TRANSPORTASI PADATAN

Materi transportasi padatan meliputi :

1. Alat pengangkut,
2. alat pengumpan,
3. alat penyimpan.

Pustaka : Brown, 1954, Unit Operations.
Perry, 1997, Chemical Engineers Handbook, 7th ed.
Wallas, 1988, Chemical Processess Selection & Design.

ALAT PENGANGKUT PADATAN

Sumber : Perry 7th ed.

Berdasarkan prinsip pengangkutannya, alat transportasi padatan dibedakan menjadi 2:

1. prinsip pengangkutan horizontal, disebut conveyor.
2. prinsip pengangkutan vertikal, disebut elevator.

Berdasarkan system atau cara pengakutan digolongkan menjadi 3 macam :

1. Mekanis :
    a. sistem scraper (mendorong)
    b. sistem carrier (mengangkut atau membawa)
2. Pneumatis : pengangkutan menggunakan udara,
    a. Pressure system,
    b. Vacuum system,
    c. Pressure & vacuum system.
3. Hidrolis : pengangkutan menggunakan air.

Pemilihan conveyor : Standardized equipment design.

Faktor-faktor pemilihan conveyor :

1. Kapasitas
   Belt conveyor : dapat digunakan dengan kecepatan tinggi, tonase banyak.
   Screw conveyor : lebih lambat.
2. Jarak :
   Belt conveyor : dalam mil.
   Air conveyor : s/d 305 m (1000 ft).
   Vibrating conveyor : ratusan meter.
3. Ketinggian
   Vertikal : bucket elevator
   Jika diinginkan vertical dan horizontal : kombinasi elevator & conveyor.
4. Sifat material: sifat utama yaitu flowability, Tabel 21-3 (Perry 7th ed.)
5. Proses yang diinginkan selain pengangkutan :
   Pendinginan, pemanasan, pencampuran, pencucian(dewatering), screening, kristalisasi.
6. Umur alat : belt conveyor yang panjang dengan standar kualitas tinggi beumur mencapai 35 th. Biasanya 10 th.
7. Harga.
   Motor penggerak berharga 10 – 30 % total cost sistem pengangkutan.
    a. 3 fase : 60 Hz, 220 V
    b. 220/440-V
    c. 550-V, four wire, 208-V
    d. Biasanya 240 & 480 –V.

Alat pengangkut mekanis :

I. Screw conveyor,
II. Belt conveyor,
III. Bucket elevator,
IV. Vibrating conveyor,
V. Roller conveyor,
VI. Continuous Flow conveyor,
VII. Chute.

Alat pengangkut pneumatic :

VIII. Vacuum conveyor,
IX. Pressure conveyor.

Alat penyimpan :

X. Pile / reclaiming,
XI. Bins/Silos/Hopper.

Alat Pengumpan :

1. **vibrating feeder.**
2. **Screw feeder.**
3. **belt / apron feeder.**
4. **Table feeder.**
5. **Vibratory feeder**
6. **star feeder**

TABLE 21-1 Conveyors for Bulk Materials*

Function	Conveyor type
Conveying materials horizontally	Apron, belt, continuous flow, drag flight, screw, vibrating, bucket, pivoted bucket, air
Conveying materials up or down an incline	Apron, belt, continuous flow, flight, screw, skip hoist, air
Elevating materials	Bucket elevator, continuous flow, skip hoist, air
Handling materials over a combination horizontal and vertical path	Continuous flow, gravity-discharge bucket, pivoted bucket, air
Distributing materials to or collecting materials from bins, bunkers, etc.	Belt, flight, screw, continuous flow, gravity-discharge bucket, pivoted bucket, air
Removing materials from rail cars, trucks, etc.	Car dumper, grain-car unloader, car shaker, power shovel, air

*From FMC Corporation, Material Handling Systems Division.

TABLE 21-2 Feeders for Bulk Materials*

Material characteristics	Feeder type
Fine, free-flowing materials	Bar flight, belt, oscillating or vibrating, rotary vane, screw
Nonabrasive and granular materials, materials with some lumps	Apron, bar flight, belt, oscillating or vibrating, reciprocating, rotary plate, screw
Materials difficult to handle because of being hot, abrasive, lumpy, or stringy	Apron, bar flight, belt, oscillating or vibrating, reciprocating
Heavy, lumpy, or abrasive materials similar to pit-run, stone, and ore	Apron, oscillating or vibrating, reciprocating

*From FMC Corporation, Material Handling Systems Division.

TABLE 21-3 Classification System for Bulk Solids*

	Material characteristics	Class
Size	Very fine—< 149 μm (100 mesh)	A
	Fine—149 μm to 3.18 mm (100 mesh to ⅛ in)	B
	Granular—3.18 to 12.7 mm (⅛ to ½ in)	C
	Lumpy—containing lumps > 12.7 mm (½ in)	D
	Irregular—being fibrous, stringy, or the like	H
Flowability	Very free-flowing—angle of repose up to 30°	1
	Free-flowing—angle of repose 30 to 45°	2
	Sluggish—angle of repose 45° and up	3
Abrasiveness	Nonabrasive	6
	Mildly abrasive	7
	Very abrasive	8
Special characteristics	Contaminable, affecting use or salability	K
	Hygroscopic	L
	Highly corrosive	N
	Mildly corrosive	P
	Gives off dust or fumes harmful to life	R
	Contains explosive dust	S
	Degradable, affecting use or salability	T
	Very light and fluffy	W
	Interlocks or mats to resist digging	X
	Aerates and becomes fluid	Y
	Packs under pressure	Z

*From FMC Corporation, Material Handling Systems Division.

Example: A material which is granular, very free-flowing, mildly abrasive, and mildly corrosive would fall in classes C, 1, 7, and P, making its classification C17P.

TABLE 21-4 Material Classes and Bulk Densities*

Material	Average bulk density, lb/ft³†	Class‡	Material	Average bulk density, lb/ft³†	Class‡
Alum, lumpy	50–60	D26§	Lime, ground, ⅛ in and under	60	B36Z
Alum, fine	45–50	B26§	Lime, hydrated, ⅛ in and under	40	B26YZ
Alumina	60	B28	Lime, hydrated, pulverized	32–40	A26YZ
Alumina gel	45	B27	Lime, pebble	53–56	D36
Aluminum hydrate	18	C26	Limestone, agricultural, ⅛ in and under	68	B27§
Ammonium chloride, crystalline	52	B26	Limestone, crushed	85–90	D27§
Ammonium sulfate	45–58	§	Limestone dust	75	A37Y§
Antimony powder		B27	Magnesium chloride	33	C36
Asbestos shred	20–25	H37WZ	Manganese sulfate	70	C28
Ashes, coal, dry, 3 in. and under	35–40	D37	Marl	80	D27§
Asphalt, crushed, ½ in and under	45	C26	Mica, flakes	17–22	B17WY
Bagasse	7–10	H36WXZ	Mica, ground	13–15	B27
Baking powder	41	A26	Mica, pulverized	13–15	A27Y
Bark, wood, refuse	10–20	H37X§	Muriate of potash	77	B28
Bauxite, crushed, 3 in and under	75–85	D28§	Naphthalene flakes	45	§
Bentonite, 100 mesh and under	50–60	A27Y§	Oxalic acid crystals	60	B36L
Bicarbonate of soda	41	A26	Oyster shells, ground, ½ in and under	53	C27
Boneblack, 100 mesh and under	20–25	A27§	Oyster shells, whole		D27X
Bonechar, ⅛ in and under	27–40	B27	Phenol-formaldehyde molding powder	30–40	A36
Bonemeal	55–60	B27	Phosphate rock	75–85	D27§
Borate of lime		A26§	Phosphate sand	90–100	B28
Borax, fine	53	B26	Phthalic anhydride flakes	30–35	C36XZ
Boric acid, fine	55	B26	Polyethylene pellets, high-density	35–45	C16K
Calcium carbide	70–80	D27	Polyethylene pellets, low-density	28–40	C16K
Carbon black, pelletized	20–25	B16TZ§	Polypropylene pellets	35–50	C16K
Carbon black, powder	4–6	§	Polystyrene cubes	35–40	C16K
Casein	36	B27§	Polyvinyl chloride pellets, compounds	35–55	C16K
Cast-iron chips	130–200	C37	Polyvinyl chloride resin, dispersion-type	12–18	A36KPY
Cement, Portland	65–85	A27Y	Polyvinyl chloride resin, solvent, non-solvent,		
Cement clinker	75–80	D28§	suspension types	20–35	A26KY
Chalk, lumpy	85–90	D37Z	Potassium nitrate	76	C17P
Chalk, 100 mesh and under	70–75	A37YZ	Pumice, ⅛ in and under	42–45	B38§
Charcoal	18–25	D37T	Salt, common dry, coarse	45–50	C37PL§
Cinders, coal	40	D28§	Salt, common dry, fine	70–80	B27PL§
Clay (see bentonite, fuller's earth, kaolin, and			Salt cake, dry, coarse	85	D27
marl)			Salt cake, dry, pulverized	65–85	B27
Coal, anthracite	60	C27P	Saltpeter	80	B26S
Coal, bituminous, mined, 50 mesh and under	50	B36P	Sand, bank, dry	90–110	B28
Coal, bituminous, mined, sized	50	D26PT	Sand, silica, dry	90–100	B18
Coal, bituminous, mined, slack, ½ in and under	50	C36P	Sawdust	10–13	§
Coke, loose	23–32	D38TX§	Shale, crushed	85–90	C27
Coke, petroleum, calcined	35–45	D28X	Shellac, powdered or granulated	31	B26K§
Coke breeze, ¼ in and under	25–35	C38	Silica gel	45	B28
Copper sulfate		D26	Slag, furnace, granulated	60–65	C28
Cork, fine ground	12–15	B36WY	Slate, crushed, ½ in and under	80–90	C27
Cork, granulated	12–15	C36	Slate, ground, ⅛ in and under	82	B27
Cryolite	110	D27	Soap beads or granules		B26T
Cullet	80–120	D28§	Soap chips	15–25	C26T§
Dicalcium phosphate	43	A36	Soap flakes	5–15	B26T§
Dolomite, lumpy	90–100	D27§	Soap powder	20–25	B26§
Ebonite, crushed, ½ in and under	63–70	C26	Soapstone talc, fine	40–50	A37Z
Epsom salts	40–50	B26	Soda ash, heavy	55–65	B27
Feldspar, ground, ⅛ in and under	65–70	B27	Soda ash, light	20–35	A27W
Ferrous sulfate	50–75	C27	Sodium nitrate	70–80	§
Flour, wheat	35–40	A36K§	Sodium sulfate (see salt cake)		
Fluorspar	82	C37	Starch	25–50	§
Fly ash, dry	35–45	A18Y§	Steel chips, crushed	100–150	D38
Fuller's earth, oil filter, burned	40	B28	Sugar, granulated	50–55	B26KT
Fuller's earth, oil filter, raw	35–40	B27	Sugar, raw, cane, or beet	55–65	B36Z§
Fuller's earth, oil filter, spent	60–65	§	Sugar-beet pulp, dry	12–15	§
Glass batch	90–100	D28§	Sugar-beet pulp, wet	25–45	§
Glue, ground, ⅛ in and under	40	B27	Sulfur, crushed, ½ in and under	50–60	C26S§
Graphite, flake	40	C26	Sulfur, lumpy, 3 in and under	80–85	D26S§
Graphite, flour	28	A16Y	Sulfur, powdered	50–60	B26SY§
Gypsum, calcined, ½ in and under	55–60	C27	Talcum powder	40–60	A27Y
Gypsum, calcined, powdered	60–80	A37	Trisodium phosphate	60	B27
Gypsum, raw, 1 in and under	90–100	D27	Vermiculite, expanded	16	C37W
Ice, crushed	35–45	D16	Vermiculite ore	80	D27
Ilmenite	140	B28	Wood chips	10–30	H36WX§
Kaolin clay, 3 in and under	163	D27	Wood flour	16–36	§
Lead arsenate	72	B36R	Zinc oxide, heavy	30–35	A36Z§
Lignite, air dried	45–55	D26	Zinc oxide, light	10–15	A36WZ§

