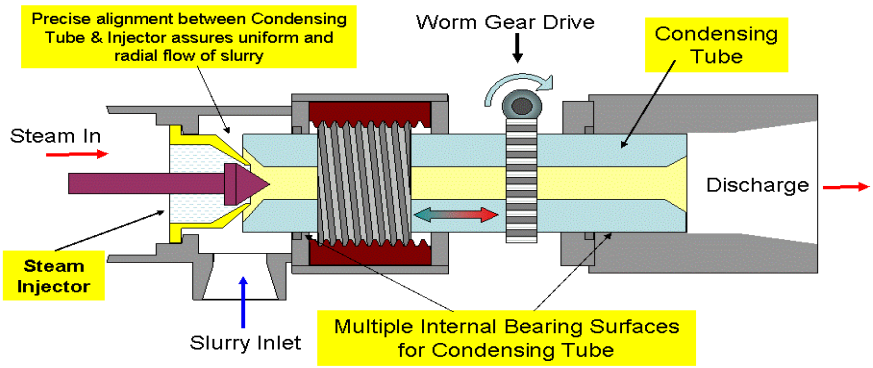
Primary Liquefaction - Starch Cooking Process

After the steeping and separation process, the starch is physically and chemically prepared for fermentation. The milled grain is mixed with process water, the pH is adjusted to about 5.8, and an alpha-amylase enzyme is added. The grain mash must go through a cook process, to raise the slurry's temperature. In the Primary Liquefaction Stage, slurry is then heated with a pressurized jet cooker at 221°F – 228°F. The mixture is then cooled by an atmospheric or vacuum flash condenser and then the mixture is held for 1–2 hours at 180–190°F to allow the enzymes time to work.

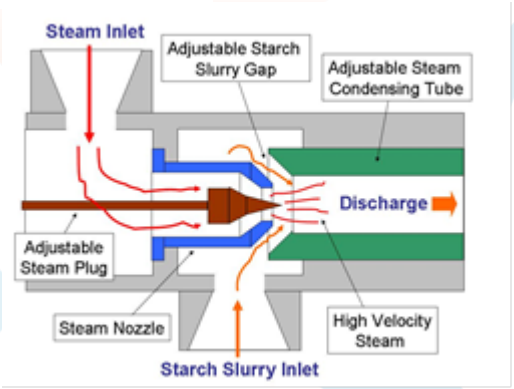
Previous first generation jet cookers suffered from various issues:

- Poor alignment of the steam injector and condensing tube force the system to run at artificially high pressure drops (delta P), causing premature localized wear, non-uniform shearing action, and an increased use of enzymes to compensate.
- The poor alignment of steam injection and condensing tube leads to overdriving the condensing tube which can reduce starch slurry flowrates through the Jet Cooker and increase energy consumption by placing a higher demand on the slurry pumps.
- Single point condensing tube drive systems lead to premature failure of drive components.



*ProSonix **OptiShear**™ … the Next Generation in Jet Cooking*

PSX Jet Cooker Key Benefits:



- **Multiple Bearing Surfaces** provides precise alignment between steam injector & condensing tube to promote **Radial Slurry Flow** which assures uniform and radial flow of the starch slurry
- **Improved Jet Cooking Performance** - The PSX **Jet Cooker** is designed for Ethanol and Starch process applications, where optimization of the pressure drop results in improved starch cook-out performance and a reduction in enzyme costs. The uniform alignment between the Condensing Tube and Steam Injector for more uniform flow and eliminates the need for over driving the combining tube to compensate for misalignment.
- **Reduced Maintenance** by eliminating the single point bolt stud connection which is a common failure point in other Jet Cookers.
- **No Proprietary Software or Controls** required. The system can be operated directly from the plant DCS/PLC.
- **No Plant Air Consumption** as the drive system utilizes an AC motor.
- **Positional Steam Inlet** – Allows the steam inlet to rotate 360° to meet the incoming steam piping regardless of the slurry inlet and discharge positions for ease of installation.

PROSONIX™
Fluid Heating Solutions

AP-40 Starch Processing
Corn Wet Milling

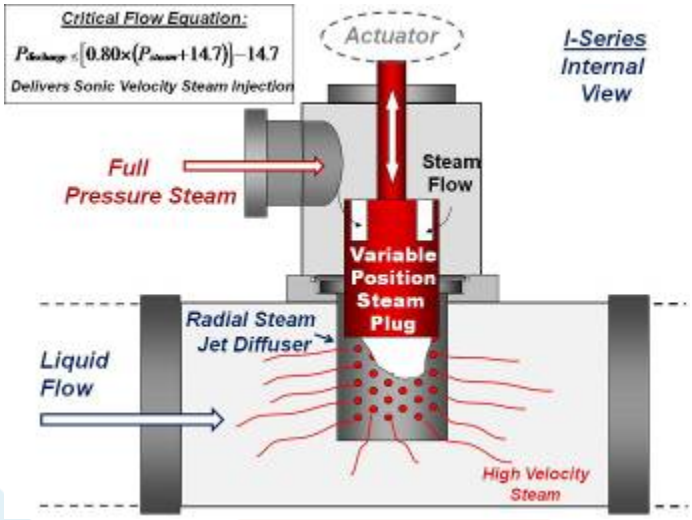
Application: Wet Mill Processing – Water Heating & Jet Cooker Optimization

Corn wet milling is the process of separating the corn kernel into starch, protein, germ and fiber in an aqueous medium prior to fermentation. The primary products of wet milling include starch and starch-derived products (e.g. high fructose corn syrup and ethanol), corn oil, corn gluten, and corn germ. All agricultural crops and residues contain starch, which is a polymer of glucose, a six-carbon sugar. To produce ethanol from grain, the starch portion of the grain is exposed and mixed with water to form a mash. The mash is heated and enzymes are added to convert the starch into glucose.

There are two primary areas where **Direct Steam Injection heating** can provide value for the Wet Mill process. They are the **Steeping process** and the **Primary Liquefaction** or starch cooking process.

Steeping Process

The steeping facilitates the separation of the grain into its many components. In the **wet milling** process, steeping is the process where the grain is first soaked or “steeped” in water and dilute sulfurous acid for 24-36 hours. Steep tanks may hold from 70.5 to 458 cubic meters (m3) (2,000 to 13,000 bushels) of corn, which is then submerged in a current of dilute sulfurous acid solution at a temperature of about 125°F (52°C). To reach this temperature, hot water is added to the steeping tanks. After steeping, the corn slurry is processed through a series of grinders to separate the corn germ. The remaining fiber, gluten and starch components are further segregated using centrifugal, screen and hydroclonic separators.



PSX Water Heater Advantages

- **Internal Steam Modulation** design of the PSX heater controls the steam mass flow and not the steam pressure thus eliminating steam hammer and vibration issues.
- **Low pressure steam may be used** since the steep system operates at low pressure
- **Low Maintenance** due to the PSX heater’s self-cleaning design
- **Stable operation** due to better steam injection heating methods (elimination of steam hammer)
- **Precise Temperature** control allows for a more reliable heating process (+/- 1 °F)
- **Reduced Pressure Drop** (typically 1-2 psig) reduces pump energy demand
- Direct mechanical control of the steam injector allows for linear process heating control
- PSX is controlled by the plant PLC/DCS or local controller with no proprietary software required
- **Ease of Installation** as the PSX heater can be installed in the piping requiring no floor space

For more information, please visit pro-sonix.com.