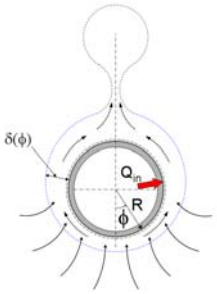
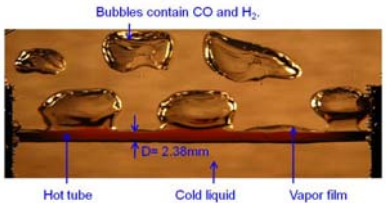
M.Eng Project
"Design of a Chemical Reactor that Builds Itself"

Modern chemical processing plants are extremely complex and large designs that cost millions of dollars to fabricate and operate. This project concerns developing a new, cheap and simple platform for promoting chemical reaction of organic gases within a vapor film of microscale thickness formed during the so-called "film boiling" process. Film boiling is a mode of heat transfer in which the surface is so hot that bubbles that form on it coalesce and form a vapor blanket. This is a very different process than boiling water in a teapot where a continuous stream of bubbles can be seen at discrete sites on the surface. Figure 1 shows the configuration of film boiling on a horizontal tube, as well as a photograph of film boiling.





Within the vapor film of film boiling, temperatures can be very high to drive chemical reaction of the confined gases. The film of thickness δ in the above figure is the actual reactor volume. The self-assembly of the reactor is implied by development of film boiling as being a natural consequence of transitioning from nucleate boiling (e.g,. boiling water in a teapot) at low heat inputs to film boiling at high heat inputs. One only has to adjust the power input to the surface to create the "reactor" – film boiling – as an entirely passive process

The high temperatures developed in the vapor film as a result of the insulating effect of the gas surrounding the surface creates the potential to convert chemical wastes in a simple manner with this process. Biodiesel production is accompanied by large amounts of glycerine, and film boiling can be used to convert the glycerine formed to a more useful substance - synthesis gas (a mixture of carbon monoxide and hydrogen).

The project itself will involve designing a new containment vessel for the reactant liquid to facilitate vapor removal and chemical detection, arranging for its fabrication (with shop personnel), and assembling and testing the design.

related publication:

W.C. Kuo, K.H. Choi, C.T. Avedisian, W. Tsang "On Using Film Boiling to Thermally Decompose Liquid Organic Chemicals: application to Ethyl Acetate as a Model Compound,", Int. J. Heat Mass Transf., 68, 456-465 (2014).

For more information please contact Prof. Tom Avedisian, cta2@cornell.edu, 6075927915