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INDUSTRIAL PLANTS

Chapter twenty-two:

Special conveyors for bulk materials

DOUBLE DEGREE MASTER IN

“PRODUCTION ENGINEERING AND MANAGEMENT”

SEAT OF PORDENONE

UNIVERSITY OF TRIESTE

Vibrating conveyors

The **vibrating conveyors** are devices that employ mechanical vibrations for the handling of bulk materials. They have the advantage of minimizing the noise in factories and generate a cyclic sequence work very constant.

Vibrating conveyors

The displacement is generated by motion-vibrators inside of channels, called "vibrating channels", which are supported by an elastic system.

The system used to generate the movement system is a free oscillation unidirectional, in that the vibrating force is directed along one direction in an alternative way sinusoidal in time.

Vibrating conveyors

The motion is expressed by the simple harmonic law, characteristic of a harmonic oscillator in the case is neither *forced* nor *damped* by external forces, which defines the displacement of the channel from the rest position at the time t (x(t)):

$$\mathbf{x(t) = A \cdot sen\ (\omega \cdot t)}$$

where:

A = vibration amplitude of the canal;

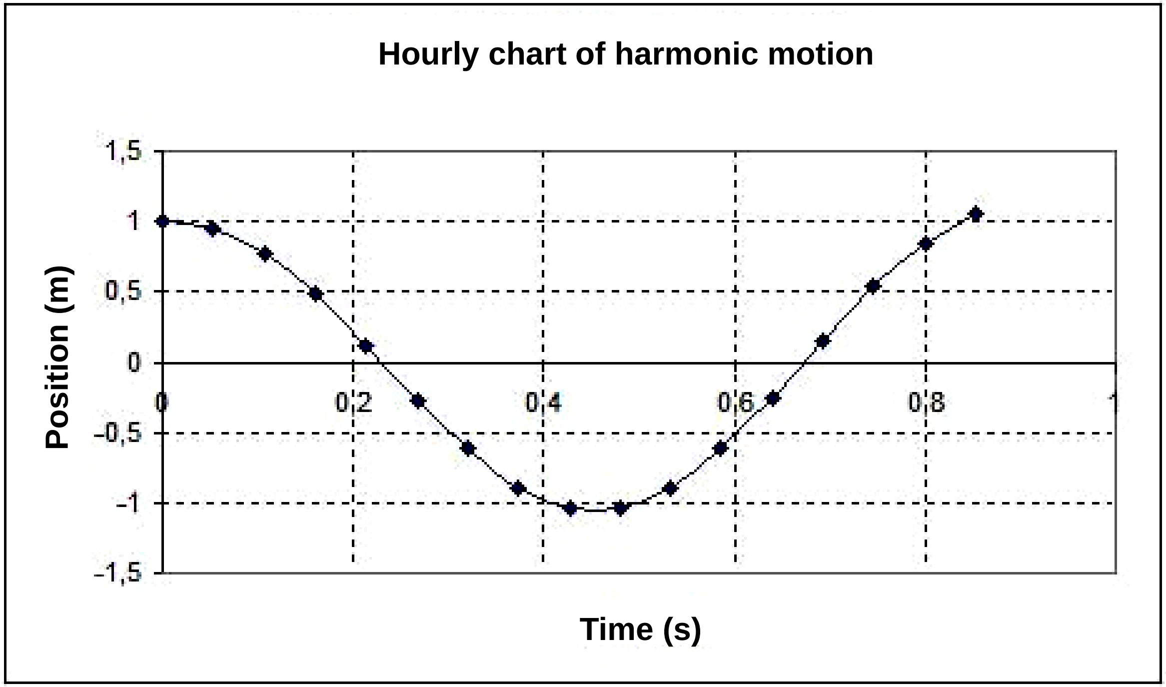
ω = pulsation of the vibration of the canal, defined by the relation:

$$\boldsymbol{\omega = 2 \cdot \pi \cdot f}$$

f = frequency of the vibration of the canal.

Vibrating conveyors

The time law of motion is a sinusoidal law, the position x varies as a function of time t as a breast or a cosine (the two functions have the same shape, only changes the initial position).



Vibrating conveyors

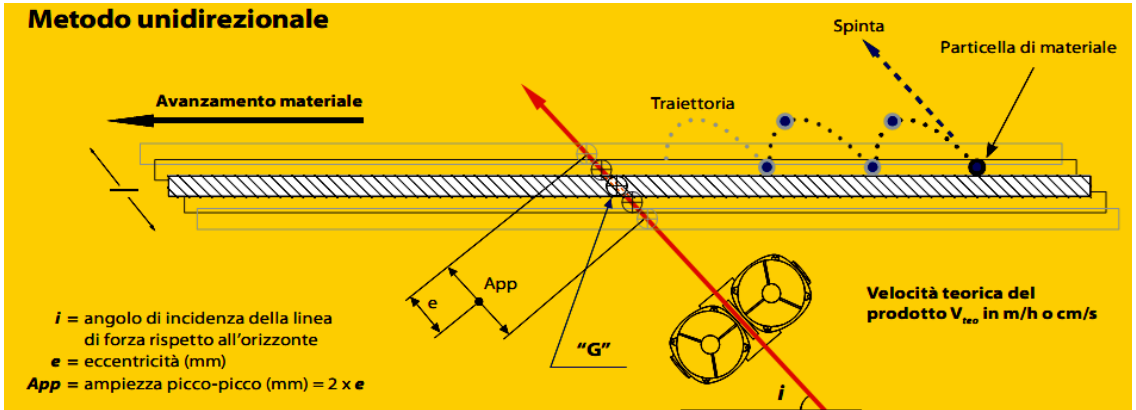
Since in simple harmonic motion, in form, the forward speed is equal to that of return, to obtain the advancement of the solid material A (vibration amplitude) and ω (pulsation of the vibration**)** must have values such that the material comes off from the channel and remains in small jumps.

