Chương 2:

MÁY VÀN CHUYỂN LIÊN TỤC

GV. Nguyễn Hải Đặng

http://www2.hcmuaf.edu.vn/?ur=dangnh
Survey information
Belt conveyors
Chain conveyors
Bucket elevators.
Screw Conveyors
Pneumatic Conveyors
Survey Information
A well designed materials handling system attempts to achieve the following:

(i) Improve efficiency of a production system by ensuring the right quantity of materials delivered at the right place at the right time most economically.
(ii) Cut down indirect labour cost.
(iii) Reduce damage of materials during storage and movement.
(iv) Maximise space utilization by proper storage of materials and thereby reduce storage and handling cost.
(v) Minimise accident during materials handling.
(vi) Reduce overall cost by improving materials handling.
(vii) Improve customer services by supplying materials in a manner convenient for handling.
(viii) Increase efficiency and saleability of plant and equipment with integral materials handling features.
However, the negative aspects of materials handling should also not be overlooked. These are:

(i) Additional capital cost involved in any materials handling system.

(ii) Once a materials handling system get implemented, flexibility for further changes gets greatly reduced.

(iii) With an integrated materials handling system installed, failure/stoppage in any portion of it leads to increased downtime of the production system.

(iv) Materials handling system needs maintenance, hence any addition to materials handling means additional maintenance facilities and costs.
The term “system” has many meanings depending on the field where applied. A general definition of the term could be: a complex unity formed of many often diverse parts subject to a common plan or serving a common purpose. The important characteristics of a system is that the parts, called subsystems, are interrelated and guided by an objective for which the system exists.
In an industry, materials handling is a subsystem (or part) of the production system. Materials handling itself can also be considered to be a system whose subsystems are:

(i) design or method to be adopted,

(ii) types of materials handling equipment to be used,

(iii) different operations like packing / unpacking, movement and storage involved,

(iv) maintenance required for the equipment employed,

(v) mode of transportation by the raw materials suppliers, distributors / customers, waste / scrap collectors etc. The common objective by which the different subsystems are guided is the lowest cost solution of the materials handling system for that industry.
Method to be adopted and choice of equipment for a materials handling system primarily depends on the type of material/s to be handled. It is, therefore, very important to know about different types of materials and their characteristics which are related to methods and equipment used for their handling.

As innumerable different materials are used and need to be handled in industries, they are classified based on specific characteristics relevant to their handling.

Basic classification of material is made on the basis of forms, which are (i) Gases, (ii) Liquids, (iii) Semi Liquids and (iv) Solids.
Following characteristics of gases, liquids and semiliquids are relevant to their handling.

For gases it is primarily pressure, high (25 psi and more) or low (less than 25 psi). Chemical properties are also important.

For liquids the relevant characteristics are density, viscosity, freezing and boiling point, corrosiveness, temperature, inflammamability etc.

Examples of common industrial liquids are: water, mineral oils, acids, alkalies, chemicals etc.

Examples of common semi-liquids are: slurry, sewage, sludge, mud, pulp, paste etc.
CHARACTERISTICS AND CLASSIFICATION OF MATERIALS (3)

Gases are generally handled in tight and where required, pressure resisting containers. However, most common method of handling of large volume of gas is through pipes by the help of compressor, blower etc. This process is known as pneumatic conveying.

Liquids and semiliquids can be handled in tight or open containers which may be fitted with facilities like insulation, heating, cooling, agitating etc. as may be required by the character of the liquid. Large quantity of stable liquids/semiliquids are generally conveyed through pipes using suitable pumps, which is commonly known as hydraulic conveying.
Solids form the majority of materials which are handled in industrial situation. Solids are classified into two main groups: Unit load and Bulk load (materials).

