BULLETIN VC-843

Polyvinylpyrolidone (PVP) polymer

(K-15, K-30, K-60, K-90, K-120)

INCI: Polyvinylpyrrolidone

Introduction

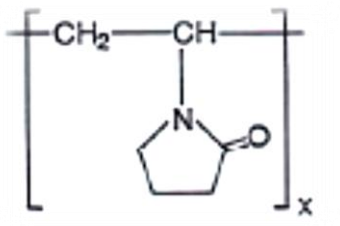
Polyvinylpyrolidone (PVP) is a linear nonionic polymer that is widely used in hair care formulations around the world. PVP polymers are considered the work-horse of the industry and have been prevalent for decades. PVP is an excellent film-former that forms stiff, transparent, shiny films. Formulations containing PVP are known to deliver good stiffness on hair. It is compatible with most inorganic salts and many resins. It also has excellent compatibility with other styling polymers to enhance overall styling performance.

Some consumers often look for a sensory signal that their hair is styled, both during and after the creation of the style. PVP delivers this signal on application on both wet and dry hair through its tack attribute. The degree of tack varies depending on the molecular weight with PVP K-60 and PVP K-90 providing the highest level of tack. This sensory signal is also evident after the hair is dry through imparting a stiff feel to the styled hair. Given its long, safe history of use, its compatibility with a wide variety of ingredients and its performance in styling formulations, PVP polymers are a perfect addition for all types of gel, cream, mousse, wax, paste and spray applications.

Benefits

- Good initial stiffness
- Medium to high tack, depending on the molecular weight
- Provides shine
- Stabilizes emulsions, dispersions and suspensions
- Foam stabilizer
- Excellent compatibility with acrylate thickeners
- Can be used in conjunction with other polymers to boost performance
- Easy to use
- Clarity in gels

Chemistry



- Planar linear molecule with high polarity
- Pseudo cationic, N^+ behavior is dominant in solution, hydrogen bonding at oxygen molecule
- Complexation via hydrogen bonding, dipolar and inductive interactions

Applications

- Gels (Clear, cream, stringing, wet look, spray)
- Mousses
- Styling creams/lotions
- Pomades, waxes, pastes
- PVP K-15 polymer and PVP K-30 polymer can be used in hair sprays

Physical Properties

- Off-white, free-flowing powder/clear aqueous solutions
- Highly hydrophilic polymer soluble in water and alcohol
- Compatible with most inorganic salts and polymers
- Hygroscopic
- Odorless
- Physiologically inert

