PIPELINE MIXING - STATIC MIXERS

Advantages of static mixers:

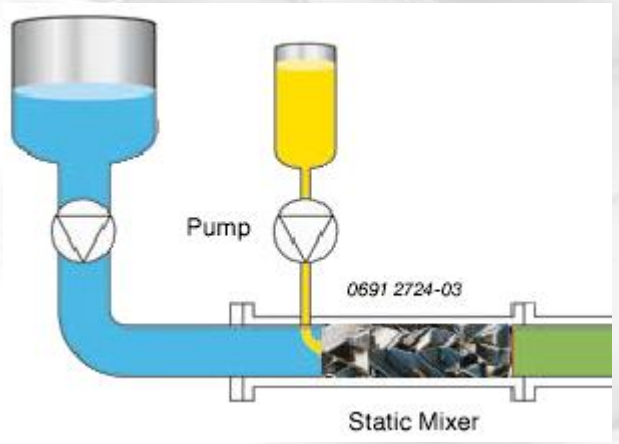
- can be built into an existing pipeline, thereby significantly reducing the built-up area compared to using traditional apparatus with a rotating agitator
- no rotating parts (shaft, bearings, seals or drive motor) which reduces investment costs
- if properly applied, have less energy consumption compared with rotating agitators
- are silent, do not require electrical power supply, and are thus suitable for working in potentially explosive atmospheres

Disadvantages of static mixers:

- short residence time of mixture in mixer
- require precise dosing of components in time (precision dosing pumps are usually expensive)

Yesterday

Today/Tomorrow



Static Mixer

Main type of static mixers

Helical static mixer – KENICS

Turbulent Blending
KM Static Mixer

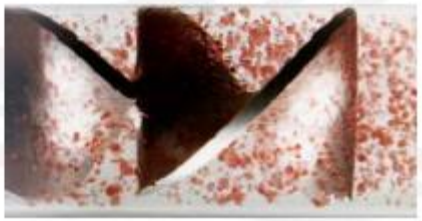
The KM Static Mixer produces rapid mixing by inducing circular patterns that reverse direction at each element intersection.

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.