SCREW CONVEYOR

Alat ini terdiri atas pisau-pisau yang berbentuk spiral, yang dipasang pada as yang berputar dalam saluran yang berbentuk U. Alat ini cocok untuk pengangkut bahan berbentuk butir atau pasta. Karena prinsip kerja alat ini mendorong bahan, maka selama transportasi juga terjadi pengecilan ukuran bahan. Pemasangan alat biasanya miring (untuk membantu pengaliran bahan) dan ukuran tidak terlalu panjang. Kapasitas dibatasi s/d 4,72 m^3/menit (= 10000 ft^3/jam).

Sebagai pemilihan dan perancangan awal dapat menggunakan table 21-5 dan 21-6 (Perry, 7^{th} ed.) atau table 13 Brown.

TABLE 21-5 Screw-Conveyor Capacities and Loading Conditions*

Material class†	Screw diam., in	Max. lump size, in		Capacity, cu ft/hr‡		Approx. area occupied by material¶
		25% lumps	100% lumps	At 1 rpm.	At max. rpm.§	
A, B, C, D, and H 16, 26, 36	6	¾	½	2.27	375	
	9	1½	¾	8.0	1,200	
	12	2	1	19.3	2,700	
	14	2½	1¼	30.8	4,000	
	16	3	1½	46.6	5,600	
	18	3	2	66.1	7,600	
	20	3½	2	95.0	10,000	45%
A, B, C, D, and H 17, 27, 37	6	¾	½	1.5	75	
	9	1½	¾	5.6	280	
	12	2	1	13.3	665	
	14	2½	1¼	21.1	1,055	
	16	3	1½	31.4	1,570	
	18	3	2	45.4	2,270	
	20	3½	2	62.1	3,105	30%
A, B, C, D, and H 18, 28, 38	6	¾	½	0.75	25	
	9	1½	¾	2.8	90	
	12	2	1	6.7	200	
	14	2½	1¼	10.5	300	
	16	3	1½	15.7	425	
	18	3	2	22.7	590	
	20	3½	2	31.1	780	15%

TABLE 21-6 Screw-Conveyor Data for 50-lb/ft³ Material and Pipe-Mounted Sectional Spiral Flights*

Capacity†		Diam. of flights, in	Diam. of pipe, in‡	Diam. of shafts, in	Hanger centers, ft	Max. size of lumps			Speed, r/min	Max. torque capacity, in-lb	Feed section diam., in	hp at motor§					Max. hp capacity at speed listed
Tons/h	ft³/h					All lumps	Lumps 20 to 25%	Lumps 10% or less				15-ft. max. length	30-ft max. length	45-ft max. length	60-ft max. length	75-ft max. length	
5	200	9	2½	2	10	¾	1½	2¼	40	7,600	6	0.43	0.85	1.27	1.69	2.11	4.8
10	400	10	2½	2	10	¾	1½	2½	55	7,600	9	0.85	1.69	2.25	3.00	3.75	6.6
15	600	10	2½	2	10	¾	1½	2½	80	7,600	9	1.27	2.25	3.38	3.94	4.93	9.6
		12	2½	2	12	1	2	3	45	7,600	10	1.27	2.25	3.38	3.94	4.93	5.4
		12	3½	3						16,400		1.27	2.25	3.38	3.94	4.93	11.7
20	800	12	2½	2	12	1	2	3	60	7,600	10	1.69	3.00	3.94	4.87	5.63	7.2
			3½	3						16,400		1.69	3.00	3.94	4.87	5.63	15.6
25	1000	12	2½	2	12	1	2	3	75	7,600	10	2.12	3.75	4.93	5.63	6.55	9.0
			3½	3						16,400		2.12	3.75	4.93	5.63	6.55	9.0
		14	3½	3		1¼	2½	3½	45	16,400	12	2.12	3.75	4.93	5.63	6.55	11.7
30	1200	14	3½	3	12	1¼	2½	3½	55	16,400	12	2.25	3.94	5.05	6.75	7.50	14.3
35	1400	14	3½	3	12	1¼	2½	3½	65	16,400	12	2.62	4.58	5.90	7.00	8.75	16.9
40	1600	16	3½	3	12	1½	3	4	50	16,400	14	3.00	4.50	6.75	8.00	10.00	13.0

*Fairfield Engineering Co. data in U.S. customary system. To convert cubic feet per hour to cubic meters per hour, multiply by 0.02832; to convert tons per hour to metric tons per hour, multiply by 0.9078; and to convert screw size in inches to the nearest screw size in centimeters, multiply by 2.5.

†Capacities are based on screws carrying 31 percent of their cross section and, in the case of feed sections with half-pitch flights, based on 100 percent of their cross section.

‡Pipe sizes given are for ¼-in (6.35-mm) flights.

§Horsepowers listed are calculated for average conditions and are of the proper motor size with factors for length of conveyor, momentary overloads, etc., taken into consideration.

