Leading through Commitment and Innovation

Since our beginning in 1961 as Luwa Corporation, LCI has provided thousands of systems to the process industries for a wide variety of applications. Our ability to provide engineered solutions to clients with process separations problems has made us widely recognized as the leader in agitated thin film separations technology used in manufacturing chemicals, specialty polymers, food products, and pharmaceuticals. LCI's strengths are:

Our broad range of thin film separation technologies.
The superior quality of the equipment and technology we provide.
Our depth of experience - our engineering teams have hundreds of years of accumulated experience. We provide a very high level of systems design and experience.
Our comprehensive support - we have our own test facility at our Charlotte, NC headquarters, provide development equipment for lease or purchase, and provide 24-hour parts and repair service.
LCI Development & Support

LCI provides the support you need from preliminary evaluation through delivery and continuing operation.

1. **Preliminary Evaluation**

Fully identifying your processing needs is the first step toward providing you with a comprehensive solution. LCI’s Preliminary Evaluation Service (PES) will quickly and inexpensively determine if one of our technologies could meet the requirements of your application.

2. **Testing Services**

If samples and data on particular feed materials are crucial to developing the right solution, LCI pilot testing services allow you to generate those samples and observe the process in operation. Our test center is the most comprehensive in the industry and is fully staffed and equipped for your most demanding development work. Or test at your own facility using one of our lease units.

3. **Final Design & Proposal**

Drawing on data gathered in your earlier design stages, our technology/engineering specialists create fixed price proposals and establish a timetable.

4. **Delivery & Support**

Our steadfast commitment to customer satisfaction means your project will be completed on time, on budget, and with the highest quality possible. That commitment doesn’t end with startup; it continues through the long life of your LCI system. We’re always on call and eager to help—with technical advice, troubleshooting in the field or promptly supplied replacement parts.

A permanent record of your system is maintained in our Charlotte, NC headquarters. Should you need a major overhaul or component repair, LCI shops are equipped to act quickly.
Agitated Thin-film Evaporation

LCI thin-film separation technology quickly separates volatile from less volatile components using indirect heat transfer and mechanical agitation of a flowing product film under controlled conditions.

Its short residence time and open, low pressure drop configuration allow continuous, reliable processing of many heat sensitive or viscous materials without product degradation.

An inherently simple device, the LCI agitated thin-film evaporator consists of two major assemblies: a heated body and a rotor. Product enters above the heated zone and is evenly distributed over the unit’s inner surface by the rotor. As the product spirals down the wall, bow waves developed by the rotor blades generate highly turbulent flow, resulting in optimum heat flux and mass transfer.

Volatile components are rapidly evaporated. Vapors flow either countercurrently or co-currently through the unit, depending on the application. In both cases, vapors are ready for condensing or subsequent processing.

Nonvolatile components are discharged at the outlet. Continuous washing by the bow waves minimizes fouling of the thermal wall where product or residue is concentrated most.

The combination of:
- extremely short residence time
- high turbulence
- narrow residence time distribution
- rapid surface renewal

permits the LCI thin-film evaporator to successfully handle heat-sensitive, viscous, and fouling-type fluids.

Advantages of Agitated Film Evaporation over Conventional Evaporation

- Short residence time
- High evaporation ratios
- High viscosity
- Low pressure drop
- Minimal temperature history
- High tolerance of fouling materials

High Viscosity

LCI processors are also used for high viscosity applications with these benefits:

- Viscosities of up to ten million cP are efficiently processed while retaining product quality
- High volatile loading
- Lower total energy costs
- Lower shear; avoids degradation
- Stripping agents usually not needed
- Minimal black specs and fish eyes
- Very effective pre-concentrator for vented extruders

Above: Rotor before insertion into an LCI high viscosity processor.
Short-path Evaporation

Short path evaporation (also called molecular distillation, sometimes SPE) is a thermal separation technique that provides minimum pressure drop, permitting high vacuum operation down to 0.001 mbar. Short path evaporation is excellent for gently processing heat sensitive, high boiling products.

In a short path evaporator, the agitator (roller or metal, graphite, or teflon wiper) surrounds an internal condenser and revolves at moderate speeds. Feed enters above the distributor and is spread into a thin film on the inside surface of the shell. The rollers or wipers on the rotor cage gently agitate the film.

The product travels down the heated surface in a very short time while generating vapors. These vapors flow through the rotor and condense on the internally mounted condenser. This short vapor path minimizes pressure drop. The distilled product and the remaining bottoms are taken out through separate outlets.

- Operating temperature up to 650°F Low pressure and high heating temperature allow processing of many hard to distill products
- Suitable for viscous products
- Excellent turn down capability
- Low product holdup, good for hazardous materials
- Residence time of a few seconds, important for heat sensitive products

The cage type construction in the standard rotor of a short path evaporator allows placement of the internal condenser, extending the operating pressure capability from 1 mbar to 0.001 mbar.

