Project Statement

Thermo-acoustic Cell Sorter (T.A.C.S)

Team #9
Nimesh Patel, David Pillittere, Mike Lalli

Sponsor: Dr. Shiva Kotha

Shiva P. Kotha, Ph.D.
Asst Prof of Biomechanics and Biomaterials
University of Connecticut - Storrs
Biomedical Eng Program, Mechanical Eng Dept
260 Glenbrook Rd, Unit 2247
Storrs, CT 06269
**Statement of Need**

Recent advances in genetic engineering have allowed for the modification of a cellular genome to express fluorescent proteins. Additionally, cells are being tagged with fluorescent markers in medical research and diagnostics. Dr. Shiva Kotha at the University of Connecticut has identified that there is an increasing need for a cost effective and reliable sensor to detect and collect these fluorescent cells and measure their intensity.

**Introduction and Overview**

The proposed solution to meet Dr. Kotha’s needs is a thermoacoustic cell sorting device. The finished device will sort cells into three different collection bins based on their level of fluorescent intensity. The fluorescent cells will flow through micro-fluidic channels and be excited by a laser diode. This will cause an ultrasound wave with a frequency that is dependent on fluorescent intensity. The wave will be measured by three Poly-Vinyl Diflouride (PVDF) membrane transducers with varying thicknesses allowing for sensitivity to three different frequencies ranges. Based on which PVDF membrane is excited, the cells will be made to flow into the appropriate collection bin. A new actuating material, made of nano-porous particles which have ions moving into and out of them upon the application of current, will be made to use as a gate to control the movement of the cells.
First, one channel will be used for testing. Proof of concept will be performed using three channels.

**Realistic Constraints**

In order to successfully create the Thermoacoustic Cell Sorter we first must have realistic expectations and limitations for this project. There are many constraints to be aware of for the success of our project. The first constraint is the economics of our final device. The T.A.C.S. must be economically efficient and feasible. Ultimately the smaller the model, the more advanced materials will be needed in order to assemble the final device. There are also many components that go into this design such as Microfluidic channels, laser diodes, PVDF membranes, and an actuating material that regulates the direction of flow. The price range for the components is not yet known.

Environmental constraints come into consideration when planning the assembly of the Thermoacoustic Cell Sorter. The T.A.C.S. will be used to sort genetically altered cells which express desired fluorescing proteins and store them in specific bins. Depending on the caliber of alteration of the cells there may need to be a specially isolated bin for the cells in order to keep them contained from the environment. When the life span of the device has passed and it turns into waste, it needs to contain elements that will not disrupt the environment. Sustainability will also be considered during the creation of this device. It may be possible to use recycled materials in order to achieve a sustainable product, although this may hinder the economical constraint of the project due to potentially higher costs for sustainable materials. Another issue that relates to the size of the final device is the site of manufacturing. If the manufacturing of this device requires technology not available on the University of Connecticut campus then another manufacturing laboratory may be required to assemble the device.

Ethics in engineering is very important. The T.A.C.S. device is no exception and must be analyzed ethically. Depending on the type of genetically altered cell that will be getting sorted, it may raise a few concerns to the public. The toxicity of the genetically altered cells also brings up the question of health and safety. When designing this device it is necessary to be aware of any health-threatening elements of the device. The T.A.C.S. contains electrical components which will need to be built so it will be safe for the user. Political and social constraints also play a part in the creation of this device. Genetically altering cells is a sensitive subject to many groups of people, therefore a device that assists in the study or science of such cells may be something to consider for this project.
Questions

First and foremost, where is such a device applicable? If the cells are already stained or have genes which cause fluorescence, are there easier visual-based sorting methods which could be applied?

What are the contents of the fluid in which the cells are flowing? Are there special restrictions because of the laser diode and the ultrasound sensors?

What type of cells are we going to be working with, and how large are they on average?

Would this tool need to be extensible to all cell sizes or would tailoring it to fit a specific type of cells be the best approach?

I imagine that the cells will flow single-file and at regular intervals. Is such an assumption realistic and realizable?

Could the cells clog the channel? Is there a way to recognize this if it happens, or a mechanism to fix it should it happen? We see this particularly as an issue at the interface between the sorter and the holding tank for unsorted cells, as well as at the gates where there could be a cell on the other side blocking an identified cell from coming through the gate way.

After a cell is identified by the ultrasonic sensors, how long do we wait until we open the appropriate gate? Will there be a way for the electronics to track the location of the cells, or will it be a timing issue? Is there any way to notify the program or the operator when a cell passes through the gate?

Will simple water pressure differences be enough to prevent cells from traveling backwards through a gate? Could we place pressure sensors on either side of each gate to make sure that pressure conditions remain optimal for the system to function? If a clog occurs, could the change in pressure be enough to damage the equipment?

What is meant by the following statement, which was in the project description given to us? “Signals from each individual transducer will be averaged (50-100 times per individual cell)” Is this a type of moving average over the waveform which we measure using the ultrasonic sensors?

Other Data

Client: Dr. Shiva Kotha
Arthur B. Bronwell Building Rm. 204
Phone: (860) 486-0370
Fax: (860) 486-5088
E-mail: skotha@engr.uconn.edu
(from ENGR.UConn.edu)