

Ultra High-Pressure Applications in the Food Industry

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Pressures greater than 30,000 psi are typically referred to as ultrahigh-pressure (UHP). A wide number of industrial applications exist for such pressures. In the food industry, applications for UHP extend from product cutting, cleaning, and homogenization, to food preservation and structure modification. UHP equipment and applications are summarized in this overview.

Waterjet cutting has proven to be a highly effective tool to increase productivity. Portioning and cutting of difficult-to-cut products are in wide commercial use. For example, fish, chicken, and beef are frequently cut using automated robotic waterjets. Waterjet cutting offers greater worker safety as well as product sanitation due to the elimination of knives.

UHP cleaning is rapidly gaining acceptance in tough cleaning applications where the use of chemicals or abrasives is not desired. UHP is frequently lower in overall cost when compared to costs associated with grit blasting or chemicals. UHP is also significantly higher in productivity when compared to soft media blasting (i.e. dry ice and soda). At pressures between 30,000 and 50,000 psi and with the proper selection of nozzles, almost all known industrial coatings from oil paint, thick rubber, and hard plasma applied to metals can be removed. Tough, burned-on deposits are easily removed by UHP waterjets. Large structures such as heat exchangers are frequently lanced cleaned using UHP. UHP cleaning is limited to hard surfaces.

UHP homogenization has found a small number of applications in the food application. As a result of discharging under high pressure, intense fluid shear can be created for product mixing and particle size reduction. However, higher discharge pressures will result in greater product heating. Due to the energy expended, a pressure above 40ksi will typically produce discharge temperature near the boiling point of wa-

ter. For non-temperature sensitive products this can create improved emulsions and dispersions.

The hydrostatic exposure of food to UHP is starting to be used as a method to extend product shelf life without thermal degradation. UHP exposure leads to the inactivation of bacteria, yeast, and molds without the use of elevated temperature. For example, *E. coli* O157:H7 bacteria in fresh orange juice can be inactivated at over 99.9999% (6 log) by a 45 second exposure to 80,000 psi pressure without ever exceeding room temperature. This ability to kill pathogens and spoilage organisms while still preserving the fresh or just-prepared characteristics of a food has enormous applications. As the cost of processing is lowered by more efficient equipment design, many more products will enter the marketplace. Applications exist for fruit, juice, egg, dairy, wine, seafood, meat, and many other products. For products such as raw meats, additional effects have been observed. Fish meat tends to be made firmer while beef tends to be made tenderer. Products high in protein typically experience slight denaturation when exposed to higher pressures. Products high in certain starches can also experience desirable texture changes. Most of the current applications produce microbial reductions similar to pasteurization in high and low acid foods. In the near future sterilization will be achieved through the use of combined moderate temperature (i.e. 95°C) and pressure. This will open the door to shelf-stable low-acid products.

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