Meeting 7

Date	Tuesday, 23 February 2021
Attendees	Dr Ali Yetisen (AY), Marie Jones (MJ), Mathusan Kandiah (MK), Zong Lee (ZL), Yuxin Liu (YL), Mustafa Naser (MN), Helen Ogbobi (HO), Wei Ooi (WO), Andreas Richardson (AR), Stephen Tan (SN), Sathurthini Thurairatnam (ST), Mingchuan Zheng (MZ), Antonia Feilden (AF), Abdullah Ahmed (AA)
Apologies	
Chair	Sathurthini Thurairatnam (ST)
Secretary	Stephen Tan (SN)

Minutes

Item	Discussion
Feedback for Interim report	AY: provided detailed alternative processes description. Appendices were useful. AY: process design, used MCDM well. Assumptions, justifications were good, well explained. AY: process description was easy to follow because of division into different sections. Block diagrams also useful, could improve heat and mass balance equations. Need to clarify some of those equations. MJ: Klaus suggested stream tables + including enthalpy was sufficient. AY: Need detailed fundamental equations + assumptions, plus simulations that would support our system. AY: Safety + Env had good discussion of waste treatment. One of the best sections. **Could expand on carbon capture**. AF: Discuss where carbon capture would be relevant in our process. Some context would be useful. AY: Business plan needs to be re-evaluated. The weakest section. Unrealistic assumptions, e.g. monopolistic market (you are the only company that can supply the product). **Competitor analysis needs to be done. Business model & economics could benefit from graph showing cost, and have some info about currency**. AY: Overall good clarity and logical flow. Higher end of an A for interim report grade. AF: High level, professional report. But **useful to have basic reactions and mass, heat balances**. Gives evidence that we understand the fundamentals. Put it in appendices. AF: Regarding hydrogen, **more discussion on the safety risk**.

	AF: Good discussion on why propanol was selected, consideration of it being greener alternative is useful. But consider boiling points, check if it is vapourised at any stage. AY: Keep up the good work! One of the better reports written already. Focus energy on final report. Maybe a few people to facilitate cross-team coordinating.
Simulation	YL: Have started using Aspen before interim report AR: Haven't started detailed modelling
Synthesis/ Flowsheeting	MJ: Block flow diagram has been made to provide more clarity of entire process in the final rerport. AY: Diagram is really good for seeing the different sub-sections. YL: Current strategy is to integrate heaters and coolers, but to leave separation units independent. Using energy analyser to do analysis, because of the large number of streams in our plant. MJ: **Will clarify with Klaus in synthesis meeting later** AA (typed): Overall, I think it was an excellent report. Also, very useful for us to benchmark against other reports. I agree with Ali, you could have **expanded your business plan and included a cost curve**. AY: There are always competitors for our product, some companies even make their own material within their own supply chain. Pretty sure this is the case for pharmaceutical companies like GSK, as they can ensure quality control and reduce costs. Business plan that includes a few graphs showing timeline to breakeven, how much to invest, how much profit to be made in 5, 10, 20 years time. MN: Breakeven analysis is included in page 7 of report. More detailed analysis in the final report. Cost curves will also be included. AY: Mustafa (MN) could include projection graphs of the same style that you did for Autumn research project. MN: Initial investment will be about £50 million. Could breakeven as early as 3.5 years or as late as 8 years. MN: Profit between £5 - £12 million. Will look at ways to increase revenue, for example by selling by-products. AY: Should expect 4 - 8 years for your company, because this is a significant investment. Can do **analysis for 3 scenarios, low risk, medium risk, high risk**.
Reactor	AR: Decided on shell & tube heat exchanger for detailed reactor design. Will be using packed beds within each tube. AR: Further work is investigating impact of entrance effects, flow pattern on conversion, check radial heat profile, catalyst immobilisation.

	AR: Will use packed beds for now, will consider using catalyst pellets or coated wall reactors if significant challenges remain. AR: Innovation aspect is considered more holistically by Jason. One potential area for novelty is to place a cooling pipe between each tube, or in the middle of the reactor to avoid hotspot in the centre of the reactor. Packed bed for liquids is also quite novel, they are normally used for slurries. AF: Can look in literature for methanol synthesis reactions and the packed bed reactors they are conducted in. MJ: Modularity comes in from being able to produce different products on different days of operation. Planned market share values have been provided in the interim report.
Separations	MZ: Main decisions taken are isothermal MSMPR crystalliser, and using kinetics for a slightly different system (o,m nitrotoluene). Justified using similar viscosities of o and p nitrotoluene. MZ: Will model both a crystalliser and wash column. MZ: Tasks remaining are to estimate extent of secondary nucleation, calculating volume of crystalliser, heat transfer, CAD for both crystalliser and wash column, COMSOL to confirm assumptions in crystalliser are valid. AY: Need to find out if the CAD import module for COMSOL is purchased. They are sold separately. Also find out if COMSOL can model at desired scale (micro or macro), as it is used mainly for micro scale. MZ: Crystal morphology is not vital, as downstream processing will melt the crystals.
Safety	HO: Stainless steel selected as material, a general justification has been done. Corrosion resistance will be added, most likely a glass layer. HO: Would be good to have the whole team involved with HAZOP, possibly next Friday. HO: Tasks remaining: layers of protection, waste streams minimisation and prevention being done now, plant layout and quantitative calculations.
Controls	MJ: Chosen subsection for control is on the Powerpoint slides. MJ: For plant wide survey, just informing what variables are manipulated, controls, and potential sensors. Will finish detailed control and P&ID by next Wednesday. AY: One of the most important aspects of design. Consider using continuous controls.
Business	MN: Will also model a coronavirus scenario. Will do CAPEX, OPEX calculations.

	MN: Tax rate for China is 25%, but can be reduced to 12-15% if we can demonstrate safe operation. MN: Can operate as a foreign wholly owned enterprise in China. This is desirable because we are a contract based company. YL: Local partners are required for selling APIs, but not generic chemicals. MN: Will check and confirm if we need a local partner by next week.
Admin	Decision: Next meeting schedule for 12:00pm next Tuesday. MJ: Safety and Business teams will need to be consulted if they need additional support. AR: Most people are okay with using LATEX, and am available to support others with questions they have. MJ: Have been looking at the progress of the report, will continue to do that. AY: Think about final presentation and assign some people to it.

Notes

Bolded words in the minutes refer to actions that will be taken into consideration for adoption for the upcoming weeks, and do not have a specific due date.

Actions

Description	Assignee	Due
Find out if COMSOL can be modelled at large (macro) scale	Separations	Next meeting
Find out if CAD add in for COMSOL is provided by Imperial	Separations	Next meeting
Find out if local partners are required for our company	Business	Next meeting

Approval

Ali Kemal Yetisen	Sathurthini Thurairatnam (Feb 23, 2021 14:25 GMT)	Stephen Tan (Feb 23, 2021 15:49 GMT)
Dr Ali Yetisen *Facilitator*	Sathurthini Thurairatnam *Chair*	Stephen Tan *Secretary*