Question and Answer

This file contains the questions and answers, which could not be previously addressed to audience during the conference day due to the presentation session time was run out.
(Note: For the questions and answers that were already addressed during the presentation session, they are not included in this file.)

Day 1: June 20th, 2023

"Decarbonization of Process Industry and Next-Generation Materials for Sustainability"

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
11:00-11.30	Keynote 1: Expeditious Transitions Toward Safe, Resource Efficient and Decarbonized Future	Professor Nay Htun, Adjunct Professor, Chemical Engineering & Materials Science, Stony Brook University, USA. and Former U.N Assistant Secretary-General, UNDP, UNEP., Director & Special Adviser Rio Earth Summit.	1. Refer to what you've said it must be the integration. In your opinion, how long does Thailand take to go net Zero? Is it possible to release no Carbon in 2050?	It is possible to release no-Carbon in 2050, if this implies decarbonizing the economy and life-styles. There is need for consensus on the vision and goals of no-Carbon by all stake holders, supported by political will. Due to the complexity and conundrum of climate – energy – environment – development, there is currently no legally and technically binding agreement on what no-Carbon, "net-zero" and "decarbonizing" would encompass, and hence the required transitional pathways. The fact that these terms are widely used by proponents and opponents, is progress in the right direction. And importantly, without formalized and prescribed / proscribed parameters, the undefined terminologies provide the opportunity to all interested stakeholders to contribute to increased understanding and articulate further response options Question 2.Answer Pedagogic knowledge, skills and capacities need to be fundamentally transformed. Current curricula contents, teaching methods and facilities are inadequate to meet the knowledge and skills demanded by the fast emerging challenges and opportunities. Unprecedented challenges and opportunities require unprecedented abilities and critical thinking for low carbon, net-zero, decarbonized future that is fast emerging.
			2.In term of preparing human resource for tackling decarbonization, low carbon, and net zero, how would you suggest the way forward?	
11.30-12.00	Keynote 2: Carbon Capture, Utilization and Storage (CCUS): The Current Status and Role towards Carbon Neutrality of Thailand	Dr. Wannee Chinsirikul, Executive Director, and Dr. Kajornsak Fuangnawakij, Director of Nanocatalysis and Molecular Simulation Research Group, NANOTEC, NSTDA	1. What are the assumption for Carbon reduction pathway? Is it possible to have 65% EV car (include all passenger cars and trucks) in 2035	The assumption for carbon reduction pathway is based on ther carbon nuetrality/net-zero goals coincided with the current strategic pathways which are key players in reducing GHG emission such as Renewable Enegry, EV, LULUCF and CCUS. The 65% EV car is very challenging. In fact, the strategic target of the country at a shorter term called 30@30 (30% EV in 2030) would be an important milestone which needs critical driving mechanisms.
			2. What are the government plan to support for industrial sector?	The incentives for industrial sectors are essential to drive the net-zero plan. For example, BOI has incentives for investment related to CCUS technology and EV. (https://www.boi.go.th/upload/content/greenhouse_gas.pdf?newpage=true) More incentives would be offered from related parties.
			3. Which sector that potential CCUS can be utilized and target location? When will it alive?	Energy and IPPU sectors are major sources of CO2 emission, and would be a target area for CCUS activity. CCU projects can be typically implemented near CO2 sources. However, for CCS projects, CO2 sink poential area must be explored to identify the target storage areas.
			4. Will CCS at Arthit project be confirmed to construct? Who fund that investment?	The CCS at Arthit project is initiated by PTTEP. Detail information of this project, if available, would be from PTTEP.
			5. Trading of carbon credits is seen as "greenwashing" in many countries. How do you see this related to the Carbon neutrality roadmap in Thailand?	Trading carbon credits domestically or internationally is one of important driving mechanisms towards carbon neutrality. For Thailand, TGO is in charge of T-VER carbon credit and the trading probably can be done via carbon credit exchange platform. There would be regulations (laws) to corporate governance, and responsible agency.
			6. Regarding the decarbonization roadmap in Thailand, which one we should do first, the renewable energy or Evs?	Boths have been implemented in Thailand. In fact, the energy sector has contributed the biggest portion of GHG emission. In my opinion, EVs utilizing electricity that is generated from fossil resources would not effectivley reduce GHG emission.
			7.Based on your study, when do you think the CCUS technology will be more economic and be able to apply widely?	This depends strongly on business model as well as the goverment policy. In my opinion, it would take 10 years or longer to see its clear potntial.
			8. How many% that CCUS can contribute in 2065	It is unknown at the moment. However, based on the present study. the target contribution of CCUS in Thailand should be higher than 40 Mton per year in 2065
			9. What is the plan for CCS on 2030	The planned activities are the Source & Sink Matching/Exploration and the Offshore Pilot & Demonstration.
			10. CCUS is the high cost investment project for implementation, Is there any support funds or knowledge sharing to small or middle-scale industries in near future?	In this CCUS TRM, we suggest that Thailand should have national CCUS competency consortium to act as a hub of technologist and knowledge for sharing with public and private sectors. Incentives are also critical for drive CCUS in the country. For example, BOI has incentives for investment related to CCUS technology and EV. (https://www.boi.go.th/upload/content/greenhouse_gas.pdf?newpage=true) More incentives would be offered from related parties.
			11. What's the criteria to select CCS or CCU? How to know that which one is proper for the industry?	This depends strongly on your business model. It can be CCU when you expect to run a business on the product from CO2 conversion as well as carbon crdit and incentive you received. For CCS, you can consider CO2 as wastes while you need to pay for waste treatment. In addition, if your location is too far from storage area, CCS is not feasible.

