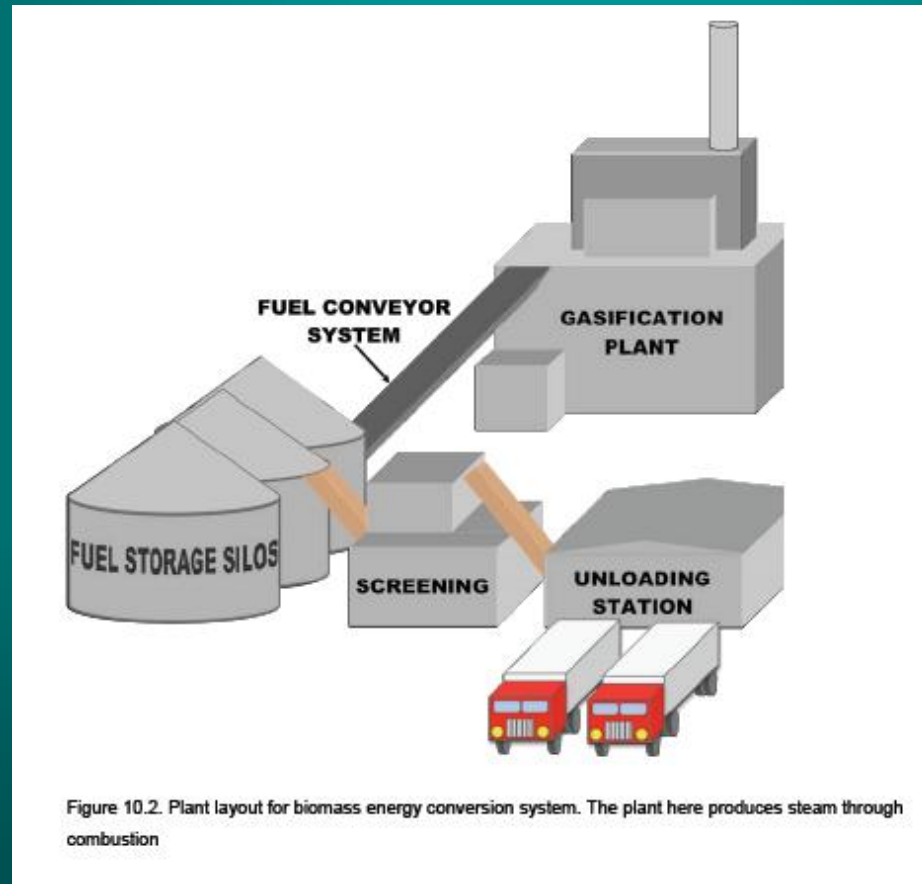


Chapter 10: Biomass Handling System



Mech 4840
Steam Plant
Engineering

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Why is the Handling System so important?

- Metering the fuel feed system is an important aspect of the biomass gasification plant because it is used to control the entire process.
- The handling system controls the flow rate of fuel into the gasifier. If the flow is variable then the gasifier will not maintain the desired temperatures and will not be as efficient.

The problem

- Unlike liquids, the biomass solids do not deform under shear stresses (causes jamming) and this is why the storage and handling of biomass is so important.
- Reasons for many shutdown incidents of biomass gasifier plants can be traced to the failure of the biomass handling system.
- Some biomass contains rocks and other debris when it arrives at the plant.

Biomass Handling System

- The Biomass Handling System can be broken down into 5 stages:
 - Biomass receiving
 - First Stage Screening (Optional)
 - Storage
 - Feed preparation
 - Conveying
 - Feeding

Biomass Receiving

- The Biomass is first transported via truck or rail-car and unloaded at the receiving station.



Figure 10.3 Biomass carrying truck is tilted to unload biomass in the plant. (Photograph by the author)

First Stage Screening (optional)

- Sometimes depending on the type of biomass there is a first stage screening to remove foreign materials.

