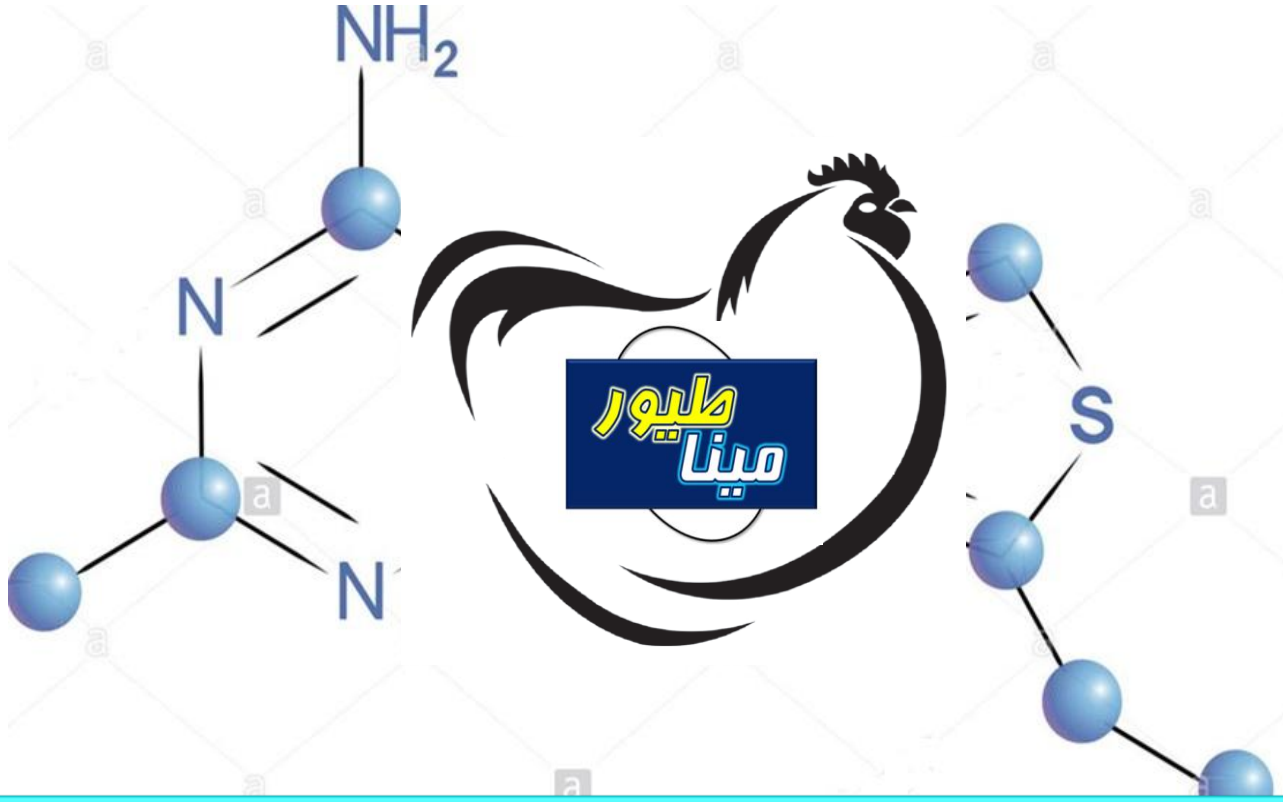
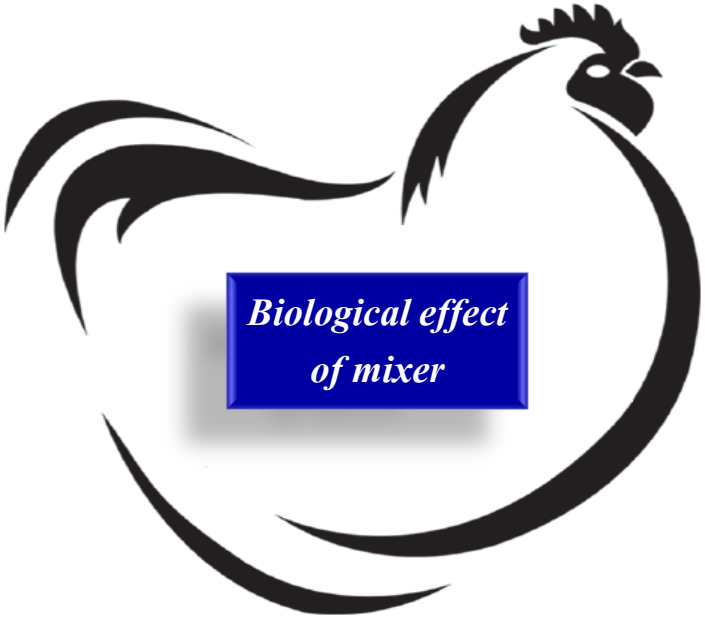


تولید کننده مکمل، پریمیکس، کنسانتره و خوراک طیور

Since 1994


میکسر در فن آوری ساخت خوراک


Biological effect
of mixer

Chick response to dietary protein variation

from 0 to 28 days of age

Treatment	Gain (g)	F/G
Control	773a	1.74a
10% CV	716a	1.82b
20% CV	703b	1.86c

Chick response to dietary protein variation

from 0 to 28 days of age

Treatment	Gain (g)	F/G
Control	773a	1.74a
10% CV	716a	1.82b
20% CV	703b	1.86c

Chick response to dietary protein variation

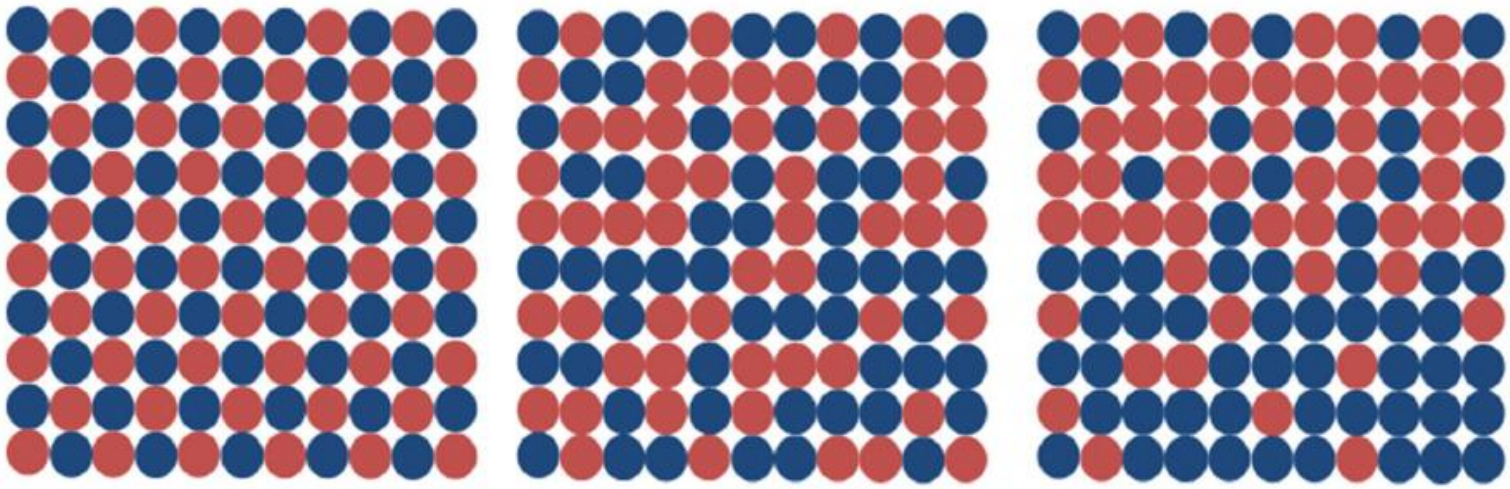
from 0 to 28 days of age

Treatment	Gain (g)	F/G
Control	773a	1.74a
10% CV	716a	1.82b
20% CV	703b	1.86c


Mixing concept

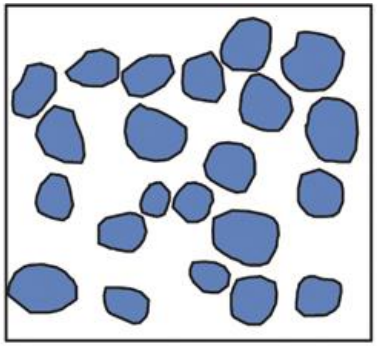
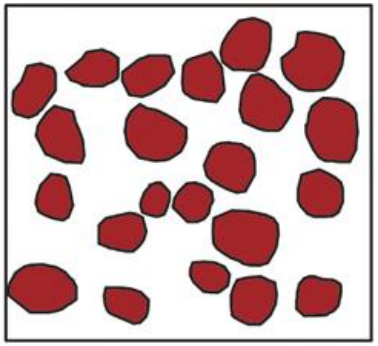
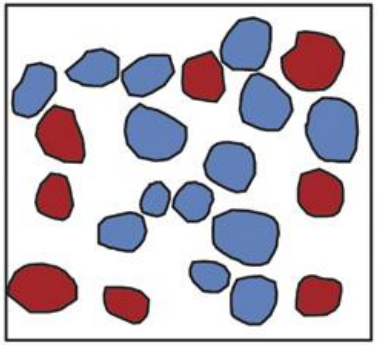
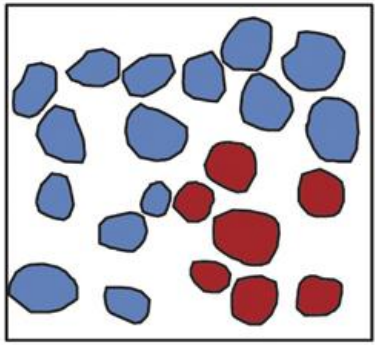
Blending

- Definitions
  - Operation aimed at processing two or more separate components, so as to achieve a situation, when each particle of any component is as close as possible to a particle of the other component
- Objectives
  - Achieve the mixture uniformity
    - uniformity of final products
  - Maximize the contact surface area of components
    - promote interfacial physical and chemical processes



Perfect mixture *Random mixture* *Segregated mixture*



- Mixing of active ingredients into a carrier material.
- Mixing of multicomponent mixture.
- Coating of a cohesive component onto a carrier.

نوع فرمول: دان مرغ مادر گوشتی راس ۳۰۸ (بر اساس کاتالوگ سال ۲۰۱۶) شماره فایل: ۱۴ تاریخ : ۱۳۹۵/۲/۷

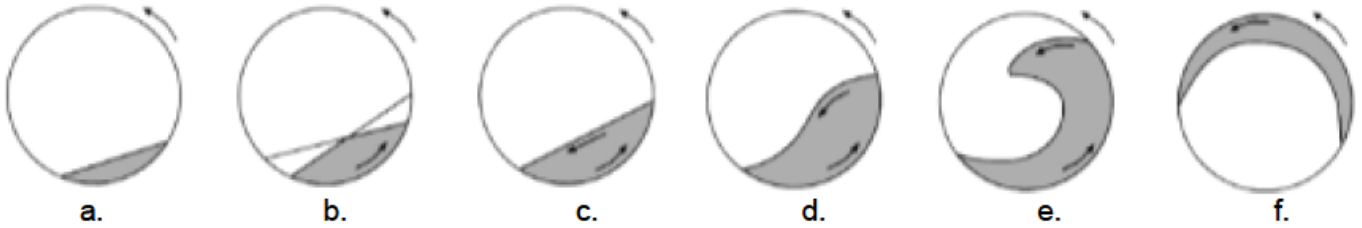
مواد خوراکی	مرحله مورد استفاده								
	۱ تا ۳ هفته Starter I Male	۱ تا ۳ هفته Starter I Female	۴ تا ۵ هفته Starter II	۶ تا ۱۵ هفته Grower و دوره تولک (قبل از تحریک نوری)	۱۶ تا ۲۳ هفته Prebreeder	۲۴ تا ۳۵ هفته Breeder I	۳۶ تا ۵۰ هفته Breeder II	۵۱ تا ۶۵ هفته Breeder III سیکل دوم (After Force Molting)	خروس ۲۳ تا ۴۰ هفته	خروس ۴۱ تا ۶۰ هفته (After Force Molting)
ذرت (برزیل)	۵۶۰/۸	۶۱۲/۵	۶۲۹/۶	۶۳۸/۷	۶۳۰/۲	۶۷۴/۴	۶۸۹/۳	۷۰۵/۲	۶۹۹/۲	۷۰۶/۴
کنجاله سویا (۴۴٪)	۳۷۸/۸	۳۱۳/۱	۲۳۹/۳	۱۲۷/۴	۱۳۵/۷	۲۰۸/۳	۱۷۸/۸	۱۵۰/۶	۸۱/۲	۶۵
روغن ذرت	۱۹/۲	–	–	–	–	–	–	–	–	–
سبوس گندم	–	۳۲/۹	۹۴/۴	۲۰۰	۱۹۳/۹	۳۱/۸	۴۳/۶	۵۰/۷	۱۸۶/۸	۱۹۵/۵
دی‌کلسیم فسفات	۱۷/۷	۱۸/۱	۱۲/۵	۱۱/۲	۷/۱	۷/۶	۷/۳	۶/۴	۷/۷	۷/۸
صدف معدنی	۱۱/۹	۱۲	۱۳/۳	۱۱/۹	۲۲/۴	۶۶/۸	۶۹/۸	۷۵/۸	۱۴/۵	۱۴/۵
نمک	۳/۵	۳/۴	۳/۴	۳/۳	۳/۳	۳/۴	۳/۴	۳/۴	۳/۳	۳/۳
جوش شیرین	۱	۱	۱	۱	۱	۱	۱	۱	۱	۱
مکمل معدنی نوع یک	۲/۵	۲/۵	–	–	–	۲/۵	–	–	–	–
مکمل ویتامینه نوع یک	۲/۵	۲/۵	–	–	–	۲/۵	–	–	–	–
مکمل معدنی نوع دو	–	–	۲/۵	۲/۵	۲/۵	–	۲/۵	–	۲/۵	–
مکمل ویتامینه نوع دو	–	–	۲/۵	۲/۵	۲/۵	–	۲/۵	–	۲/۵	–
مکمل معدنی نوع سه	–	–	–	–	–	–	–	۲/۵	–	۲/۵
مکمل ویتامینه نوع سه	–	–	–	–	–	–	–	۲/۵	–	۲/۵
دی ال متیونین	۲/۱	۱/۹	۱/۲	۱/۲	۱/۱	۱/۴	۱/۵	۱/۳	۱	۱
ال لیزین	–	–	–	–	–	–	–	–	–	۰/۲
ال ترئونین	–	۰/۱	–	–	–	–	–	۰/۳	–	–
ناتوزیم پی	–	–	۰/۳	۰/۳	۰/۳	۰/۳	۰/۳	۰/۳	۰/۳	۰/۳
جمع	۱۰۰۰	۱۰۰۰	۱۰۰۰	۱۰۰۰	۱۰۰۰	۱۰۰۰	۱۰۰۰	۱۰۰۰	۱۰۰۰	۱۰۰۰
شکل فیزیکی	آردی	آردی	آردی	آردی	آردی	آردی	آردی	آردی	آردی	آردی
اندازه ذرات (میلی متر)	۲-۱	۲-۱	۳-۲	۴-۳	۴-۳	۵-۴	۵-۴	۵-۴	۴-۳	۵-۴
مواد مغذی (٪)										
انرژی قابل متابولیسم (کیلوکالری/کیلوگرم)	۲۹۰۰	۲۸۰۰	۲۸۰۰	۲۷۰۰	۲۷۰۰	۲۸۰۰	۲۸۰۰	۲۸۰۰	۲۸۰۰	۲۸۰۰
پروتئین خام	۲۱	۱۹	۱۷	۱۳/۸	۱۴	۱۵	۱۴	۱۳	۱۲	۱۱/۵
کلسیم	۱	۱	۱	۰/۹	۱/۲	۲/۹	۳	۳/۲	۰/۹	۰/۹
فسفر قابل دسترس	۰/۴۵	۰/۴۵	۰/۴۵	۰/۴۲	۰/۳۵	۰/۳۵	۰/۳۴	۰/۳۲	۰/۳۵	۰/۳۵
سدیم	۰/۱۸	۰/۱۸	۰/۱۸	۰/۱۸	۰/۱۸	۰/۱۸	۰/۱۸	۰/۱۸	۰/۱۸	۰/۱۸
لیزین قابل هضم	۱/۱	۰/۹۵	۰/۸۰	۰/۵۷	۰/۵۸	۰/۷۱	۰/۶۴	۰/۵۷	۰/۴۵	۰/۴۴
متیونین قابل هضم	۰/۵۱	۰/۴۶	۰/۳۷	۰/۳۳	۰/۳۲	۰/۳۷	۰/۳۶	۰/۳۳	۰/۲۹	۰/۲۸
متیونین + سیستین قابل هضم	۰/۸۱	۰/۷۴	۰/۶۲	۰/۵۴	۰/۵۴	۰/۶۰	۰/۵۷	۰/۵۴	۰/۴۹	۰/۴۷
ترئونین قابل هضم	۰/۷۳	۰/۶۶	۰/۵۷	۰/۴۴	۰/۴۵	۰/۵۱	۰/۴۷	۰/۴۷	۰/۳۸	۰/۳۶

دکتر مجتبی زاغری
ش ن م ۰۷۰۸۵۱۱۱۲۶

Spontaneity of mixing

- Positive
  - proceeds spontaneously without external action
  - e.g. diffusive mixing of gases in a vessel
- Negative
  - segregation proceeds spontaneously, without external action the components will separate
  - e.g. suspension settling
- Neutral
  - nothing happens without external action
  - e.g. powder mixture

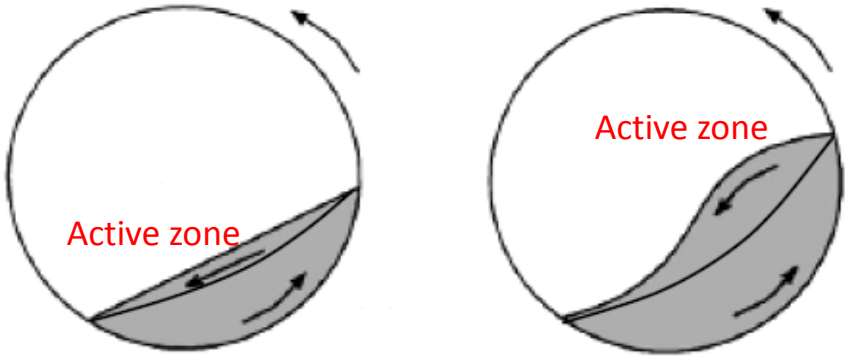
Powder movement in blender



- Powder movement regimes
  - a. sliding
  - b. slumping (0 - 3 % f_c)
  - c. rolling (3 - 30 % f_c)
  - d. cascading (3 - 30 % f_c)
  - e. cataracting (30 - 100 % f_c)
  - f. centrifuging

Powder movement in blender

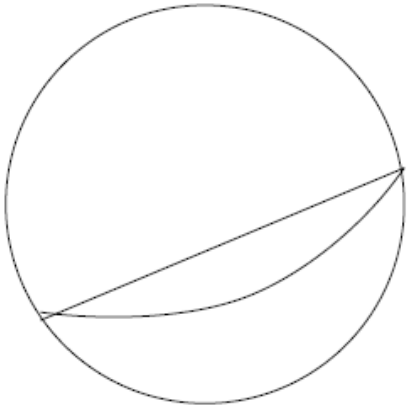
- Rolling and cascading motion

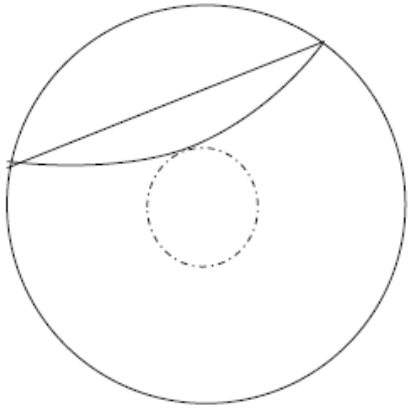


- Depends on the filling ratio
- Mixing proceeds only in the active zone

Filling ratio

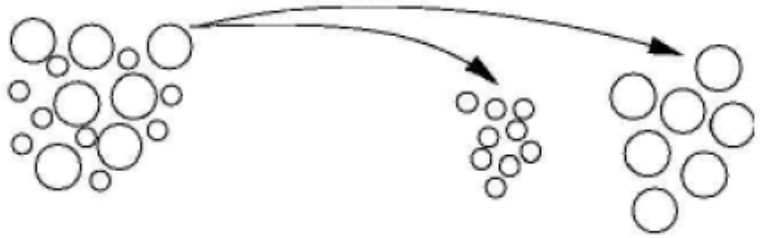
- Filling ratio > 50 %
  - non-mixed core may develop