Thin-film Drying

LCI thin-film dryers are used in a wide variety of process duties including drying, stripping, cooling, reacting, devolatilizing, de-monomerizing, and melting.

LCI’s Vertical and Horizontal Dryers, and the Combi (Vertical and Horizontal designs together), are being used in a multitude of installations worldwide. They can be heated by steam or hot oil, and can be operated semi-batch-wise or continuously at atmospheric pressure or under vacuum.

**FEATURES OF VERTICAL DRYER**
- Dilute feed materials dry to free-flowing solids in single pass, eliminating several process steps
- Little or no thermal degradation of heat sensitive or hazardous products due to low residence time
- Thermal surface fouling minimized by action of pendulum blades
- Fully enclosed design to process reactive, toxic and hazardous substances

**FEATURES OF HORIZONTAL DRYER**
- Short residence time, small product hold-up
- Superior mixing efficiency
- Self-cleaning of heating surface
- Flexibility through configurable rotor elements
- Melt low MW thermoplastics

**FEATURES OF COMBI DRYER**
- Variable residence time for heat sensitive products and those requiring more thorough drying
- Can cool in same system
- Low residual volatiles in final powder
Heat Transfer Rate vs. Process Parameters

System design must consider many variables such as feed rate, temperature, rotor speed, blade clearance, wall thickness, construction materials, and the physical and thermodynamic properties of processed materials.

These variables are interrelated in how they affect performance. Selecting the optimum combination to best solve your processing problems is just one of LCI’s valuable services.

Designs for a Variety of Applications

**ROTOR DESIGNS**

- **Fixed Clearance**
  
  For all horizontal designs and most vertical applications for less viscous liquids, generally less than 50,000 cps.

- **Drying**
  
  For solids-containing streams from which liquid must be evaporated or distilled.

- **Wiped Film/Hinged Blade**
  
  For materials with very high fouling tendencies or vaporization ratios.

- **Transported Flow**
  
  This rotor design provides positive transport for viscous materials which do not flow by gravity—usually those of 50,000 cp or more.

**ROTOR ORIENTATION**

- **Vertical**
  
  Used for most applications, the vertical configuration provides reliable, efficient processing of viscous and fouling fluids. Units are available with either an internal or external bottom bearing.

- **Horizontal**
  
  These designs are ideal for applications where longer residence times are required for mass transfer and reactions, or where headroom is limited. The tapered configuration allows adjustment of the rotor clearance to control residence time, and assures heat transfer surface wetting at low throughput rates.

**VAPOR FLOW**

- **Countercurrent**
  
  Used for most vertical applications since it maximizes both heat and mass transfer efficiencies and accommodates internal vapor/liquid entrainment separation.

- **Co-Current**
  
  The best choice for applications where there is heavy vapor loading, foaming, or flashing.
LCI Processing Solutions: Example Applications

**CHEMICAL**
- Recycling solvents from paints, inks, oils and resins
- Recovery of organic products from tars and residues
- Recovery of acetic acid from process streams
- Volume reduction of inorganic salt streams in the nuclear industry
- Recovery of polymer in plastic-coated paper recycling
- Recovery of catalysts from reaction residues
- Recovery of ethylene glycol from polyester condensate
- Purification and separation of components in petrochemicals and natural oils
- Purification of chlorinated hydrocarbons

**PHARMACEUTICAL**
- Concentration of penicillin and related products
- Desolventizing of delicate botanical and fermentation extracts
- Concentration of fermentation broths

**SPECIALTY**
- Purification, color improvement, and depitching of rosin acids
- Purification and deodorization of antioxidants, oil additives, and plasticizers
- Purification of isocyanates
- Purification and separation of fatty acids
- Removal of monomers and volatile solvents from acrylic resins
- Removal of reactants, solvents, and monomers to ppm levels from engineered thermoplastics
- Removal of free phenol and water from phenolic resins
- Reaction and removal of caprolactam from Nylon 6
- Concentration of surfactants
- Improved shelf life and reactivity for herbicides, insecticides, and fungicides

**GREEN TECHNOLOGIES**
- Purification of methyl ester biodiesel
- Purification of glycerin
- Distillers grains drying
## RESULTS

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## INDUSTRIES

- Specialty chemicals
- Specialty foods
- Adhesives/sealants
- Biodiesel
- Pharmaceuticals
- Biologicals
- Paints/coatings
- Polymers/resins
- Solvent/used oil recycling
- Soap/fats/oils
- Nuclear

## OPERATIONS

- Concentration
- Resource recovery
- Devolatilization
- Evaporation / purification
- Finishing
- Distillation/fractionation
- Solvent recovery
- Drying/dehydration
- Reactions
- Reboiling
- Stripping