In fact you follow these three steps:

a) the canal and the material move forward together;

b) when, in absolute value, the vertical component of the deceleration of the canal exceeds the acceleration of gravity, the material is detached from the same making a parabolic trajectory, while the channel continues its motion;

c) after a certain time the canal, which is no longer in the descending phase, and the material will meet, and the cycle is repeated.

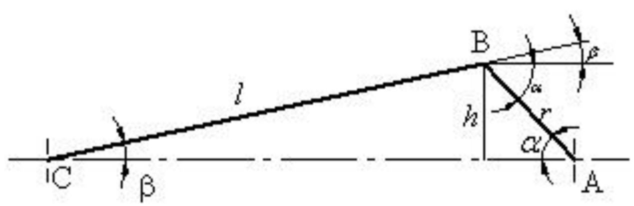


Vibrating conveyors

There are three systems that are used for this type of conveyors:

a) to connecting rod and crank

They consist essentially of a frame on which rests via steel wheels, the cart power, which, sliding alternately forwards and backwards, causes the advancement of the material itself. The stroke of the carriage is adjustable and is given by a connecting rod-crank driven by a motor-reduction unit



Vibrating conveyors

There are three systems that are used for this type of conveyors:

b) to eccentric masses

They consist essentially of a canal in sheet, suspended from the fixed casing by means of anti-vibration rubbers, and set in motion by means of two eccentric shafts driven by an electric motor by means of the belts. They have a continuous power supply with constant potentiality and allow the machine to work at full throttle. They are used to secondary supply of gravelly alluvial or pre-crushed

Vibrating conveyors

There are three systems that are used for this type of conveyors:

c) electromagnetic

The vibratory motion is produced by an electromagnet, which allows to do vibrate a plate constrained to move according to a rectilinear motion. The oscillation frequency is 50 Hz, although it is sometimes possible to have values of 25 Hz that allow the transport of fragile and scaly materials without damaging them. They are often used for solving problems of manual sorting of materials transported.

Vibrating conveyors to resonance

Are conveyors at mechanical control operated by one or two vibrators or by a vibrator to piston rod groups with reagents of resonance in rubber or steel springs. Have widths varying from 300 mm to 2 m, with lengths of up to 30 m.

They are suitable for the transport of abrasive materials, hot and aggressive, for the transport of materials in a closed cycle or in an inert atmosphere.

Permit the construction, during transport, the processes of cooling or drying.

Transporting fragile materials and scaly, without damaging them and can be equipped with exhaust mouths intermediate.

Vibrating conveyors to resonance

Transporting materials even in large size with temperatures around the 1000-1200°C in the steel industry (ad example in a foundry are used for the transport and the cooling of the castings remove by bracket or for the supply of melting furnaces for brass with various scrap).

Vibrating feeders and extractors

The **vibrating feeders** are used to extract the product and dose it with precision.

They have an electronic control that allows you to continuously adjust the flow of material. Are employed in the composition of mixtures in the chemical industry and of the cement.

Vibrating feeders and extractors

The **vibrating conveyor tubular** is an alternative to the auger conveyor with propeller of transport of bulk materials. The product runs on the machine due to the vibration without alteration and with limited wear. The assembly and sealing the powder of these machines are simple. The vibrating conveyor tubular can be equipped with a motor or electromagnetic vibrators or electric vibrators.

Vibrating feeders and extractors

The **movable vibrating feeders** are ideal for charging scrap and additives for electric furnaces for melting ferrous and nonferrous

Vibrating feeders and extractors

The vibrating feeders and extractors are vibrating conveyors whose channel is wound spirally around a tubular column carrier.

The material is high advancing for successive jumps, allowing to raise delicate products that must not breaking during transport (ad example, flakes and expanded - enamels, resins, ceramics etc.).

They are also used to elevate explosive or flammable products that shall be handled with extreme caution and without the danger of sparks and/or explosions.

Are widely used as conditioners vibrating and this thanks to the fact that, in view of the spiral development of the channel, have long runs, so long residence times which facilitate the operations of heat exchange.

Vibrating feeders and extractors

To solve problems of drying and/or cooling are used in the chemical, pharmaceutical, food, plastics and rubber, with hot or cold air flows, or with interspaces of circulation of water or steam. Closed in a hood static are also suitable for working in an atmosphere of inert gases.

Vibrating feeders and extractors

The potential of transport Q of this type of conveyor is expressed by the relation:

$$Q = \gamma \cdot k_1 \cdot k_2 \cdot v_m \cdot B \cdot H$$

where:

γ = specific weight absolute of the material;

k_1= experimental coefficient, that takes into account various parameters, which tend reduce the potentiality of the conveyor (humidity, particle size, shape of the material, temperature, chemical composition, height of the state of the material). The values are close to 0.75;

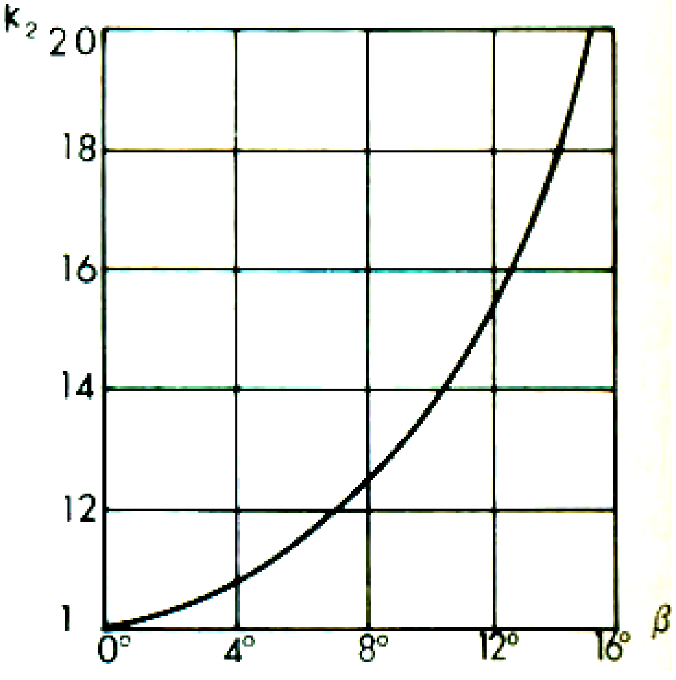
Vibrating feeders and extractors

The potential of transport Q of this type of conveyor is expressed by the relation:

$$Q = \gamma \cdot k_1 \cdot k_2 \cdot v_m \cdot B \cdot H$$

where:

k_2 = coefficient, which takes account of the increase in potentiality rate due to the possible slope of the canal β and whose values are detectable by the following diagram



