PVA

POLYVINYL ALCOHOL

長 CCP 春

長春石油化學股份有限公司
Chang Chun Petrochemical Co., Ltd.

長春化工（江蘇）有限公司
Chang Chun Chemical (JIANGSU) Co., Ltd.

CCP

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Introduction

Polyvinyl Alcohol (PVA) is a water soluble and biodegradable synthetic polymer. It is a dry solid, and is available in granule and powdered forms. Grades include both fully hydrolyzed and partially hydrolyzed. PVA is an excellent adhesive with superior bonding strength, film forming and emulsifying properties. The film of PVA exhibits outstanding resistance to oil, grease and solvents. In addition to its film forming property, it has excellent adhesion to both hydrophilic and hydrophobic materials. PVA has been extensively used in textile industry for warp sizing and resin finishing; in paper industry for surface sizing and pigment coating; in the production of PVAc emulsion as protective colloid; in the suspension polymerization of PVC as a dispersion agent; as binder for ceramics, magnet, foundry cores and pigments.

PVA is manufactured by polymerization of vinyl acetate monomer, followed by hydrolysis of the polyvinyl acetate. CCP PVA is produced in a wide range of hydrolysis and polymerization. In the partially hydrolyzed grades, 86-89 mole% of acetate group is replaced by alcohol group. Likewise, in the fully hydrolyzed grade, 98.5~99.2 mole % of acetate group is replaced by alcohol group.

Individual PVA grade varies in molecular weight (degree of polymerization) and degree of hydrolysis. In order to help our valued PVA users to choose the most appropriate grade, CCP has defined CCP PVA grade as following:

BF-17: Fully hydrolyzed PVA with degree of polymerization about 1700.
BP-20: Partially hydrolyzed PVA with degree of polymerization about 2000.

The two-digit number indicates the degree of polymerization by one-hundredth; the higher the number, the higher degree of polymerization, so is the viscosity.

The most important properties which the majority of applications depend are degree of polymerization and degree of hydrolysis. The degree of polymerization is an expression of the size of polymer. The higher the degree of polymerization of polymer is, the bigger the size and the longer the length of polymer is. Similarly, the degree of hydrolysis is an expression of the ratio of hydrophilic alcohol group and hydrophobic acetate group. The properties of PVA are summarized as follows.

1 Based on degree of polymerization

- ♦ The higher degree of polymerization of polymer is, the higher viscosity of solution and adhesion strength of film are.
- ♦ The higher degree of polymerization of polymer is, the less water solubility and the higher solvent resistance are.
- ♦ The higher the degree of polymerization of polymer is, the higher tensile strength of PVA film is.
- ♦ The higher the degree of polymerization of polymer is, the less penetration and softness of film is.
- ♦ The higher the degree of polymerization of polymer is, the better protective ability is.

2 Based on degree of hydrolysis- Dissolving properties

- ♦ Fully hydrolyzed grade PVA (BF type) can be easily dissolved in over 90°C water, but it only swells in room temperature water.
- ♦ Partially hydrolyzed grade PVA (BP type) can be slowly dissolved in room temperature water. But in normal uses, raising temperature to 90°C is necessary for saving dissolving time.
- ♦ Super low hydrolyzed grade PVA (BC type) can be dissolved in 25°C to 50°C water, according to their grades.

3 Characteristic of BF type PVA

- ♦ Good affinity to hydrophilic fiber such as cotton, rayon and paper.
- ♦ Better water resistance film property than BP type PVA film.
- ♦ Viscosity is less stable in the condition of low temperature and high concentration than BP type PVA.
- ♦ Dissolving rate is slower than BP type PVA

4 Characteristic of BP type PVA

- ♦ Good affinity and cohesion power to hydrophobic fiber such as polyester, nylon, polyester /cotton blended and polyester/ rayon blended fiber.
- ♦ Good compatibility with oiling agent.
- ♦ Good solution viscosity stability.
- ♦ Better protective colloid property than BF type PVA.

Grades and Specifications

1. Standard Grades

Grade	Viscosity[1] (cps)	Hydrolysis (mole %)	Volatile (wt%)	Ash[2] (wt%)	pH[3]
Fully Hydrolyzed					
BF-26	70-80	98.5-99.2	<5	<0.7	5-7
BF-24	58-68	98.5-99.2	<5	<0.7	5-7
BF-24E	58-66	97-98.5	<5	<0.7	5-7
BF-17H	25-30	99.4-99.8	<5	<0.7	5-7
BF-17	25-30	98.5-99.2	<5	<0.7	5-7
BF-17E	25-30	97-98.5	<5	<0.7	5-7
BF-17W	25-30	95-97	<5	<0.7	5-7
BF-14	13-16	98.5-99.2	<5	<0.7	5-7
BF-14W	13-16	95-97	<5	<0.7	5-7
BF-08	8-10	98.5-99.2	<5	<0.7	5-7
BF-05	5-6	98.5-99.2	<5	<0.7	5-7
BF-04	4-5	98-98.8	<5	<1	5-7
BF-03	3-4	98-98.8	<5	<1	5-7
Partially Hydrolyzed					
BP-28	60-70	86-89	<5	<0.5	5-7
BP-26	50-58	86-89	<5	<0.5	5-7
BP-24	44-50	86-89	<5	<0.5	5-7
BP-20	27-33	86-89	<5	<0.5	5-7
BP-20H	27-33	90-93	<5	<0.5	5-7
BP-17	21-26	86-89	<5	<0.5	5-7
BP-14	11-14	86-89	<5	<0.5	5-7
BP-08	8-10	86-89	<5	<0.5	5-7
BP-05	5-6	86-89	<5	<0.5	5-7
BP-04	4-5	86-89	<5	<0.5	5-7
BP-03	3-4	86-89	<5	<0.5	5-7
Sub- Partially Hydrolyzed (* For PVC)					
BC-24*	44-52	78.5-81.5	<5	<0.3	5-7
BC-24P*	38-44	75.5-77.5	<5	<0.3	5-7
BC-20*	36-42	78.5-81.5	<5	<0.3	5-7
BC-20P*	28-33	74-76	<5	<0.3	5-7
TC-07H*	5.5-6.5	76-79	<5	<1	5-7
TC-07P*	5.5-6.5	69-72	<5	<1	5-7
BC-05	5-6	72-76	<5	<0.5	5-7
Low Ash					
BP-17G	21-26	86-89	<5	<0.3	5-7
BP-05G	5-6	86-89	<5	<0.3	5-7

2. Low Foaming Grades

BP-05A	Specification is same as BP-05, and with better defoaming property.
BP-17A	Specification is same as BP-17, and with better defoaming property.
BP-14A	Specification is same as BP-14, and with better defoaming property.
BP-20A	Specification is same as BP-20, and with better defoaming property.
BP-24A	Specification is same as BP-24, and with better defoaming property.

3. Tackified Grades

Grade	Viscosity[4] (cps)	pH
AW-401	4,200 ~ 6,000	4.0 ~ 4.8
AW-201	1,200 ~ 2,000	4.0 ~ 4.8

4. Fine Particle[5] Grades, S-grades

BF-17S	Specification is same as BF-17, and with particle pass 80 mesh screen
BP-05S	Specification is same as BP-05, and with particle pass 80 mesh screen
BP-17S	Specification is same as BP-17, and with particle pass 80 mesh screen
BP-20S	Specification is same as BP-20, and with particle pass 80 mesh screen
BP-24S	Specification is same as BP-24, and with particle pass 80 mesh screen

Remark:

(1) Viscosity of a 4 wt % standard grade PVA solution at 20°C which is determined by Brookfield Viscometer with UL adapter.

(2) Calculated as Na_2O.

(3) pH is determined by pH meter at 20°C

(4) Viscosity of a 10 wt % tackified grade PVA solution which is determined by Brookfield Viscometer at 25°C

(5) Particle size of standard grades is all passes through 10-mesh screen.

Molecular Weight and Degree of Polymerization of CCP PVA

Grade	Degree of Polymerization	Molecular Weight
BF-26	2,500-2,600	112,000-120,000
BF-24	2,400-2,500	107,000-112,000
BF-24E	2,400-2,500	108,000-113,000
BF-20	2,000-2,100	89,000-95,000
BF-17H	1,700-1,800	75,000-80,000
BF-17	1,700-1,800	75,000-80,000
BF-17E	1,700-1,800	76,000-81,000
BF-17W	1,700-1,800	77,000-82,000
BF-14	1,100-1,200	50,000-55,000
BF-14W	1,100-1,200	50,000-55,000
BF-08	800-900	35,000-40,000
BF-05	500-600	22,000-27,000
BF-04	400-500	18,000-22,000
BF-03	300-400	13,000-18,000
BP-26	2,500-2,650	124,000-130,000
BP-24	2,400-2,500	118,000-124,000
BP-20	2,000-2,100	99,000-104,000
BP-20H	2,000-2,100	99,000-100,000
BP-17	1,700-1,800	84,000-89,000
BP-14	1,100-1,200	54,000-60,000
BP-08	800-1,000	40,000-50,000
BP-05	550-650	27,000-32,000
BP-04	420-550	21,000-27,000
BP-03	300-420	15,000-21,000
BC-24	2,500-2,700	132,000-140,000
BC-20	2,300-2,500	120,000-132,000

Physical Properties of CCP PVA

- ***Appearance:*** White to ivory granule or powder
- ***Specific Gravity:*** 1.23~1.31
- ***Bulk Density:*** 0.5~0.7 g/ml
- ***Storage Stability:*** Indefinite in dry storage
- ***Refractive Index at 20°C:*** 1.52~1.55 (anhydrous polymer)
- ***Specific Heat:*** 1.65~1.67 J/g°C(0.4 cal/g°C)
- ***Heat of Combustion:*** 5.9 kcal/g
- ***Mean Coefficient of Thermal Expansion:*** 7~10*10^{-5}/°C
- ***Glass Transition Temperature:*** 60°C(BP type)~85°C(BF type)
- ***Melting Point:*** 180~190°C(BP type), 230°C(BF type)
- ***Heat Sealing Temperature(dry, unplasticized):*** 165-210°C
- ***Compression-Molding Temperature(plasticized):*** 100-150°C
- ***Heat Stability:*** The color turns yellowish gradually when heated above 100°C, turns dark rapidly above 160°C. Decomposes above 200-220°C.
- ***Flammability:*** Burn at about the rate of paper.
- ***Light Stability:*** Excellent
- ***Effect of Strong Acids:*** Dissolves or decomposes
- **Effect of Strong Alkalies:** Softens or dissolves
- ***Effect of Weak Acids:*** Softens or dissolves
- ***Effect of Weak Alkalies:*** Softens or dissolves
- ***Effect of Organic Solvents:*** Resistant to most solvent
- ***Gas Permeability:*** Effectively resist permeation of gases such as oxygen, nitrogen, and carbon dioxide.
- ***Hygroscopicity:*** Less sensitive to humidity than other water-soluble resins.
- ***Toxicity:*** Non-toxic to human and animal.

Preparation of PVA Solution

Dissolving Procedures - For BF and BP type PVA

(1) Start with unheated water[1]. The temperature of water should not over 30°C.

(2) Turn on agitator.

(3) Charge PVA slowly. One to two minutes per 20 kgs bag with uniform adding rate is recommended. The slower the rate of charging, the less lump will form.

(4) Let PVA slurry be swelled without heating for 15~30 minutes.

(5) Heat to 85~90°C for BP type PVA; heat to 90~95°C for BF type PVA[2].

(6) Hold at temperature till PVA is completely dissolved.

Dissolving Procedures - For BC type PVA

(1)-(4) is same as for BF and BP type PVA.

(5) Slowly raise temperature to 70-80°C. (Please do not exceed 80°C)

(6) Keep the temperature for 10-30 minutes.

(7) Stop heating the solution.

(8) Keep stirring till the PVA is completely dissolved

Remark:

(1) It is likely to form lumped material if PVA is added to preheated water. Lumps are very difficult to dissolve completely.

(2) Failure to reach the minimum temperature may result in undissolved PVA, regardless of cook time.

Dissolving Device

■ ***Vessel***

PVA is usually processed in the form of aqueous solution. Since the solution is slightly acidic (pH 5~7), vessel should be made of materials, which will not contaminate the solution with corrosive material or rusts. Stainless steel vessel, enameled containers or polyester tanks are recommended.

The specific gravity of PVA is ranging from 1.26 to 1.31, which is heavier than that of water. Low agitation speed or unfavorable agitating condition sometimes causes coarse particles to precipitate and to block the outlet of the dissolving tank. Hence, a flush valve or tank valve is recommended to be installed in the bottom of the vessel to prevent the particles from blocking the discharge line.