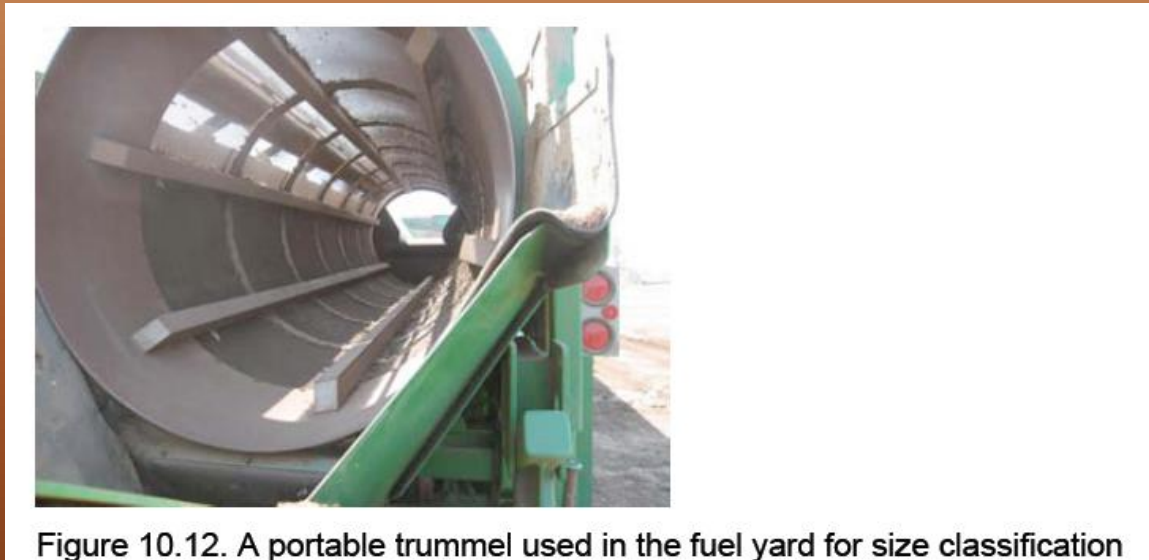


Figure 10.12. A portable trammel used in the fuel yard for size classification

Storage

- Once received (or screened) the biomass is transported by conveyor belt to one of the 2 types of storage types:
 - Above ground storage for large biomass
 - Silo or bunker for enclosed storage of smaller biomass.

Above Ground Storage



Silo or Bunker Storage



Figure 10.5 A typical grain silo used for storing cattle feed

Retrieval from Storage

- The following are some methods of biomass retrieval from storage
 - Simple gravity feed or chute
 - Screw type auger feed
 - Conveyor belt
 - Pneumatic blower
 - Pumped flow
 - Bucket conveyor
 - Front loader
 - Bucket grab

Feed Preparation

- Once retrieved the biomass is transported to the Feed Preparation System because biomass can not be fed directly into the gasifier for the following reasons
 - Presence of foreign materials like rocks and metals
 - Unacceptable level of moisture in biomass
 - Too large (or uneven) in size
- The feed preparation process consists of
 - Screening
 - Drying
 - Sizing

Screening

- The most common foreign materials that must be removed are:
 - Stones
 - Ferrous metals like iron
 - Non-ferrous metals like aluminum
- This is why there is a screening (possibly second) process that consists of
 - De-stoner
 - Non-ferrous metal separators
 - Magnetic metal separation

De-stoner

- The purpose of a de-stoner is to separate heavier-than-biomass materials like glass, stones and metals.
- Typically use vibratory actions in series with airflow to separate materials according to specific gravity.

