SURFACE COATING

Reference: Shreve's Book Ch. 24, pp. 380-399

Classifications

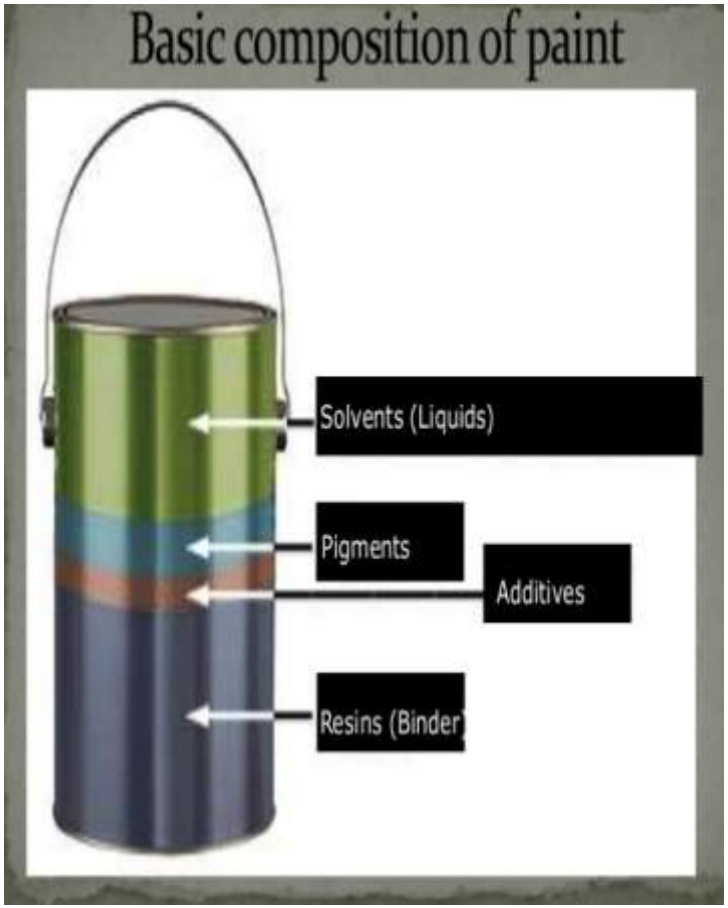
- Paints (relatively opaque solid coating applied as thin layer) whose film are usually formed by polymerization.
- Varnishes (Clear coating).
- Enamels (Pigmented varnishes).
- Lacquers (Films formed by evaporation only).
- Printing inks

Types of paints

- Solvent-based paints
- Water-based paints

Raw Materials

- Paint is a composite material of a finely divided pigment dispersed in a liquid composed of a resin or binder and a volatile solvent.



Constituent

1. Pigments

Pigments, gives color and covering power, are finely dispersed solid particles. In some cases they can be used for certain protective properties, such as: rust prevention, and to control gloss levels

- Titanium dioxide provide excellent hiding or whitening, and brightening).
- Zinc Oxide (Resists ultra violet light).
- Mica, red lead, carbon black

TiO_2

Constituent

- Pigment Volume Concentration

$$PVC = \frac{volume\ of\ pigment\ in\ paint}{volume\ of\ pigment\ in\ paint + volume\ of\ non\ volatile\ solvent\ in\ paint}$$

- PVC control such factors as:

Gloss, reflectance, rheological properties, washability and durability

Paint type	PVC %
Gloss paint	25-35
Wood primers	35-40
Exterior house paint	28-36

Constituent

2. Resins (film former)

- Bind or glue ingredients (pigments and additives)of paint together.
- Provide adhesion to the substrate.
- Provide durability and resistance properties such as: moisture and chemical resistance).
- (Vinyls, cellulose, epoxy, urethane, styrene, and polyesters)

- The binder may be dissolved in a solvent, or in the form of an emulsion or colloidal dispersion in water. This results in solvent-borne and water-borne paints, respectively.

Constituent

3. Fillers or extenders

- Fillers are a special type of pigments that serve to thicken the film, support its structure, increase the volume of the paint.
- Fillers are usually comprised of cheap and inert materials such as talc, lime and clay.

