

POWDER TRANSPORTATION AND  
POWDER CONVEYING

**///TWGema**



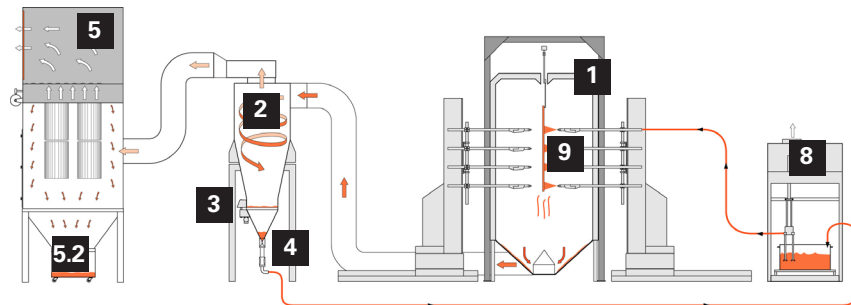
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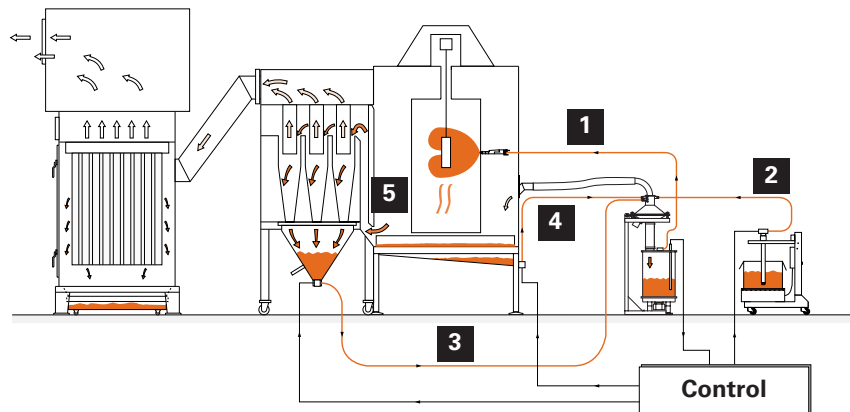
## 1. Why Powder Transportation and Conveying

In a powder coating system, the powder has to be forwarded from one place to another, taking into consideration the specific characteristics and the safety rules. The most acquainted application is the transportation of the powder from the powder container to the gun. With automatic systems the powder is forwarded from the FreshPowder container to the intermediate container and from there on to the gun. In addition the powder which is not applied is collected in the booth, recovered and fed back to the intermediate container. The powder is thus always in movement. The properties of the powder should not be changed by the transportation. Respectively the transportation of the powder should be such as to preserve the powder properties.



Pulverkreislauf des Schnellfarbwechselsystems MagicPlus

- |                        |                     |
|------------------------|---------------------|
| 1 Booth                | 5 After Filter      |
| 2 Cyclone separator    | 5.2 Waste container |
| 3 Powder Sieve Machine | 8 Powder center     |
| 4 Dense Phase conveyor | 9 Automatic Guns    |



Scheme of powder flow

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>1 Precision conveying from the powder container to the gun</li> <li>2 Mass conveying from the FreshPowder container (powder with little air)</li> <li>3 Mass conveying from the cyclone recovery container to the powder container</li> </ul> | <ul style="list-style-type: none"> <li>4 Mass conveying from the fluid channel to the powder container (powder with little air)</li> <li>5 Mass conveying from the booth to the cyclone/multicyclone/filter (powder with a lot of air)</li> </ul> |
|--|---|

## 2. Mechanical properties of the powder

The mechanical properties and to a point the chemical properties as well influence the transportation of the powder. The powder possesses considerably different properties to paints. They are dry and mostly do not trickle. Depending on the additives the powder possesses bad slip-characteristics and has a high tendency to sinter. Its essential properties are:

- dry, granular
- size of particles from 1 - 100  $\mu$  in varying composition
- big angle of rest
- tendency to sinter at high speeds
- various chemical compositions
- sensible to temperature beginning at approx. 50°C