Vibrating feeders and extractors

The potential of transport Q of this type of conveyor is expressed by the relation:

$$Q = \gamma \cdot k_1 \cdot k_2 \cdot v_m \cdot B \cdot H$$

where:

v_m = average speed of advance of the material, which is expressed by the relation:

$$v_m = 2 \cdot A \cdot n \cdot F$$

A = vibration amplitude of the canal;

n = number of revolutions per minute, which with respect to the pulsation of the oscillation of the canal ω is equal to: $n = \frac{60 \cdot \omega}{2 \cdot \pi}$

F = parameter dependent on the angle of the jet α and defined by a coefficient k to depending on the number of revolutions per minute will be twice the vibration amplitude of the canal A:

$$F = \frac{\pi}{60} \cdot ctg\,\alpha \cdot \sqrt{sen^2\alpha - \frac{1}{k^2}}$$

Vibrating feeders and extractors

F = parameter dependent on the angle of the jet α and defined by a coefficient k to depending on the number of revolutions per minute will be twice the vibration amplitude of the canal A:

$$F = \frac{\pi}{60} \cdot ctg\,\alpha \cdot \sqrt{sen^2\alpha - \frac{1}{k^2}}$$

with:

$$k = \frac{A \cdot \omega^2}{g}$$

g = acceleration of gravity;

B = canal width;

H = average height of the layer of material.

Vibrating feeders and extractors

In the case suppose to transport of the steel scrap, these have:

γ = 78000 N/m^3;

k_1 = 0,75;

k_2 = 12,5 having a slope of the canal of β = 8°;

A = 0,5 m;

ω = 10 rad/s from which is obtained n = 95.5 rounds/minute;

α = 30°;

k = 5,09;

F = 0,016;

v_m = 0,025 m/s;

B = 1,5 m;

H = 0,2 m.

Vibrating feeders and extractors

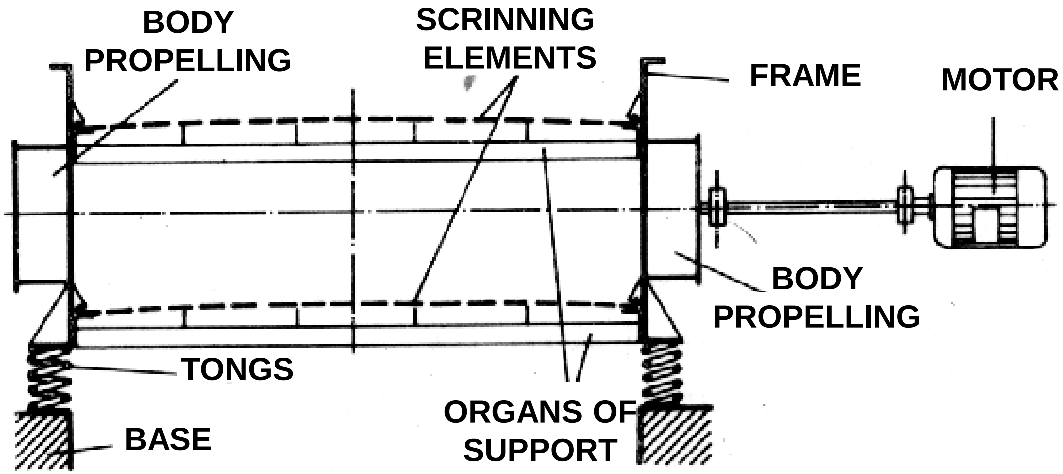
Is therefore a potentiality detectable transport which is equal to:

$$Q = \gamma \cdot k_1 \cdot k_2 \cdot v_m \cdot B \cdot H = 78000 \cdot 0{,}75 \cdot 12{,}5 \cdot 0{,}025 \cdot 1{,}5 \cdot 0{,}2 = 5484 \;\; N/s$$

Vibrating screens

The **vibrating screens** are used to subdivide the bulk materials in certain size classes, to separate solid and liquid products, for washing, to de-dusted for certain products or to clean the pieces cut or turned.

The vibrating screens are constituted by a rigid frame which supports in its interior, suitably spaced between them, the supporting bodies, floors or shaped arc, of the screening elements or planes of screening. The frame is fixed to thruster body, adapted to generate the characteristic motion of vibratory of the system. The scheme of a vibrating screen is:



Vibrating screens

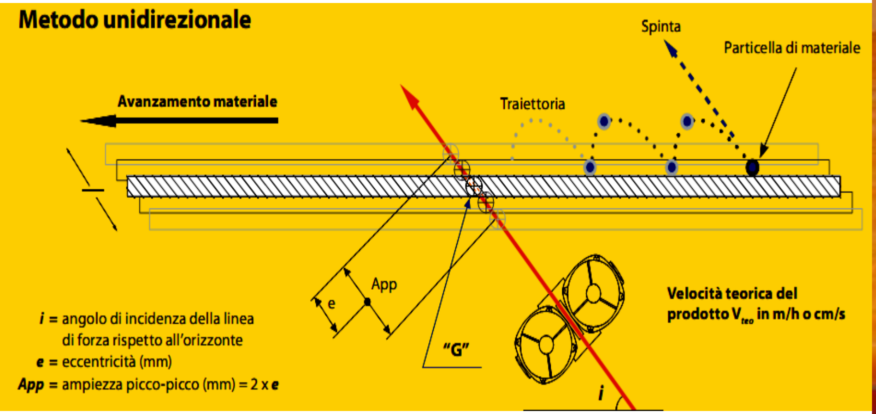
Vibrating screen with polyurethane networks

