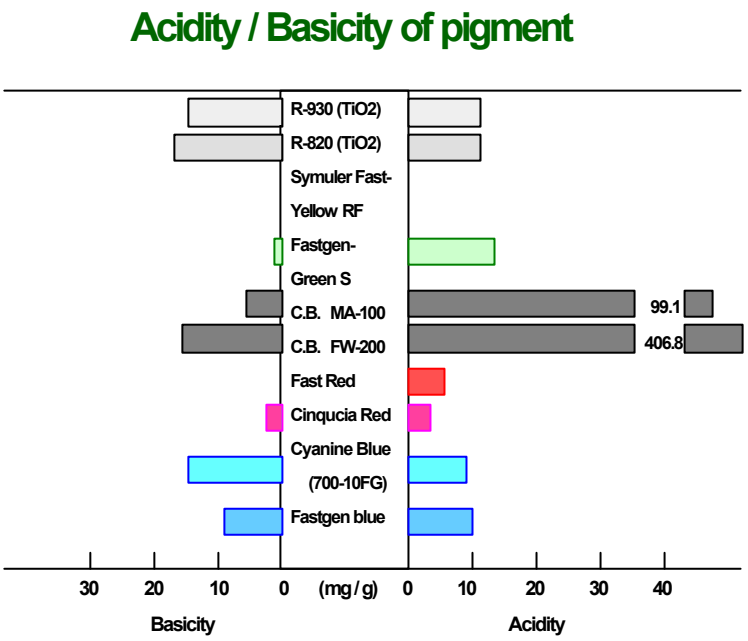
Effects and Types of Pigment Wetting Agents and Dispersants

1. Introduction

As functional and performance requirements from the industries that deal in paints, printing inks, cosmetics and other pigment dispersion substances become increasingly more intricate and diverse, dispersion of pigment continues to be one of major technical challenges. The smaller the size of the pigment particle, the more fully the capabilities and properties inherent in the particle will be exerted and better results can be expected. In many cases, however, the vehicle alone is not enough to obtain required dispersibility and thus wetting agents and dispersants become necessary. Wetting agents and dispersants, even a small amount of which can produce effects, are very effective and offer an easy way to make good pigment dispersion substances and products.
This paper provides explanation of the effects of wetting agents and dispersants along with introduction of one of our products that includes a polymer additive, which marks significant advancement recently.

2. Acidity and Basicity of the Pigment Particle

The stability of pigment dispersion is considerably dependent on the dispersant's wettability and absorbability to the pigment particle. One of the interactive elements between the dispersant and the pigment surface is acidity/basicity of the particle surface; there are acid site, basic site, inactive site and others and it varies among different particle types. In principle, the acid site of the pigment particle surface absorbs basic substances and the basic site absorbs acid substances. The degree of acidity//basicity of the pigment particle is measured by the amount of the substance necessary to make it saturated. In this case oleic acid is used as the acid substance and oleyl amine is used as the basic substance. From Figure-1, you can see that the surface condition varies from pigment to pigment; for instance, titanium white is slightly basic and carbon black is strongly acid.



(Figure-1)

3. Classification of Wetting agents and Dispersants

Wetting agents and dispersants are surfactants, which are amphiphilic compounds mainly consisting of hydrocarbon chain with multiple functional parts of different polarity or solvent affinity, such as hydrophobic radical which has an affinity to oil and the hydrophilic radical which has an affinity to water.
Some of favorable properties as wetting agents and dispersant include;

1) Strong orientation to the pigment/liquid surface
2) Strong affinity to inorganic and organic pigments
3) Moderate compatibility with liquids (vehicle)

To make a good classification of wetting agents and dispersants, sorting them according to whether it will ionize in the solution is considered to be an adequate method. Of various wetting agents and dispersants, the compounds suitable for non-aqueous based dispersants fall into four broad categories, according to their ionic ity (Figure-2).

CLASSIFICATION OF WETTING AGENTS & DISPERSANTS

	DISPARLON	A.V.	Am.V.
ANIONIC compound	2150	(140)	---
$[CH_3-(CH_2)_x-CH_2-COO]^-\ ^+[NH_4]$	1220	(143)	---
Sulfate, Sulfonate, Phosphate etc.	7004	(40)	(19)
	KS-873N	(33)	(57)
CATIONIC compound	---		
$[CH_3-(CH_2)_x-NH_3]^+\ ^-Cl$			
Aliphatic amin salt etc.			
NONIONIC compound	---		
POLYMER compound	DA-703-50	11	32
	DA-325	14	20
OTHER	AMPHOTERIC compounds	FLUORIDE compounds	

(Figure-2)

Anionic compounds

Have negatively charged non-polar (hydrophobic) part; most commonly used as non-aqueous based dispersant for paints. They have an affinity to general-purpose resins and solvents and have little side effects.

