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# STATIC MIXING TECHNOLOGY

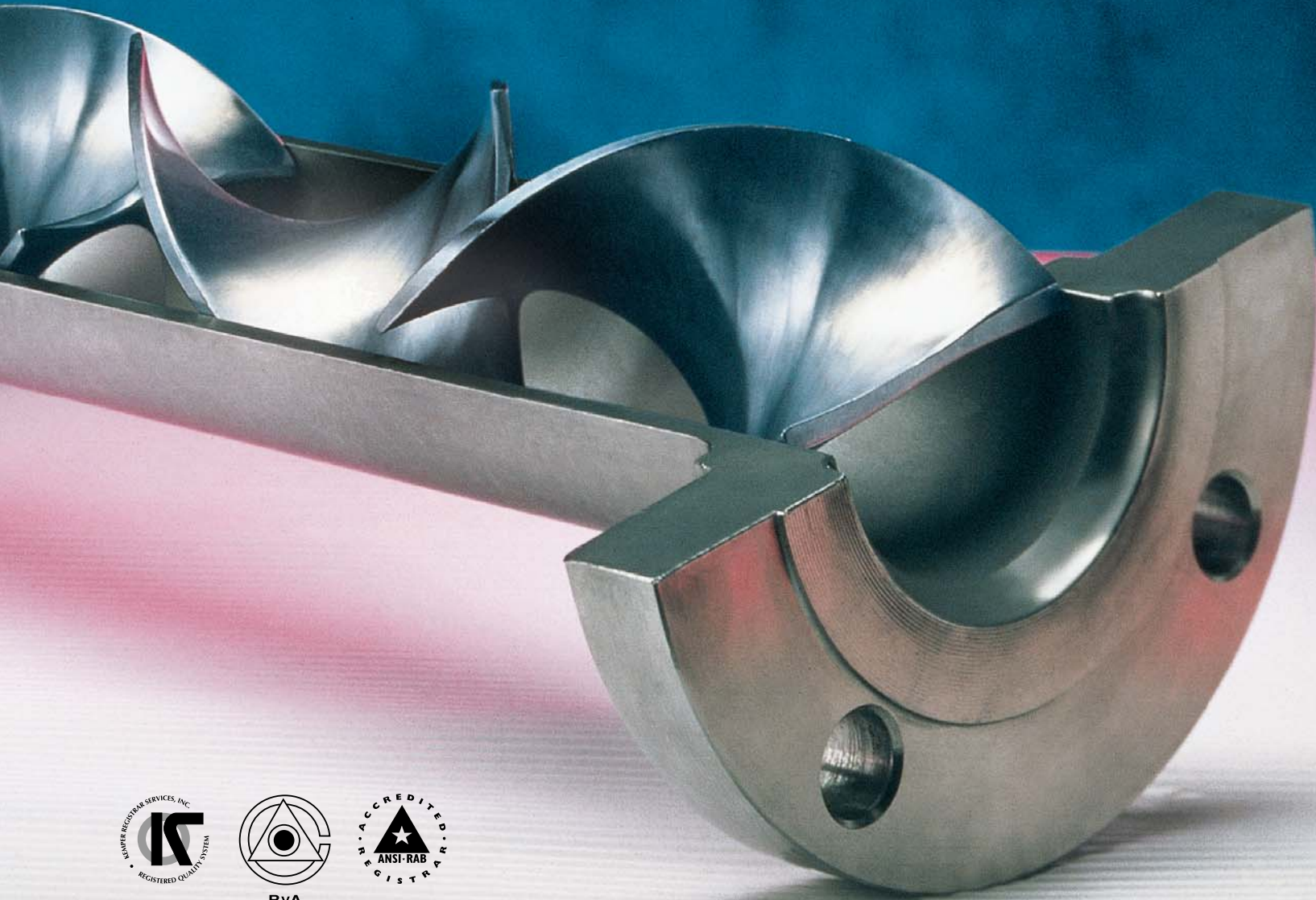
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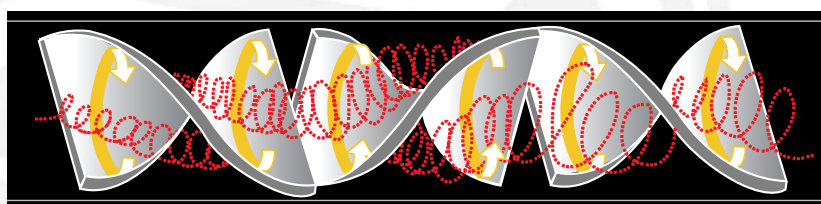
# PRODUCT INNOVATION

For over 30 years, in thousands of installations worldwide, Kenics® Static Mixers have set the standard for in-line mixing and heat transfer performance. Chemineer incorporates advanced technology into every Kenics Mixer to give you reliable, uninterrupted performance that you can depend on for the long term. The result: maximum operating efficiency and overall cost savings.