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
			12 Is there any limitation about CO2 quality and storage capacity in each CCUS place?	Yes! Generally, you need to capture CO2 from your gas stream first. Then pure CO2 is released from your capture system and ready to transport to a CO2 storage area. On the other hand, CCU can utilize either pure CO2 or dilute (low quality) CO2 depending the technology and applications.
13.30-14.00	Carbon Materials for Energy Storage Technologies	Assoc.Prof.Dr. Montri Sawangphruk, Centre of Excellence for Energy Storage Technology (CEST), School of Energy Science and Engineering, Vidyasirimedhi Institute of Science and Technology (VISTEC)	1. What is your opinion for solid state into EV car?	I think solid-state batteries have the potential to revolutionize the electric vehicle (EV) market. They offer a number of advantages over traditional lithium-ion batteries, including: • Better safety: Solid-state batteries are non-flammable, which makes them much safer than lithium-ion batteries. This is a major advantage for EVs, as it could help to reduce the risk of fires and explosions. • Faster charging: Solid-state batteries can be charged much faster than lithium-ion batteries. This could make EVs more convenient to use, as drivers would no longer have to wait as long for their cars to charge. • Greater range: Solid-state batteries have a higher energy density than lithium-ion batteries. This means that they can store more energy, which could give EVs a longer range. However, there are still some challenges that need to be overcome before solid-state batteries can be widely adopted in EVs. These challenges include: • Cost: Solid-state batteries are currently more expensive than lithium-ion batteries. This is due to the fact that they are made with more expensive materials. • Manufacturing: Solid-state batteries are more difficult to manufacture than lithium-ion batteries. This is because the solid electrolyte is more sensitive to impurities. Despite these challenges, I believe that solid-state batteries have the potential to revolutionize the EV market. As the technology continues to develop, I expect that the cost of solid-state batteries will come down and the manufacturing process will become more efficient. Once these challenges are overcome, I believe that solid-state batteries will become the standard battery technology for EVs. Here are some specific examples of companies that are working on solid-state batteries for EVs: • Toyota • BMW • QuantumScape • Solid Power • Samsung I am excited to see how the development of solid-state batteries progresses in the coming years. I believe that they have the potential to make EVs more affordable, convenient, and efficient.
14.00-14.30	Issues and Insights on the Next-Generation Materials for Sustainability	Ms. Rebecca Somers, McKinsey & Company	1. What is the Key producers of Bio-plastic in Thailand? Feedstock for the plant? Challenges to being producer and make business succeed?	Thailand has a few bioplastic producers as well as planned discussions. Total-Corbion has lactic acid / PLA; GCMCC for PBS. Recently SCG has announced plans for a JV with Braskem for bioethanol-based bio-PE plant, while Natureworks has broken ground on a new PLA plant. Traditional feedstock for Thailand for bio-based plastics have been 1G - mainly sourced from Sugar Cane and Cassava. Challenges for the producer include cost competitiveness against petroleum-based feedstocks and being able to command a premium high enough to justify the production. Key success factors include finding the appropriate high value application which can command the premium and marketing properly to capturing the share
			2. Thank you for the great presentation, there are many study on CO2 utilization to generate new material, do you have any insight for potential chemical?	CCU is indeed a hot topic! Right now, there are several domains that are commonly being investigated, including uses of CO2 for Enhanced Oil Recovery (EOR), Construction materials, such as CO2-cured cement or CO2-derived aggregates, biochar, uses in F&B, etc. The most market potential is likely to lie in the whole “CO2 to X” class of chemicals and fuels, which is CO2 combined with green / blue hydrogen. Making green methanol can not only unlock fuel use, but also chemicals with methanol as feedstock; however, ensuring cost competitiveness (through choosing appropriate geographies to source the lowest renewable power, ensuring benefits from subsidies and other incentives) is essential at this stage in time. Currently, only EOR applications are widely used for CO2 utilization due to economic reason
14.30-15.00	Solving the Circularity Challenges in Plastics Value Chain	Arun Rajamani, BCG (Boston Consulting Group)	1. What is the price different between Virgin plastic vs Chemical recycling plastic?	The price difference (premium for recycling plastic) varies by a lot by markets. For example on rPET the premium has varied anywhere between 20% to 100% depending on the market. The level of premium is highly influenced by availability of local recyclate supply.
			2. Any example of the success business model of any company in collecting the waste from end users?	Collection of waste from consumers is typically the domain of Cities/ Muncipalities and not companies. However, some brand owners / retailers have tried to develop innovative models like proving consumers discounts if they return the plastic containers/ recyclables back to the store. At a city level, the Deposit Return Scheme (DRS) has so far been the most successful method for waste collection
			3. Thank you for the great presentation, do you have any comment on composable materials, whether it could play key role on decarbonization?	Indeed, compostable materials or bio-degradable materials can play a huge role in circular economy. There are already some bio-plastics that are already bio-degradable. However, their high cost is limiting widespread adoption