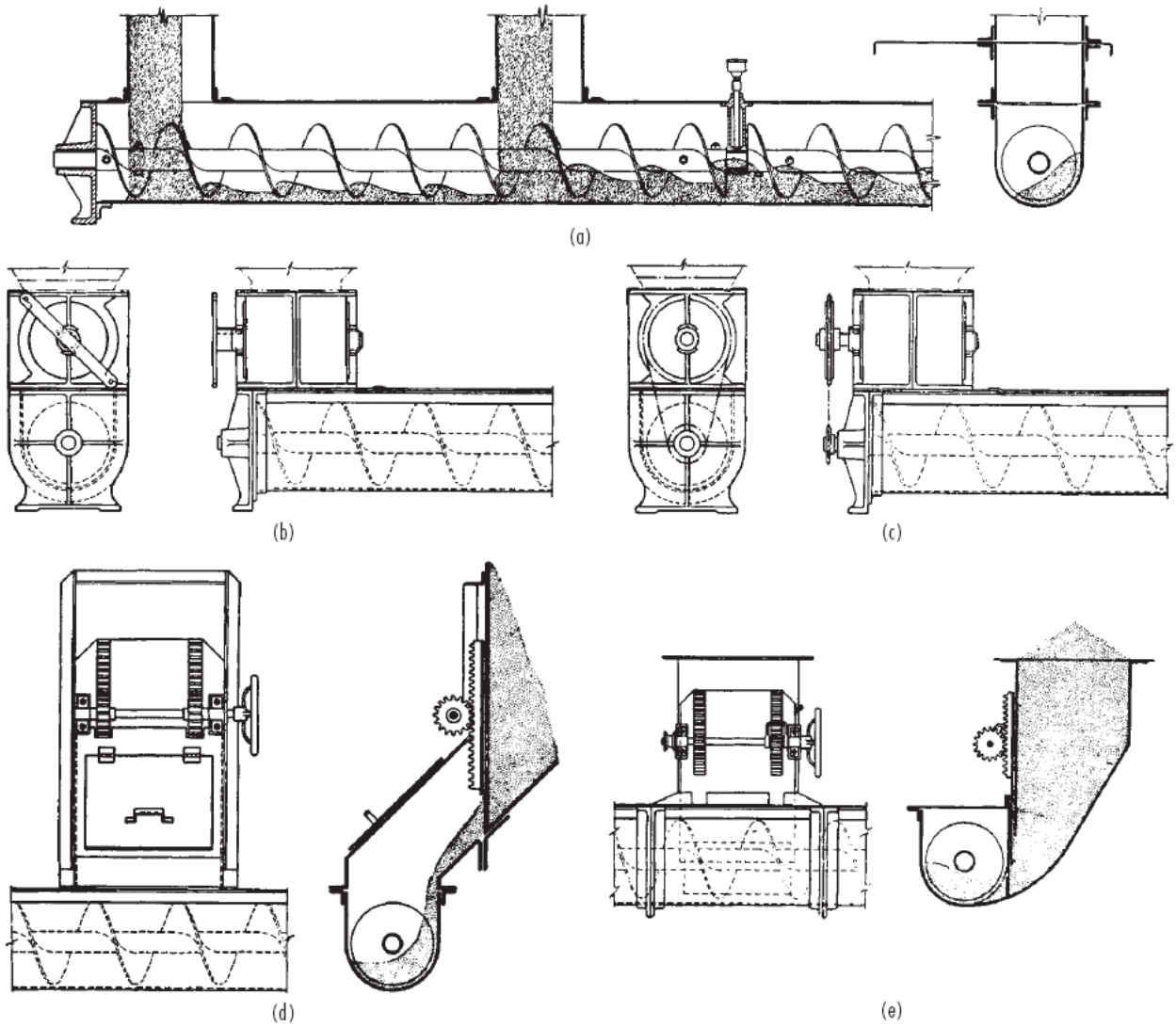


FIG. 21-1 Typical feed arrangements for screw conveyors. (*a*) Plain spouts of chutes. (*b*) Rotary cutoff valve. (*c*) Rotary-vane feeder. (*d*) Bin gate. (*e*) Side inlet gate. (*FMC Corporation, Material Handling Systems Division.*)

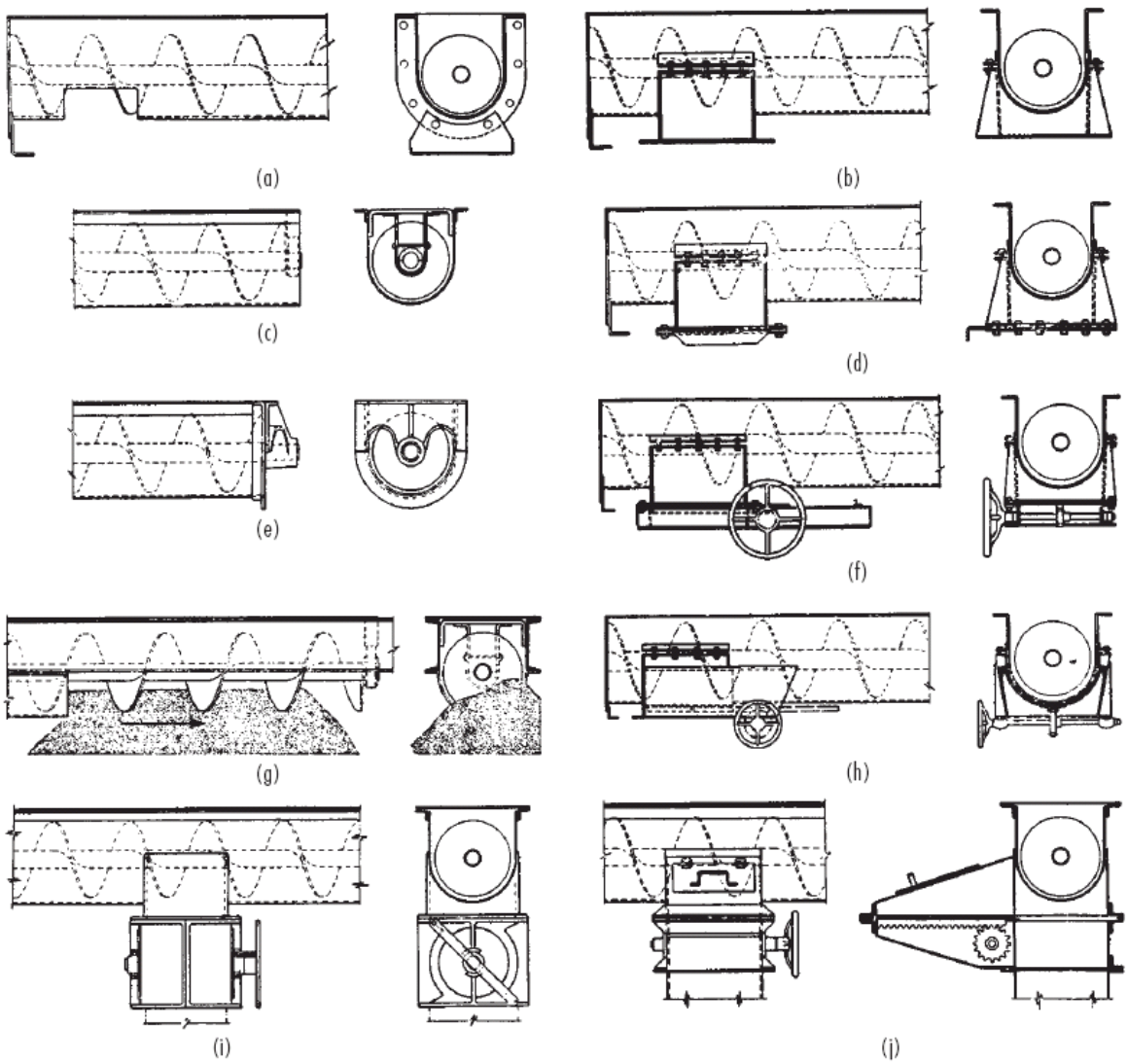


FIG. 21-2 Typical discharge arrangements for screw conveyors. (*a*) Plain discharge opening. (*b*) Discharge spout. (*c*) Open-end trough. (*d*) Hand slide gate. (*e*) Discharge trough end. (*f*) Rack-and-pinion flat side gate. (*g*) Open-bottom trough. (*h*) Rack-and-pinion curved slide gate. (*i*) Rotary cutoff valve. (*j*) Enclosed rack-and-pinion gate. (*FMC Corporation, Material Handling Systems Division.*)

Untuk tujuan kristalisasi dan pencampuran, spiral screw diganti dengan screw yang tidak penuh (lihat Fig. 5.7 Wallas). Untuk pencampuran pasta, spiral screw diganti dengan dayung atau plate. Secara umum, screw conveyor untuk mentransfer bahan secra horizontal, tetapi bisa juga untuk mengangkut bahan dengan elevasi tertentu.

BELT CONVEYOR

Alat ini banyak dipakai, disamping bersifat kontinyu, penggunaan powernya lebih rendah.

- Jarak tempuh dapat bermil-mil.
- Kecepatan s/d 5,08 m/detik = 1000 ft/menit.
- Kapasitas s/d 4539 metric ton/jam = 5000 ton/jam.
- Kemiringan : maksimum 30^o, biasanya 18 – 20^o.

Sebagai preliminary design dapat menggunakan table 21-7, Fig. 21-3 dan Fig 21-4 (Perry 7^{th} ed.) atau table 15 dan 16 Brown. Macam-macam material belt :

- Kawat, kasa kawat baja,
- Natural rubber,
- Special rubber, cotton, asbeston fiber,
- Elastomers : neoprene, Teflon, buna-N-rubbers, vinyls.

