

The Process (step-by-step)

INSPECTION AND CLEANING



Refinery staff inspect arriving corn shipments and clean them twice to remove cob, dust, chaff and foreign materials before steeping, the first processing step, begins. Corn refining has been the fastest growing market for U.S. agriculture over the past twenty years, and refiners now use around 15% of the \$25 billion U.S. corn crop. Since a large amount of the nations' corn production never leaves the farm on which it was produced, corn refining is a vital factor in the cash market for U.S. corn. Each day the production of about 33 thousand acres of corn arrives at corn refining facilities before conversion to food, industrial and feed products.

STEEPING



Each stainless steel steep tank holds about 3,000 bushels of corn for 30 to 40 hours of soaking in 50 degree water. During steeping, the kernels absorb water, increasing their moisture levels from 15 percent to 45 percent and more than doubling in size. The addition of 0.1 percent sulfur dioxide to the water prevents excessive bacterial growth in the warm environment. As the corn swells and softens, the mild acidity of the steepwater begins to loosen the gluten bonds within the corn and release the starch. After steeping, the corn is coarsely ground to break the germ loose from other components. Steepwater is condensed to capture nutrients in the water for use in animal feeds and for a nutrient for later fermentation processes. The ground corn, in a water slurry, flows to the germ separators.

GERM SEPARATION

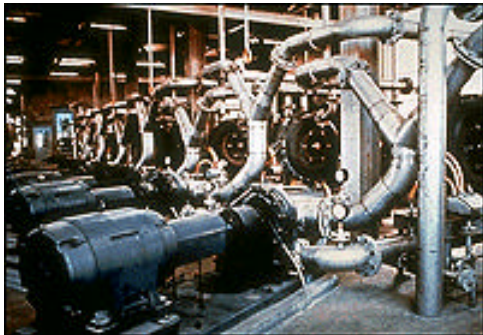


Cyclone separators spin the low density corn germ out of the slurry. The germs, containing about 85% of corn's oil, are pumped onto screens and washed repeatedly to remove any starch left in the mixture. A combination of mechanical and solvent processes extracts the oil from the germ. The oil is then refined and filtered into finished corn oil. The germ residue is saved as another useful component of animal feeds.



FINE GRINDING AND SCREENING

The corn and water slurry leaves the germ separator for a second, more thorough, grinding in an impact or attrition-impact mill to release the starch and gluten from the fiber in the kernel. The suspension of starch, gluten and fiber flows over fixed concave screens (illustrated) which catch fiber but allow starch and gluten to pass through. The fiber is collected, slurried and screened again to reclaim any residual starch or protein, then piped to the feed house as a major ingredient of animal feeds. The starch-gluten suspension, called mill starch, is piped to the starch separators.



STARCH SEPARATION

Gluten has a low density compared to starch. By passing mill starch through a centrifuge, the gluten is readily spun out for use in animal feeds. The starch, with just one or two percent protein remaining, is diluted, washed 8 to 14 times, rediluted and washed again in hydroclones to remove the last trace of protein and produce high quality starch, typically more than 99.5 percent pure. Some of the starch is dried and marketed as unmodified corn starch, some is modified into specialty starches, but most is converted into corn syrups and dextrose.



SYRUP CONVERSION

Starch, suspended in water, is liquified in the presence of acid and/or enzymes which convert the starch to a low-dextrose solution. Treatment with another enzyme continues the conversion process. Throughout the process, refiners can halt acid or enzyme actions at key points to produce the right mixture of sugars like dextrose and maltose for syrups to meet different needs. In some syrups, the conversion of starch to sugars is halted at an early stage to produce low-to-medium sweetness syrups. In others, the conversion is allowed to proceed until the syrup is nearly all dextrose. The syrup is refined in filters, centrifuges and ion-exchange columns, and excess water is evaporated. Syrups are sold directly, crystallized into pure dextrose, or processed further to create high fructose corn syrup (illustrated).



FERMENTATION

Dextrose is one of the most fermentable of all of the sugars. Following conversion of starch to dextrose, many corn refiners pipe dextrose to fermentation facilities where the dextrose is converted to alcohol by traditional yeast fermentation or to amino acids and other bioproducts through either yeast or bacterial fermentation. After fermentation, the resulting broth is distilled to recover alcohol or concentrated through membrane separation to produce other bioproducts. Carbon dioxide from fermentation is recaptured for sale and nutrients remaining after fermentation are used as components of animal feed ingredients.

[Review the **Process Flow Chart**](#)

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