■ ***Agitator***

The agitator should be of highly effectively in agitation and heating. Any agitator that is capable of preventing the formation of lumps, and transfer heat evenly can be used for dissolving PVA. Two-blade paddle type propellers are usually used, with agitation speed of 80-100 rpm. The propeller blade should be carefully designed with care, especially for dissolving high viscosity and high solid content BP type PVA. Propeller blade of up to 65-75% of the inside diameter of the vessel, with the propeller shaft perpendicular to the bottom, and a speed of 80-100 rpm seems to give the favorable results.

■ ***Methods of Heating***

Indirect jacket heating with low-pressure steam source or hot water bath will be favorable. To shorten the heating time, steam can be discharged directly into the solution. However, the steam condensate should be taken into consideration.

■ *The approximate concentration limits of PVA solution*

BF-24, BF-24E, AW-401, BF-26	10%~15%
BP-24, BC-24, BF-17H, BF-17, BF-17E, BF-17W, BP-20, BP-20H, BP-17, AW-201, BC-20,	15%~20%
BF-14, BF-08, BF-05, BF-14W, BP-14, BP-08, BP-05, BC-05	20%~30%
BP-03, BF-03, BP-04	40%~50%

Remark:

- For a storage time of more than 24 hours, adding 0.02-0.2% of preservatives or biocide to PVA solution is necessary to avoid the growth of microorganisms.
- During the dissolving of BP and BC type PVA, foaming may be a nuisance. It is recommended that the temperature should not be raised too rapidly. The addition of small quantity of defoamer prevents the formation of foam.
- All lines and tanks should be free of boric acid or borax to avoid coagulation.

Applications of PVA by Industry

(A) Textile Industry

1. Warp Sizing Agent

Fiber	Spun Yarn	Filament Yarn
Cotton	BF-17, BF-17W, BF-14, BF-14W, BP-17	
Rayon	BF-17, BF-17W, BF-14, BF-14W, BP17	BP-05(A)
T/C, T/R Blended	BP-20(A), BP-17(A), BP-14(A)	
Nylon	BP-20(A), BP-17(A), BP-14(A)	BP-05(A)
Polyester	BP-20(A), BP-17(A), BP-14(A)	BP-05(A)
Acetate	BP-20(A), BP-17(A), BP-14(A)	BP-05(A), BP-14(A)
Glass Fiber	BP-14(A)	BP-05G
Wool	BP-20(A), BP-17(A), BP-14(A)	

2. Resin Finishing Agent

Hard Finishing	BF-24, BF-17, BF-26
Crease and Shrinking Resistant	BF-24, BF-17, BF-26

3. Adhesive for Screen Printing

Temporary Adhesive for Screen Printing	BP-17, BP-20, BP-24

(B) Paper Industry

Adhesive	BF-17, AW-201, AW-401, BF-24, BF-26, BP-20
Remoistenable Adhesive	BP-05, BP-03, BP-20, BP-24, BC-24, BC-20
Surface Sizing	BF-17, BF-08, BF-05
Pigment Binding	BF-14, BF-05, BF-03, BF-08, BF-17, BP-03, BP-05
Internal Sizing	BF-17S

(C) Plywood and Woodwork Industries

Modifier for Thermosetting Resins	BF-17, BF-17S

(D) Polymer Industry

Protective colloid for PVAc emulsion	BP-24, BP-20, BP-17, BP-26, BP-05, BP-04, BF-26, BF-24, BF-24E, BF-17, BF-17E, BF-17W, BF-14, BF-05, BF-03
Suspending agent for PVC	BC-24, BC-20, TC-07P, TC-07H, BP-24, BP-24E, BP-26
Suspending agent for Polystyrene	BP-24E, BP-24, BP-26, BF-24E, BP-20

(E) Architecture

Additive of Cement	BP-20S, BP-17S, BP-05S
Adhesive for Forming Board	BF-24, BF-17

(F) PVA Sponge, Emery Wheel and Grinding Material

PVA Sponge	BF-24, BF-17, BF-14, BF-08, BF-05, BP-20
Emery Wheel	BF-24, BF-17, BF-14, BF-08, BF-05, BP-20
Grinding Material	BF-24, BF-17, BF-14, BF-08, BF-05, BP-20

(G) Packaging Materials

Cold Water Soluble PVA Film	BP-20, BP-17, BP-14, BC-20, BC-24
Cold Water Insoluble PVA Film	BF-17, BF-14, BF-14W, BF-05

(H) Printing Industries

Photosensitive Film of Stencil Screen Printing	BP-20, BF-17W, BF-17E, BF-24E
Photosensitive Film of Lithographic Printing Plate	BP-03, BP-05, BP-17

(I) Release Agent of Plastics

Mold Release Agent of Plastics	BF-03, BF-05, BF-08, BF-14

(J) Modified PVA

Formalized PVA (PVF)	BP-24, BP-20, BP-14, BP-05, BP-03
Butyralized PVA (PVB)	BF-24, BF-17, BF-14, BF-08, BF-05, BF-03

(K) Ceramics and Ferrite

Temporary Adhesive for Ferrite	BF-17, BF-24, BP-17, BP-24
Adhesive for Ceramic Resister and Plug	BP-05, BF-05, BP-17, BF-17

(L) Stationary

Vehicles for Water-Based Inks and Colors	BC-05, BP-20, BP17, BP-05, BF-17
Office Glue	BP-24, BP-17, BP-05

(M) Steel Industries

Quenching Agent for Steel	BP-20, BP-24

(N) Electroplating and Electrolytic Refining

Surface Smoothness Agent	BF-03, BF-05, BF-08, BF-14

(O) Others

Soil Conditioners	BP-05S, BP-05, BP-17
Binding Agent of Seed	BP-05S, BP-05, BP-17
Binding Agent of Animal Food	BF-24, BF-17
Facial Mask, Hand Cleaner, Cold Cream	BP-24, BP-17, BP-20, BP-05
Temporary Protective Coating for PVC Sheet, Plywood, Acrylate Sheet	BF-17, BP-20, BP-17, BP-05
Binding Agent for Compressed Tablet	BF-05, BP-05, BP-17, BP-20
PVA Sheet, Hose, Roller, Tube, Belt	BP-20, BF-17
For Monitor Fluorescent Pigment Coating	BP-17, BP-24
PVA Fiber (Vinylon)	BF17HHL

Applications of PVA by Grade

(A) Fully Hydrolyzed PVA:

Grade	Main Applications
BF-26, BF-24,	Adhesive, protective colloid for PVAc emulsion, paper surface sizing,
BF-24E	Stiffen agent for textile.
BF-17HHL	For Vinylon fiber.
BF-17, BF-17E,	Warp sizing agent for cotton or rayon spun yarn, paper surface sizing,
BF17W	Color coating binder, adhesive for paper, protective colloid for PVAc emulsion, PVA film, PVA sponge, modifier for thermosetting resin, binder for ferrite, binder for non-woven fabrics, PVA sponge
BF-14, BF14W	Color coating binder, warp-sizing agent for cotton or rayon spun yarn, and protective colloid for PVAc emulsion.
BF-08, BF-05, BF-03	Color coating binder, protective colloid for PVAc emulsion, mold release agent, PVA sponge, modified PVA.

("E" type has better gelling resistance than corresponding grade)

(B) Partially Hydrolyzed PVA:

Grade	Main Applications
BP-26, BP-24E	Adhesive, remoistenable adhesive, protective colloid for PVAc emulsion,
BP-24	Suspending agent for PVC polymerization, office glue, tackifier, binder for monitor pigment coating.
BP-20, BP-20H	Warp sizing agent for T/C, polyester spun yarn, protective colloid for PVAc
BP-17	Emulsion, remoistenable adhesive, facial mask, hand cleaner, PVA film.
BP-14	Warp sizing agent for T/C, polyester, glass fiber spun yarn.
BP-08	Protective colloid for PVAc emulsion, viscosity modifier for warp sizing agent.
BP-05	Warp sizing agent for filament yarn, protective colloid for PVAc emulsion, binder for pigmented coating of art paper, remoistenable adhesive, photosensitive film of lithographic printing plate
BP-04, BP-03	High solid content adhesive, remoistenable adhesive, protective colloid for PVAc emulsion, photosensitive film of lithographic printing plate

(C) Super Low Hydrolyzed Grade PVA (BC type)

Grade	Application
BC-24, BC-20	Suspending agent for PVC and Polystyrene polymerization
TC07P,TC07H	Suspending agent for PVC polymerization

(D) Tackified Grades PVA

Grade	Application
AW-201,AW-401	Adhesive for paper tube, core, can winding and solid fiber laminating.

Applications of CCP PVA

The applications of PVA for textile industry include

- Warp sizing
- Resin finishing
- Adhesive for screen printing

Textile Warp Sizing

The high film strength, flexibility, abrasion resistance, and good adhesion of PVA combined with its water solubility make PVA an efficient warp size for spun and filament yarn. The advantages of CCP PVA as a sizing agent are listed as following:

- Low add-on. CCP PVA exhibits high adhesion and cohesion, especially when compared with nature products, thus enabling sizing to be carried out with greatly reduced amount, and greatly reducing abrasion on the sizing machine and loom.

- High weaving efficiency. Yarns sized with PVA show excellent weaving efficiency with few loom stops.

- Stable solution viscosity. PVA solution is real solution as oppose to the colloidal suspension formed with starch. Solution of PVA can be held at elevated temperatures for days without viscosity degradation.

Recommended PVA for Spun Yarn Warp Sizing

Hydrophilic Fiber	PVA
Cotton, Ramie, Rayon	BF-17, BF-17W, BF-14, BF-14W

Hydrophobic and Blended Fiber	PVA
T/C, T/R, CVC	BP-20(A), BP-17(A), BP-14(A)
Polyester Yarn	BP-20(A), BP-17(A), BP-14(A)
Glass Fiber	BP-14, BP-05(G), BP-17(G)
Animal Wool	BP-20(A), BP-17(A), BP-14(A)

Spun Yarns Warp Sizing Examples

Example (1)	
Fiber	Composition
100% Cotton	30'S*30'S/100*60
BF-17	2.8%
Modified Starch	6.0%
Oil/Wax	0.7%
Antiseptic	0.04%
Concentration	9.54%
Temperature	90~92°C
Add on	10~11%

Example (2)	
Fiber	Composition
100% Cotton	30'S*30'S/120*100
BF-17	5.5%
Modified Starch	4.5%
Acrylic	0.5%
Oil/Wax	0.7%
Antiseptic	0.04%
Concentration	11.24%
Temperature	90~92°C
Add on	12~13%

Example (3)	
Fiber	Composition
100% Rayon	40'S*40'S/110*76
BF-17	6.0%
Modified Starch	4.5%
Oil/Wax	0.75%
Antiseptic	0.04%
Concentration	11.29%
Temperature	70~80°C
Add on	13~14%

Example (4)	
Fiber	Composition
100% Rayon	30'S*30'S/120*100
BF-17	5.5%
Modified Starch	4.5%
Acrylic	0.5%
Oil/Wax	0.7%
Antiseptic	0.04%
Concentration	11.24%
Temperature	70~80°C
Add on	12~13%

Example (5)	
Fiber	Composition
T/C 65/35	45'S*45'S/110*76
BP-20(A)	4.0%
Modified Starch	6.0%
Acrylic	0.5%
Oil/Wax	0.8%
Antiseptic	0.04%
Concentration	11.34%
Temperature	85~90°C
Add on	12~13%

Example (6)	
Fiber	Composition
T/C 65/35	45'S*45'S/136*72
BP-17(A)	6.0%
Modified Starch	5.0%
Acrylic	0.5%
Oil/Wax	0.8%
Antiseptic	0.04%
Concentration	12.34%
Temperature	85~90°C
Add on	13~15%

Example (7)	
Fiber	Composition
T/C 65/35	35'S*35'S/68*65
BP-20(A)	3.4%
Modified Starch	5.0%
Acrylic	0.45%
Oil/Wax	0.7%
Antiseptic	0.04%
Concentration	9.59%
Temperature	85~90°C
Add on	10~12%

Example (8)	
Fiber	Composition
T/R 65/35	40'S*40'S/110*76
BP-17(A)	6.0%
Modified Starch	5.0%
Acrylic	0.5%
Oil/Wax	0.8%
Antiseptic	0.04%
Concentration	12.34%
Temperature	80~85°C
Add on	13~14%

