Shin-Etsu

Nissin Chemical Industry Co., Ltd.

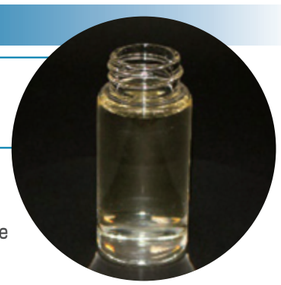
Functional Materials for Inkjet Ink

Functional Materials for Inkjet Ink

We manufacture and sell products that can be applied to various kinds of ink. We offer a wide lineup of products designed to improve functions of inkjet ink.

OLFINE

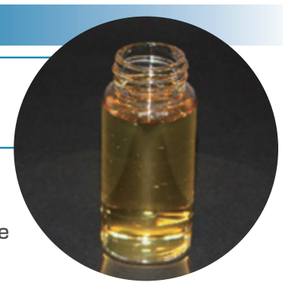
EXP. Series



These acetylenic surfactants have the ability to lower the dynamic surface tension and the dynamic contact angle.

OLFINE

PD-600 Series



These acetylenic surfactants can, in small amounts, quickly disperse water insoluble dyes.

SILFACE

SAG Series

These silicone surfactants have the abilities to lower the static surface tension and to wet materials, particularly non-absorbable materials.

VINYBLAN

700 Series

These vinyl chloride emulsions are made using acrylic aqueous solutions as protective colloids in polymerization. These emulsions exhibit excellent pigment dispersibility thanks to the fine particles and the dispersibility that is characteristic of vinyl chloride resins.

CHALINE

E Type

These silicone/acrylic hybrid resins can provide abrasion resistance thanks to the excellent sliding properties of silicone resins.

SOLBIN

CLL3

This vinyl chloride-vinyl acetate copolymer resin is soluble in eco solvent thanks to the technology of copolymerization with vinyl acetate; they also exhibit the excellent pigment dispersibility characteristic of vinyl chloride resins.

○Inkjet ink classification chart

Water-based	Pigment type	Substrate: paper, film, fiber	Applicable products: • OLFINE EXP. Series • OLFINE PD-600 Series • SILFACE SAG Series • VINYBLAN 700 Series • CHALINE E Type
	Dye type	Substrate: paper, fiber	Applicable products: • OLFINE EXP. Series • OLFINE PD-600 Series • SILFACE SAG Series
Eco solvent-based	Pigment type	Substrate: paper, film	Applicable products: • SOLBIN CLL3

List of products applicable to various types of inkjet ink

	OLFINE		SILFACE	VINYBLAN	CHALINE	SOLBIN
	EXP. Series	PD-600 Series	SAG Series	700 Series	E Type	CLL3
Water-based pigment type						
Dispersibility		○		● p.7		
Nozzle suitability	○		○	● p.7		
High-speed printability	● p.3-4		○	○		
Wettability	● p.3-4		● p.5-6			
Adhesion				○		
Abrasion resistance					● p.8	
Water-based disperse dye type						
Dispersibility	● p.10	● p.9		○		
Nozzle suitability	○		○			
High-speed printability	○		○			
Wettability	○		○			
Abrasion resistance					○	
Eco-solvent-based pigment type						
Dispersibility						○
Nozzle suitability			○			● p.11
Adhesion						○
Heat stability						○
Solubility						○

Eco-solvents: Acetate-based solvents and glycol-based solvents

We offer various product grades in addition to those listed in this catalog.

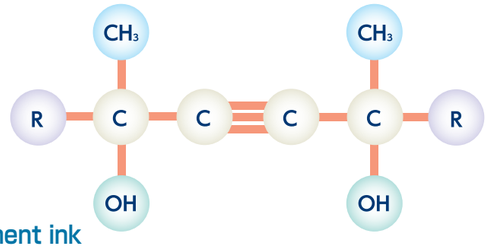
For more information about each product or product series, please contact us. We can provide catalogs, technical data sheets, safety data sheets, etc

Water-based pigment type

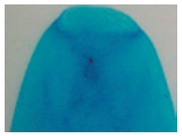
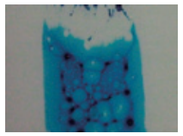
Features of OLFINE

OLFINE is an acetylenic surfactant that has the ability to lower the dynamic surface tension and the dynamic contact angle. The OLFINE EXP. Series is superior in said ability compared to conventional types and is therefore suitable for high-speed printing.

Structural diagram of acetylene glycol



○Results of wettability and defoaming tests with pigment ink

	A Competitor's Wetting Agent	A Competitor's Defoaming Agent	OLFINE
Wettability Test			
Defoaming Test			
	Exhibits high wettability but foams	Defoams but repels liquid	Exhibits high wettability and foams a little

○Conventional grade

	Effective ingredients (%)	Solubility in water (%)	Dynamic surface tension (mN/m)		Contact angle(°)	Foaming property (mL)	
			1Hz	10Hz	SUS304	Immediately after addition	After 5 minutes
E1010	100	>1	41	45	70	17	2

The EXP. Series was developed to be better suited for high-speed printing.