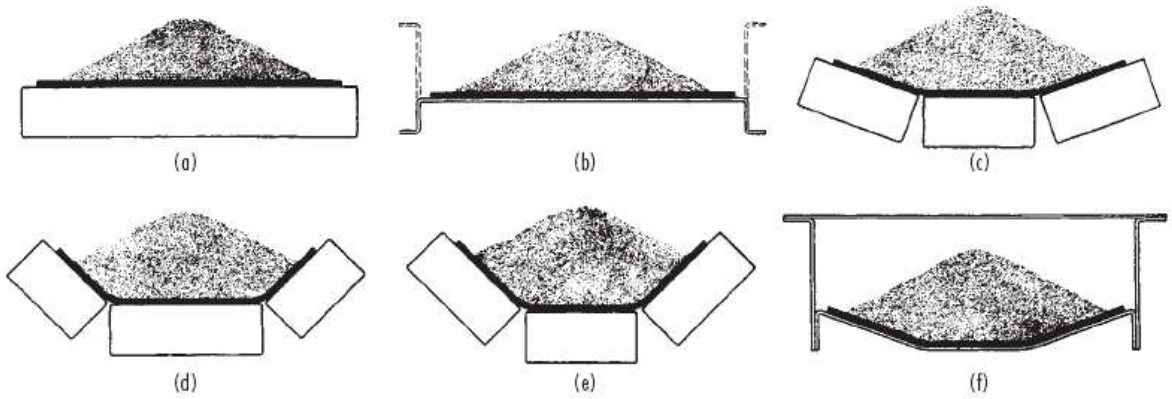
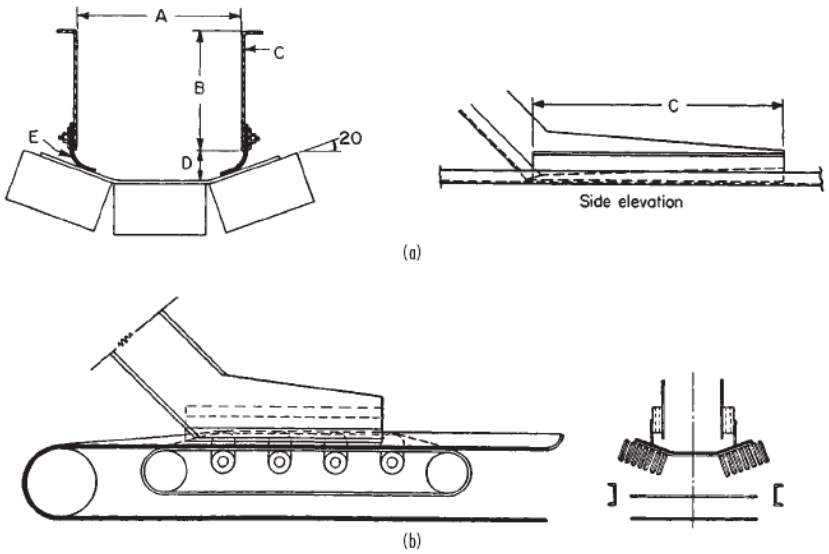


FIG. 21-3 Typical belt-conveyor idler and plate-support arrangements. (*a*) Flat belt on flat-belt idlers. (*b*) Flat belt on continuous plate. (*c*) Troughed belt on 20° idlers. (*d*) Troughed belt on 45° idlers with rolls of unequal length. (*e*) Troughed belt on 45° idlers with rolls of equal length. (*f*) Troughed belt on continuous plate. (*FMC Corporation, Material Handling Systems Division.*)



Skirt Plate and Seal Dimensions

Symbol	Name	Dimensions
A	Trough width	See table for (*a*).
B	Skirt depth	Minimum: 6 in (150 mm); maximum: 12 in (300 mm)
C	Skirt length	Minimum: 6 ft (1.8 m); maximum: 8 ft (2.4 m)
D	Skirt-to-belt clearance	See table for (*a*).
E	Seal specification	0.25-in- (6-mm-) thick live rubber, 6 in (150 mm) × *C*

Belt width, in (cm)	14 (35)	16 (40)	18 (45)	20 (50)	24 (60)	30 (75)	36 (90)	42 (110)	48 (125)	54 (140)	60 (155)
Trough width *A*, in (cm)	9 (23)	11 (28)	12 (30)	13 (33)	16 (41)	20 (51)	24 (61)	28 (71)	32 (81)	36 (91)	40 (102)
Skirt seal *D*, in (cm)	2.0 (5.1)	2.25 (5.7)	2.25 (5.7)	2.88 (7.3)	2.88 (7.3)	3.13 (8.0)	3.63 (9.2)	4.0 (10.1)	4.38 (11.1)	4.75 (12.1)	5.25(13.3)

FIG. 21-4 Belt-conveyor loading details. (*a*) Typical skirt-plate design and dimensions. (*b*) Pad belt and special roller-bearing idlers for heavy-duty loading. (*Stephens-Adamson Division, Allis-Chalmers Corporation.*)

Sifat alat :

1. bahan yang ditransfer tidak mengalami pengecilan ukuran,
2. sederhana, paling banyak digunakan,
3. sudut naik (elevasi) terbatas,

4. baik untuk mengangkut tepung, granular, gumpalan,
5. tidak baik untuk mengangkut bahan yang mudah terbawa angin.

Kapasitas (banyaknya padatan/watu) belt conveyor tergantung :

a. bulk density bahan,
b. sudut gelincir bahan
c. ukuran bahan,
d. lebar belt,
e. kecepatan belt,
f. elevasi pengankutan.

Kecepatan belt tergantung :

1. ukuran bahan
2. sifat material yang dibawa
3. lebar belt

Kecepatan maksimum dibatasi oleh timbulnya pendebuan bahan yang dibawa karena resistansi udara. Kecepatan minimum dibatasi oleh keperluan discharge sistemnya.

BUCKET ELEVATOR

Fig 21-5, table 21-8 dan table 21-9 dapat digunakan sebagai preliminary design.

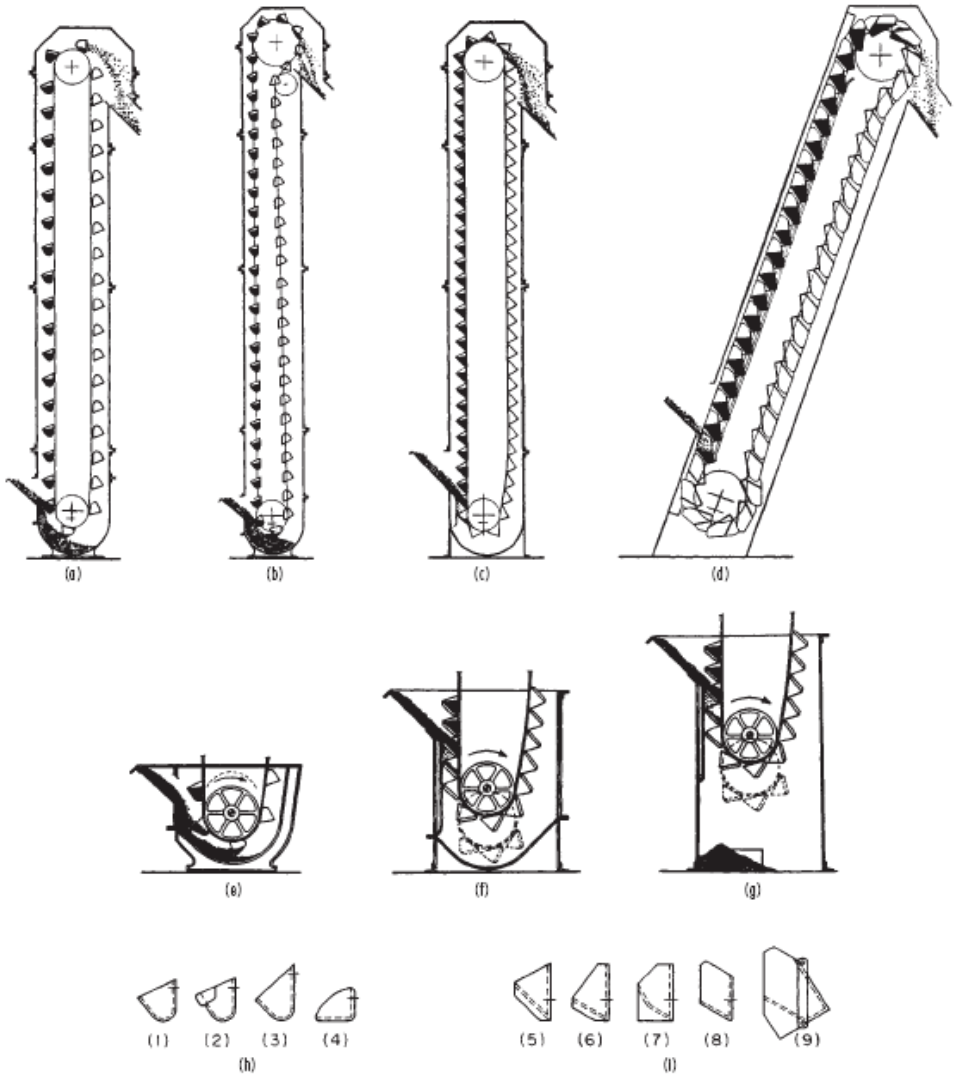


FIG. 21-5 Bucket-elevator types and bucket details. (*a*) Centrifugal-discharge spaced buckets. (*b*) Positive-discharge spaced buckets. (*c*) Continuous bucket. (*d*) Supercapacity continuous bucket. (*e*) Spaced buckets receive part of lead direct and part by scooping from bottom. (*f*) Continuous: buckets are filled as they pass through loading leg, with feed spout above tail wheel. (*g*) Continuous: buckets in bottomless boot, with cleanout door. (*h*) Malleable-iron spaced buckets for centrifugal discharge. (*i*) Steel buckets for continuous-bucket elevators. (*Stephens-Adamson Division, Allis-Chalmers Corporation.*)