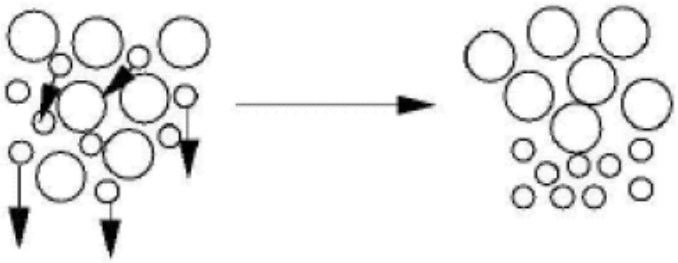


Segregation mechanisms

- Trajectory



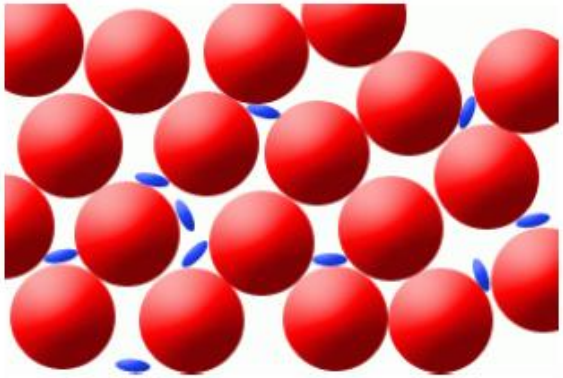
- Percolation



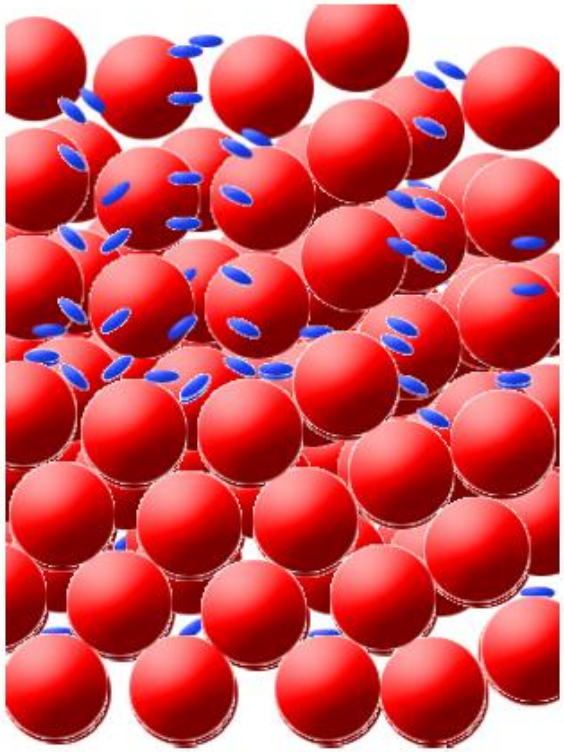
- Fluidization

Segregation mechanisms

- Sifting

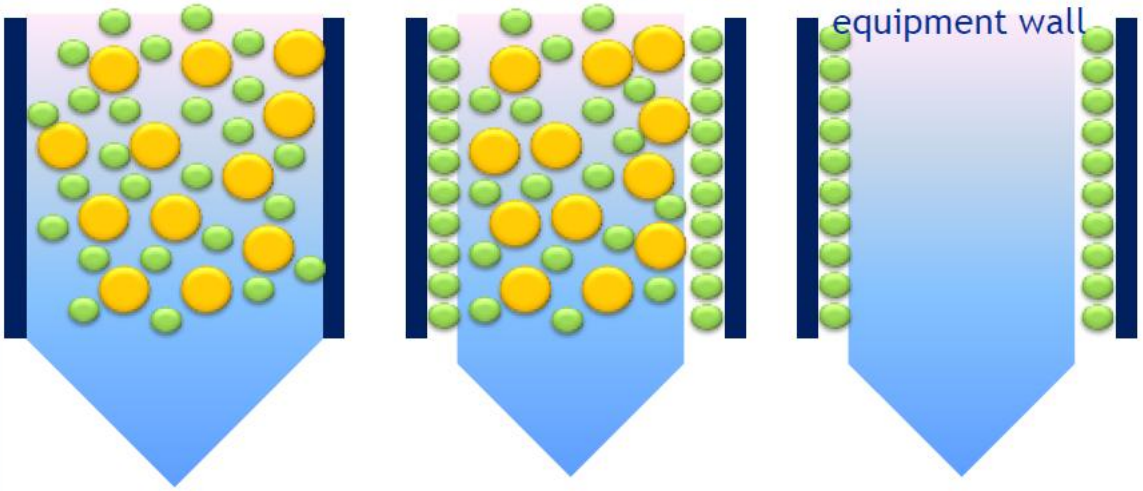


- Fluidization



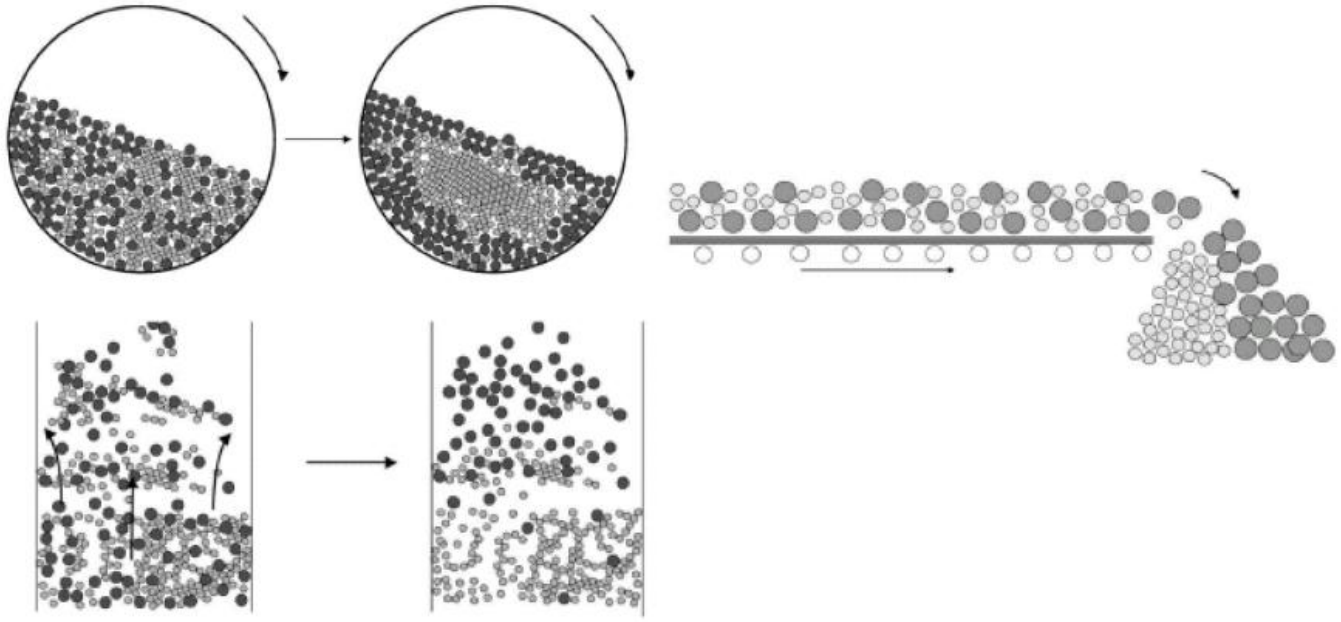
Wall segregation

- Flow of particulate solid near wall
- Adhesive discrimination between particles
- Some particles possess higher affinity to equipment wall



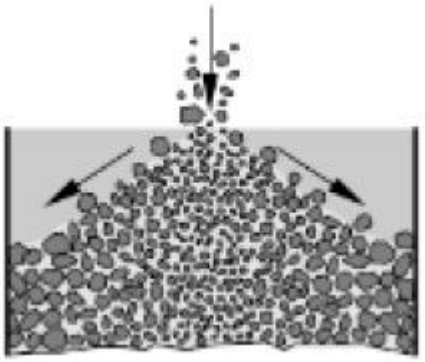
Segregation

» Segregation in different blenders

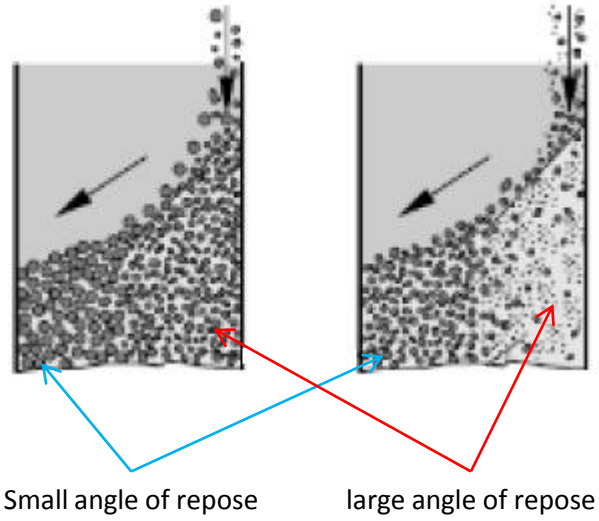


Segregation examples

Larger particles are heavier and are subjected to higher inertial forces

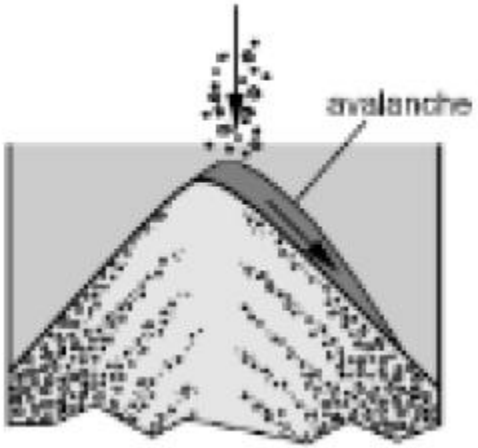


Different angle of repose

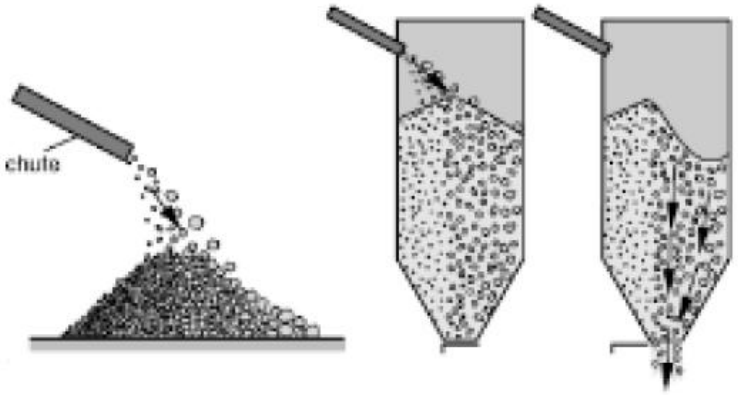


Segregation examples

Larger particles may trigger an avalanche

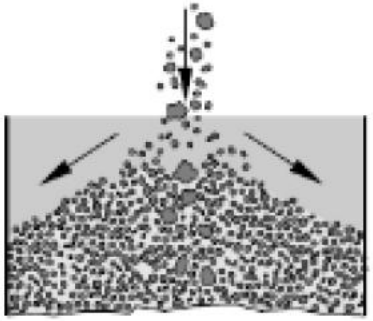


Trajectory segregation in aerodynamic conditions

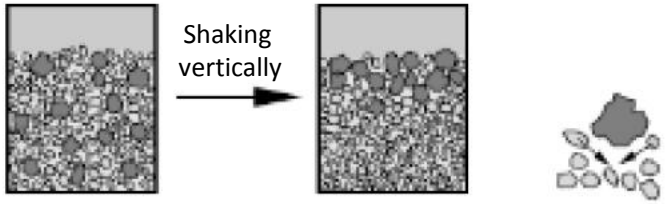


Segregation examples

Larger particles are heavier and fall into the "crater"

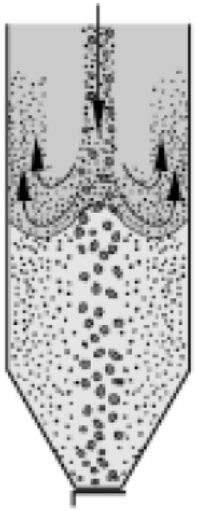


Sifting - large particles cannot pass through the small ones, but the opposite is possible

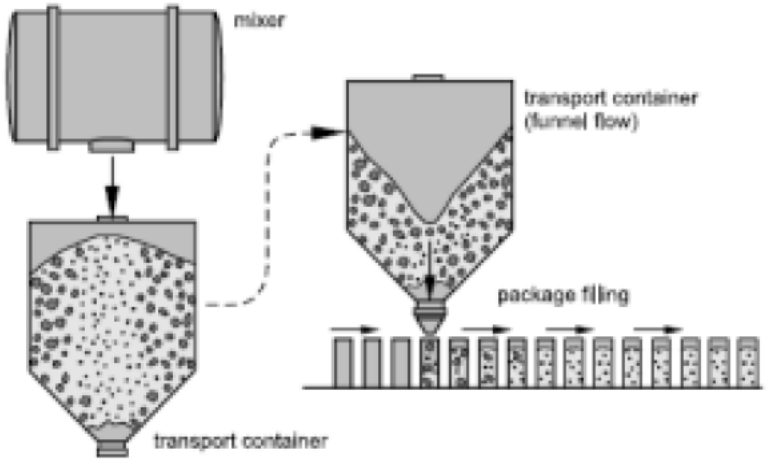


Segregation examples

Fluidizing at silo filling



Discharging segregated mixture
by funnel flow



Causes for segregation

- Differences in particle size

- Differences in morphology

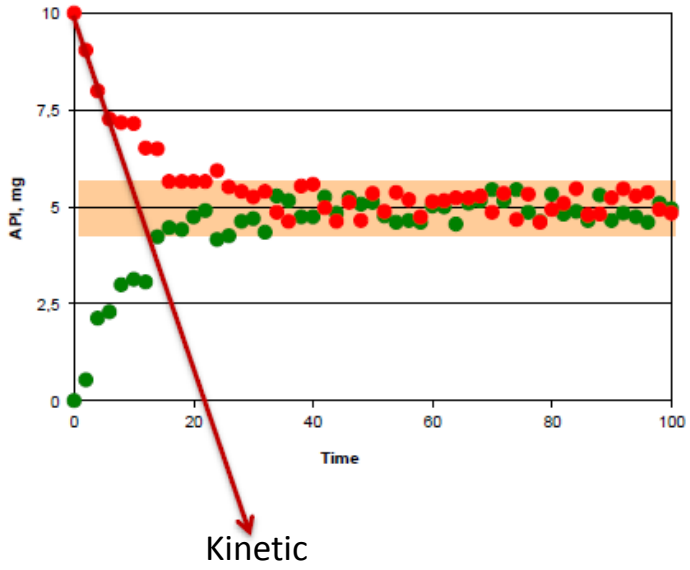
- Differences in density

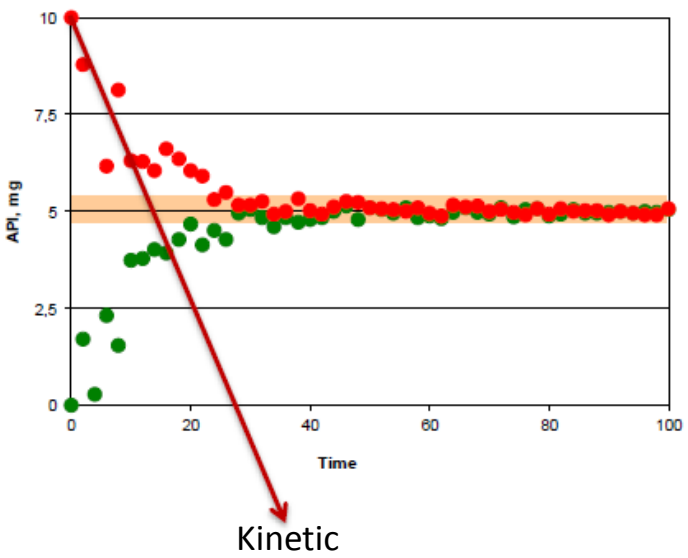
- Components ratio

- Cohesive interactions
  - moisture
  - static charge

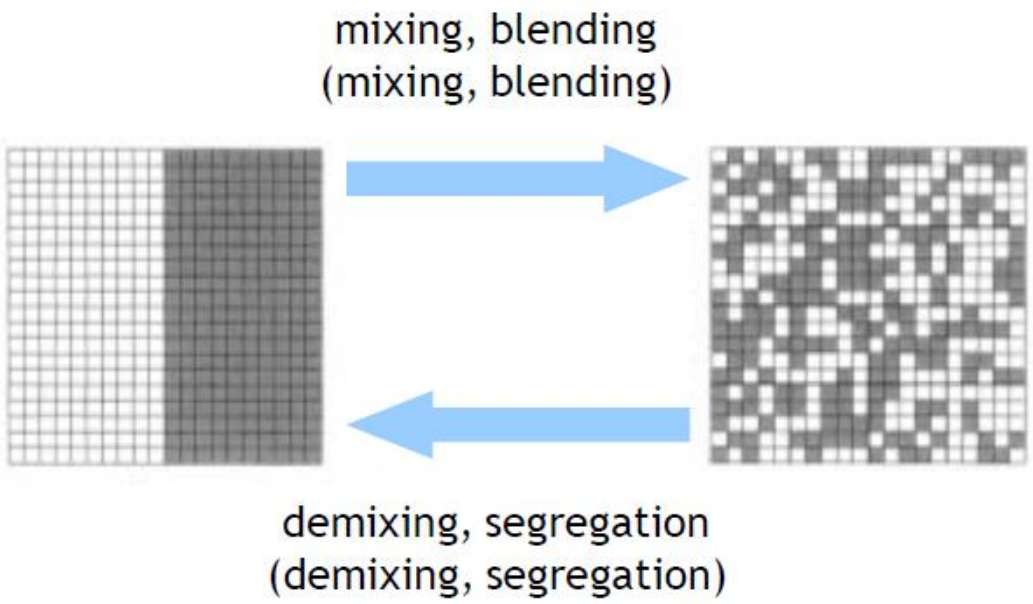
Kinetics and eqiuilibrium of blending

- Kinetics - **How long to mix ?**
- Equilibrium - **How well mixed it can become ?**





Mixing is reversible process

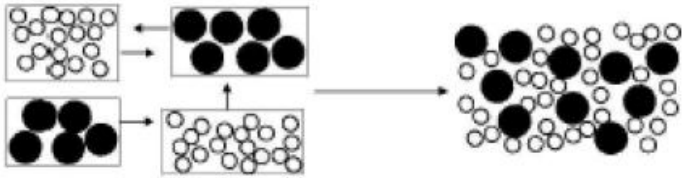


Mixing particulate solids

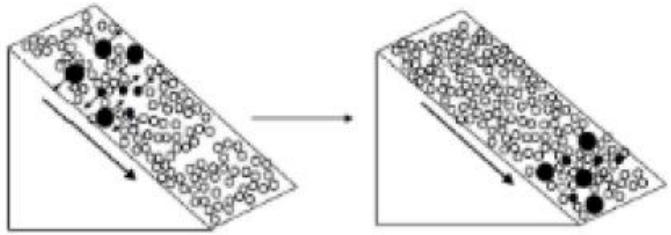
- Mechanisms of mixing
  - convestion
    - movement of particle groups relative to other groups
    - macroscopic mixing,
  - dispersion
    - movement of individual particles among other particles
    - micro-mixing
  - shear
    - movement of powder layers
    - disruption of agglomerates

