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KLM Technology Group #03-12 Block Aronia, Jalan Sri Perkasa 2 Taman Tampoi Utama 81200 Johor Bahru Malaysia	PROCESS DESIGN OF SOLIDS HANDLING SYSTEMS (PROJECT STANDARDS AND SPECIFICATIONS)	

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SCOPE

This Project Standards and Specification is intended to cover basic minimum process requirements, and governing the selection of a proper handling system for bulk materials, with specific concern to capacity requirements, material characteristics, process requirements, and flow properties of solids. Classification codes summarizing bulk solids behavior, process design considerations from the views of operating conditions and other process design information and criteria to the extent specified herein are covered.

REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

1. **BSI (British Standards Institution)**

- | | |
|-----------------------|--|
| BS 4409, Part 1, 1991 | "Screw Conveyors, Specification for Fixed Trough Type" |
| BS 4409, Part 3, 1982 | "Screw Conveyors, Method for Calculating Driver Power" |

2. **ISO (International Organization for Standardization)**

- | | |
|--------------------------|---|
| ISO 7119, 1st. Ed., 1981 | "Continuous Mechanical Handling Equipment for Loose Bulk Materials Screw Conveyors" |
| ISO 5048, 2nd. Ed., 1989 | "Continuous Mechanical Handling Equipment Belt Conveyors with Carrying Idlers- Calculation of Operating Power and Tensile Forces" |
| ISO 2148, 1st. Ed., 1974 | "Continuous Handling Equipment Nomenclatures" |

3. **ANSI/CEMA (American National Standard Institute/Conveyor Equipment Manufacturers Association)**

- | | |
|--------------------------------|------------------------------|
| 350 Class III E, 1st Ed., 1971 | "Screw Conveyors" |
| 350 Class IV E, 1st. Ed., 1970 | "Package Handling Conveyors" |

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4. **IATA (International Air Transportation Association)**

5. **CAB (Civil Aeronautics Board)**

SYMBOLS AND ABBREVIATIONS

SYMBOL/ABBREVIATION

DESCRIPTION

CAB	Civil Aeronautics Board.
CEMA	Conveyor Equipment Manufacturers Association.
D	Nominal screw diameter, in (m).
DOT	Department Of Transportation.
g	Acceleration due to gravity, in (m/s ²).
H	Height to which the material to be elevated, in (m).
IATA	International Air Transportation Association.
I_v	Volume flow rate, in (m ³ /h).
L	Length of conveyor, in (m).
OGP	Oil, Gas and Petrochemical.
P_H	Power necessary for the progress of the material, in (kW).
P_N	Drive power of screw conveyor at no load condition, in (kW).
P_{st}	Power due to inclination, in (kW).
$\rho_{(rho)}$	Bulk density, in (kg/m ³).
$\phi_{(Phi)}$	Trough filling coefficient, (dimensionless).
$\theta_{(theta)}$	Cone angle, in (rad).
W	Product capacity, or carrying capacity of belt, in (kg/s).

UNITS

This Standard is based on International System of Units (SI) except where otherwise specified.

GENERAL CONSIDERATION

Most Salient Features

Selection of a specific handling system for bulk materials requires a full knowledge of the physical and chemical properties of the materials to be handled. Material characteristics and the prevailing plant conditions, play an important role in determining the flow behavior of the product, thereby influencing

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the type of the equipment selected. The most salient features for selection of a suitable handling system are:

1. Capacity

Capacity requirement is a prime factor in conveyor selection. Belt conveyors which can be manufactured in relatively large sizes, to operate at high speeds, deliver large tonnage economically. On the other hands screw conveyors become extremely cumbersome as they get larger and can not be operated at high speeds without creating serious abrasion problems.

2. Distance

Length of travel is definitely limited for certain type of conveyors. With high-tensile-strength belting, the length limit on belt conveyors can be a matter of miles. Air conveyors are limited to 300 meters, vibrating conveyors to 100 meters. In general as the length of travel increases, the choice among alternatives become narrower.

3. Lift

Lift usually can be handled most economically by vertical or inclined bucket elevators, but when lift and horizontal travel are combined, other conveyors should be considered. Conveyors that combine several direction of travel in single unit are generally more expensive, but since they require a single drive, this feature often compensates for the added base cost.

4. Materials

Material characteristics, both chemical and physical characteristics should be considered especially flowability, abrasiveness, friability and lump size. Effects of chemicals, moisture and oxidation effects from exposure to atmosphere can be harmful to the material being conveyed, or to the conveyor's material. Certain type of conveyors lend themselves to such special requirements better than the others.

