KESTER WADE

NASA Internship Report

Background on the Intern

Kester Wade is a third year undergraduate student at Stanford University in California, majoring in Chemical Engineering.

Hailing from Diamond Vale, Diego Martin, Kester graduated from St. Mary's College, POS in July 2013 having successfully completed CAPE Physics, Chemistry, Pure and Applied Mathematics. No stranger to extra-curricular engagements, for his seven years at St. Mary’s he was a member of the First Trinidad Sea Scouts Troop which holds a wide variety of water based and scouting activities in addition to numerous community service ventures- even serving as Troop Leader for two years. Furthermore, he was Treasurer on the St. Mary’s Prefect Body 2012-2013, in which capacity he helped guide and mentor younger students on the bases of discipline, academics, and achievement.

Now at Stanford, Kester serves as the President of the on-campus Caribbean Students Association which seeks to spread awareness about Caribbean culture and issues throughout the campus, and wider Bay area. He even spearheads the organisation of annual banquets, roundtable discussions, and the hosting of Caribbean professionals on-campus to help boost Caribbean connectivity of the diaspora in Silicon Valley. Kester also served as Dorm President in both of his years at Stanford, helping to foster dorm community by planning and coordinating extracurricular activities and events. This academic year, Kester is serving as a Resident Assistant in all-freshman dormitory- providing guidance to some eighty-four first year students as they embark on their own Stanford journeys. He even feeds his passion for philanthropy as the Vice-President of Community Service for an unhoused on-campus fraternity (Stanford SigEp), coordinating numerous visits to Soup Kitchens, Blood and Bone Marrow Drives, and several other volunteering opportunities to assist the needy in the Wider Bay Area.

His interest in Chemical Engineering stemmed from a love of Chemistry, Maths and innovation and tentatively focuses on Energy and the Environment. Kester aspires to use his knowledge one day to address major environmental issues on a global scale.

Overview of the Experience

My home for the summer- Ames Research Center- was located within an old Air Force Base in Mountain View, California. Built in the 1950's, the entire NASA campus had a vintage feel, though it was surrounded by the very technological Silicon Valley, and even shared borders with Google. So one major highlight of the experience was living independently- and cooking independently- for the entire summer without necessarily having any family to nurture or care for me.

Yet the most memorable moment was putting my research to the test at my Department's Fourth of July BBQ. As part of our Internship experience, my colleagues and I were all challenged to test out the water filtration capabilities of water filters currently being used in space. So we were all made to fill our own filtration bag with urine, and after allowing the filter to remove the toxic impurities for a day, sample the product as a group the following day. I can now say that I've drunk my own urine!

Furthermore, simply being at NASA allowed me to sit in on deeply interesting seminars and tours on topics surrounding space exploration and planetary issues. Most notably I learnt about revolutionizing the observation techniques employed when exploring a new planet, and listened to a motivational speech from the NASA Administrator on achieving the impossible as a former astronaut and as the first African American to head NASA. And despite NASA being more readily associated with out-of-earth research, I learnt about agency-wide initiatives on the Exploration of the deep seas and oceans (which make up two thirds of planet earth), and even the tracking and limitation of seafood consumption by the ever-growing sushi industry. We were even afforded a tour of the centrifuge- a twenty-foot wide rotating device used to subject astronauts and objects to large gravitational forces, much more than those experienced on earth.

But the biggest-ticket mission at the moment is realising the journey to Mars. While I was only personally involved with the Advanced Life Support perspective of this mission, I was fortunate to learn about many other sets of research. There were so many open houses displaying research on the long-term effects of microgravity on the heart and bones, exploration of self-regenerating power sources, and even the practical and logistical considerations necessary for the successful execution of a three year-long journey in a confined spaceship.

Tasks Undertaken

For ten weeks, I was a part of the Advanced Life Support Group, focusing on the wellbeing of astronauts on the International Space Station (ISS). The key objectives of Advanced Life Support are: to keep the astronaut alive- since there is no alternative in space when systems fail; to provide a habitable environment for astronauts during their long-term mission in space; to optimize the cost of successful advanced life support systems. In the case of the ISS and the mission to Mars, this directly applies to maintaining steady supplies of Oxygen, dealing with Carbon Dioxide and other human waste, constant access to clean water, and maintenance of a sustainable temperature and climate.