## 3. Requirements to the Conveying Systems

### 3.1. The precision conveying

The requirements to the system are manifold. Depending on use one distinguishes between a precision conveying and a mass conveying. The precision conveying is applied for the powder feed to the gun. Its requirements are:

- high consistency of the powder flow
- repeatability
- free of pulse
- flow rate 50 - 500 gr/min

The transportation is influenced by:

- length of powder tube
- the guiding of the powder tube
- the diameter of the powder tube
- filling level in the powder container
- suction height in the container
- total air amount in the powder tube

### 3.2 The Precision Conveying Systems

Function:

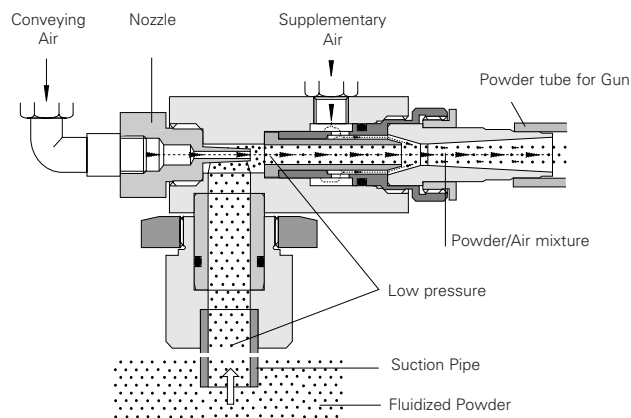
Suction and conveying of a preset amount of powder from the container to the gun and the admixture of dosing air to stabilize the total air quantity. By changing the nozzle pressure, the vacuum in the injector changes. The amount of powder varies depending on the vacuum. The change of the nozzle pressure increases/reduces the quantity of air. With smaller powder quantities (small air quantity), the amount of air has to be increased by the dosing air, so that the powder can be transported through the powder tube constantly without pulsing.

The advantages:

- easy mechanical assembly and easy maintenance

The disadvantages:

- accuracy of control +/- 10 %
- periodical maintenance required
- no regular circuit

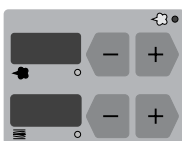


#### GENERAL CONDITIONS FOR PI 3 / EASYFLOW INJECTORS

Powder type:	Epoxy/Polyester	
Powder hose length	[m]	10
Powder hose ø	[mm]	11
Input pressure	[bar]	5.0
Conveying air nozzle ø - PI 3 / EasyFlow	[mm]	1.6
Supplementary air nozzle ø - PI 3 / EasyFlow	[mm]	1.4

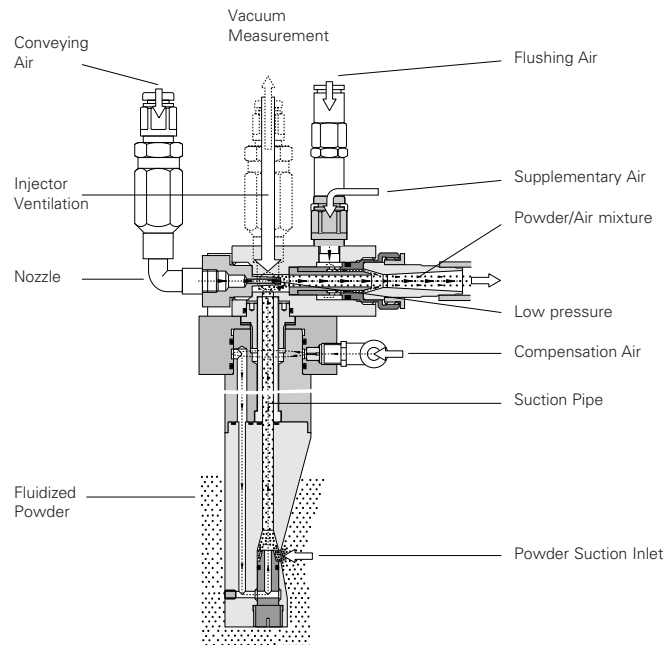
#### GUIDE VALUES FOR OPTITRONIC WITH PI 3 / EASYFLOW INJECTORS