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
			4. What do you thought about chemical recycling if compare with mechanical recycling?	While mechanical recycling remains the most popular form of recycling currently, it is limited to narrow range of applications - rigid plastics, mono-materials etc. Long term, we will need chemical recycling as the technology is scalable and probably the only solution for flexibles and mixed materials
			5. What are the technologies recommended for plastic recycling?	Mechanical recycling - PET, Rigid plastics like HDPE etc Chemical recycling - Flexibles, compounded plastics; the core technology for chemical recycling currently is Pyrolysis
			6. Considering there are no real substitutes for plastic in some case, what can we actually do to solve this problem?	Plastics will continue to be key component of several applications going forward. Overall, we need to continue to use the 'Reduce - Reuse - Recycle' logic to support circularity. As technology advances, we will find more economical ways to recycle plastic
16.00-16.30	A Novel Revamp Technology to Maximize Fired Heater Capacity and Run-Length while Cutting CO2 and Nox Emissions	Mr. Erwin Platvoet, CTO, XRG Technology	1. Flameless technology, are there the impact to steam production (lower) in Pyrolysis cracking furnace? (which usually produce steam)	A pyrolysis cracking furnace is already double fired, and the burner system is typically designed for a peak/average flux ratio of 1.1 max. Therefore, Xceed will not impact the radiant efficiency very much. The steam production will therefore also not be affected. The biggest impact is for single fired tubes, where Xceed can add additional heat to the backside of the tubes. In that case the radiant efficiency does go up, the arch temperature will go down, and any steam production in the convection section will reduce as a result.
			2. Does Xceed burner cover wide range of fuel composition (H2/CH4) without any modification?	Yes, Xceed covers an extremely wide range of fuels. It is not very sensitive to fuel injection velocity so we can size the ports for the lightest fuel (hydrogen) to make sure the firing capacity can be met for all fuels.
			3. What are the modifications required for the incorporation of this technology apart from the nozzle modification?	We need to cut holes in the casing, which sometimes requires some additional local stiffening. We need to add some fuel piping and valves between the burner and the Xceed nozzles. If not already installed, we require a (fast) CO and O2 analyzer at the arch. Finally, some BMS modifications to add the Xceed permissives and interlocks.
			4. Why increase circulation of fuel gas increased box efficiency (convention heat?) while the radiation heat dominant in firebox?	The additional heat absorption comes for a combination of convective heat and radiation. The biggest contributor is the Xceed fuel oxidizing near the backside of the tubes. This tube surface is normally very cold and underutilized. By using this coil surface more efficiently, the total firebox efficiency increases and we see a drop in arch temperature.
16.30-17.00	TOYO's Solution for Energy Transition in Ethylene Plant	Masanori Takizawa, Deputy Team Manager, Toyo Engineering Corporation	1. Could you have information about NH3 cracking technology (for N2 and H2 production) ?	KBR has own technology of Ammonia Cracking. TOYO has achieved 86 ammonia projects and more than 50 years alliance with KBR. Please contact TOYO or KBR if further information is required for NH3 cracking technology.
			2. Could you suggest what we would do with the remaining CH4 which is by product?	It depends on your preference of downstream products. If methanol is preferred as another product, one of option is methane reforming to Syngas and methanol is synthesized in TOYO's proprietary MRF-Z Reactor.
			3. How to control Nox from Ammonia fuel?	In Green innovation project in Japan, Low NOx Ammonia firing burner is under development. Depending on the requirement of NOx emission, combination with SCR (Selective Catalytic Reduction) is one of option.
			4. For e-furnace, in term of reliability compare to fuel gas furnace please.	Reliability is important factor for development of e-furnace. As explained, not only traditional thermal furnace, many type of new electrical furnace is under development. However, detail information is not disclosed from technology holders in this stage.
			5. Could you have more information about NH3 cracking technology (for N2 and H2 production)?	KBR has own technology of Ammonia Cracking. TOYO has achieved 86 ammonia projects and more than 50 years alliance with KBR. Please contact TOYO or KBR if further information is required for NH3 cracking technology.

Day 2: June 21st, 2023

"Decarbonization of Process Industry and Next-Generation Materials for Sustainability"

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
08:30-09.00	Introduction to Sinopec HPPO Process & Vinyl acetate process to maximize Carbon efficiency	Dr. Xia Changjiu, RIPP (for HPPO) Mr. Wang Yushi,SSEC (for Vinyl Acetate)	1. How the waste water together with all by-product is treated?	For HPPO process, the by-products majorly in the form of propylene glycol and propanediol ethers, which are also very useful intermediates and easily seperated from waste water via a typical process developed by SINOPEC. Then, the residued waste water canbe efficiently treated by common treatment method, hence this process is rather clean and efficient.
09.00-09.30	How digital transformation drives decarbonization and circularity within the chemical industry	Naveen Kumar, Vice President, Chemicals Segment, AVEVA	1. Do you have perceptaul map compared AVEVA with other company (anonymously) so we can know your unique strength?	We would like to know more about your organization and business situation. Once we have this information, we can share inputs on how AVEVA can help you do better.
			2. From the emission platform, how to realize emission in real-time? Do you use simulation model or data driven?	The reference to emissions in my presentation was with reference to 'accounting' which typically looks at an aggregate day in perspective. We do have solutions which allows you to track emissions in real time- we use a combination of real time data, simulation and predictive models.
			3. About the renewable intregation, can the platform suggest the addition capacity to achieve net zero?	The platform as such can't suggest what additional capacity is required. However, it can be used to develop a road-map based on 'assumed' data and replace it with actuals as investments are confirmed to re-evaluate options further down the line.
			4. Other than plant age, what is the parameter that take into account in defining the dynamic target? How to make sure the dynamic target is achiveable?	The dynamic targets are developed using a first principal, online rigorous model that includes all plant constraints and safety limits as provided by operators and technical team- thus these targets are always achievable.
09.30-10.00	Hydrogen Burning Turbines, CHP applications, enablers of decarbonization	Mr. Francesco Cervini, Baker Hughes	1. Is the plant in Malaysia running with H2?	It is not running with H2.
			2. How Baker Huges develop Hydrogen-firing gas turbine to overcome hydrogen serious safety and the nature of embritrlement?	Baker Hughes has analyzed all safety aspects on combustion system but also on GT Package and auxiliaries systems to develop a Hydrogen fueled gas turbine. Safety aspects are faced modifying or improving current design. These changes could impact fuel nozzles, fuel gas piping, valves, electric certification, instrumentation or others.
			3. What degree that the hydrogen will be the game changer in climate crisis in the domain of hydrogen for electricity?	Quantity of hydrogen is strictly related to its availability but also on carbon footprint targets. Our Nova LT16 and our Heavy duty gas turbines are ready to burn up to 100%H2 to full decarbonize.
			4. What are keys of concern when 100% GT sizing is scaled up?	Baker Hughes develops those solutions working on combustion (High flame temperatures, flashback, wide flammability limits,…), on package (material compatibility, equipment certification, sealing, ..) and operations (start up/shutdown procedures, performances, durability, package purge requirements..)
			5. Baker Hughes has experience on modification of the conventional gas turbine generator from pure natural gas with steam injection+SCR to 100%H2 with DLN or not?	Baker Hughes performed several studies to propose those modifications on different gas turbine models Currently 100%H2 DLN combustion system is not available. It will be available on NovaLT16 in the next 2/3 years. We remain at your disposal to propose solution to full decarbonize today.
			6. How can we reduce the electricity consumption of H2 compressor but still maintain the pressure ratio?	May you please clarify this question?
			7. What is the timeline when you expect H2 prices to become competitive w.r.t NG ? and when H2 CHPs are expected to become mainsteam?	The hydrogen market is expected to grow significantly in the coming years. Within this context, hydrogen turbine technology will play a fundamental role in the decarbonization roadmap, as hydrogen combustion does not produce CO2 emissions. In case hydrogen costs will decrease and/or CO2 taxation will increase, there would be a breakeven point where a hydrogen turbine will become more competitive
10.30-11.00	CCUS Pathway to Net Zero	Dr. Bowornsak Wanichkul, ExxonMobil Limited	1. Are there any Exxon CCUS project in Thailand or SEA region? Timeline and capacity?	(Note: The answer will be published once receive the answer from speaker.)
			2. For Net Zero target in Thailand, if we need to choose CCS or CCU which one is the feasibility and what is the criteria to be considered?	(Note: The answer will be published once receive the answer from speaker.)
			3. Which year that Exxon expect that the CCUS project will economic?	(Note: The answer will be published once receive the answer from speaker.)
			4. Based on the current technology, is it feasible to capture CO2 at below 5%mol of CO2 concentration?	(Note: The answer will be published once receive the answer from speaker.)