Non-Ferrous Metal Separators

- Uses an eddy current to separate according to specific mass and resistivity

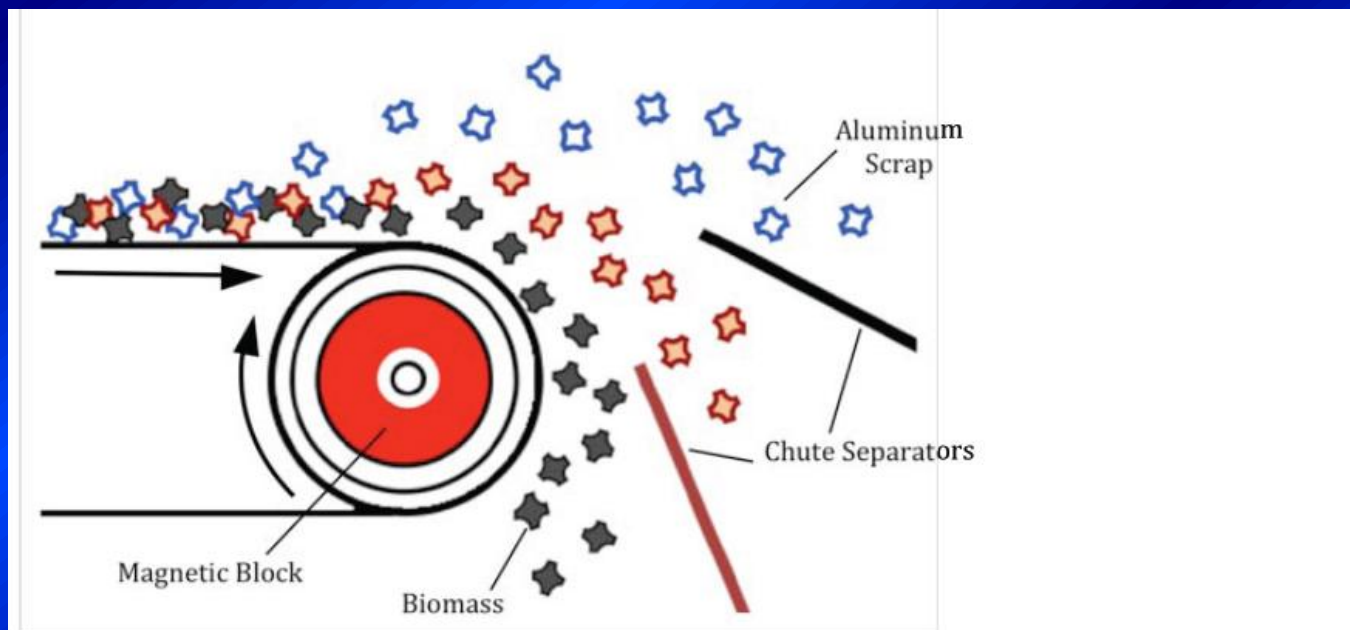
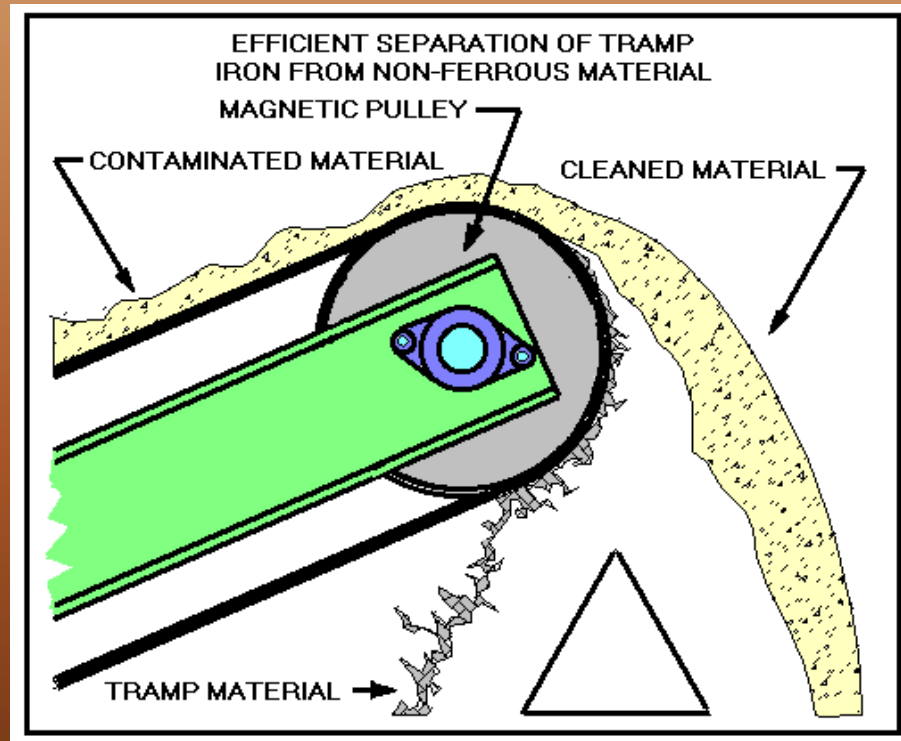


Figure 10.10 Separation of non-ferrous metals from biomass using eddy current separation

Magnetic Metal Separation

- Use powerful magnets for separation of iron and other magnetic materials.



Drying

- Freshly cut biomass can contain up to 40-60% surface moisture and a gasification process typically requires moisture to be less than 10-15%.
- Use heat in the flue gas or external sources of heat to reduce moisture levels.
- If moisture is not removed then the gasifier can not reach high enough temperatures and the efficiency of the plant is decreased.

Sizing

- Typical equipment that are used for cutting biomass into different sizes.
 - Chunker: 250 to 50 mm
 - Chipper: 50 to 5 mm
 - Grinder: <80 mm
 - Pulverizer: dust <100 micrometers

Conveying

- Once the biomass prepared, it is then transported to the hopper which gravity feeds the feeder.