Constituent

4. Solvents

- Used to adjust viscosity of the paint.
- evaporates, leaving the dry film coating
- Water is the main solvent of the water based paint.
- Solvent based paint can have various combination of solvents including aliphatics, ketones and alcohols.

Constituent

Drying oil and fatty acids:

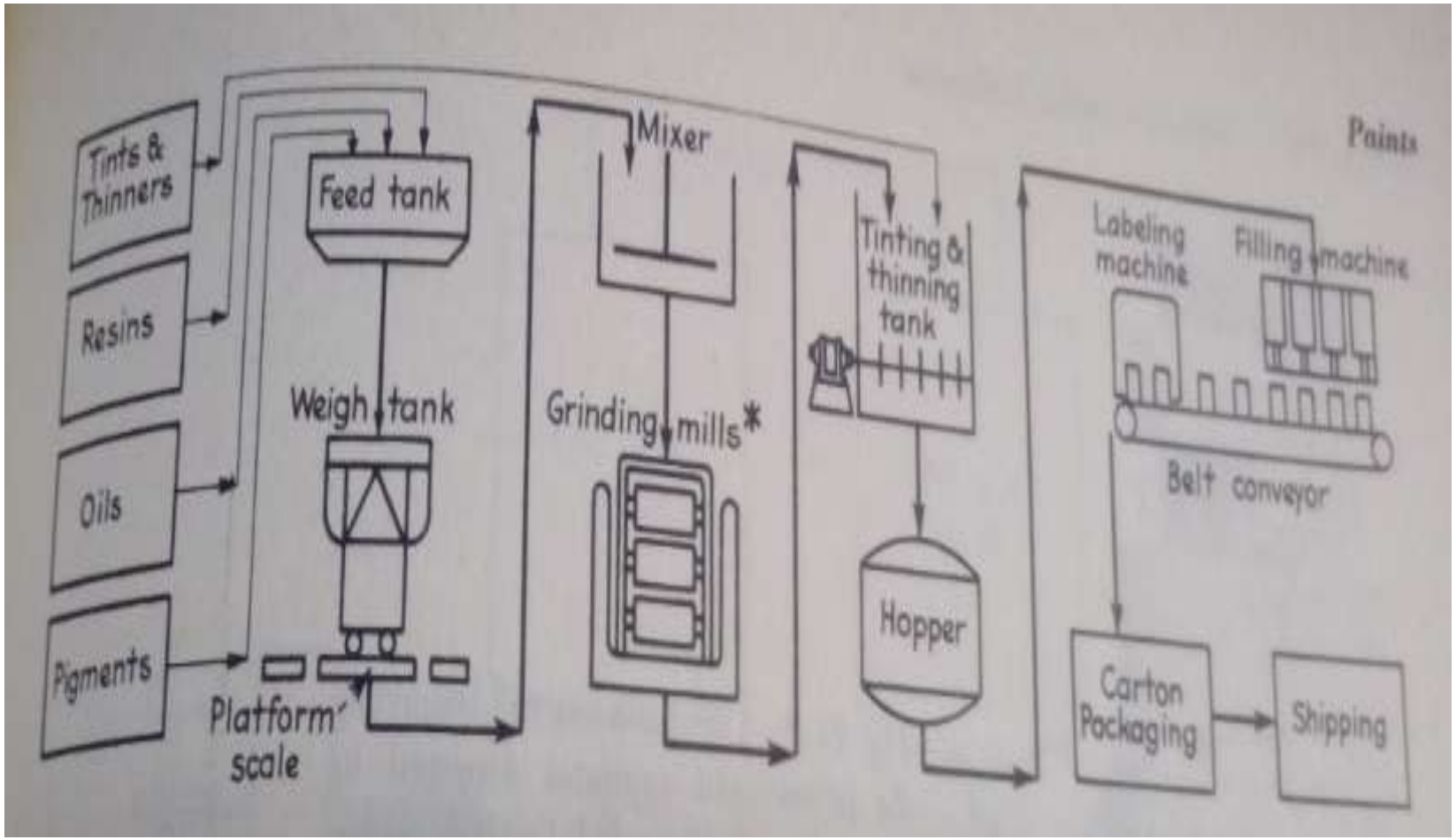
- Linseed oil
- Soybean oil
- Castor oil
- Coconut oil

Constituent

5. Additives

Additives are used in small amounts, to modify the film or paint. Examples are driers, which promote the drying time of some coatings; flow-control agents, which give a smooth surface; defoamers, which prevent the formation of bubbles that could dry in the film; and anti-skinning agents to prevent the paint from forming a 'skin‘.