OLFINE EXP. Series

This series is suitable for high-speed printing.

○Basic properties

	Effective ingredients (%)	Solubility in water (%)	Dynamic surface tension (mN/m)		Contact angle(°)	Foaming property (mL)	
			1Hz	10Hz	SUS304	Immediately after addition	After 5 minutes
EXP.4001	80	0.01~0.05	26	34	14	2	0
EXP.4200	75	0.50~1.00	32	40	32	3	0
EXP.4123	40	5.00~10.0	40	50	56	3	0
EXP.4300	60	0.10	26	37	17	25	8

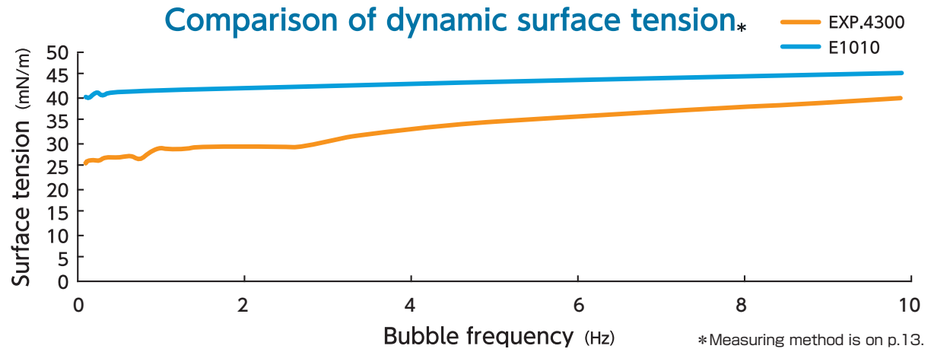
■Comparison of properties between 0.1% aqueous solutions of OLFINE EXP. 4300 and E1010

It's very important for surfactants to migrate to the newly created surface as rapidly as possible and to reduce the surface tension particularly at the high speed printing such as inkjet ink.

○Suitability for high-speed printing

… The EXP. 4300 exhibits low dynamic surface tension, thus enabling stable ejection of ink droplets even during high-speed printing.

Comparison of dynamic surface tension*

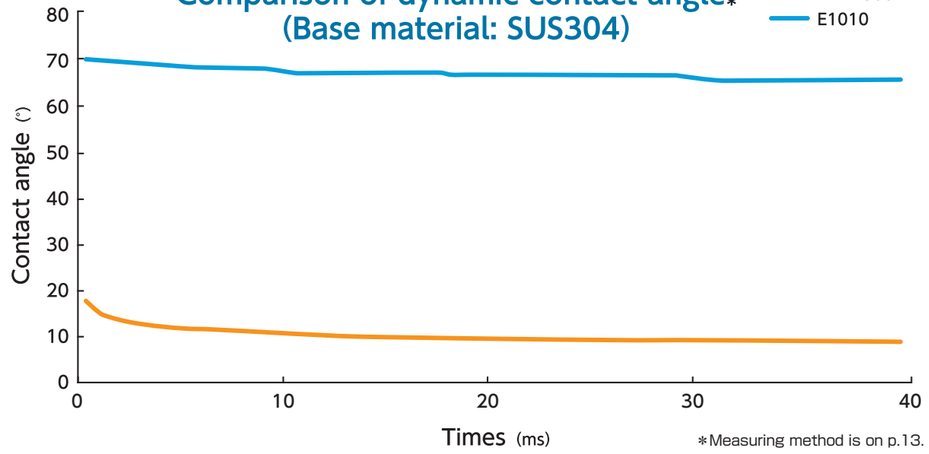


*Measuring method is on p.13.

○Wettability

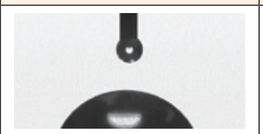
… Compared to the E1010, the EXP. 4300 is more effective for lowering the contact angle immediately after jetting ink onto a print surface. As a wetting agent, it is particularly suitable for providing wettability to substrate with low surface energy.

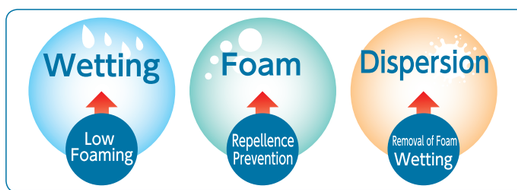
Comparison of dynamic contact angle* (Base material: SUS304)



*Measuring method is on p.13.