TABLE 21-8 Bucket-Elevator Specifications for Centrifugal-Discharge Buckets on Belt, Malleable-Iron, or Steel Buckets*

Size of bucket, in (mm), and bucket spacing, in (mm)†	Elevator centers, ft‡	Capacity, tons/h (metric tons/h)§	Size of lumps handled, in (mm)¶	Bucket Bucket speed, ft/min (m/min)	r/min, head shaft	hp required at head shaft	Additional hp/ft for intermediate lengths	Head	Tail	Head	Tail	Belt width, in
6 × 4 × 4¼ – 12	25	14 (12.7)	¾ (19.0)	225 (68.6)	43	1.0	0.02	1 15/16	1 11/16	20	14	7
	50	14 (12.7)	¾ (19.0)	225 (68.6)	43	1.6	0.02	1 15/16	1 11/16	20	14	7
(152 × 102 × 108) – (305)	75	14 (12.7)	¾ (19.0)	225 (68.6)	43	2.1	0.02	1 15/16	1 11/16	20	14	7
8 × 5 × 5½ – 14	25	27 (24.5)	1 (25.4)	225 (68.6)	43	1.6	0.04	1 15/16	1 11/16	20	14	9
	50	30 (27.2)	1 (25.4)	260 (79.2)	41	3.5	0.05	1 15/16	1 11/16	24	14	9
(203 × 127 × 140) – (356)	75	30 (27.2)	1 (25.4)	260 (79.2)	41	4.8	0.05	2 7/16	1 11/16	24	14	9
10 × 6 × 6¼ – 16	25	45 (40.8)	1¼ (32.0)	225 (68.6)	43	3.0	0.063	1 15/16	1 15/16	20	16	11
	50	52 (47.2)	1¼ (32.0)	260 (79.2)	41	5.2	0.07	2 7/16	1 15/16	24	16	11
(254 × 152 × 159) – (406)	75	52 (47.2)	1¼ (32.0)	260 (79.2)	41	7.2	0.07	2 15/16	1 15/16	24	16	11
12 × 7 × 7¼ – 18	25	75 (68.1)	1½ (38.1)	260 (79.2)	41	4.7	0.1	2 7/16	1 15/16	24	18	13
	50	84 (76.3)	1½ (38.1)	300 (91.4)	38	8.9	0.115	2 15/16	1 15/16	30	18	13
(305 × 178 × 184) – (457)	75	84 (76.3)	1½ (38.1)	300 (91.4)	38	11.7	0.115	3 7/16	2 7/16	30	18	13
14 × 7 × 7¼ – 18	25	100 (90.8)	1¾ (44.5)	300 (91.4)	38	7.3	0.14	2 15/16	2 7/16	30	18	15
	50	100 (90.8)	1¾ (44.5)	300 (91.4)	38	11.0	0.14	3 7/16	2 7/16	30	18	15
(355 × 179 × 184) – (457)	75	100 (90.8)	1¾ (44.5)	300 (91.4)	38	14.3	0.14	3 7/16	2 7/16	30	18	15
16 × 8 × 8½ – 18	25	150 (136.2)	2 (50.8)	300 (91.4)	38	8.5	0.165	2 15/16	2 7/16	30	20	18
	50	150 (136.2)	2 (50.8)	300 (91.4)	38	12.6	0.165	3 7/16	2 7/16	30	20	18
(406 × 203 × 216) – (457)	75	150 (136.2)	2 (50.8)	400 (121.9)	38	16.7	0.165	3 15/16	2 7/16	30	20	18

*From Stephens-Adamson Division, Allis-Chalmers Corporation.
†Bucket size given: width × projection × depth. Assumed bucket linear speed is 150 ft/min (45.7 m/min).
‡Elevator centers to nearest SI equivalent are 25 ft ≃ 8 m, 50 ft ≃ 15 m, and 75 ft ≃ 23 m.
§Capacities and horsepowers are given for materials having bulk densities of 100 lb/ft³ (1602 kg/m³). For other densities these will vary in direct proportion: a 50-lb/ft³ material will reduce the capacity and horsepower required by 50 percent.
¶If the amount of lump product is less than 15 percent of the total, lump size may be twice that given.

TABLE 21-9 Bucket-Elevator Specifications for Continuous Buckets on Chain*

Size of bucket and bucket spacing, in (mm)†	Elevator centers, ft‡	Capacity, tons/h (metric tons/h)§	Size of lumps handled, in (mm)¶	r/min, head shaft	hp required at head shaft	Additional hp/ft for intermediate lengths	Head	Tail	Head	Tail
8 × 5½ × 7¾ – 8	25	35 (31.7)	1 (25.4)	28	1.8	0.06	1 15/16	1 11/16	20½	14
(203 × 140 × 197) – (203)	50	35 (31.7)	1 (25.4)	28	3.4	0.06	2 7/16	1 11/16	20½	14
	75	35 (31.7)	1 (25.4)	28	5.0	0.06	2 15/16	1 11/16	20½	14
10 × 7 × 11¾ – 12	25	60 (54.5)	1½ (38.1)	23	3.0	0.10	2 7/16	1 15/16	25	17½
(254 × 178 × 298 – (305)	50	60 (54.5)	1½ (38.1)	23	5.5	0.10	2 7/16	1 15/16	25	17½
	75	60 (54.5)	1½ (38.1)	23	8.0	0.10	2 15/16	1 15/16	25	17½
12 × 7 × 11¾ – 12	25	70 (63.5)	1½ (38.1)	23	3.5	0.12	2 7/16	1 15/16	25	17½
(305 × 178 × 298) – (305)	50	70 (63.5)	1½ (38.1)	23	6.5	0.12	2 15/16	1 15/16	25	17½
	75	70 (63.5)	1½ (38.1)	23	9.5	0.12	3 7/16	2 7/16	25	17½
14 × 7 × 11¾ – 12	25	80 (72.6)	1¾ (44.5)	23	4.0	0.14	2 7/16	2 7/16	25	17½
(356 × 178 × 298) – (305)	50	80 (72.6)	1¾ (44.5)	20	7.5	0.14	2 15/16	2 7/16	29	17½
	75	80 (72.6)	1¾ (44.5)	20	11	0.14	3 7/16	2 7/16	29	17½
14 × 8 × 11¾ – 12	25	100 (90.8)	2 (50.8)	20	5.0	0.17	2 15/16	2 7/16	29	17½
(356 × 203 × 298) – (305)	50	100 (90.8)	2 (50.8)	20	9.3	0.17	3 7/16	2 7/16	29	17½
	75	100 (90.8)	2 (50.8)	20	13.3	0.17	3 15/16	2 7/16	29	17½
16 × 8 × 11¾ – 12	25	115 (104.4)	2 (50.8)	20	6.0	0.20	2 15/16	2 7/16	29	17½
(406 × 203 × 298) – (305)	50	115 (104.4)	2 (50.8)	20	11	0.20	3 15/16	2 7/16	29	17½
	75	115 (104.4)	2 (50.8)	20	16	0.20	4 7/16	2 7/16	29	17½
18 × 8 × 11¾ – 12	25	130 (118.0)	2 (50.8)	20	7	0.22	2 15/16	2 7/16	29	17½
(406 × 203 × 298) – (305)	50	130 (118.0)	2 (50.8)	20	13	0.22	3 15/16	2 7/16	29	17½
	75	130 (118.0)	2 (50.8)	20	20	0.22	4 7/16	2 7/16	29	17½

*From Stephens-Adamson Division, Allis-Chalmers Corporation.
†Bucket size given: width × projection × depth. Assumed bucket linear speed is 150 ft/min (45.7 m/min).
‡Elevator centers to nearest SI equivalent are 25 ft ≃8 m, 50 ft ≃15 m, and 75 ft ≃23 m.
§Capacities and horsepowers are given for materials having bulk densities of 100 lb/ft³ (1602 kg/m³). For other densities these will vary in direct proportion: a 50-lb/ft³ material will reduce the capacity and horsepower required by 50 percent.
¶If the total amount of lump product is less than 15 percent of the total, lump size may be twice that given.

VIBRATING/OSCILATING CONVEYOR

Fig. 21-7 dan 21-8 dapat digunakan sebagai preliminary design.