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
			5. For Net Zero target in Thailand , Which one is feasibility between CCU and CCS, and what is the criteria to considering?	(Note: The answer will be published once receive the answer from speaker.)
11.00-11.30	Role of Chemical Industry in Driving Decarbonization and Fostering Global Standard for PCFs	Mr. Yoshiyuki Kashiwagi, BASF	1. In taking care of scope 3 emission, what will be BASF next step to reduce emission from raw material?	We continue current approach to collaborate with our suppliers to reduce CO2 emission. Also, we focus on circular feedstock to reduce fossil resources in our production.
			2. For energy transition type selection around EU area, how BASF consider to compare to use and prioritize for H2 Fuel, Renewable power and CCS?	We try to take wholistic approach to tacke this challenging tasks towards net zero emission. We pursue transition to renewable energy to reduce Scope 1 emission. H2 for us is valuable raw material for chemical product as well as energy source for certain processes. So we're working on developing H2 production with CO2 free process. CCU/S is also considered and we're evaluating where and how we can apply such concept.
			3. How we can use the LCA method for planning the CO2 reduction project in advance, Cloud you please explain? Thank you.	There are numbers of services available in the market to conduct LCA. Our methodology SCOTT is one of them. It provides transparency of CO2 emissions according to ISO norms and industry guideline. Visualization of CO2 emission contributor gives you opportunities to identify focus areas improvement options.
			4. Does BASF incorperate scope 3 into emission reduction target in 2030 and 2050 as well?	We're starting with commitment toward circular feedstock - 250,000t by 2025 - to reduce usage of fossil raw materials. We'll move further approach as we build learning together with our suppliers & customers.
			5. Aside from PCF and TFS program, what kind of collabolation BASF do with supplier to reduce emission in scope 3?	Sharing of our vision, experiences & knowlegeable partners for suppliers to identify area of improvement & practical approach for PCF reduction.
			6. What is your view on the price of product for example shampoo with 0 carbon and -500 carbon as your mention? How many% expensive or should it be the same?	Pricing of products should be based on the value for users and society as a whole. It is important to bring transparency of PCF as first step, so the value of zero-carbon products is perceivable from whole value chain including consumers to make right decision.
11.30-12.00	Bringing Decarbonization to Life	Mr. Alvin Teo Yuen Han, KBC (A Yokogawa Company)	1. What are the key focus areas within your energy efficiency studies?	The key focus areas are heat integration, Shaftwork, furnaces and process technology
			2. What are the steps that you take to ensure that the energy efficiency is fully maximized?	The consultants will do a benchmarking study to look at the gaps for the key focus areas and ensure those gaps are closed as much as possible to maximize energy efficiency.
			3. Would the EMS model help with upset condition or only at the steady state condition?	If the plant is in an upset condition, the operations team will be more focus on bringing back the plant to normal status. All optimization tools are recommended to be switched off so as to not interfere with emergency alarm response.
13.00-13.30	Alternative Fuel toward Carbon Neutrality Using IHI's Standard Methanation	Mr. Daiki Kamiya, IHI Corporation	1. How much catalyst need to use your e-methane unit? How about the cost for catalyst?	It is confidential about the volume and cost of Catalyst. Please contact us if you're interested in the e-methane unit.
			2. Does IHI have its own carbon capture tecnology?	Yes, IHI has own carbon capture technology. We adopt chemical absorption method using amines. While methanation reaction is exothermic reaction, the heat is required to release the CO2 absorbed by amine. Therefore, we propose the high efficient system combining the e-methane unit
			3. What is the reaction effectively of the reactor to produce CH4 form CO2 and H2? And how much energy needed for this reaction?	In the methanation reaction, about 20% of the energy is converted to heat during the reaction. Therefore, it is important to utilize the generated heat effectively. The heat input energy is not required after the methanation reaction start because it is exothermic reaction. In addition, following small input energy is required, - Oil recirculation pump for heat media - Ventilation Fan, and Control system including lighting - Cooling Water
			4. Methanation, is it required low temp. to recovery CH4?	The methanation reaction shall be kept within certain high temperature for good performance. At IHI unit, the suitable temperature is controlled to produce 95%-CH4 or more from pure CO2 and H2. Although in high temperature condition the catalyst performance deteriorates due to sintering, IHI
			5. Difficulty in scaling up methanation?	The challenges to scaling up is how to design the large size of Reactor where the all catalyst temperature can be effectively controlled without any crucial hotspot. In IHI, the heat transition process is simulated based on the operation data at Lab scale and Demo scale facility. Then IHI reflect the result in the Reactor design for scale up.
14.00-14.30	Decarbonization Opportunities in a Capital Constraint Era with Plantweb Insights	Mr. Marcio Donnagelo and Mr. Yeaw Wee Chek, Emerson Automation Solution	1. What is the criteria to define "priority" HEX?	"Some factors are taken into account, such as: predisposition to fouling depending on the part of the process where the heat exchanger is located, enthalpy of the system, etc. For better assessment, please contact me at marcio.donnangelo@emerson.com, and I can put the refining team to discuss specific case"