Total air	Powder output  [%]	4 Nm³/h	5 Nm³/h	6 Nm³/h
		Powder output [g/min]		
	<b>10</b>	30	35	45
	<b>20</b>	60	75	90
	<b>30</b>	85	100	120
	<b>40</b>	110	130	150
	<b>50</b>	130	160	175
	<b>60</b>	150	180	210
	<b>70</b>	175	200	235
	<b>80</b>	200	240	270
	<b>90</b>	215	260	
	<b>100</b>	235	290	



Settings for EasyFlow injector

### 3.3 Powder dosing injector with regular circuit



Cross-Section through Powder dosing injector

The principle of functioning:

The vacuum in the injector is in direct coherency with the transported quantity of powder. By measuring the vacuum, the powder quantity can be controlled fully automatically.

The advantages:

- exact dosage of the amount of powder
- constant air amount (controlled by the regular circuit)
- changes in resistance in the tube/injector/gun are automatically adjusted
- Flow free of impulses
- constant suction in the injector riser pipe using compensation air
- easy mechanical assembly
- suitable for color changes

The disadvantages:

- a complicated control and measurement of air quantity

### 3.4 The powder dosage system

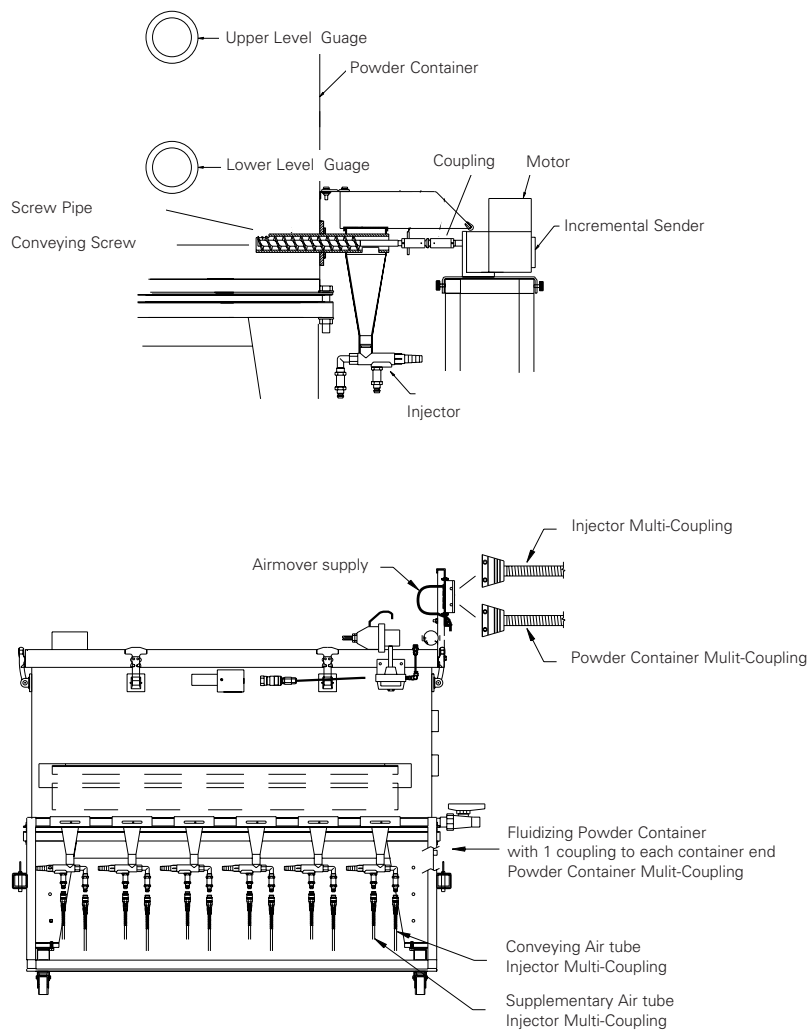
The principle of functioning: the powder reaches the injector and then the gun as homogeneous powder-air-mixture, with a PLC-controlled dosing screw with adjustable rotational speed.