○Images of the contact angle immediately after jetting ink onto SUS304

Pure water	E1010	EXP.4300
		



Some of our acetylenic surfactant products can be used not only as wetting agents but also as defoaming agents or dispersants.

For more information, please contact our sales representative.

SILFACE SAG Series

As wetting agents, this series of silicone surfactants has the ability to lower the static surface tension of water and organic solvent mixtured ink and is highly effective for improving ink wettability, particularly on non-absorbable media.

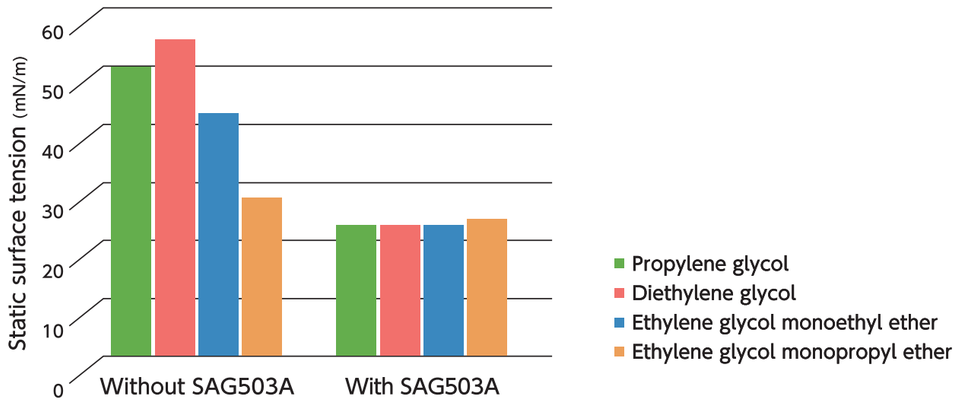
○Basic properties

	Appearance	Effective ingredients (%)	Ionicity	Solubility in water (%)
SAG503A	Clear light brown	>95	Non-ionic	>10

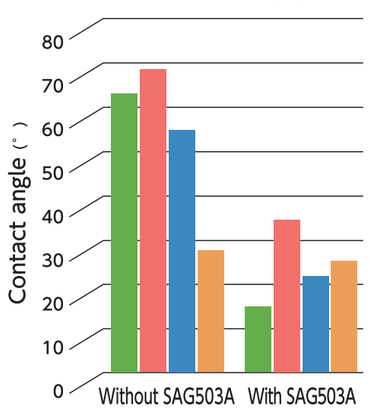
○Wettability Comparison of static surface tension and contact angle provided by different types of solvents

- **Evaluation method** Without SAG503A: Each type of solvent 30%, water 70.0%
  With SAG503A: Each type of solvent 30%, water 69.5%, SAG503A 0.5%

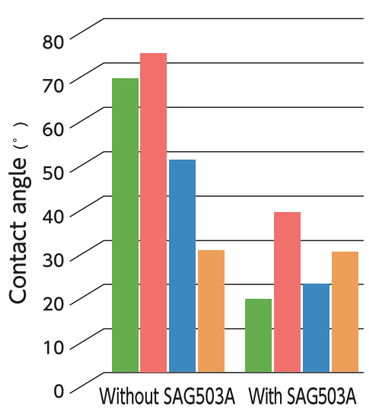
Static surface tension



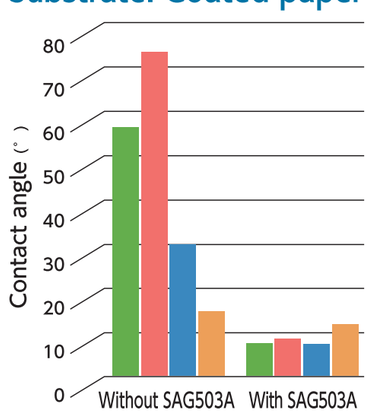
Substrate: PET



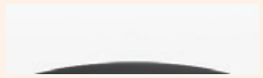
Substrate: PVC



Substrate: Coated paper



○Contact angle immediately after jetting ink onto SUS304

	After 1 second	After 10 seconds	After 30 seconds
Without SAG (pure water only)	 100°	 98°	 96°
SAG503A (0.1% aqueous solution)	 32°	 14°	6°

○Comparison of other grades in the SAG series

Without SAG: Each type of solvent 30%, water 70.0%
With SAG: Each type of solvent 30%, water 69.5%, SAG 0.5%