5. Processing

Processing requirements can be met by some conveyors with little or no change in design. For example, screw conveyors are available for a wide variety of processing operations such as mixing, dewatering, heating and cooling. A continuous flow conveyor may provide a desired cooling for solids simply because it puts the conveyed material into direct contact with heat conducting metals.

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6. Flow properties of solids

The flow characteristics of bulk solid materials depend on their physical and chemical properties. The main characterizing factors to be considered in selection of solids conveying systems are:

Product grouping

The flowability of the product yields two main categories of bulk solids is specified below:

- Group I

This group includes free-flowing materials, i.e., non cohesive products; those that do not undergo any plastic deformation when subjected to high pressures. When the load is removed, the particles return to their original condition in terms of both shape, and flow characteristics.

- Group II

All products which undergo plastic deformation when subjected to external pressure i.e., cohesive products for which the degree of deformation is strongly influenced by both temperature and moisture. When the load is removed, the particles do not regain their original shape, thereby yielding poor flow condition.

Fluidization Characteristics

The ability of the material to fluidize and whether the product has an affinity to trap air or gas is of major importance when designing and selecting of solids handling and storage systems.

Flow Function

Flow functions for both short and long residence time in silos and storage bins shall be taken into account in design and selection. Additional complications occur when the product is stored at elevated temperature or when humidity could influence the moisture content of the product.

Important Flow Features

For the successful operation of any materials handling system the flow of solids from bins and silos must be controlled. The following important features should be considered in selection and design of such storage facilities.

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Factors influencing flow

Three essential factors must be considered when designing a storage hopper or bin:

1. Geometric form of the hopper: the elements which must be considered includes:
 - a. cone angle θ (theta);
 - b. size of outlet;
 - c. shape (circular or rectangular);
 - d. hopper construction material.
2. Product characteristics:
 - a. particle size and shape;
 - b. particle size distribution;
 - c. particle density and bulk density;
 - d. cohesiveness of the product;
 - e. fluidizability;
 - f. floodability;
 - g. deaeration characteristics.
3. Additional factors:
 - a. influence of humidity;
 - b. temperature of product and process;
 - c. storage time;
 - d. ambient conditions.

CONVEYING OF BULK SOLIDS

Conveyor Selection

1. Main guidelines and prime factors are given under Clause 5 of this Specification that must be considered in the course of evaluating and selection. However, it is advisable to check with the manufacturer to be sure that the application is proper.
2. Conveyor selection must be based on the as-conveyed characteristics of a material. For instance if packing or aerating can occur in the conveyor, the

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machine's performance will not meet expectations if calculations are based on an average mass per cubic meter. Storage conditions, variations in ambient temperature and humidity, and storage methods may all affect conveying characteristics. So, such factors should also be carefully considered before making a final conveyor selection.

Mechanical Conveyors

1. General

Mechanical conveying techniques are the most widely used form of materials handling in chemical and petrochemical industries. Mechanical conveyors have distinct advantages in terms of the ability to affect accurate control in the monitoring of material from one process to another.

Under this Project Standards and Specification, some basic features of the various types of mechanical conveyors as well as the safety and environmental considerations are covered.

2. Belt conveyors

a. General

Belt conveyors are the most widely used and versatile mode of mechanical conveying systems employed to transport materials horizontally or on an inclined either up or down. Fig. 1, represents a typical belt-conveyor arrangement, with following main components of the system:

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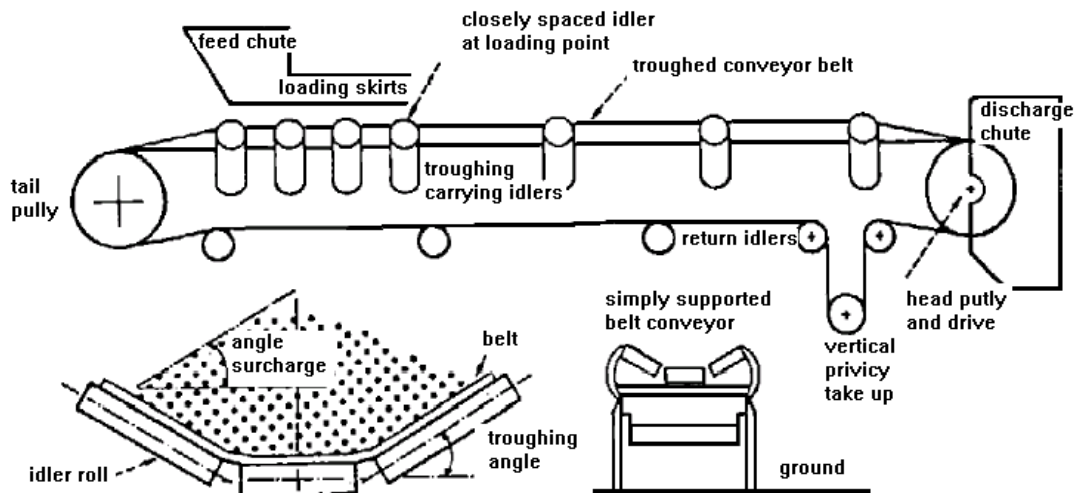