Hopper

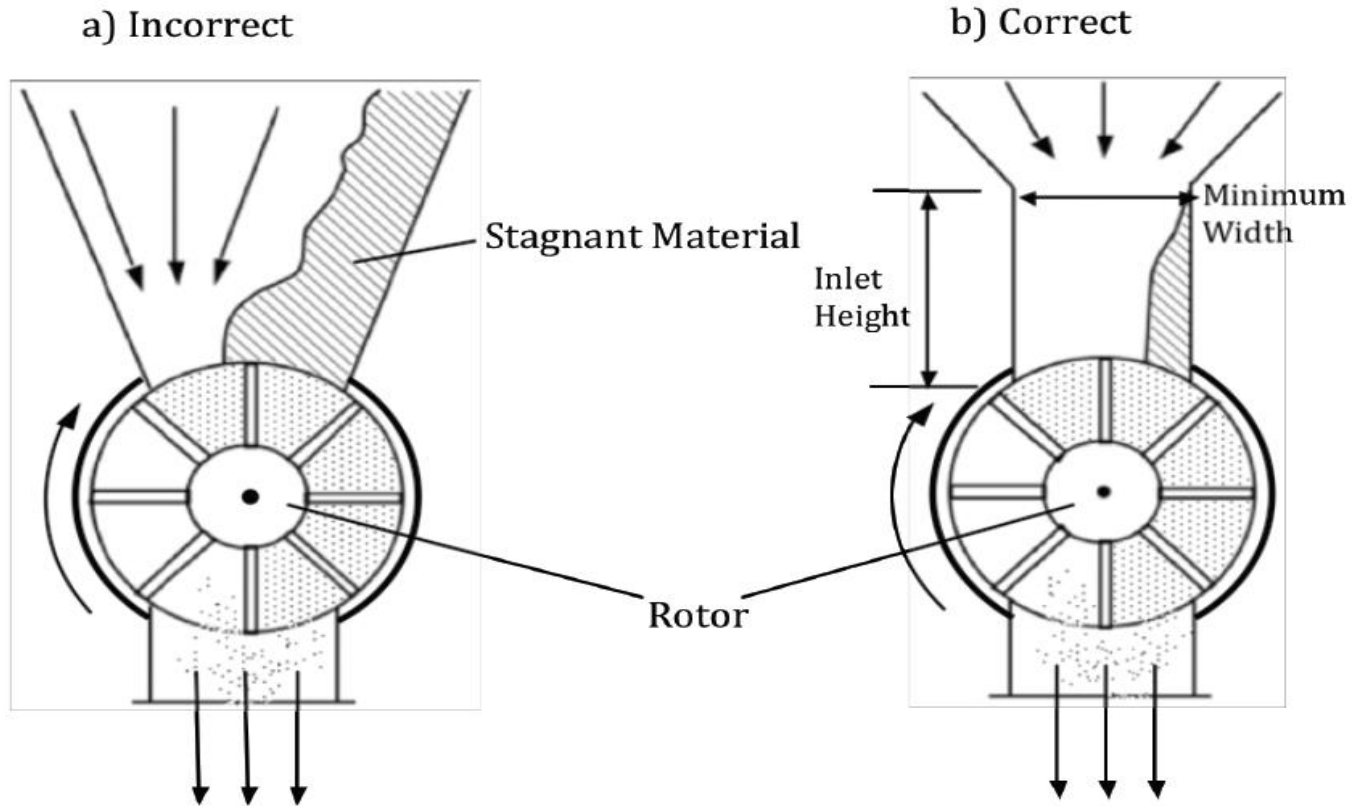


Figure 10.9 A small vertical section above a rotary feeder as shown on the right gives better flow.

6 Main Types of Feeders

- **Gravity Chute**
- **Screw Conveyor**
- **Pneumatic Injection**
- **Rotary Spreader**
- **Moving Hole Feeder**
- **Belt Feeder**

