16th STS-AIChE Southwest Process Technology Conference

- Future of Chemical Engineering
- Dan Coombs PE
- Chairman PCT – EVP LYB Retired

Sept 22-23, 2025, University of Houston

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Dan Coombs PE

- He currently serves as Chairman of the Board for PureCycle Technologies. He formerly served as an Executive Vice President for LyondellBasell, leading global manufacturing, projects, and businesses. He also led Global Olefins and Polyolefins, Global Intermediates and Derivatives, Refining, and Technology during his tenure there. Prior to that he served as Chevron Phillips Chemical Company Senior Vice President. Dan also served as Deputy General Manager of Qatar Chemical during the completion of the Q-Chem II project.
- Dan is a Trustee of the American Institute of Chemical Engineers Foundation, and Chairperson of the Foundation's Corporate Council. Dan and his wife Ellen Coombs were AIChE Philanthropists of the Year in 2021, recognized for supporting STEM education.
- Coombs is a Distinguished Alumnus of The Ohio State University and received the College of Engineering Dean's Meritorious Service to Students Award in 2023. He currently serves on The Ohio State University Foundation Board and the Chemical and Biomolecular Engineering Advisory Board.
- Dan Coombs earned chemical engineering degrees from The Ohio State University (BS) and the University of Tulsa (MS), and earned an MBA from Texas A&M.

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Fundamentals of Chemical Engineering

- Balances - Mass, Energy, Momentum
- Transport Phenomena: Heat, Mass, Momentum
- Thermodynamics
- Kinetics
- Process Design
- Process Control and Optimization
- Economics
- Risk Reduction
- All Engineering
  - Data Analysis and Problem Solving
  - Continuous Improvement

Challenges and Opportunities for the Future

- Perception of industry (trust)
  - Process safety
  - Product stewardship
- Battle for talent
  - Incoming, developing and retaining
- Ever widening cycles
  - Industry capacity cycles
  - Investor preferences and demands
  - Political landscapes
- Sustainability
- Food, water, medicine, materials
- Innovation – Add more “Zero to One” to “n to n+1” that we do so well
- Artificial Intelligence

Chemical Engineering Leadership Views on the Future of Chemical Engineering (1)

- Chemical industry is essential to humanity and quality of life
- Sustainability is important
  - Clean affordable energy
  - New materials – more recyclable or biobased
  - More sustainable practices
  - EV's
  - Resource management
  - Energy transition
- Artificial Intelligence is moving forward
  - Automated optimization, process control, plant design and construction, reliability, EHS, product development

Chemical Engineering Leadership Views on the Future of Chemical Engineering (2)

- Micro, nano and molecular scale engineering
  —– blending chemical engineering with physics, chemistry and biology
- Intersection of chemical engineering with medicine, health and bio related fields
  —- will continue to grow, leading to new products in the food, biofuels and pharma space
- More overlap of engineering disciplines
  —- like chemical, mechanical, electrical, environmental, civil, computer, materials and systems will continue