Example (9)	
Fiber	Composition
T/W 50/50	52'S*52'S/100*85
BP-20(A)	6.2%
Modified Starch	3.5%
Acrylic	1.0%
Oil/Wax	0.55%
Antiseptic	0.03%
Concentration	11.28%
Temperature	80~85°C
Add on	13~14%

Example (10)	
Fiber	Composition
100% Polyester	45'S*45'S/110*76
BP-17(A)	7.0%
Modified Starch	4.0%
Acrylic	1.0%
Oil/Wax	0.7%
Antiseptic	0.03%
Concentration	12.73%
Temperature	85~90°C
Add on	14~15%

Filament Yarns Warp Sizing Examples

Example (1)	
Fiber	Composition
Rayon	50~120D
BP-05(A)	5~7%
Acrylic	0.4~0.7%
Oil	0.5~0.6%
Add on	4~5%

Example (2)	
Fiber	Composition
Acetate	75~150D
BP-05(A)	5~7%
Acrylic	0.4~0.7%
Oil	0.4~0.6%
Add on	4~5%

Example (3)	
Fiber	Composition
Nylon	50~120D
BP-05(A)	5~6%
Acrylic	0.5~1.0%
Oil	0.5~0.6%
Add on	4~5%

Example (4)	
Fiber	Composition
Polyester	50~120D
BP-05(A)	5~7%
Acrylic	3~6%
Oil	0.4~0.7%
Add on	5~7%

Example (5)	
Fiber	Composition
Rayon	120D
BP-05(A)	5.0%
Acrylic	0.5%
Oil	0.5%
Concentration	6.0%
Add on	3~4%
Temperature	35~45°C

Example (6)	
Fiber	Composition
Nylon	70D
BP-05(A)	5.5%
Acrylic	1.0%
Oil	0.4%
Antistatic	0.2%
Defoamer	0.02%
Concentration	7.12%
Add on	4.5~5.0%
Temperature	35~45°C

Example (7)	
Fiber	Composition
Polyester	50~75D
BP-05(A)	6.0%
Acrylic	5.0%
Oil	0.5%
Antistatic	0.2%
Defoamer	0.02%
Concentration	11.72%
Add on	7.0%
Temperature	35~45°C

Example (8)	
Fiber	Composition
Polyester Texture Yarn	50~75D
BP-05(A)	7.0%
Acrylic	5.0%
Oil	0.5%
Antistatic	0.2%
Defoamer	0.02%
Concentration	12.72%
Add on	10~11%
Temperature	35~45°C

Resin Finishing for Textile

PVA is used as a modifier for thermosetting resin, such as urea formaldehyde resin or melamine formaldehyde resin, to make fabric resist to wrinkle and shrinkage. PVA is chemically bonded to the thermosetting resin, reducing the brittleness of resin, and preventing any decrease in the tear resistance of the fabric. PVA is also used alone to give the fabric hard finish without the irritating smell of formaldehyde.

Example: Hard finish (PVA only)

PVA: BF-17, BF-24, BF-26

PVA	3-8%
Pick up	80%
Pre-dry	80-85°C, 5 minutes
Curing	130-150°C, 3-5 minutes

Example: Hard finish with thermosetting resin

PVA: BF-17, BF-24, BF-26

PVA	6-8%
Thermosetting Resin	1.2-1.6%
Acidic Catalyst	0.8-1.0%
Pick up	80%
Pre-drying	80-85°C, 5 minutes
Curing	130-150°C, 3-5 minutes

Example: Permanent press finish with thermosetting resin

PVA: BF-17, BF-24, BF-26

PVA	2-3%
Thermosetting Resin	12-18%
Acidic Catalyst	0.8-1.0%
Wetting Agent	0.1-0.3%
Pick up	75-85%
Pre-drying	80-85°C, 5 minutes
Curing	130-150°C, 3-5 minutes

PVA for Paper Industry

PVA BF-17 is usually used as a surface treatment agent for paper and paperboard. When higher coverage is required, BF-05 or BF-08 may be applied. A sizing solution of 2-5% is used, with a plasticizer for example glycerol, an insolubilizer for example glyoxal and defoamer added to the solution. A wax emulsion (10-50% of the weight of PVA) may be added to prevent sticking to the dryer and staining on the calendar roll. Metallic stearates and rosins may also be applied. The applications of PVA for paper industry are listed as follows.

- Clear surface sizing
- Pigmented surface sizing
- Binder for ink jet paper
- Carrier for optical brightener
- Oil and grease resistance
- Silicone hold out
- Co-binder for color or pigment coating

Example: PVA for paper and paperboard surface sizing

PVA: BF-17

Paper and paper board	Solid content, wt%	Dry pick up (g/m^2)
Kraft liner board	2 ~ 2.5	0.4 ~ 0.8
Jute liner board	1.5 ~ 4	0.3 ~ 1.2
Uncoated white board	2 ~ 2.5	0.4 ~ 0.8
Carton board for food, greasy article and chemical	2 ~ 5	0.4 ~ 2
Wood free printing paper	3 ~ 6	0.5 ~ 1.5
Base paper for coated paper and paper board	2 ~ 4	0.4 ~ 1.0
One side coated paper	3 ~ 5	0.5 ~ 1.5
Grease barrier paper	5 ~ 10	1.5 ~ 3
Base paper of carbon paper	2 ~ 4	0.4 ~ 1
Release paper	2 ~ 10	0.4 ~ 3
Glassin paper	2 ~ 5	0.5 ~ 1.2
Banknote paper	7 ~ 8	1.5 ~ 2

PVA as Adhesive for Paper Industry

Both fully hydrolyzed grade and tackfied grade have been extensively used as adhesive for paper and paper-board. For example, they can be used in formulating quick-setting water resistant adhesives for bag seam and bag bottom pastes. They are also used as paper-laminating adhesive for the manufacture of solid fiberboard, linerboard, spiral tubes and drums. In many of these applications, PVA are used in combination with extender such as clay, starch and dextrin. Simply binary mixture of tackified PVA (AW-201, AW-401) and clay are effective laminating adhesive. They set rapidly to form water resistant bonds. They also give excellent mileage.

Adhesive for spiral tube AW-201, AW-401, BF-17, BF-24, BF-26

	Example 1	Example 2	Example 3
PVA	60 kg	100 kg	90 kg
PVAc(45%) Emulsion	60 kg		60 kg
Acidic clay	80 kg	80 kg	100 kg
Water	800 kg	820 kg	810 kg
Solid content	16.7%	18%	19%
Viscosity(cps at 30°C)	1,000~1,500	800~1,200	1,800~2,200

Adhesive for corrugated board AW-201, AW-401, BF-17, BF-24, BF-26

Example 1		Example 2	
PVA(AW-201)	60 kg	PVA(BF-17)	100 kg
Acidic clay	80 kg	Acidic clay	80 kg
Water	800 kg	Water	820 kg
Solid content	16.7%	Solid content	18%
Viscosity (@30°C)	1,000~1,500	Viscosity (@30°C)	800~1,200

Adhesive for Kraft paper bag: AW-201, AW-401, BF-17, BF-24, BF-26

Example 1		Example 2	
PVA(AW-201/BF17)	90 kg	PVA(BF-17/BF-24)	100 kg
Acidic clay	90 kg	PVAc(45%) Emulsion	80 kg
Water	800 kg	Water	820 kg
Solid content	16.7%	Solid content	18%
Viscosity (@30°C)	1,000~1,500	Viscosity (@30°C)	800~1,200

Adhesive for Kraft paper bag: AW-201, AW-401, BF-17, BF-24, BF-26

Example 1		Example 2	
PVA(AW-201/BF17)	84 kg	PVA(BF-17/BF-24)	100 kg
Acidic clay	96 kg	PVAc(45%) Emulsion	60 kg
Water	860 kg	Water	840 kg
Solid content	18 %	Solid content	13%
Viscosity (@30°C)	1,500~2,000	Viscosity (@30°C)	900~1,300

Remoistenable adhesive: Labels and gummed tape

Labels, postage stamps, gummed tape and wallpaper are pasted with glue that should not tack in dry state but will quickly show its adhesiveness when wetted. BP type and BC type are useful for this application. A small amount of glycerol or ethylene glycol is often used with PVA to improve the pliability of gummed paper.

Example: Gummed wall paper

Example 1		Example 2	
PVA BP-20	10%	PVA BP-20	10%
PVA BP-05	6%	PVA BP-05(03)	16%
Viscosity(@30°C)	2,500-3,000	Viscosity (@30°C)	4,000-4,500
Glue take up(g/m^2)	20-25	Glue take up(g/m^2)	20-25

Example: Gummed wall paper

Example 1		Example 2	
PVA BP-05	20 %	PVA BP-05	25%
PVA BP-03	20 %	Dextrine	15%
Viscosity (@30°C)	3,000-4,000	Viscosity (@30°C)	2,000-3,000
Glue take up(g/m^2)	35-40	Glue take up(g/m^2)	20-25

Example: Label

Example 1		Example 2	
PVA BP-20	6 %	PVA BP-05	20%
PVA BP-05	12 %	Glycerol	3%
Viscosity (@30°C)	1,200-1,500	Viscosity (@30°C)	400-700
Glue take up(g/m^2)	15-20	Glue take up(g/m^2)	15-20

Protective Colloid for PVAc Emulsion

CCP PVA acts as a protective colloid in the polymerization of PVAc emulsion and as a thickener for these emulsions. The criteria of choosing proper grade PVA or combination of different grades is based upon the emulsion properties desired. Generally, BF type PVA gives good water resistant to the emulsion. BP type PVA gives finer particle size, and higher viscosity than BF type does. Combination of two or more grades of PVA is often used to obtain well-balanced properties.

CCP PVA BF-26, BF-24, BF-17 has good water resistance, and BF-17E and BF-24E have excellent low temperature stability. BP-17 and BP-24 are also recommended for medium to high viscosity and low temperature resistance. BP-05 is used for high solid content emulsion and for viscosity adjustment.

Usage: About 10 - 15 wt% / monomer of PVA is recommended.

The comparison BF type and BP type PVA as a protective colloid on the properties of PVAc emulsions

Item	BF type	BP type
1. Structural viscosity index	Low	High
2. Wet tack	High	Low
3. Water resistance	High	Low
4. Viscosity	Low	High
5. Adhesive strength	High	Low
6. Setting speed	Fast	Slow
7. Particle size	Large	Small
8. Freeze / thaw stability	Fair	Good
9. Compatibility with urea-formaldehyde	Fair	Good
10. Wetting property	Fair	Good
11. Film clarity	Low	High
12. Gloss	Low	High
13. Bulk density	Low	High
14. Fluidity	Good	Fair

Examples: Starting Formulations for PVAc Emulsion

Raw material \ Recipe	1	2	3	4
BP-24	0	0	2.0	0
BP-20	7.5-8.0	3.0-3.5	0	3.5
BP-05	0	0	2.05	0
BF-17	0	0.8-1.2	0	1.0
VAc monomer	24	41.5	41.5	36.5
DBP plasticizer	3.0	3.5	3.0	4.0
H2O2 initiator	0.2-0.25	0.2-0.25	0	0
APS initiator	0	0	0.1-0.15	0.1-0.15
Tartaric acid	0.1	0.1	0	0
Sodium acetate	0.1	0.05	0	0
Sodium bicarbonate	0	0	0.05-0.1	0.05-0.1
Defoamer	0.02-0.1	0.02-0.1	0.02-0.1	0.02-0.1
Preservative	0.05-0.1	0.05-0.1	0.05-0.1	0.05-0.1
Water	65	51	51	55
Properties of PVAc Emulsion				
pH	4-6	4-6	4-6	4-6
Solid content	35	49	49	45
Viscosity at 30°C (cps)	500,000-800,000	300,000-500,000	20,000-40,000	6,000-10,000
Viscometer	LVF	LVF	LVF	LVF
Spindle / rpm	4/0.6	4/0.6	4/12	4/30

Binder for Ceramics and Ferrites

PVA is used as binder for ferrite magnet and ceramics such as thermoresister, IC substrate, IC package and ceramic condenser. BF17(W), BP20, BP17 and BP05 are suitable for this application. PVA is added at concentration of 1-5% of raw material.

PVA as a Modifier for Plywood Glues

PVA BF-17 has been used to modify thermosetting glues such as urea-formaldehyde, phenol-formaldehyde, melamine-formaldehyde resin for many years. The benefits of using BF-17 to modify thermosetting glues include:

- Improvement of initial adhesives for non-clamp process,
- Improvement of impact strength,
- Improvement of aging resistance,
- Improvement of fluidity and workability

PVA BF-17 may be used as a modifier for plywood in two ways:

- Pre-addition: 1.5 ~ 3 % of the weight of urea of BF-17 is added during the preparation of resin condensation.
- Post-addition: 3 % of the weight of urea-formaldehyde resin of BF-17 is added to serve as an extender, which increases the durability of resin.