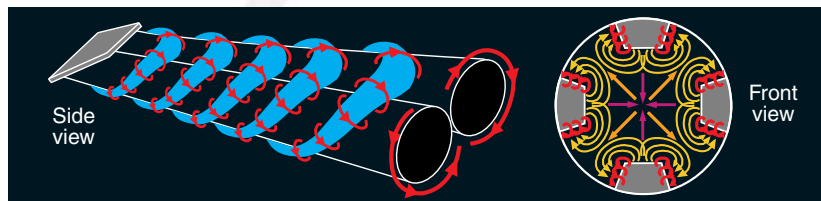
## PRINCIPLES OF OPERATION

In the **KM Static Mixer**, a patented helical mixing element directs the flow of material radially toward the pipe walls and back to the center. Additional velocity reversal and flow division result from combining alternating right- and left-hand elements, increasing mixing efficiency. All material is continuously and completely mixed, eliminating radial gradients in temperature, velocity and material composition.



KM Static Mixer

In the **HEV Static Mixer**, the patented tab geometry maximizes the conversion of turbulent energy into efficient mixing. The HEV produces complete stream uniformity through controlled vortex structures generated by the mixing elements.



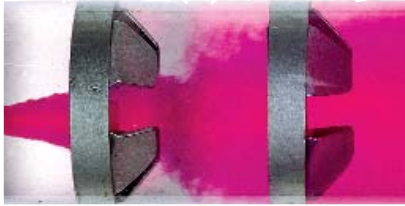
HEV Static Mixer

The element geometry takes advantage of the naturally occurring vortices induced by the element edges.

These mixing principles result in an applications technology that can be easily reproduced and reliably

scaled. Numerous independent studies have shown Kenics Static Mixers maximize mixing efficiency—without the wasted energy and material blockage typically found in more restrictive motionless mixers.

# MIXING APPLICATIONS



## **Turbulent Blending HEV Static Mixer**

Each tab of the HEV Static Mixer generates a pair of streamwise counter-rotating vortices that produce vigorous cross-stream mixing and rapid uniformity.



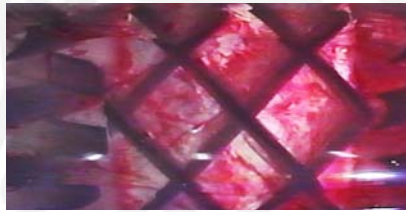
## **Turbulent Blending KM Static Mixer**

The KM Static Mixer produces rapid mixing by inducing circular patterns that reverse direction at each element intersection.



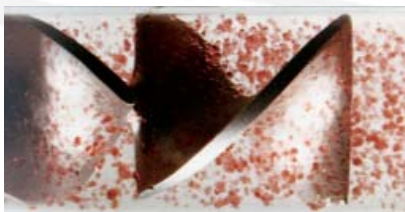
## **Laminar Blending KM Static Mixer**

The alternating helical elements of the KM Static Mixer continually divide, stretch and reorient the flow stream to produce complete mixing with minimum pressure drop.



## **Laminar Blending KMX Static Mixer**

The intersecting blades of the KMX mixer create cross-stream mixing and flow splitting to achieve rapid mixing even in the most demanding applications such as those with extreme viscosity and volume ratios.



## **Liquid/Liquid Dispersion**

The uniform turbulent shear field of the KM Mixer quickly disperses immiscible liquids and produces a narrow drop size distribution.



## **Gas/Liquid Dispersion**

Gases can be incorporated into turbulent liquids using the KM Static Mixer. Mass transfer rates are dramatically enhanced to maximize absorption or reaction.