Sustainability Example – Plastics Recycling

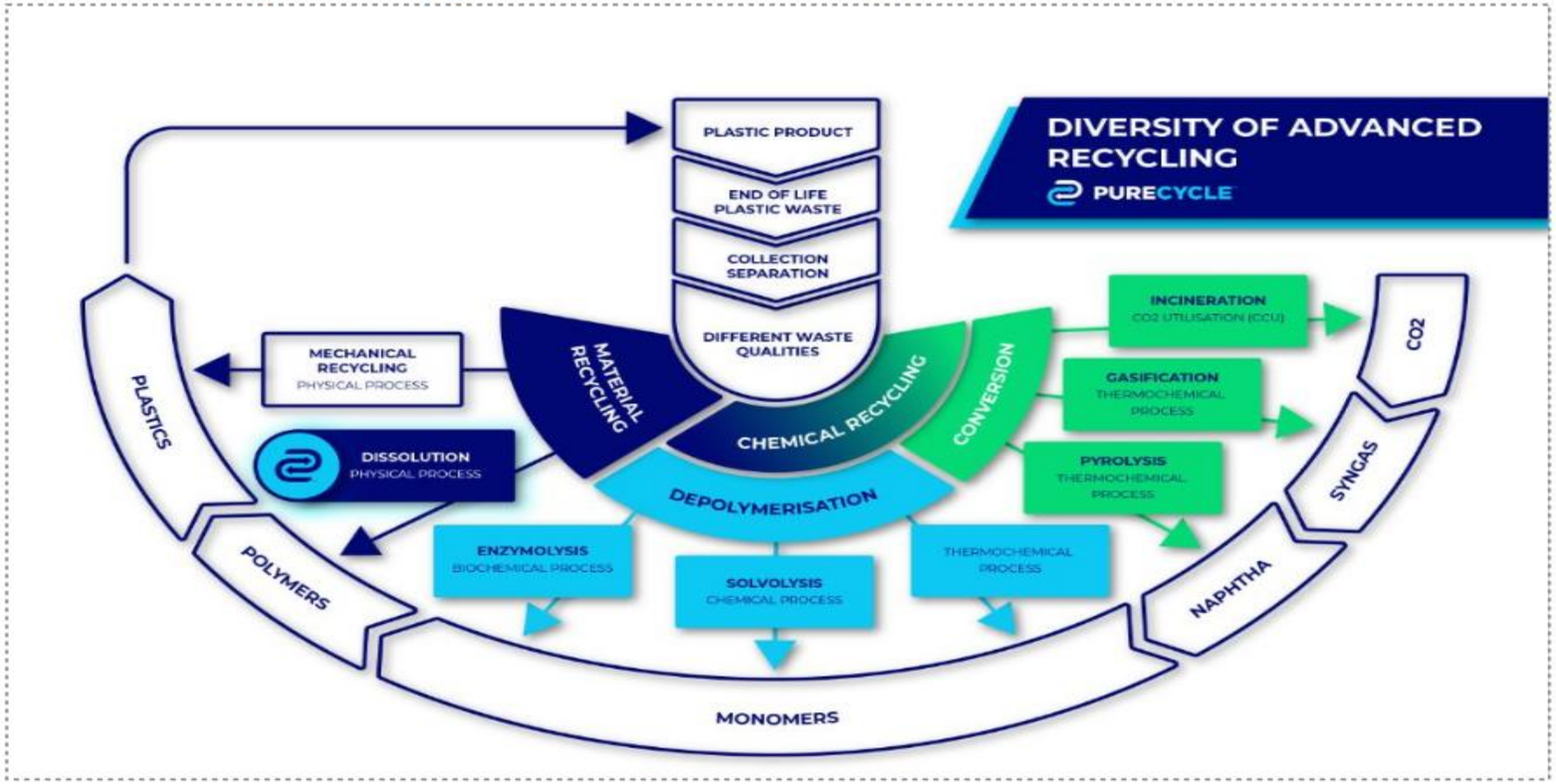
Different Plastics Recycling Technologies

PureCycle's purification method is NOT chemical recycling.

It is dissolution, a physical process.

Key Benefits

- High product quality
- High plastic recovery rate for reuse
- Low energy usage and low carbon footprint



Nova-institute.eu 2023 ; https://renewable-carbon.eu/publications/product/diversity-of-different-advanced-recycling/

Artificial Intelligence

- In the 1960's President Kennedy declared a space race to put a person on the moon by the end of the decade – Are we in an undeclared AI race now – if so, who is racing and who is winning?
- "Properly used, AI does not replace critical thinking but enhances and accelerates it" – Energy Industry CEO
- "I firmly believe that the fundamentals of chemical engineering will remain relevant, but the way we acquire and apply this knowledge will evolve with the advent of AI and complementary technologies" – Engineering Company CEO

Artificial Intelligence

- To date the process industries have had mixed results using AI
- "I think in three years AI will become useful for mathematicians. It will be a great co-pilot. You're trying to prove a theorem, and there's one step that you think is true, but you can't quite see how it's true.“ Terrance Tao (Fields Medalist)
- How do we produce AI literate chemical engineers that understand the fundamentals well enough to ask AI the right questions and to understand how best to use the tools
- Using AI we can automate the optimization of the whole facility with the supply chain to a much greater extent than we can optimize the sum of all the parts within each process – AI can integrate first principles, process data base information, planning and optimization meetings, LP models, shift logs and other information to create a fully automated optimized enterprise
- Using it to Improve R&D and product development success rates
- Using it to improve problem recognition and training

Are We Teaching Chemical Engineers Problem Solving Skills?

- Recognition
- Definition
- Prioritization (risk reduction, value creation)
- Understanding root cause
- Developing the solution
- Implementing the solution
- Measuring results and adjusting
- Applying learnings across greater enterprise

Are We as Chemical Engineers Using Next Level Skills Beyond Fundamentals?

- Some next level skills beyond the fundamentals include:
  - Attracting new talent to the organization and the industry
  - Multi-disciplinary team skills and leadership
  - Process safety leadership to fully engage operators and crafts people in the process
  - AI fluency and use
  - Bringing the frontiers of science to scale to create value
  - Thirst for continuing education
  - Career path development