		Solvent used	Solvent SP value	Without SAG	SILFACE SAG005	SAG008	SAG016	SAG020
Compatibility (appearance)		Propylene glycol	15.9	—	2	3	2	1
		Diethylene glycol	15.3	—	3	3	2	1
		Ethylene glycol monoethyl ether	11.5	—	3	3	3	2
		Ethylene glycol monopropyl ether	11.1	—	3	3	3	3
[Compatibility (appearance) score] 3: soluble, 2: uniformly cloudy, 1: insoluble								
Static surface tension (mN/m)		Propylene glycol	15.9	50	30	29	22	22
		Diethylene glycol	15.3	54	29	28	22	21
		Ethylene glycol monoethyl ether	11.5	41	27	27	22	24
		Ethylene glycol monopropyl ether	11.1	28	23	22	27	22
Contact angle to substrate (°)	PET	Propylene glycol	15.9	63	75	61	6	61
		Diethylene glycol	15.3	69	67	59	32	60
		Ethylene glycol monoethyl ether	11.5	55	48	54	4	40
		Ethylene glycol monopropyl ether	11.1	28	15	16	25	8
	PVC	Propylene glycol	15.9	67	67	62	9	63
		Diethylene glycol	15.3	72	72	65	34	68
		Ethylene glycol monoethyl ether	11.5	49	49	49	14	40
		Ethylene glycol monopropyl ether	11.1	28	15	16	28	7
	Coated paper	Propylene glycol	15.9	56	44	42	6	55
		Diethylene glycol	15.3	73	54	40	1	71
		Ethylene glycol monoethyl ether	11.5	30	20	23	1	16
		Ethylene glycol monopropyl ether	11.1	15	7	8	12	5

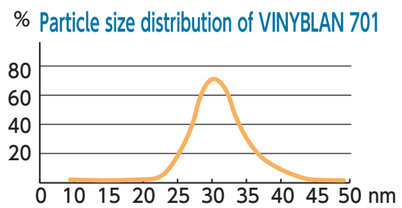
VINYBLAN 700 Series

The VINYBLAN 700 Series consists of vinyl chloride emulsions in which acrylic aqueous solutions or the like serve as protective colloids. These water-based emulsions are made without any solvents or surfactants; thus, they exhibit excellent pigment dispersibility.

○Basic properties

	Solid content (%)	Viscosity (mpa·s)	PH	Average particle size (nm)	Tg (℃)	Acid value (KOHmg/g)
700	30	50	7.5	30	70	57
701	30	50	7.5	30	73	46
755	25	50	7.5	30	34	75

○Nozzle suitability



Composed of fine particles without any coarse particles that may affect ink ejection

○Solvent miscibility

Highly miscible with alcohol- or glycol-based solvents.

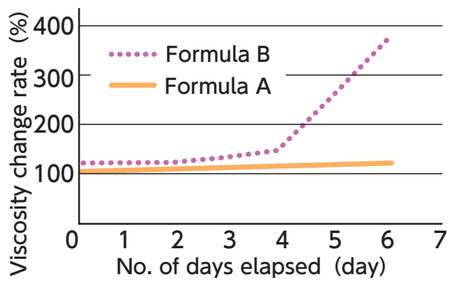
• **Evaluation method:** VINYBLAN and each type of solvent were mixed in a ratio of 1:1 and the stability was checked.

Type of solvent	
Alcohol-based	Methanol, Ethanol, Isopropanol
Glycol-based	Diethylene glycol, Triethylene glycol, Propylene glycol
Glycol-ether-based	Triethylene glycol monobutyl ether, Dipropylene glycol monomethyl ether
Diol-based	1,2-Hexanediol, 1,5-Pentanediol

○Dispersibility

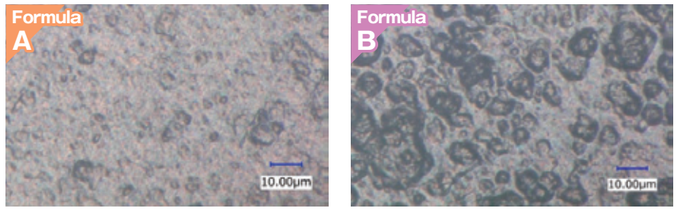
• Composition of dispersion liquid	Composition (wt%) Formula A	Formula B
VINYBLAN 701	10	0
Polyurethane dispersion *(polycarbonate-based)	79.5	89.5
Carbon black *Mitsubishi Chemical MA-100	10	10
Wetting agent OLFINE EXP.4300	0.5	0.5

• **Dispersion method** Composition ratio: 50 g of Formula A or B liquid was mixed with 5 g of beads.
Beads: Zirconia beads (dia. 5 mm)
Disperser: Paint shaker (2-hour dispersion)



The dispersion liquid to which VINYBLAN was added exhibited almost no changes in viscosity over time.

Microscopic photographs of dispersion liquids



The dispersion liquid containing VINYBLAN enabled carbon black to disperse more uniformly than the other dispersion liquid.

- Base material: PET film
- Coating condition: Bar Coater No. 7 (wet, 6 g/m²)
- Drying conditions: 105°C for 5 minutes

CHALINE E Type

CHALINE E Type are silicone/acrylic hybrid resins. Thanks to the sliding property of silicone, the friction coefficients decrease and this CHALINE improves the abration resistance.