Vibrating screens

Depending on the type of vibratory motion impressed on them, the vibrating screens are divided into:

- ***vibrating screens unidirectional***

  The motion of all points of the vibrating screen can be reduced to an oscillation of harmonic type, along a direction having a specific inclination (between 0 and 90°) to the vibrating surface



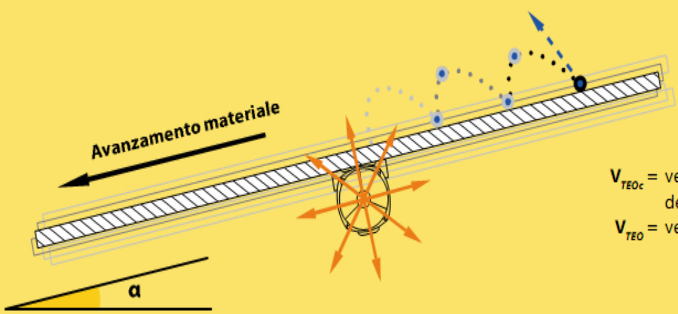
Vibrating screens

Depending on the type of vibratory motion impressed on them, the vibrating screens are divided into:

- ***vibrating screens circular or elliptical***

  The motion of all points of the vibrating screen can be reduced to a motion of circular or elliptical, with trajectories lying in a plane orthogonal to the planes of screening or sifting in the plane of the same

Metodo rotazionale



Velocità teorica corretta del prodotto V_{TEOc} in m/h o cm/s

$$V_{TEOc} = \frac{V_{teo} + V_i}{F\alpha}$$

V_{TEOc} = velocità teorica corretta per tener conto dell'inclinazione della macchina

V_{TEO} = velocità teorica prodotto

Valore stabilito	Valori ricavati in funzione di α		
α	*i*	Fα	V_i
10°	80°	0,81	80
15°	75°	0,71	75
20°	70°	0,60	70
25°	65°	0,48	65
35°	55°	0,25	55

α = angolo di inclinazione della macchina rispetto all'orizzontale
i = angolo di incidenza = 90 - α
Vi = velocità di incidenza (cm/s oppure m/h)
Fα = fattore correttivo per il calcolo della velocità teorica corretta V_{TEOC}
e = eccentricità (mm)

} Ricavabili in funzione di α (vedi tabella a lato)

Vibrating screens

Depending on the type of vibratory motion impressed on them, the vibrating screens are divided into:

- *micro-vibrating screens*;
- *macro-vibrating screens*;

while according to the type of inclination, the same can be distinguished in:

- *plans screens*;
- *inclined screens*: the inclination in the direction of movement of the material can be of 15-20°, so that the advancement of the product on the planes of screening also takes place by gravity.

Will have vibrating screens to one or more baffles of selection, characterized by holes of different sizes.

Vibrating screens

The length and width of the screen depend on:

- quantity and specific weight of material disposed of by the screen;
- geometric configuration of the granules to be treated;
- particle size, moisture and smoothness of the material to be treated;
- hole size of the elements of screening.

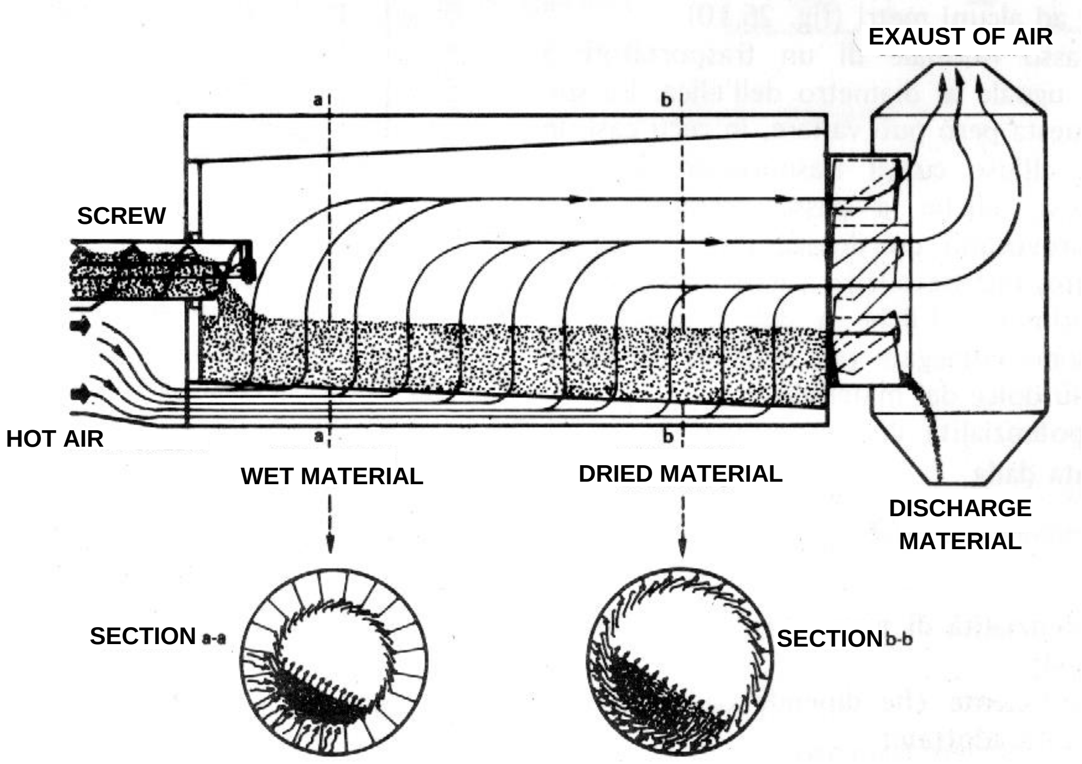
They are divided into a vibrating screens to:

- ***open execution***: is a solution that permits the direct control of the screening, although it is often impractical because it can trigger problems of dust into the environment unless they adopt of the hoods;
- ***close execution***: is a solution that provides for the closure with rigid elements fixed to the supporting structure of the sieve, possibly connected to a suction system. Presents difficulties in monitoring and replacement of the sieving.

