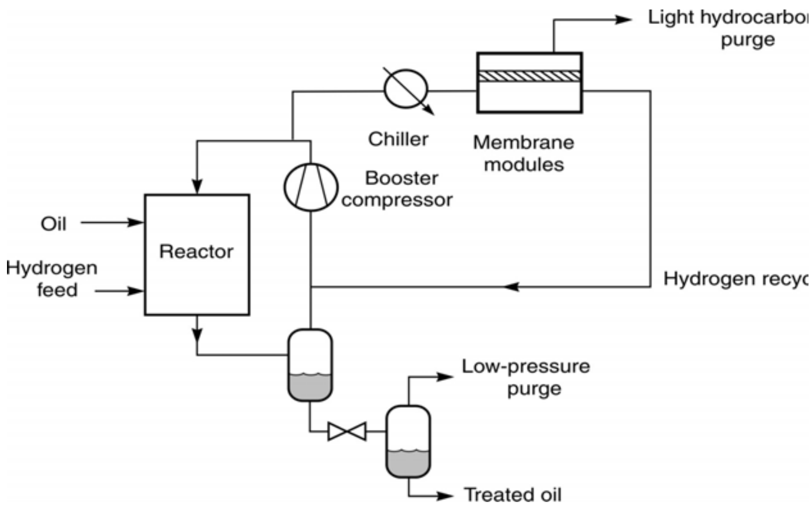
1.4.2 RESOURCE RECOVERY AND UTILIZATION

Technology Description

Resource recovery and utilization technologies help minimize waste from industrial processes, reducing energy and material requirements. Wastes include materials, process byproducts, chemical reactants, gases, solvents, diluents**,** wastepaper, plastics, cooling water, and more. These materials can be reprocessed for use as feedstocks, used to make different products, burned as fuels, or recycled. These practices mitigate greenhouse gas (GHG) emissions by improving plant efficiency and eliminating the energy required to treat wastes and to produce the displaced feedstocks. One example of recovery and reuse is a membrane separation process being developed to recover valuable chemicals from gas streams that are currently burned as low-value fuel. The process will efficiently and economically separate light hydrocarbons (ethane, methane, ethylene, propylene) and hydrogen for use as chemical feedstocks, which are two to three times more valuable than the fuel.



Recovery of olefins such as ethylene and propylene reduces the use of fuel and feedstocks.

System Concepts

- Resource recovery and utilization involves cradle-to-grave stewardship over industrial products. In the example cited, the recovery of feedstock chemicals mitigates CO_2 emissions because it increases product yield and displaces some of the fuel energy initially required to produce the feedstock, which is a petroleum fraction.
- The approximate 30 million tons of iron-making and steelmaking byproducts generated each year – oxide dusts, sludges, scale, and slags – contain nearly 7 million tons of valuable iron units. Currently, about 50% of this volume is recovered and recycled. Research leading to increased internal recycling of these residues can increase the steel industry's primary yield while reducing disposal costs and saving energy.
- Resource recovery and utilization can involve advanced separations, new chemistries, improved catalysts, advanced materials, optimal process and engineering design, sensors and controls, post-consumer processing, market sensitivity, and close coordination among producers, users, and post-consumer processors.
- This pathway includes technologies that impact the other three industry technology pathways, particularly energy conversion and utilization and industrial process efficiency.

Representative Technologies

- Recovery technologies include advanced separations, new and improved chemistries, sensors and controls, and the capture of carbon monoxide and NO_x.
- Reuse technologies include recycling; design-for-recycle or reuse; new and improved chemistries; and closed-loop, sustainable plant design.
- Improved understanding of fundamental chemistry allows use of carbon dioxide and other recovered byproducts as feedstocks. Technologies include C1 chemistry (single carbon) to produce chemicals from carbon dioxide, and chemistries to create fuels from plastics and rubber.
- Component technologies include advanced separations, improved chemistry and catalysts, advanced materials, optimal process and engineering design, sensors and controls, and post-consumer processing.

Technology Status/Applications

- Many industries make a concerted effort to reuse wastes to minimize the high cost of handling and disposal. Others, like the refining and pulp-making industries, rely heavily on byproduct fuels produced on site. However, there are still many opportunities to reuse wastes and byproducts that are not captured because technology does not exist, is currently not economical, or is not practical for other reasons.

Current Research, Development, and Demonstration

RD&D Goals

- Research program goals in this area target a range of improved recycling/recovery efficiencies. For example, in the chemicals industry, the goal is to improve recyclability of materials by as much as 30%.
- Additional goals target new and improved processes to use wastes or byproducts; improve separations to capture and recycle materials, byproducts, solvents, and process water; identify new markets for recovered materials, including ash and other residuals such as scrubber sludges.

RD&D Challenges

- Specifically target the energy-intensive U.S. industries and contribute to their goals of reducing energy, water use, and toxic and pollutant dispersion per unit of output.
- Gaining a better understanding of the fundamentals behind separations and new chemical pathways; modeling capabilities for improved process and engineering design; and technology transfer.
- Efficient and economical separation processes; demonstrating the viability of new markets; improving sensing and control capabilities; analyzing process and engineering design for optimized materials use and durable advanced materials.

RD&D Activities

- Solicitations issued by the Industrial Technologies Program have funded projects to improve energy efficiency and reduce waste; participants include industry, DOE laboratories, small businesses, and academia.
- Ongoing activities include novel techniques for effective separation of materials in industrial streams for recovery and reuse, recycling of water and other liquid and solid-waste streams, recycling of wood byproducts and pulping waste into high-value products, and recycling of problematic wastes such as sludges, refractories, slag, and mill scale.
- DOE is working with CQ Inc. and other partners to improve energy recovery and reduce waste in coal processing. By adding a binding agent into the process, mills can improve the physical characteristics of the coal to create a more acceptable fuel, improve processing efficiency, and reduce environmental impact.

Recent Progress

- DOE supported Air Products in the development of an energy-efficient process employing pressure swing adsorption refrigeration (PSA) for the recovery of olefins from polyolefin plant vent gases. There already are two commercial applications of the PSA technology. Widespread commercialization could yield a recovery rate of more than 17 million pounds of olefins per year, as well as energy and emission reductions.
- Development is underway of advanced membrane technology that enables separation of hydrocarbons from various gaseous streams. The technology could enhance recovery and use of volatile compounds, carbon dioxide, and other chemicals in waste streams.

Commercialization and Deployment Activities
• Technologies that compete with resource recovery and utilization include waste disposal in landfills, incinerators, and approved hazardous waste-disposal sites. • The economics of resource recovery and utilization technologies are an important factor in deployment. Markets and applications for recovered materials must be well-defined if commercialization is to be successful. **Market Context** • Markets for recovered materials are as diverse as the manufacturing industry and the products it creates. Significant commercial success already has been achieved in various markets, such as the use of recovered post-use steel, aluminum, paper, glass, and plastic. Several new market opportunities are available in these – as well as other – areas and are just now being explored.