○Basic properties

	Composition	Solid content (%)	Viscosity (mpa·s)	PH	Average particle size (nm)	Ionicity
E-370	Acrylic modified	45	100 or less	7	300	Anion
LC-190	Specially modified	44	100 or less	7	300	Anion
E-790	Specially modified	44	100 or less	7	300	Anion

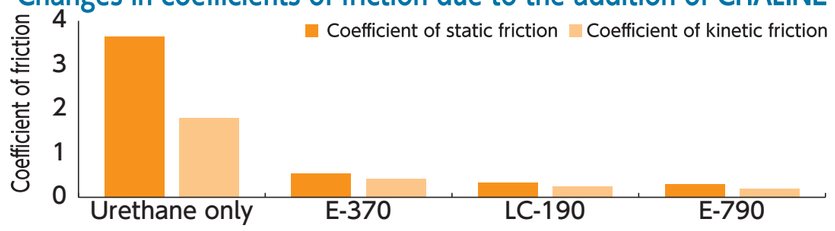
○Evaluation method

- Base material: PET film
- Specimen: Each grade of CHALINE was mixed with a urethane emulsion at a ratio of 10% (of the total solid content).
- Drying temperature: 80°C for 2 minutes
- Film thickness: Approx. 10μ (dry)

○Coefficients of static and kinetic friction

The friction coefficients of test pieces were measured using a surface property tester.

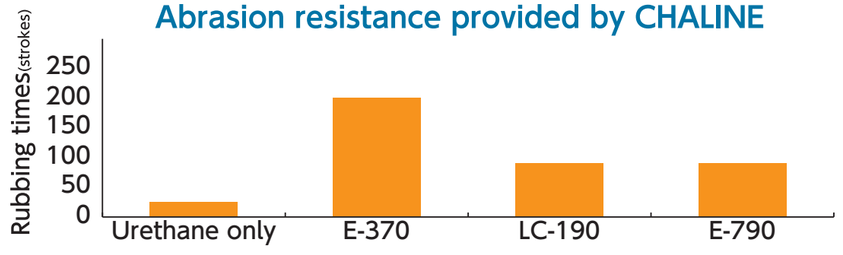
Changes in coefficients of friction due to the addition of CHALINE



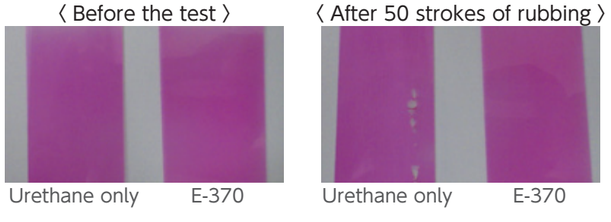
○Abrasion resistance

Using a JIS Type II (Gakushin-type) rubbing tester (with a load of 9.8N) and cotton cloth, the rubbing times were counted until partial peeling of coating was observed.

Abrasion resistance provided by CHALINE



Photographs of the abrasion resistance test



Water-based disperse dye type

OLFINE PD-600 Series

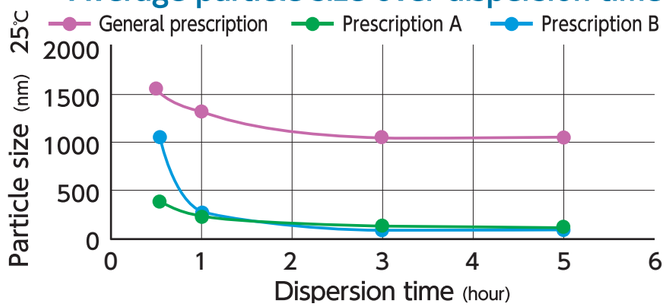
The OLFINE PD-600 Series of acetylenic dispersants can, in small amounts, quickly disperse water insoluble dyes. The series can also prevent changes in properties over time after dispersion.

○Basic properties

	Appearance	Effective ingredients (%)	Ionicity	Solubility in water (%)	Melting point (℃)
PD-611	Light yellow paste	100	Anion	>10	30
PD-631	Light yellow paste	100	Anion	>10	20

○Dispersibility

Average particle size over dispersion time



• Formulation

	General prescription	OLFINE Prescription A	OLFINE Prescription B
C.I.Disperse Red60 (dye)	15	15	15
Sodium ligninsulfonate	15	—	—
PD-611		1.5	
PD-631			1.5
Pure water	70	83.5	83.5

• Dispersion method
Composition ratio: Dispersion liquid and beads were mixed in a ratio of 1:3.
Beads: Zirconia beads (dia. 0.3 mm)
Disperser: Paint shaker (640 rpm/min)

Sodium ligninsulfonate: Dispersant commonly used for water-based dye-type ink
The OLFINE PD600 Series exhibits good dispersibility in a smaller amount compared to sodium ligninsulfonate.