PVA for Building Industry and Cement Additives

CCP fine powder PVA BP-05S, BP-20S and BP-24S are specially designed for cement additives and building industry. They improve plaster properties such as flexibility, water retention, and increase plaster viscosity as well. In addition, they do not only reduce the friction of plaster but also enhance its working capacity and quality. (Prevent cracking and shedding of plaster, increase adhesion and smoothness of cement.) To mix desired amount of PVA with cement well before water is added prevents the lumping of PVA.

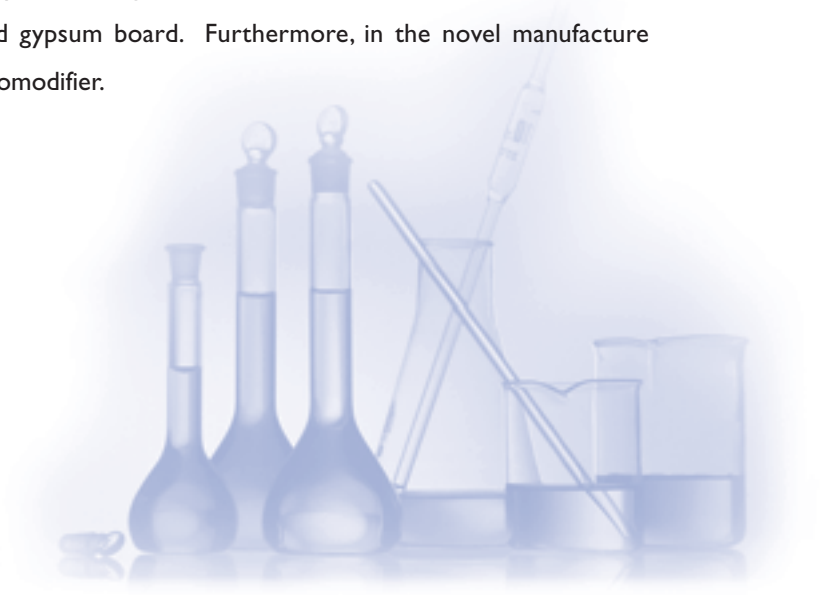
● For building materials binder:

CCP PVA has been extensively utilized as a variety of building materials binder. For instance, it is used as a binder in the maturity of asbestos, rockwool and gypsum board. Furthermore, in the novel manufacture method of slate, CCP PVA may be used as the hydromodifier.

● For tile adhesion:

Suitable PVA grade: BP-20S, BP-24S

Suggested quantity: 0.5-1.0% PVA/cement



● **For decorated wall:**

Suitable PVA grades: BP-05S (or BP-05S/BP-20S = 2:1, BP-05S/BP24S = 2:1)

Suggested PVA quantity: 0.2-1.0% PVA/cement

For Casting and Laminating Resin as Mold Release Agent

CCP PVA is used as a mold release agent in the manufacture of unsaturated polyester corrugated boards, epoxy resin piles, PVC flooring, unsaturated polyester molding for air crafts, automobiles, and ships. The adhesion of glass fiber reinforced plastics to the mold can be minimized by the interfacial PVA film to allow rapid mold release operation.

The advantages of PVA as a mold release agent are listed as following.

- Good film forming property, without cracking
- Anti-adhesive release effect, even when thinly applied
- Impermeability of PVA film to the organic material used, e.g. styrene
- The PVA film which adhesives to the cast article can be peeled off by hand

Suitable grades: BF-05, BF-14, BF-17.

PVA solution of above-mentioned grades can be applied to the mold by brushing or spraying. The viscosity of the selected grade and concentration determine the thickness of release coating. About 10 to 30 wt % of solid content is recommended for this purpose. Up to 15% of plasticizer, such as glycerol or ethylene glycol, relatively to the weight of PVA, can be added to the formulation to improve the flexibility of mold release film.

As the PVA solution can be prepared with a solid content not exceed 30%, a considerable amount of water has to be evaporated for film formation. This process can be speed up by adding lower alcohols such as methanol, ethanol and propanol to the solution. The quantity added is depending on the grade of PVA and alcohol used. The limit of compatibility is indicated by the incipient turbidity of PVA solution.

Example:

Mold Release Coating		Strippable Coating	
PVA	10-25%	PVA	10-20%
Methanol	10-20%	Glycerin	5-7%
Ethanol	10-20%	Sulfonated caster oil	3%
Plasticizer	1-4%		
Water	Balance	Water	Balance

Analytical Methods for CCP PVA

Scope

These procedures describe the methods for determining the general properties of CCP PVA including viscosity, degree of hydrolysis, pH value, volatile content and ash content.

Viscosity of 4.00 wt % PVA Solution

Prepare three samples of 22 g each in a 600 ml beaker in accordance with the calculation formula. Add distilled water to the concentrations of 3.8%, 4.0%, and 4.2% and then let it swell for 30 minutes.

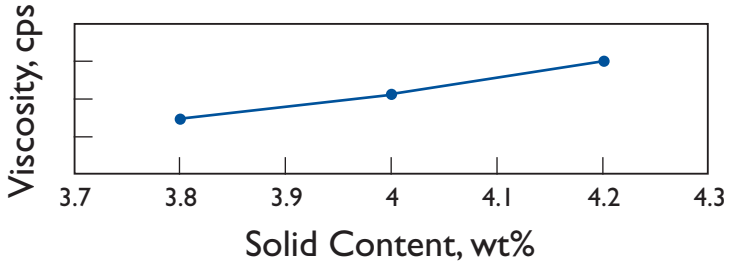
$$Wa = \frac{22 \times (100 - R)}{Cs} - 22$$

Where Wa : water to be added

R% : volatile content of PVA

Cs : prescribed concentration

After swelling, dissolve it completely in a boiling water bath and leave it cool to room temperature. Measure the viscosity of each solution at 20±0.1°C by Brookfield Viscometer with UL Adapter. Then, measure accurately the concentration of each solution (Note 1). Report the viscosity (Cps) of 4.00 wt% solution as estimated from a curve based on the relationship between concentration and viscosity, as follows:



Note 1 : Method of concentration measurement

Weigh 5 g each of aqueous solution in a evaporating dish and vaporize it in an oven at 105 ± 2°C for more than 3 hours until the weight is constant. Remove the dish from the oven; leave it to cool in a desiccate for 15 minutes.

Weight the dish then calculate the concentration as follows:

$$Cm = (r \times 100)/a$$

where Cm : concentration (wt %)

r : residual weight (g)

a : weight of each experimental aqueous solution (g)

Degree of Hydrolysis

A. Fully hydrolyzed grade (BF type) :

Weigh 3 g (for BF17W, BF14W weigh 1.5g) of the sample into a 300 ml stoppered conical flask and pour 100 ml of distilled water to dissolve the sample completely by heating then leave it cool to room temperature.

Add 25 ml of N/10 NaOH solution, seal the flask and leave it still for at least 2 hours in room temperature. Add accurately 25 ml of N/10 H_2SO_4 solution and titrate back the excess amount of H_2SO_4 solution present with N/10 NaOH solution using phenolphthalein as the indicator, until the solution appears in pale pink color.

The volume of N/10 NaOH solution consumed in this titration is a ml. Carry out a blank test separately; the volume of N/10 NaOH solution consumed in this blank test is b ml.

$$A=0.60*(a-b)*F*100/(S*P)$$

$$B=44.05*A/(60.05-0.42*A)$$

$$C=100-B$$

Where

A : wt % of residual acetate groups

B : mole % of residual acetate groups

C : mole % of hydrolysis of the sample

S : weight of the initial sample

P : Purity =100 - volatile of the sample - NaAc content of the sample

F : concentration factor of N/10 NaOH solution

B. Partially hydrolyzed grade (BP & BC type) :

Weigh 0.5 g (for TC-07P, BC-20, BC-05 weigh 0.4 g) of the sample into a 300 ml stoppered conical flask and pour 100 ml of distilled water to dissolve the sample completely by heating then leave it cool to room temperature.

Add 25 ml of N/5 NaOH solution, seal the flask and leave it for at least 2 hours at room temperature. Add accurately 25 ml of N/5 H2SO4 solution and titrate back the excess amount of H2SO4 solution present with N/10 NaOH solution using phenolphthalein as the indicator, until the solution appears in pale pink color.

The volume of N/10 NaOH solution consumed in this titration is a ml. Carry out a blank test separately; the volume of N/10 NaOH solution consumed in this blank test is b ml. Calculate the hydrolysis by the same equation set forth in procedure (A).

pH of 4% Solution

Pour 80 ml of 4% solution to the 100 ml beaker. Calibrate the glass rod pH meter by using a buffer solution of pH 4 and pH 7. Measure the pH of 4.0wt% PVA aqueous solution at room temperature to the scale of two decimals.

Volatile Content

Weigh 5 g of the sample in an evaporating dish and dry it in an oven at 105 ± 2°C for 3 hours. Remove the evaporating dish from the oven, leave it to cool in a desiccator and weigh the dish.

$$R = \frac{S - W}{S} \times 100$$

Where

R : volatile content (wt %)

S : weight of the sample (g)

W: weight of dried sample (g)

Ash content

Weigh 5 g of the sample in a porcelain crucible and ignite it in an electric furnace at 750 ~ 800°C for 5 hours until the sample is reduced to ash and the weight become constant. Remove the crucible, leave it to cool in a desiccator for 30 minutes after that weigh its weight.

$$K = \frac{a}{b} \times 100$$

Where

K : wt % of ash based on initial sample

a : increased weight of the crucible after incineration

b : weight of dried sample

MATERIAL SAFETY DATA SHEET

SECTION 1 Chemical Product and Manufacturer's Identification

Chemical Name and Synonyms:	Polyvinyl Alcohol (PVA, PVOH, PVAL)
Trade Name:	BP28, BP26, BP24, BP20, BP20H, BP17, BP16, BP14, BP08, BP05, BP04, BP03, BP24A, BP24S, BP20S, BP20A, BP17A, BP05A, BP17G, BP05G, BP05S, BF26, BF24, BF24H, BF24E, BF17H, BF17, BF17E, BF17S, BF17W, BF14, BF08, BF05, BF04, BF03, BC03H, BC16, BC20, BC24, TS30, TP17
Chemical Family:	Polymer, Synthetic Resin
Chemical Formula:	[$-CH_2CHOH-$]n [$CH_2CHOOCCH_3$]m
Supplier Information:	Chang Chun Petrochemical Co., Ltd 301 Songkiang Road, 7th Fl., Taipei, Taiwan, 10477 Tel: 886-2-25038131, 886-2-25001800 Fax: 886-2-25033378
Emergency Contact	Guo Don Lin, Senior Manager. Liang Shin Shi, Deputy Senior Manager Tel: 886-37-320673 ext 237, 222 Fax: 886-37-355591

SECTION 2 Composition / Information on Ingredients

Ingredient	CAS No	Percent
Polyvinyl Alcohol	9002-89-5 (Fully hydrolyzed) 25213-24-5 (Partially hydrolyzed)	> 95%
Methyl Alcohol	67-56-1	< 3%
Methyl Acetate	79-20-9	< 1%

SECTION 3 Hazards Identification-Emergency Overview

CAUTION! May form combustible dust concentrations in air. Nuisance dust.

Potential Health Effects

Inhalation:	Dust may be formed under certain conditions of use. Treat as a nuisance dust.
Ingestion:	Not expected to be a health hazard via ingestion.
Skin Contact:	May cause skin irritation. Not expected to be a health hazard from skin exposure.
Eye Contact:	May cause eye irritation.

SECTION 4 First Aid Measures

Inhalation:	Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:	If large quantities of this material are swallowed, call a physician immediately. Do not induce vomiting unless directed to do so by a physician. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:	Wash exposed area with soap and water.
Eye Contact:	Wash thoroughly with running water. Get medical advice if irritation develops.

SECTION 5 Fire Fighting Measures

NFPA: Health: 1, Flammability: 1, Reactivity: 1.
Flammable properties: Flammable limits in air, % by volume: Upper: Not applicable. Lower: Not applicable. Auto ignition temperature: Not applicable. Flash point: None.
Fire: As with most organic solids, fire is possible at elevated temperatures or by contact with an ignition source. Minimum dust ignition temperature: 440°C.
Explosion: Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard. Minimum explosion concentration 35 g/m3. Maximum explosion pressure: 6.26 kg/cm2.
Fire Extinguishing Media: Water spray, dry chemical, alcohol foam or carbon dioxide.
Special Information: In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full face-piece operated in the pressure demand or other positive pressure mode.

