

Food Engineering

STARTING SALARY (FOR CHEMICAL ENGINEERING): \$65,403
MEDIAN INCOME (FOR CHEMICAL ENGINEERING): \$94,350



Take a walk down any aisle in your local grocery store. What most people don't realize is that behind every product on every shelf are engineers that work to make that food taste good and healthy. Every aspect of food production, processing, marketing, and distribution benefits from engineering.

Food engineers are involved in all aspects of food preparation and processing. They influence the packaging, storage, and distribution systems of foods as varied as candy bars and frozen dinners. Because new products and environmentally friendly food-processing equipment need to be developed, engineers are in demand within the food industry.

Food engineering, a division of chemical engineering, pertains to the properties and characteristics of foods that affect their processing. Food engineering requires an understanding of the chemical, biochemical, microbiological, and physical characteristics of food. There will be a shortage of food engineers as long as society demands that engineers develop lower-fat, lower-salt, lower-cholesterol, or nutrient-packed foods for their diets.

FOOD FOR THOUGHT - THE ENGINEER WHO CAME TO DINNER

Remember when the frozen "TV dinner" was the only convenience food around? If you do, it's not so much a reflection of your age, as of the rapid changes in food technology. Whether they're more convenient, tastier, fresher, more nutritious, or just more fun, many of today's foods are engineering achievements.

What do engineers have to do with food? The question might actually be, what don't they? According to most reports, agriculture and food processing account for 20 percent of the nation's gross national product. Many of the 1.8 million engineers in the country work on getting food to your table every day, as

Job Outlook

Employment of food engineers, similar to chemical engineers, is projected to grow 4 percent from 2012 to 2022, slower than the average for all occupations. Demand for food engineers' services depends largely on demand for the products of food manufacturing industries.

Industries with the highest levels of employment in this occupation:

1. Architectural, Engineering, and Related Services
2. Food Manufacturing
3. Scientific Research and Development Services
4. Sugar and Confectionery Product Manufacturing
5. Animal Food Manufacturing

Top paying industries for this occupation:

1. Food Manufacturing
2. Sugar and Confectionery Product Manufacturing
3. Animal Food Manufacturing
4. Architectural, Engineering, and Related Services
5. Scientific Research and Development Services

Source: US Bureau of Labor Statistics

well as on special things like Valentine's Day chocolates and food for astronauts on the Space Shuttle.

Of course, a food engineer's most important job is to ensure food safety, supply, nutrition, and stability. But, beyond these basics, engineers continue to work to make food tastier, more convenient, and more appealing.

While TV dinners, now 42 years old, may not inspire the excitement they once did, even some recent innovations are pretty much taken for granted. One example is TetraPak juice boxes, which combine added convenience with improved product quality and stability.

Recently, with concerns about landfill capacity, engineers have looked more closely at how to make food packaging more environmentally friendly.

Everyone's familiar with decaffeinated coffee. Yet how many realize that engineers developed the supercritical carbon dioxide process to remove caffeine from coffee without using traditional hydrocarbon solvents? Now, we can all sleep better.

And, what about the ubiquitous microwave and microwavable food, not to mention freeze-dried and dehydrated foods, boil in a bag, and all the other forms of food packaging? All were developed by engineers.

To wash all this food down, you might drink milk bought right off the grocery shelf, without refrigeration. Using ultra-high temperature processing, engineers have developed a way to keep milk fresh longer, even at room temperature. Of course, this is just the latest development in a series of engineered advances for milk that includes vitamin fortification and lactose-free and low-fat varieties.

For dessert, how about some engineered ice cream? Frozen desserts, like ice cream, have presented unique challenges to engineers. Ice cream is a three-phase emulsion system (oil, water, and air) which has to be delicately balanced to provide the desired product characteristics.

Processing conditions such as freezing rate influence the rate of ice crystal formation and have an effect on the resulting texture and "mouthfeel" of the product. Formulation plays a role as well, when different flavors, fruits, and colors are added, the balance of the system is altered.