○Table of compatibility with various dyes

Color		Yellow	Red	Blue		Brown
C.I.Name		**DY-54**	**DR-60**	**DB-359**	**DB-360**	**DBr-27**
Dye		15	15	15	15	15
Required amount of the PD Series		1.5	1.5	3.0	3.0	1.5
Pure water		83.5	83.5	82.0	82.0	83.5
PD-611 Preservation stability	25℃ x7days	3	3	3	3	3
	60℃ x7days	3	3	3	1	1
PD-631 Preservation stability	25℃ x7days	3	3	3	3	3
	60℃ x7days	3	3	3	2	2

[Rate of change in particle size] 3: less than 10%, 2: 10 to 15%, 1: 15% or more

Ink that contains the OLFINE PD-600 Series exhibits excellent preservation stability, regardless of dye type.

OLFINE
NISSIN CHEMICAL INDUSTRY CO.,LTD.
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OLFINE EXP. Series

The OLFINE EXP. Series of dispersion aids that can reduce the dispersion time when used with sodium ligninsulfonate.
Dispersion liquids containing OLFINE exhibit excellent stability.

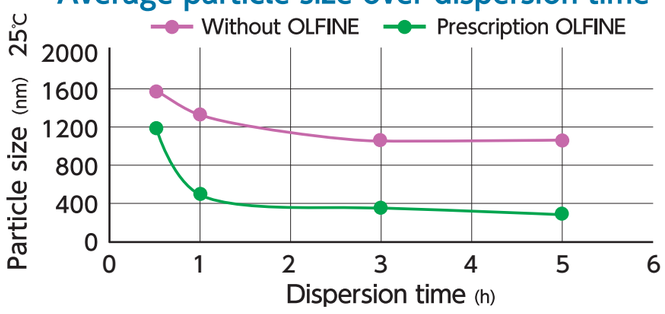
○Basic properties

	Effective ingredients (%)	Solubility in water (%)	Dynamic surface tension (mN/m) 1Hz	Dynamic surface tension (mN/m) 10Hz	Contact angle (°) SUS304	Foaming property (mL) Immediately after addition	Foaming property (mL) After 5 minutes
EXP.4123	40	5~10	40	50	56	3	0

○Dispersibility

Use of OLFINE EXP. Series with sodium ligninsulfonate

Average particle size over dispersion time

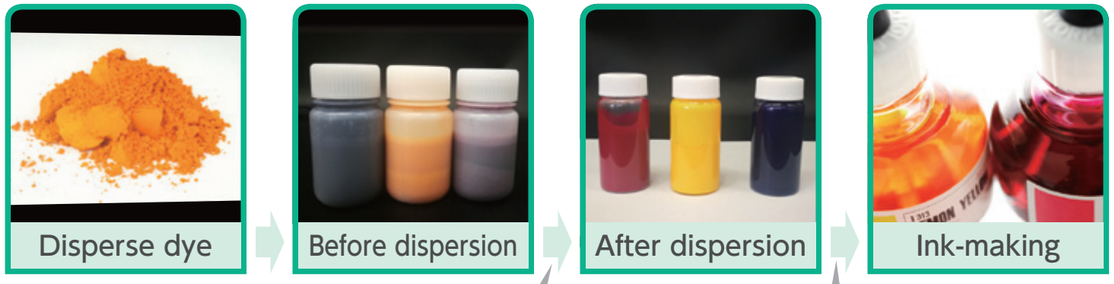


• Formulation

	Without OLFINE	With OLFINE
C.I.Disperse Red 60 (dye)	15	15
Sodium ligninsulfonate	15	15
OLFINE EXP. 4123		0.5
Pure water	70	69.5

• Dispersion method
Composition ratio: Dispersion liquid and beads were mixed in a ratio of 1:3.
Beads: Zirconia beads (dia. 0.3 mm)
Disperser: Paint shaker (640 rpm/min)

○Disperse dye ink manufacturing process diagram



Eco-solvent-based pigment type

SOLBIN CLL3

SOLBIN CLL3 is a vinyl chloride-vinyl acetate copolymer resin that is soluble in eco solvent thanks to the technology of copolymerization with vinyl acetate. It also exhibits the excellent pigment dispersibility characteristic of vinyl chloride resins.