Gravity Chute

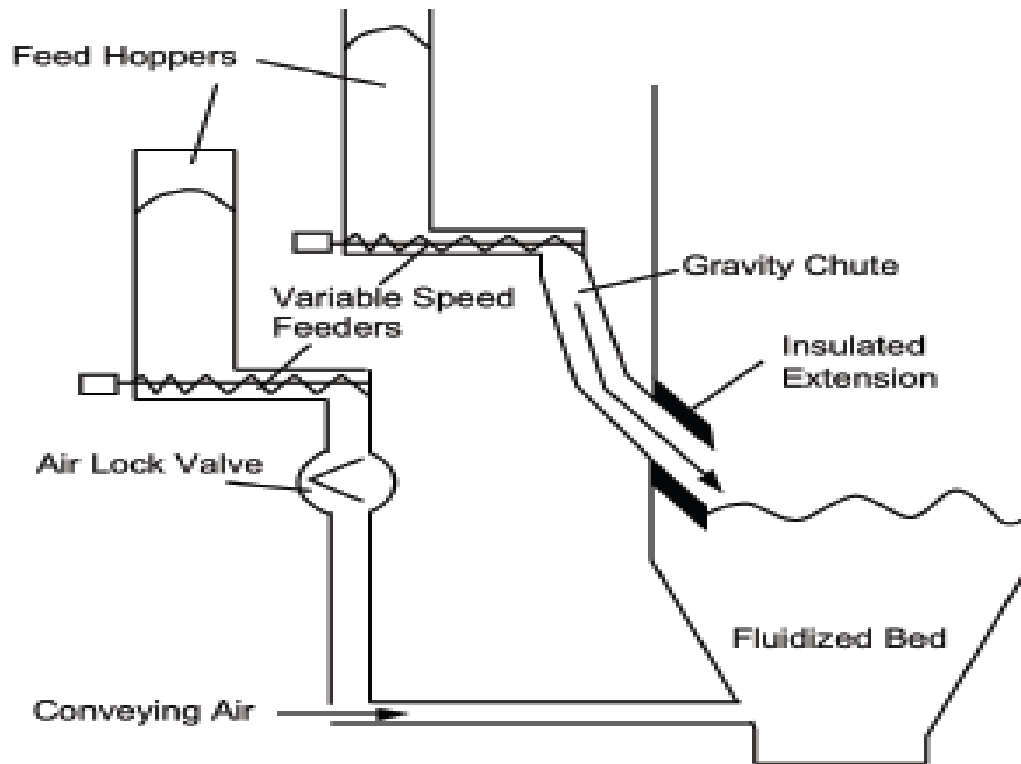


Figure 10.19 Position of over-bed and under-bed feeders in a bubbling fluidized bed