Food provides a special challenge to engineers, because it is not as simple as other systems where physical and chemical properties are well defined and compositions known. Most foods are complex mixtures made up of thousands of compounds. Although food's chemical components can be broadly categorized as proteins, carbohydrates, fats, vitamins, minerals, flavors, and enzymes, this simplification does not truly reflect the variety of compounds within each class.

What complicates matters more is that the compounds all interact with each other. And, processing food in the plant or cooking it at home changes the flavor, color, and nutritional characteristics.

Food engineers are also involved in cutting-edge technologies, like genetic engineering, to produce crops more resistant to pests, or more durable for processing. In processing, newer technologies such as freeze drying or supercritical extraction are used in cases where maintaining heat-labile compounds (such as flavors) are important.

How is a typical new food "engineered?" After a product concept is developed in a lab, it is done "bench-scale," where there is close control of composition and processing. One of the engineer's tasks is to translate a lab process to large-scale production. The product also has to be packaged in a way to ensure easy distribution and preparation. And, through the entire interval, from the time the product leaves the plant until it is served at the table, it must maintain its quality.

Established products must be continually "re-engineered" to give them advantages over the competition. These include better overall flavor (or more variety), making the packaging more recyclable, reducing manufacturing costs, improving nutrition, or innovations for added convenience.

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Glossary of Terms

Automation - automatically controlled operation of an apparatus, process, or system by mechanical or electronic devices that take the place of human labor

Biotechnology - the use of living cells, bacteria, etc., to make useful products

Concentrate - to make (something, such as a liquid) stronger by removing water

Dehydrate - to remove water or moisture from (something, such as food)

Deteriorate - to become impaired in quality, functioning, or condition

Effluent - liquid (such as sewage or industrial chemicals) that is released as waste

Emission - something sent out or given off

Extrude - to force, press, or push (something) out

Evaporate - to change from a liquid into a gas

Filtration - the act or process of removing something unwanted from a liquid, gas, etc., by using a filter

Freeze - to solidify as a result of abstraction of heat

Ingredient - one of the things that are used to make a food, product, etc.

Membrane - a thin sheet or layer

Microbiology - a science that studies extremely small forms of life such as bacteria and viruses

Microstructure - the microscopic structure of a material as a mineral or a biological cell

Mix - to add something to something else

Monitor - to watch, observe, listen to, or check (something) for a special purpose over a period of time

Preserve - to prevent (food) from decaying

Preservative - a chemical that is added to food to keep it fresh longer

Process - a continuous operation or treatment especially in manufacture

Quality - a high level of value or excellence

Reduction - the act of making something smaller in size, amount, number, etc

Sanitation - the process of keeping places free from dirt, infection, disease, etc.

Separation - the process of isolating or extracting from or of becoming isolated from a mixture