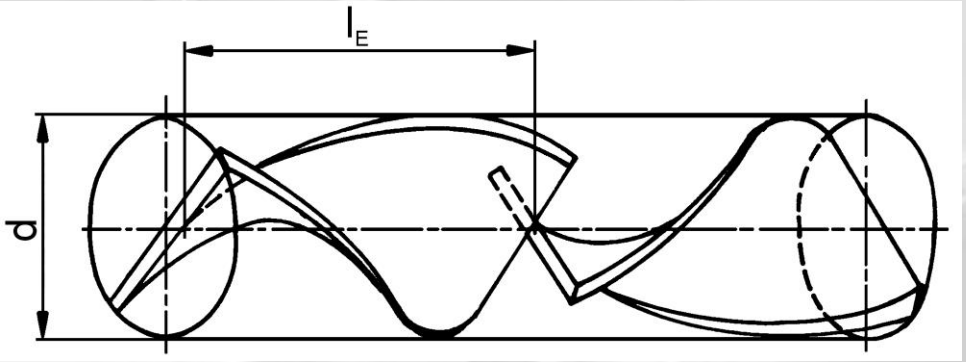
Liquid/Liquid
Dispersion

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

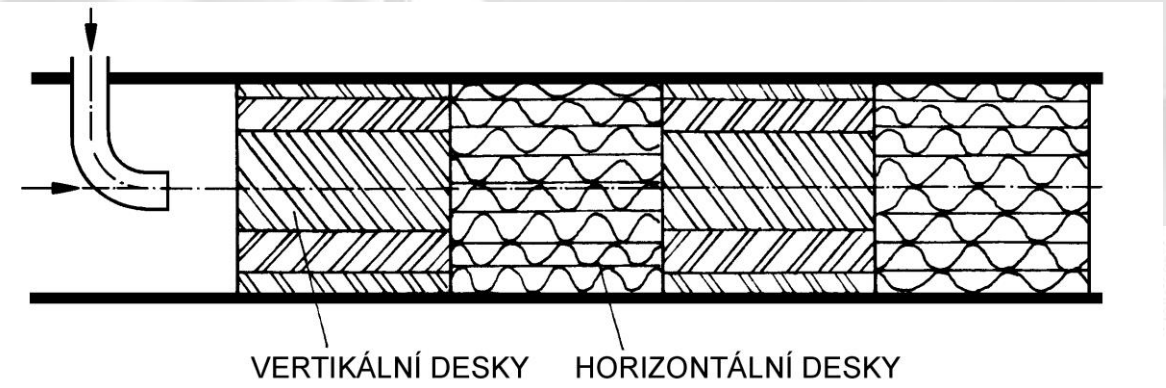


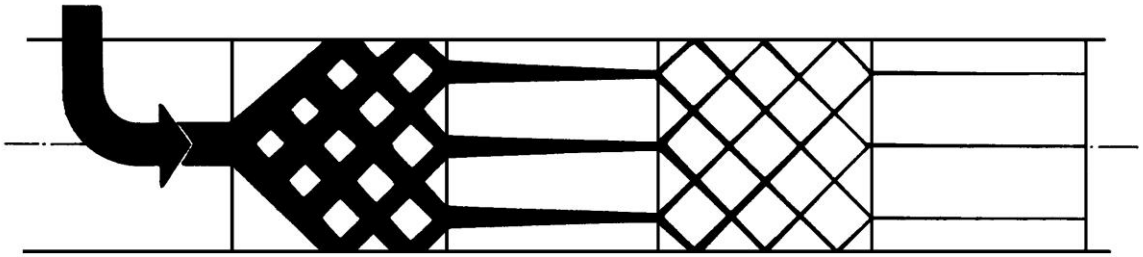
Gas/Liquid
Dispersion

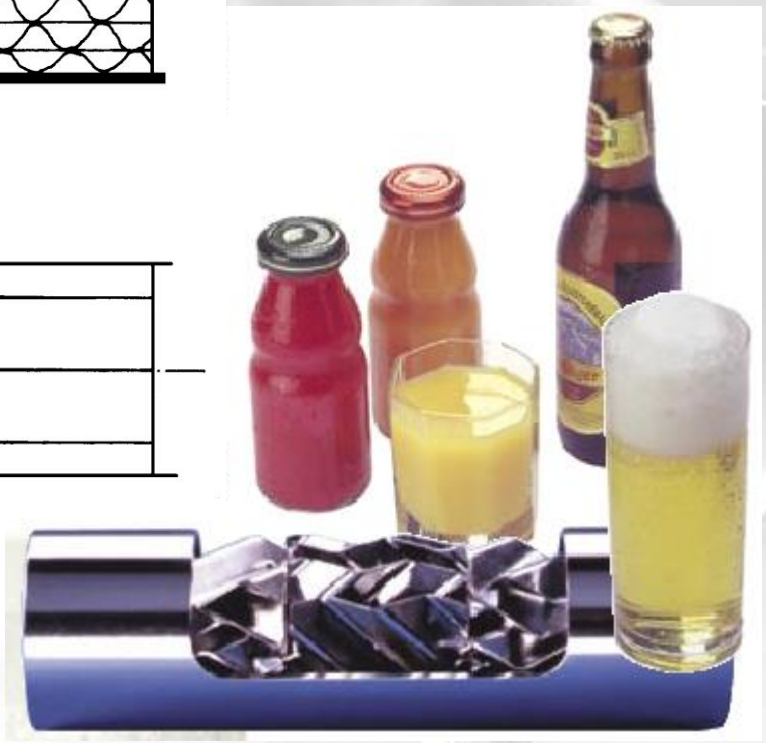
Gases can be incorporated into turbulent liquids using the KM Static Mixer. Mass transfer rates are dramatically enhanced to maximize absorption or reaction.