Mixing particulate solids

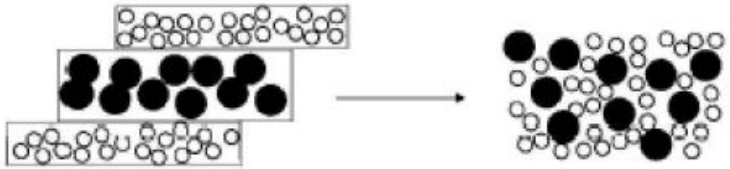
- Mechanisms of mixing
  - convection



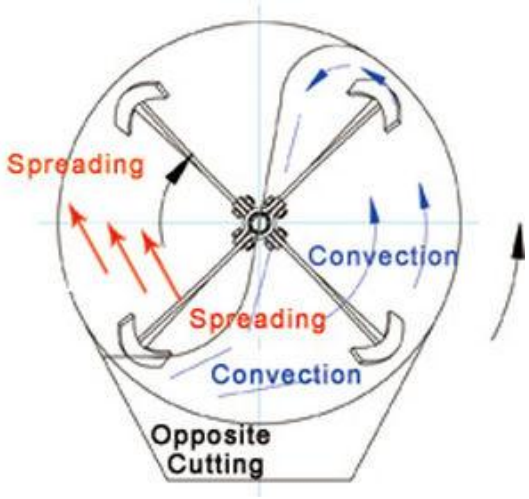
  - dispersion



  - shear
    -



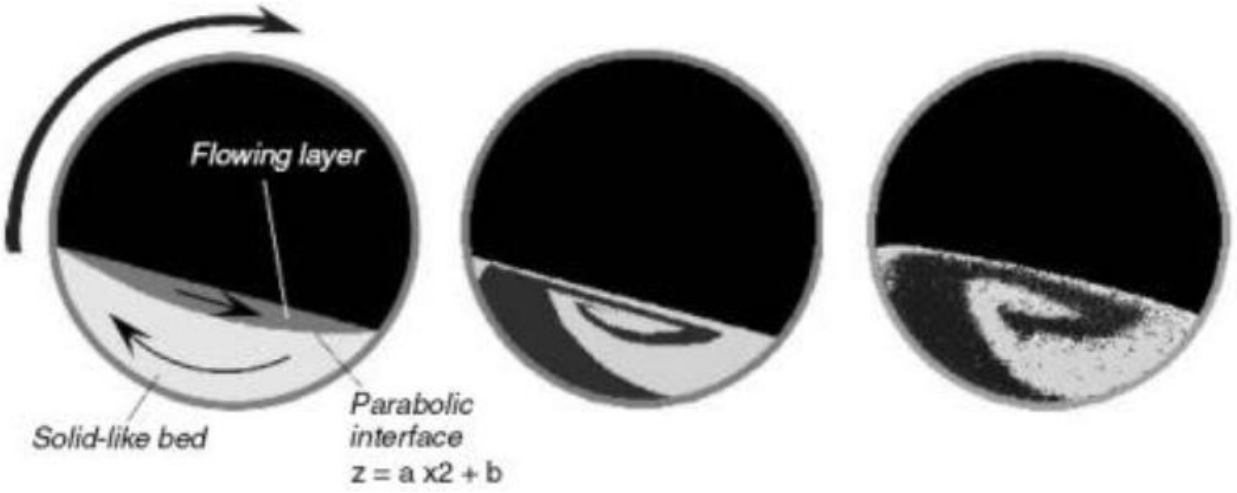
Diffusive



Convective

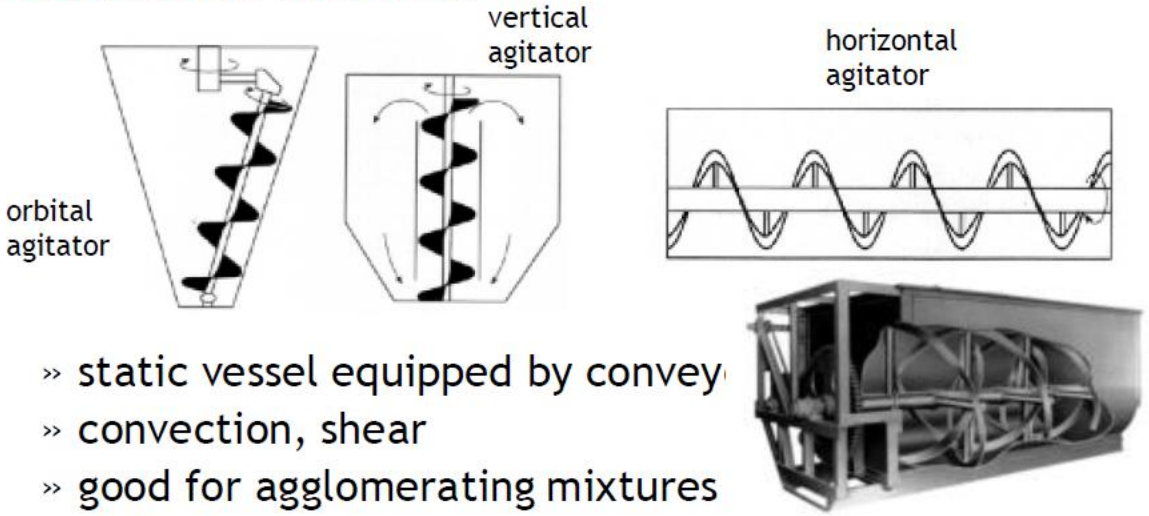
Shear

Convective and dispersion mixing



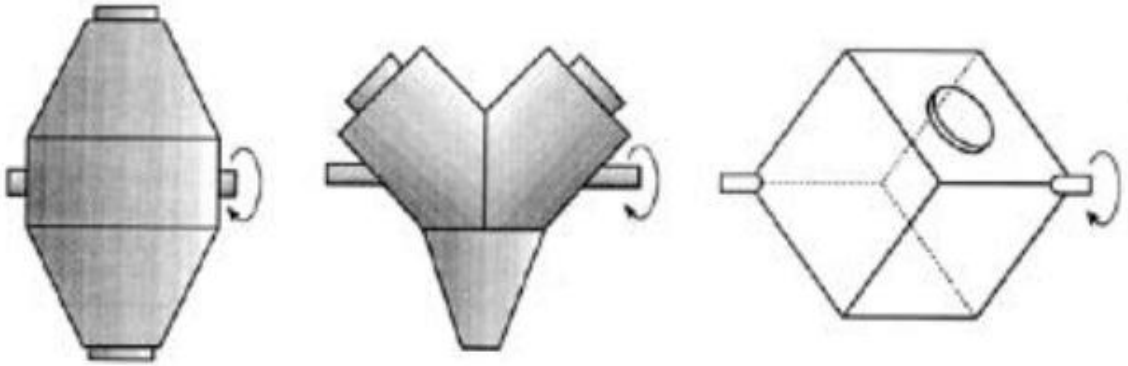
Mixing particulate solids

- Convective blenders



  - static vessel equipped by convey
  - convection, shear
  - good for agglomerating mixtures
  - difficult cleaning

Tumbling blenders

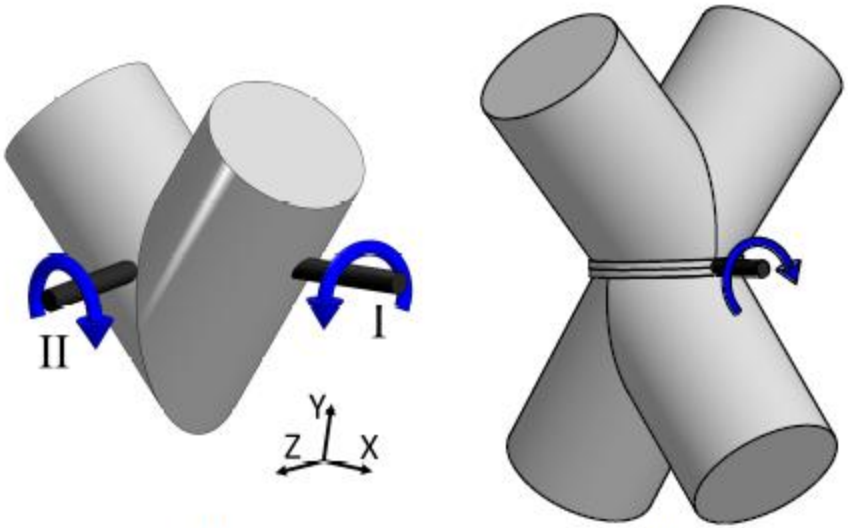


- rotating vessels with elements
- convection and diffusion
- rotating frequency 5 - 30 s^{-1}

Process parameters of tumbling blenders

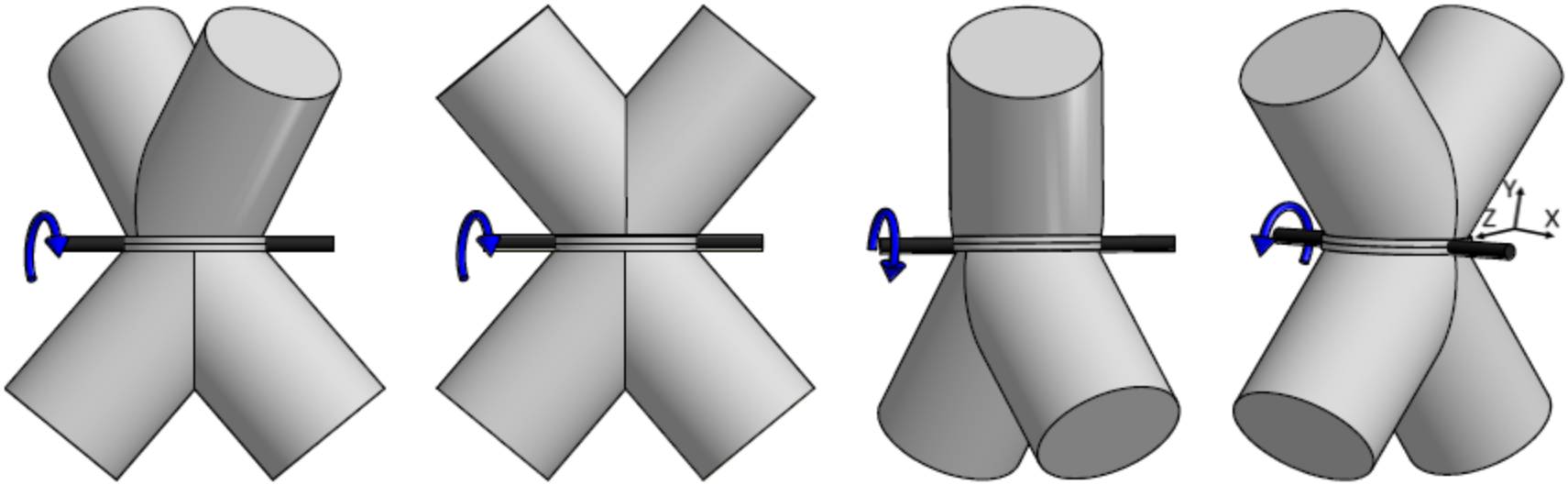
- Key parameters
  - rotating frequency … f [s^{-1}]
  - filling ratio … φ [%]
  - equipment size
- Critical rotating speed
  - causes centrifugal movement of particles = no mixing

$$f_c = \frac{1}{2\pi}\sqrt{\frac{g}{R}}$$



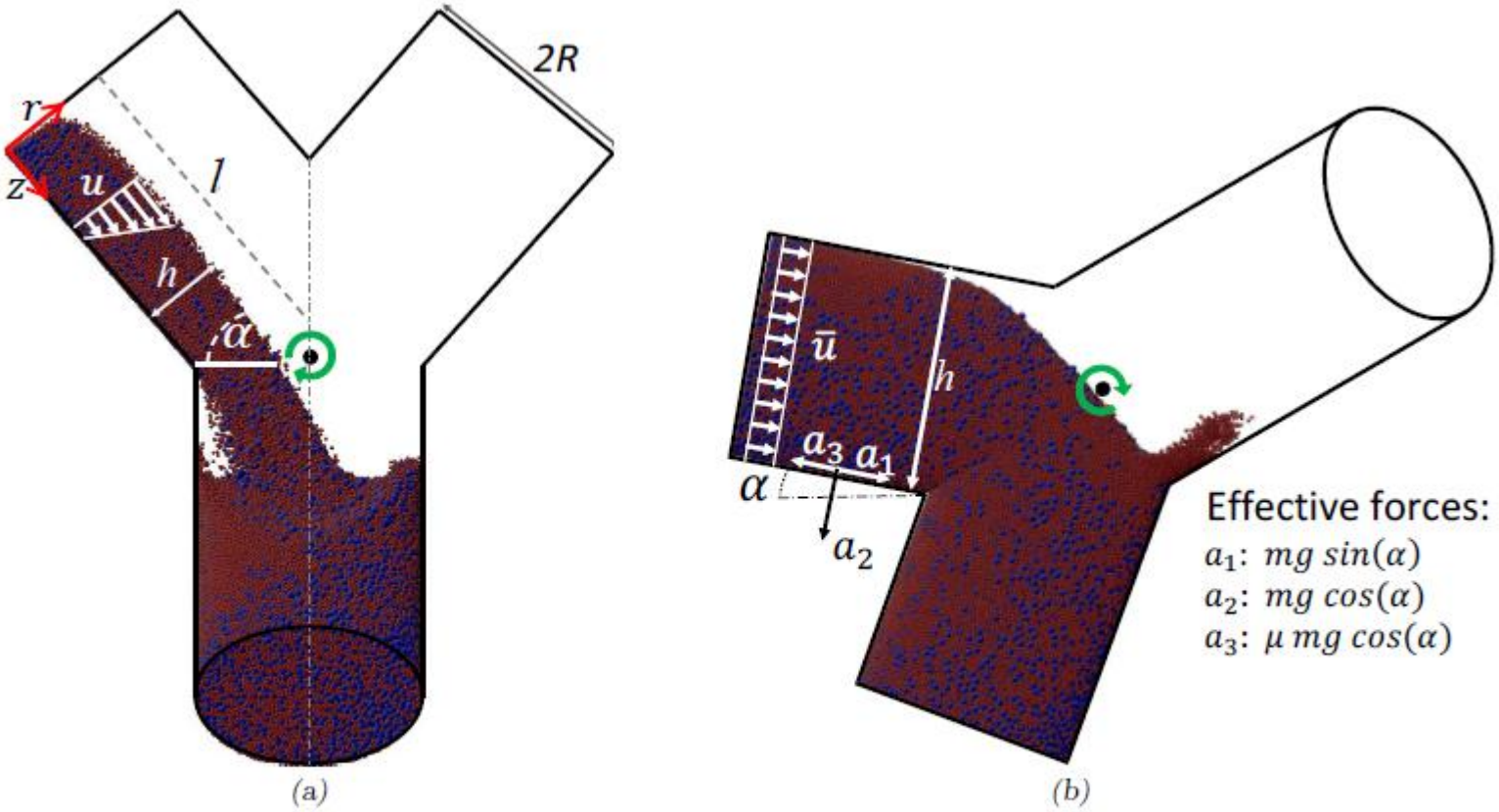
(a) (b)

Rotation of (a) the V-blender around two axes and (b) the standard tetrapodal blender.



(a) Case E (45-0) (b) Case F (0-0) (c) Case G (90-45) (d) Case H (90-90)

Different configurations of the twisted tetrapodal blender



(a) Regular granular flow in the tetrapodal blender, (b) granular flow in the simplified model of this work for the scale-up of the blender. The red and blue colors correspond to the two types of particles in the system.

Blender selection

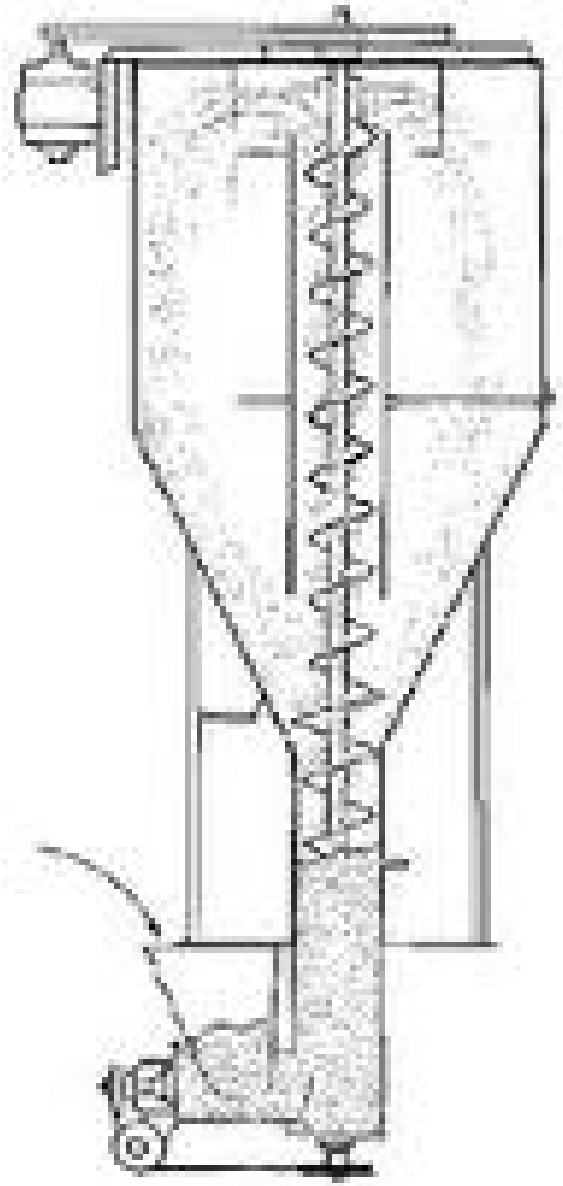
- Idealized blender
  - 3D movement of particles (not agglomerates)
  - eliminating dead zones
- Real blender
  - trade-off between mixing quality and process compatibility
- Blender selection
  - eliminate inadequate types
  - select optimal blender by mixing efficiency, throughput, price

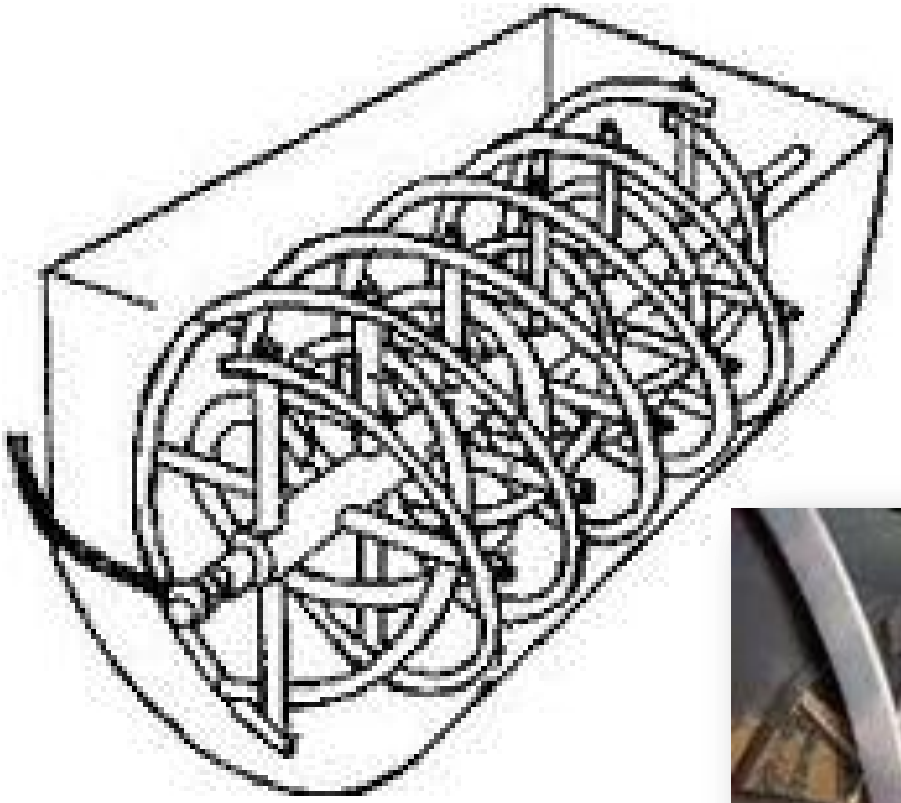
Selected factors influencing the blender choice