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
14.30-15.00	Activities of MHI Group and MCO for Energy Transition	Mr. Yuta Okumura, Mitsubishi Heavy Industries Compressor Corporation	1. Why MCO Hydrogen compressor has higher cost saving 50% than conventional type?	It is because concept design is applied the multiple compressor layout on both end driver side. In case to apply the conventional type, many compressor trains are required. Therefore, CAPEX can be saved from the conventional type by applying the concept of compact design.
			2. What's the theoretical polytropic efficiency achievable of Hydrogen and CO2 compressor?	It is difficult to reply the specific polytropic efficiency, because it is depended on the operating conditions (process flow rate, suction & discharge conditions, and so on). Please feel free to contact us if feasibility study are required.
			3. What is the efficiency of integrally geared compressor?	Same reply as No.2.
16.00-16.30	Providing and Developing Decarbonization Solutions to Support Industry Facing Energy Transition	Ms. Plain Cecile, Decarbonization and Consulting Group (AXENS)	1. Does AXENS has a real commercial operation of SAF unit?	Please contact the speaker at Cecile.PLAIN@axens.net
16.30-17.00	Building a better future through the successful development of low-carbon footprint material substitution in concrete	Mr. Chalermphol Bunsong, EGAT	1. How about cost comparing with current concrete?	As per our calculation, the cost of AFA depends on many factors such as selling price of fly ash, transportation cost and mix design etc. As we have calculated the cost of AFA with normal strength, shows that it is lower than traditional concrete about 10% at fly ash recently price.

Date 3: June 22st, 2023

""3# Energy Saving and Optimization"

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
09.00-09.30	Decarbonizing Olefins Projects	Mr. Michael Tallman, KBR	1. What is the current limit at 90%? And What is key concern to move to 100%?	Current "limit" is based on testing done for one of KBR's projects. We have now completed testing of 100% hydrogen and understand small modifications needed to our burners for this. We are ready to offer 100% hydrogen firing in our burners today.
			2. What is key challenge (furnace design metter) to bulid E-cracking to commercial scale?	There are a couple of options regarding the furnace design itself that KBR is evaluating. Also, a commercial scale furnace would require a significant amount of power, and the ability to generate that power from renewable sources and the infrastructure required to supply that quantity of power needs to be developed.
			3. What is temperature of combusion air preheat in the case of low CO2 cracker design?	It can very based on project rerquirements.
			4. Can you elaborate more on enhance H2 recovery? Does it require additional facilities?	It may require modification in the cold box area of the plant and, depending on the plant's recovery section design, additional knock-out drum and potential changes to the tail gas expander.
			5. Can you explain more why higher COP is the direction for cracker optimization? For furnace, it should require higher feed to maintain capacity, right?	KBR has looked into that primarily for ethane cracking, since the pressure effect on the ethylene yield is not as great as with other feeds. Directionally feed consumption will increase, but, since KBR's SC-1 furnace design starts at a higher-yield point relative to other furnaces, the increase in pressure typically results in a yield equal-to or greater-than that of other technologies. The effect of operating pressure on yields is greater with heavier feeds. Higher pressure directionally reduces the CAPEX (due to lower volumetric flow rate through the transfer line, water quench tower and PGC suction line), and lowers the power consumption of the CGC.
			6. Why not use 100% H2 to reduce CO2? See around 75-85% Hydrogen using as a fuel gas.	In a typical ethane cracker, if all of the hydrogen produced from the furnace is used as fuel the composition will end up in the 75-85 mole percent range to satisfy the fired duty requirement. Use of conbustion air preheat can reduce the fired duty requirement such that internal hydrogen at approximately 95 mol% purity can be used. Going to higher hydrogen content is possible but requires an extenal source of hydrogen.
			7. Is it possible to use wind or solar power for electrification the process?	Yes, availability of this will vary widely depending on the plant site. KBR's scope is the cracker design, and for CO2 emissions to be reduced it is assumed that the power is available from renewable sources.
			8. Does "Selective recovery section electricfication" mean electrification of CG and Ref. compressor? If so, have you ever experienced using motor driven?	"Selective" recovery section electrification means motor drive for selected compressor(s), to match the plant steam balance and available power supply. Motor drives have been applied by KBR on smaller olefins units, and large size motors have been applied in other KBR technologies
			9. Do H2 firing testing in actual cracking furnace? Impact to run length? Other concerns?	To date KBR has tested 100% hydrogen firing in a test facility. Plans are being made to test this in a commercially operating furnace.
			10. What is your recommend for electrical source which has enough reliability for changing to motor drive in olefin plant?	the source of electic power is outside the scope of KBR's ethylene plant design.
			11. For Hydrogen firing, we need to rearrange burner or add more wall burner to keep furnace performance or not?	It will depend on the original burner / furnace design. KBR's SCORE furnace use 100% floor burners and this will not change with 100% hydrogen fuel.
09.30-10.00	Sustainable Olefin Technology solutions	Mr. Franz Dalitz, Linde	1 How much cost per ton of CO2 capture?	Depending on project specification such as capacity, CO2 content in flue gas, plot limitations, power/steam price and so on, costs of capture could be as low as 45 USD/tCO2, but can go beyond 100 USD/tCO2 in unfavorable cases.
			2. Could you share sustainable olefin solutions for low carbon process with existing plant, minimize revamping?	This is very project and site specific and would be needed to study on a case by case. Could be CO2 capture from furnace or H2 firing with blue H2.
			3.Can we apply the flue gas CO2 capture tecnology with other petrochemical plant or refinery?	OASE blue could be used for all flue gas sources of 2-25v%CO2 and 4-16v% O2. See presentation. Depending on impurities in flue gas pre- or after-treatment might be needed
			4. I am wondering if all 6 olefins plant in Thailand move on for this carbon capturing, what are you going to do with all CO2 in your opinion?	Only CCS is a viable option for these quantities of CO2 at the moment. In the other hand, CCU is one good solutions for utilize CO2 in the future.

