50 mL of air is introduced into the circuit. However, they will pass smaller but still potentially lethal quantities of smaller bubbles.



Email (amal.alzubedy@gmail.com)