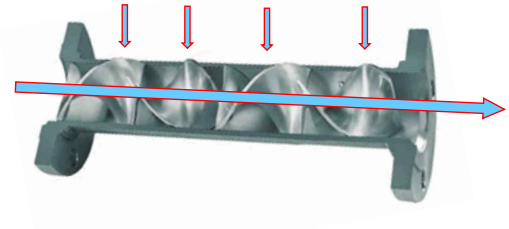
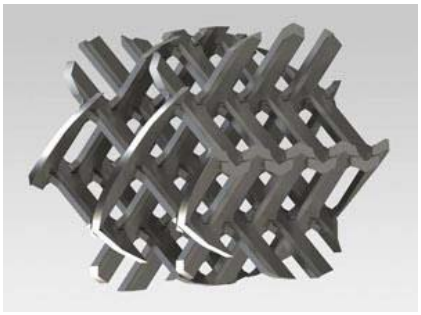
Statična mešala

Uporablja se jih predvsem pri kontinuiranih procesih, mešalni elementi so lahko vgrajeni v cevovode, kamor se dodaja še druge komponente.



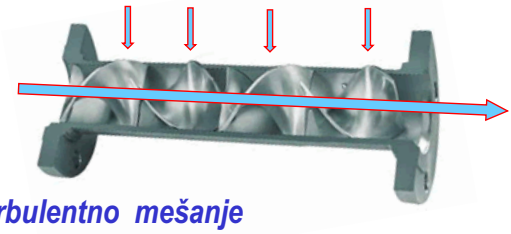
Laminarno mešanje

Tok snovi se pri prehodu skozi element usmeri in na vhodu v naslednji element deli. Pri prehodu skozi naslednji element se usmeri v nasprotno smer in spet deli… Tako je doseženo pomešanje z minimalnim tlačnimi izgubami.



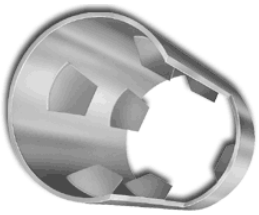
Statična mešala

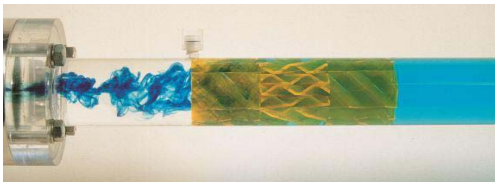
Uporablja se jih predvsem pri kontinuiranih procesih, mešalni elementi so lahko vgrajeni v cevovode, kamor se dodaja še druge komponente.



Turbulentno mešanje

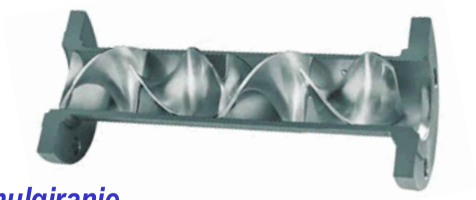
Statična mešala ustvarjajo intenzivno mešanje s povzročanjem intenzivne cirkulacije toka, ki se vzpostavi s prehodom elementa. V naslednjem se cirkulacija zasuka zopet v prvotno smer.





Statična mešala

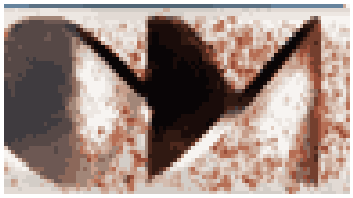
Uporablja se jih predvsem pri kontinuiranih procesih, mešalni elementi so lahko vgrajeni v cevovode, kamor se dodaja še druge komponente.

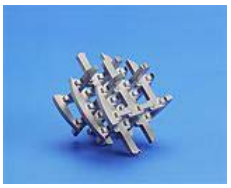


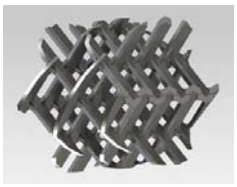
Emulgiranje

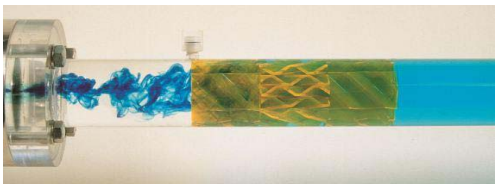
Statično mešalo dispergira medsebojno netopljive kapljevine in proizvaja ozek razred velikosti kapljic.