Screw Conveyor

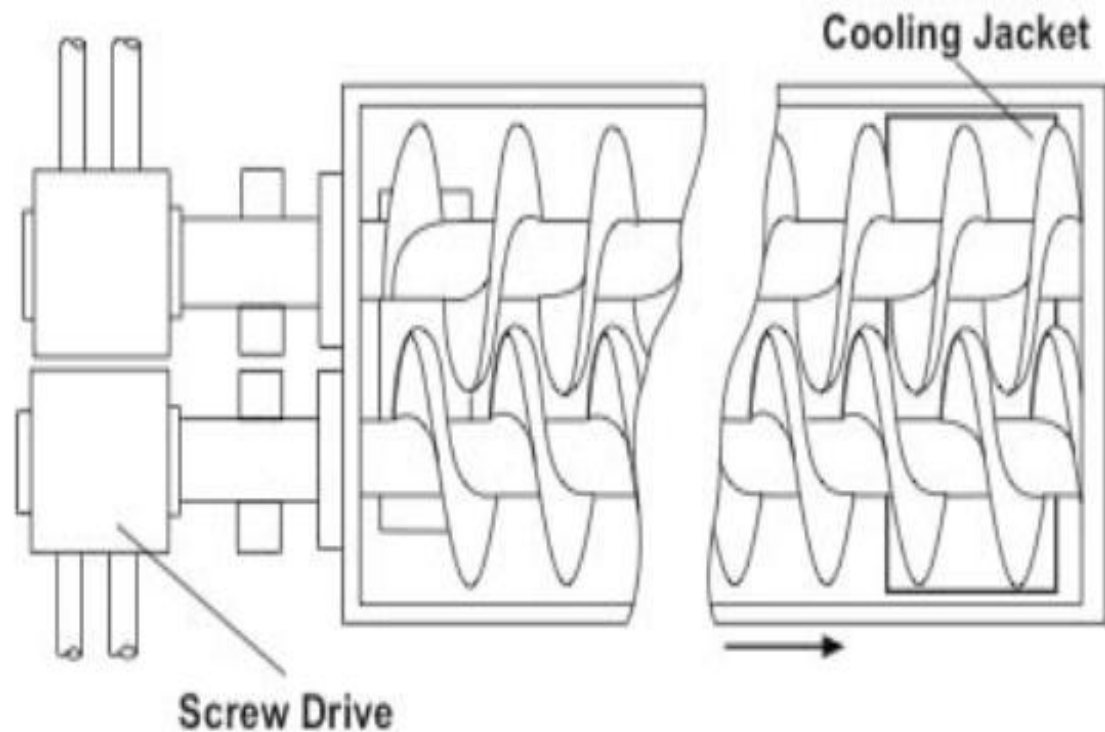


Figure 10.17 Double screw feeders help uniform flow of biomass

Pneumatic Injection