SECTION 6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container.

SECTION 7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Separate from incompatibilities. Avoid dust formation and control ignition sources. Employ grounding, venting and explosion relief provisions in accord with accepted engineering practices in any process capable of generating dust and/or static electricity.

SECTION 8. Exposure Controls/Personal Protection

Airborne Exposure Limits **OSHA Permissible Exposure Limit (PEL):** 15 mg/m3 total dust, 5 mg/m3 respirable fractions for nuisance dusts. **ACGIH Threshold Limit Value (TLV):** 10 mg/m3 total dust containing no asbestos and < 1% crystalline silica for Particulates Not Otherwise Classified (PNOC).
Ventilation System: A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred.
Personal Respirators: If the exposure limit is exceeded, a half-face dust/mist respirator may be worn for up to ten times the exposure limit or the maximum use concentration specified by the appropriate regulatory agency or respirator supplier, whichever is lowest.
Eye Protection: Use chemical safety goggles.
Skin Protection: Wear protective gloves and clean body-covering clothing.

SECTION 9. Physical and Chemical Properties

Appearance:	White to ivory granule or powder
Odor:	Odorless.
Solubility:	Moderately soluble.
Specific Gravity:	1.23 - 1.31
pH:	5~7 (4wt% solution)
Boiling Point:	Not Applicable.
Melting Point:	180~230°C
Vapor Density (Air=1):	Not Applicable.
Vapor Pressure (mm Hg):	Not Applicable.
Evaporation Rate (BuAc=1):	Not Applicable.

SECTION 10. Stability and Reactivity

Stability: Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products: Complete combustion will emit carbon dioxide and water when heated to decomposition. Incomplete combustion may produce carbon monoxide and oxidation products, including organic acids, and alcohol.
Hazardous Polymerization: Will not occur.
Incompatibilities: Strong oxidizers.
Conditions to Avoid: Heat, flame, ignition sources, dusting and incompatibles.

SECTION 11. Toxicological Information

Oral rat LD50: > 5000 gm/kg; practically nontoxic to animals by ingestion.
Inhalation LC50: >20.0 mg/l (rats; dust with 3-5 micron particle size; 1 hr. exposure); practically nontoxic to animals by acute inhalation exposure.
Skin: In powder form, Polyvinyl Alcohol was nonirritating to rabbit skin. In aqueous solution, slight irritation to rabbit skin was noted. Practically nontoxic to animals (LD50, rabbits: >1,000 mg/kg).
Eye: The powder and aqueous solutions are slightly irritating to rabbit eyes; irritation subsided by 48 hrs after exposure.
Carcinogenicity: Polyvinyl Alcohol is not classifiable as to (its) carcinogenicity in humans".
Reproductive/Developmental Effects: No information available.
Repeated Exposure: A review of Polyvinyl Alcohol studies by the Cosmetic Ingredient Review Expert Panel is available in the published literature (Int. J. Toxicology, 17(Suppl. 5): 67-92 (1998)). The Panel concluded that Polyvinyl Alcohol is safe as used in cosmetic formulations.

SECTION 12 Ecological Information

Ecotoxicity: Polyvinyl alcohol exhibits low acute toxicity to aquatic species. Fish (Pimephales promelas) 96-hr. LC50: > 40,000 ppm. Fish (Lepomis macrochirus) 96-hr. LC50: >10,000 ppm. Crustacean (Ceriodaphnia dubia) 48-hr. LC50 = 7,850 ppm. Crustacean (Daphnia magna) 48-hr. LC50 = 8,300 ppm. Bacteria (Photobacterium phosphoreum), Microtox Method, EC50: >50,000 ppm.
Environmental Fate: **Biodegradation:** Polyvinyl alcohol (PVOH) has been reported to be substantially biodegraded in several test systems after a lag time for microbial acclimation. Almost 100% degradation of 30-day BOD with a PVOH-acclimated culture can be reached.

SECTION 13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Dispose of as a non-hazardous solid waste.

SECTION 14. Transport Information

This product is not classified as dangerous goods according to the international regulations for transport by land, inland waterway, sea and air.

SECTION 15. Regulatory Information

Chemical Inventory Status

Ingredient\Area	TSCA	EC	Japan	Australia
Methyl Alcohol (67-56-1)	Yes	Yes	Yes	Yes
Polyvinyl Alcohol (9002-89-5)	Yes	No	Yes	Yes

SECTION 16. Other Information

NFPA Ratings: Health: 0, Flammability: 1, Reactivity: 0
Label Hazard Warning: CAUTION! MAY FORM NUISANCE DUST.

Disclaimer:

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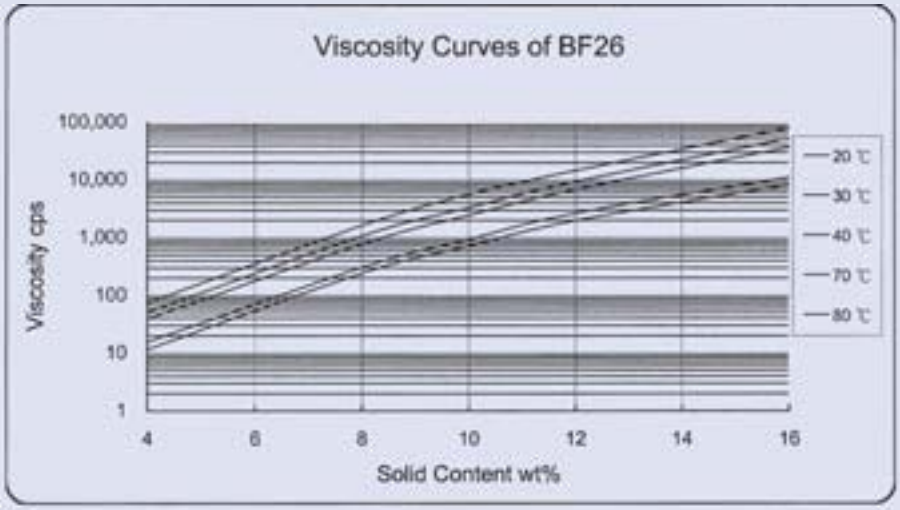
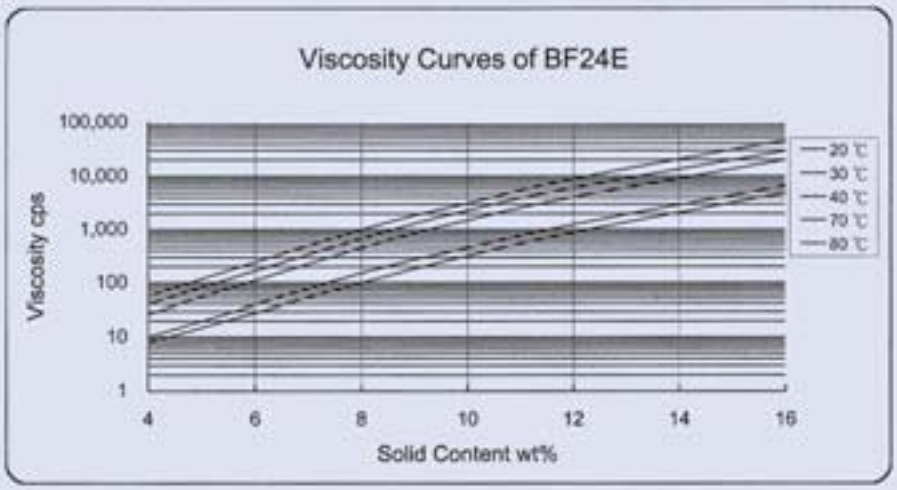
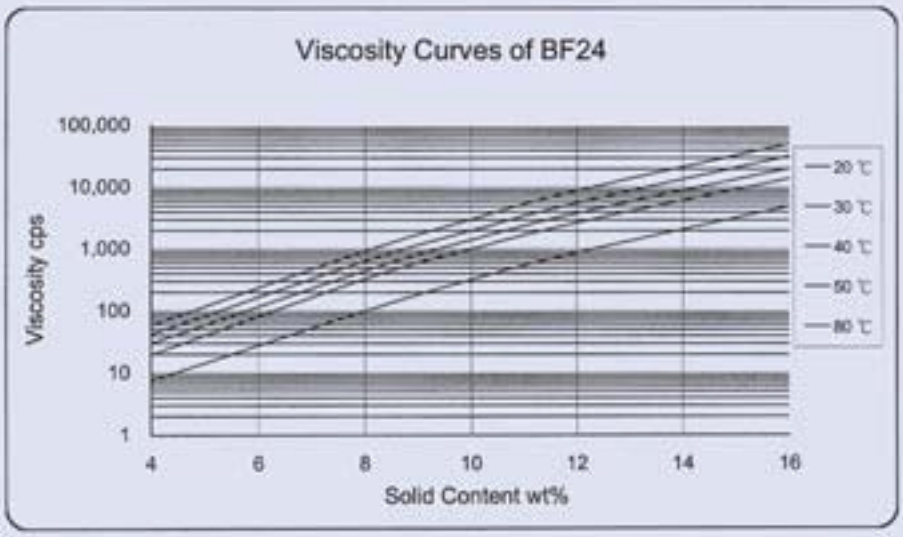
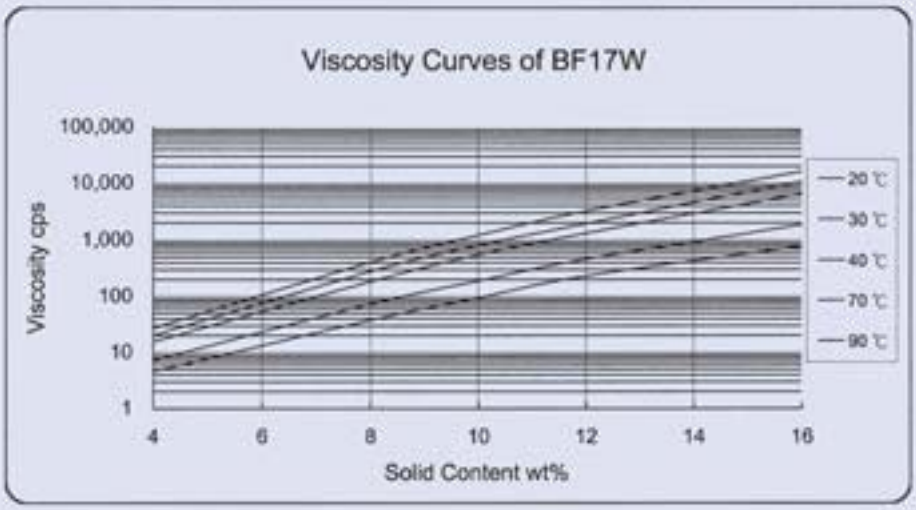
Charts of Viscosity Curves