○Basic properties

	Composition ratio(%)		Degree of polymerization	K-value	Molecular weight(Mn)	Glass transition point(℃)
	VC	VAc				
CLL3	82	18	260	37	1.6×10^4	70

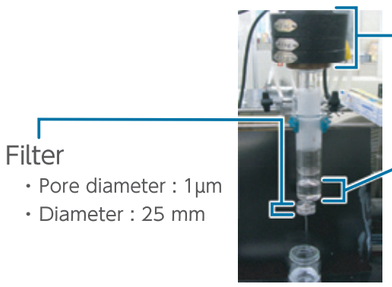
○Nozzle suitability

Filterability

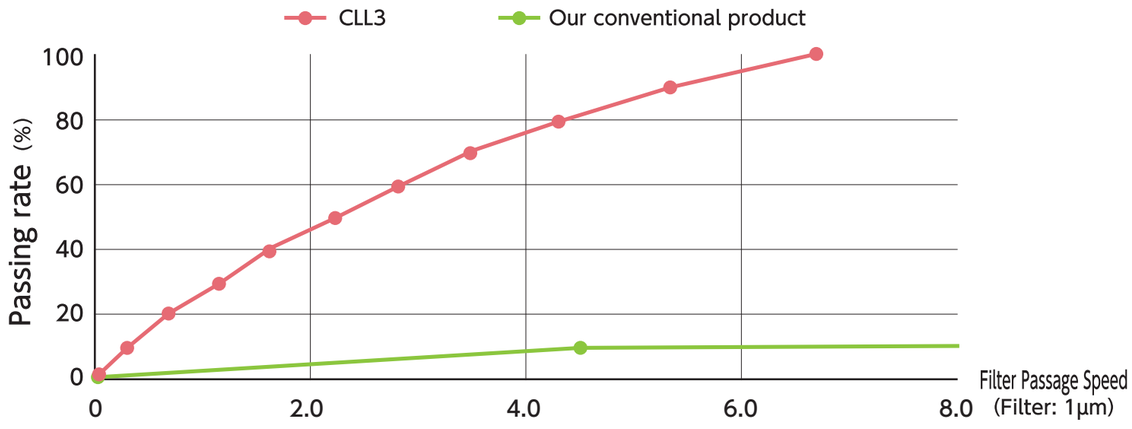
- **Conditioning method**
  1. 5 wt% SOLBIN was added to 10 wt% cyclohexanone (Anone).
  2. The mixture was stirred at 50°C for 60 minutes.
  3. The mixture stirred in step 2 was added to a mixed solution of 25 wt% propylene glycol monomethyl ether acetate (PMA) and 60 wt% ethylene glycol mono-n-butyl ether acetate (EBA), and this mixed solution was stirred for approximately 15 minutes.

- **Evaluation method**
  A 4 kg load was applied to 100 ml of the solution, and the time was measured until all of the solution passed through the filter.

Measurement filter



Filter Passing Speed (Filter: 1μm)



SOLBIN CLL3 solutions have low viscosity and good filterability, enabling the design of ink with excellent nozzle suitability.

Examples of formulations of water-based pigment-type ink

	Unit (wt%)	Example of material added	Unit (wt%)
Pigment dispersion (Pigment)	10～30	VINYBLAN 701 dispersion liquid with carbon black	30.0
Solvent A	5～20	Dipropylene glycol monomethyl ether	10.0
Solvent B	5～20	Isopropanol	10.0
Resin (binder)	10～30	VINYBLAN 755	30.0
Wetting agent	0.1～1.0	OLFINE EXP. 4300	0.5
Additive to provide abrasion resistance	1～10	CHALINE LC-190	10.0
Defoaming agent	0.1～0.5	OLFINE D-10PG	0.1
Water	Remainder	Water	9.4

○Coating method

Each film was coated with the solution above using Bar Coater No. 6 (wet, approx. 14 g/m²) and dried at 80°C for 1 minute. Then the several evaluations were conducted.

○Evaluation

Rubbing test conditions: 30 strokes of rubbing with a 200 g load (Substrate:PET)

Evaluation item		Evaluation result	Evaluation method
Adhesion	PVC	3	Cellophane tape peeling test
	PET	3	
	NYLON	3	
Abrasion resistance		3	Rubbing test using gauze
Water friction resistance		3	Rubbing test using gauze moistened with water
Alcohol resistance		3	Rubbing test using gauze moistened with ethanol
Acid resistance		3	Rubbing test using gauze moistened with a 1% hydrochloric acid aqueous solution

3: No part of the coated surface peeled off. 2: Less than 50% of the coated surface peeled off. 1: 50% or more of the coated surface peeled off.