Rotary Spreader

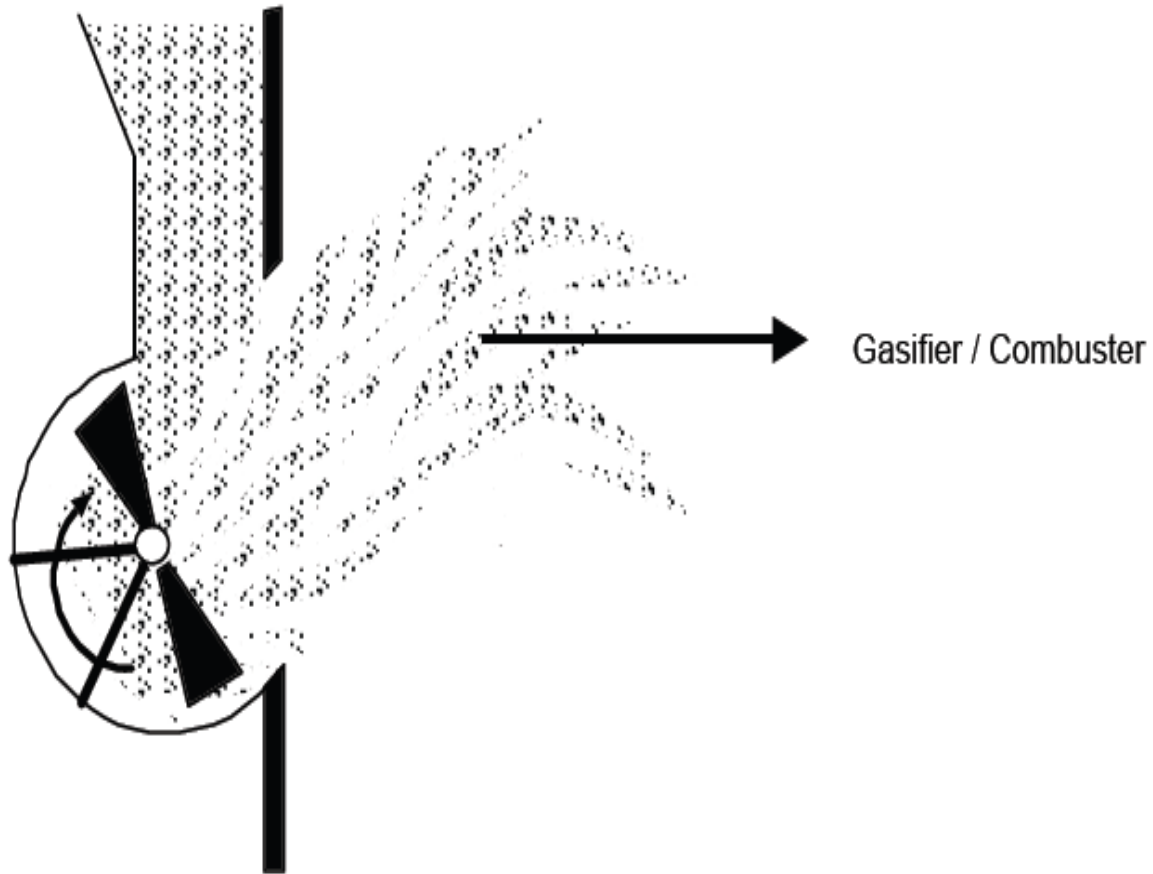
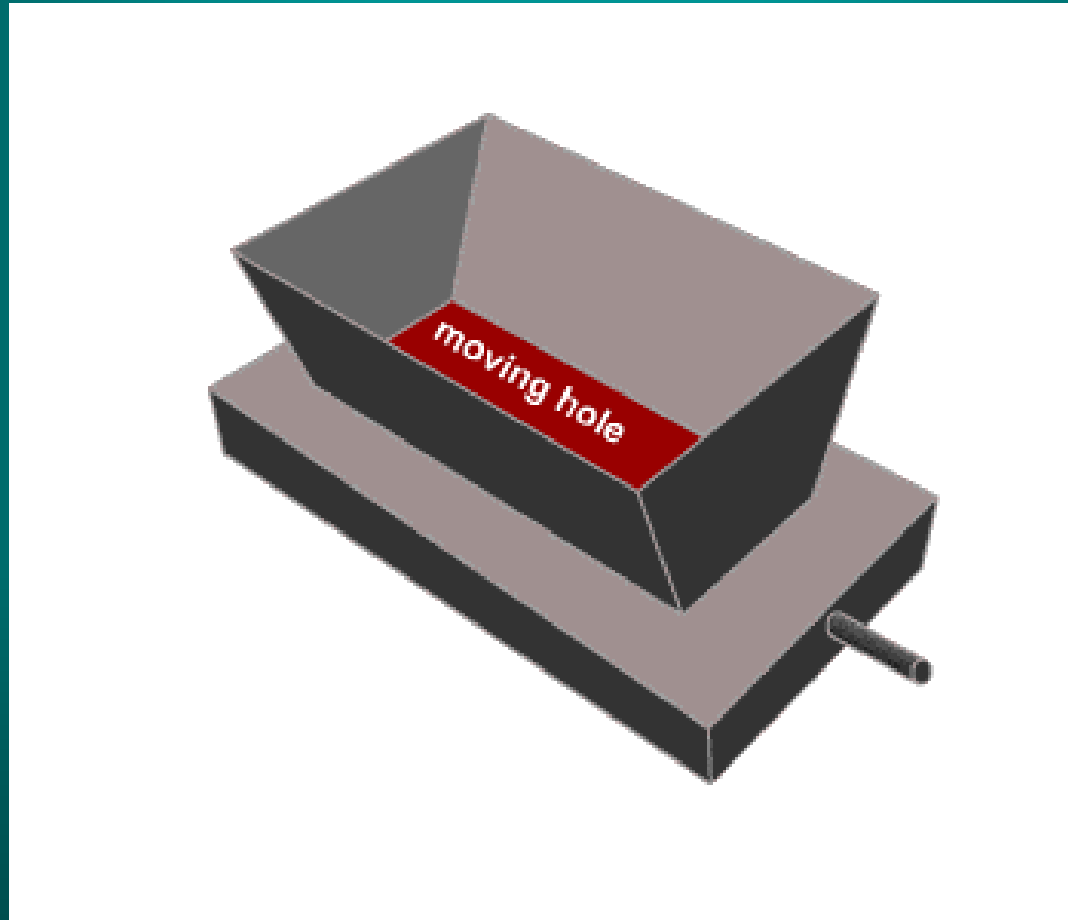
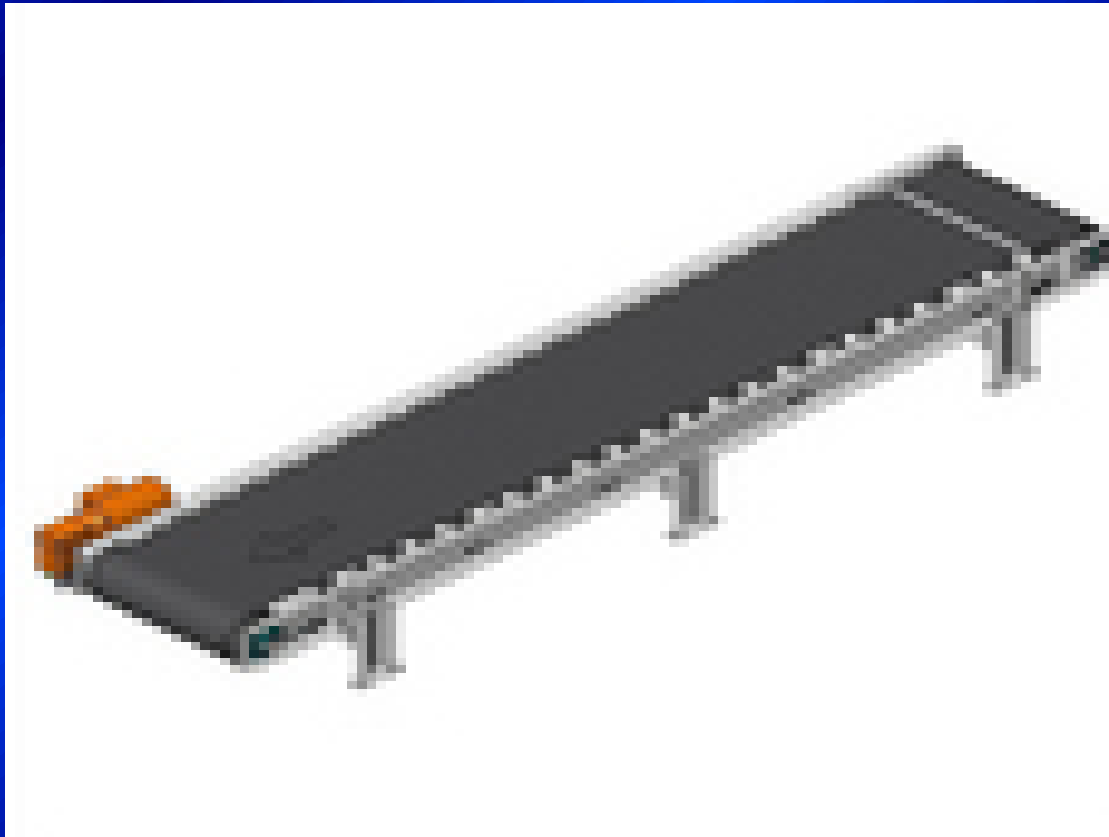