**K**enics Static Mixers provide precise blending and dispersion of all flowable materials, without utilizing moving parts. Mixing is achieved by redirecting the flow patterns already present in empty pipe. Kenics Static Mixers are currently being used in numerous processing applications, in order to reduce overall cost and significantly improve efficiency, speed and control. Kenics Static Mixers can be found in a wide range of markets including chemical, refining, polymer, food, pulp and paper, water and wastewater treatment. These high efficiency mixers also handle other critical processes, such as:

### **Heating/Cooling**

Kenics Mixers dramatically boost heat transfer rates over those typically found in open pipe under both laminar and turbulent flow conditions.

### **Residence Time Control**

By eliminating the parabolic velocity profile characteristic of laminar flow in open pipes, the helical element of Kenics Mixers promotes plug flow in continuous processes.

### **Temperature Uniformity**

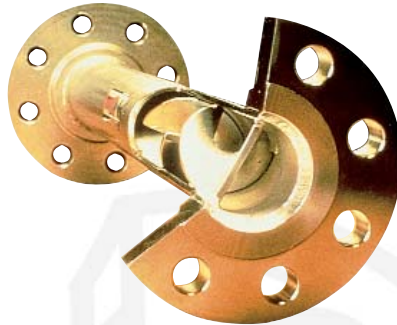
The radial mixing action of the KM elements rapidly eliminates temperature gradients, reducing fouling and thermal degradation.

# KM SERIES STATIC MIXERS

**K**enics KM Series Static Mixers feature a patented helical mixing element which produces complete radial mixing and flow division for any combination of liquids, gases, or solids.

## Adapts to Any Piping System

Mixer dimensions match all standard pipe sizes. Mixer housings feature plain, threaded, weld prep or flanged ends for easy installation. Flange styles include raised face slip-ons, weld neck, lap joint, ring joint and Grayloc-type hubs in all standard pressure ratings. Mixers are available in carbon steel, 304SS, 304LSS, 316SS, 316LSS, Alloy 20 Cb-3, Titanium, Monel 400, Nickel 200, Inconel, Hastelloy C-276, Hastelloy B-2, FRP, PVC, CPVC, PTFE, Kynar, PVDF, Tantalum, Zirconium and other high alloys.



### Fixed Element — KMS

- Used for laminar, transitional, and turbulent flow applications; suitable for most blending or dispersion problems involving liquids or gases
- Mixing elements are attached to the housing wall



### Removable Element — KMR

- Used for laminar, transitional, and turbulent flow applications where periodic cleaning or inspection is required; suitable for most blending or dispersion problems involving liquids or gases
- Mixing elements are easily removed from housing



### Element Assembly — KMA

- Mixing elements are inserted in the customer's existing housing
- Precisely controlled to assure proper fit and ease of installation in any standard or custom pipe size



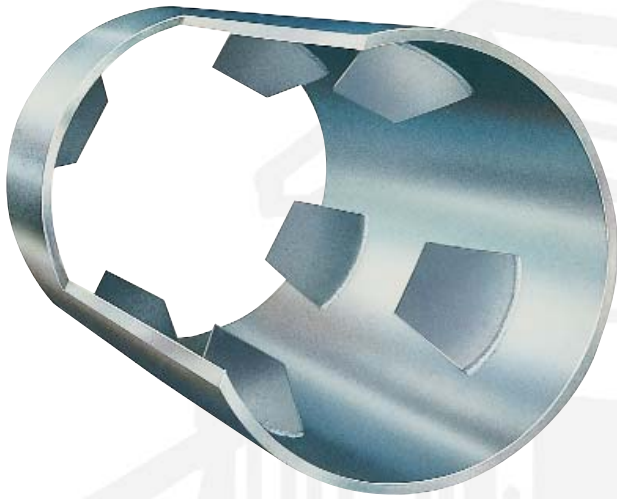
### Edge-Sealed Element — KME

- Used for maximum heat transfer, polymer reactors, certain fibrous applications, and mixing liquids with wide viscosity ratios
- Mixing element edges are furnace-brazed to the housing wall eliminating dead areas
- Continuous joining of elements to the housing eliminates wall clearance to maximize heat conduction and minimize thermal degradation or fouling
- Available with internal surface finishes down to 8 microinches

### Construction options include:

- ASME/B31.3 certification and testing
- Design pressures to over 10,000 psi
- Jackets, nozzles, fittings
- Complete custom fabrication
- Diameters to over 8 feet