Rotating drums

Are used when, next to the transport of certain materials in bulk, it must carry out operations of washing, classification, separation or drying of the same.

Consist of a cylinder, generally inclined downward by a few degrees (<10°) in the sense of the motion, which, rotating around its axis, ago advance the material.



Rotating drums

Rotating drums

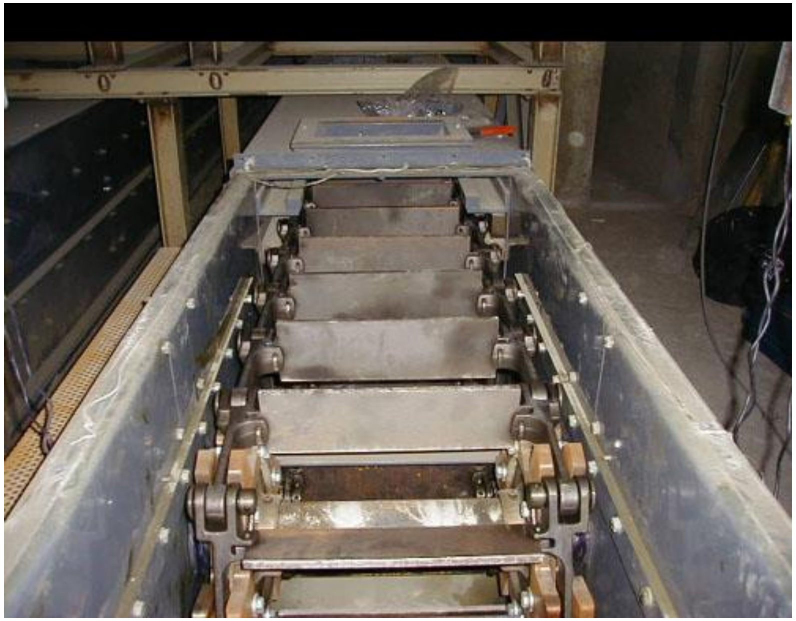
Known the specific weight of the material γ (t/m^3) and the diameter of the drum D (m), the potentiality of the transport Q is defined by the relation:

$$Q = 130 \cdot \gamma \cdot D^{5/2}$$

while the power absorbed from the drum is proportional to the transport potentiality Q and to its length.

Scraper conveyors

Consist of one or two chains which, moving in a sheet metal channel, run through a closed circuit and drag the material in powder form or granular by the opening by the loading up to the discharge.



Scraper conveyors for powder and with steel chain mesh printed

Scraper conveyors

The chains crawl on the bottom or on side rails or supported by wheels which in turn run on special guides. They are equipped with vanes or appendages specific, so that the bulk materials are pushed and dragged at the same time.

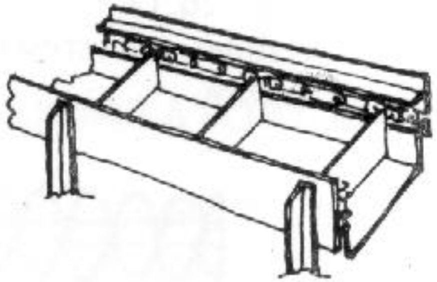
These systems for continuous transport are suitable of lightweight, non-abrasive or fragile materials.

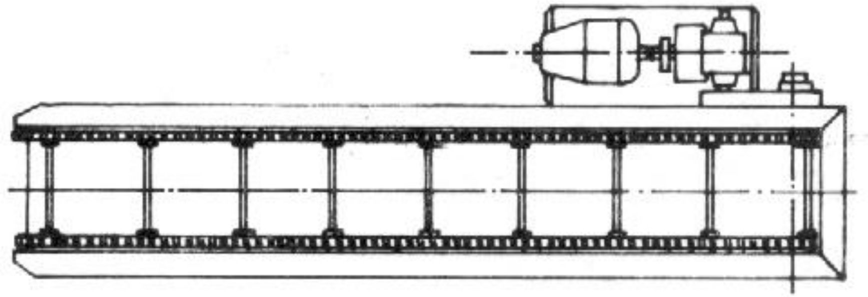
Adherence resulting at the internal friction of the material transported allows to overcome sloping paths, vertical or mixed.

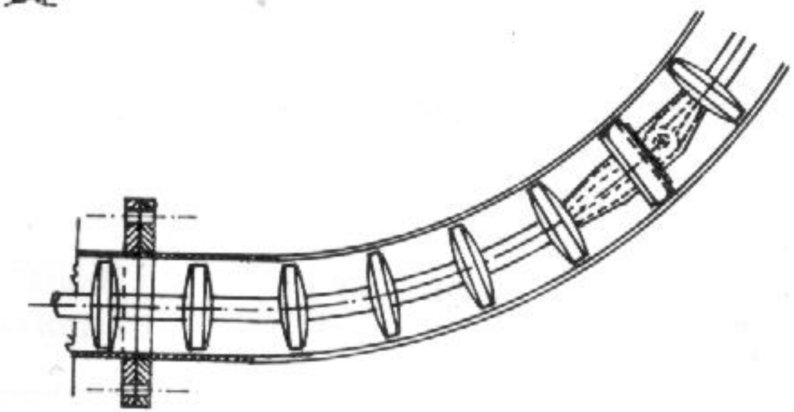
The loading and unloading presents no difficulty.