Unit loads are formed solids of various sizes, shapes and weights. Some of these are counted by number of pieces like machine parts, molding boxes, fabricated items. Tared goods like containers, bags, packaged items etc. and materials which are handled en-masses like forest products (logs), structural, pig iron etc. are other examples of unit loads.
CHARACTERISTICS AND CLASSIFICATION OF MATERIALS (5)

(a) Shape of unit loads - (i) basic geometric forms like rectangular, cylindrical, pyramidal/conical and spherical; (ii) typical or usual forms like pallets, plate, containers, bales and sacks; (iii) irregular forms like objects with flat base dimension smaller than overall size, loads on rollers/wheels and uneven shapes.

(b) Position of C.G. (stability) of load.

(c) Mass of unit load in 10 steps from 0-2.5 kg to more than 5000 kg.

(d) Volume per unit in 10 steps from 0-10 cm³ to more than 10 m³.
CHARACTERISTICS AND CLASSIFICATION OF MATERIALS (6)

(e) Type of material in contact with conveying system like metal, wood, aper/cardboard, textile, rubber /plastics, glass and other materials.

(f) Geometrical shape (flat, concave, convex, irregular/uneven, ribbed etc.) and physical properties (smooth, slippery, rough, hard, elastic etc) of base surface of unit load.

(g) Specific physical and chemical properties of unit loads like abrasive, corrosive, dust emitting, damp, greasy/oily, hot, cold, fragile, having sharp edges, inflammable, explosive, hygroscopic, sticky, toxic, obnoxious, radioactive etc.

(h) Loads sensitive to pressure, shock, vibration, turning/tilting, acceleration/deceleration, cold, heat, light, radiation, damp etc.
CHARACTERISTICS AND CLASSIFICATION OF MATERIALS (7)

Bulk materials are those which are powdery, granular or lumpy in nature and are stored in heaps. Example of bulk materials are: minerals (ores, coals etc.), earthly materials (gravel, sand, clay etc.), processed materials (cement, salt, chemicals etc.), agricultural products (grain, sugar, flour etc.) and similar other materials.

Major characteristics of bulk materials, so far as their handling is concerned, are: lump-size, bulk weight, specific weight, moisture content, flowability (mobility of its particles), angles of repose, abrasiveness, temperature, proneness to explosion, stickiness, fuming or dusty, corrosivity, hygroscopic etc.
Lump size of a material is determined by the distribution of particle sizes. The largest diagonal size ‘a’ of a particle in mm (see Fig.1.4.1) is called the particle size. If the largest to smallest size ratio of the particles of a lumpy material is above 2.5, they are considered to be unsized.

Bulk weight or bulk density of a lumpy material is the weight of the material per unit volume in bulk. Because of empty spaces within the particles in bulk materials, bulk density is always less than density of a particle of the same material.
Mobility not flowability of a bulk material is generally determined by its angle of repose. When a bulk material is freely spilled over a horizontal plane, it assumes a conical heap.

Classification and codification of bulk materials based on lump size, flowability, abrasiveness, bulk density and various other characteristics have been specified by the BIS specification number IS:8730:1997(3)
CHARACTERISTICS AND CLASSIFICATION OF MATERIALS (10)

**MATERIAL CODE =**

- One or more alphabets L to Z corresponding to **miscellaneous characteristics**.
- One alphabet H to K corresponding to **Bulk Density**.
- One number 6 to 9 specifying **Abrasiveness**.
- One number 1 to 5 specifying **Flowability**.
- One alphabet A to G specifying **Lump size**.
### CHARACTERISTICS AND CLASSIFICATION OF MATERIALS (11)