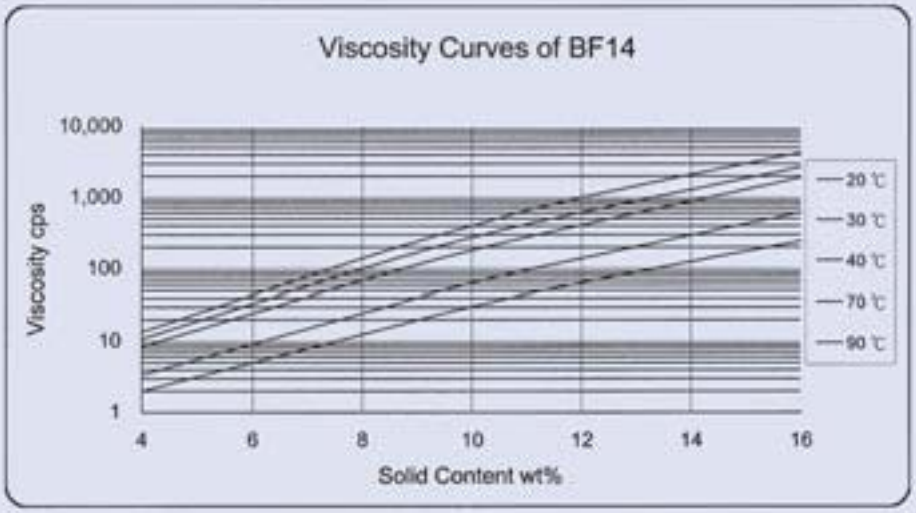


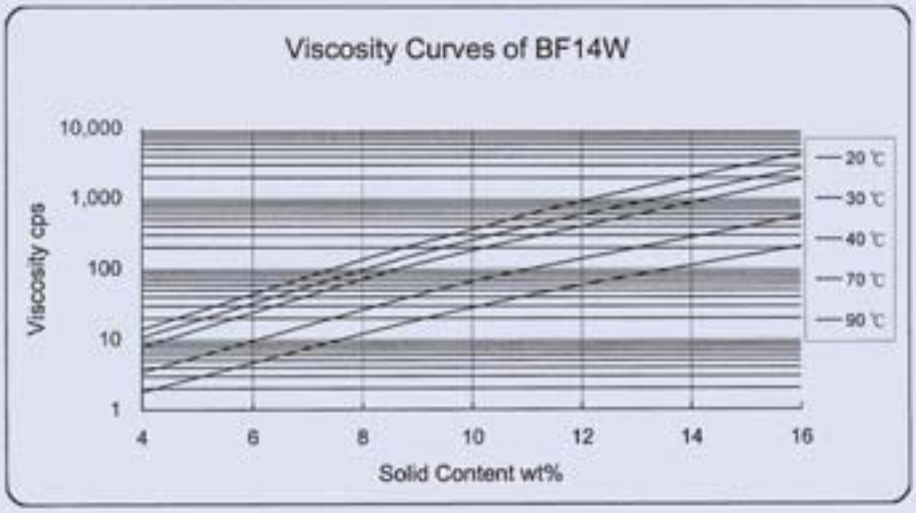




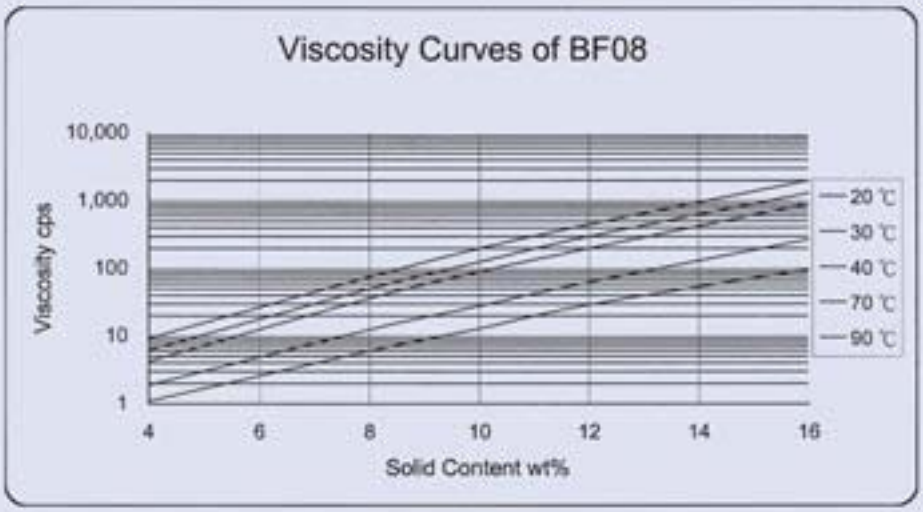
Charts of Viscosity Curves

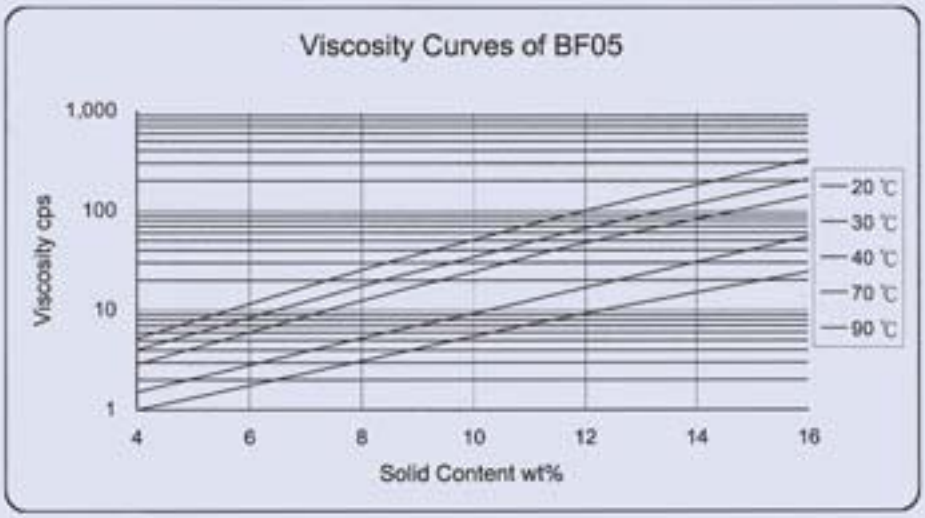


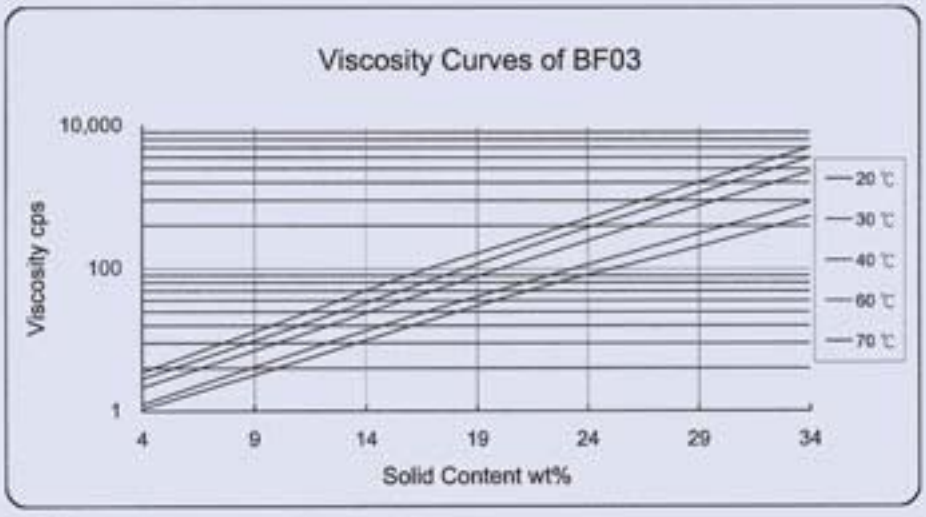




Charts of Viscosity Curves







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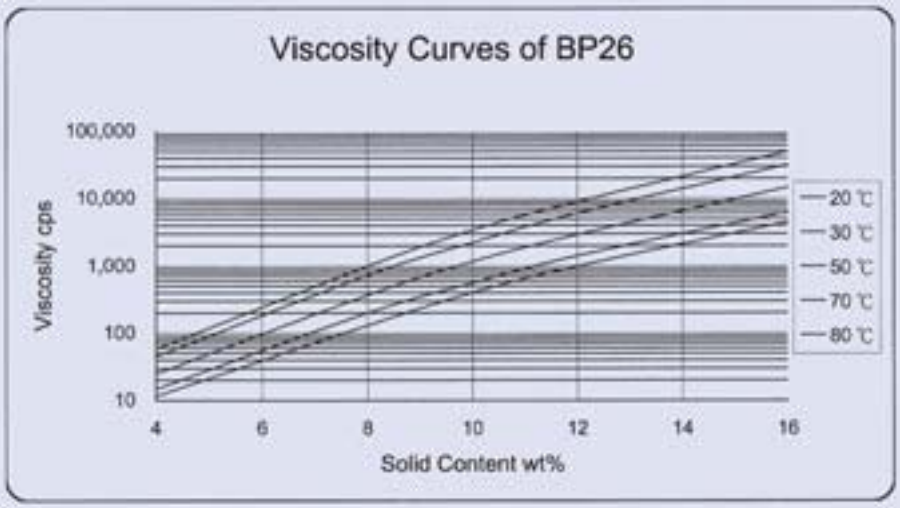

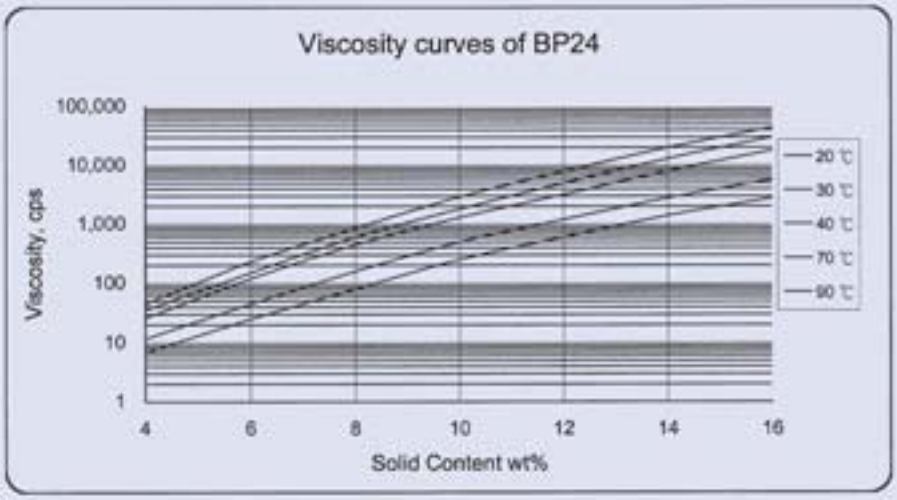

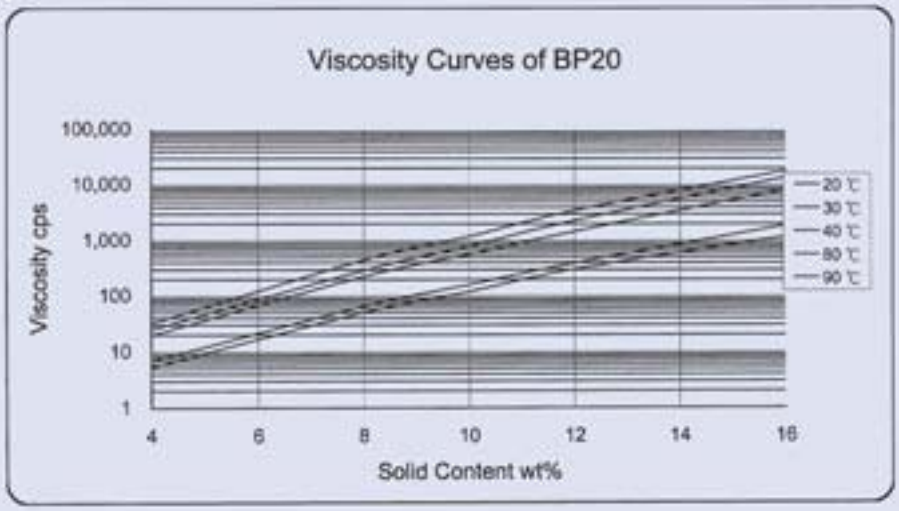

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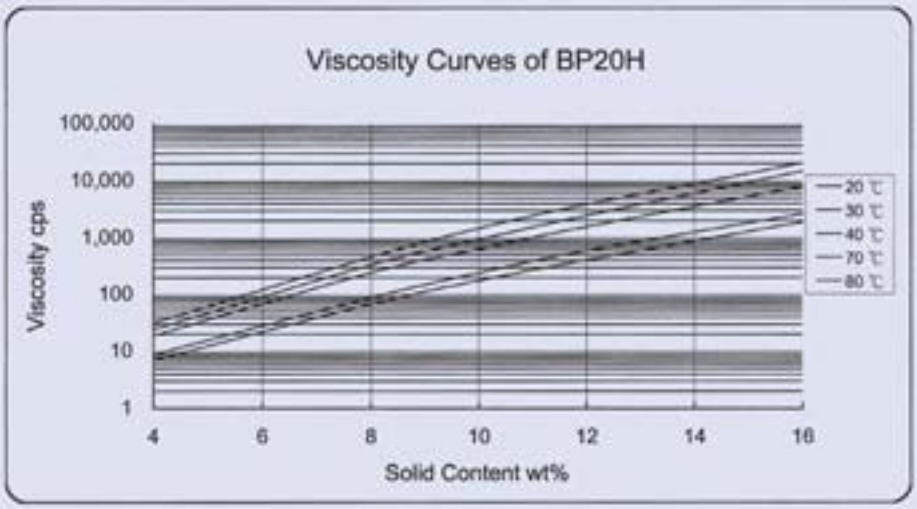

