University of Bahrain
College of Engineering
Department of Chemical Engineering

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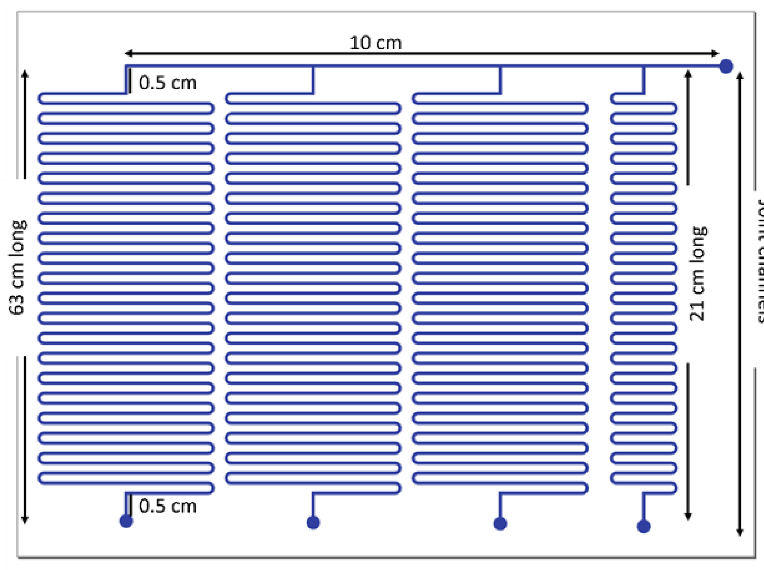
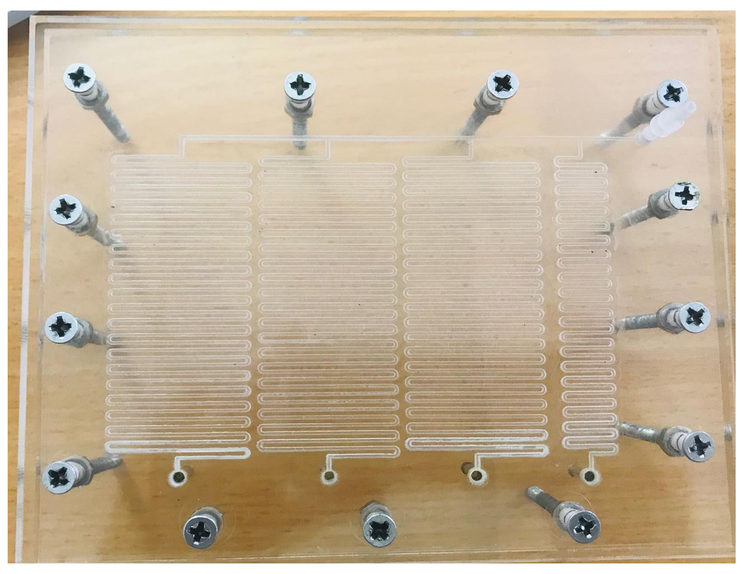
Branched Microreactor for Biodiesel Optimization