# HEV STATIC MIXERS



**H**EV high-efficiency static mixers handle all turbulent-flow mixing applications regardless of line size or shape. Mixing is accomplished by controlled vortex structures generated by the patented low-profile tab geometry. **This provides uniform blending while limiting mixer length to less than 1-1/2 pipe diameters. Complete mixing is achieved with pressure losses 75% less than conventional static mixers.**

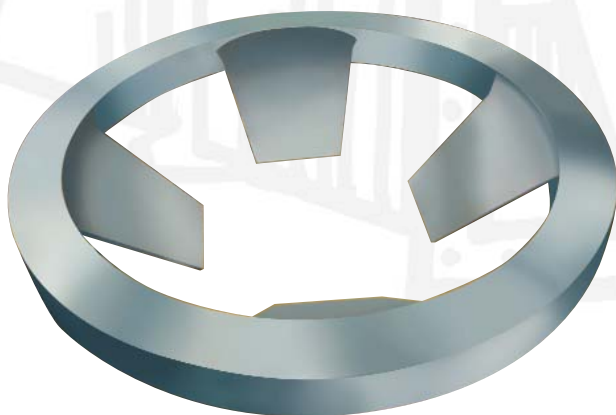


Typical applications for the HEV include all low-viscosity liquid-liquid blending processes, as well as gas-gas mixing. The HEV is ideal for processes where pressure loss and length are critical.

## **HEV Static Mixer features include:**

- Lowest pressure drop available
- Unlimited sizes and shapes
- Shortest possible mixer length
- Easy retrofit to existing lines
- Available in all metals and alloys, FRP, PVC, PFA, and epoxy-coated steel
- Low cost, wafer design is available for installation between flanges

HEV static mixers provide installation flexibility and can be configured to square, rectangular or 3-sided ducts. They are adaptable to open channels typically found in water treatment systems.



# KMX STATIC MIXERS



The Kenics KMX Static

Mixer is the choice for demanding mixing applications, such as those involving fluids with extreme viscosity or volume ratios. The

common limiting factor

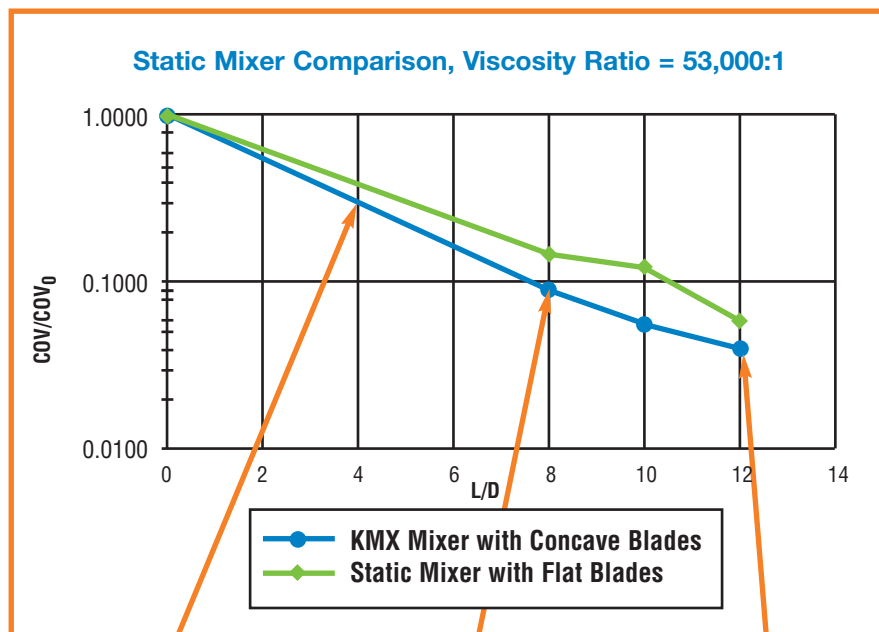
in static mixer design is the allowable mixer length and the patented element design offers a short length and the most efficient mixing performance.