Paints Industry Flowsheet



Equipment Used in Paints Industry

- Mixers
- Milling machines
- Filters
- Packing machines

Equipment Used in Paints Industry

1. Mixers

- Mixers are used to achieve **homogeneity between different components,** specially in the production of **varnishes or water-based paints**. Mixers are used in the following operations:

- Mixing oils or resins.
- Mixing pigments and fillers with coating materials.
- Decreasing the viscosity of resins, and varnishes.
- Mixing additives with paints or varnishes.
- Adding solvents or diluting agents (thinner) to paints, to adjust the viscosity.
- Preparing emulsion (water-based) paints.

There are many types of mixers used in paint industry, they differ in their suitability for different applications.

Equipment Used in Paints Industry

- Choice of mixer type depends on the following
- **Viscosity** : mixers types used in preparing pastes differ from those used in the production of low viscosity paints.

- **Density difference between components** : achieving the desired homogeneity depends on the type of impeller, blades design, mixing speed, and inclination of impeller axis with respect to mixing tank axis.

- **Solid particle size :** Some components, such as pigments agglomerates, have relatively large particle size compared to other components. Also volatility of solvents affects the design of mixers and the need for cooling

Equipment Used in Paints Industry

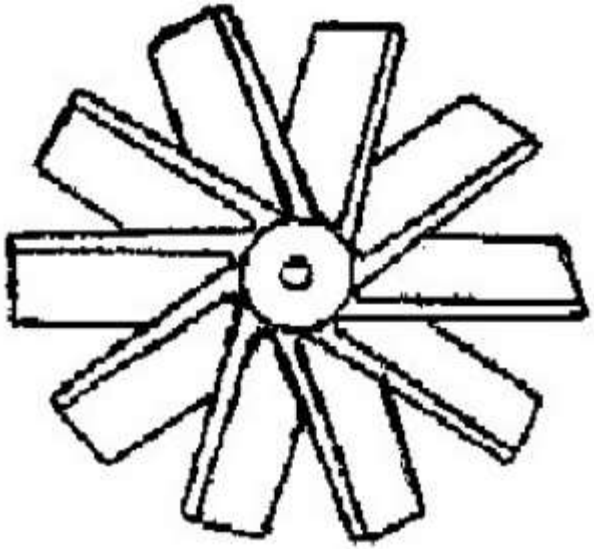
- The mixers usually consists of mixing tank, usually vertical, and one or more impeller(s) driven by electrical motor, the mixing tank may also have vertical baffles. The impeller consists of a shaft assembled with one or more mixing blades propellers. Propellers can be divided into two main types, axial and radial flow propellers.

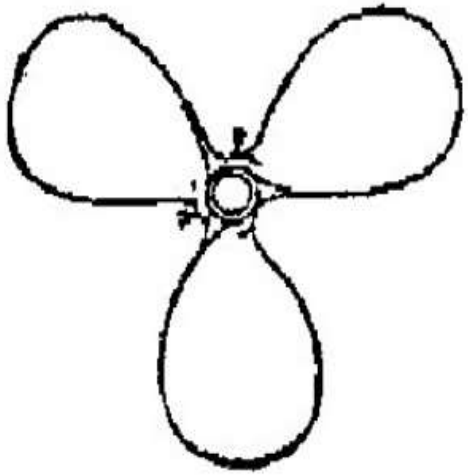
Equipment Used in Paints Industry

a. Axial flow propellers

Axial patterns run parallel to the blade.

Propeller





Equipment Used in Paints Industry

b. Radial flow propellers

Radial patterns run perpendicular to the blade.