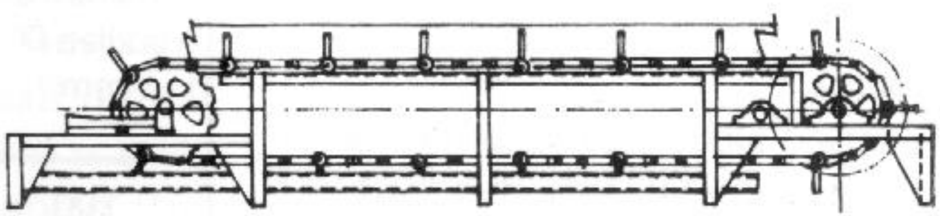
The speeds of the chains scraping vary from 0.1 to 0.5 m/s.

Scraper conveyors









Scraper conveyors

The potentiality of transport depends by:

- coefficient of friction between the chains and the supports;
- additional stress due to sliding of the material against the walls of the canal.

Screw conveyors

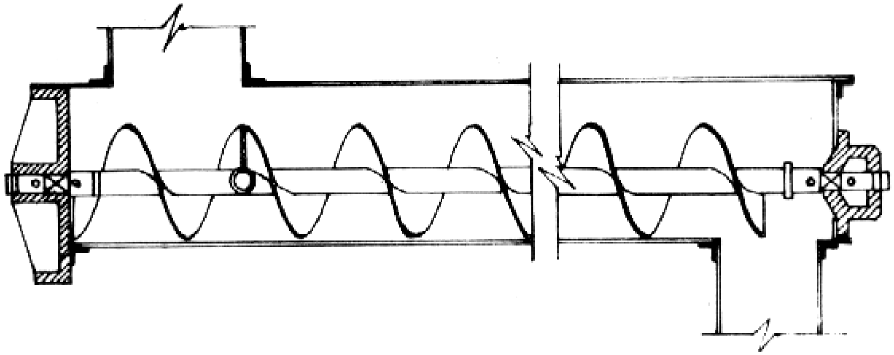
The **screw conveyors** are essentially constituted by a propeller rotating in a circular duct coaxial with a sheet that the encloses: the motion of the propeller pushes the material introduced towards the end.

They are suitable for the transport of materials in powder or having a small particle size, provided that no abrasive or adhesives or viscous.

The screw conveyors are often used for the inside of plant, because, being completely closed, without a transport permit the construction a transport no dust and protected from the weather, also thanks to the limited number of components installed. These machines require minimal maintenance.

Screw conveyors

Screw conveyors



Screw conveyors

Preferably used for transport in horizontal or gently sloping routes, are adopted for vertical or steeply inclined transport, to the detriment of the transport potentiality.

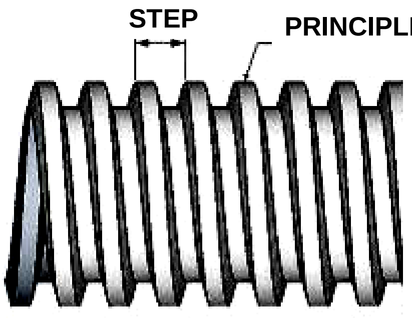
They are used as extractors for powdery materials from silos, hoppers and tanks.

Is also used for the transfer of liquids at different distances and difference in level not exceeding a few meters.

The normal pitch of this type of conveyor is equal to the diameter of the propeller.

In the case of increasing pitch propellers, one has the possibility of dosing the material transported, while those to the decreasing step compress it.

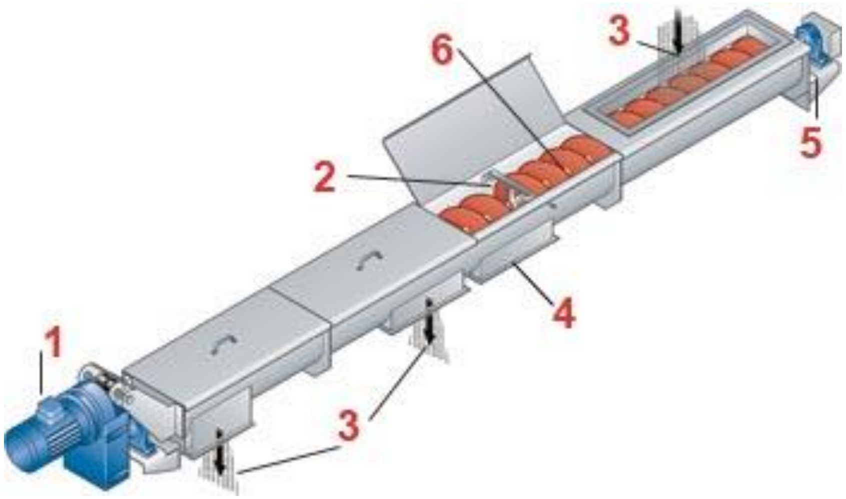
Propellers at two principles are used to obtain a more gentle movement of the material.