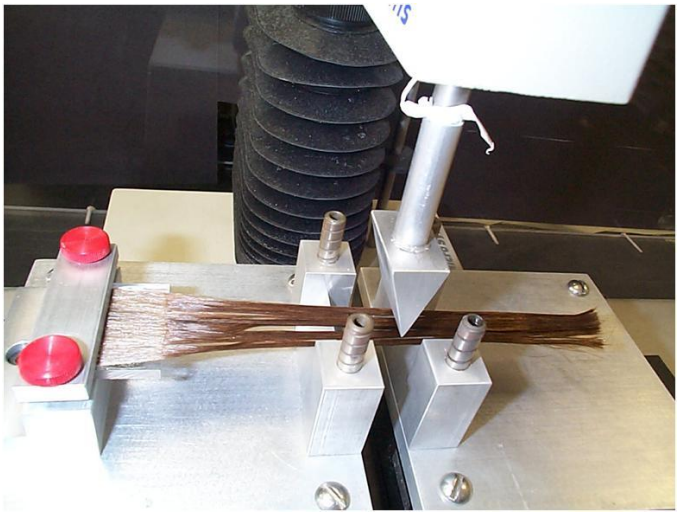
Formulations Guidelines

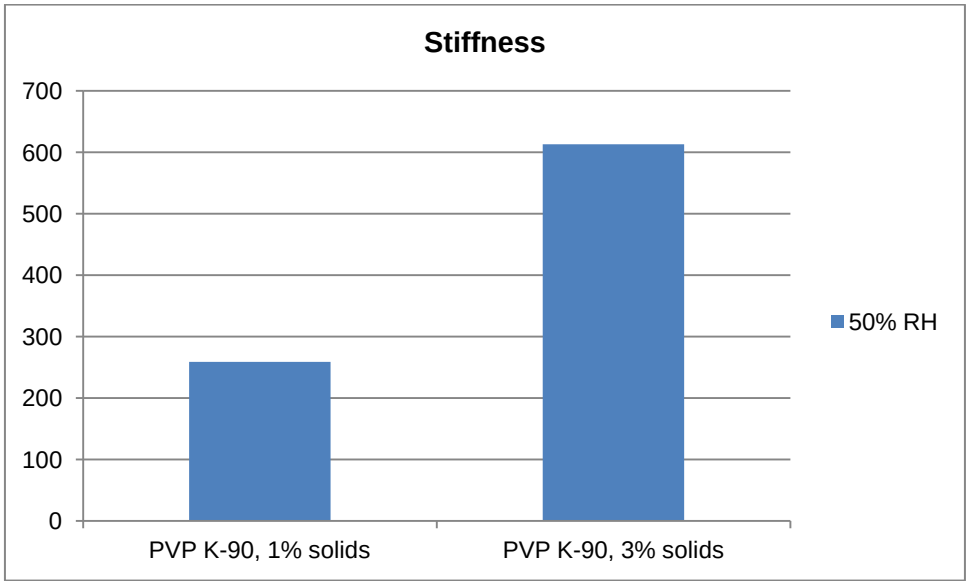
- Recommended use level:
    - PVP K-15, PVP K-30, PVP K-60: 0.25 - 6.0% solids
    - PVP K-90: 0.25 – 3.0% solids
    - PVP K-120 polymer: 0.25 - 3% solids
- Typical pH ranges from 3 - 7.5
- Added in cold or hot phase
- Easy to plasticize (make more flexible/less cracking)
- Easy to use
- No neutralization required
- Compatible with commonly used raw materials
- Tolerant to normal processing techniques

Performance Properties

Film stiffness on hair

An instrumental method that is able to quantify the stiffness benefit of PVP is the Texture Analyzer. Equipped with a three point bending apparatus, see figure below, the mechanical properties of the polymer treated hair is assessed with respect to its initial stiffness (F1) at 50% Relative Humidity (RH). A styling gel was formulated with 0.5% Ashland™ 980 carbomer and PVP K-90. The study was conducted with two levels of PVP K-90: 1% solids and the recommended use level of 3% solids. Results show that the higher use level delivers better stiffness at 50% RH.





Typical Formulations

Texturizing Spray Gel
 # 11384-41

Ingredients (Trade Name | INCI)		% w/w	Supplier
Water	Deionized Water	98.11	
Versene* Na_2	Disodium EDTA	0.05	Dow
AMP-95	Aminomethyl Propanol	0.03	Dow
UltraThix™ P-100 polymer	Acrylic Acid/VP Crosspolymer	0.40	Ashland
Lubrajel™ NP hydrogel	Glycerin and Glyceryl Acrylate/Acrylic Acid Copolymer	0.25	Ashland
PVP K-90	PVP	0.50	Ashland
Liquid Germall™ Plus preservative	Propylene Glycol (and) Diazolidinyl Urea (and) Iodopropynyl Butylcarbamate	0.50	Ashland
AMP-95	Aminomethyl Propanol	0.16	Dow
Total		**100.00**	

Styling polymer solids: 0.9%

Procedure:

1. Add water to the main vessel; begin mixing.
2. Add the remaining ingredients in the order listed, stirring thoroughly after each addition.