The advantages:

- precise dosage of the powder quantity
- adjustable with preset PLC-values
- very high repeatability
- clearly defined powder-air-mixture
- constant conveying speed in the tube

The disadvantages:

- many mechanical parts
- suction of outside air, because of the open system
- not suitable to color changes
- calibration needed for each powder type
- very intensive in maintenance



Dosing System with Screw

### 3.5 The precision conveyors in comparison

Criteria	Precision Injector	Precision Injector with circuit	Dosing System with screw
Size	Small	Small	Mid-sized
Air consumption	5 nm <sup>3</sup> /h	5 nm <sup>3</sup> /h	2 nm <sup>3</sup> /h
Span of regulation	50 – 400 gr/min	20 – 200 gr/min	20 – 200 gr/min
Accuracy of regulat.	+/- 10 %	+/- 3 %	+/- 3 %
Colour change	suitable	suitable	not suitable
Operating Costs	low	high	high

### 3.6 The High-Output Injector

With the mass conveyance the powder has only to be transported from one container to another. The consistency is not important neither on a short-time basis nor on a long-time basis. On the other hand the transportation should be economical and not adversely affect the powder.

The Function:

Suction and transportation of such big amount of powder as possible using the smallest energy input, e.g. from the FreshPowder container to the central powder container, from the cyclone recovery container to the powder container.

The construction:

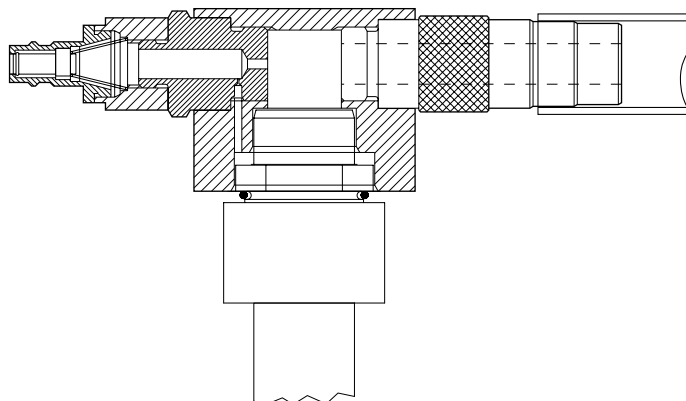
The preset nozzle-pressure at the High-output injector creates a vacuum. The vacuum influences directly the amount of powder transported.

The advantage:

- easy, maintenance free conveying system

The disadvantage:

- high consumption of compressed air



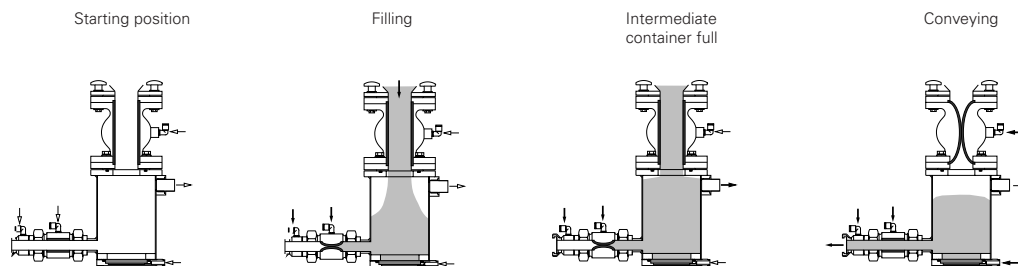
Powder Pump

### 3.7 Push Conveying (Plug Conveying)

Using the plug conveying a small amount of air allows a continuous transportation of a big amount of powder. The conveying process takes place in several steps:

- Step 1: Top valve open  
Bottom valve closed
- Step 2: Top valve closed  
Bottom valve closed
- Step 3: Pressure impulse is fed into the chamber
- Step 4: Bottom valve is opened  
Powder is pushed out under pressure
- Step 5: Bottom valve is closed

The powder falls into the pressure chamber under gravity. Using ideal settings on the conveying system, only a small amount of air is fed into the powder, so that no separation elements have to be installed at the end of the line. The powder is pushed and not flushed by air. The pushing conveyance is used then, when bigger amounts of powder of 4-6 kg/min, have to be transported with a small amount of air. The conveying distance can be up to 30 m. A separation of the powder-air-mix is not necessary anymore at the point of use.