More specifically, my team focused on astronaut's access to potable water. Currently, sending just one litre of water to space costs on the order of a million US dollars- considering fuel, material, storage and other costs. Therefore, NASA aims to recycle all of the water already on-site in the ISS. But with continuous usage, water filters require high maintenance as they become clogged by calcium and mineral scale, and are poisoned by the build-up of trace contaminants. Even following NASA's triple redundancy protocol, which involves always having two back-up plans in place, has not been affordable given the high cost of maintaining additional weight on ISS. My group therefore endeavoured to develop a water treatment system that can easily repair itself and last much longer, thus eliminating the need for triple redundancy.

As such, the Water Group (my Sub-Team) drew inspiration from nature to develop a synthetic biological membrane, which consisted of a lipid bi-layer filter. This unique filter would coat itself on the feed side- side of impure water- with fatty acids, which would bond themselves to the aforementioned water impurities. Upon excessive impurity build-up, the fatty acid layer would be peeled off of the filter and replaced, thereby leaving the filter unharmed and renewed for usage.

In order to produce the fatty acids that would preserve the bio-membrane, various bacteria must be grown and maintained. I was therefore tasked with determining the flow of Oxygen and Carbon Dioxide across the membrane in order to prepare for tailoring the ideal conditions for the bacteria of choice. As such, I simulated the flow and use of a model bio-membrane filter under room temperature and pressure conditions, taking regular measurements of dissolved Oxygen, and pH for the presence of Carbon dioxide in solution. I therefore engineered a vacuum-sealed system (See Diagram 1) to accurately observe the flow of Oxygen and Carbon Dioxide across the bio-membrane.