Typical Properties

Appearance: Clear, low viscosity gel
pH: 6.5 ± 0.2
Viscosity: 5,000 +/- 1,000 cP (Brookfield, RVDV-II+ viscometer, spindle #4 @ 20 rpm)

Packaging
Pump Precision, P1, 0.18 ml dosage, .012” MBU, Jumbo Dip Tube

Description
This texturizing spray gel improves the visual and tactile properties of the desired hair style. It is a cost effective, clear formula that demonstrates the dual functionality of **UltraThix P-100,** which provides both styling benefits and rheology modification (thickening plus yield value). In addition, at this use level, it has sufficient shear-thinning and pseudoplastic rheology that allows the formula to be sprayed. The inclusion of **PVP K-90** aids in boosting the initial stiffness and crunch from the formula. **Lubrajel NP** provides enhanced feel properties during application and increased shine and feel properties to hair due to its moisturization effect.

Sculpting Power Wax
 # 12460-41

Ingredients (Trade Name | INCI)		% w/w	Supplier
Phase A			
Water	Water	49.43	
Jeenchem* Bugl	Butylene Glycol	4.00	Jeen International
UltraThix™ P-100 polymer	Acrylic Acid/VP Crosspolymer	0.50	Ashland
Tealan 99%	Triethanolamine	0.35	Rita
Phase B			
White Beeswax	Beeswax	4.00	Frank B. Ross
Ozokerite wax	Ozokerite wax	4.00	Strahl & Pitsch
Carnauba Wax#1	Carnauba Wax#1	1.00	Frank B. Ross
Cerasynt™ SD stearate ester	Glyceryl Stearate	2.00	Ashland
Emulsynt™ GDL ester	Glyceryl Dilaurate	8.00	Ashland
Ceraphyl™ 368 ester	Ethylhexyl Palmitate	10.00	Ashland
Ceraphyl SLK ester	Isodecyl Neopentanoate	4.00	Ashland
Phase C			
AquaStyle™ 300 AF polymer	Polyquaternium-69	6.67	Ashland
PVP K-90 Solution	Polyvinylpyrrolidone	4.55	Ashland
Optiphen™ Plus preservative	Phenoxyethanol (and) Caprylyl Glycol (and) Sorbic Acid	1.50	Ashland
Total		**100.00**	

Styling polymer solids: 2.9%

Procedure

1. Phase A: Disperse UltraThix P-100 into water. When the particles are fully wet, add TEA to neutralize until fully dissolved. Add butylene and propylene glycol.
2. Begin to heat Phase A to 80-85ºC
3. Phase B: Premix ingredients and heat to 80-85º
4. Add Phase B to Phase A with good mixing; avoid aeration.
5. Slow paddle sweep and begin to cool to 50º
6. Once batch has cooled to 50ºC, add Phase C ingredients one at a time until completely uniform and continue to cool batch to 30-40ºC.

Typical Properties

Appearance: Off-white soft wax
pH: 5.7
Viscosity: 140,000 cps (Brookfield RVT-F @ 10 RPM)

Description

Wax that can create short, extreme styles resulting in fullness and control to hair or one that gives style, body and volume to longer hair. **AquaStyle 300 AF** polymer provides all-day hold resulting in extreme stiff to a smooth flexible hold. The polymer also effectively reduces frizz while delivering shine to hair. **PVP K-90** contributes to the hold and shine of the formulation. **UltraThix P-100** rheology modifier helps in building rheology while contributing to the hold.

Spiking Hair Glue
 # 11014-19

Ingredients (Trade Name | INCI)		% w/w	Supplier
Phase A			
Water	Deionized Water	88.30	
PVP K-90	PVP	5.00	Ashland
Copolymer 845	VP/Dimethylaminoethylmethacrylate Copolymer	5.00	Ashland
Flamenco* Ultra Sparkle 4500	Mica (and) Titanium Dioxide	0.20	BASF
Liquid Germall™ Plus preservative	Propylene Glycol (and) Diazolidinyl Urea (and) Iodopropynyl Butylcarbamate	0.50	Ashland
Phase B			
RapiThix™ A-100 polymer	Sodium Polyacrylate	1.00	Ashland
Total		**100.00**	

Styling polymer solids: 6%

Procedure:

1. Combine ingredients of Phase A one at a time, mix until uniform.
2. Add Phase B and mix until uniform.

Typical Properties

Appearance: Translucent viscous/gel
pH: 6.0 +/- 0.3
Viscosity: 55,700 cps (Brookfield RVT, T-D, 20 rpm

Description

Spiking hair glue is a great hair control styling product**. PVP K-90** provides the hard spike and **Copolymer 845** adds flexibility and durability. **RapiThix A-100** polymer imparts substantial thickness and great “pick-up” at only 1% use level. There is enough wet strength to hold hair up while it is drying in a spike.