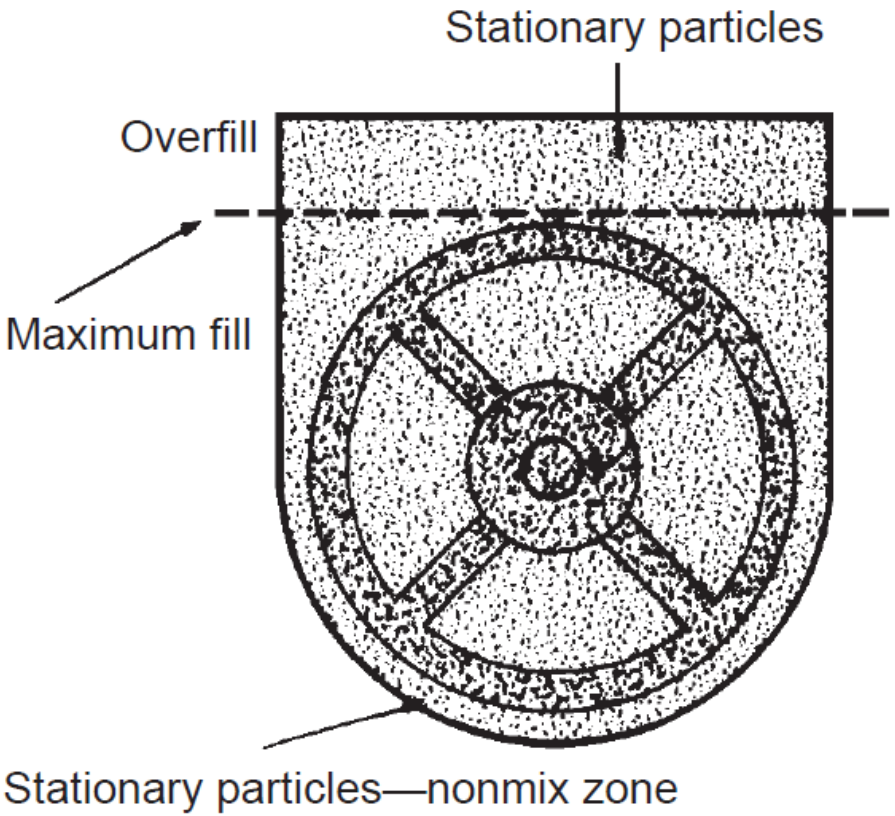
- Process requirements
  - Particle comminution during blending
  - Cleaning
  - Continuous / Batch
- Mixing / Segregation relationship
  - Better for convection, worse for dispersion
- Effect of particulate solid flowability


Mixer types

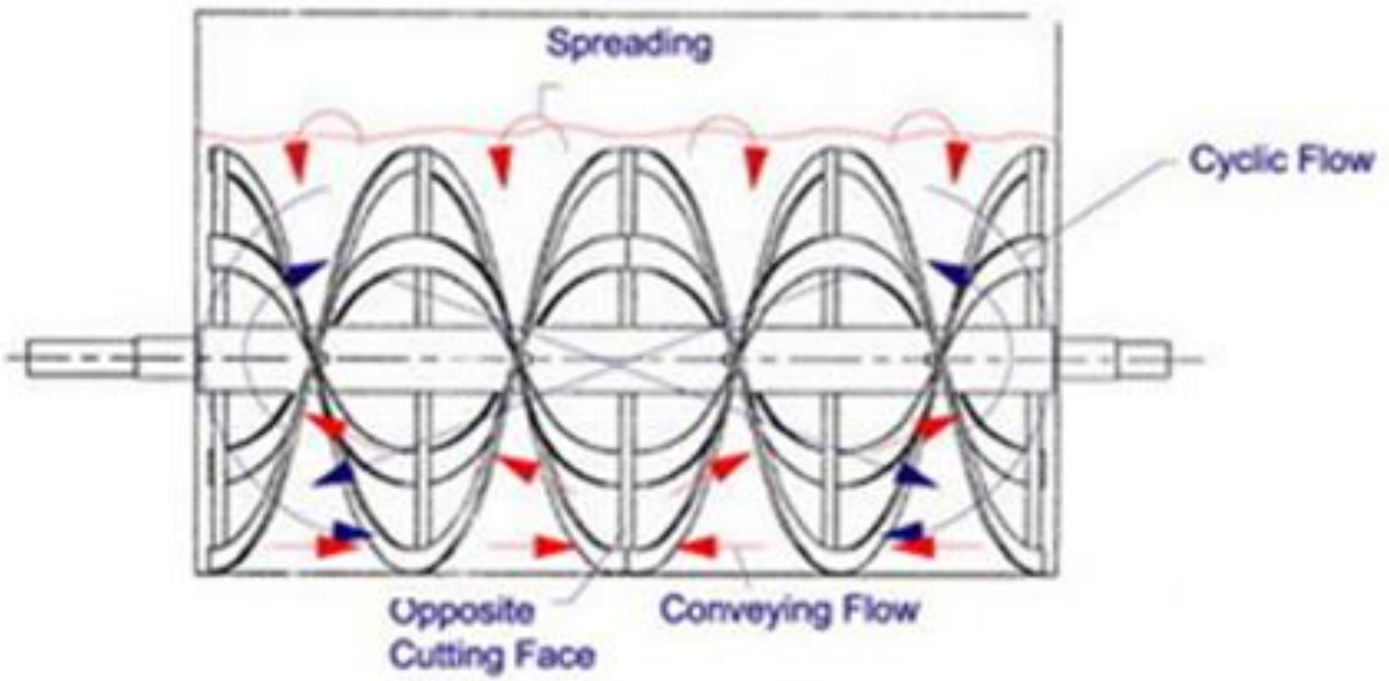
- ✓ Affords good homogeneity with the component included at lowest possible content
- ✓ Short mixing time
- ✓ Variable degree of filling, with no loss of mixing efficiency
- ✓ Complete emptying
- ✓ Easy cleaning
- ✓ Provision for adding liquids
- ✓ Absence of heat during mixing
- ✓ Provision to break the lumps
- ✓ Easy to operate
- ✓ Less consumption of energy
- ✓ Less maintenance cost
- ✓ Cost effective