## EXCLUSIVE MIXING PRINCIPLE

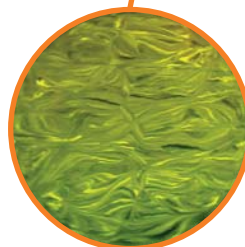
The KMX utilizes cross-stream mixing and flow splitting to achieve very rapid blending. Each element is approximately one pipe diameter in length and consists of multiple intersecting blades, which generate fluid layers as the mixture flows downstream.

**KMX Mixer features include:**

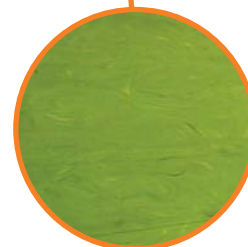
- Superior mixing performance
- Laminar flow and high-low viscosity mixing
- Liquid dispersion/gas-liquid contacting
- Cost effective solution
- Short length
- Standard diameters up to 24"



KMX-4

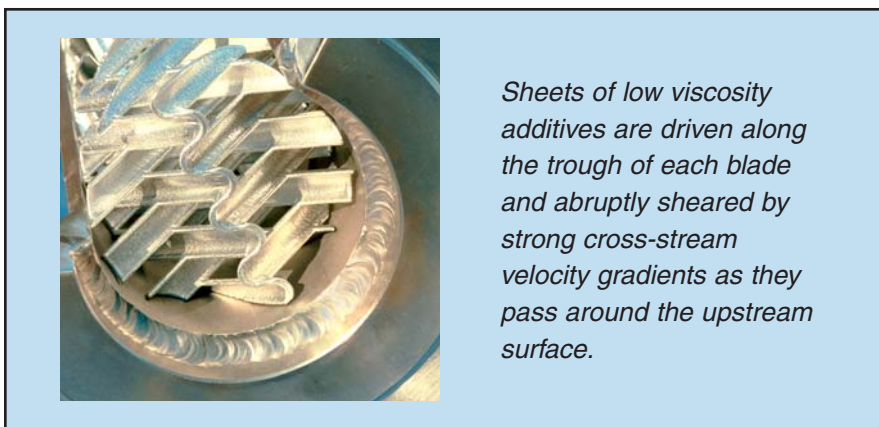


KMX-8

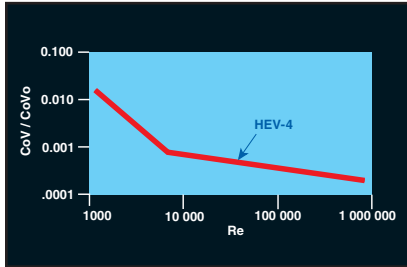


KMX-12

*Laser induced fluorescence (LIF) images showing cross-sectional uniformity*

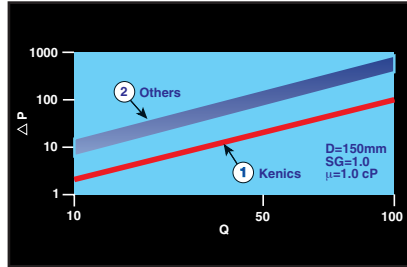


# TECHNOLOGY APPLICATION



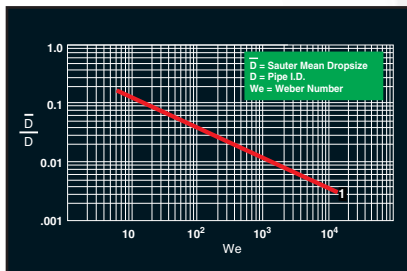
## Mixing Uniformity

By analyzing the inlet stream conditions, final mixture quality can be predicted for all Kenics Mixer designs.



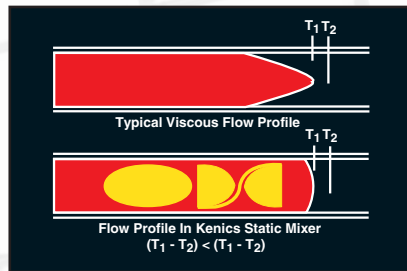
## Pressure Drop

The pressure drop through Kenics Static Mixers is the lowest in the industry resulting in reduced operating costs and increased process capacity.



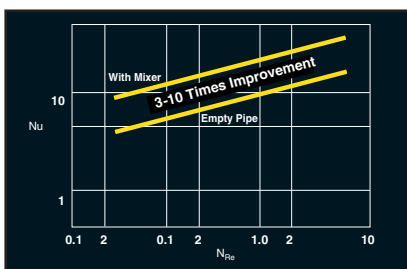
## Drop Size Prediction

Accurate drop size prediction allows optimization of mass transfer controlled processes while avoiding problems with downstream separation equipment.



