The Dispersion Process

When producing pigmented coatings the basic physical process is to incorporate extremely fine solid particles into the surrounding vehicle, to produce a colloidal suspension. A colloidal suspension is characterized by its behavior that the finely divided small particles do not settle under the force of gravity.

The Dispersion process can be divided into three individual steps:

1. Wetting of the pigment particles by the fluid components of the mill base
2. Breakdown of the associated particles (agglomerates and aggregates) leading to smaller particle sizes
3. Stabilization of the dispersion preventing renewed association (flocculation)

Pigment particles can be divided into three classes:

- Primary particles = crystal
- Aggregates = Primary particles with surface to surface contact
- Agglomerates = Primary particles touching each other via edges and corners

Pigments are classified according to their chemical nature as organic and inorganic pigments. Inorganic pigments are usually coarser than organic pigments, with the exception of carbon blacks and a few special pigment types, such as transparent red oxides. The diameter of the primary particles of inorganic pigments usually ranges between 0.2 and 0.5 microns; while organic pigments lie between 0.03 and 0.08 microns.

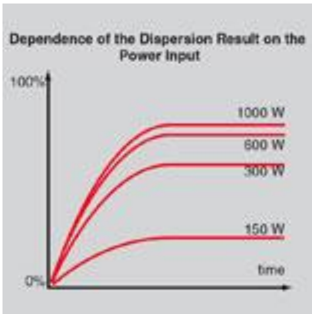
Comparison Organic and Inorganic Pigments		
	Organic	**Inorganic**
Specific surface area		smaller
Particle size		coarser
Color strength		weaker
Transparency		less
Scattering		higher
Temperature stability	max 300 °C	max 1000 °C

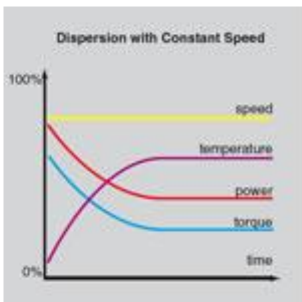
Dispersion Result:
The dispersion result is closely related to the mechanical power input:

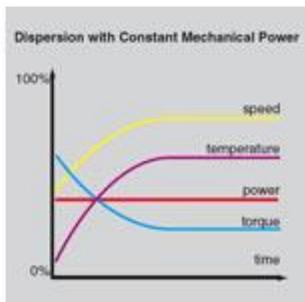
$$P = 2 \pi n M$$

The mechanical power input determines the energy that is transmitted by the agitator to the product.

During dispersion, the temperature of the millbase changes parameters influencing the flow behavior. If the dispersion is done at a constant speed, the torque and power input will change at an uncontrolled manner. BYK-Gardner offers dispersion equipment with a worldwide patented technolgy, C-technology, which continuously measures all important operating parameters: speed, torque, power input and product temperature. The instruments can be run at either constant speed or constant power input. By dispersing at a constant power input reproducible results will be obtained no matter what the product temperature is. The equipment automatically adjusts the speed to keep the mechanical power input constant.







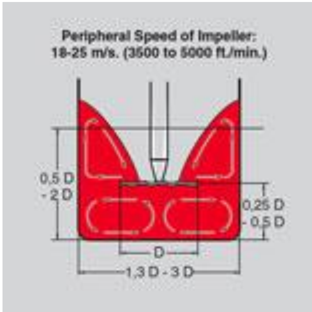
Dispersion Equipment
The breakdown of the associated particles takes place during wetting caused by a more or less spontaneous breakdown of the forces holding the smaller agglomerates together. However, the majority of the agglomerates have to be broken down by transferring mechanical energy into the system. This transfer of energy is performed with special dispersion equipment. Dispersion equipment can be divided into two classes:

1. Equipment without grinding material: Dissolver
2. Equipment with grinding material: Bead mills, attritors, ball mills.

High speed dissolvers:
Dissolvers are used for easy to disperse pigments, most inorganics, and for pre-dispersion and wetting of hard dispersible pigments.

The best dispersion results are obtained with the highest possible mechanical power input without destroying the so called ”doughnut“ flow pattern.

This laminar flow pattern is obtained when the diameter for the vessel and the impeller as well as the distance between plane of disc and base of vessel are matched to one another.



Procedure:
First the liquid component is put into the vessel. Then, under moderate speed pigments and fillers are added slowly. The impeller speed can be increased until the doughnut effect is detected at a higher rpm. After this premixing step the dispersion is carried out at high peripheral speeds that correlate to the tip speeds used in production by maintaining the doughnut. Dispersing small quantities will require high rotational speeds to match production results.

Example: If an impeller disc of 30 mm diameter is used, the Dispermat®must be run at a rotational speed of 10,000 to 15,000 rpm to obtain peripheral velocities of 18 to 25 m/s (3000 ft/min to 5000 ft/min) which is used in many production applications.

Horizontal Bead Mills
Bead mills are used for hard to disperse pigments, most organics and some inorganic pigments, to achieve very small particle sizes.

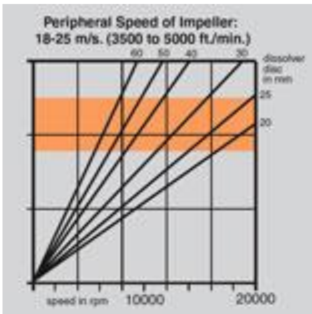
The actual dispersing system consists of a chamber and a rotor; the chamber is filled with grinding media and the product to be dispersed. The actual particle size reduction is accomplished by the moving grinding material, which is activated by a high speed and high energy agitator.

As the grinding material collides and rolls about each other, the solid particles get caught between them and are gradually reduced in size. Each primary particle or aggregate in the finished product is the result of billions of bombardments by the grinding media.
The quality of the dispersion degree is dependent on the mechanical power input which is influenced by the torque transmitted by the shaft onto the millbase.

$$P = 2 \pi n M$$

The torque is dependent on the flow behavior (viscosity, agitator geometry) and the type, quantity and size of grinding beads. High bead filling volumes increase the torque and the probability that agglomerates come into a spatial dispersion situation. The BYK-Gardner beadmill Dispermat® SL-C measures the torque and can be run at a constant power input.

When milling with constant power input, not only can complicated dispersion processes be performed in a reproducible manner, but different dispersions can be compared exactly. The dispersion results from production are easily repeated with the Dispermat®SL-C and formulations worked out in the laboratory can be transferred into production.


Peripheral Speed of Impeller:
18-25 m/s. (3500 to 5000 ft./min.)
60
50
40
30
dissolver
disc
in mm
25
20
speed in rpm
10000
20000