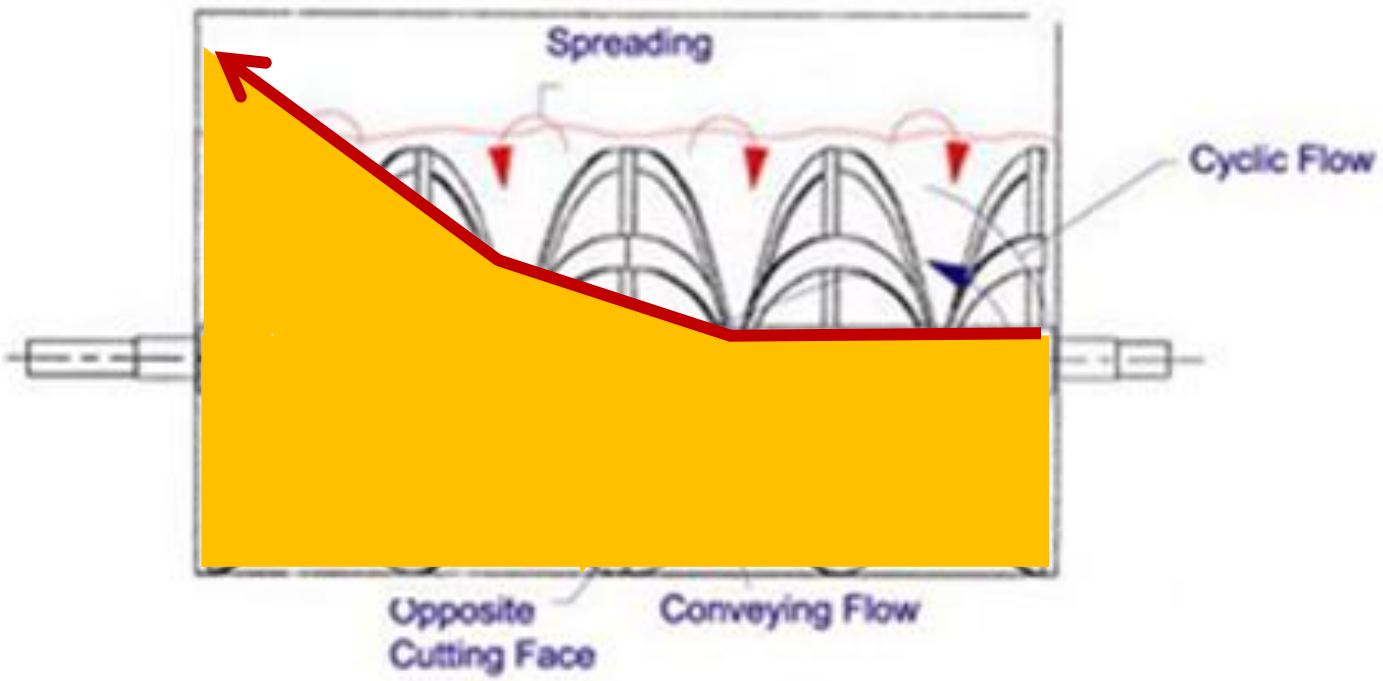


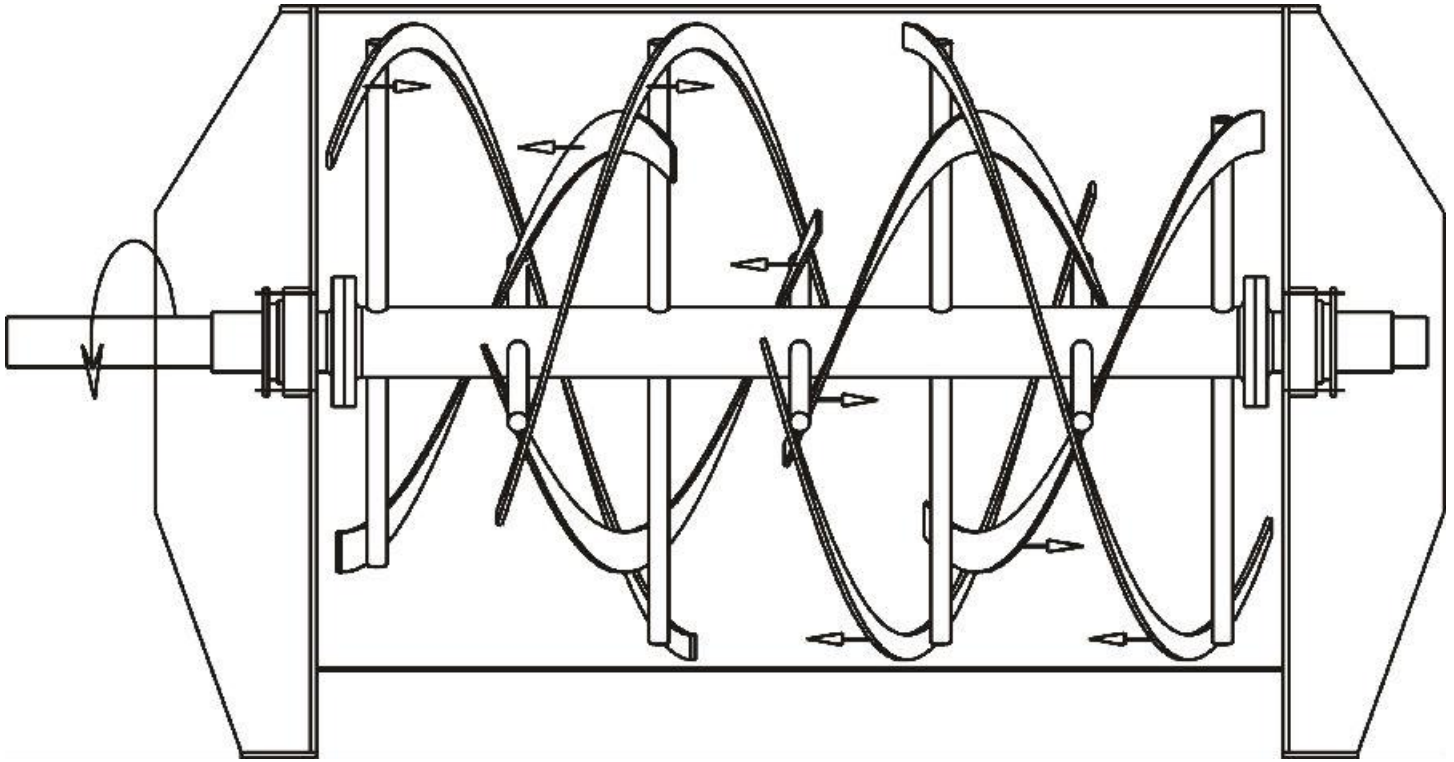

Stationary particles
Overfill
Maximum fill
Stationary particles—nonmix zone

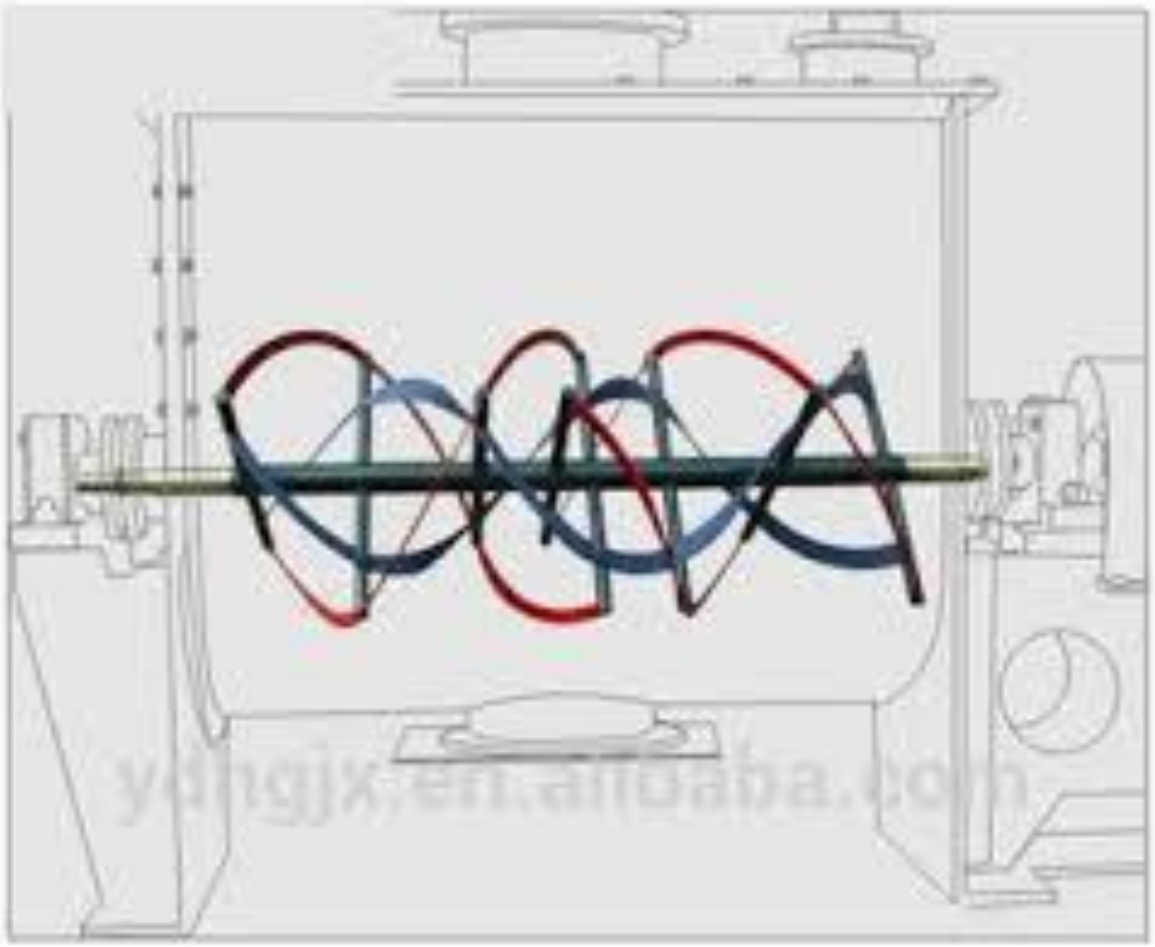
Ribbon Mixer

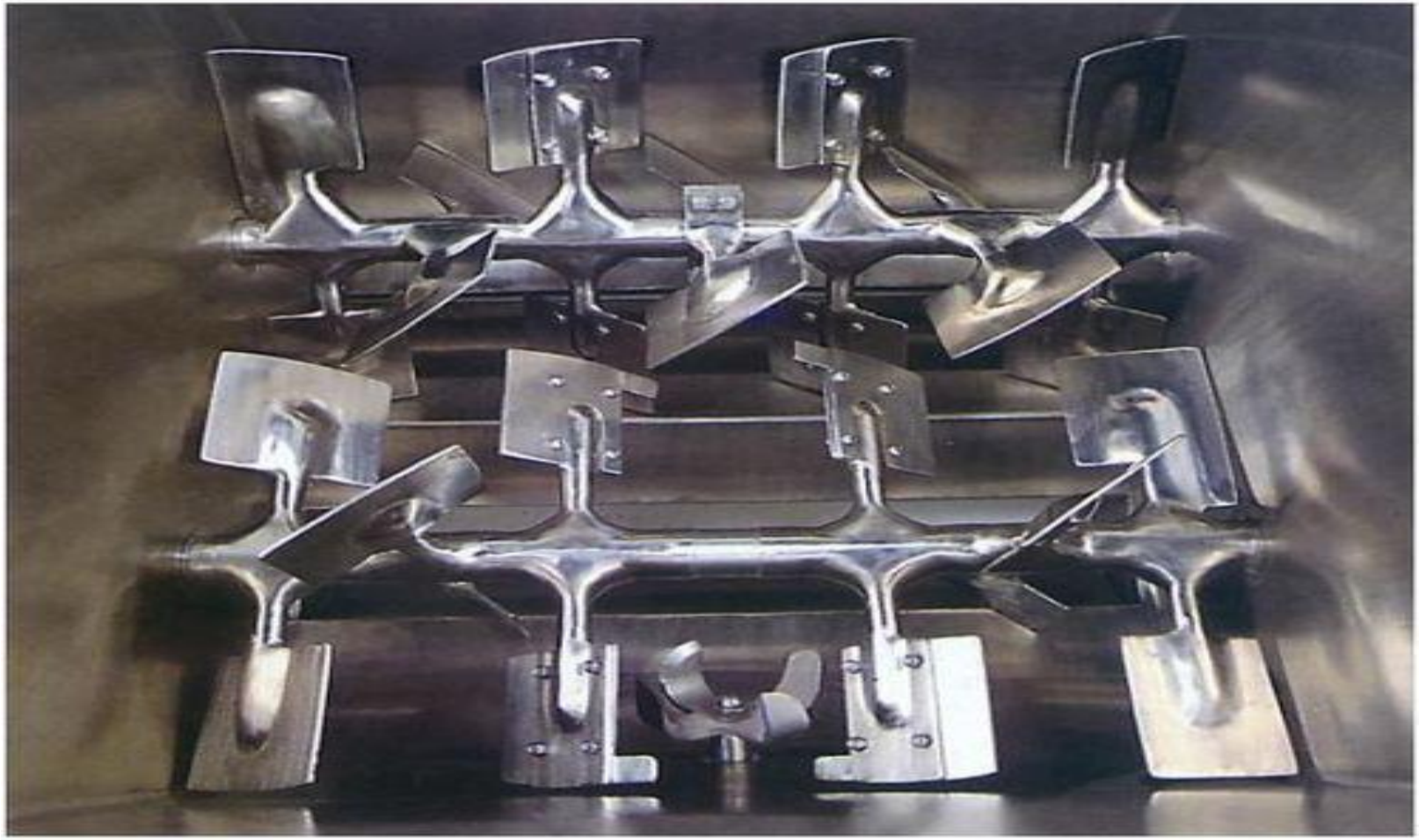


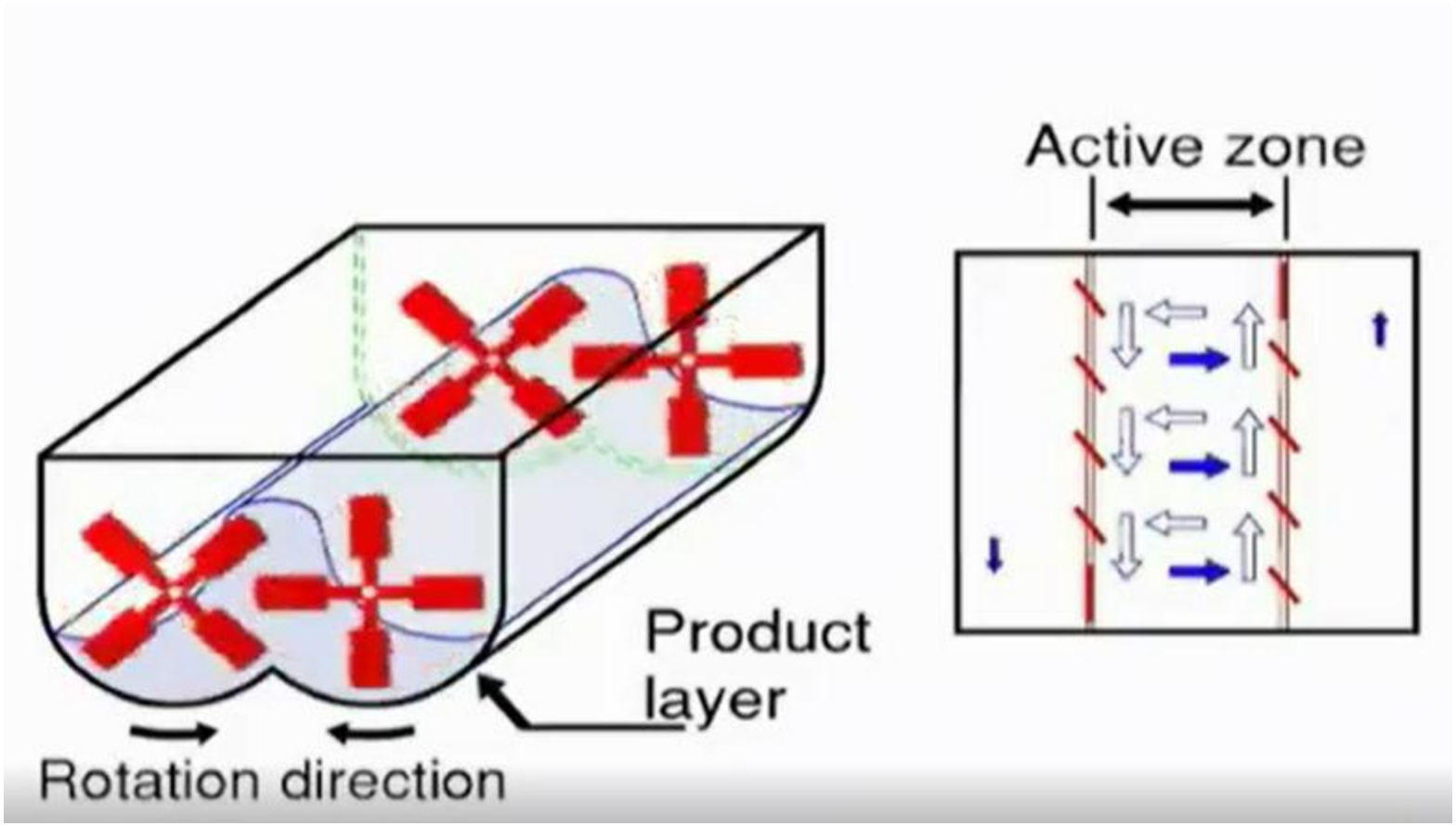
Ribbon Mixer

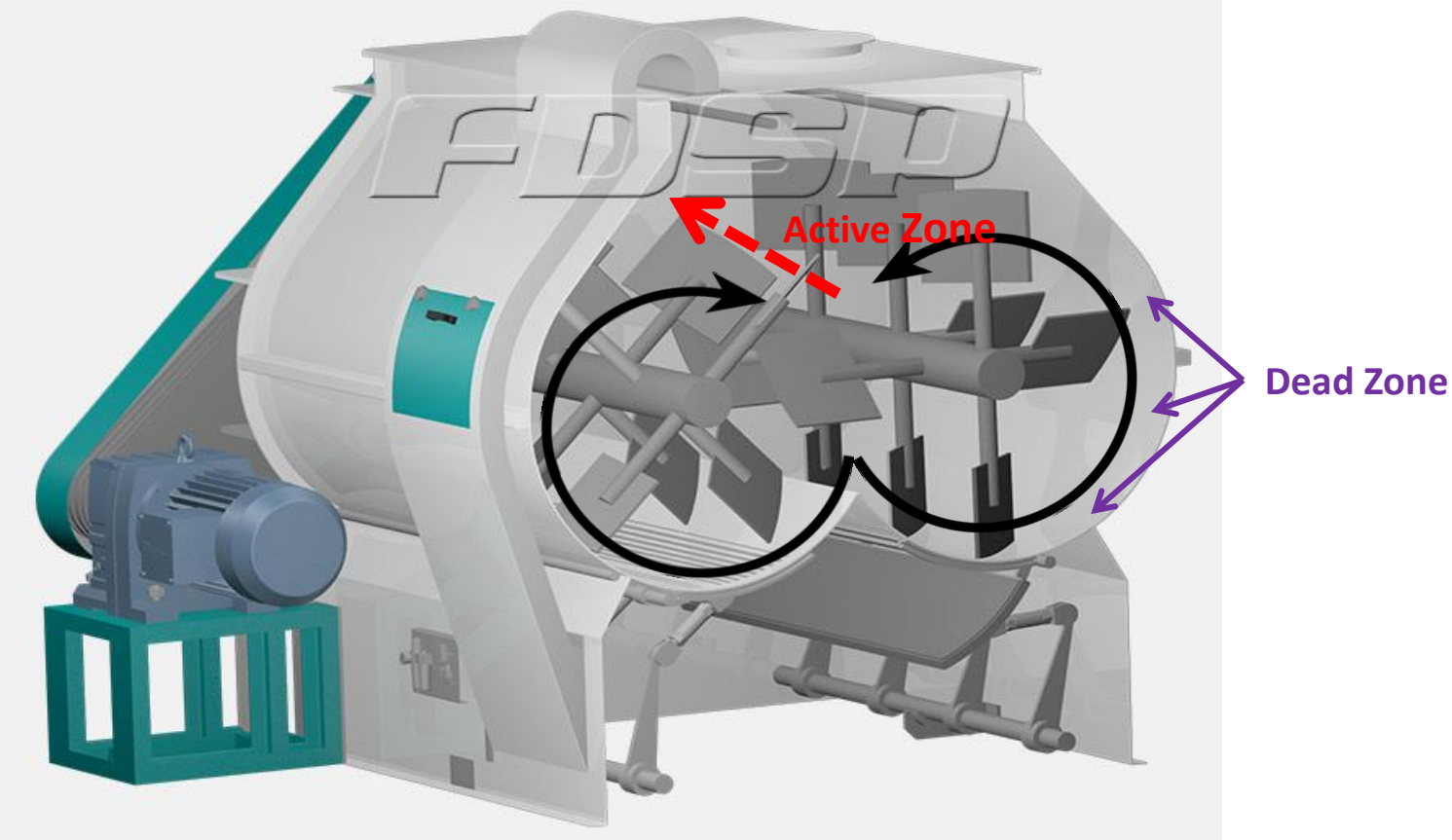


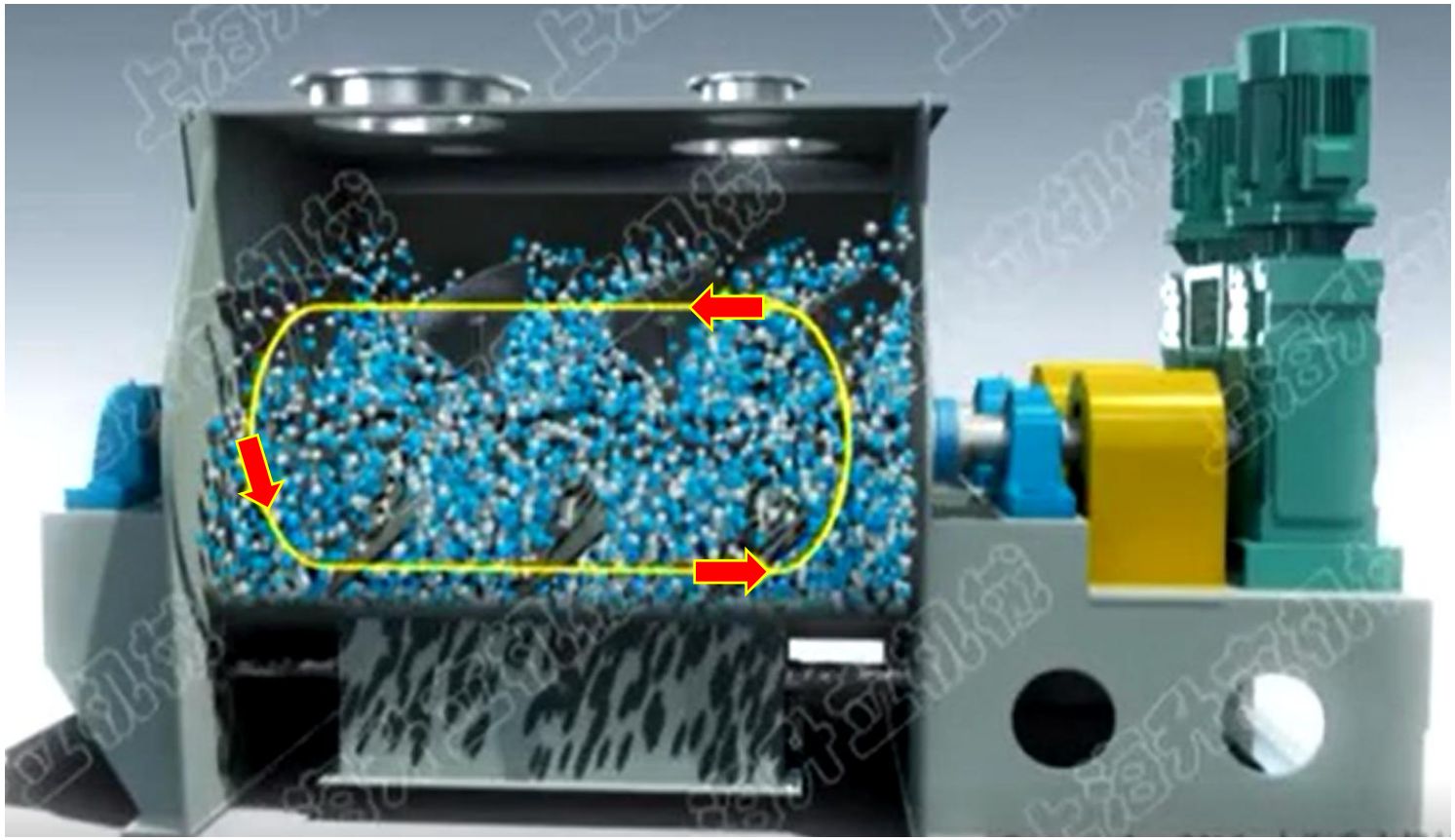


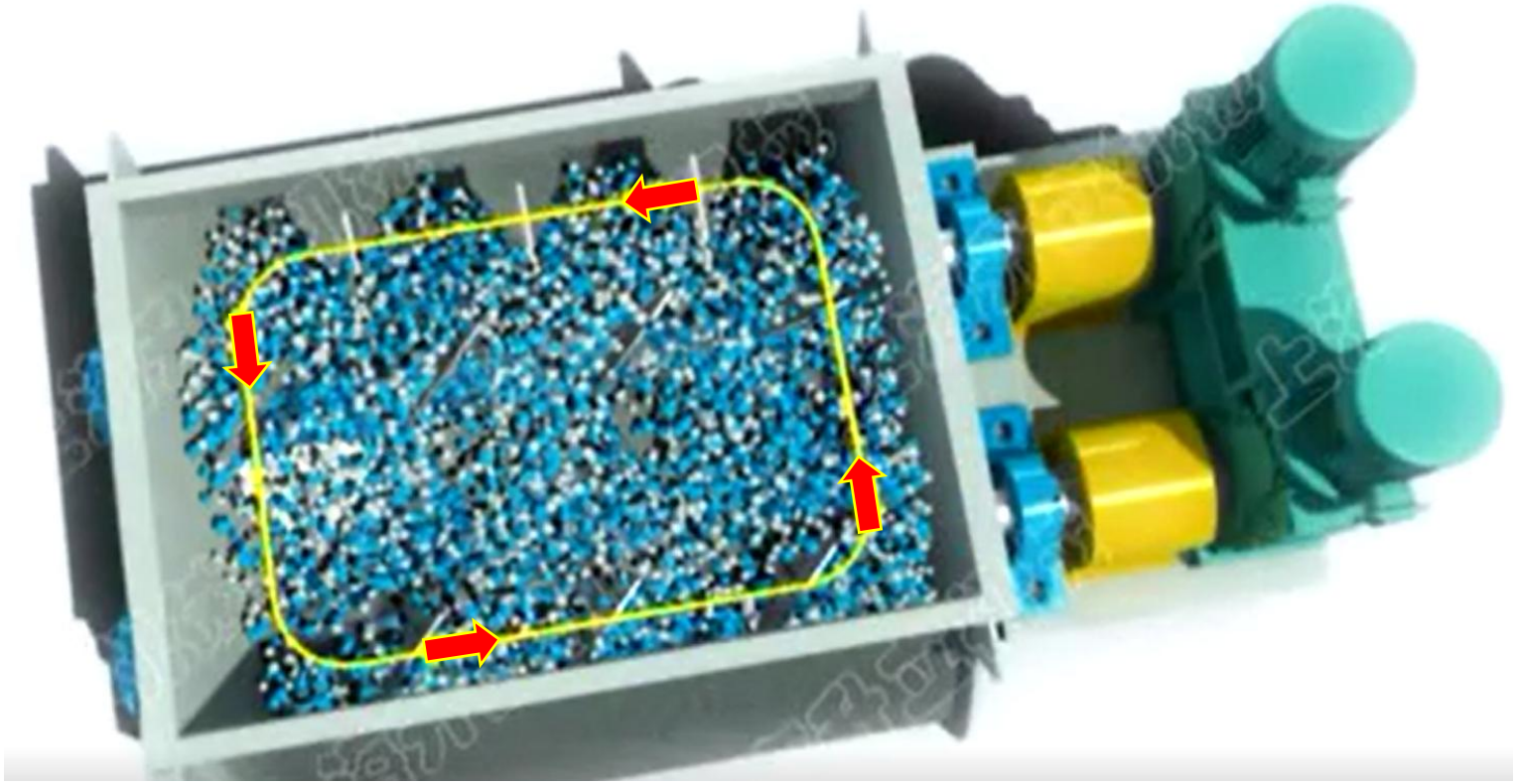


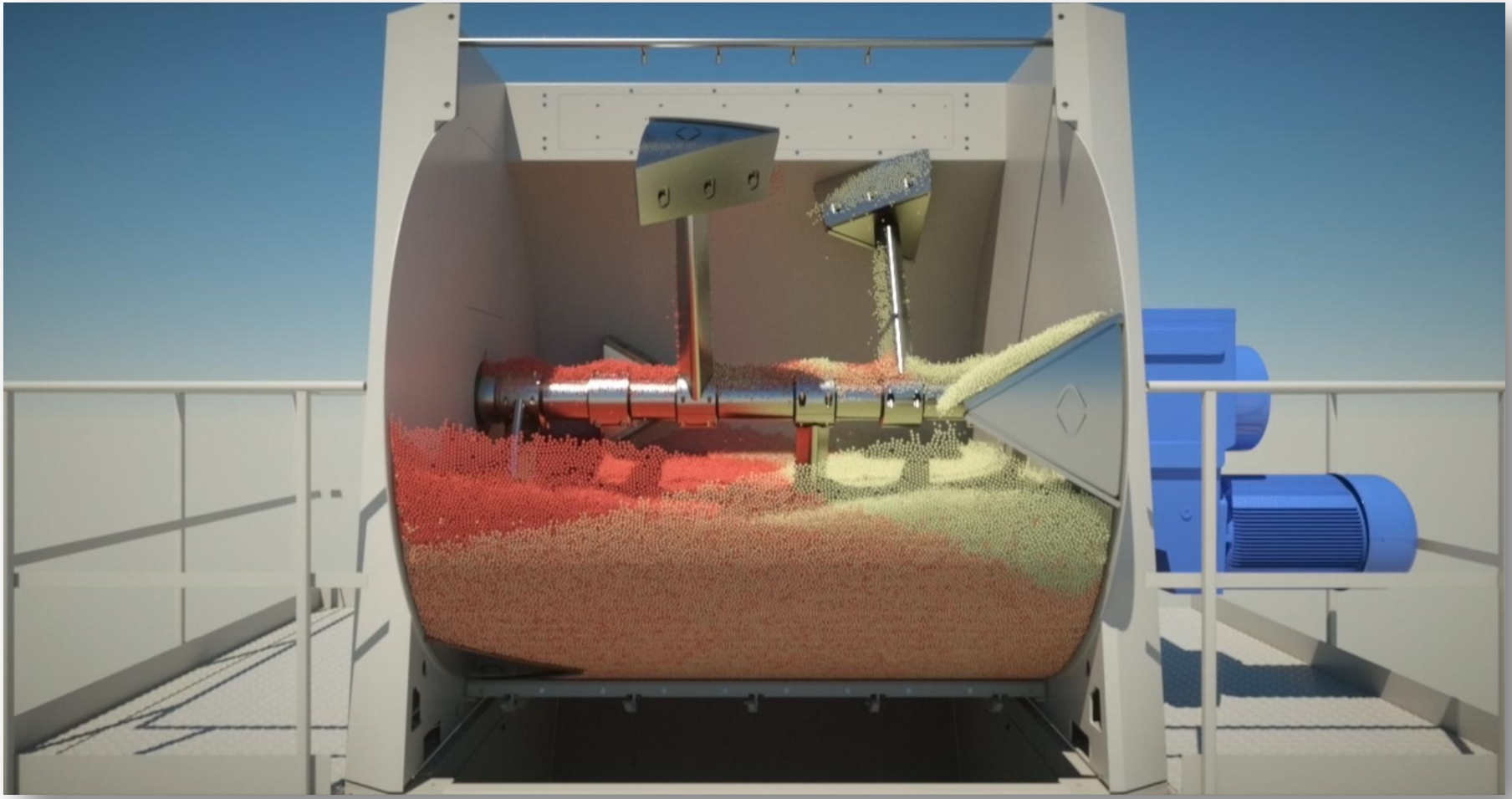


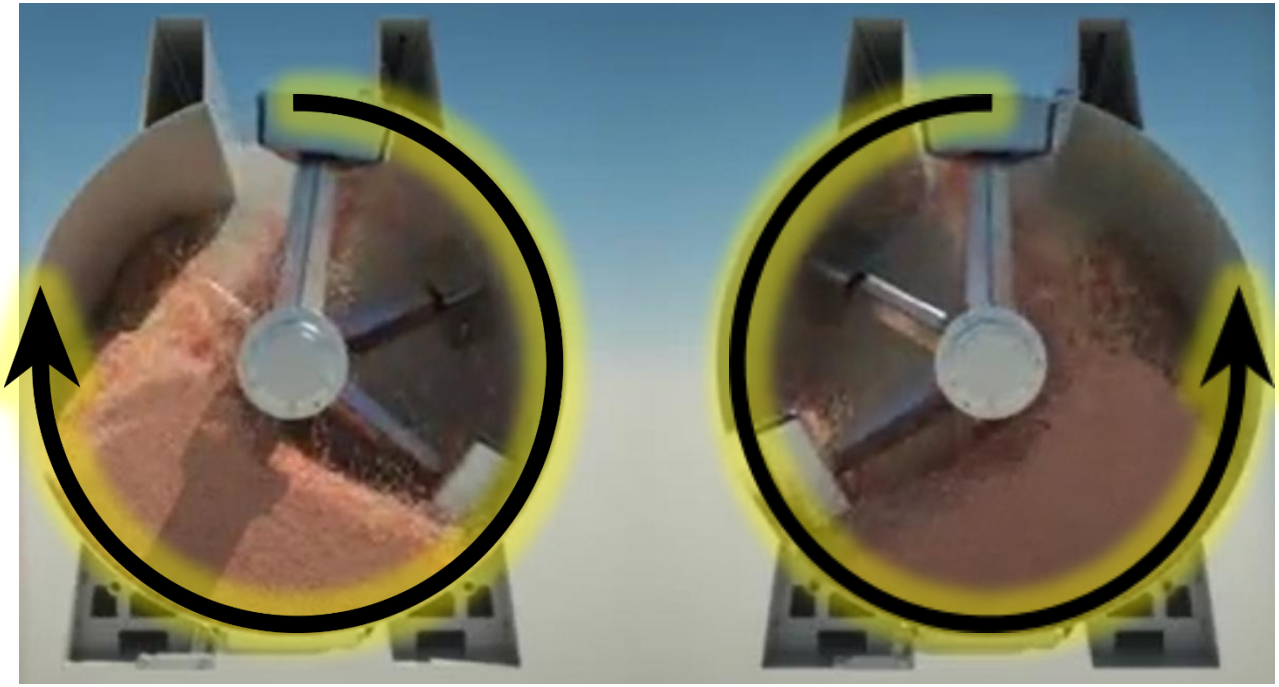

Active zone
Product layer
Rotation direction


Active Zone
Dead Zone





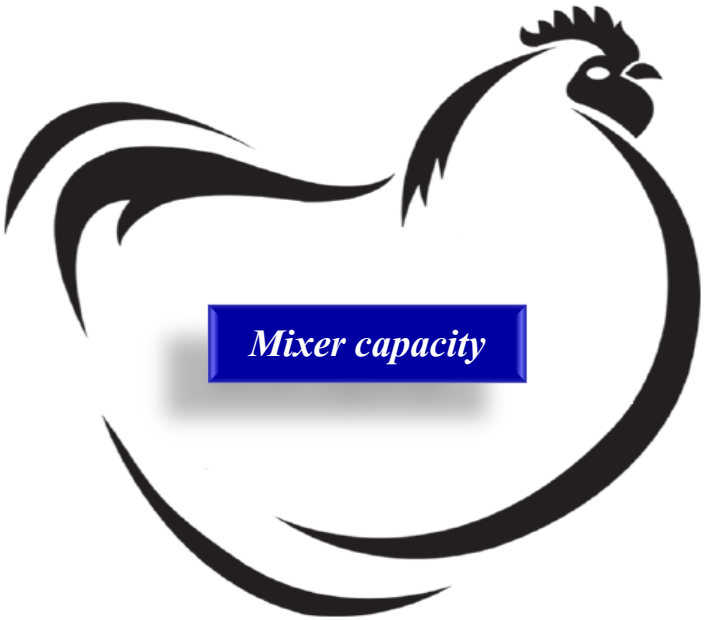




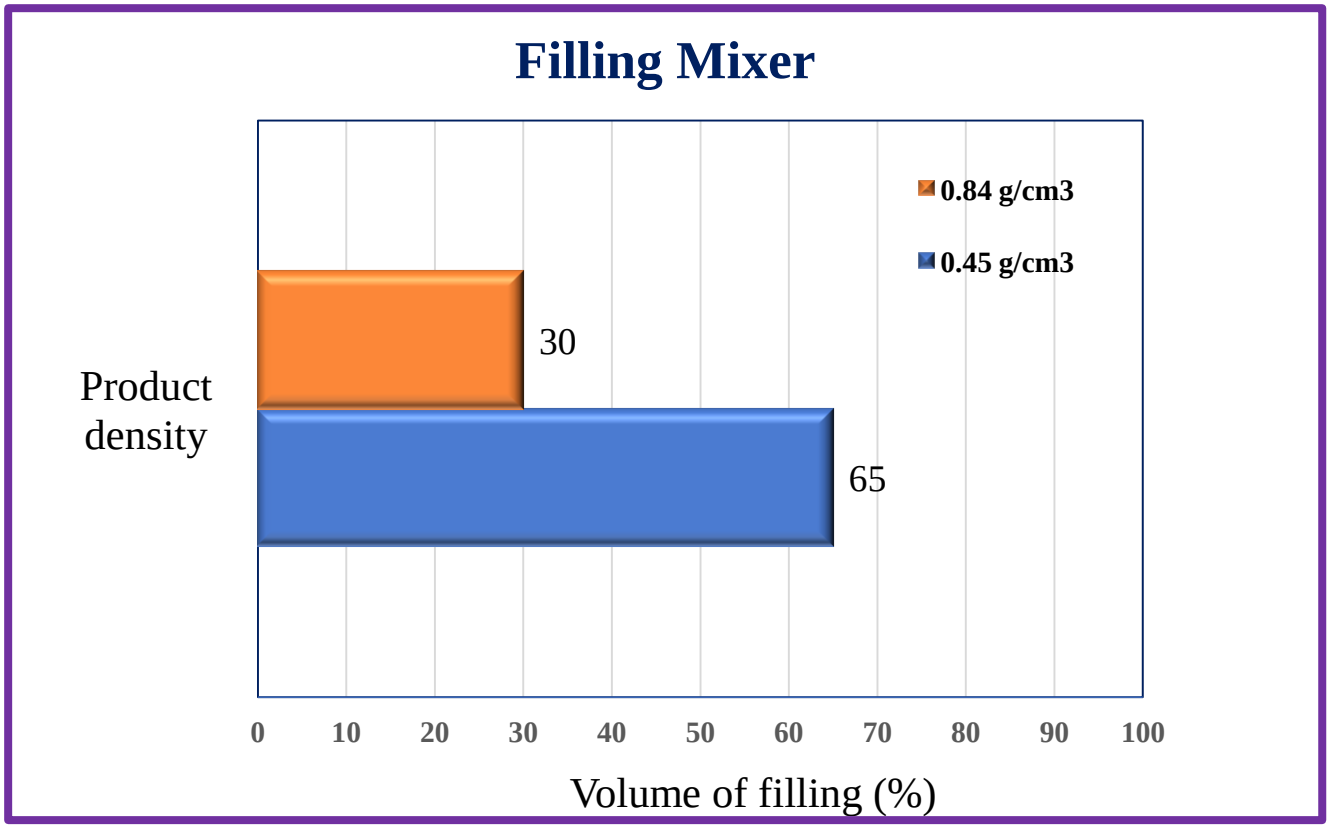

Promix 3D Powder Mixer
can mix several ingredients
of different crystal size
and density

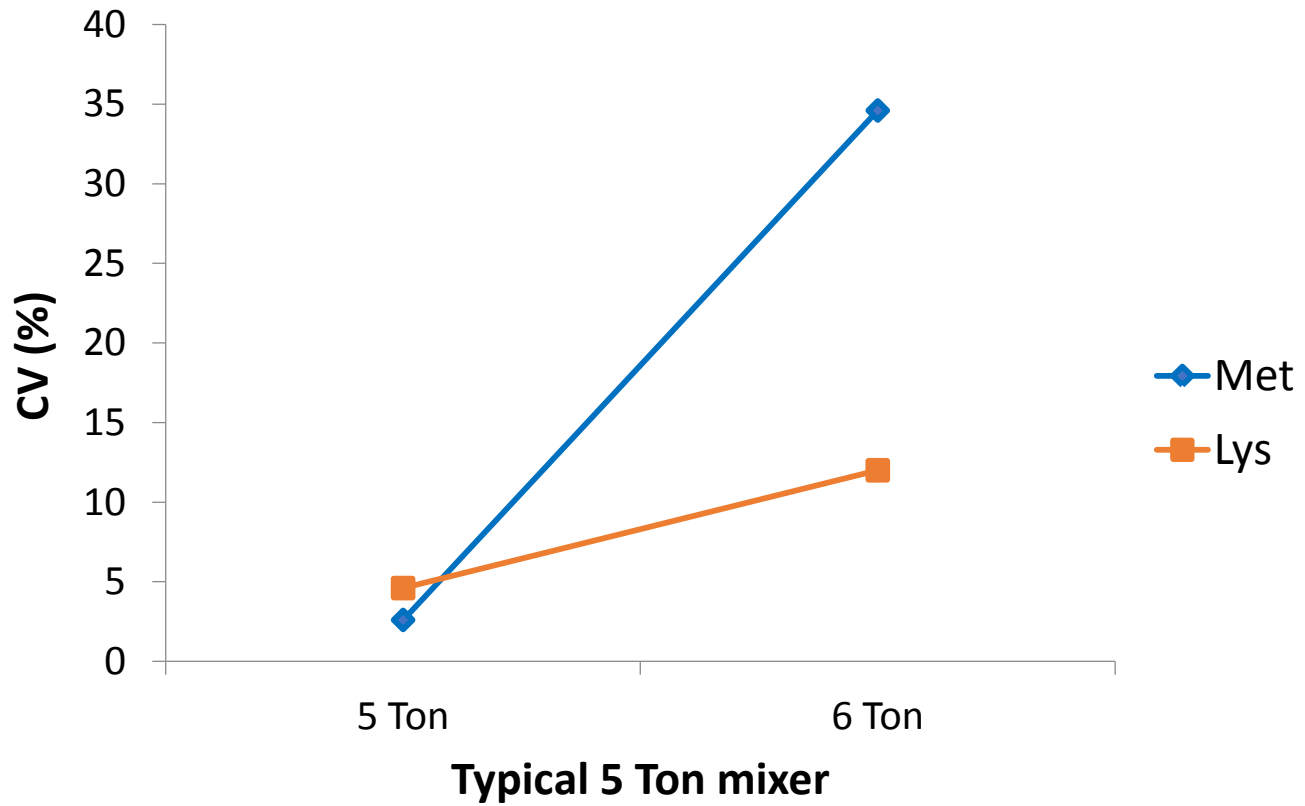

Easy to operate
Product
2.0 kg
Mixing time (min) 1
Rotational speed (rpm) 20
Lower limit (rpm) 10
Upper limit (rpm) 39
Quantity (kg) 2.0
Container size (l) 10

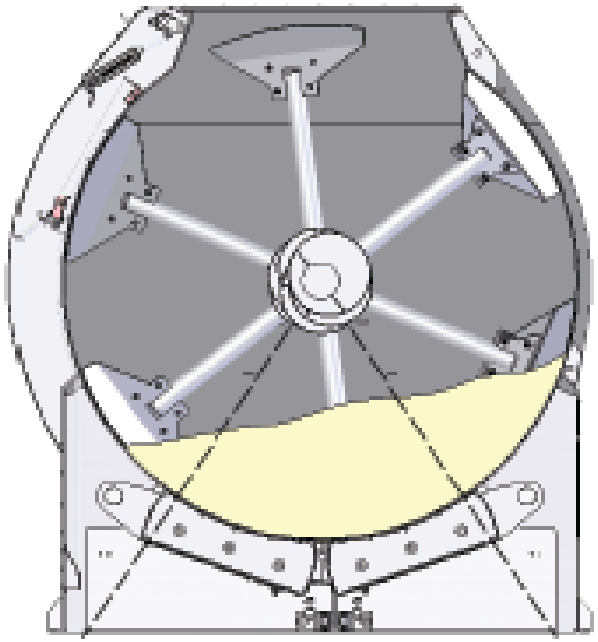

Short mixing time


Mixer capacity

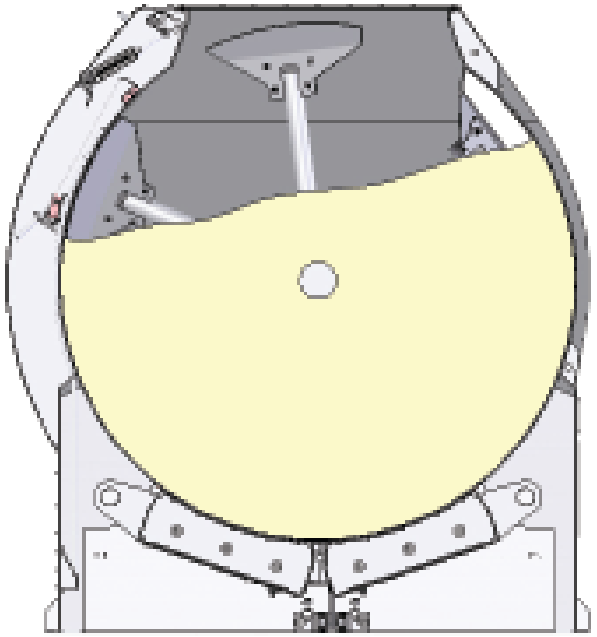
Type		Dimensions for sketch in mm													
	A	B	C	D	E	F	G	H	Bomb door above	Minimum product content	Maximum product content***		Total mixer volume	Motor power mixer	Main shaft speed
									Height	(L)	(L)	(kg)	(L)	(kW)	(rpm)
300	1624	910	1000	2122	n.a.	820	360	150	n.a.	90	300	150	420	9.2	49
500	1764	1040	1140	2412	n.a.	960	450	210	n.a.	150	500	250	700	11	54
1.000	2200	1320	1500	2810	n.a.	1200	550	185	n.a.	300	1.000	500	1.400	15	45