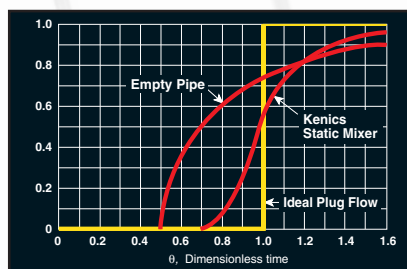
## Temperature Uniformity

Kenics Mixers eliminate hot or cold spots typical of flow in open pipes. Improved thermal uniformity optimizes process performance.



## Heat Transfer

Exclusive edge-sealed mixing elements give Kenics Heat Exchangers transfer rates up to 10 times greater than open tubes.



## Reactor Engineering

By interrupting the parabolic velocity profile characteristic of open pipe, Kenics Static Mixers produce residence time distributions approaching plug flow.

## Guaranteed Mixing Uniformity

The standard technique used for measuring the degree of mixing in pipe flow is the coefficient of variation, CoV. The coefficient of variation is the ratio of the standard deviation of component concentration to its mean concentration. The coefficient of variation achieved at the mixer discharge is dependent on the inlet coefficient of variation (CoV)<sub>0</sub>. The initial coefficient of variation is defined as:

$$(\text{CoV})_0 = \left[ \frac{1 - V_a}{V_a} \right]^{1/2}$$

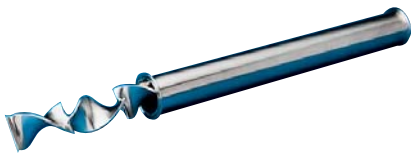
where  $V_a$  is the volume fraction of the stream added. To allow plotting against geometrical factors such as element style, as well as Reynolds number, a normalized coefficient of variation is defined as:

$$\frac{\text{CoV}}{(\text{CoV})_0}$$

The correlations Chemineer has developed through fundamental research, as well as years of operating experience, allow us to accurately predict mixer performance and offer you **100% guaranteed results.**

# SPECIAL PURPOSE PRODUCTS

In addition to our standard static mixer line, Chemineer manufactures a range of products designed to meet your specialized process requirements.



## Sanitary Mixers

- Polished internal and external surfaces
- Removable element assemblies for fast, easy cleaning
- Fitted with tri-clamp-style ferrules
- Available in five diameters from 1/2" to 4"
- 316L construction materials
- Meet 3A standards
- [Request Bulletin 820](#)



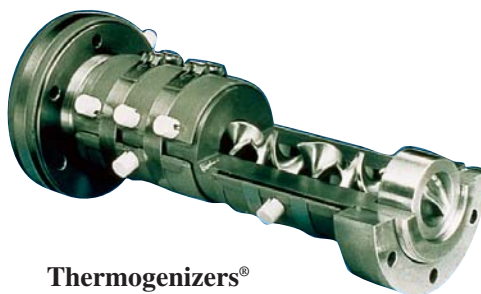
## Pilot Plant Heat Exchangers

- Standard off-the-shelf design for immediate shipment
- Direct scale-up with 100% process warranty
- All stainless steel construction
- Can be used in pilot plants or slip streams to full-scale process



## Heat Exchangers

- Used for process applications, including polymers, plastics, adhesives, hydrocarbon processing, and food industries
- Effective for both heating and cooling of viscous fluids
- Three-to-ten times greater transfer rates than empty tubes
- Boosts heat transfer with minimal flow disruption
- Custom fabrication to ASME/TEMA standards
- [Request Bulletin 808](#)



## Thermogenizers®

- Delivers uniformly mixed melt for extrusion applications
- Offers improved gauge control
- No radial temperature gradients
- Reduced color concentrate usage by improving mixture uniformity
- One-piece design for easy installation and cleaning
- [Request Bulletin 806](#)



## Tube Mixers

- Used for applications with low flow rates in full-scale and pilot plant operations
- Exclusive edge-sealed mixing elements attached to housing wall
- Plain ends accommodate a wide variety of common fittings
- Standard 22-gauge 316SS housings available in diameters from 3/16" to 1/2"



## Tubular Reactors

- Continuous plug flow performance
- Single or multi-tube construction
- Continuous solution phase reactions and polymerizations
- High heat transfer rates with low pressure drop

**No matter what your process needs or system considerations, Kenics Static Mixers can handle your mixing requirements.**



# CUSTOMER SERVICE & SUPPORT



## Commitment to Quality

We manufacture Kenics Static Mixers and Heat Exchangers in our ISO 9001 certified facility in North Andover, Massachusetts. ISO certification allows us to offer customers 100% guaranteed quality products, and represents our ongoing commitment to customer satisfaction.