Razmerje viskoznosti do 1 : 50000







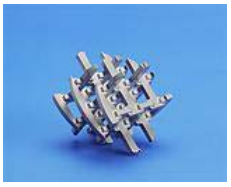


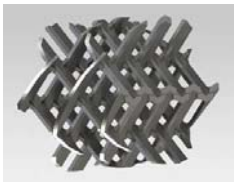
Statična mešala

Uporablja se jih predvsem pri kontinuiranih procesih, mešalni elementi so lahko vgrajeni v cevovode, kamor se dodaja še druge komponente.

Dispergiranje plinov v kapljevine

Pri turbulentnem režimu kapljevine se lahko primeša pline. Tako je dosežena maksimalna absorbcija oz. prenos snovi glede na energijski vnos.





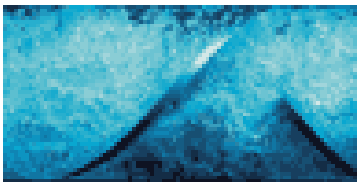
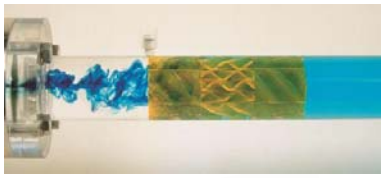
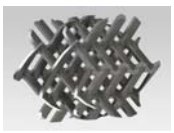


Table 7-1 Pipeline Equipment Options

Flow Regime	Pipe	Tee Mixer	Impingement Jet Mixer	Spray Nozzle	Static Mixer	Inline Mechanical
Laminar regime						
Mixing/blending					X	X
Dispersion					X	X
Heat transfer					X	X
Reaction					X	X
Plug flow					X	
Turbulent regime						
Mixing/blending	X	X	X	X	X	
Dispersion	X	X	X	X	X	
Heat transfer	X			X		
Reaction			X	X	X	X





Impingement mixing is a novel, relatively simple, continuous flow mixing process wherein mixing is accomplished by immersing a high velocity jet in a slower co-flowing stream. The resulting recirculating flow produces an energy cascade that provides a wide range of length scales for efficient mixing.