Cationic compounds

Have positively charged non-polar (hydrophobic) part; aliphatic amine and its compounds, Class 4 ammonium salt and others are used.

Nonionic compounds

Have hydroxyl or ether bond which will not ionize in water. They are not electrically charged and adsorption to the pigment is weak, but commonly used in water-based paints.

Polymer compounds

The theoretical molecular weight is thousands to tens of thousands. The molecular weight is large compared to conventional wetting agents and dispersants, as shown in a separate section. They significantly contribute to paints' fluidity and dispersion stability.

4. Effects of Wetting Agents and Dispersants

The process of pigment dispersion can be classified into three phases: wetting, mechanical crush and dispersion. Actually, wetting agents and dispersants work in three phases in making paints in general, namely paint manufacturing (grinding), storage and painting/paint film formation.
Shown below is how wetting agents and dispersants work in each process; (Figure-3)

[Paint Manufacturing] (Grinding)

- Reduce the mill base viscosity
- Increase the pigment volume concentration
- Reduce the dispersion time

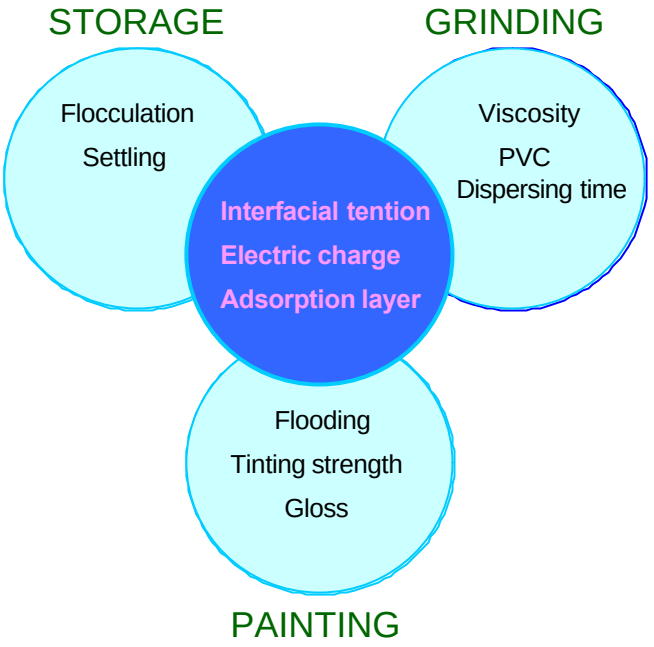
[Storage]

- Prevent pigment flocculation
- Prevent pigment settling

[Painting/Paint Film Formation]

- Prevent flooding
- Improve tinting strength
- Improve gloss

As you can see from this, wetting agents and dispersants can be used in various ways.
They are thought to contribute to improve the dispersibility by reducing the interfacial tension between pigment particles and the vehicle (e.g. resin) to improve wettability, controlling the electric charge of the pigment particle surface, and creating a thick and stable absorption layer, which provides the repulsive force to overcome the Van Der Waals force between particles.

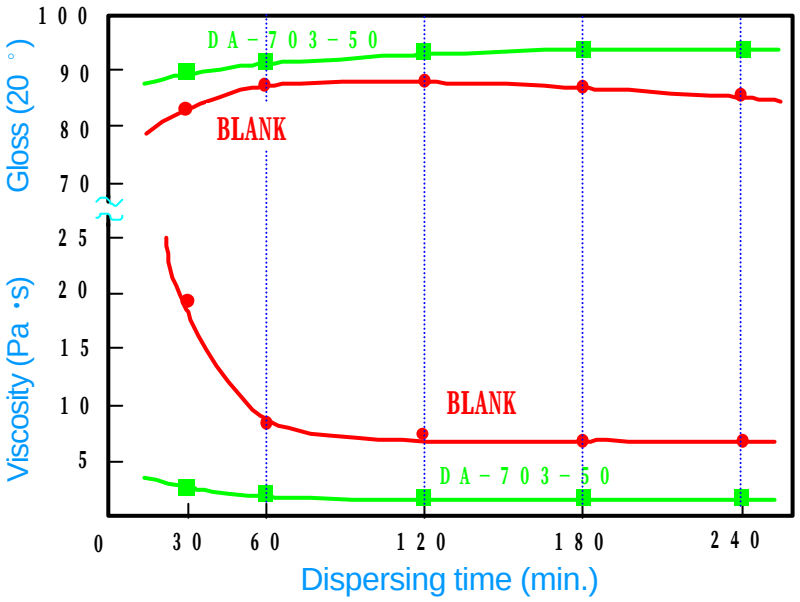


(Figure-3)