Storage - the safekeeping of goods in a depository

Thermal - of, relating to, or caused by heat

ABET Accredited Programs in Chemical Engineering

School Name and Location	Website	Program and Degree Name
Arizona State University, Tempe, AZ, US	www.asu.edu	Chemical Engineering, BSE
Auburn University, Auburn, AL, US	www.auburn.edu	Chemical Engineering, BChE
Brigham Young University, Provo, UT, US	www.byu.edu	Chemical Engineering, BS
Brown University, Providence, RI, US	www.brown.edu	Chemical and Biochemical Engineering, BS
Bucknell University, Lewisburg, PA, US	www.bucknell.edu	Chemical Engineering, BS
California Institute of Technology, Pasadena, CA, US	www.caltech.edu	Chemical Engineering, BS
California State Polytechnic University, Pomona Pomona, CA, US	www.csupomona.edu	Chemical Engineering, BS
California State University, Long Beach, Long Beach, CA, US	www.csulb.edu	Chemical Engineering, BS
Carnegie Mellon University, Pittsburgh, PA, US	www.cmu.edu	Chemical Engineering, BS
Case Western Reserve University, Cleveland, OH, US	www.case.edu	Chemical Engineering, BS
Christian Brothers University, Memphis, TN, US	www.cbu.edu	Chemical Engineering, BS
City University of New York, City College, New York, NY, US	www.ccnyc.cuny.edu	Chemical Engineering, BE
Clarkson University, Potsdam, NY, US	www.clarkson.edu	Chemical Engineering, BS
Clemson University, Clemson, SC, US	www.clemson.edu	Chemical Engineering, BS
Cleveland State University, Cleveland, OH, US	www.csuohio.edu/ engineering	Chemical Engineering, BS
Colorado School of Mines, Golden, CO, US	www.mines.edu	Chemical Engineering, BS
Colorado State University, Fort Collins, CO, US	www.colostate.edu	Chemical and Biological Engineering, B.S.
Columbia University, New York, NY, US	www.columbia.edu	Chemical Engineering, BS
Cooper Union, New York, NY, US	www.cooper.edu	Chemical Engineering, BS
Cornell University, Ithaca, NY, US	www.cornell.edu	Chemical Engineering, BS
Drexel University, Philadelphia, PA, US	www.drexel.edu	Chemical Engineering, BS
Florida A&M University, Tallahassee, FL, US	www.famu.edu	Chemical Engineering, BS
Florida Institute of Technology, Melbourne, FL, US	www.fit.edu	Chemical Engineering, BS
Florida State University, Tallahassee, FL, US	www.fsu.edu	Chemical Engineering, BS
Georgia Institute of Technology, Atlanta, GA, US	www.gatech.edu	Chemical and Biomolecular Engineering, BS
Hampton University, Hampton, VA, US	www.hamptonu.edu	Chemical Engineering, BS
Howard University, Washington, DC, US	www.howard.edu	Chemical Engineering, BS
Illinois Institute of Technology, Chicago, IL, US	www.iit.edu	Chemical Engineering, BS
Iowa State University, Ames, IA, US	www.iastate.edu	Chemical Engineering, BS
Kansas State University, Manhattan, KS, US	www.k-state.edu	Chemical Engineering, BS
Kettering University, Flint, MI, US	www.kettering.edu	Chemical Engineering, B.S.
Lafayette College, Easton, PA, US	www.lafayette.edu	Chemical Engineering, BS
Lamar University, Beaumont, TX, US	www.lamar.edu	Chemical Engineering, BS
Lehigh University, Bethlehem, PA, US	www.lehigh.edu	Chemical Engineering, BS
Louisiana State University and A&M College, Baton Rouge, LA	www.lsu.edu	Chemical Engineering, BS
Louisiana Tech University, Ruston, LA, US	www.latech.edu	Chemical Engineering, BS
Manhattan College, Riverdale, NY, US	www.manhattan.edu	Chemical Engineering, BS