<table>
<thead>
<tr>
<th>Material Characteristics</th>
<th>Description of characteristics with Typical Examples</th>
<th>Limits of Characteristics</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lump size</td>
<td>Dusty material (cement)</td>
<td>“$a_{\text{max}}$” upto 0.05 mm</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Powdered material (fine sand)</td>
<td>“$a_{\text{max}}$” upto 0.05 to 0.50 mm</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Granular material (grain)</td>
<td>“$a_{\text{max}}$” upto 0.5 to 0.10 mm</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>Small sized lumpy (iron ore)</td>
<td>“$a_{\text{max}}$” upto 10 to 60 mm</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Medium sized lumpy (chipped wood)</td>
<td>“$a_{\text{max}}$” upto 60 to 200 mm</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>Large lump materials (boulder)</td>
<td>“$a_{\text{max}}$” upto 200 to 500 mm</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Especially large lump size</td>
<td>“$a_{\text{max}}$” over 500 mm</td>
<td>G</td>
</tr>
<tr>
<td>2. Flowability</td>
<td>Very free flowing (cement, dry sand)</td>
<td>Angle of repose: 0°-20°</td>
<td>1</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------</td>
<td>------------------------</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Free flowing (whole grains)</td>
<td>Angle of repose: 20°-30°</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Average flowing (anthracite coal, clay)</td>
<td>Angle of repose: 30°-35°</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Average flowing (bituminous coal, ores, store)</td>
<td>Angle of repose: 35°-40°</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Sluggish (wood chips, bagasse, foundry sand)</td>
<td>Angle of repose&gt;40°</td>
<td>5</td>
</tr>
<tr>
<td>3. Abrasiveness</td>
<td>Non-abrasive (grains)</td>
<td>-----</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Abrasive (alumina)</td>
<td>-----</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Very abrasive (ore, slag)</td>
<td>-----</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Very sharp (metal scraps)</td>
<td>Cuts belting of conveyors.</td>
<td>9</td>
</tr>
<tr>
<td>4. Bulk density</td>
<td>Light (saw, dust, peat, coke)</td>
<td>Upto 0.6 t/m³</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Medium (wheat, coal, slag)</td>
<td>0.6 to 1.6 t/m³</td>
<td>I</td>
</tr>
<tr>
<td></td>
<td>Heavy (iron ore)</td>
<td>1.6 to 2.0 t/m³</td>
<td>J</td>
</tr>
<tr>
<td></td>
<td>Very heavy</td>
<td>2.0 to 4.0 t/m³</td>
<td>K</td>
</tr>
<tr>
<td>5. Miscellaneous characteristics</td>
<td>Aerates and develops fluid</td>
<td>-----</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Contains explosive (or external) dust</td>
<td>-----</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>Sticky</td>
<td>-----</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Contaminable, affecting use or saleability</td>
<td>-----</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Degradable, affecting use or saleability</td>
<td>-----</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td>Gives off harmful fumes or dust</td>
<td>-----</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Highly corrosive</td>
<td>-----</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Mildly corrosive</td>
<td>-----</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>Hygroscopic</td>
<td>-----</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Oils or chemicals present</td>
<td>May affect rubber products</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>Packs under pressure</td>
<td>-----</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Very light and fluffy (or very high flowability and dusty)</td>
<td>May be swept by wind</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Elevated temperature</td>
<td>-----</td>
<td>Z</td>
</tr>
</tbody>
</table>
Table 1.4.2 List of a Few Typical Bulk Materials with Codes