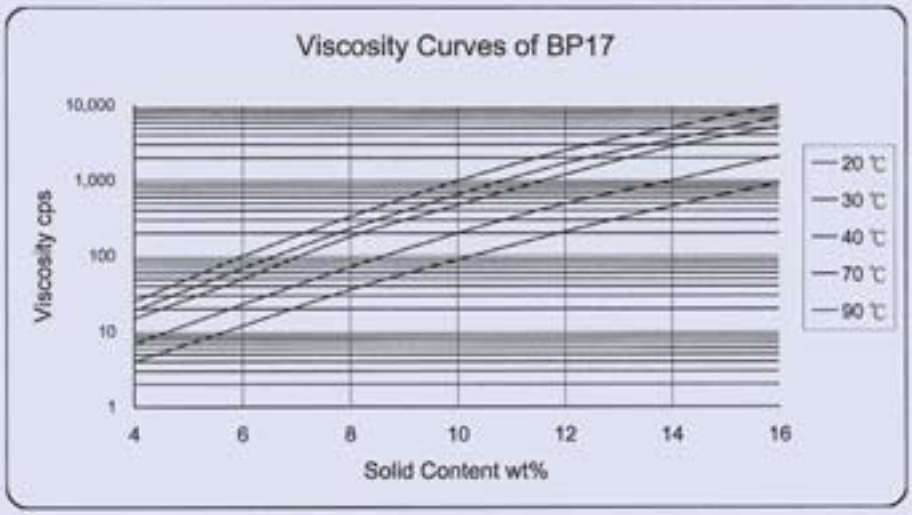

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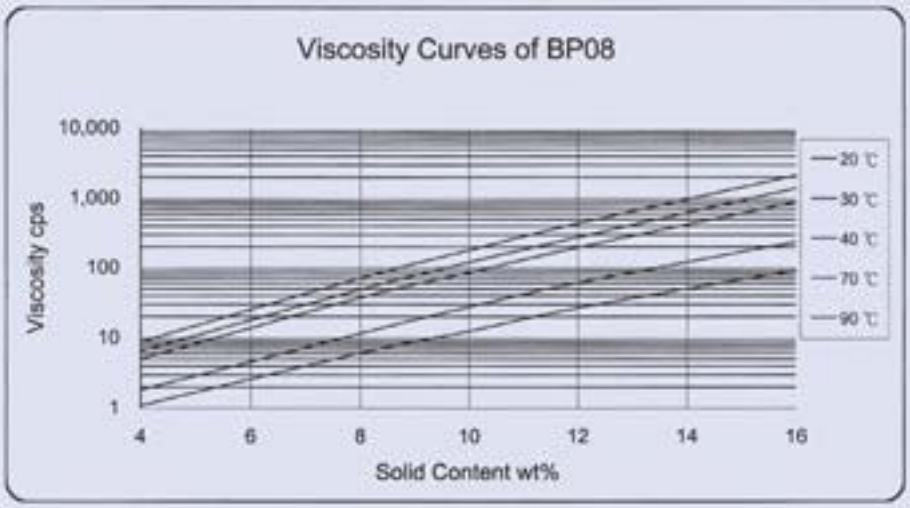

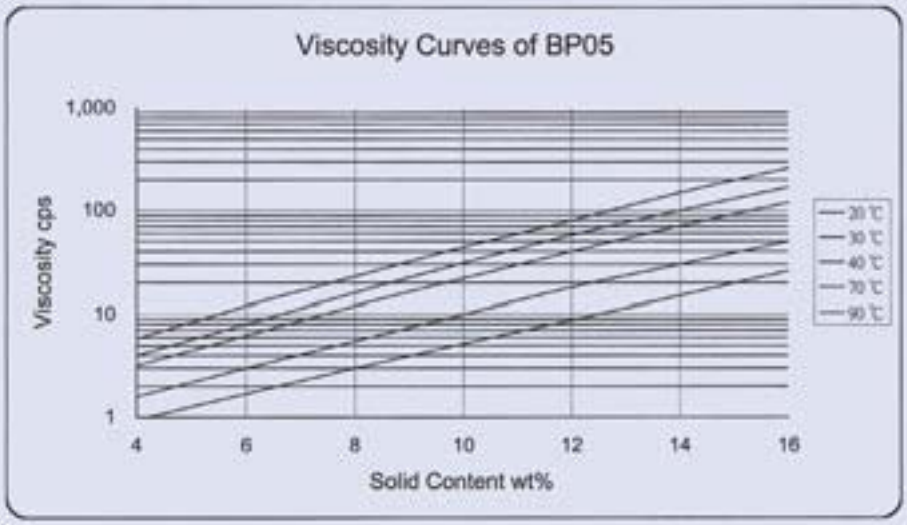

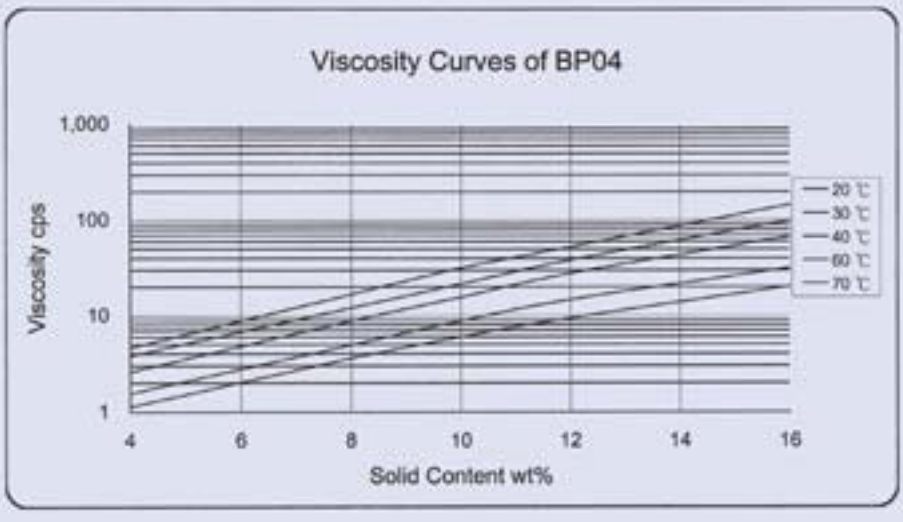

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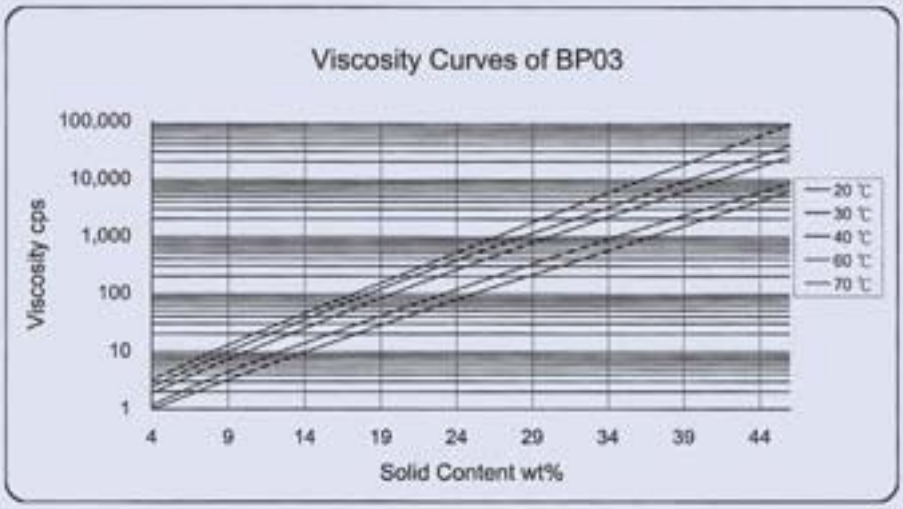