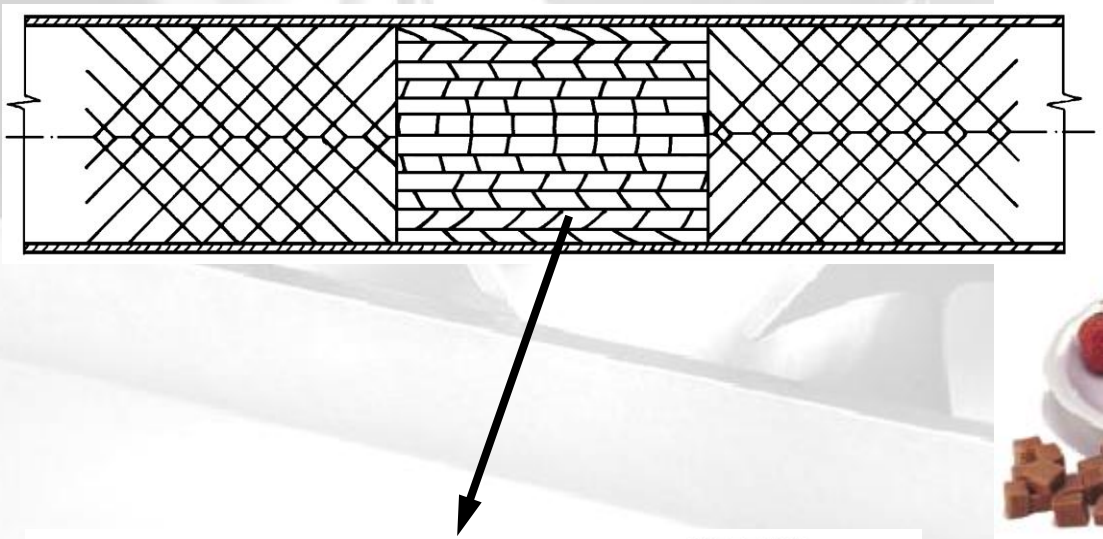
Lamella static mixer – SULZER SMV

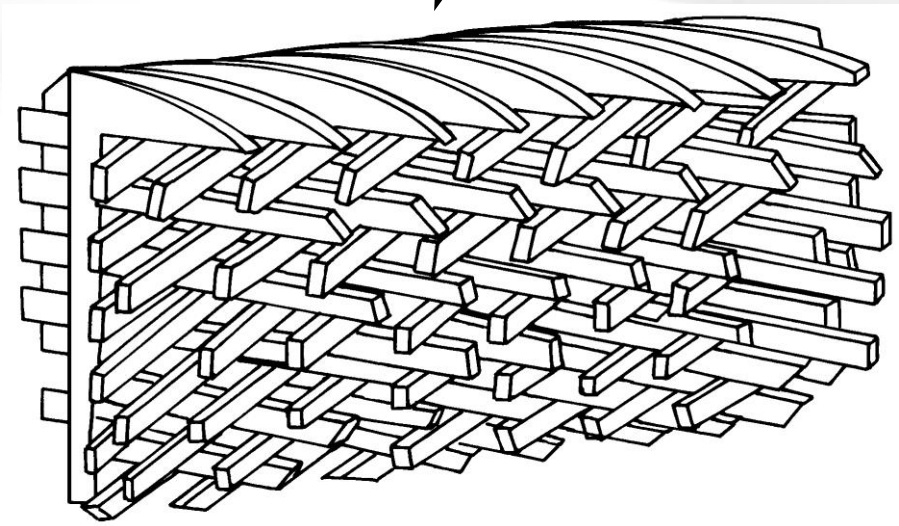


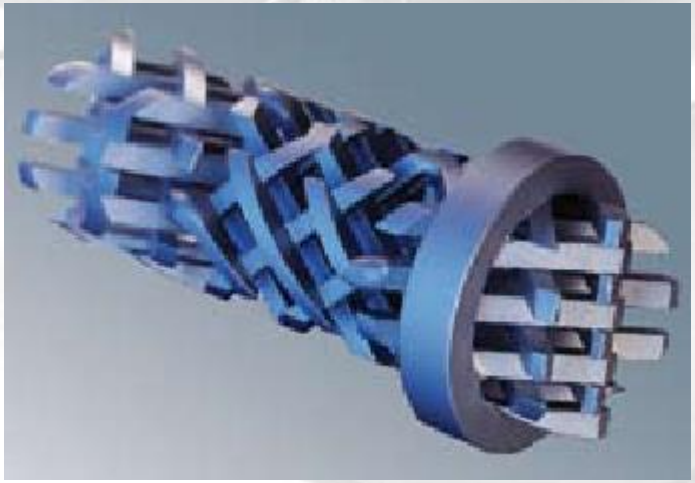




Latticed static mixer – SULZER SMX







Static mixer – SULZER SMF

Mixing of liquids containing solids

Sulzer's SMF mixer is used for product flows that contain solids (e.g. fruit pieces in yoghurt). The large, clear cross section in the tube and open structure design of the mixing chamber guarantee a reliable operation that safeguards integrity of processed solids and is not prone to clogging – even less so thanks to the inclined guide elements which, in addition to actual mixing, allow a continuous flow of particles downstream.