5. Effects of Dispersants to Carbon Black

5-1. Viscosity and Gloss

In general carbon black has large surface area, high oil absorption and low surface energy; it tends to be repellent to the vehicle and lose stability, such as significant increase in viscosity or reaggregation in the vehicle. In this case, the leveling, gloss, image sharpness and other properties of the film surface will be affected and high-quality appearance cannot be expected.
We examined the effects of one of our polymer dispersants using an alkyd melamine paint, which includes highly acid carbon black as we mentioned at the beginning (Figure-4)



(Figure-4)

We used Disparlon DA-703-50 (the amount added was 60% of the pigment weight) as the dispersant and a batch-type test sand mill as the dispersing machine. When the additive was not used, the viscosity of the mill base (measured by the E-type viscometer/25°C) declined sharply in the early stage of dispersion and then declined mildly. When DA-703-50 was added, the viscosity was low from an early stage and the gloss was also significantly improved.

5-2. Observation of the Surface

Shown here is the picture of the paint film surface obtained at 5-1, taken by the differential interference optical microscope (Photo-1)
When DA-703-50 was added, the number of aggregation lumps declined in 30 minutes and the surface became almost even in 2 hours. When not added, small aggregation lumps remained even after 4-hour dispersion and the quality of the surface was not very good.

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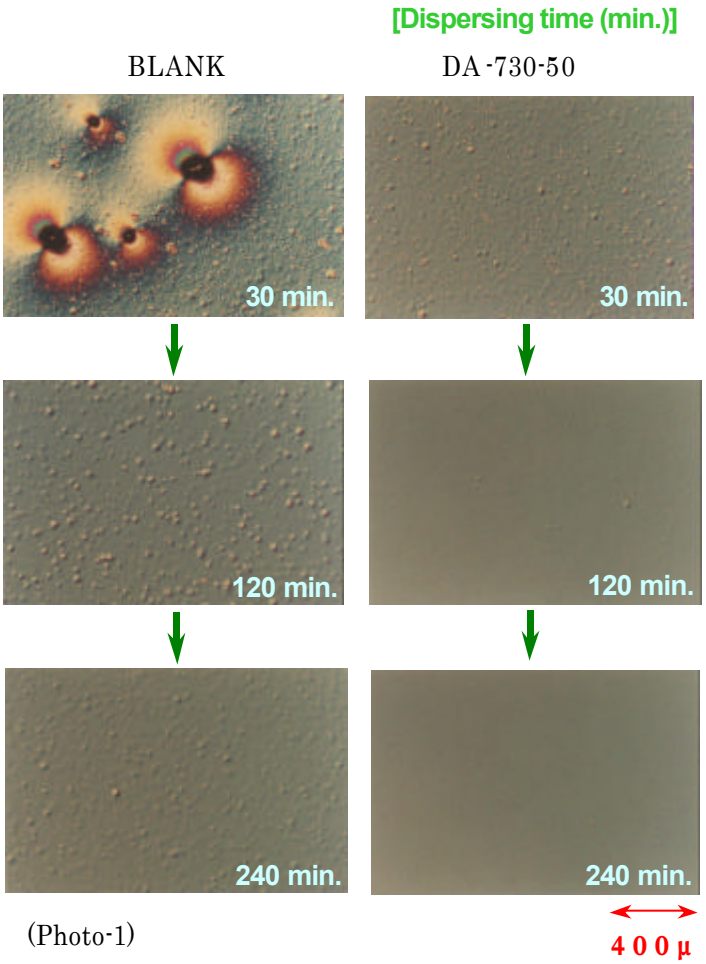

(Photo-1)

6. Closing

A very small amount of dispersants added into paints improves wettability and humidification of the pigment surface and produces various favorable effects. When using them, it is important to understand the nature of the pigment surface. Use of the dispersant suitable for the pigment surface contributes to improve functions and performance of the paint. It is extremely difficult to conduct a systematic study on composition and effects of dispersants used in complex composites consisting of various ingredients, such as paints. We will continue to develop high performance dispersants to meet users' needs by capitalizing on dispersion theories and organizing experiment results.