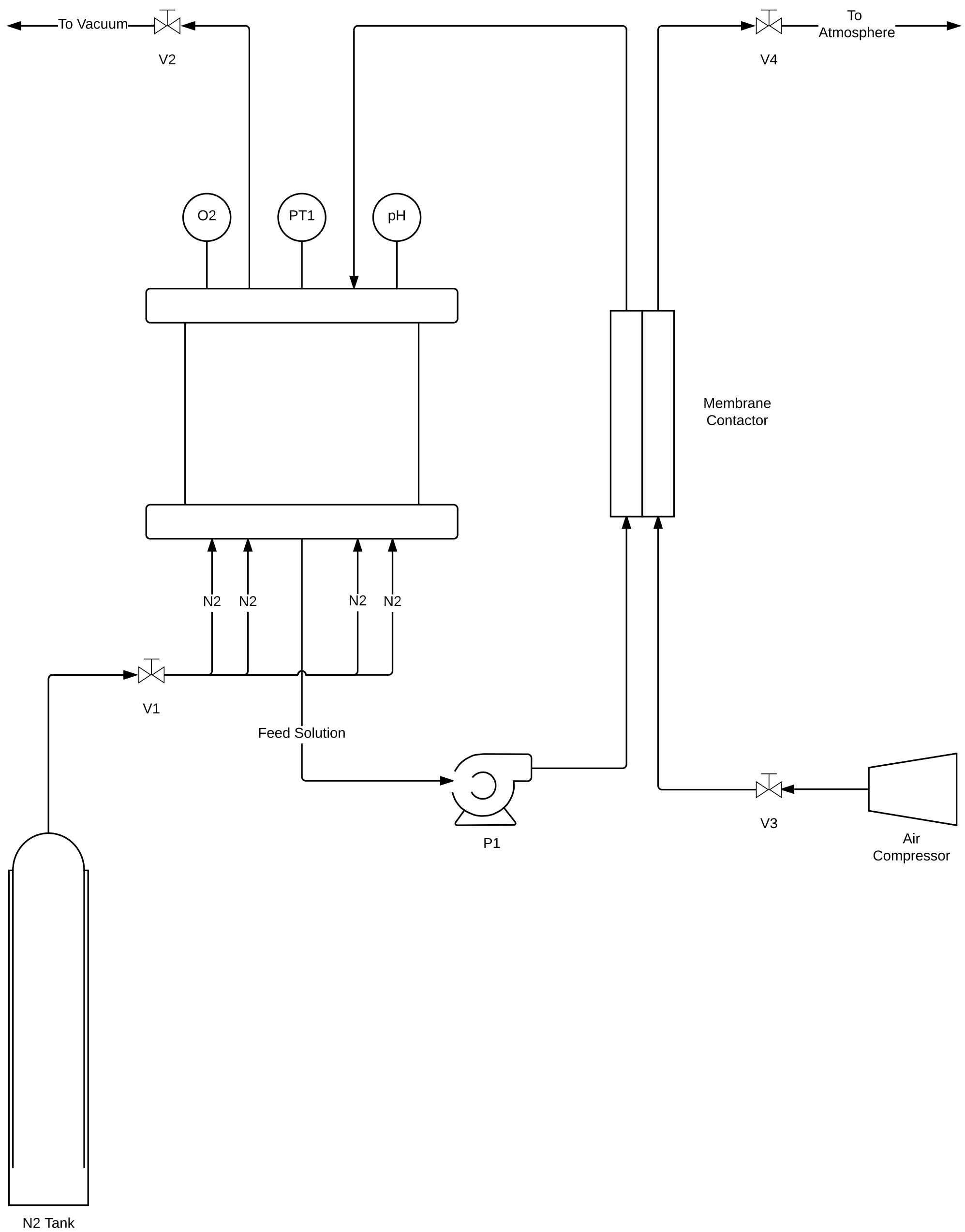
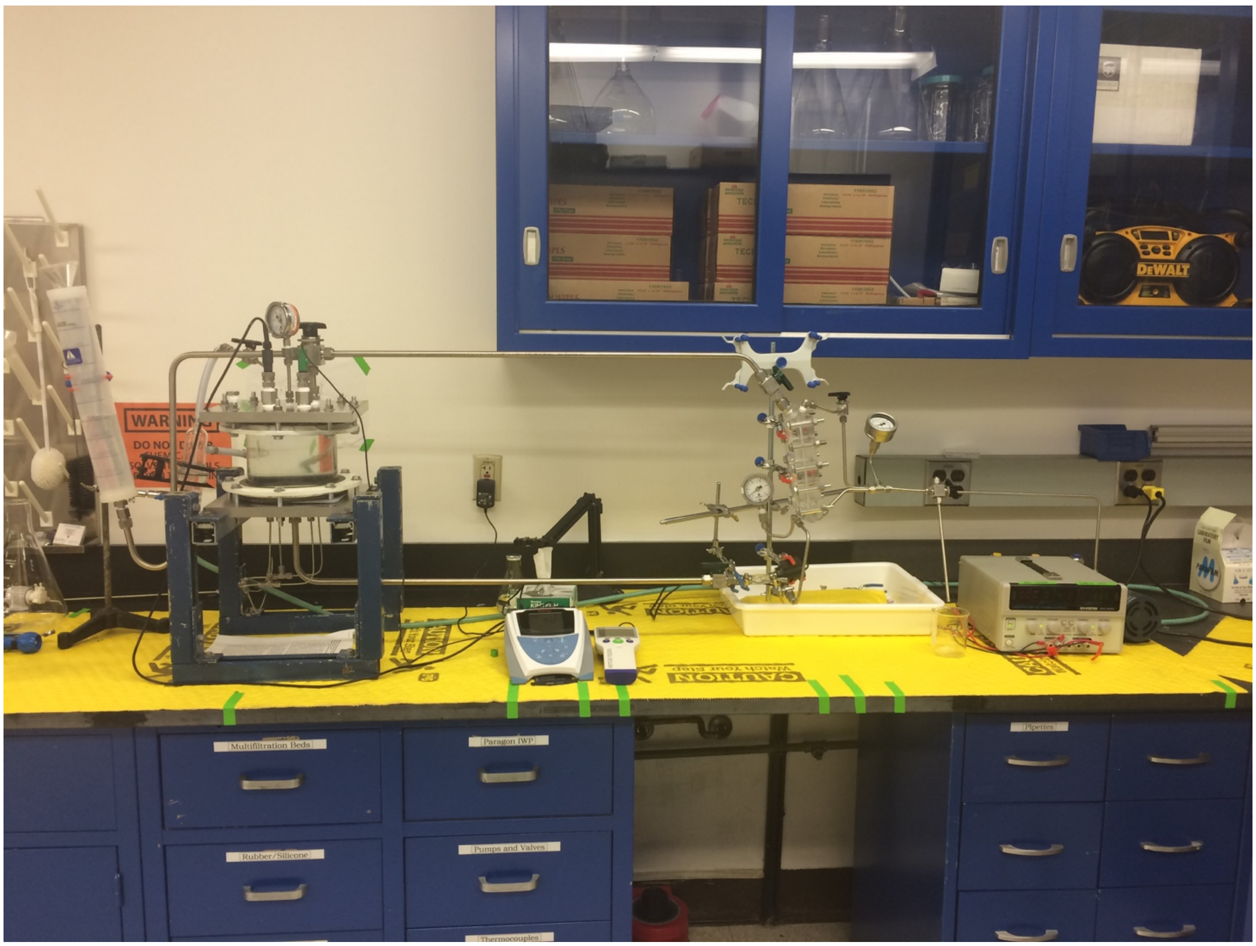