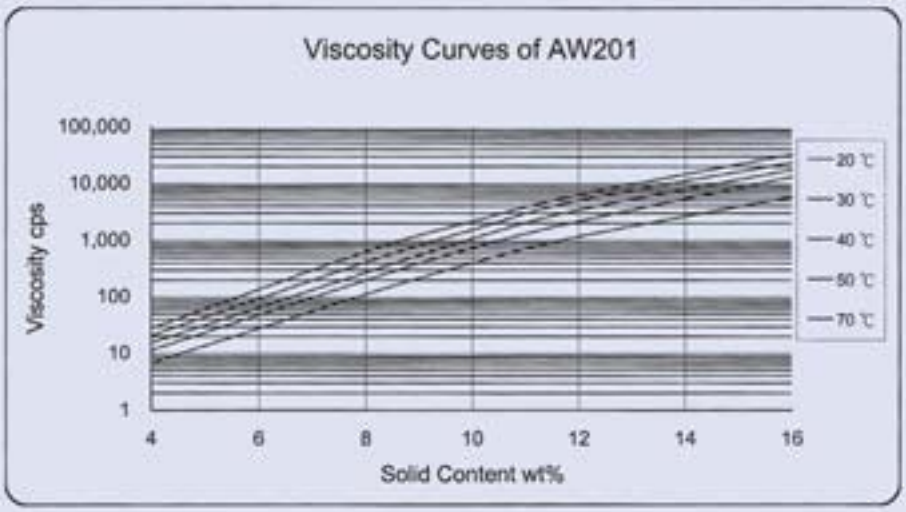

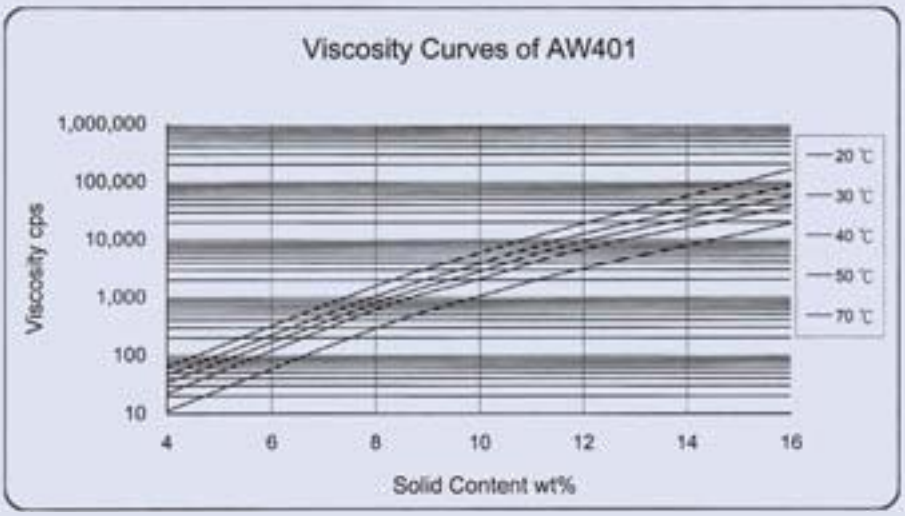

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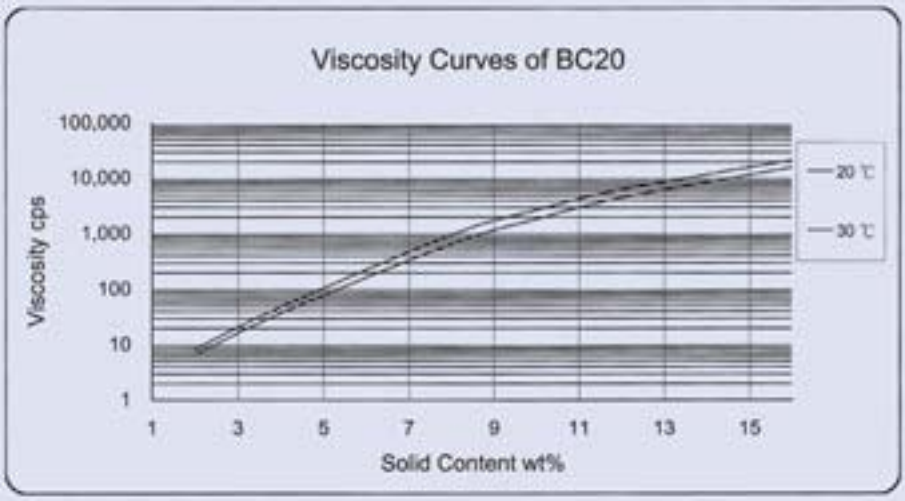
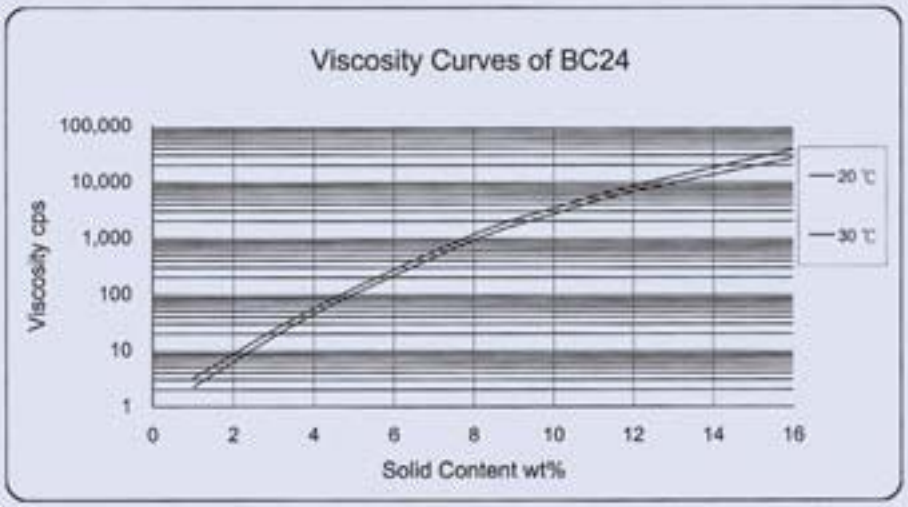
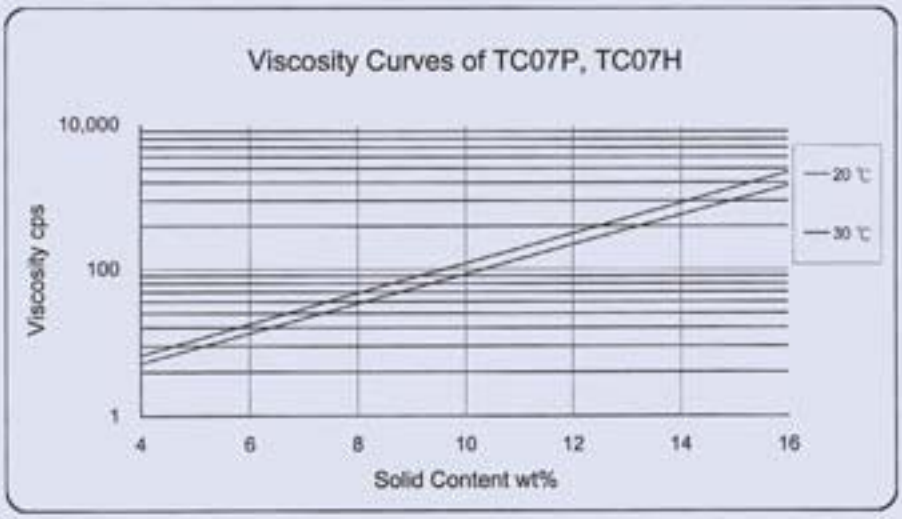






ISO 9001
BSMI
認可登錄
REGISTERED

QUALITY MANAGEMENT SYSTEM CERTIFICATE

THE BUREAU OF
STANDARDS, METROLOGY AND INSPECTION (BSMI),
MINISTRY OF ECONOMIC AFFAIRS,
TAIWAN, R.O.C.

hereby certifies that the firm

CHANG CHUN PETROCHEMICAL CO., LTD. (MIAO LI PLANT)

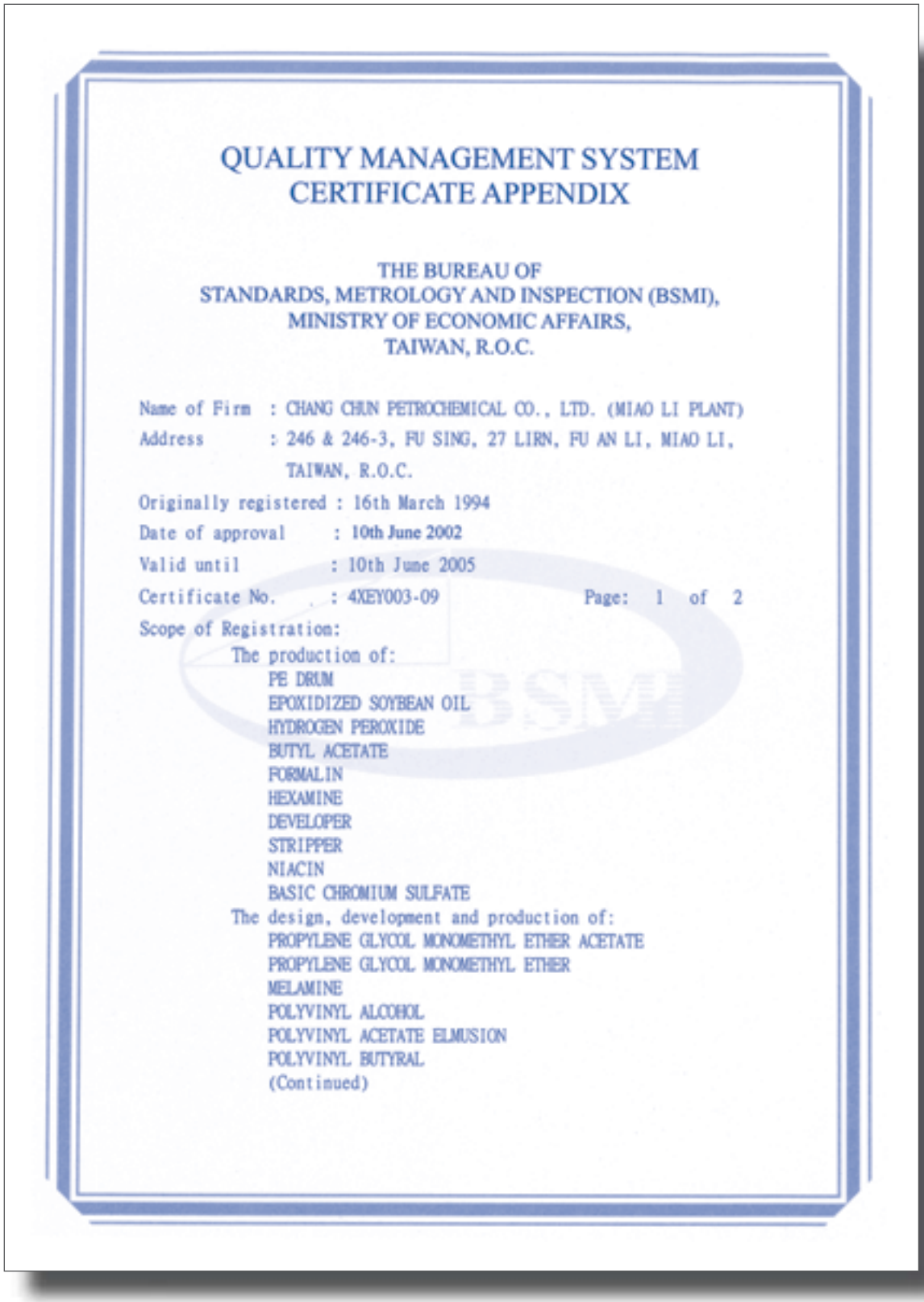
has fulfilled the requirements of Quality Management System specified as

ISO 9001:2000/CNS 12681

and is granted registration by the Bureau.
The scope of registration described in the Appendix.
The Appendix forms an integral part of this certificate,
which shall be invalid when used without the Appendix.

Originally registered	:	16th March 1994
Date of approval	:	10th June 2002
Valid until	:	10th June 2005
Certificate No.	:	4XEY003-09

Director General



QUALITY MANAGEMENT SYSTEM
CERTIFICATE APPENDIX

THE BUREAU OF
STANDARDS, METROLOGY AND INSPECTION (BSMI),
MINISTRY OF ECONOMIC AFFAIRS,
TAIWAN, R.O.C.

Name of Firm : CHANG CHUN PETROCHEMICAL CO., LTD. (MIAO LI PLANT)
Address : 246 & 246-3, FU SING, 27 LIRN, FU AN LI, MIAO LI,
TAIWAN, R.O.C.
Originally registered : 16th March 1994
Date of approval : 10th June 2002
Valid until : 10th June 2005
Certificate No. : 4XEY003-09 Page: 1 of 2

Scope of Registration:

The production of:
PE DRUM
EPOXIDIZED SOYBEAN OIL
HYDROGEN PEROXIDE
BUTYL ACETATE
FORMALIN
HEXAMINE
DEVELOPER
STRIPPER
NIACIN
BASIC CHROMIUM SULFATE

The design, development and production of:
PROPYLENE GLYCOL MONOMETHYL ETHER ACETATE
PROPYLENE GLYCOL MONOMETHYL ETHER
MELAMINE
POLYVINYL ALCOHOL
POLYVINYL ACETATE ELMUSION
POLYVINYL BUTYRAL
(Continued)

ISO 14001
BSMI
認可登錄
REGISTERED

ENVIRONMENTAL MANAGEMENT SYSTEM CERTIFICATE

THE BUREAU OF
STANDARDS, METROLOGY AND INSPECTION (BSMI),
MINISTRY OF ECONOMIC AFFAIRS,
TAIWAN, R.O.C.

hereby certifies that the firm

CHANG CHUN PETROCHEMICAL CO., LTD.
(MIAO LI PLANT & MIAO LI II PLANT)

has fulfilled the requirements of Environmental Management System specified as

ISO 14001:1996 / CNS 14001

and is granted registration by the Bureau.
The scope of registration described in the Appendix.
The Appendix forms an integral part of this certificate,
which shall be invalid when used without the Appendix.

Originally registered : 21st August 1998
Date of approval : 27th June 2002
Valid until : 27th June 2005
Certificate No. : 4XEE005-04

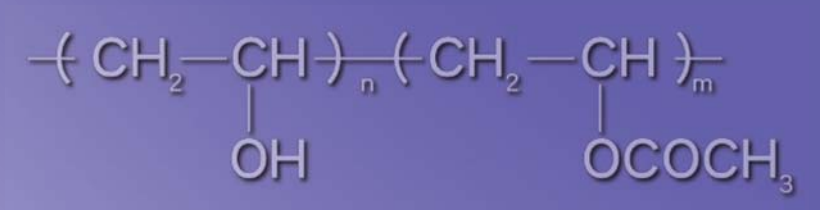
Director General

ENVIRONMENTAL MANAGEMENT SYSTEM CERTIFICATE APPENDIX

THE BUREAU OF
STANDARDS, METROLOGY AND INSPECTION (BSMI)
MINISTRY OF ECONOMIC AFFAIRS,
TAIWAN, R.O.C.

Name of Firm : CHANG CHUN PETROCHEMICAL CO., LTD.
(MIAO LI PLANT & MIAO LI II PLANT)
Address : 245, WUN SHANG LI & 246, 246-3, FU SING, 27 LIRN, FU AN LI, MIAO LI CITY, MIAO LI, TAIWAN, R.O.C.
Originally registered : 21st August 1998
Date of approval : 27th June 2002
Valid until : 27th June 2005
Certificate No. : 4XEE005-04 Page: 1 of 2
Scope of Registration:

The related activities of the production of:
POLYVINYL ALCOHOL
BUTYL ACETATE
FORMALIN
HEXAMINE
POLYVINYL ACETATE EMULSION
POLYVINYL BUTYRAL
GLACIAL ACETIC ACID
HYDROGEN PEROXIDE
EPOXIDIZED SOYABEAN OIL
ACRYLIC RESIN
COPPER FOIL
HDPE DRUM
TRIMETHYLOL PROPANE
SODIUM FORMATE
ANTI OXIDANT (HINDERED PHENOL TYPE, PHOSPHITE TYPE)
DEVELOPER
PYRIDINE
(Continued)



CHANG CHUN GROUP

CHANG CHUN PLASTICS CO., LTD.
CHANG CHUN PETROCHEMICAL CO., LTD.
DAIREN CHEMICAL CORPORATION.
TAI-HONG CIRCUIT IND. CO., LTD.
CHANG CHIANG CHEMICAL CO., LTD.
TSU-KONG CO., LTD.
TRIPLEX CHEMICAL CORPORATION.
JI LIN CHEMICAL CO., LTD.
CHANG CHUN CHEMICAL (JIANGSU) CO., LTD.

長春總公司
地址：台灣104台北市松江路301號7樓
電話：886-2503-8131
傳真：886-2503-3378
網址：www.ccp.com.tw

CHANG CHUN HEAD OFFICE
301 SONGKIANG RD., 7TH FL., TAIPEI 104, TAIWAN
TEL: 886-2-2503-8131 (17LINES)
FAX: 886-2-2503-3378
WEB SITE: www.ccp.com.tw

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