Figure 10.18 Rotary spreader for spreading the fuel over a large bed area

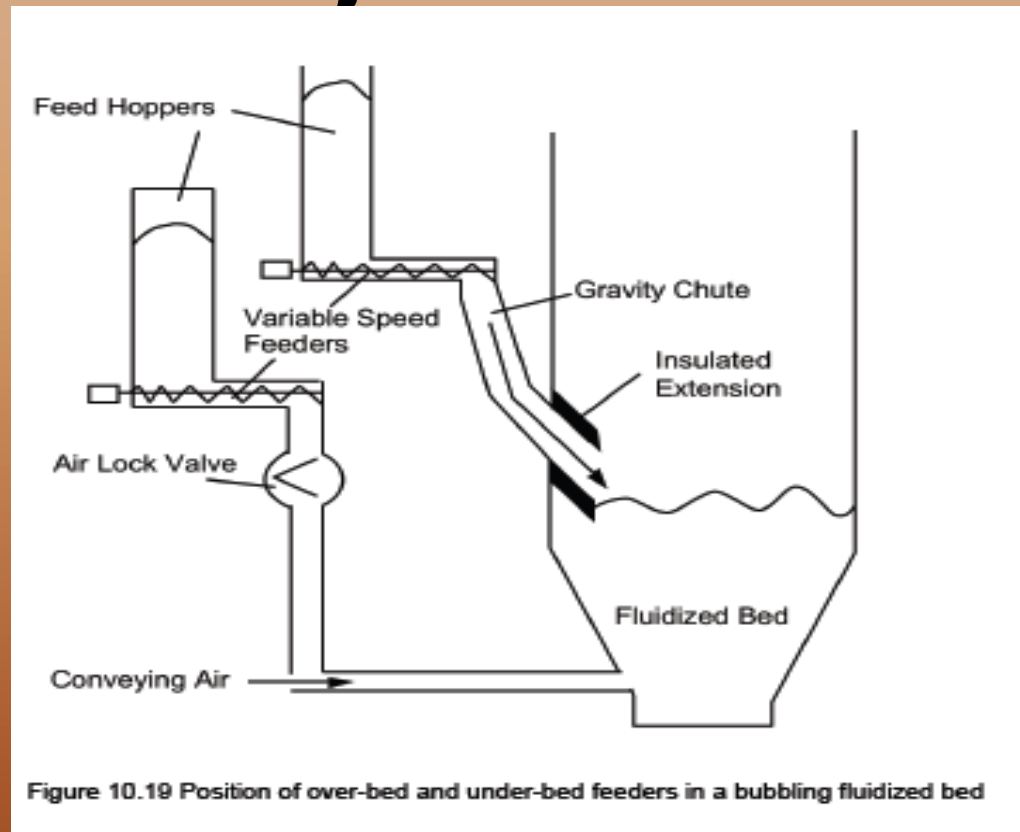
Moving Hole Feeder



Belt Feeder



Mode of Fuel Injection in Fluidized Beds



- **Over-Bed System** – handles coarser particles
- **Under-Bed System** – handles fine particles

References

- Google Images
- Chapter 10: Biomass Handling System by Dr. Basu