Benefits:

- No clogging when introducing fruit pieces or solid particles, and no destruction of the fruit structure

Typical Applications:

Dairy processing industry

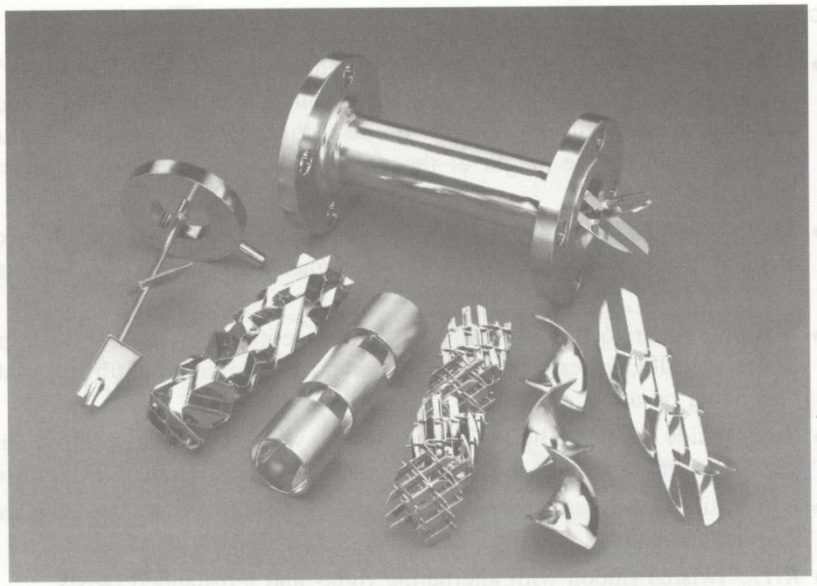
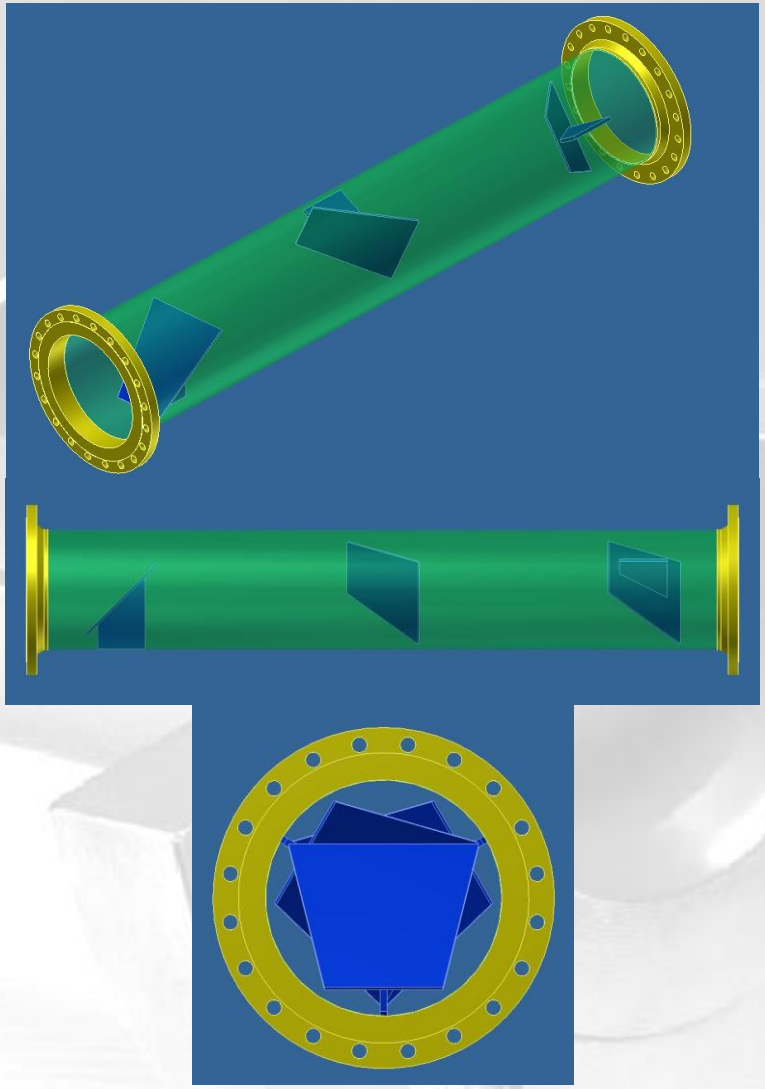