Screw conveyors

The characteristics of a screw conveyor are:

1) **group of comand**, composed of motor-reducer to parallel axis directly coupled to the motor shaft with a torque arm and rubber damper. Alternatively, the operator can be realized with a belt drive or chain drive;

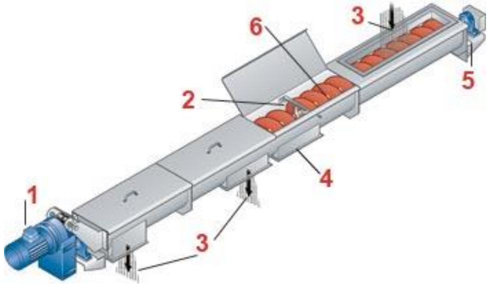


2) **intermediate supports**, are used to limit deflection of the shaft, avoiding contact between the coils and the interior of self-lubricating or be lubricated from outside, while the connection between the two lengths of tree is realized with plugs bolted or with special anchors that allow pull the pin without pull the tree;

Screw conveyors

The characteristics of a screw conveyor are:

3) **mouths of loading/unloading flanged**, prearranged for the connection to other machines;
4) **hatches cleaning**, easily removable to allow cleaning the inside of the conveyor and are applied in the case of transport of materials particularly encrusting;
5) **supports of header**, may be of the type standing decomposable placed on special saddles or flanged made of cast iron. The seal between the shaft and head can be realized through adjustable gland packings or by flushing with air for special applications;
6) **spirals**, can be printed in sectors or in continuous, at constant or variable thickness. The materials most commonly used are: carbon steel (S235JR, S275JR, S355JR), stainless steel (AISI 304, AISI 316 and series 400) and wear resistant steels (T1, Hardox 400, Creusabro 321, 4800 and othersi).



Screw conveyors

Suppose to sizing a system with a propeller continues and with normal pitch equal to the diameter (p = D) and of carrying alumina powder of the specific weight of pile γ_m = 8000 N/m^3, in a horizontal trajectory (slope δ = 0°) of length of L = 20 m and with a potential of 5 kN/h.

To a screw conveyor that operate at full section, the potentiality can be expressed by the relation:

$$Q = \frac{\pi \cdot D^2}{4} \cdot p \cdot n \cdot \gamma_m \cdot \alpha \cdot \frac{600}{1000} \quad (kN/h)$$

where:

D = propeller diameter (m);

p = pitch of propeller (m);

n = number of propeller revolutions per unit time (revolutions/minute);

α = filling ratio, which, for pourable materials in non-abrasive grains and small pieces powder (Zignoli, table CCCXXII – class II), is 0,3.

Screw conveyors

Classi – Materiali – Coefficienti α e β

Classe I: **Materiali in polvere, non abrasivi facilmente scorrevoli**

peso specifico $\gamma = 0{,}4 \div 0{,}6$ t/m³

riempimento $\alpha = 0{,}4$

Materiale	γ t/m³	Coeff. *B*
Calce in polvere aerata idrata	0,70	1,2
Carbone polvere	0,60	1,2
Crusca	0,25	0,8
Farina di frumento	0,65	0,8
» di lino e simili	0,70	1,2
Orzo in grani	0,60	0,8

Classe II: **Materiali scorrevoli non abrasivi in grani e piccoli pezzi con polvere.**

Peso specifico $\gamma = 0{,}6 \div 0{,}8$ t/m³

riempimento $\alpha = 0{,}3$

Materiale	γ t/m³	Coeff. *B*
Allume polvere	0,8	1,2
Calce idrata	0,3	1,6
Carbone pisello	0,75	1,8
Grafite grani	0,60	0,8
Grani di cacao	0,65	0,8
» caffè	0,68	0,8
» cotone	0,80	1,2
» fave	0,80	1,0
» frumento	0,65	1,0
» soia	0,80	1,0

Classe III: **Materiali semiabrasivi in pezzi mescolati a polvere (non molto consigliabili).**

Peso specifico $\gamma = 0{,}9\text{-}1{,}2$ t/m³

riempimento $\alpha = 0{,}25$

Materiale	γ t/m³	Coeff. *B*
Allume in grani	0,96	2,8
Asbesto in grani	0,40	2,0
Borace in grani	0,85	1,4
Burro	0,95	0,8
Carbone nocetta	0,80	2,0
Gesso calcinato grani	0,98	2,4
Lignite in grani	0,80	2,0
Lardo	0,95	0,8
Orzo tallito	0,95	1,2

Classe IV: **Materiale abrasivo in polvere, semiabrasivo in pezzi misti a polvere.**

Peso specifico $\gamma = 0.8\text{-}1.6$ t/m³

riempimento $\alpha = 0{,}20$

Materiale	γ t/m³	Coeff. *B*
Asfalto in pezzi	1,3	4,0
Bauxite polvere	1,4	3,6
Cemento polvere	1,3	2,8
Creta in polvere	1,2	2,8
Farina d'ossa	0,95	3,4
Feldspato polvere	1,10	4,0
Dolomite	1,40	4,0
Grani di ricino	0,60	1,0
Nerofumo	0,40	3,4
Resine sintetiche	0,65	2,8
Sabbia di fonderia	1,5	4,0

Classe V: **Materiale abrasivo in pezzi e polvere. Talvolta si usano coclee a 2-3 principii.**

riempimento $\alpha = 0{,}12$ perchè il materiale non deve toccare i supporti

Materiale	γ t/m³	Coeff. *B*
Polvere alto forno	1,6	7
Scorie asciutte	0,65	8
» bagnate	0,80	10
» di cinerario	0,70	7

Classe alimentatori: **In questo caso il materiale deve riempire la sezione e deve essere polverulento e scorrevolissimo.**

Portata in m³ all'ora per ogni giro di coclea normale

Diam. coclea (mm)	Diametro albero mm: 42	60	75	90
	portata in m³ ora per giro di coclea al 1′			
150	0,150	0,140	0,130	
200	0,540	0,520	0.500	
250	0,750	0.750	0,700	
300	—	1.300	1,260	1,20
350	—	—	2,060	2,0
400	—	—	—	3,0
450	—	—	—	4,30

NB. — Passando dalla classe I alla V l'uso della coclea diventa sempre meno conveniente. È consigliabile usarla per i materiali della classe I e II.