Push conveying with Mono-cyclone

### 3.8 Mass Conveyors in Comparison

Criteria	High-output injector	Pushing Conveyor
Size	Very small	small
Assembly	Directly at the container	Directly at the container
Air consumption	10 Nm <sup>3</sup> /h	1 Nm <sup>3</sup> /h
Separation powder-air-mix	with a dropping cyclone	not needed
Colour change	suitable	suitable
Price	favourable	mid-priced
Costs of operation	small	small

## 4. The separation of the Powder-Air-Mix

Respecting the safety rules, the suction of the powder out of the powder booth normally takes place with big air quantity. Before the powder can be returned to the powder container, the air has to be separated from the powder. Separating devices such as mono-cyclones, multi-cyclones, cartridge filters, or plate filters are used.

### 4.1 The Mono-cyclone

The Function:

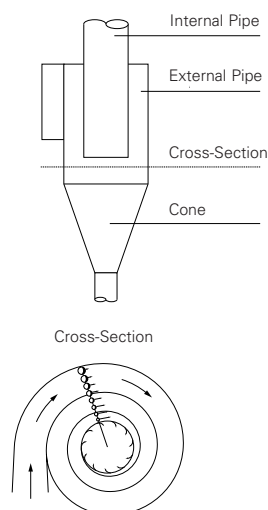
The cyclone makes use of the physical law of centrifugal force. The powder particles enter the cyclone tangentially and are catapulted to the outer wall by the rotation. With help of the spiral moved air, the powder particles are moved in direction of the cyclone exit, where they are collected. The lighter air is sucked through the plunger tube. In general following applies: the higher the entry speed, the smaller the diameter of the cyclone and the bigger the powder particles the higher the separation level. Air sucked through leaks result in bad separation levels.

The advantages:

- well-priced separation system and suitable for color changes

The disadvantages:

- big particles are separated better than small particles
- change in the granular spectrum
- separation level 90 - 97% (3 - 10% loss)
- possibility of powder sintering (max. air speed 20 - 22 m/sec.)
- voluminous, big construction height
- piping necessary between booth and cyclone entrance



Function scheme of Mono-cyclone

## 4.2 The Multi-Cyclone

The Function:

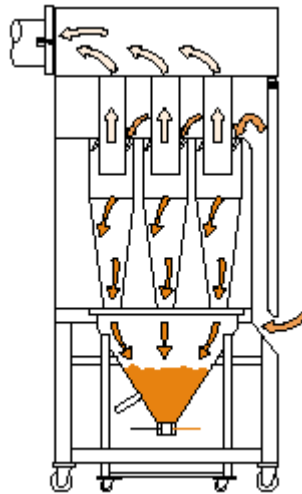
The principle of separation is the same as with the mono-cyclone. By separating the air to several, smaller cyclones, the construction height is reduced to approx. 2.5m, processing similar air quantities. The air entry into the cyclone is not tangential. The rotation of the air is attained with installed guiding-elements.

The advantages:

- low, compact, construction and easy, controllable cleaning.  
It is also assembled directly at the booth wall.

The disadvantages:

- the different cyclones interfere with each other, which results in a lower separation level
- tendency to sinter in the guiding element
- higher energy consumption



Function scheme of Multi-cyclone

### 4.3 The Plate filter

The Function:

For the separation of powder in the plate filter, sintered and porous plastic materials are used. To reduce the porosity the surface is coated with teflon. The powder is separated in the filter and the cleansed air is sucked away with a ventilator. During the process, the filter cake grows continuously, which increases the resistance and lowers the air quantity. Cyclical pressure impulses clean the plate filter from inside and the filter cake is repulsed.