Diagram 1: Milestone 18 Test System for O_2 and CO_2 flow measurement

In designing the system, I applied general chemistry concepts like forward osmosis (when a fluid moves from high to low concentration), chemical analysis to identify and choose the best materials for the system, plus planning to employ N_2 gas flushing before every experiment to remove all components from the gas chamber that might have affected the O_2 or CO_2 concentrations. Furthermore, as I undertook building the system- all by myself- I was able to practise quite a bit of mechanical engineering, architecture and plumbing. Most challenging objective was fully vacuum sealing the system to eradicate atmospheric leakage that would affect result accuracy.

The results collected are scheduled to be used in the selection of suitable fatty acids, and the corresponding bacteria (fatty acid producers) that would thrive in the conditions observed.



<u>Diagram 2: Completed Test System</u>

Lessons Learnt

Some general lessons that the experience taught me include:

Interest in Energy & the Environment: As a budding Chemical Engineer, I aspire to solve issues surrounding Life, Energy and the Environment. This experience with the Advanced Life Support group provided a perfect opportunity to work on a project with huge environmental implications, and further fuelled my passion for the area of focus.

Importance of Experience: This internship really reassured me of the value of learning outside of the classroom. While there is great value to in-class learning, there is so much to learn from hands-on experiences whereby one can apply the theories learnt in class. There are so many key lessons that one is unable to pick up from a rushed classroom setting, and I definitely picked up a few skills on the go from working on my own in the lab, and asking for help while undertaking difficult tasks.

Communicating Science Is a Vital Skill: After sitting in on countless presentations over the summer, I came to appreciate why scientists need great communication skills. Receiving highly technical data as a non-expert is a facet of everyday life, and is so vital for justifying why others should be interested in one’s work, sometimes to the extent of wanting to help invest in/fund the investigations.

Collaboration is Key: There is so much value to working with others. Not only do comrades compliment one’s skillset, but they can also provide a deeper level of wisdom given their very different set of perspectives.

Research takes Time: I confirmed that research is a long process. There is a great deal of trial and error, exploration, and uncertainty involved in a research investigation, so the entire process from start to finish could extend from months to years.

Personally, I also learnt so much from my mentor about possible career and life paths. Firstly, I was gifted with a mentor for life as my research mentor took a genuine interest in my success in life beyond the summer internship. My mentor even guided me toward understanding tangible differences between careers in a particular industry versus in the realm of academia, and how NASA could be a great intersection of the two.

Moving Forward with Trinidad and Tobago

Seeking to extend the opportunities afforded me, I will work to increase STEM exposure for younger students in T&T by helping to enlighten and convince many young students about the potential of STEM, and how it could help shape our futures. As a Stanford student, I also hope to help encourage TT scholars to consider studying abroad in the US and UK at some of the more established research institutions in the world.

I strongly believe that sustainability would enhance life in Trinidad, from developing green energy to relieve national dependence on highly polluting and depleting fossil fuels, to innovating technologies that address imminent issues like rising sea levels. Trinidad has been experiencing the effects of climate change, and I certainly believe awareness of research initiatives in this area is key and will soon become a directly applicable to national decisions. Furthermore, as we seek channels of economic diversification, T&T could spearhead innovative water recycling technology markets that would become vital not only regionally where proper infrastructure might be lacking, but also globally in situations of natural disaster.

I also see a great opportunity to bring T&T into the future of science and engineering at all levels. Through newly established collaborations with my NASA research mentor, plus connections at Stanford, there is great potential for further investment and support from local scientists and businesses to house much-needed local research into pressing national and regional issues like renewable or sustainable energy. Fostering a culture of STEM, R&D and entrepreneurship would really revitalize T&T.