○Examples of applicable materials

Solvent A (glycol-based)	Propylene glycol, Diethylene glycol, Triethylene glycol, 2-Pyrrolidone, Glycerin, Triethylene glycol monobutyl ether, Dipropylene glycol monomethyl ether, etc.
Solvent B (alcohol-based)	Benzyl alcohol, Isopropanol, 2-Phenoxyethanol, etc.
Binder	VINYBLAN 700 Series, various emulsions, various dispersions
Wetting agent	OLFINE EXP. Series, OLFINE E Series, SILFACE
Agent for providing abrasion resistance	CHALINE E-370, LC-190, E-790
Defoaming agent	OLFINE D-10PG, E1004

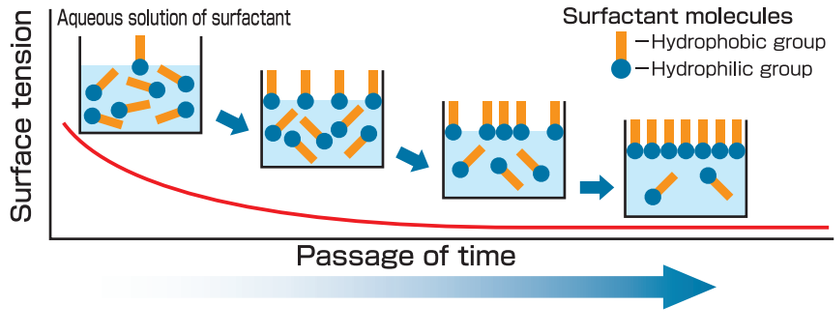
* This is reference data; it does not guarantee inkjet ink performance.

Glossary, Measuring method

○Surface tension (static/dynamic)

By reason of intermolecular forces, surface tension is the tendency of liquid surfaces to shrink into the minimum surface area possible.
⇒This tendency is referred to as interfacial tension, and especially as surface tension at a liquid-air interface.

Surface tension that becomes equilibrated over time is referred to as “dynamic surface tension”, while surface tension that is in equilibrium is referred to as “static surface tension”.
⇒Generally, dynamic surface tension tends to be higher than static surface tension and it is harder to wet a material in contact with a liquid.

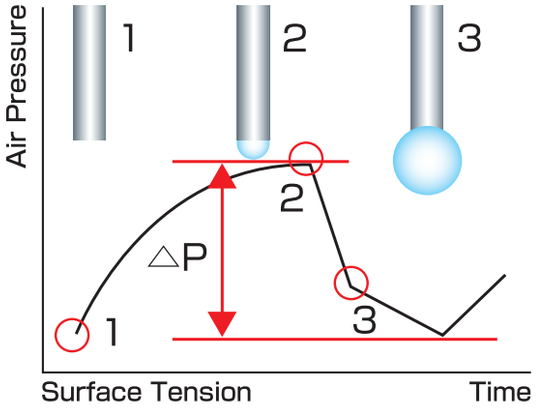


<Dynamic surface tension>
Surface adsorption of surfactant:
Not in equilibrium

<Static surface tension>
Surface adsorption of surfactant:
In equilibrium

○Dynamic Surface Tension

Different from "Static Surface Tension" obtained by measuring the surface tension of a static interface, the dynamic surface tension represents surface tension of an interface in motion. Liquid is flowing due to agitation, circulation, application, etc. in many cases when "wetting" is actually considered; therefore, the dynamic surface tension is a more practical index of "wetting."

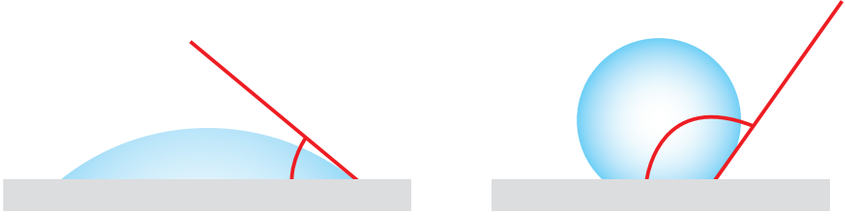


$$\sigma = \frac{\triangle P \cdot r}{2}$$

σ : Surface Tension
△P : Pressure Difference
r : Capillary Diameter

○Contact Angle

A contact angle represents how easily liquid is wet to a solid surface. A surface that is easy to wet (liquid that easily wets a surface) has a low contact angle, and a surface that is hard to wet (liquid that has difficulty wetting a surface) has a high contact angle.

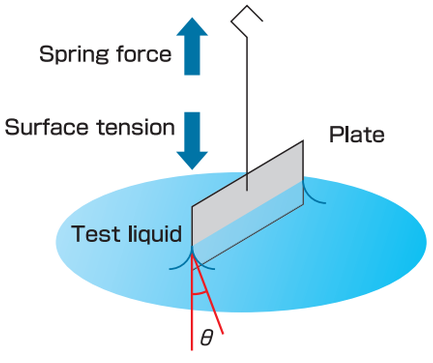


Hydrophilic

Water Repelling

○Static surface tension Wilhelmy method (plate method or vertical plate method)

When a plate touches a liquid surface, the liquid moves up and wets the plate, and the surface tension acts along the plate’s perimeter as a force pulling the plate into the liquid. To determine the surface tension, the magnitude of this force is measured.



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⚠WARNING

◆Please follow the instructions on the Safety Data Sheet and Technical Data Sheet.

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