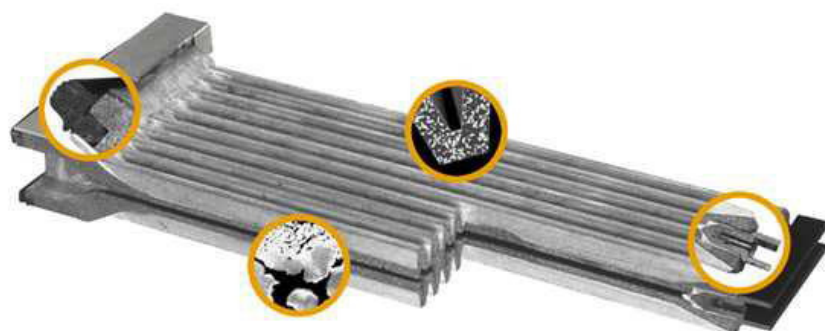
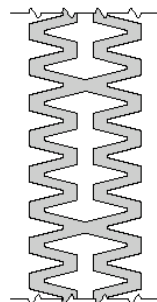
The advantages:

- robust, long-life filter material
- very high separation level (near 100 %)
- compact construction
- suitable for various, even abrasive, materials

The disadvantages:

- not suitable for color changes
- high energy consumption

Cross-Section through a filter plate



Cross-Section through an element of a filter plate

#### 4.4 The Cartridge filter

The function:

Cartridges are cylindrical filters with continuously folded filter materials. To filter, a filter cake is built up, which is blown off in cycles. To clean the filters, compressed-air jet systems or rotating wing cleansers are used. The cleaning results in the cavities of the folds is problematic.

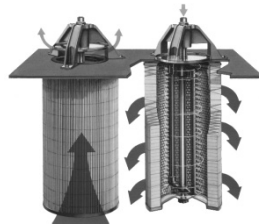
The advantages:

- high level of separation
- low resistance
- high air output, low filter dimensions

The disadvantages:

- cartridges are prone to wear
- not suitable for color changes
- sensitive to moisture
- danger of clogging when using finely particled dust

Cleaning system with rotary wings



Integration of plate filters in manual booths

#### 4.5 The comparison between cyclone- and filter separation

Criteria	Monocyclone with After Filter	Multicyclone with After Filter	Plate Filter	Cartridge Filter
Lev of separat.	90 – 97 %	90 – 96 %	> 99 %	> 99 %
Colour change	yes	yes	no	no
Air through put	big	big	big	big
Air resistance	middle– high	high	high	middle
Area of use	Pre-Separator	Pre-Separator	Main-/After Filter	Main-/After Filter
Absolute filter	needed	needed	no	recommended
Working Life			> 5'000 Std.	2'000 Std.

## 5. The Powder Preparation

The recovered powder and partly the Fresh Powder has to be cleaned from fibres, coarse particles and dirt before use. Mechanical sieves with different mesh densities are used for this purpose. Following requirements should be fulfilled by sieving machines:

- Separation of powder and undesired dirt
- Dissolution and sieving of clumps of powder
- Carry out of dirt

Depending on the quality requirements, different sieve-machine types are used.

### 5.1 The vibration sieve

The Function:

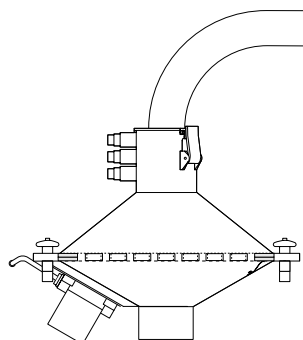
The powder is led on to a vibrating sifter mesh. The combination of horizontal- and vertical movements has the powder fall through the sieve. The waste particles are held back. **Most vibrating sieves do not have an appliance to automatically extract the waste.** The waste has to be sucked away manually from time to time.

The advantages:

- well-priced, simple sieve appliance
- easy to clean
- low wear and tear / low on maintenance

The disadvantages:

- no automatic waste extraction
- sieve mesh 300 - 500  $\mu$
- not suitable for high quality requirements



Vibration sieve on powder center

## 5.2 Mono-cyclone with built-in vibrating sieves

The function is the same as above. The sieve is built directly into the cyclone.



