There is a lot of trial and error in this field, and you often learn more from the ideas that don't work than those that do. Usually a *Ph.D.* degree is required to do research or teach in a university.

Researchers must learn from each other and share what they learn with their colleagues. Whether in industry or the university, they must convince others of the value of their work.

Other Areas:

There are many other roles that chemical engineers play. Some specialize in *environmental* engineering; monitoring/ modifying plant operations and becoming expert in government regulations. **Don't forget**: air, water, and soil are all chemicals. *Control engineers* specialize in developing the advanced computer control systems and operator stations necessary to run a plant efficiently. Engineers often become *managers* (who would make a better plant manager or engineering manager than a chemical engineer who has come up the ranks)? *Technical sales* is a way for an engineer to help solve his customer's problems by matching the right process or product to the customer's needs. Of course, there would be no chemical engineers without chemical engineering *professors*.

***B**iomedical engineers* apply basic chemical engineering to the medical field, primarily artificial organs and limbs. *Biochemical* engineers use their understanding of the chemical reactions in our bodies to identify/treat disease and reproduce some of this chemistry on a very large scale.

Chemical engineers can move into non-engineering jobs. Their problem solving skills and technical rigor have proved to be an excellent basis for going into *patent law, medicine, and even investment banking*.

Who Hires Chemical Engineers?

Many chemical engineers work in the *chemical, petrochemical, food, pharmaceutical, pulp and paper, electronics, and consumer products* industries. Some teach in *universities*, and others work for the *government* (typically in the environmental and energy areas).

How do you become an Engineer?

You should study as much math and science in high school as possible; typically three years of science and four of math are the minimum requirement for acceptance into engineering school. A **Bachelors** degree (BS) can be earned in four years; five if you co-op (take paid assignments working in industry on alternate semesters). Most positions in industry require only a BS degree. Research and teaching positions typically require a **Ph.D.** which takes about five more years of study.

Formal education is only the beginning. Engineers must always keep up with the latest technology and learn new skills.

AIChE Chicago

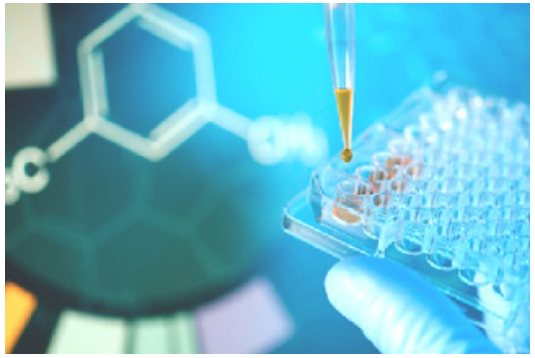
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

CHICAGO SECTION

WHAT IS CHEMICAL ENGINEERING?

Every day thousands of *chemical engineers* help solve some of today's most difficult problems :

- developing new sources of energy
- reducing energy consumption
- producing new materials
- reducing emissions and cleaning up the environment
- producing new drugs and drug delivery systems
- producing fertilizers to increase world food supplies
- finding ways to use recycled waste.



Chemical Engineers touch all our lives; our food, gasoline, drinking water, clothes, even medical care.

What do Chemical Engineers do?

Chemical engineers are problem solvers who combine the science of chemistry with the discipline of engineering. They take chemistry out of the laboratory, apply it on a large scale, and bring it into the world around by producing things we all use.

Chemical engineers help produce fertilizer, paper, gasoline, natural gas, nylon , and plastics. Their expertise is also required to make coffee, Astroturf, electric cars, medicine, microchips, bioengineered drugs, nicotine patches, and artificial hearts. They design and run water treatment plants, plastics recycling plants, and devices to control emissions from power plants, and much more.

What kind of jobs do Chemical Engineers have?

Because *chemical engineers* are problem solvers, and have such broad technical training, they do an amazing variety of jobs. If you wanted to make dual pane house windows that don't fog up, who would you ask to do the design and testing? *A chemical engineer!* If you wanted to make *billions* of potato chips that were exactly the same size, fit into a can, and didn't break, who would develop the manufacturing process? *A chemical engineer!* If you wanted to manufacture 50,000 gallons/year of flu vaccine of the highest quality at the lowest possible cost, who would you want supervising your plant? ***A chemical engineer!*** If the State of Illinois needed someone to write a computer program to predict where pollution from a leaking storage tank would go through the soil into the ground water, who do they hire? *A chemical engineer!*

Production:

Production engineers are responsible for the day to day operations in a manufacturing plant; making sure that what it manufactures is the quality the customer wants, as efficiently as possible, as safely as possible. They change the way the plant operates to respond to changing conditions, such as varying feed stock, varying customer specifications, and changing costs of raw materials. Since no product is made if the plant shuts down, they spend a lot of time troubleshooting their plant, trying to identify problems before they cause trouble, or figure out what caused the problem when the plant does shut down unexpectedly. They are always looking for ways to improve the way the plant operates, especially ways to reduce unwanted by-products, reduce energy use, and reduce pollution.

Operations engineers must work with plant management (*to find out what the production goals are for today*), other operations engineers (*to find out how the other part of the plant that supplies feed to their unit is doing*), and the plant operators (*to find out what's really going on in the engineer's unit).*

Design:

Engineers must apply their knowledge of chemistry, engineering principles, plant operations, industry design standards, economics, and people skills to build a new facility. In the *conceptual* stage they select the basic "flow scheme". This identifies the types of processes and equipment needed to make the product. In the *process engineering* stage, operating conditions (temperatures, pressures, compositions, flows) are selected and basic specifications (size, materials of construction) are developed for the major equipment. Now a cost estimate can be made. In the *detailed engineering* stage, everything has to be specified *exactly,* and bought. Once the plant layout is decided, every vessel, pump, pipe, valve, and controller must be either bought or built. Safety systems, control rooms, utilities (steam, cooling water, instrument air) must also be considered.

Everything comes together in the *construction* phase. All this stuff must be installed, connected, inspected, tested, and prepared for operation. The efforts of the design team are rewarded when the new plant *starts up.* Raw material is introduced , the equipment is slowly brought up to capacity, controls are tuned, operating measurements are taken, process changes are made where necessary, and the plant is in production!

Obviously no one person can do all this alone. Chemical engineers must work in teams with chemical engineers and other disciplines. If they don't work with customers, salespeople, construction workers, and operators they accomplish nothing.

Research and Development:

Research and Development engineers find new uses for existing materials and processes; new ways to design (mathematically model) chemical processes; and invent new products and ways to make products. Research is conducted in **universities** (typically more fundamental and theoretical) and in **industry** (typically more practical). R&D engineers must test their ideas and designs; often in the laboratory, but increasingly on the computer instead. Researchers must know the basic subject matter, study all the results of other researchers in the field, conceptualize an idea or a process, plan the necessary experiments to prove their idea, then prepare their conclusions in a way that will be useful to others (define how this can be used in the real world). As you can imagine, not every idea works.