Turbine propellers

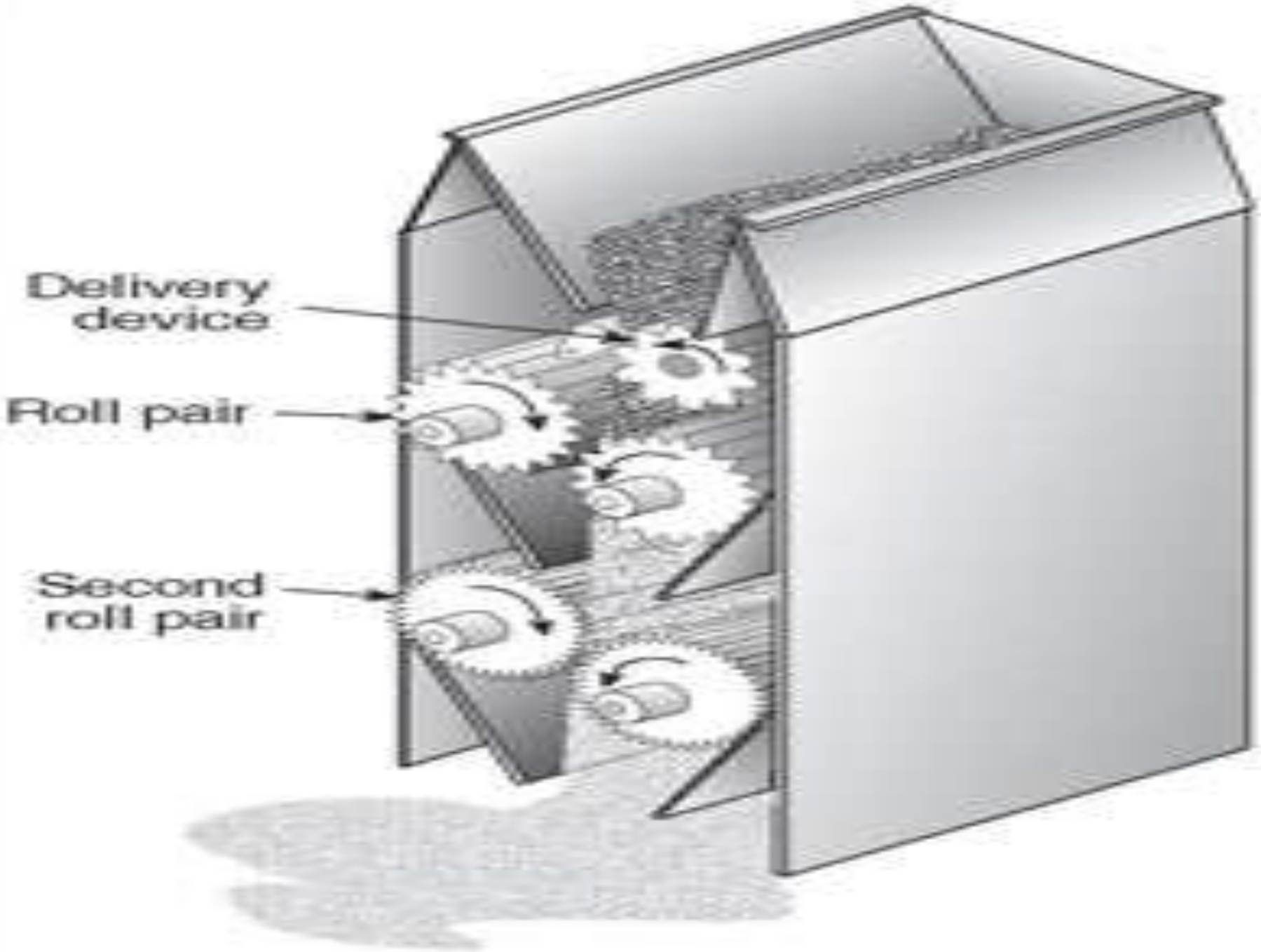
Anchor impeller

Equipment Used in Paints Industry

- **2. Mills**

A. Roller mills

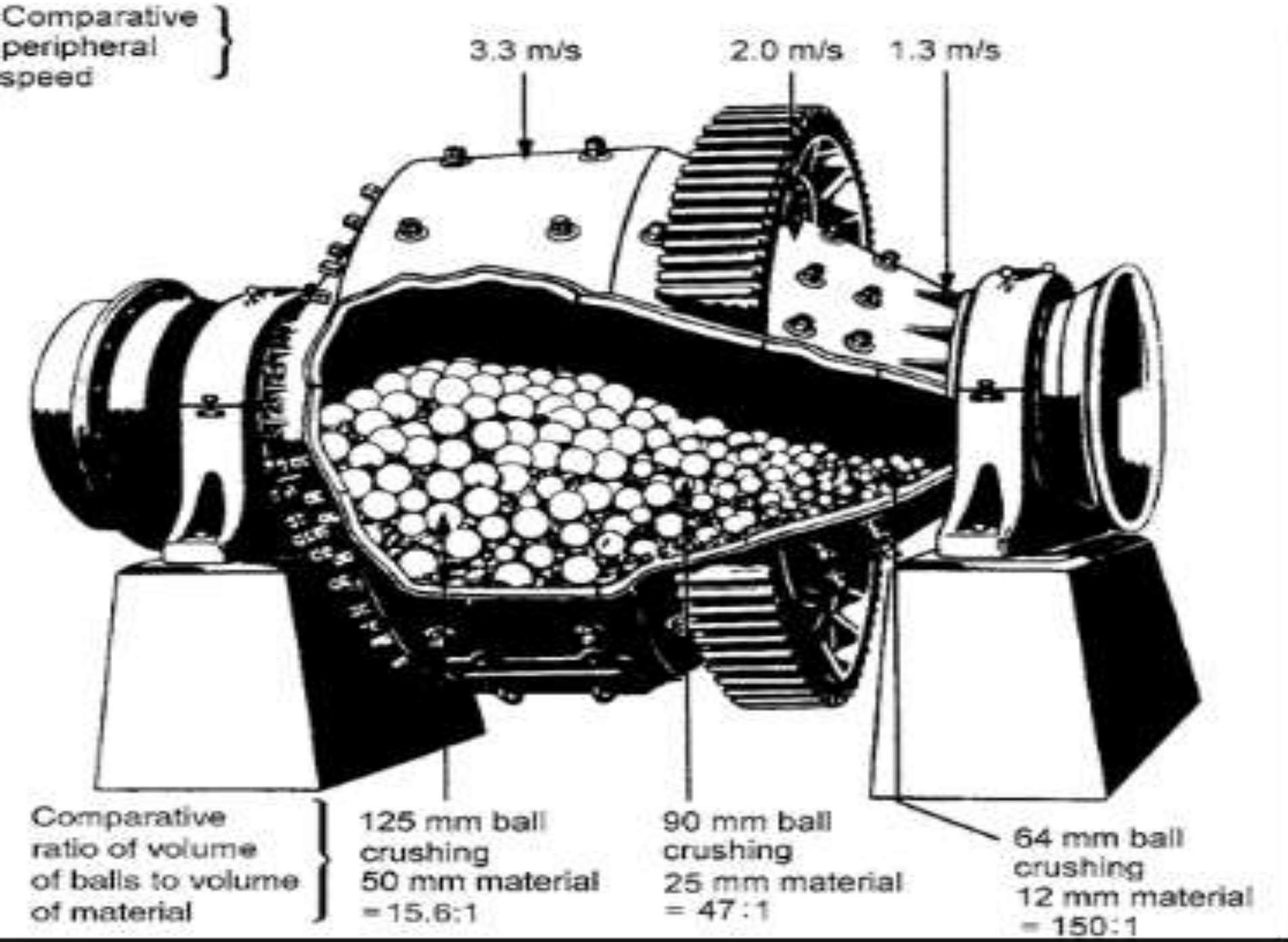
- Each roller rotates in the opposite direction of the others and with different speeds. The clearance between each two rollers must be controlled accurately to maintain the desired finesse of dyes.
- This type of mills is open and therefore cannot be used in grinding of paints which contain high volatility solvents as solvent emissions to the atmosphere could occur.