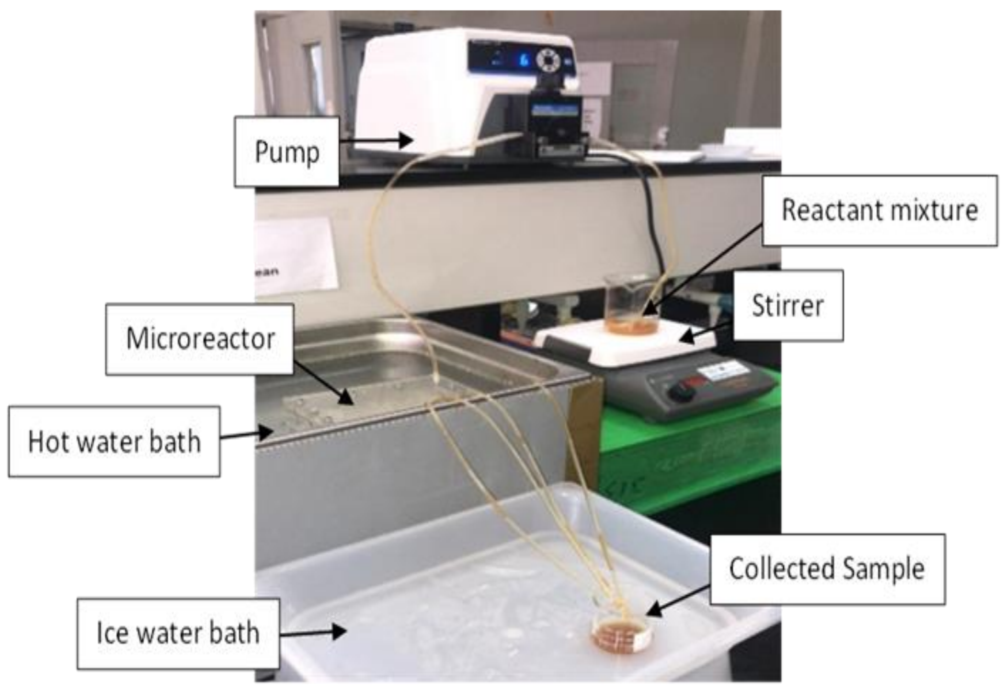
Abstract

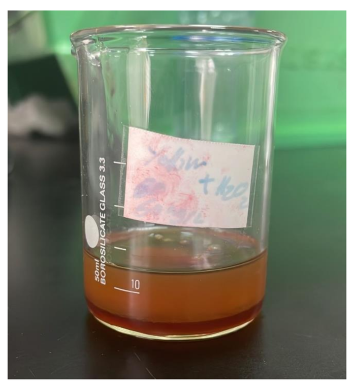
Biodiesel as an alternative for fossil fuel was produced from waste cooking oil and methanol in the presence of NaOH through transesterification reaction in branched microreactor. To get a high throughput of biodiesel, a microreactor with four serpentines was designed and fabricated in this study. The Minitab software was used to design the experiment with different operating conditions (methanol to oil molar ratio, catalyst concentration, and reaction temperature) and optimize the biodiesel yield. The maximum biodiesel yield found to be 97% at MR of 12:1, 1.5wt%, and of 59.4°C, while maintaining an inlet flow rate of 8.5 µL/s.

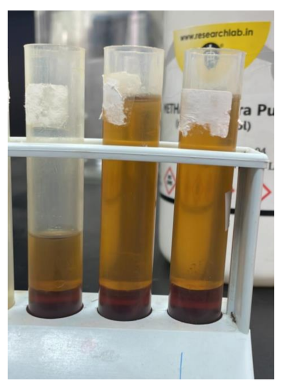
Design and Implementation

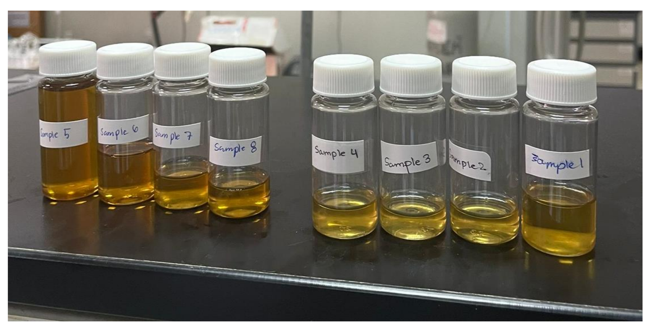












Conclusion

A microreactor with 4 serpentines assembled in one chip was designed and fabricated successfully as an attempt to increases the throughput. The microreactor's performance was examined for biodiesel production. Minitab software was used to design the experiment and optimize the biodiesel yield. The optimum biodiesel yield was found to be around 83% when the reaction temperature, methanol to oil molar ratio, and the catalyst concentration were 59.4°C, 12:1, and 1.5 wt%, respectively, at an inlet flow rate of 20 µL/s. However, applying lower flow rate (8.5 µL/s), achieved a yield of around 97%, which successfully proved that the designed microreactor can meet Europe % yield standard value.