2.000	2540	1663	1900	3450	n.a.	1500	690	215	700	600	2.000	1.000	2.800	22	44
4.000	3295	2120	2240	4215	n.a.	1950	1000	440	650	1.200	4.000	2.000	5.600	45	37
6.000	3540	2250	2700	3905	n.a.	2220	1110	320	650	1.800	6.000	3.000	8.400	75	35
8.000	3760	2560	2925	4220*	2750	2440	1220	430	650	2.400	8.000	4.000	11.200	90/110**	33
10.000	3950	2660	3115	4530*	2890	2630	1220	500	650	3.000	10.000	5.000	14.000	132	33


Filling Mixer
0.84 g/cm3
0.45 g/cm3
30
65
Product density
0
10
20
30
40
50
60
70
80
90
100
Volume of filling (%)

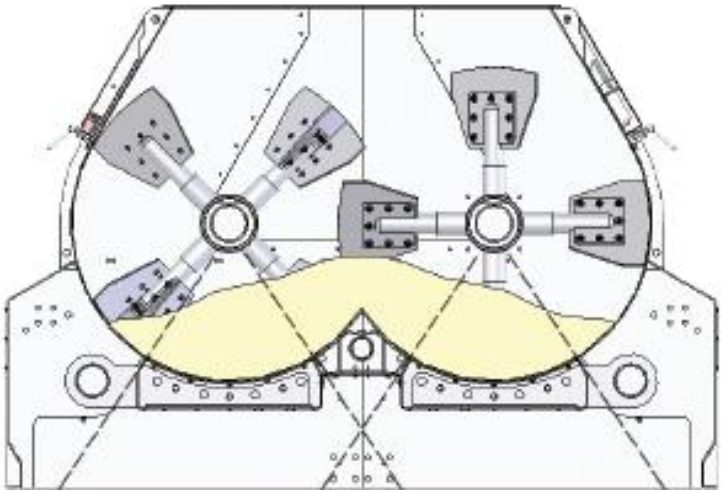

40
35
30
25
20
15
10
5
0
CV (%)
5 Ton
6 Ton
Typical 5 Ton mixer
Met
Lys



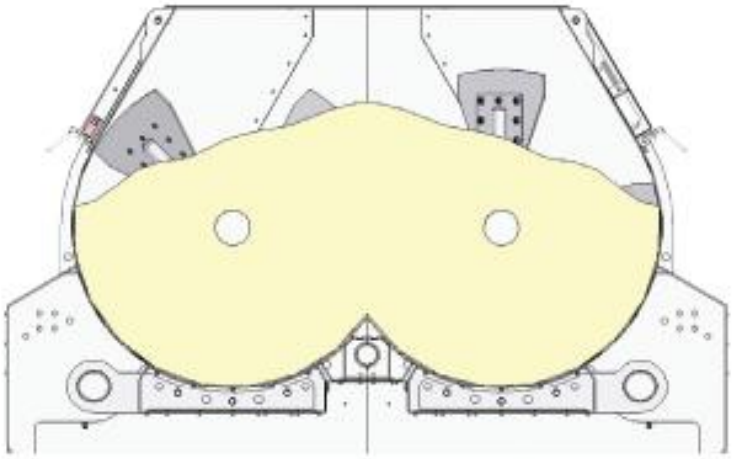
Minimum Filling



Maximum Filling



Minimum Filling



Maximum Filling

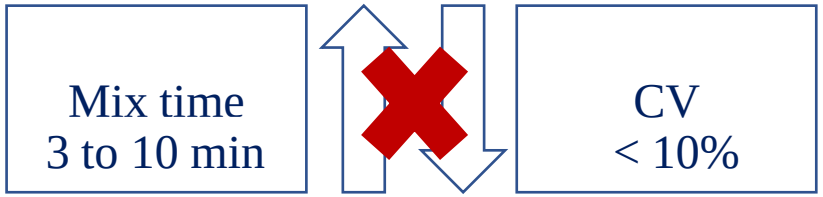

Mixer elements

A good rule of thumb is that when the gap between the shell and the mixing element exceeds 1.3 cm, then the mixing element should be adjusted to decrease this gap.

Maintenance management

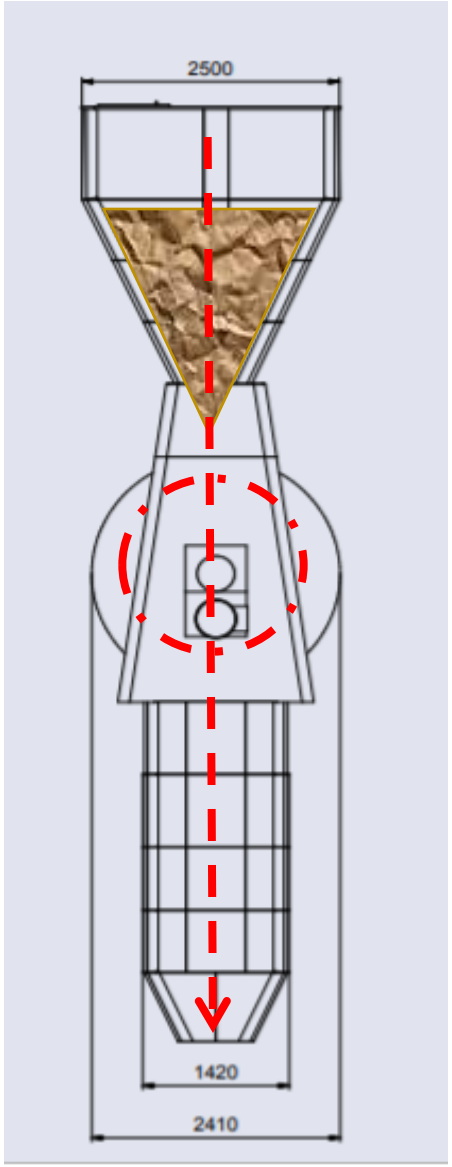
Important management tool

Worn or improperly adjusted mixer

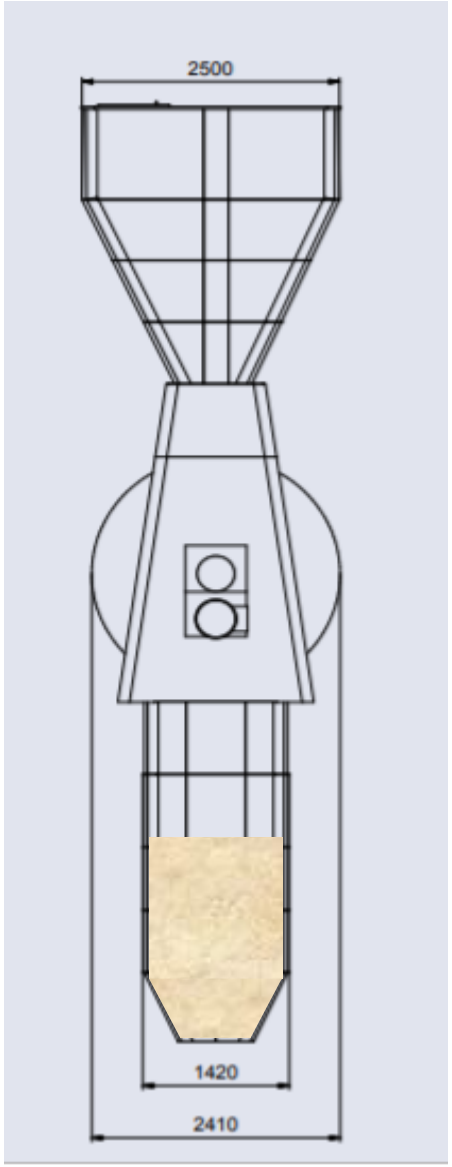


Do's	Don'ts
Clean the mixer before and after use.	Collection of first few bags after mixing
Area must be free of remains of previous batch	Collection of premix in unlabeled bag
Addition of Ingredients when the mixer is on	Collection of premix when the mixer is on.
Note the mixing start and end time	Collection of premix before the specified mixing time
Strict adherence to the mixing order	Addition of reactive materials in the beginning.