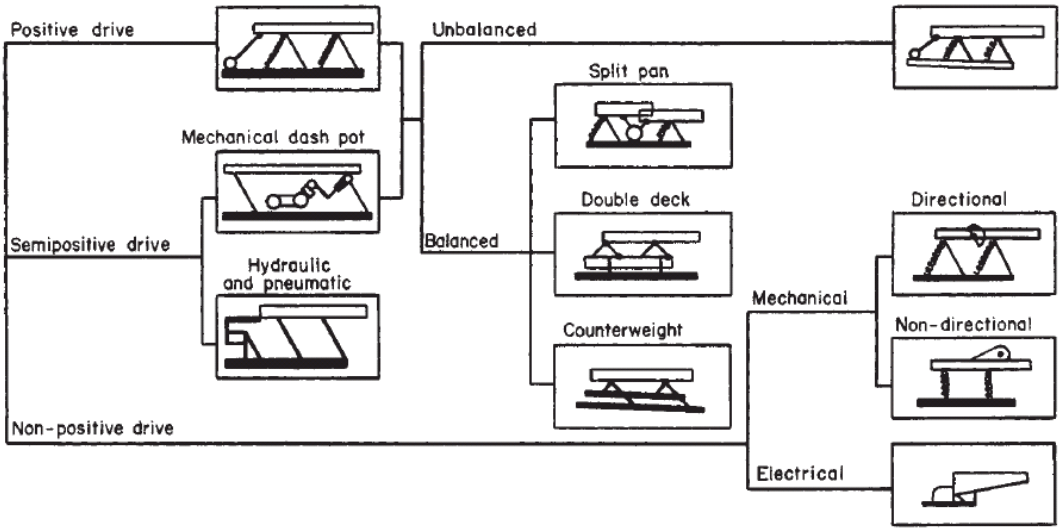
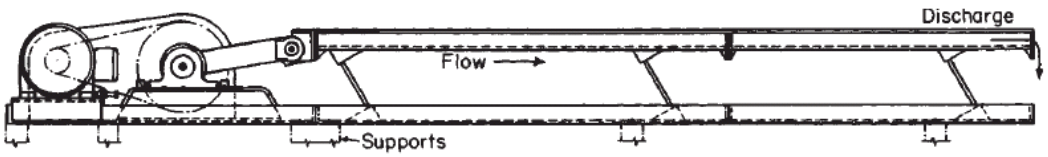
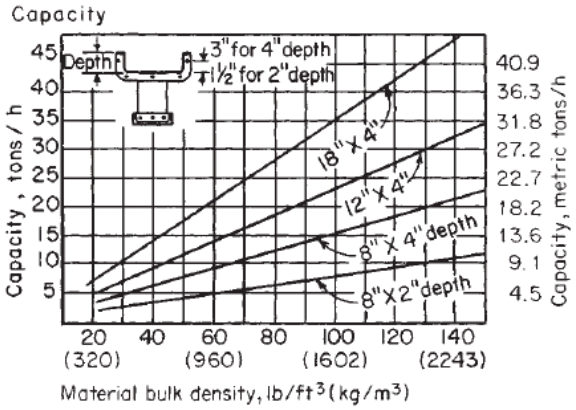
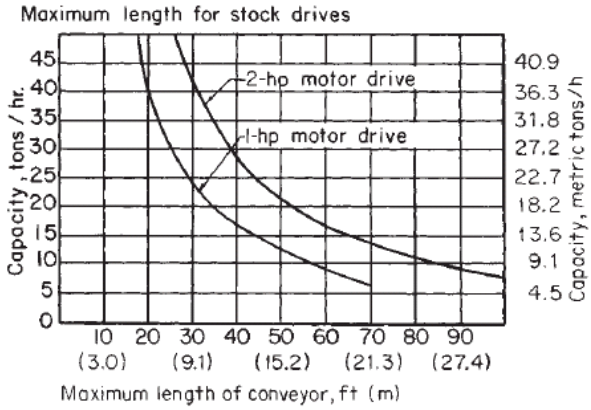


FIG. 21-7 Vibration-conveyor classification. (*Modern Materials Handling.*)







Pan width and stream depth: nearest metric equivalents

in	mm	in	mm
18 x 4	450 x 100	8 x 4	200 x 100
12 x 4	300 x 100	8 x 2	200 x 50

FIG. 21-8 Standardized leaf-spring mechanical oscillating conveyor with selection charts. Multiply pounds per cubic foot by 16.02 to get kilograms per cubic meter; multiply feet by 0.3048 to get meters. (*FMC Corporation, Materials Handling Systems Division.*)

CONTINUOUS – FLOW CONVEYOR

Permukaan transfer conveyor didorong oleh material, dimana luas permukaan material lebih besar dibandingkan luas permukaan conveyor. Saluran conveyor terisi penuh oleh material.

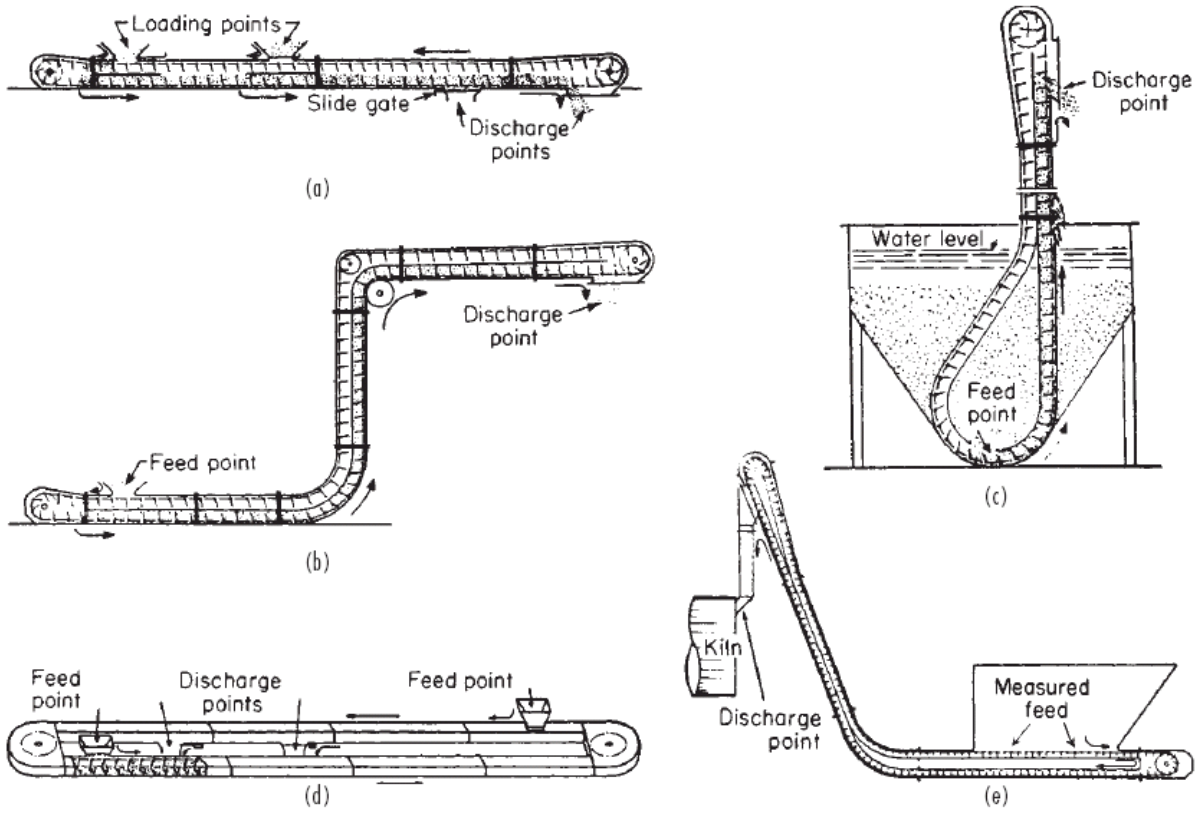


FIG. 21-10 Typical arrangements and applications for continuous-flow conveyors. (*a*) Horizontal conveyor. (*b*) Z-type conveyor-elevator. (*c*) Loop-feed elevator used for dewatering. (*d*) Side-pull horizontal recirculating conveyor. (*e*) Horizontal inclined conveyor-elevator. (*Stephens-Adamson Division, Allis-Chalmers Corporation.*)

Contoh (Perry, 7th ed.):

1. Closed belt conveyor (Fig 21-9 d)
2. Flight Conveyor (Fig 21-9 a,b,c, Table 21-10)
3. Appron conveyor (Fig 21-11, table 21-11).

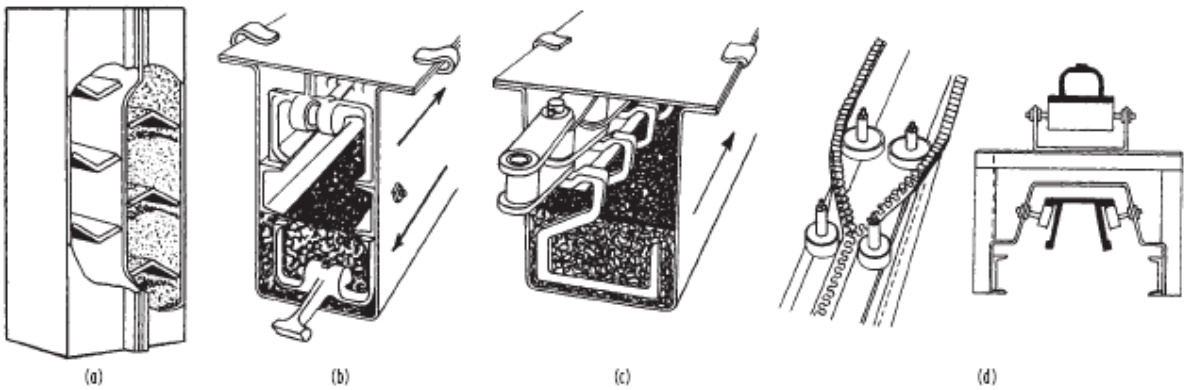


FIG. 21-9 Closed and open flights for continuous-flow conveyors. (*a*) and (*b*) Conveyor-elevator. (*c*) Horizontal conveyor with side-pull chain. (*d*) Detail of closed-belt conveyor, opening and closing rollers mesh and unmesh teeth in the same manner as a conventional clothing fastener. (*FMC Corporation, Material Handling Systems Division; Stephens-Adamson Division, Allis-Chalmers Corporation.*)