Objective and Motivation

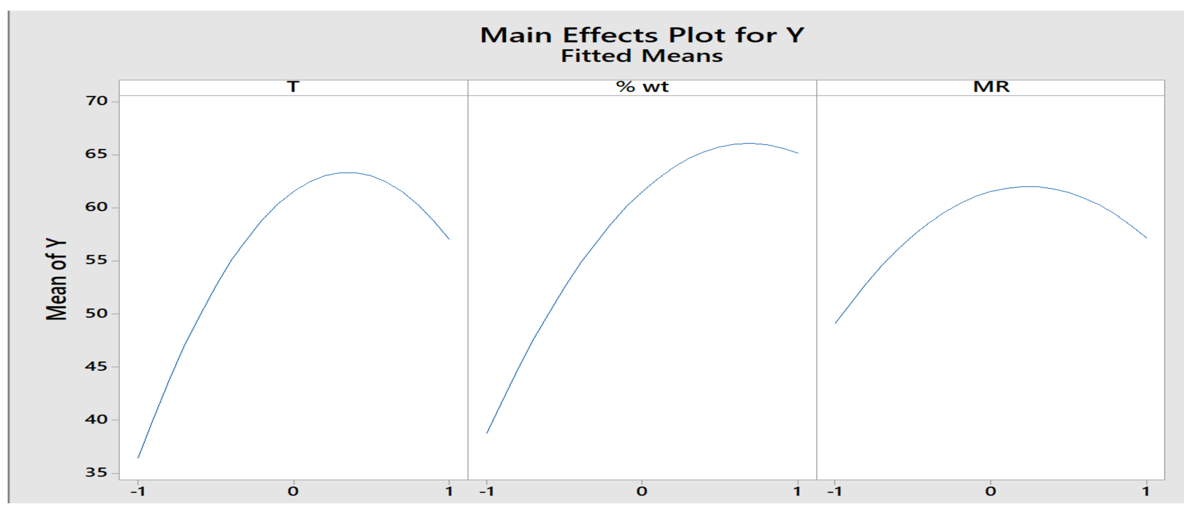
Recently, fossil fuel demand has increased in various fields, while its resources have been reduced with time, and environmental pollution has intensified. Thus, to overcome these problems, biodiesel as a renewable fuel was produced, since its a green and sustainable transportation fuel.

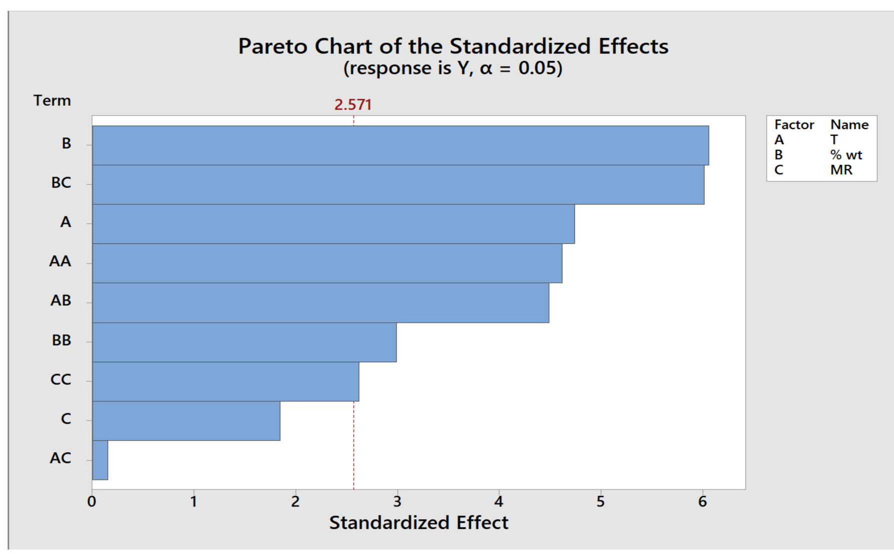
Waste cooking oil was recycled and used as the primary source of biodiesel production to overcome environmental and economical issues.