Fig. 1 Typical Belt-Conveyor Arrangement

- The belt, which forms the moving and supporting surface on which the conveyed material rides.
- The idler, which form the supports for the carrying and return strands of the belt.
- The pulleys, which support and move the belt and control its tension
- The drive, which imparts power to one or more pulleys to move the belt and it's load.
- The structure, which supports and maintains the alignment of the idlers and pulleys, and supports the driving machineries.

b. Requirements

Unless otherwise specified, all conveyers, drives, supports, electricals including control panel and other materials necessary to complete the conveying system shall be furnished by the Vendor.

Vendor shall furnish all appliances, special tools, and accessories that are necessary or incidental to the proper installation and safe operation of the equipment, even though these items may not be included in the drawings, specifications, or data sheets.

A summary of utility requirements including electric power, plant and instrument air, cooling water, steam, etc., shall be submitted with the Vendor's quotation.

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Vendor shall submit recommendations for following 3 categories of spare parts:

- Erection and pre-commissioning.
- Commissioning and initial operation.
- 2 years of normal operation.

c. Design

- o Conveying system shall be designed for 24 hours, continuous operation at the rated output in the specified environment.
- o General arrangement drawings of conveying system showing location of gravity take-up, bents, support locations, etc., which shall be prepared by the Vendor.
- o Vendor shall be responsible to guarantee performance of the belt conveyor system. The data sheets, and drawings shall indicate minimum requirements, but these shall in no way relieve the Vendor from his responsibility for providing a system capable to meet the required performance.
- o Materials of construction shall be selected and specified in accordance with service condition and handling material specification.
- o Belt conveyors shall be CEMA Grade 2, designed for the material conveying temperature.
- o The following operating conditions shall be considered in belt conveyor design:
 - Service condition, is the first step which should be considered. The method by which the conveyor will be fed, the point where loading will take place, and where the material will be discharged.
 - Surroundings, which involve such conditions as high temperature or corrosive atmosphere can affect the belt, machinery and structure.
 - Continuous service, may require extremely high quality components and even specially designed equipment for servicing while the belt is in operation.
 - Belt width and operating speed, are functions of the bulk density and lump size of the material, using the narrowest possible belt for a given lump size and operating it at maximum speed can result in lowest cost.

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- For detailed design requirement of belt conveyors, reference is given to ISO 5048, 1989, "Continuous Mechanical Handling Equipment Belt Conveyors".
- o The following criteria shall be considered in design of the belt conveyor:
 - Belt conveying capacity, belt incline, and belt loading points shall clearly be determined in design data sheets.
 - Design and engineering of belt conveyors must be directed toward keeping the belt in operating condition.
 - The belt transfer points should be reduced to a minimum to cut degradation, dust and cost.
 - All belt lines should be elevated to a specified level above ground to ease inspection, maintenance, and cleanup.
 - Clearances above roadways and rail lines should permit the passage of cranes and other mobile equipment, as well as fire control vehicles. Minimum vertical clearance for passage above/below other facilities shall be as per table 2.
 - Care should be taken to control dust emissions. The amount of dust released depends upon the physical characteristics of the bulk material and the manner in which the material is handled. An enclosure around the transfer should be placed to control the dust emission.
 - In addition to requirements specified above, the following design information shall be submitted for the Company's review:
 - Dimensioned outline drawings showing equipment physical arrangement and elevation.
 - Completed specification sheets giving manufacture, size, type or model of specific equipment to be furnished.
 - Materials of construction.
 - Calculations and data necessary to support and interpret the calculations.
 - Detailed drawing and data showing:
 - device for cleaning the conveying surface of the belt;
 - length of each type and size of belt to be furnished for field splices;
 - type and location of idlers;
 - seal and lubrication sign of idlers.