Massachusetts Institute of Technology, Cambridge, MA, US	www.mit.edu	Chemical Engineering, BS
Miami University, Oxford, OH, US	www.muohio.edu	Chemical Engineering, BS
Michigan State University, East Lansing, MI, US	www.msu.edu	Chemical Engineering, BS
Michigan Technological University, Houghton, MI, US	www.mtu.edu	Chemical Engineering, BS
Mississippi State University, Mississippi State, MS, US	www.msstate.edu	Chemical Engineering, BS
Missouri University of Science and Technology, Rolla, MO, US	www.mst.edu	Chemical Engineering, BS
Montana State University - Bozeman, Bozeman, MT, US	www.montana.edu	Chemical Engineering, BS
New Jersey Institute of Technology, Newark, NJ, US	www.njit.edu	Chemical Engineering, BSChE
New Mexico Institute of Mining and Technology Socorro, NM, US	www.nmt.edu	Chemical Engineering, BS
New Mexico State University, as Cruces, NM, US	www.nmsu.edu	Chemical Engineering, BSChE
North Carolina Agricultural and Technical State University Greensboro, NC, US	www.ncat.edu	Chemical Engineering, BS
North Carolina State University at Raleigh, Raleigh, NC, US	www.ncsu.edu	Chemical Engineering, BS
Northeastern University, Boston, MA, US	www.northeastern.edu	Chemical Engineering, BS
Northwestern University, Evanston, IL, US	www.northwestern.edu	Chemical Engineering, BS
Ohio University, Athens, OH, US	www.ohiou.edu	Chemical Engineering, BS
Oklahoma State University, Stillwater, OK, US	www.osu.okstate.edu	Chemical Engineering, BSChE
Oregon State University, Corvallis, OR, US	www.oregonstate.edu	Chemical Engineering, BS
Pennsylvania State University, University Park, PA, US	www.psu.edu	Chemical Engineering, BS
Polytechnic Institute of New York University Brooklyn, NY, US	www.poly.edu	Chemical and Biological Engineering, BS
Polytechnic University of Puerto Rico, San Juan, PR, US	www.pupr.edu	Chemical Engineering, BS
Prairie View A&M University, Prairie View, TX, US	www.pvamu.edu	Chemical Engineering, BSChE
Princeton University, Princeton, NJ, US	www.princeton.edu	Chemical Engineering, BSE
Purdue University at West Lafayette, West Lafayette, IN, US	www.purdue.edu	Chemical Engineering, BS
Rensselaer Polytechnic Institute, Troy, NY, US	www.rpi.edu	Chemical Engineering, BS
Rice University, Houston, TX, US	www.rice.edu	Chemical Engineering, BSChE
Rose-Hulman Institute of Technology, Terre Haute, IN, US	www.rose-hulman.edu	Chemical Engineering, BS
Rowan University, Glassboro, NJ, US	www.rowan.edu	Chemical Engineering, BS
Rutgers, The State University of New Jersey New Brunswick, NJ, US	www.rutgers.edu	Chemical Engineering, BS
San Jose State University, San Jose, CA, US	www.sjsu.edu	Chemical Engineering, BS
South Dakota School of Mines and Technology Rapid City, SD, US	www.sdsmt.edu	Chemical Engineering, BS
Stanford University, Stanford, CA, US	www.stanford.edu	Chemical Engineering, BS
State University of New York at Buffalo, Buffalo, NY, US	www.buffalo.edu	Chemical Engineering, BS
Stevens Institute of Technology, Hoboken, NJ, US	www.stevens.edu	Chemical Engineering, BE
Stony Brook University, New York, NY, US	www.sunysb.edu	Chemical and Molecular Engineering, BE
Syracuse University, Syracuse, NY, US	www.syr.edu	Chemical Engineering, BS
Tennessee Technological University, Cookeville, TN, US	www.tntech.edu	Chemical Engineering, BS
Texas A&M University, College Station, TX, US	www.tamu.edu	Chemical Engineering, BS
Texas A&M University - Kingsville, Kingsville, TX, US	www.tamuk.edu	Chemical Engineering, BS
Texas Tech University, Lubbock, TX, US	www.texastech.edu	Chemical Engineering, BS
The Johns Hopkins University, Baltimore, MD, US	www.jhu.edu	Chemical and Biomolecular Engineering, BS