TABLE 21-10 Flight-Conveyor Capacities*

Flight size and no. of strands, in (mm)	Maximum size of lumps: All lumps, in (mm)	Maximum size of lumps: 10% lumps, in (mm)	Capacity, tons/h (metric tons/h)† for various flight spacings, conveyor, horizontal, in (mm): 18 (460)	24 (610)	36 (915)	Design type‡
10 × 4 (255 × 100)—1	1½ (38)	3 (76)	32 (29)	25 (23)	16 (15)	1
12 × 5 (305 × 130)—1	1¾ (45)	3½ (89)	46 (42)	35 (32)	23 (21)	1
15 × 5 (380 × 130)—1	2 (51)	4 (102)	66 (60)	50 (45)	33 (30)	1
15 × 6 (380 × 155)—2	3½ (89)	7 (178)	87 (79)	67 (61)	44 (40)	2
16 × 8 (405 × 205)—2	4 (102)	8 (203)	110 (99)	82 (74)	55 (50)	2
18 × 8 (460 × 205)—2	5 (127)	9 (229)	124 (113)	93 (84)	62 (56)	2
20 × 10 (510 × 255)—2	6 (152)	10 (254)	— —	141 (128)	94 (85)	2
24 × 10 (610 × 255)—2	8 (203)	13 (305)	— —	176 (160)	116 (105)	2
30 × 10 (765 × 255)—2	10 (254)	14 (355)	— —	— —	250 (227)	2
12 × 5 (305 × 130)—1	1¾ (45)	3½ (89)	56 (51)	42 (38)	28 (25)	3
15 × 7 (380 × 180)—1	2½ (64)	4½ (114)	78 (71)	58 (53)	39 (35)	3
18 × 8 (460 × 205)—1	3 (76)	5 (127)	124 (113)	93 (84)	62 (56)	3
12 × 5 (305 × 130)—2	2 (51)	4 (102)	56 (51)	4 (38)	28 (25)	4
15 × 6 (380 × 155)—2	3 (76)	5 (127)	76 (69)	57 (52)	38 (34)	4
18 × 7 (460 × 180)—2	4 (102)	8 (203)	96 (87)	72 (65)	48 (44)	4
24 × 8 (610 × 205)—2	8 (203)	12 (305)	— —	124 (113)	83 (75)	4

*Data from Fairfield Engineering Co.
†Basis: 30-lb/ft³ (480-kg/m³) bulk density and conveyor velocity of 100 ft/min (30.5 m/min). For inclined conveyors capacities are reduced by factors given:

Slope off horizontal	Factor
15°	0.80
30°	0.55
45°	0.33

‡Type 1: malleable-iron conveyor flights; type 2: steel flights on roller chain; type 3: steel flights with wear shoes or rollers; type 4: steel flights on plain chain.

TABLE 21-11 Apron-Conveyor Capacities*

Capacity without skirts for various speeds and bulk densities for material depth of 4 in (102 mm) on pans

Apron width, in (mm)	50 ft/min (15.2 m/min): ft³/h (m³/h)	tons/h: 50 lb/ft³ (801 kg/m³)	(metric tons/h): 100 lb/ft³ (1602 kg/m³)	100 ft/min (30.5 m/min): ft³/h (m³/h)	ton/h: 50 lb/ft³ (801 kg/m³)	(metric tons/h): 100 lb/ft³ (1602 kg/m³)
18 (460)	1125 (31.9)	28 (25)	56 (51)	2250 (63.7)	56 (51)	112 (102)
24 (610)	1500 (42.5)	38 (34)	75 (68)	3000 (85.0)	75 (68)	150 (136)
30 (765)	1875 (53.2)	47 (43)	94 (85)	3750 (106.2)	94 (85)	188 (171)
36 (915)	2250 (63.7)	56 (51)	113 (102)	4500 (127.4)	113 (102)	226 (205)
42 (1070)	2625 (74.3)	66 (60)	131 (119)	5250 (148.7)	131 (119)	262 (238)
48 (1220)	3000 (85.0)	75 (68)	150 (136)	6000 (170.0)	150 (136)	300 (272)
54 (1370)	3375 (95.6)	85 (77)	169 (153)	6750 (191.2)	169 (153)	338 (307)
60 (1525)	3750 (106.2)	94 (85)	188 (171)	7500 (212.4)	188 (171)	376 (341)

Capacities with skirts for various material depths, 0.75 loaded cross section and 10-ft/min (3-m/min) velocity

Pan width, in (mm)	Width between skirts, in (mm)	Max. lump size, in (mm)	Capacity, tons/h (metric tons/h); 50-lb/ft³ (801-kg/m³) bulk-density material; material depth on pans, in (mm): 4 (105)	8 (205)	12 (305)	18 (460)	21 (535)	24 (610)
18 (460)	16 (410)	3 (76)	5.0 (4.5)	10.0 (9.1)	15.0 (13.6)	22.5 (20.4)	26.3 (23.9)	30.0 (27.2)
24 (610)	22 (560)	4 (102)	6.9 (6.3)	13.7 (12.4)	20.6 (18.7)	31.0 (28.1)	36.1 (32.8)	41.2 (37.4)
30 (765)	28 (715)	6 (152)	8.8 (8.0)	17.5 (15.9)	26.2 (23.8)	39.3 (35.7)	45.9 (41.7)	52.5 (47.7)
36 (915)	34 (865)	8 (203)	10.7 (9.7)	21.3 (19.3)	32.0 (29.1)	48.0 (43.6)	56.0 (51.8)	64.0 (58.1)
42 (1070)	40 (1020)	10 (254)	12.5 (11.3)	25.0 (22.7)	37.5 (34.0)	56.3 (51.1)	65.7 (59.6)	75.0 (68.1)
48 (1220)	46 (1170)	12 (305)	14.4 (13.1)	28.8 (26.1)	43.2 (39.2)	64.8 (58.8)	75.6 (68.6)	86.3 (78.3)

*Data from Fairfield Engineering Co.

PNEUMATIC CONVEYOR

Dapat digunakan untuk mengangkut fine mat'l (6,35 mm) sampai ukuran pellet (0,25 in) dan bulk density 16 sampai dengan lebih dari 2100 kg/m^3.