Mixer Loading


2500
1420
2410


Mixer discharge


2500
1420
2410


Mixer cleaning

Important cleaning?

- Cross contamination
- Microbial contamination
- Unseal discharge door or gate
- Self cleaning
- Hand cleaning


Mixing time

Mixing Time

- Varies depending upon type of mixer used.
  - Under mixing will cause poor dispersion of active ingredients.
  - Over mixing can cause segregation due to the development of static charge of small pure crystalline products.

Recommended mix times by mixer type (Froetschner, 2005)

Mixer Type	Mix Time, min	
	Dry Mix	Wet Mix
Paddle	3	3
Double shaft, double paddle	0.5	1
Ribbon	2	3
Double ribbon	1-2	2-3
Double shaft, double ribbon	0.75-1	2

Recommended mix times by mixer type (Froetschner, 2005)		
Mixer Type	Mix Time, min	
	Dry Mix	Wet Mix
Paddle	3	3
Double shaft, double paddle	0.5	1
Ribon	2	3
Double ribbon	1-2	2-3
Double shaft, double ribbon	0.75-1	2

Recommended mix times by mixer type (Froetschner, 2005)

Mixer Type	Mix Time, min	
	Dry Mix	Wet Mix
Paddle	3	3
Double shaft, double paddle	0.5	1
Ribbon	2	3
Double ribbon	1-2	2-3
Double shaft, double ribbon	0.75-1	2

Recommended mix times by mixer type (Froetschner, 2005)		
Mixer Type	**Mix Time, min**	
	Dry Mix	**Wet Mix**
Paddle	3	3
Double shaft, double paddle	0.5	1
Ribbon	2	3
Double ribbon	1-2	2-3
Double shaft, double ribbon	0.75-1	2

Recommended mix times by mixer type (Froetschner, 2005)		
Mixer Type	Mix Time, min	
	Dry Mix	Wet Mix
Paddle	3	3
Double shaft, double paddle	0.5	1
Ribbon	2	3
Double ribbon	1-2	2-3
Double shaft, double ribbon	0.75-1	2

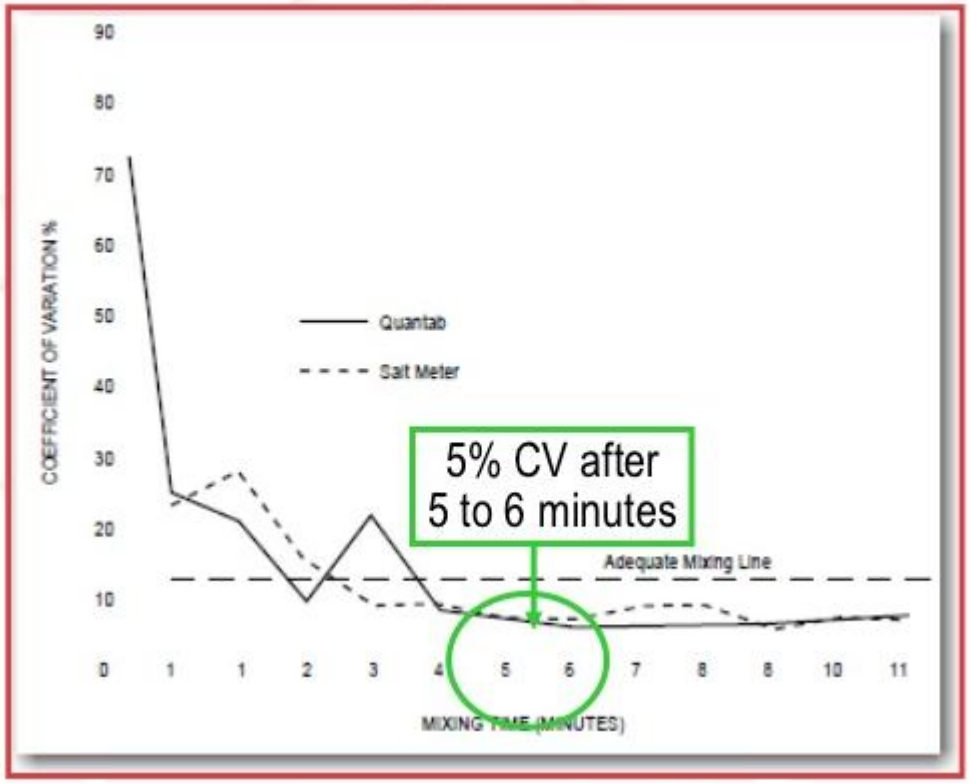
Recommended mix times by mixer type (Froetschner, 2005)		
Mixer Type	Mix Time, min	
	Dry Mix	Wet Mix
Paddle	3	3
Double shaft, double paddle	0.5	1
Ribbon	2	3
Double ribbon	1-2	2-3
Double shaft, double ribbon	0.75-1	2

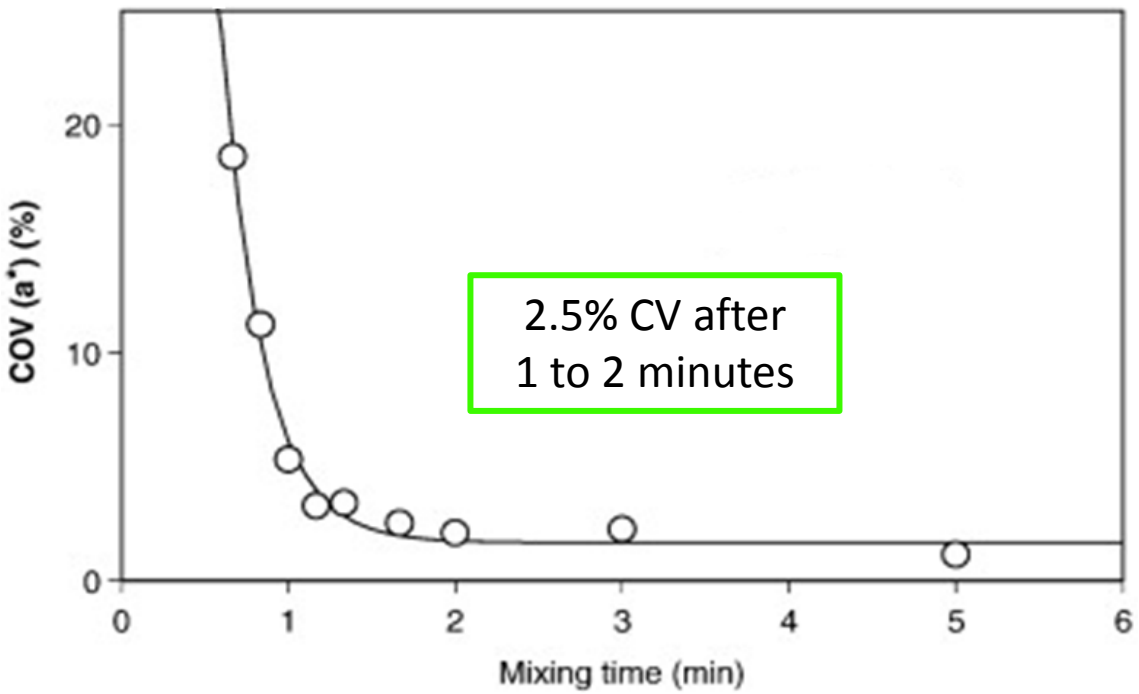
Recommended mix times by mixer type (Froetschner, 2005)

Mixer Type	Mix Time, min	
	Dry Mix	Wet Mix
Paddle	3	3
Double shaft, double paddle	0.5	1
Ribbon	2	3
Double ribbon	1-2	2-3
Double shaft, double ribbon	0.75-1	2

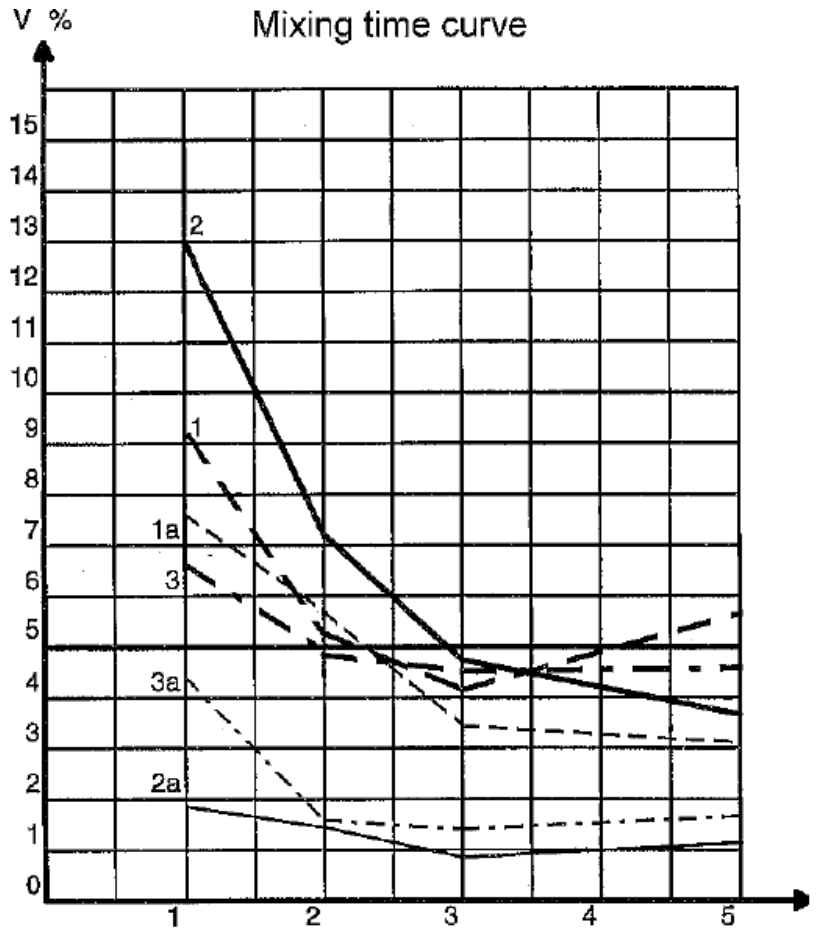
Recommended mix times by mixer type (Froetschner, 2005)

Mixer Type	Mix Time, min	
	Dry Mix	Wet Mix
Paddle	3	3
Double shaft, double paddle	0.5	1
Ribbon	2	3
Double ribbon	1-2	2-3
Double shaft, double ribbon	0.75-1	2


90
80
70
60
50
40
30
20
10
0
1
1
2
3
4
5
6
7
8
8
10
11
COEFFICIENT OF VARIATION %
MIXING TIME (MINUTES)
Quantab
Salt Meter
Adequate Mixing Line
5% CV after
5 to 6 minutes


COV (a*) (%)
20
10
0
0
1
2
3
4
5
6
Mixing time (min)
2.5% CV after
1 to 2 minutes

Proper Mixing Time Reduces Variation



1 Poultry feed / methyl violet

1a Poultry feed / table salt

2 Pig feed / methyl violet

2a Pig feed / table salt

3 Dairy feed / methyl violet

3a Dairy feed / table salt


Mixing order

Mixing order

The sequence of addition of various ingredients while loading the mixer can affect the quality of premix. If proper mixer loading sequence is not followed, oil balls, chemical interactions and particle segregation can result in a premix.

Add reactive material at the end

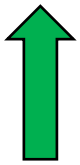

Mixer efficiency

Efficiency of the mixer

The efficiency of the mixer characterizes the ability of the mixer to disperse the vitamin products homogeneously in the premix or the feed. Measurement of the efficiency of the mixer takes into account the effect of shear (energy transmitted to the mixture) and the mixing duration.

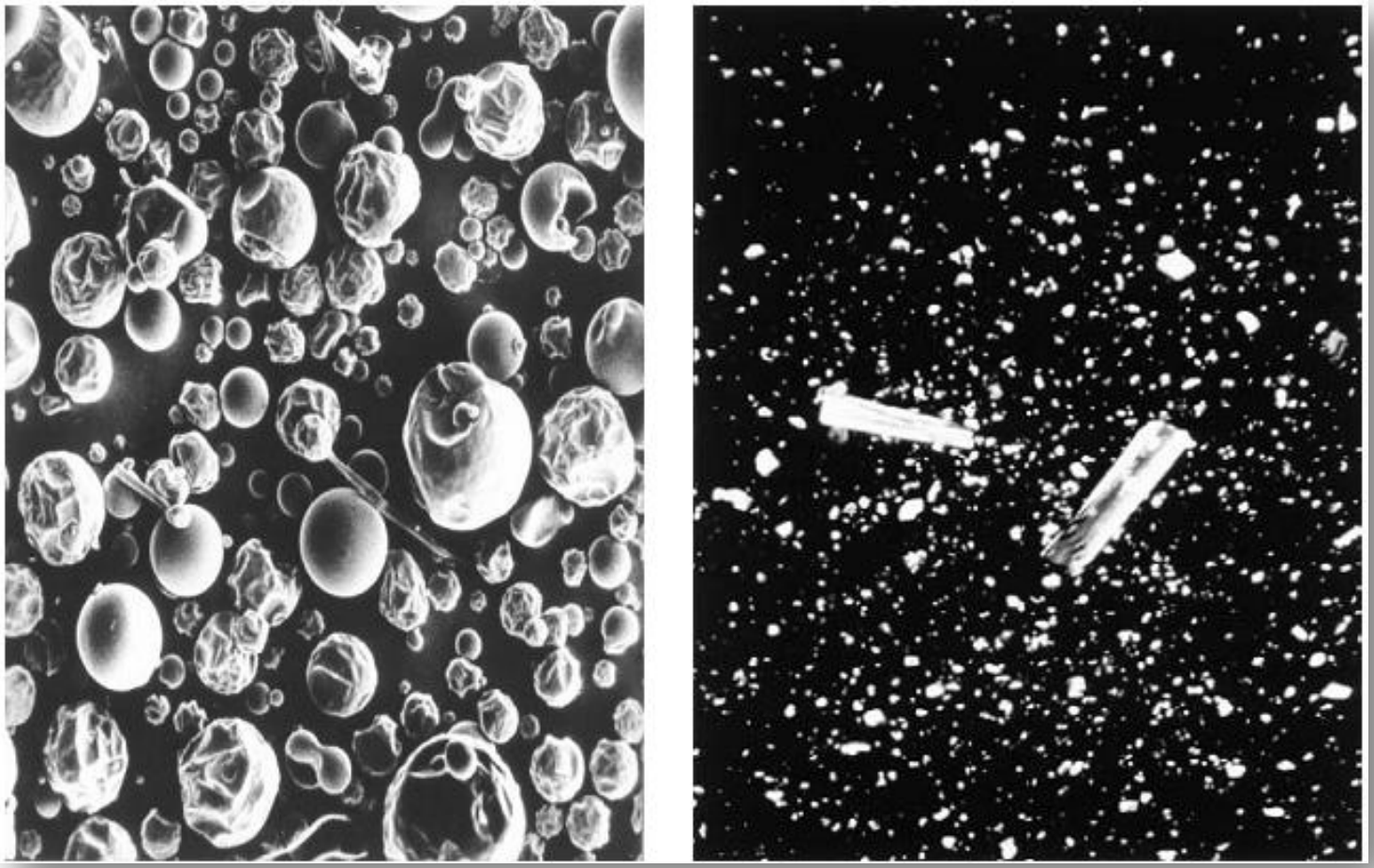
The efficiency of the mixer is determined experimentally and should be supplied by the manufacturer of the mixer.

very low daily feed consumption

very large particle count  distributed uniformly throughout the mix

A comparison of biotin intake by broiler chicks consuming two sources of biotin		
category	**product**	
	Rovimix biotin	Competitive triturate
Inclusion rate, mg/ton	100	100
Biotin consumption, particle/days	1000	12

Why is particle size important?



$$\mu = \frac{0.16 + 0.18 + 0.17 + 0.23}{4} \times 1000 = 187\mu m$$

Relationship between the particle size profile and the number of particles		
Size of Particles		Particle number in 1.0 gram (specific gravity = 1.0) from D.E.Axe (1995)
U.S Sieve series	Diameter microns (µm)	
N° 18	1000	1,530
N° 20	841	2,580
N° 25	707	4,350
N° 30	595	7,460
N° 35	500	
N° 40	420	20,800
N° 45	354	
N° 60	250	84,700
N° 80	177	281,000
N° 100	149	392,000
N° 120	125	
N° 140	105	1,200,000
N° 170	88	
N° 200	74	3,260,000
N° 230	63	
N° 325	44	15,600,000

Vitamin Supplement Formulation

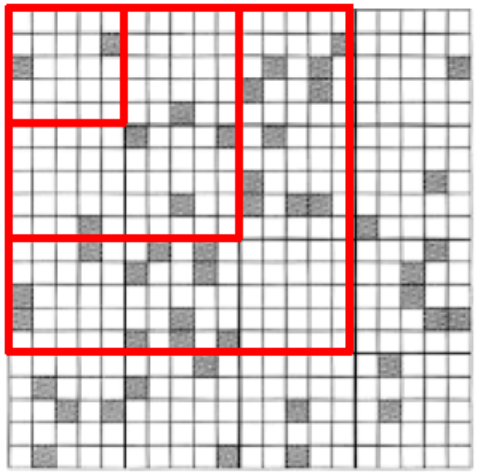
Ingredients	Requirement		Characteristics of Commercial Product						gr / Ton feed	gr / 500 kg Premix(0.25%)
	Unit	Value	Physical Shape	Compound	Unit	Bioavailability	Purity of Vitamin	Commercial Purity		
Vit A	Iu/kg	13000	Fine Powder	Retinol 13 cis	Iu/kg	50	100	1000000000	26.00	5200.00
Vit D3	Iu/kg	5000	Fine Powder	Cholecalciferol	Iu/kg	100	100	500000000	10.00	2000.00
Vit E	Iu/kg	80	Coarse Powder	DL-α-tocopheryl	Iu/kg	110	100	500000	145.45	29090.91
Vit K3	mg/kg	4	Coarse Powder	Menadione Sodium Bisulfate	%	100	50	50	16.00	3200.00
Vit B1	mg/kg	4	Fine Powder	Thiamin Mononitrate	%	100	92	98	4.44	887.31
Vit B2	mg/kg	9	Fine Powder	Riboflavin 5 Phosphate	%	100	73	80	15.41	3082.19
Vit B3	mg/kg	60	Fine Powder	Nicotinic acid	%	100	100	98	61.22	12244.90
Vit B5	mg/kg	15	Fine Powder	DL Pantothenic Acid	%	50	100	99.5	30.15	6030.15
Vit B6	mg/kg	4	Fine Powder	Pyridoxine Hydrochloride	%	100	82.3	99	4.91	981.87
Vit B9	mg/kg	2	Fine Powder	Folic Acid	%	100	100	80	2.50	500.00
Vit B12	mg/kg	0.02	Fine Powder	Cyanocobalamin	mg/kg	100	100	10000	2.00	400.00
Vit H2	mg/kg	0.15	Coarse Powder	D-Biotin	%	100	100	2	7.50	1500.00
Choline	mg/kg	400	Fine Powder	Choline Chloride	%	100	85	60	784.31	156862.75