The Ohio State University, Columbus, OH, US	www.osu.edu	Chemical Engineering, BSChE
The University of Akron, Akron, OH, US	www.uakron.edu	Chemical Engineering, BS
The University of Alabama, Tuscaloosa, AL, US	www.ua.edu	Chemical Engineering, BSChE
The University of Alabama in Huntsville, Huntsville, AL, US	www.uah.edu	Chemical Engineering, BSE
The University of Kansas, Lawrence, KS, US	www.ku.edu	Chemical Engineering, BS
The University of Toledo, Toledo, OH, US	www.utoledo.edu	Chemical Engineering, BS
The University of Tulsa, Tulsa, OK, US	www.utulsa.edu	Chemical Engineering, BS
Trine University, Angola, IN, US	trine.edu/wearetrine	Chemical Engineering, BSChE
Tufts University, Medford, MA, US	www.tufts.edu	Chemical Engineering, BS
Tulane University, New Orleans, LA, US	www.tulane.edu	Chemical Engineering, BSE
Tuskegee University, Tuskegee, AL, US	www.tuskegee.edu	Chemical Engineering, BS
University of Arizona, Tucson, AZ, US	www.arizona.edu	Chemical Engineering, BS
University of Arkansas, Fayetteville, AR, US	www.uark.edu	Chemical Engineering, BS
University of California, Berkeley, Berkeley, CA, US	www.berkeley.edu	Chemical Engineering, BS
University of California, Davis, Davis, CA, US	www.ucdavis.edu	Chemical Engineering, BS
University of California, Irvine, Irvine, CA, US	http://www.uci.edu/	Chemical Engineering, BS
University of California, Los Angeles, Los Angeles, CA, US	www.ucla.edu	Chemical Engineering, BS
University of California, Riverside, Riverside, CA, US	www.ucr.edu	Chemical Engineering, BS
University of California, San Diego, La Jolla, CA, US	www.ucsd.edu	Chemical Engineering, BS
University of California, Santa Barbara, Santa Barbara, CA, US	www.ucsb.edu	Chemical Engineering, BS
University of Cincinnati, Cincinnati, OH, US	www.uc.edu	Chemical Engineering, BS
University of Colorado at Boulder, Boulder, CO, US	www.colorado.edu	Chemical Engineering, BS
University of Connecticut, Storrs, CT, US	www.uconn.edu	Chemical Engineering, BSE
University of Dayton, Dayton, OH, US	www.udayton.edu	Chemical Engineering, BChE
University of Delaware, Newark, DE, US	www.udel.edu	Chemical Engineering, BS
University of Florida, Gainesville, FL, US	www.ufl.edu	Chemical Engineering, BS
University of Houston, Houston, TX, US	www.uh.edu	Chemical Engineering, BSChE
University of Idaho, Moscow, ID, US	www.uidaho.edu	Chemical Engineering, BS
University of Illinois at Chicago, Chicago, IL, US	www.uic.edu	Chemical Engineering, BS
University of Illinois at Urbana - Champaign, Urbana, IL, US	www.illinois.edu	Chemical Engineering, BS
University of Iowa, Iowa City, IA, US	www.uiowa.edu	Chemical Engineering, BSE
University of Kentucky, Lexington, KY, US	www.uky.edu	Chemical Engineering, BSChE
University of Kentucky (Extended Campus-Paducah) Paducah, KY, US	www.uky.edu	Chemical Engineering, BSCME
University of Louisiana at Lafayette, Lafayette, LA, US	www.louisiana.edu	Chemical Engineering, BS
University of Louisville, Louisville, KY, US	www.louisville.edu	Chemical Engineering, BS
University of Maine, Orono, ME, US	www.umaine.edu	Chemical Engineering, BS
University of Maryland Baltimore County, Baltimore, MD, US	www.umbc.edu	Chemical Engineering, BS
University of Maryland College Park, College Park, MD, US	www.umd.edu	Chemical Engineering, BS
University of Massachusetts Amherst, Amherst, MA, US	www.umass.edu	Chemical Engineering, BS
University of Massachusetts Lowell, Lowell, MA, US	www.uml.edu	Chemical Engineering, BS
University of Michigan, Ann Arbor, MI, US	www.umich.edu	Chemical Engineering, BSE
University of Minnesota - Twin Cities, Minneapolis, MN, US	www.umn.edu	Chemical Engineering, BChE
University of Minnesota Duluth, Duluth, MN, US	www.d.umn.edu	Chemical Engineering, BSChE
University of Mississippi, University, MS, US	www.olemiss.edu	Chemical Engineering, BS
University of Missouri-Columbia, Columbia, MO, US	www.missouri.edu	Chemical Engineering, BSChE