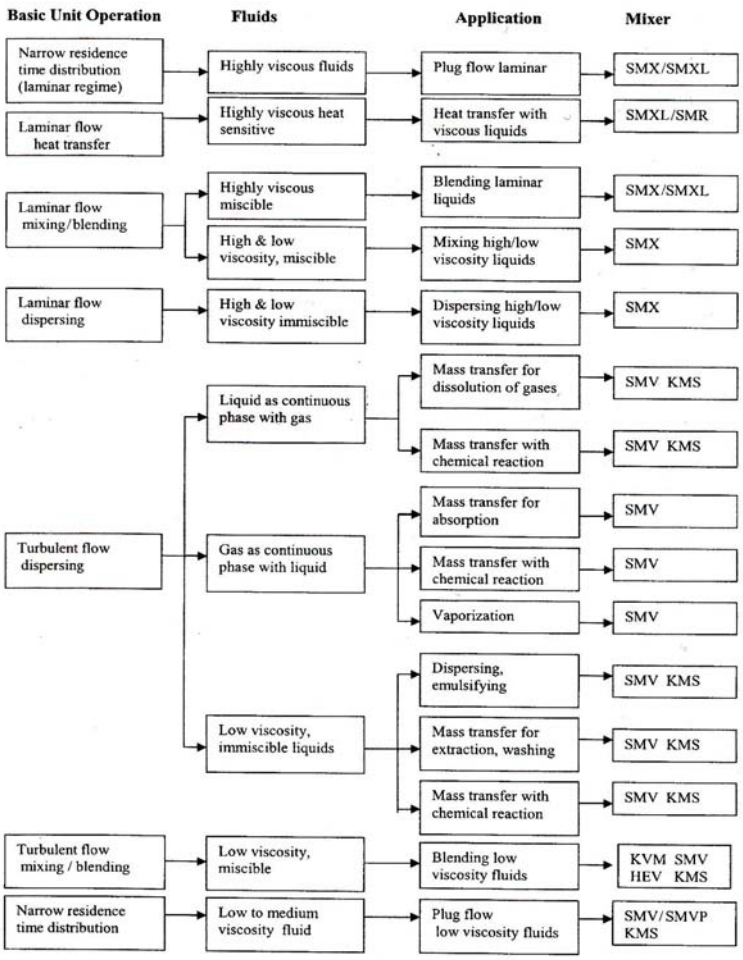


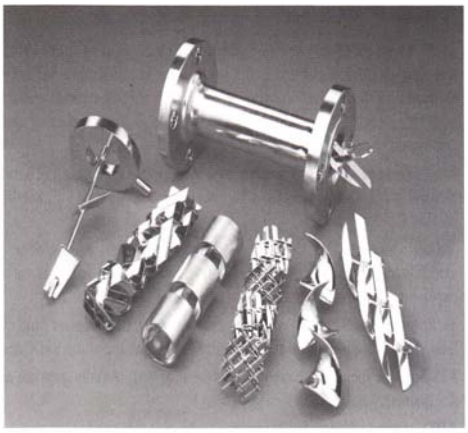
Figure 7-17 Correct static mixer design: applications.

Edward L. Paul, Victor Atiemo-Obeng, Suzanne M. Kresta *Handbook of Industrial* Mixing: Science and Practice, JW&S, Hoboken , New Jersey, 2004

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).



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

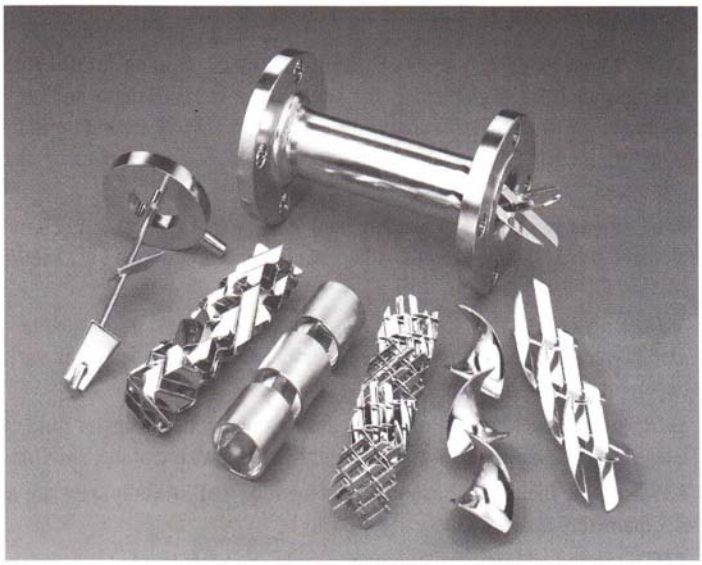


Figure 7-16 Static mixer design options. From left: vortex mixer (type KVM), corrugated plate (type SMV), wall-mounted vanes (type SMF), cross-bar (type SMX), helical twist (type KHT), cross-bar (type SMXL). (Courtesy of Koch-Glitsch, LP.)

Table 7-5 Laminar Blending and Pressure Drop Parameters for Motionless Mixers

Device	K_L	KiL
Empty pipe	1	—
KMS	6.9	0.87
SMX	37.5	0.63
SMXL	7.8	0.85
SMF	5.6	0.83
SMR	46.9	0.81

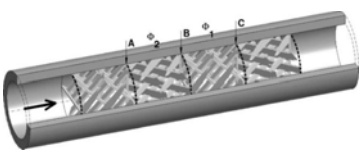
Source: Streiff et al. (1999).

Table 7-6 Turbulent Blending and Pressure Drop Parameters for Motionless Mixers

Device	Ne[a]	K_T	KiT
Empty pipe	0.01	1	0.95
KMS	1.5	150	0.50
KVM	0.24	24	0.42
SMX	5	500	0.46
SMXL	1	100	0.87
SMV	1–2	100–200	0.21–0.46
SMF	1.3	130	0.40

[a]Ne is the Newton number, equivalent to 2f, twice the Fanning friction factor.

Source: Streiff et al. (1999).



Osnove dimenzioniranja statičnega mešala

a) Tokovni režim

Določitev tokovnega režima na osnovi *Re* števila :

$$Re = \frac{\rho\, D\, v}{\mu}$$

b) Tlačne izgube

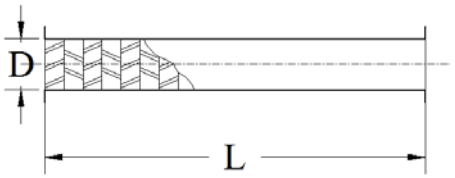
- ***Laminarno področje; Re<2100***

ekvivalentna tlačna izguba za statično mešalo:

$$\Delta p_{sm} = K_L\, \Delta p_c$$

$$\Delta p_c = 4 f_L \frac{L}{D} \rho \frac{v^2}{2}$$

$$f_L = \frac{16}{Re}$$



- ***Turbulentno področje; 4000 < Re < 100000:***

ekvivalentni tlačna razlika za cev:

$$\Delta p_{sm} = K_T\, \Delta p_c$$

$$\Delta p_c = 4 f_T \frac{L}{D} \rho \frac{v^2}{2}$$

$$f_T = \frac{0{,}079}{Re^{0{,}25}}$$

K_L,K_T … koeficient vrste mešala, Tab.7-5 in 7-6
D…notranji premer statičnega mešala [ ]
L… dolžina mešala [ ]
f_L, f_T…. Fanningov faktor trenja [ ]
v…hitrost [ ]
ρ…gostota kapljevine [ ]
μ…dinamična viskoznost [ ]
Δp_c…tlačne izguba za prazno cev

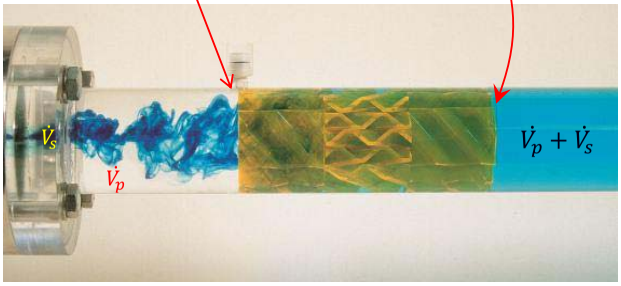
c) Stopnja pomešanja

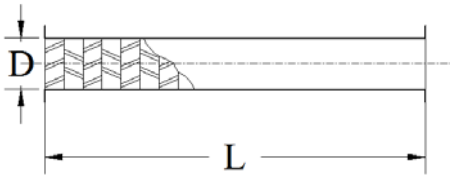
$$CoV_r = K_i^{\,L/D}$$

Določitev začetne stopnje pomešanja (na vstopu v statično mešalo)

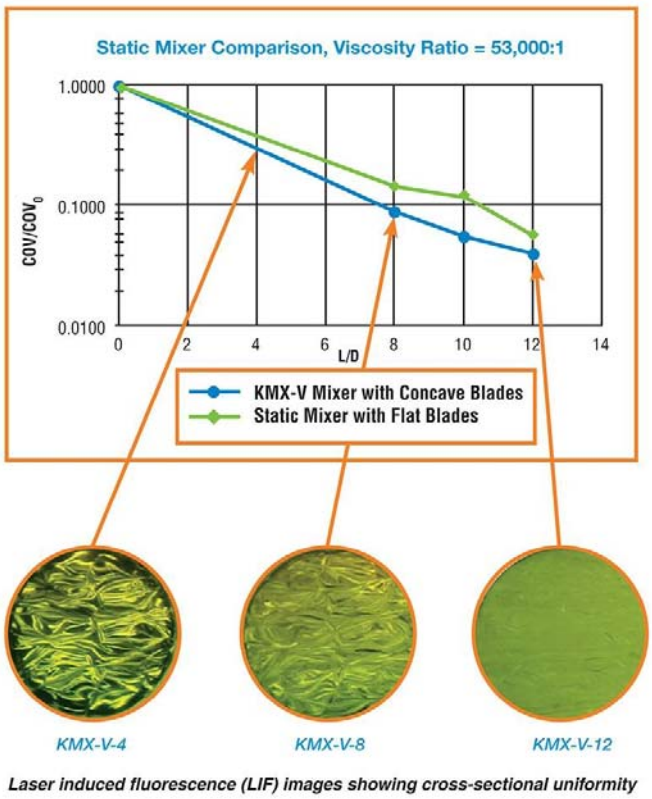
$$CoV_0 = \left(\frac{1 - C_v}{C_v}\right)^{0{,}5}$$

$$C_v = \frac{\dot{V}_s}{\dot{V}_p + \dot{V}_s}$$





K_{iL},K_{iT} … koeficient vrste mešala, Tab.7-6 in 7-6
D…notranji premer statičnega mešala [ ]
L… dolžina mešala [ ]
CoV_0… začetna stopnja pomešanja
C_v… začetno volumsko razmerje
$\dot{V}_p, \dot{V}_s$… primarni in sekundarni volumski tok



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

RRP III.sem. Edward L. Paul, Victor Atiemo-Obeng, Suzanne M. Kresta *Handbook of Industrial* Mixing: Science and Practice, JW&S, Hoboken , New Jersey, 2004

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