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
10.00-10.30	Biomass to Energy: Technology and Challlenge	Prof. Dr Tharapong Vitidsant, Chulalongkorn University	1. How do you separate the Naphtha?	Due to Naphtha range of boiling point of 60-120oC, pyrolysis oil was kept at costant temperture at 150oC inside a separator. Naphtha was firstly evaporated, condensed and stored in storage tank at the specific quantity that we calculated. It is not precise method comparing distillation that we have not a large scale in our center.
			2. How to increase the liquid production?	The liqyuid yield is depended on the optimum temperture. Higher temperature used, lower yield of liquid fraction obtained. The optumum temperature range is 400-430oC.
			3. What is the criteria to choose any kind of plant to be the biomass raw materials?	All kind of biomass can be used for feedstock. The priority will be wood, which is dense biomass with low ash content.
			4. Do you have any environmental issues of your process?	For plastic pyrolysis, there will be some of chloride, which came from PVC but we add 0.5% of CaO , which can remove all chloride to become CaCl2. In case of vegetable oil,there is nothing cocerning about waste.
			5. How to find a lot of plastic waste to feed the plant?	Waste plastic came from sorting line in municipal waste, normally it is old waste from opened dump.
			6. What is your comment on the high CO2 output on the gasification process?	Our new technology catalyst converts not only CO and H2 but including CO2, which is in syngas about 15% to liqyuid fuels.
			7. How to manage other impurity HC either Diesel from thermo waste?	Thermo waste, I mean the combustion gas, which come from burning biomass to heat up the reactor, normally no HC or diesel inthis thermo waste.
11.00-11.30	Organic Rankine Cycle , Power generation from waste heat	Mr.Chee Aun, EXERGY International	1. What is the minimum unit capacity to be economy of scale?	The interesting economic of scale depends fundamentally on the waste heat data, site conditions and the price of electricity domestically. The kind of waste heat available including the content and medium of wasted heat flow, temperature coupled with site conditions would allow us to engineer the best suitable solution. The higher the electricity price the faster the return of investment.
11.30-12.00	Using Digital Technologies for Effective Energy, Emission Management and Optimization	Ms. Sharon Zhou, KBC Advanced Technology (A Yokogawa Company)	1. Visual MESA - Why do you call it a Energy Digital Twin?, please elaborate.	The “Digital Twin” (DT) concept has been around since 2002 when Michael Grieves, at the University of Michigan, first used the terminology. It is based on the idea that a digital informational construct about a physical system could be created as an entity on its own (1). This digital information would be a “twin” of the information that was embedded within the physical system itself and be linked with that physical system through its entire lifecycle. For more details, please, see reference (1) Origins of the Digital Twin Concept, 2016, M. Grieves and J. Vickers, https://www.researchgate.net/publication/307509727_Origins_of_the_Digital_Twin_Concept Visual MESA fits very well with the above definition because it is a model (i.e., a digital construct) of the energy system, that is connected to your plants data historian and other relevant operating data sources (e.g. lab data) to retrieve operating data in real time. These information are then validated and utilized by our Visual MESA model to calculate parameters such as steam enthalpy, equipment efficiency, emissions, etc., which is based on your plant’s current operating data. This model thus functions as a DT of your utilities/energy system, providing you with information regarding you current utility/energy operations (including the ability to perform mass and energy balances) with the added software capabilities of monitoring, optimization and optimal scheduling. In summary, Visual MESA provides •A single integrated DT for energy, utilities and related systems •Full range of asset operation, with auto-adaptation in real-time •Able to deal with time as per history, real-time and future •Automated to consider business workflows •Centralized single version of the truth, used by everyone
			2. Does the VisualMESA have a function to simulate the combustion reaction by program itself without manually input stoichiometry?	Visual MESA can calculate the energy from combustion either stoichiometrically, if the fuels composition is provided, or by using heating values for the fuels. Alternative, if fuel stoichiometry is available via lab or online gas chromatograph GC) data, Visual MESA has the option to connect to a wide variety of data sources and can retrieve this “automatically” without the need for “manual input”.
			3. Is Petro SIM a solution for all Chemical process sites or more focused for Petrochemical plants?	Petro-SIM can simulate both Petrochemical and Chemical process. For Petrochemical plants, we have integrated rigorous kinetic reactor models (e.g. Naphtha cracking, polymers reactors, etc.) in Petro-SIM. For Chemical process plants, kinetic reactor unit operations in Petro-SIM coupled by