University of Nebraska - Lincoln, Lincoln, NE, US	www.unl.edu	Chemical Engineering, BSCH
University of Nevada, Reno, Reno, NV, US	www.unr.edu	Chemical Engineering, BS
University of New Hampshire, Durham, NH, US	www.unh.edu	Chemical Engineering, BSChE
University of New Haven, West Haven, CT, US	http://www.newhaven.edu/8/	Chemical Engineering, BS
University of New Mexico, Albuquerque, NM, US	www.unm.edu	Chemical Engineering, BS
University of North Dakota, Grand Forks, ND, US	www.und.edu	Chemical Engineering, BS
University of Notre Dame, Notre Dame, IN, US	www.nd.edu	Chemical Engineering, BS
University of Oklahoma, Norman, OK, US	www.ou.edu	Chemical Engineering, BS
University of Pennsylvania, Philadelphia, PA, US	www.upenn.edu	Chemical and Biomolecular Engineering, BSE
University of Pittsburgh, Pittsburgh, PA, US	www.pitt.edu	Chemical Engineering, BS
University of Puerto Rico, Mayaguez Campus Mayaguez, PR, US	www.uprm.edu	Chemical Engineering, BS
University of Rhode Island, Kingston, RI, US	www.uri.edu	Chemical Engineering, BS
University of Rochester, Rochester, NY, US	www.rochester.edu	Chemical Engineering, BS
University of South Alabama, Mobile, AL, US	www.usouthal.edu	Chemical Engineering, BS
University of South Carolina, Columbia, SC, US	www.sc.edu	Chemical Engineering, BSE
University of South Florida, Tampa, FL, US	www.usf.edu	Chemical Engineering, BS
University of Southern California, Los Angeles, CA, US	www.usc.edu	Chemical Engineering, BS
University of Tennessee at Chattanooga, Chattanooga, TN, US	www.utc.edu	Chemical Engineering, BSChE
University of Tennessee at Knoxville, Knoxville, TN, US	www.utk.edu	Chemical Engineering, BS
University of Texas at Austin, Austin, TX, US	www.utexas.edu	Chemical Engineering, BS
University of Utah, Salt Lake City, UT, US	www.utah.edu	Chemical Engineering, BS
University of Virginia, Charlottesville, VA, US	www.virginia.edu	Chemical Engineering, BS
University of Washington, Seattle, WA, US	www.engr.washington.edu	Chemical Engineering, BSChE
University of Wisconsin - Madison, Madison, WI, US	www.wisc.edu	Chemical Engineering, BS
University of Wyoming, Laramie, WY, US	www.uwyo.edu	Chemical Engineering, BS
Vanderbilt University, Nashville, TN, US	www.vanderbilt.edu	Chemical Engineering, BE
Villanova University, Villanova, PA, US	www.villanova.edu	Chemical Engineering, BS
Virginia Commonwealth University, Richmond, VA, US	www.vcu.edu	Chemical and Life Science Engineering, BS
Virginia Polytechnic Institute and State University Blacksburg, VA, US	www.vt.edu	Chemical Engineering, BS
Washington State University, Pullman, WA, US	www.wsu.edu	Chemical Engineering, BS
Washington University, St. Louis, MO, US	www.wustl.edu	Chemical Engineering, BS
Wayne State University, Detroit, MI, US	www.wayne.edu	Chemical Engineering, BSChE
West Virginia University, Morgantown, WV, US	www.wvu.edu	Chemical Engineering, BS
West Virginia University Institute of Technology Montgomery, WV, US	www.wvutec.edu	Chemical Engineering, BS
Western Michigan University, Kalamazoo, MI, US	www.wmich.edu	Chemical Engineering, BSE
Widener University, Chester, PA, US	www.widener.edu	Chemical Engineering, BS
Worcester Polytechnic Institute, Worcester, MA, US	www.wpi.edu	Chemical Engineering, BS
Yale University, New Haven, CT, US	www.seas.yale.edu	Chemical Engineering, BS
Youngstown State University, Youngstown, OH, US	www.ysu.edu	Chemical Engineering, BE