## Computerized Process Optimization

CEDS® (Chemineer Expert Design System) is a comprehensive computer program developed by Chemineer that interprets process design data and selects only those mixers that it has verified for process and mechanical design integrity. Chemineer field engineers use this technology via laptop computers to provide you with immediate design alternatives.



## Factory Services and Field Engineering

Every Kenics Static Mixer is backed by product and application engineering, a fully equipped mixing laboratory, and complete in-house manufacturing and quality control. Our process engineers combine hands-on experience with fundamental technology to provide you with optimal, cost-effective mixer performance.



## Sharing Our Technology

Our Applications Specialists are ready to bring the latest static mixing technology right to your front door. Your process and development engineers are introduced to mixing principles for blending, dispersion, heat transfer and reactor design allowing them to optimize plant operating performance. Contact your local Chemineer Sales Engineer to arrange an in-house seminar.

## Worldwide Distribution

Kenics Static Mixers are marketed globally through locations in the United States, Canada, England, Mexico, Brazil, India, Singapore, China and Taiwan. Kenics worldwide distribution is ready to serve your mixing needs . . . anywhere . . . anytime.

# PRODUCT APPLICATIONS

**K**enics Mixers are used in numerous industries for a variety of blending, dispersion, heat transfer and residence time control applications.

## TYPICAL APPLICATIONS

### Agricultural Chemicals

- Fertilizer and pesticide preparation
- Gas/liquid dispersion
- Dilution of feed concentrates

### Chemicals

- Chlorination and oxidation
- Organic/aqueous dispersions
- Dilution of acids and bases

### Cosmetics

- Heating slurries and pastes
- Additive blending
- Dispersion of oils

### Energy

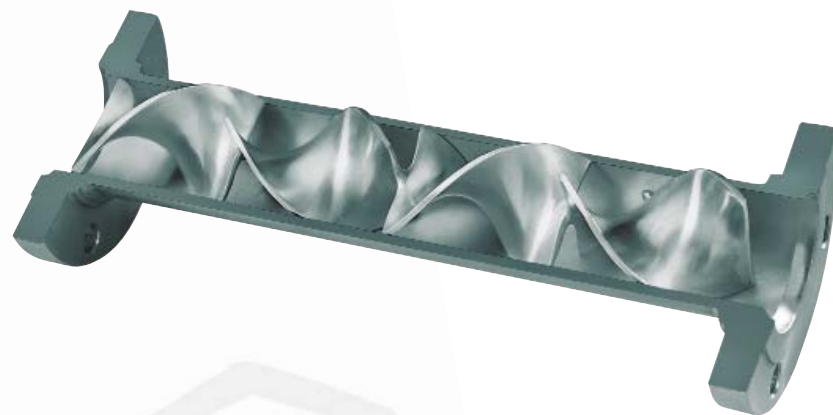
- Chemical addition for enhanced oil recovery
- Injection of geothermal steam
- Preheating coal/oil slurries
- NOX/SOX control

### Foods

- Blending food constituents
- Washing fats and oils with acid
- Heating and cooling sugar solutions
- Starch slurry cooking

### Pharmaceuticals

- Nutrient blending
- pH control
- Sterilization



### Grain Processing

- Starch conversion
- Chemical addition
- Mud dilution
- Steam injection

### Minerals Processing

- Metals recovery by solvent extraction
- Chemical addition and pH control
- Oxidation and bleaching

### OEM

- Adhesive and epoxy dispensing systems
- Adhesives heating
- Monitoring and sampling systems

### Paints & Resins

- Dilution of TiO<sub>2</sub> slurries
- Coloring and tinting
- Solvent blending

### Petrochemical & Refining

- Blending gaseous reactants
- Washing hydrocarbon streams
- Gas scrubbing
- Lube oil blending
- Crude oil sampling