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
13.00-13.30	Affordable CCS - Shell CANSOLV CO2 Capture Process	Mr. Srihari Kannan, Shell Catalysts and Technologies	1. Have you considered the benefits of oxyfuel combustion for CCS, and do the benefits outweight the cost of oxygen production? How?	Shell is looking at mutiple pathways for CCS including oxy combustion - however the technology is not at the maturity level of amine based Co2 capture.
			2. How much cost per ton for CO2 capture?	The cost of CO2 capture is project specific. It largely depends on the scale of the capture plant, the concentration of CO2 in the flue gas (partial pressure of CO2) - these in turn determine capex and opex. Opex in turn is driven by cost of utilities (steam, power, cooling media), solvent costs. The
			3. Do you have some idea about cost per ton CO2 reduction on your example?	The cost of CO2 capture is project specific. It largely depends on the scale of the capture plant, the concentration of CO2 in the flue gas (partial pressure of CO2) - these in turn determine key parameters like capex and opex. Opex in turn is driven by cost of utilities (steam, power, cooling media), solvent costs. The capex and opex vary by region/ country/ location.
			4. I have read something about so called bisphasic solvent, or phase change solvent, do you think this will help with the energy problem?	I have also seen that biphasic solvents are expected to lower energy consumption but I am not sure about the technology readiness level of this technology.
			5. How do we know the CO2 which is captured underground is still there?	The question is best posed to geologists / sub-surface experts - I understand that there are fairly developed measurement, monitoring and verification programs that ensure that the CO2 is where it is supposed to be once injected underground.
			6. With limited carbon storage, we should also be looking into carbon utilisation, any innovation or research that Shell is doing on carbon utilisation catalyst?	While these are early days Shell is exploring multiple pathways for CO2 utilization - an exmaple is using the CO2 to produce jet fuel via reverse water gas shift + fischer tropsch synthesis followed by hydrocracking.
			7. Does the CO2 stored underground enter the natural carbon cycle?	The Co2 stored underground is expected to get mineralized over prolonged durations (few thousand years)
			8. Is amine based capture will ever be possible for direct air capture?	Amine based CO2 capture is potentially applicable for very low CO2 concentrations (e.g., Aluminium smelters) but I imagine there has to be a point source for amine based CO2 capture; the cost of Co2 capture at low CO2 concentrations is high compared to cost of CO2 capture from higher CO2 concentraiton streams. I understand that since the direct air capture essentially talks of removing CO2 from atmosphere there are probably alternate technologies that companies are working on - adsorption/ chemical looping etc.
			9. Do you have a plan for changing CO2 to the benefit thing? If so, what is it?	sorry but I am afraid I don't fully understand the question. Assuming this is about CO2 utilization, Shell is exploring multiple pathways for CO2 utilization.
			1. What is the maximum heat liberation of non-premixed wall burner?	Typical design heat release for John Zink Wallfire burner is 0.5-2.0mmBtu/hr
			2. Do the ultra low NOx burner able to handle a wide range of H2 composition in the fuel gas?	Non-premixed ultra low-NOx burners can fire up to 100% H2. For premixed burners, the maximum H2 content depends on the burner design specifics but generally speaking up to roughly 70% can be achieved. When firing 100% H2 in floor burners, the maximum heat flux will be greater than and at a lower elevation compared to firing natural gas or other hydrocarbon blends. This may have an impact on run-length or production.
			3. Do you have any HRSG supplementary design for H2 or NH3 fuel gas for power plant which is switched to use Hydrogen or Ammonia Turbine?	Unfortunately not - Lummus Technology is not involved with licensing HRSG designs
			4. Can wallfire work with natural gas? Can we switch fuel from 100%H2 to natural gas (as back up fuel) ?	Yes, Wallfire can work with natural gas. Design of both burners and heater for high/100% hydrogen will typically consider use of natural gas or plant off-gas as back-up fuel.

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
13.30-14.00	Hydrogen and Ammonia: Zero Carbon Fuels for Steam Crackers	Mr. Kevin Allister, Lummus Technology	5. Can we use pure O2 to furnace instead of air to prevent or reduce NOx generation in case of H2/NH3 fuel?	Even with use of pure oxygen as combustion medium ("oxyfuel combustion") to eliminate the nitrogen from the combustion air, there will be some nitrogen present as heater box is not designed to be completely air-tight. The firebox remains under negative pressure and there will still be some ingress of tramp air through coil penetrations and peep doors - it is not possible to completely exclude nitrogen from the firebox. When firing Hydrogen with oxyfuel , we would anticipate that the reduced concentration of nitrogen in the firebox would have a positive impact on reducing thermal NOx formation. However, when firing NH3, there is the nitrogen in the fuel to consider and the NOx emissions are not solely from thermal NOx mechanism - therefore we would not expect a significant benefit to overall NOx for this fuel. Firing pure O2 produces very high flame temperatures which current burners and furnaces are not designed for. A good alternative is to recycle flue gases and add O2 into the recycled flue gas. When this is done the oxidant stream is a mixture of CO2, H2O, and O2 which can produce flame temperatures equivalent to air and is a proven method of NOx reduction for both hydrocarbon combustion and hydrogen combustion (but not NH3).
			6. Using NH3 as a fuel source will increase Scope 2 emissions and carbon emissions might be a net increase. Any comments on that?	The use of both hydrogen and ammonia fuels to decarbonise combustion processes requires either blue or green hydrogen and ammonia. You are correct, if the fuel is derived from conventional fossil fuel (gray) sources, then Scope 2 emissions could result in a net increase.
			7. How much NOx reduction is expected for each 100% H2 and NH3 combustion at Wallfire?	Premixed burners cannot tolerate 100% H2 if they are designed to also fire natural gas as a startup or backup fuel. For this reason it is not possible to compare NOx between premixed and Walfire burner technologies at 100% H2. For ammonia combustion, the NOx reduction is very substantial, possibly a factor of 20 reduction!
			8. What about 100% NH3? Attainable or not?	100% NH3 firing has not yet been demonstrated in ethylene crackers, and the technology is not currently at a stage where it is being proposed for commercial applications, although development of this technology is ongoing. I anticipate that a solution involving firing a H2/NH3 blend may be feasible before 100% NH3 firing is. John Zink has developed burner technologies that can fire 100% NH3. However the NOx production is substantial and will likely require post-combustion NOx reduction by an SCR.
14.00-14.30	Hydrogen Economy and Hydrogen Fuel Switching technology	Mr. Vishal Pandey, Linde	1. Do you know the plan on what year will the "Green" hydrogen be implemented in Thailand?	Its difficult to say unless there are clear policies in place. Economics of Green Hydrogen depends up renewable power cost, Utilization Factor, Electrolyzer cost and Government Policies. All the three factors should work together to complete with Gray Hydrogen which range form 1.5-2 $/Kg
			2. What is suitable hydrogen production plant for Thailand? Is NH3 cracker plant suitable?	Blue Hydrogen is more suitable for Thailand due to close vicinity to CO2 Sequestration wells. As per Linde's view Ammonia cracking will be commercialized around 2027-2028
			3. For H2 price, What do you think that Green H2 price will be reduced and become competitive in future?	100% NH3 firing has not yet been demonstrated in ethylene crackers, and the technology is not currently at a stage where it is being proposed for commercial applications, although development of this technology is ongoing. I anticipate that a solution involving firing a H2/NH3 blend may be feasible before 100% NH3 firing is. John Zink has developed burner technologies that can fire 100% NH3. However the NOx production is substantial and will likely require post-combustion NOx reduction by an SCR.
15.30-16.00	LEAPmbr -Upgrading Waste Water treatment for Energy Savings	Mr. Simon Reitmaier, Honeywell UOP	1. Do we need to treat backwash water from cleaning process?	No treatment is require for the backwash water as there is no discharge from backwash operation. Permeate used for backwashing will be permeate back through the membrane.
			2. As picture of Stockholm plant, can aeration & MBR install in indoor location (look like under the mountain) ?	Aeration tank and membrane tank can be installed indoor. Veolia has many indoor or even underground installation to free up above ground space/land for other usage.
			3. Why big bubble has more efficiency than fine bubble for cleaning the MBR membrane surface during operation?	Larger bubble create higher shear force to scrub MLSS from the membrane surface.
16.00-16.30	Unleashed AGRU Performance using Rigorous Modeling Technique and IOW Optimization	Mr. Thodsaphon Phansadsadee and Mr. Vorathorn Charoensuk, PTT Pubilc Co.,Ltd	1. Please share the program that you use.	ProMax (BR&E), Aspen HYSYS
			2. Could you share which equation of state you use?	Acid Gas - Chemical Solvents