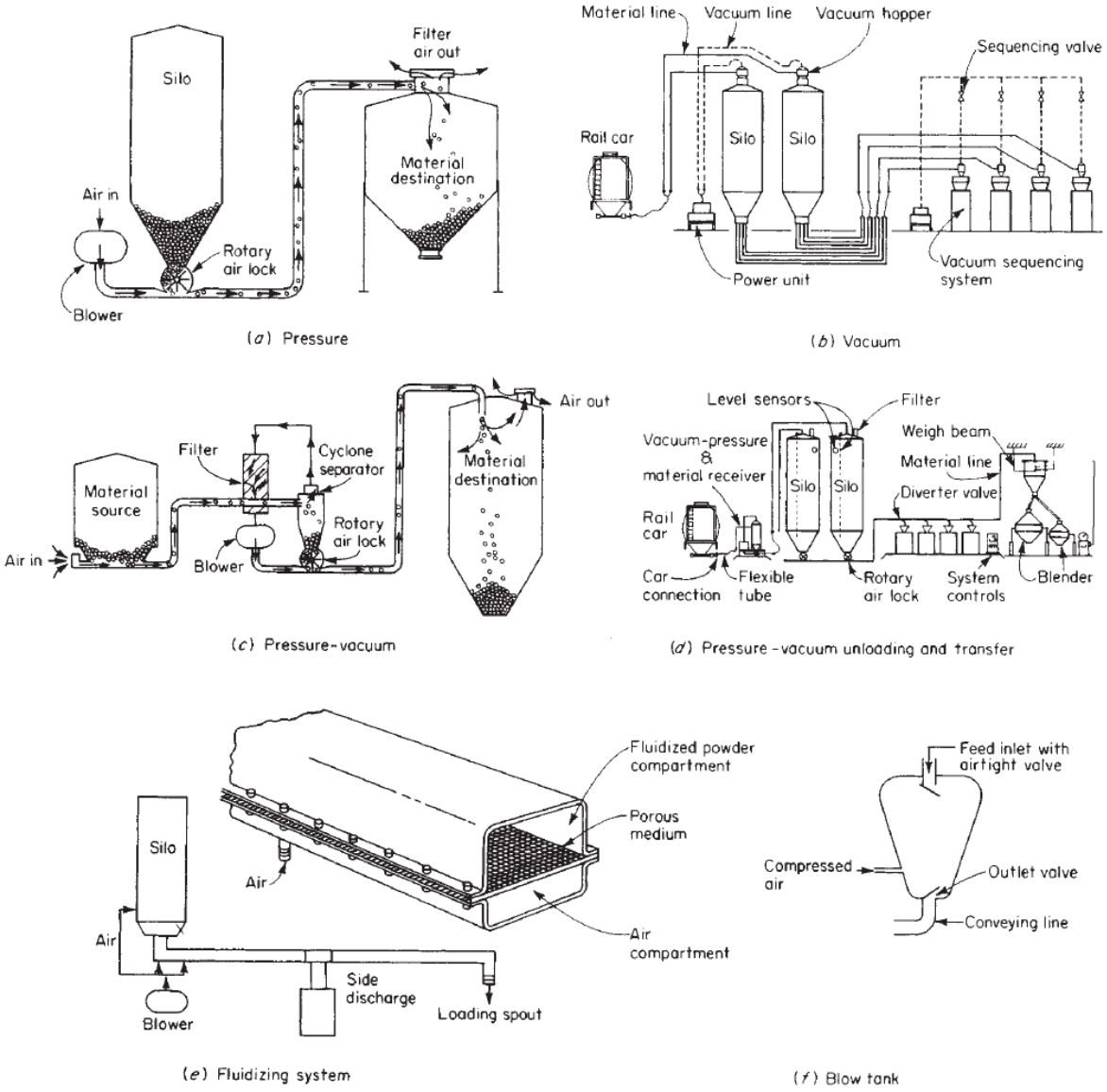


FIG. 21-12 Types of air-conveying systems. (*a*) Pressure. (*b*) Vacuum. (*c*) Pressure-vacuum. (*d*) Pressure vacuum unloading and transfer. (*Whitlock, Inc.*) (*e*) Fluidizing system. (*Fuller Co.*) (*f*) Blow tank.

TABLE 21-13 Air Velocities Needed to Convey Solids of Various Bulk Densities*

Bulk density		Air velocity		Bulk density		Air velocity	
lb/ft^3	kg/m^3	ft/min	m/min	lb/ft^3	kg/m^3	ft/min	m/min
10	160	2900	884	70	1120	7700	2347
15	240	3590	1094	75	1200	8000	2438
20	320	4120	1256	80	1280	8250	2515
25	400	4600	1402	85	1360	8500	2591
30	480	5050	1539	90	1440	8700	2652
35	560	5500	1676	95	1520	9000	2743
40	640	5840	1780	100	1600	9200	2804
45	720	6175	1882	105	1680	9450	2880
50	800	6500	1981	110	1760	9700	2957
55	880	6800	2072	115	1840	9900	3118
60	960	7150	2179	120	1920	10500	3200
65	1040	7450	2270				

*Courtesy of Flotronics Division, Allied industries.

ALAT PENGUMPAN

FEEDER : alat bantu tranportasi agar aliran padatan konstan.

1. **vibrating feeder.**

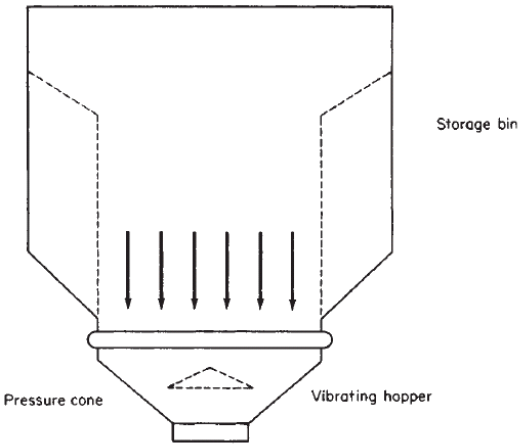


FIG. 21-26 Vibrating hopper. It enlarges the storage-bin opening and breaks up material bridging. (*Courtesy of* Mechanical Engineering.)

2. **Screw feeder**

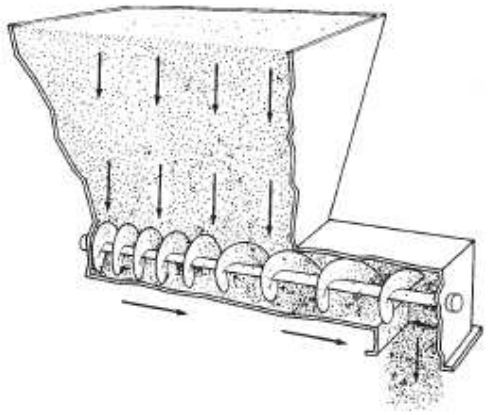


FIG. 21-27 Screw feeder. It needs a variable-pitch screw to produce a uniform draw of material. (*Courtesy of* Chemical Engineering.)

3. belt / apron feeder

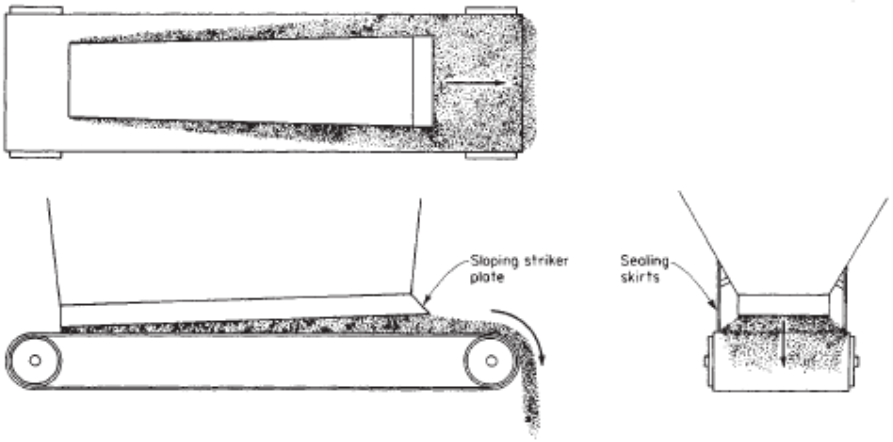


FIG. 21-28 Sloping striker plate in the belt of an apron feeder ensures the flow of non-free-flowing solids. (*Courtesy of* Chemical Engineering.)

4. Table feeder

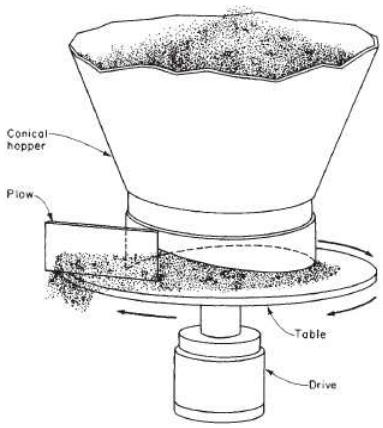


FIG. 21-29 Table feeder. The skirt is raised in a spiral pattern for increased capacity in the direction of rotation. (*Courtesy of* Chemical Engineering.)

5. Vibratory feeder

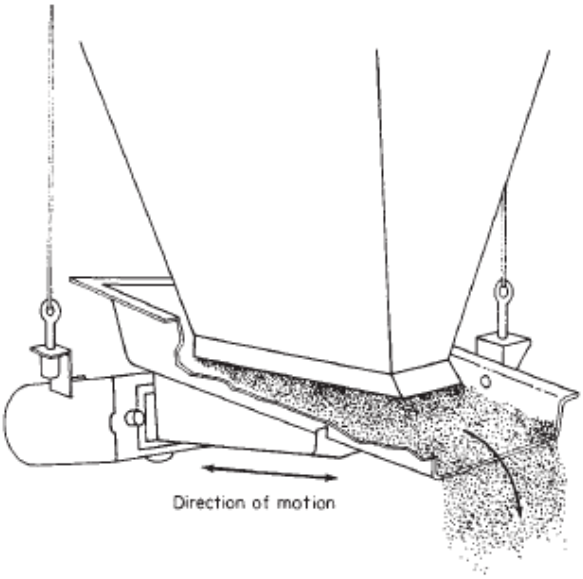


FIG. 21-30 Vibratory feeder. The distance between the feeder pan and the hopper is increased in the direction of feed. (*Courtesy of* Chemical Engineering.)

6. star feeder

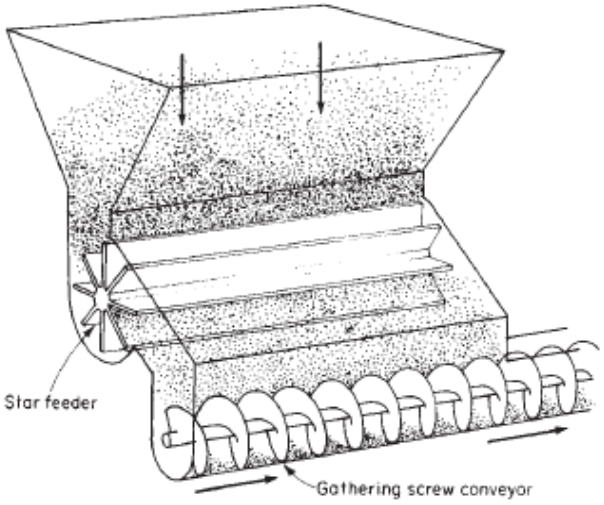


FIG. 21-31 Star feeder. The collecting screw ensures uniform withdrawal. (*Courtesy of* Chemical Engineering.)