Figure 7-16 Static mixer design options. From left: vortex mixer (type KVM), corrugated plate (type SMV), wall-mounted vanes (type SMF), cross-bar (type SMX), helical twist (type KHT), cross-bar (type SMXL). (Courtesy of Koch-Glitsch, LP.)

Table 7-4 Rough Guidelines for Applications in the Laminar and Turbulent Flow Regimes[a]

	Static Mixer Design									
Flow Regime	KMS	KMX	HEV	SMV	SMX	SMXL	SMR	KVM	SMF	ISG
Laminar										
Mixing/blending	c	a			c	c			a	a
High–low viscosity		a			c	a				a
Dispersion	a	a			c	a				a
Heat transfer	c				b	c	c			
Plug flow	b				c	b	c*			
Turbulent										
Mixing/blending										
High turbulence	a		c	c†				c		
Low turbulence	c			c	a	a			a	
Dispersion										
Liquid–liquid	c			c	a	a	c*		a	
Gas in liquid	c			c	a	a	a*		a	
Liquid in gas	a			c	a					
Fluidized beds					c‡					

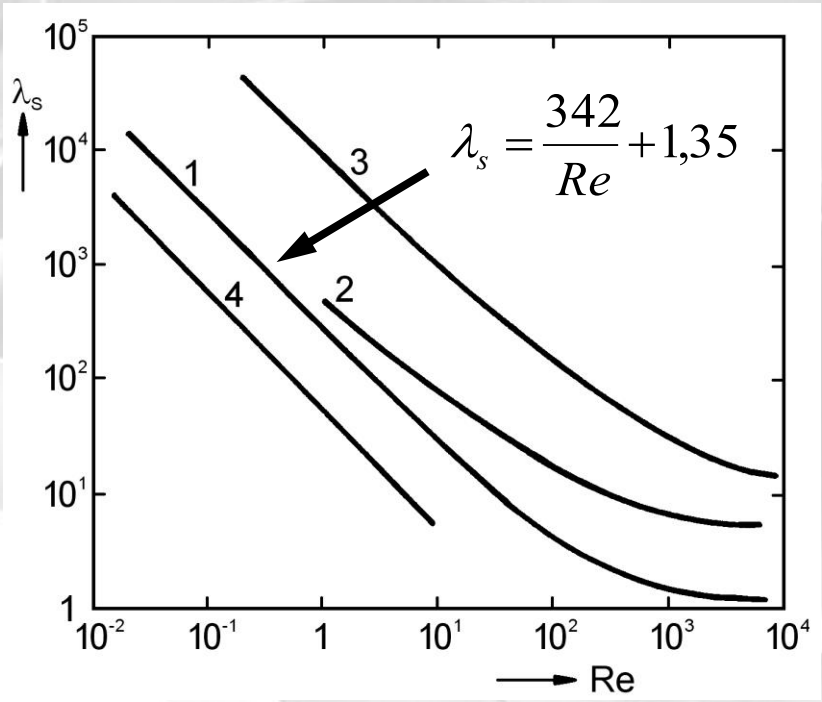
[a] a, Applicable; b, typically applied; c, best design choice. *, Where temperature control is required; †, especially for very large diameters and nonround cross-sections; ‡, gas fluidized solid particles, specialized design (Koch-type KFBE).



Main parameters of static mixers

Pressure drop in pipe with static mixers

$$e_z = \lambda_s \frac{l}{d} \frac{\bar{u}^2}{2}$$



1 *– helical static mixer* ($l_E / d = 2$),
2 *– disk static mixer,* ***3*** *– lamella sttic mixer* ($l_E / d = 1$), ***4*** *– free pipe*

Blending in static mixers