### Polymers & Plastics

- Blending reactants & catalysts
- Thermal homogenization
- Plug flow finishing reactors
- Preheating polymers prior to devolatilization

### Pulp & Paper

- Stock dilution and consistency control
- Chemical and coatings preparation
- pH control
- Pulp bleaching

### Rubber Processing

- Blending latex compounds
- Adding pre-polymers and activators
- Heating and cooling adhesives

### Textiles

- Blending additives
- Eliminating thermal gradients
- Heating and cooling polymers
- Achieving uniform heat history

### Water & Waste Treatment

- Polymer dilution
- pH control
- Chemical addition and flash mixing
- Disinfection and aeration

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B800

Name \_\_\_\_\_ Title \_\_\_\_\_  
 Address \_\_\_\_\_ Phone \_\_\_\_\_  
 City \_\_\_\_\_ FAX \_\_\_\_\_  
 State/Zip \_\_\_\_\_ E-Mail \_\_\_\_\_

**Process Description:****Mixing or Dispersion**

Date \_\_\_\_\_ Items \_\_\_\_\_ of \_\_\_\_\_

Item ref. \_\_\_\_\_

	Units	Stream 1	Stream 2	Stream 3	Mixture
Component Name		_____	_____	_____	_____
Flow Rate	_____	_____	_____	_____	_____
Density	_____	_____	_____	_____	_____
Viscosity	_____	_____	_____	_____	_____
Temperature	_____	_____	_____	_____	_____
Pressure	_____	_____	_____	_____	_____
Liquid/Gas/Solids		_____	_____	_____	_____

**Process Requirement:**
 Blending     Dispersion     Reaction     Residence Time
Components Miscible:     Yes     No    Interfacial Tension: \_\_\_\_\_

Required Droplet/Bubble Size: \_\_\_\_\_ Allowable Pressure Drop: \_\_\_\_\_

**Process Description:****Heating/Cooling**

	Specific Gravity	T, in	T, out	Viscosity	Sp. Heat	Thermal Cond.	Flow Rate
Process Fluid	_____	_____	_____	_____	_____	_____	_____
Heating/Cooling Fluid	_____	_____	_____	_____	_____	_____	_____
Allowable Pressure Drop:	Jacket _____	Tube _____					

**Mechanical Design**

Material of Construction: \_\_\_\_\_ Existing Line Size: \_\_\_\_\_

End Connections:     Plain     THD     Flanged    Type: \_\_\_\_\_ Class: \_\_\_\_\_

Design Temperature: \_\_\_\_\_ Design Pressure: \_\_\_\_\_

Other Process Details/Special Requirements: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Commercial Requirements:**Pricing:     Budgetary     Immediate Purchase

Delivery Requirement: \_\_\_\_\_

 Response needed by:     Today     Tomorrow  
                                    One Week     Other \_\_\_\_\_
**Comments:** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

# ROBBINS MYERS



## PROCESS SOLUTIONS GROUP

Chemineer, Inc. is part of the family of businesses that comprise the Process Solutions Group of Robbins & Myers, Inc. The Process Solutions Group is the most effective, single-source, integrated global provider of innovative process solutions for the CPI, pharmaceutical and numerous other markets. The group brings together its global engineering, manufacturing and application expertise to develop tailored system solutions for its customers that deliver field-proven performance advantages in the most critical applications. Applying its proprietary engineering technology tools, best in class manufacturing cost structure, multi-disciplinary engineering resources and project management expertise, the Process Solutions Group ensures effective process solutions and system integrity.

The Process Solutions Group, headquartered in Rochester, New York, is a global organization with manufacturing facilities in nine countries. The group markets its glass-lined vessels, wiped film evaporators, dynamic and static mixers, heat exchangers and fluoropolymer products globally under industry-leading brand names such as: Pfaudler®, TyconTechnoglass®, Chemineer®, Prochem®, Kenics®, Greerco® and Edlon®.

The Process Solutions Group's parent company, Robbins & Myers, Inc., is a leading supplier of highly-engineered, critical equipment and systems for global energy, industrial, municipal, chemical and pharmaceutical markets. Robbins & Myers provides innovative products, application engineering expertise, customer support and a competitive cost structure that create value for its customers.



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