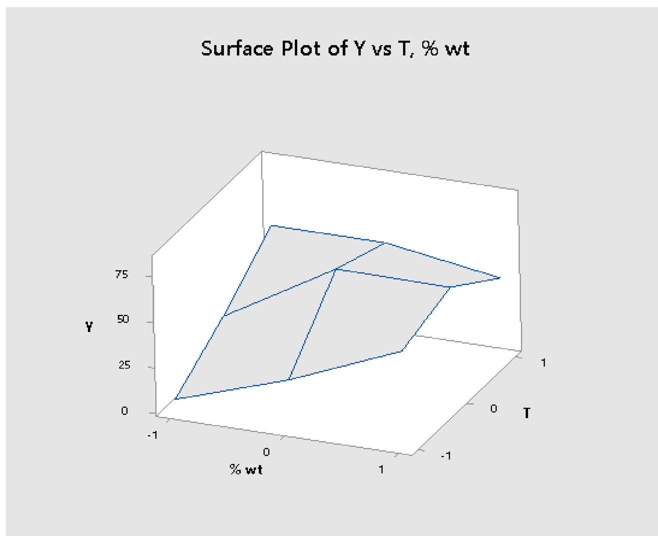
Microreactors are found to be favored over the conventional reactors. They help in overcoming the limitations of mass transfer and heat transfer in the transesterification process, due to their large surface to volume ratio. However, production amount of microreactors is limited due to the microscale of miniaturized systems. Therefore, to get a high throughput of biodiesel and to overcome the issues of using external tubes and connections (such as leakage problems), a microreactor with four serpentines assembled in one chip was designed and fabricated.

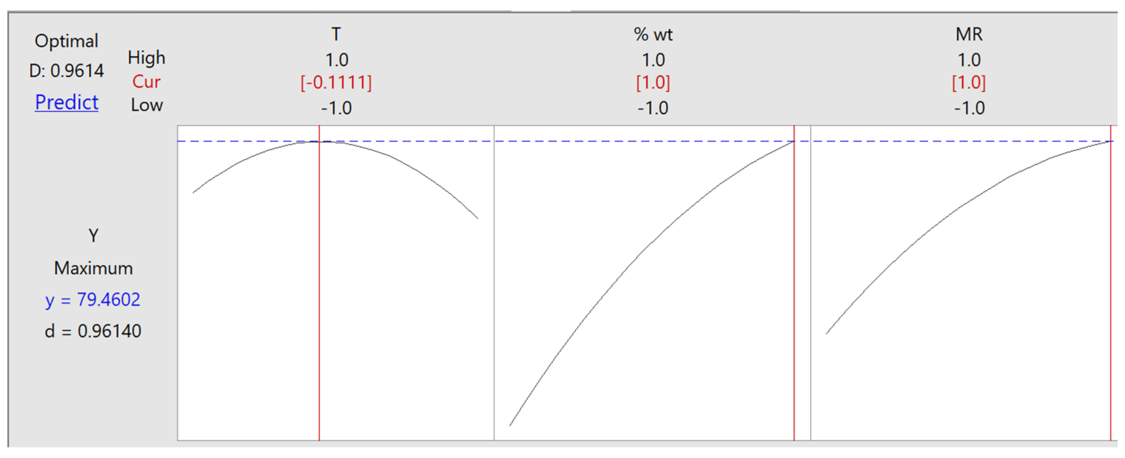
Optimization of the biodiesel yield was done due to it is importance to achieve the best conditions that maximize the biodiesel yield.

Results









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