"11# Chemical Process Safety Sharing (CPSS)"

For CPSS, all questions have been answered during the presentation session.

Day 4: June 21st, 2023

4# Digital Technology for Smart Industry

Time	Subtopics	Speakers	Question (Remain from Slido Q&A)	Answer
09.30-10.30	Panel Discussion on "How Digital Enable Decarbonization of Process Industry and Next-Generation Materials for Sustainability"	MC: Ms Yue Yeng (YY) Fong, Vice President, Stakeholder Engagement, AIBP Panelist : Mr. Ashu Bhatia, Accenture Mr. Sanya Chindaprasert, SCGC Dr.Krisda Tapracharoen, NSTDA Dr.Preesan Rakwatin, DEPA Mr. Sanjay Peshin, TCS	1. What is the difficult barrier of Digital Technology implementaion in your opinion and experience?	Answer from one member in the panel: Acceptance of users to the digital technology, especially if they need to change the usual way they are working. Resistance to change is common for human.
			2. Technology is two-edged sword, there are surely a lot of advantages but on the other side it present a certain threat. How to avoid and overcome those threats?	Answer from one member in the panel: First, we need to clearly understand the technology before implementation. Then, we shall evaluate all threats and risks of technology. Finally, we shall prepare 2P2S that allow the technology implementation, while preventing the threats/risks.
			3. From all the project portfolio in hands, how you evaluate impact/benefit versus complexity which lead to project prioritize?	Answer from one member in the panel: We analyze 2x2 on impact vs complexity. Then, we prioritize to do low-hanging-fruit projects first (low effort/complex with high impact/benefit). Meanwhile, we are planning for other high-impact projects. This evaluation and prioritization will be reviewed regularly.
			4. Creation of model is not difficult as maintaining the model effectively and reliably. More facilities are needed. What is your strategy for that?	Answer from one member in the panel: We setup a dedicated team in the format of organizational structure with process and system in place to maintain the digital solutions. In case the users have capability to maintain by themselves, we will perform proper knowledge transfer and prepare user-friendly interface of the models for them.
			5. we understand that decarbonization improvements need huge investment. Do you have reference of how low we should accept the IRR to compromise zero emission?	Answer from one member in the panel: There are three kinds of projects. First, projects in the kind of energy efficiency improvement, energy reduction, waste reduction, shall follow the company's acceptable IRR. Second, projects in the kind of renewable energy and circular economy, are normally difficult to meet the acceptable IRR. We need to include the Internal Carbon Pricing in the IRR calculation, so the IRR could be accepted. Third, projects that will help meet the net-zero, are costly and may not make the return. We shall have different criteria than the IRR, but timing of the project decision shall be considered well.
			6. During recession peroid of petrochem industry like this time, all company has to keep cash for survival. How to apply digital in cheapest way?	Answer from one member in the panel: To apply the digital solutions in cost-effective manner, there are two approaches: 1) Application of digital solutions without capital investment, such as process optimization on existing asset. For example, we can let our talent employees develop the digital solutions from open-source resources. This approach is low cost, but may have low-to-medium benefits 2) Application of digital solutions with carefully considered investment, such as process optimization with advanced-process-control system. This approach normally has high benefits, but we need to decide based on quick pay-back period, such as 6-12 months only
			7. As Bill Gate book "How to Avoid a Climate Disaster", what do you think about the idea that we have to break through innovation to solve, like Nuclear power?	Answer from one member in the panel: I agree that the breakthrough innovations are necessary to accomplish the net zero at Y2050. However, these innovations are being developed and we need to wait for their outcomes. In short term (Y2030), we shall apply all existing innovations to mitigate the climate crisis. After that, we will integrate the new innovations once they are ready.

"2# Process Scale-up Sharing"

For CPSS, all questions have been answered during the presentation session.