Diameters (μm): 177 Vitamin A consumption, particles/day= 730

Diameters (μm): 500 Vitamin A consumption, particles/day= 19


Mixer evaluation

Scale of scrutiny



- Homogeneous mixture = samples taken from the mixture have equal properties
- Homogeneity depends on the sample size
  - all mixtures seem being uniform at sufficiently large sample size
- Scale of scrutiny
  - Minimum sample size to be used to achieve the variance of samples below desired limit

Choosing a Test Substance

The following criteria should be considered when choosing the test substance:

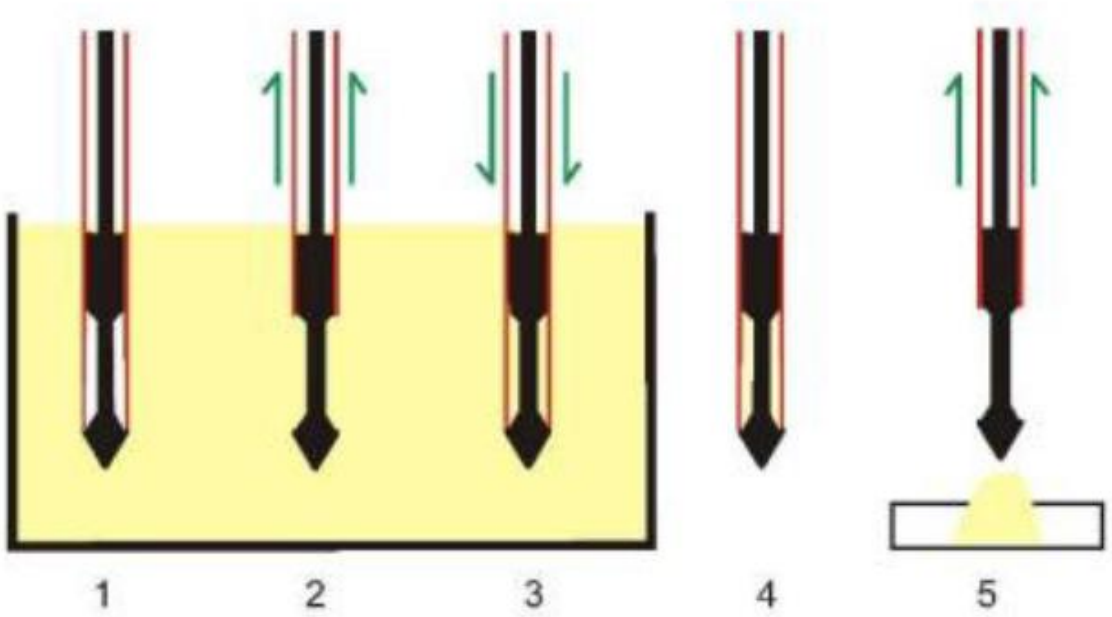
- The method to determine the level of the substance should be highly reproducible and have a low variation (e.g., for lab methods, the analytical variability should be less than the target CV for the mixer).
- Only one ingredient should significantly contribute to the concentration of the test substance in the mix to avoid masking non-uniformity.
- With respect to selection of the test substance, one or all of the following nutrients would appear to be suitable in most instances
  - Met (synthetic)
  - Minerals

Prescribed Critical Limits

The mixer is considered to be producing homogenous feeds when the coefficient of variation for the test batch is:

- No greater than **5**% for dilute drug premixes
- No greater than **10**% for micro or macro premixes and supplements
- No greater than **15**% for complete feeds and total mixed rations

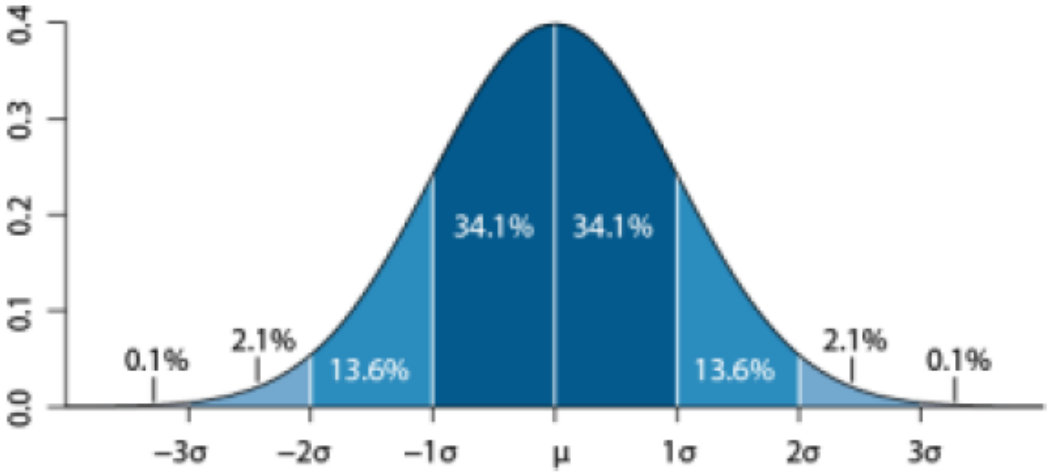
Sampling




Samples should be
taken at, or as close
to the mixer
discharge

Standard error of a random variable

- measure of variability of random variable
  - random variable result will be within +- standard deviation from average with approximately 2/3 probability
  - andom variable result will be within +- 2 x standard deviation from average with with very high probability



$$\sigma_X = \sqrt{\frac{\sum_{i=1}^{N} (X_i - \overline{X})^2}{N}}$$

Statistics tutorial

- Random variable
  - variable, the value of which is given by the result of random event
    - throwing dice result
    - API content in sample of random mixture
- mean value of a random variable
  - sum of all possible results of random event multiplied by their probability
    - mean value of dice throw result

$$E(X) = 1 \cdot \frac{1}{6} + 2 \cdot \frac{1}{6} + 3 \cdot \frac{1}{6} + 4 \cdot \frac{1}{6} + 5 \cdot \frac{1}{6} + 6 \cdot \frac{1}{6} = 3{,}5$$

Statistics tutorial

- Mean value of a random variable
  - mean value of API content in sample taken from a bulk mixture

$$E(X) = \lim_{N \to \infty} \frac{\sum_{i=1}^{N} X_i}{N}$$

    - number of random sampling results is almost infinite
- Selective mean value - arithmetic average
  - mean value of API content in taken sample, calculated from selection of finite number of carried out experiments

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{N}$$

Statistics tutorial

- Selective standard error
  - measure of random events variability
    - API content variability in taken samples

$$s_x = \sqrt{\frac{\sum_{i=1}^{N} (X_i - \overline{X})}{N-1}}$$

- Relative (selective) standard error, RSD %
  - measure of variability related to mean value
    - e.g. comparable for two drug potencies (2 mg and 4 mg of API content)

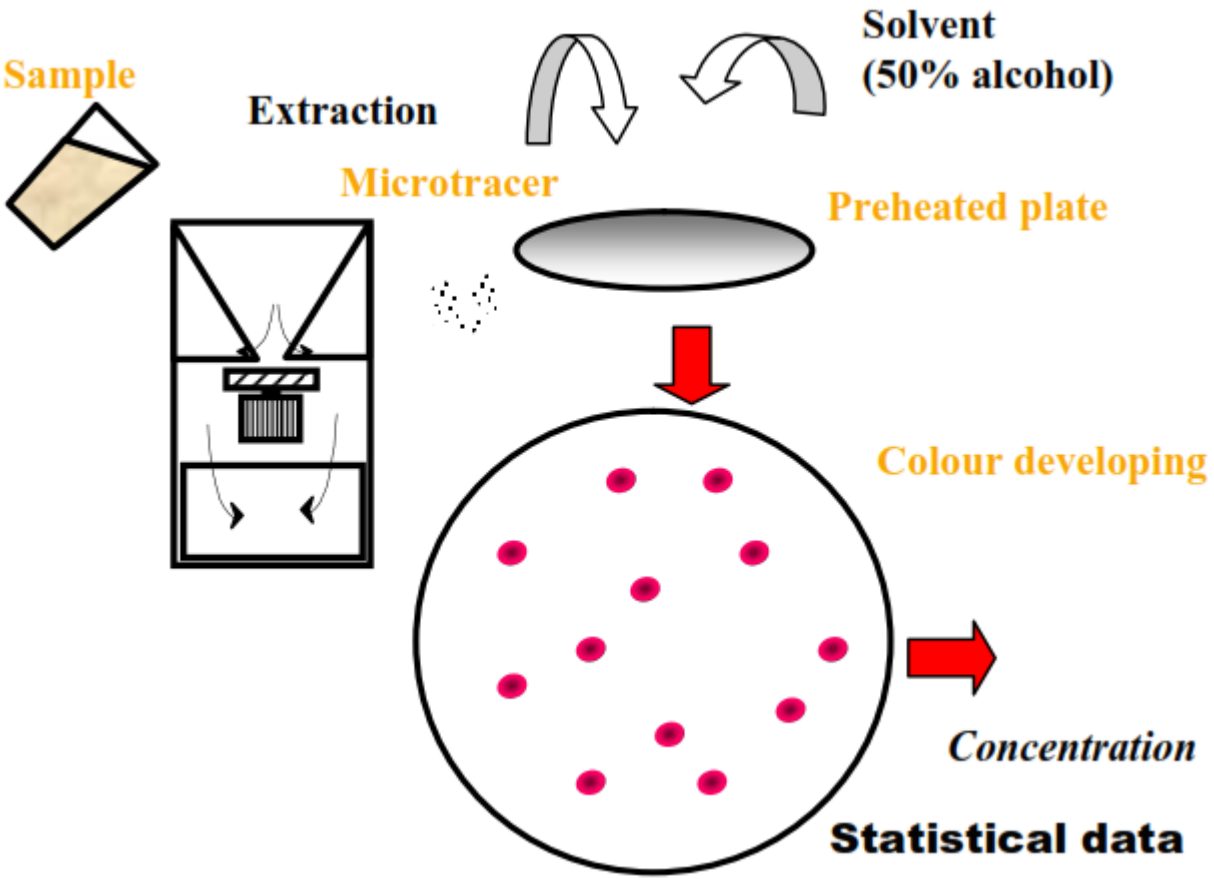
$$RSD = \frac{s_X}{\overline{X}} \cdot 100\ \% = \frac{1}{\overline{X}} \sqrt{\frac{\sum_{i=1}^{N} (X_i - \overline{X})}{N-1}} \cdot 100\ \%$$

Evaluation of homogeneity in feed by method of micro tracers®

Archiva Zootechnica 12:4, 85-91, 2009

Granulometric analyses

Performed by method of Test sieving (ISO1591-1 1988 (E)).
Homogeneity of mashes was determined by Microtracer® method (Micro Tracers, Inc., San Francisco, CA 94124) as a physical method of homogeneity testing. A sufficient amount of iron filings (Microtracer F, blue) , colored with a water soluble die, is added to the mix in mixing ratio 1:20.000 (50g/t) which results in 125 counts (particles) per sample, with the sample size of 100 grams. Feed mashes were mixed in horizontal ribbon mixer, under the same conditions and time of mixing was 5 minutes. After mixing, samples were taken directly from mixer. Sample size was about 100-150 g, and after analyzing of samples all values were calculated on 100 g sample size. Microtracer particles were separated from the feed sample with rotary magnet where iron particles were fixed on the magnetic surface of rotary detector. The iron particles are demagnetized and then sprinkled onto a large filter paper. The filter paper is then moistened with 50 % ethanol. When spots begin to develop, the paper is transferred to a preheated hot plate and dried (Arlet, 2003). All particles are counted. Number of spots presents concentration of added tracer in sample. All data are calculated by statistical program (Poison statistic) to determine mixing homogeneity. The value of PROBABILITY was criteria for homogeneity where it means that $P<1$ % mixture is not homogenous, when $P>5\%$ mixture is homogenous and in range of $1\%<P<5\%$ tracer results indicate mixing is marginal (Eisenberg, 1992).


Sample
Extraction
Solvent
(50% alcohol)
Microtracer
Preheated plate
Colour developing
Concentration
Statistical data

Evaluation of homogeneity in feed by Kansas University method

K-STATE
Research and Extension

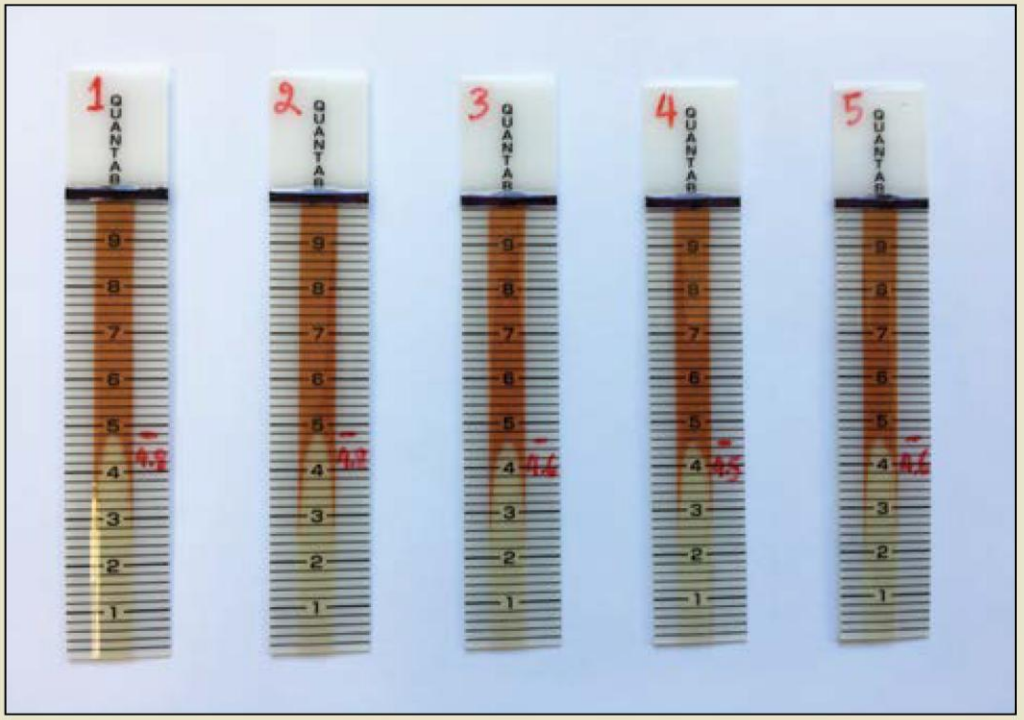
Sampling port near mixer discharge.

Uniformity test using the Quantab® Chloride Titator method

1. Weigh a 10-g sample of ground feed into a cup, then add 90-g of hot distilled water (140°F) to the cup using a 0.1-g readability scale for both sample and water.
2. Stir mixture for 30 seconds, allow to rest for 60 seconds and stir for another 30 seconds.
3. Place a folded filter paper into the cup and then insert a Quantab® strip range 30 to 600 mg/L (Hach Company, Loveland, CO) into the liquid at the bottom of the filter paper. The same lot of Quantab® strips should be used for all ten samples.
4. Read the Quantab® number at the top of the white peak after the color of the top band of the strip has changed from yellow to black, and then convert the Quantab® strip reading to %NaCl using the chart on the bottle.
5. Calculate the %NaCl of the sample by multiplying the %NaCl from the table on the bottle (from Step 4) by 10.
6. Compute a CV from the results of 10 samples within a batch to determine mixing uniformity. The CV for each batch is calculated by dividing the standard deviation by the average value multiplied by 100.

(Right): Quantab in filter paper.

(Below): Quantabs from mixer test.



Interpretation and corrective action of mixer tests (Herrman and Behnke, 1994)

Percent coefficient of variation	Rating	Corrective action
<10%	Excellent	None
10–15%	Good	Increase mixing time by 25 to 30 percent.
15–20%	Fair	Increase mixing time 50 percent, look for worn equipment, overfilling, or sequence of ingredient addition.
>20%	Poor	Possible combination of all the above. Consult extension personnel or feed equipment manufacturer.

K-STATE Research and Extension

Effect of marker selection and mix time on the coefficient of variation (mix uniformity) of broiler feed

Kansas University

Effect of marker selection and mix time on CV in the mixing process			
Marker	Mix time (min)		
	0.5	2.5	5.0
DL Met	23.86a	4.56ab	9.47b
L Lys HCl	19.75a	16.00ab	8.70b
CP	7.73	7.29	6.86
Chloride ion	20.26	12.75	15.08
P	13.72	6.46	6.27
Mn	36.25a	20.80a	17.59b
Microtracer Red #40 (count)	21.77a	11.72ab	10.43b
Microtracer Red #40 (absorbance)	21.13	20.52	16.88
Microtracer RF Blue lake	32.49a	20.09a	18.64
Roxarsone (3 Nitro)	30.42	25.15	25.54
Semduramicin	27.40a	16.11a	11.23b

Effect of marker selection and mix time on CV in the mixing process			
Marker	Mix time (min)		
	0.5	2.5	5.0
DL Met	23.86a	4.56ab	9.47b
L Lys HCl	19.75a	16.00ab	8.70b
CP	7.73	7.29	6.86
Chloride ion	20.26	12.75	15.08
P	13.72	6.46	6.27
Mn	36.25a	20.80a	17.59b
Microtracer Red #40 (count)	21.77a	11.72ab	10.43b
Microtracer Red #40 (absorbance)	21.13	20.52	16.88
Microtracer RF Blue lake	32.49a	20.09a	18.64
Roxarsone (3 Nitro)	30.42	25.15	25.54
Semduramicin	27.40a	16.11a	11.23b

Effect of marker selection and mix time on CV in the mixing process			
Marker	Mix time (min)		
	0.5	2.5	5.0
DL Met	23.86a	4.56ab	9.47b
L Lys HCl	19.75a	16.00ab	8.70b
CP	7.73	7.29	6.86
Chloride ion	20.26	12.75	15.08
P	13.72	6.46	6.27
Mn	36.25a	20.80a	17.59b
Microtracer Red #40 (count)	21.77a	11.72ab	10.43b
Microtracer Red #40 (absorbance)	21.13	20.52	16.88
Microtracer RF Blue lake	32.49a	20.09a	18.64
Roxarsone (3 Nitro)	30.42	25.15	25.54
Semduramicin	27.40a	16.11a	11.23b

Effect of marker selection and mix time on CV in the mixing process			
Marker	Mix time (min)		
	0.5	2.5	5.0
DL Met	23.86a	4.56ab	9.47b
L Lys HCl	19.75a	16.00ab	8.70b
CP	7.73	7.29	6.86
Chloride ion	20.26	12.75	15.08
P	13.72	6.46	6.27
Mn	36.25a	20.80a	17.59b
Microtracer Red #40 (count)	21.77a	11.72ab	10.43b
Microtracer Red #40 (absorbance)	21.13	20.52	16.88
Microtracer RF Blue lake	32.49a	20.09a	18.64
Roxarsone (3 Nitro)	30.42	25.15	25.54
Semduramicin	27.40a	16.11a	11.23b

Effect of marker selection and mix time on CV in the mixing process			
Marker	Mix time (min)		
	0.5	2.5	5.0
DL Met	23.86a	4.56ab	9.47b
L Lys HCl	19.75a	16.00ab	8.70b
CP	7.73	7.29	6.86
Chloride ion	20.26	12.75	15.08
P	13.72	6.46	6.27
Mn	36.25a	20.80a	17.59b
Microtracer Red #40 (count)	21.77a	11.72ab	10.43b
Microtracer Red #40 (absorbance)	21.13	20.52	16.88
Microtracer RF Blue lake	32.49a	20.09a	18.64
Roxarsone (3 Nitro)	30.42	25.15	25.54
Semduramicin	27.40a	16.11a	11.23b

www.minatoyoor.com