Vibration sieve on the Monocyclone

## 5.3 Rotary sieve

The function:

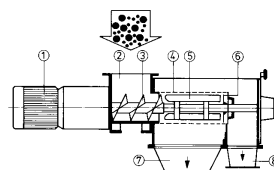
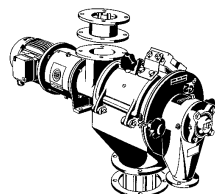
The powder particles are catapulted through the sieve basket using centrifugal force. The in-feed of the powder takes place continuously by a screw into the spinning wings. The dirt particles are conveyed to the dirt extraction exit.

The advantages:

- automatic dirt extraction
- mesh strating from 200 $\mu$  possible

The disadvantage

- color change time-staking
- a lot of moving parts
- high maintenance
- continious in-feed necessary



Cross-Section through the rotary sieve

## 5.4 The Wobbling sieve

The function:

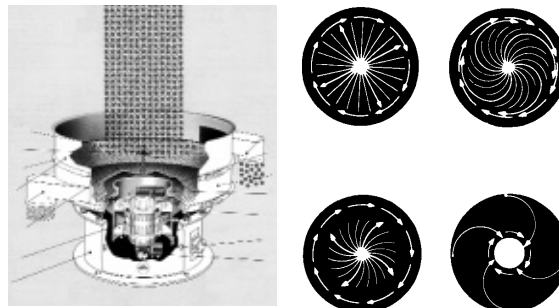
The wobbling sieve is used, when high quality is required. The clearly defined, and preset wobbling movements, have the powder settle in the centre of the sieve, and the waste particles are brought the rim of the sieve, where they are automatically separated.

The advantages:

- automatic waste extraction
- mesh of 120  $\mu$  possible
- preserving powder conveying

The disadvantages

- color changes very time-taking
- large-sized machine
- high investment costs



Cross-Section through the wobbling sieve

### 5.5 The Ultrasonic sieve

The function:

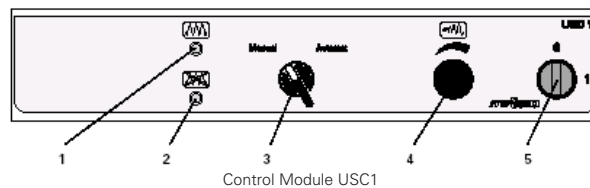
The mesh is equipped with an ultrasonic-head. The ultrasonic waves prevent the sintering on the mesh. This allows a steady and complete availability of the mesh.

The advantages:

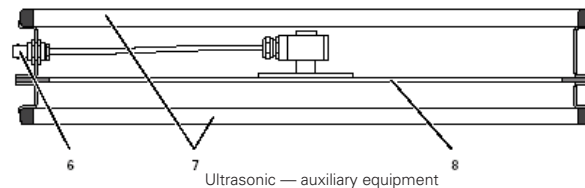
- mesh up to 120 μ possible

The disadvantage:

- is only available in combination with vibrating screens or wobbling sieves
- ultrasonic head is sensitive to mechanical damage



- 1 Oscillation ON-indicator (green)
- 2 Disturbance indicator (red)
- 3 Switch for Operation-mode manual/automatic
- 4 Amplitude-Setting/Potentiometer
- 5 Main Switch — ON-OFF



- 6 HF socket
- 7 Rubber Seal
- 8 Ultrasonic Sieve Assembly Unit

Function scheme Ultrasonic sieve

### 5.6 The choice of mesh

The quality attained by sieving depends on the choice of the mesh and the process of sieving., i.e. vibration screens or rotating sieves. Vibrating screens need greater sieve surfaces in comparison to rotating sieves, based on equal output.

### 5.7 The sieves in comparison

Criteria	Vibrating screen	Vibrating screen with ultrasonic	Rotating sieve	Wobbling sieve	Ultrasonic sieve
Sieving quality	Sufficient	Very good	Good	Very good	Very good
mesh	300 – 500 μ	120 – 250 μ	200 – 300μ	120 – 250 μ	100 – 200 μ
waste extraction	no	possible	automatic	automatic	possible
colour changes	yes	yes	conditional	no	yes
maintenance	small	little	average	little	little
commissioning	easy	easy	easy	complicated	easy

## 6. Powder Preparation in Containers

As the powder is neither fluid nor does it trickle, it cannot be transported from the container without any further measures. The powder has the tendency to build bridges and agglomerations, that can be prevented using suitable measures.