Delivery device
Roll pair
Second roll pair

Equipment Used in Paints Industry

B. Ball mills

- Consists of a cylinder rotating about its horizontal axis and containing the grinding balls which may be made of steel.
- The grinding efficiency and fineness of particle depend on the dimensions of the cylinder, speed of rotation, balls size and balls density. In some mills the length of the cylinder is equal to its diameter, but to maintain higher degree of fineness mills with a length larger than diameter are used.


Comparative peripheral speed
3.3 m/s
2.0 m/s
1.3 m/s
Comparative ratio of volume of balls to volume of material
125 mm ball crushing 50 mm material =15.6:1
90 mm ball crushing 25 mm material = 47 :1
64 mm ball crushing 12 mm material = 150:1

Equipment Used in Paints Industry

- Relations between the internal diameter of ball mills and the ball diameter

Internal diameter	Ball diameter (cm) & their percentage
30 – 60	1.5 (70%), 2.5 (30%)
90 – 120	1.5 (30%), 2.5 - 4 (60%), 4 - 5 (10%)
120 – 150	2 – 2.5 (85%), 5 – 6.5 (15%)

Equipment Used in Paints Industry

3. Filters

- During the manufacturing steps in paints or varnishes industry or during the oil heating process the liquids are contaminated by foreign matters that fall into them. Moreover the paint may contain particles that were not ground to the required size or some polymers that didn't dissolve. Some surface hardness may also exist. For all the previous reasons, paints and varnished liquids must be purified by one of the following methods:

- Single cylinder mill: It can work as a screen as all large pigments particles and foreign particles will be separated in the mill hopper.

- Fine screens.
- Filter press.
- Settling
- Centrifuge

Equipment Used in Paints Industry

4. Packing machines

The packing may be manual, semi-automatic, or automatic according to the size of production

Quality Control

- Viscosity
- S.G
- Color (spectrophotometer)
- Opacity
- Drying
- texture –consistency
- gloss/sheen
- NVC

Quality Control

1. Opacity: Opacity/ Hiding power is measured by painting it over a black surface and a white surface. The ratio of coverage on the black surface to coverage on the white surface is then determined.

2. Texture consistency : The Texture of the paint is determined by applying it on the wall using a Texcote roller to check for sagging.

Quality Control

3. Gloss/Sheen : is measured by determining the amount of reflected light given off a painted surface, using a Gloss meter.

Quality Control

4. Adhesion : Is tested by making a crosshatch on a dried paint surface. A piece of tape is applied to the crosshatch, and then pulled off. A good paint will remain on the surface.

Quality Control

5. Weathering/ Resistance of the color to fading:

Is determined by exposing a portion of a painted surface to outdoor conditions i.e. sunlight, water, extreme temperature, humidity, and comparing the amount of fading to a painted surface that was not exposed.

Defects

S/N	DEFECTS	CAUSES
1.	Settling	Low dispersion
2.	Paint Separation	Incompatibility
3.	Foaming	Mixing at high speed, insufficient defoamer.
4.	Foul smell/ Mould growth	Micro-organisms
5.	Sagging, no texture/ pattern	Too much water, sand omitted
6.	Low viscosity	Excess solvent
7.	High Viscosity	Insufficient solvent

Defects

S/N	DEFECTS	CAUSES
8.	High Specific gravity	Insufficient solvent
9.	Low Specific gravity	Excess solvent, foaming
10.	Foreign matter	Adding foreign contaminants without manufacturers specification (lead to film defect)
11.	Chalking (is the progressive powdering of the paint film on the painted surface).	Polymer degradation of the paint matrix, due to exposure from UV radiation.

Defects

S/N	DEFECTS	CAUSES
12.	Erosion (Erosion is a very quick chalking)	due to external agents like rainfall
13.	Peeling/Blisterin g	Improper surface treatment before application& dampness present in the substrate.
14.	Cracking	When paint coatings are not allowed to cure/dry completely before the next coat is applied.

Defects

S/N	DEFECTS	CAUSES
15.	Pigment Flocculation	The pigment, after dispersion, reverts to a greater or lesser degree, when rubbed. (Colour change)
16.	Tacking/ not drying	Insufficient drier
17.	Skinning	Absence of anti-skinning agent, excess drier
18.	Low sheen	Excess pigment/extender