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Material</th>
<th>Average Bulk Density, kg/m³</th>
<th>Angle of Repose, degrees</th>
<th>Code*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alumina</td>
<td>800–1040</td>
<td>22</td>
<td>B27M</td>
</tr>
<tr>
<td>2</td>
<td>Bauxite, crushed, 75mm and under</td>
<td>1200–1350</td>
<td>---</td>
<td>D38</td>
</tr>
<tr>
<td>3</td>
<td>Cement, Portland</td>
<td>1500</td>
<td>39</td>
<td>A27M</td>
</tr>
<tr>
<td>4</td>
<td>Coal, anthracite, sized</td>
<td>960</td>
<td>27</td>
<td>C27</td>
</tr>
<tr>
<td>5</td>
<td>Iron ore</td>
<td>1600–3200</td>
<td>35</td>
<td>D37</td>
</tr>
<tr>
<td>6</td>
<td>Lime, hydrated</td>
<td>560–720</td>
<td>40</td>
<td>---</td>
</tr>
<tr>
<td>7</td>
<td>Rice, hulled or polished</td>
<td>720–768</td>
<td>20</td>
<td>B16</td>
</tr>
<tr>
<td>8</td>
<td>Sand, foundry, prepared</td>
<td>1440</td>
<td>39</td>
<td>D38</td>
</tr>
<tr>
<td>9</td>
<td>Slag, blast furnace, crushed</td>
<td>1280–1440</td>
<td>25</td>
<td>A28</td>
</tr>
<tr>
<td>10</td>
<td>Stone, crushed</td>
<td>1360–1440</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>11</td>
<td>Wheat</td>
<td>720–768</td>
<td>28</td>
<td>C26N</td>
</tr>
<tr>
<td>12</td>
<td>Wood chips</td>
<td>290–320</td>
<td>–</td>
<td>E56WY</td>
</tr>
</tbody>
</table>
Phân loại

- Máy VCLT có bộ phận kéo: băng tải, xích tải, gầu tải.
- Máy VCLT không có bộ phận kéo: băng chuyển con lăn, vít tải, máng lắc, băng tải rung....
- Máy vận chuyển bằng thủy khí: dùng sức nước (không khí) để vận chuyển vật liệu.
Phân loại:
Đặc tính của vật liệu vận chuyển:

- Vật liệu đóng kiện và bao bì: các chi tiết máy, cụm máy, hòm, thùng, kiện, túi, bao,…
- Vật liệu ròi: hạt, bột, vỏ trấu, sản phẩm sau vỏ viên,…
- Vật liệu dạng nhão quánh: bột nhão,..
Đặc tính của vật liệu đóng kiện

- Trọng lượng của kiện
- Hình dạng và kích thước
- Loại bao bì
- Tính chất và diện tích mặt tựa
- Sự tiện lợi khi đặt hoặc treo.
- Mức độ chống lắc giật và rung.
- Các tính chất khác: nhiệt độ, khả năng gây nổ, cháy,...
Đặc tính của vật liệu rợi

- Tỉ trọng
- Thành phần hạt
- Góc đọc tự nhiên
- Hệ số ma sát tịnh và động
- Các tính chất đặc biệt: độ ẩm, tính hút ẩm, tính mài mòn, nhiệt độ,…
- Độ giòn, độ nhạy với tác dụng cơ học.
Phân loại vật liệu ròi

Theo kích thước

- Cục lớn: >160 mm
- Cục trung bình: 60 – 160 mm
- Cục nhỏ: 10 – 60 mm.
- Hạt: 0,5 – 10 mm.
- Bụi: <0,5 mm.

Theo tính đồng nhất:

- Chưa gia công: \( \frac{\alpha_{\text{max}}}{\alpha_{\text{min}}} > 2,5 \)
- Gia công: \( \frac{\alpha_{\text{max}}}{\alpha_{\text{min}}} < 2,5 \)

Theo tỷ trọng

- Nhẹ: \( \leq 0,6 \text{ T/m}^3 \)
- Trung bình: 0,6 – 1,1
- Nặng: 1,1 – 2.
- Rất nặng: >2.
CHỌN THIẾT BỊ VẬN CHUYỂN LIÊN TỤC

- Đặc điểm của vật liệu vận chuyển.
- Năng suất yêu cầu của thiết bị.
- Phương vận chuyển.
- Chiều dài vận chuyển.
- Phương pháp bảo quản vật tại nơi chất và đổ tải.
- Đặc tính của các quá trình gia công.
- Điều kiện tương quan bổ trợ các thiết bị vận chuyển.
- Các yếu tố phát sinh.
Sơ đồ vận chuyển hạt
Dây chuyền chế biến thức ăn gia súc