Screw conveyors

Table CCCXXII

Maximum permissible speed for the various classes of materials, degree of filling and the coefficients A and B

Outer diameter of the screw *D* mm	Maximum speed n in revolutions to the first for the classes					Coefficient of construction A for bearings			
	I	II	III	IV	V	Ball bearings	Bronze bearings well lubricated	Bronze bearings porous	Stellite bearings
100	180	120	90	70	31	0,012	0,021	0,033	0,051
150	170	115	85	68	30	0,018	0,033	0,054	0,078
200	160	110	80	65	30	0,032	0,054	0,096	0,132
250	150	105	75	62	28	0,038	0,066	0,114	0,162
300	140	100	70	60	28	0,055	0,096	0,171	0,246
350	130	95	65	58	27	0,078	0,135	0,255	0,345
400	120	90	60	55	27	0,106	0,186	0,336	0,480
450	110	85	55	52	26	0,140	0,240	0,414	0,585
500	100	80	50	50	25	0,165	0,285	0,510	0,705
600	90	75	45	45	24	0,230	0,390	0,690	0,945

Screw conveyors

Having chosen P = Q, the equation reduces:

$$D^3 \cdot n = 4{,}42 \text{ m}^3 \text{ revolutions/minute}$$

Recalling that the same table CCCXXII of Zignoli is detected for class II:

D (mm)	n_{max} for class II (giri/minuto)	$D^3 \cdot n$ (m^3 revolutions/minute)
350	95	4,07
400	90	5,76
450	85	7,75

Is chosen so a diameter D of the screw of 400 mm, which corresponds to a number of revolutions n = 69 revolutions/minute.

The motor moment must equal the torque moment on the tree of screw and is:

$$M_t = 28{,}6 \cdot (A + B \cdot Q/n) \cdot L \quad (\text{N m})$$

Screw conveyors

From the table CCCXXII of Zignoli, is obtained for that value of the coefficient of filling α = 0,3:

A = coefficient of effort dependent on the shape of the screw (for ball bearings) = 0,106

B = coefficient of effort depending on the material (alumina) = 1,2.

Ultimately:

$$M_t = 28{,}6 \cdot (0{,}106 + 1{,}2 \cdot 0{,}5/69) \cdot 20 = 65{,}6 \text{ N m}$$

value that is amply less than the limit value admitted to a conveyor with a diameter D of 400 mm (1800 N m).

The power absorbed by the electric motor is:

$$P_{ass} = M_t \cdot \frac{2 \cdot \pi \cdot n}{60 \cdot \eta \cdot 102} = M_t \cdot \frac{2 \cdot \pi \cdot 69}{60 \cdot 0{,}88 \cdot 1000} = 0{,}54 \text{ kW}$$

with:

η = performance of the gearbox and electric motor.

Screw conveyors

Imputing conservatively all friction to a contact material-conducted in sheet, the propeller shaft will be compressed by a force R such that, multiplied by the speed of translation of the material, is responsible for all the useful power required:

$$R = \frac{P_{utile}}{v} = \frac{P_{ass} \cdot \eta \cdot 60 \cdot 1000}{n \cdot D} = \frac{0{,}54 \cdot 0{,}88 \cdot 60 \cdot 1000}{69 \cdot 400} = 1{,}03 \text{ kN}$$

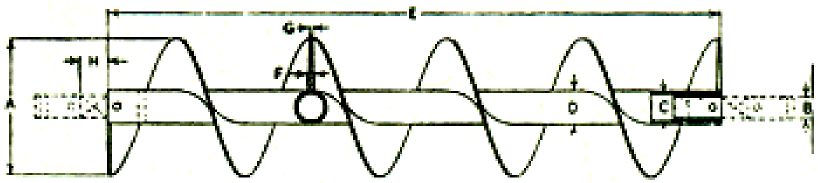
One can then use of the normalized tables to determine all the characteristic dimensions of the carrier (external/internal diameter of the shaft, thickness of the hub and the periphery of the propeller, length of a section, diameter and length of the joint, diameter of the two coupling bolts , length of the pin, weight of a section etc. (table CCCXX of Zignoli).

Based on these data, it is possible to determine the number of sections needed and the total weight of the conveyor.

Screw conveyors

TAB. CCCXX – **Normal screw conveyor**

Element of the normal screw conveyor



Diameter A mm	Length of the section E mm	Weight of the section kg	Shaft diameter D/C mm	Joint diameter B mm	Length of the joint l mm	Diameter of 2 bolt of the joint mm	Thickness of the propeller F mm	Thickness of the propeller G mm	Length axle H mm	Moment trasmitted M_t kg.cm	Power trasmitted at 100 revolutions HP
100	2400	12 15	12/32	25	300	1/2''	3 4,5	2 2,5	40 40	920 920	1,5 1,5
150	2500	24 28 33	60/50	38	350	5/8''	3 6 9	1,5 3 5	50	3 500	5
225	2500	45 55 65	60/50 75/65 75/65	38 50 50	350 400 400	5/8'' 5/8'' 5/8''	9 9 12	5 5 6	50	3 500 7 000 7 000	5 10 10
250		38 60	60/50 75/65	38 50	350 400	5/8''	5 9	2,5 5	50	3 500 7 000	5 10
300	3500	82 90 105	75/65 78/90 98/100	50 60 75	400 450	5/8'' 3/4'' 7/8''	9 9 12	5 5 6	50 75 75	7 000 10 700 18 000	10 15 25
350	3500	80 115	78/90 88/100	60 75	450 500	3/4'' 7/8''	6 11	3 5	75	10 700 18 000	15 25
400	3500	105 145	88/100 100/115	75 88	500 550	7/8'' 1''	8 12	4 6	75	18 000 18 000	25 25
500	3500	160 220	88/100 100/115	75 88	500 550	7/8'' 1''	6 9	6 9	75 100	18 000 30 000	25 41
600	3500	230 270	100/115 100/115	88 88	500 550	1'' 1''	6 9	6 9	100 100	30 000 30 000	41 41