Following technical solutions are used nowadays:

- preparation with stirrers
- preparation by fluidification
- preparation by fluidification 0.4

### 6.1 The stirrers

The function::

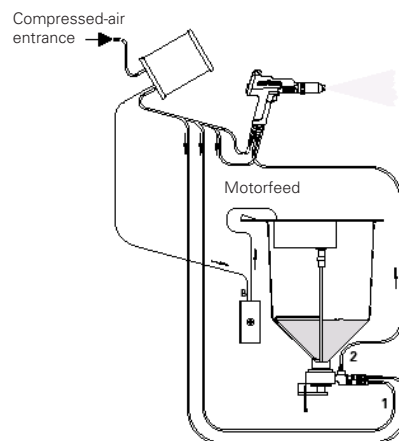
With help of the stirrers the bridge building can be prevented. The stirrer can be used for all types of powder. It is specially suited for powder which is difficult to fluidize as well as powder-mixtures, containing several components, e.g. metallic.

The advantages

- suitable for all powders, small or big amounts
- constant powder conveyance (direct suction from the bottom)
- no change in granular spectrum

The disadvantages

- additional mixer feature (maintenance)
- expensive (Investment)
- limited number of guns (12)



Manual Powder System Easy-S

## 6.2 The fluidizing container

The function:

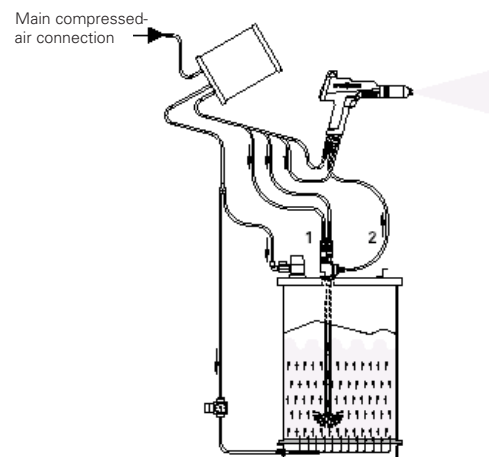
Fluidizing is the most popular method of powder preparation. Compressed air streams through the porous floor of the container and keeps the powder in a suspended state. Depending on the quality of powder, additives and spread of granular size, the powder tends more or less to clump. As a result channels and craters are formed, which can hinder a constant powder flow through the injector. The tendency of irregular fluidification is increased, when the powder sinks during a plant stop, and the plant is restarted. A suitable pre-fluidification can prevent this effect. The volume of the fluidized powder increases by the factor 2, which means that the container can only be half-filled when in rest, so that it does not overflow during operation.

The advantages

- simply, well-priced construction
- can be cleaned for color changes
- easy access to the injector connections on the cover

The disadvantages:

- Bridge-/Crater formations
- powder de-mixing
- output of powder depends on material level
- regular fluidification in big containers is difficult.



Manual Powder System Easy-F

### 6.3 Container with combination Fluidification / Vibration

The function:

To relieve the disadvantages of fluidizing containers, the powder preparation is assisted with additional vibrations. The formation of clumps and craters is prevented.

The advantages:

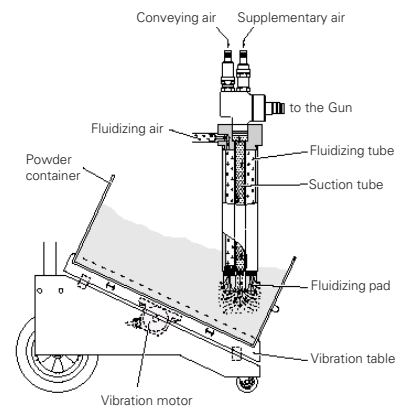
- constant, regular fluidification
- also suitable for powder with fine granular spectrum

The disadvantages:

- higher costs of investment
- incorrect vibrations can lead to solidification of the powder



Fluidizing/Suction Unit



Manual Powder System Easy-B