Tacky Hair Glue for Creating Styles with Shine
 # 10852-121

Ingredients (Trade Name | INCI)		% w/w	Supplier
Phase A			
Water	Deionized Water	54.50	
PVP K-90	PVP	6.00	Ashland
Styleze™ W-20 polymer	Polyquaternium-55	10.00	Ashland
Glycerin	Glycerin	5.00	Dow
Phase B			
Drakeol* 35 Min Oil	Mineral Oil	8.00	Penreco
Ritoleth* 5	Oleth-5	8.00	Rita
Arlasolve* 200	Isoceteth-20	8.00	Croda
Phase C			
Germall™ Plus preservative	Diazolidinyl Urea (and) Iodopropynyl Butylcarbamate	0.50	Ashland
Total		**100.00**	

Styling Polymer Solids: 8.0%

Procedure:

1. Combine ingredients of Phase A and heat to 70°C with mixing.
2. Combine ingredients of Phase B and heat to 70°C with mixing.
3. Add Phase B to Phase A and mix slowly to avoid aerating.
4. Cool to 45°C and add phase C. Mix slowly.
5. Pour or scoop out into containers.

Typical Properties

Appearance: White/Opaque crème
pH: 3.8
Viscosity: N/A

Description

Styleze W-20 is coupled with **PVP K-90** to provide a stringy, tacky hair styling glue. The combination of ingredients offers super fixative properties to help create novel styles that hold up, even in humidity and light rain. Tacky Hair Glue is a great styling product for adding texture and shine to hair.

6% VOC Bodifying Mousse
 # 10852-87

Ingredients (Trade Name | INCI)		% w/w	Supplier
Water		86.30	
Mirataine* CB	Cocamidopropyl Betaine	0.50	Rhodia
Styleze™ CC-10	VP/DMAPA Acrylates Copolymer	2.50	Ashland
PVP K-90	PVP	1.00	Ashland
Ceraphyl™ 65	Quaternium-26	0.10	Ashland
Lipamide* MEAA 100%)	Acetamide MEA	0.10	Lipo
Liquid Germall™ Plus	Propylene Glycol (and) Diazolidinyl Urea (and) Iodopropynyl Butylcarbamate	0.50	Ashland
A-46	Isobutane (and) Propane	6.00	AGI
Dymel 152a	Hydrofluorocarbon 152a	3.00	DuPont
Total		**100.00**	

Procedure
1. Add ingredients in order listed, mixing well between each addition.
2. Fill into cans, vacuum crimp and charge with propellant.

Typical Properties
Appearance: Clear concentrate
pH: 7.00 - 7.60
Viscosity: 11 – 17 cps ULA adaptor 12 rpm

Packaging
Can CCL Polyamid Imide lined aluminum cans.
Valve Seaquist valve – VX-81, 2x0.020” Stem, 2x0.30” VT.

Formulation Description:
This formula is a great, lightweight styling mousse that contains **Styleze CC-10** for body, shine and manageability. **Ceraphyl 65** detangles hair, eliminates static and provides conditioning properties, making it an effective styling product for all hair types.

55% VOC Stiff Feel Pump Hair Spray
 # 10598-88

Ingredients (Trade Name | INCI)		% w/w	Supplier
SD Alcohol 40-B (200 proof)		49.75	
Water	Deinoized Water	34.85	
Aquaflex™ FX-64 polymer	Isobutylene/Ethylmaleimide/Hydroxyethyl Maleimide Copolymer	15.00	Ashland
PVP K-30	PVP	0.30	Ashland
Wacker-Belsil* DMC 6031	PEG/PPG-25/25 Dimethicone	0.10	Wacker
Total		**100.00**	

Styling polymer solids: 6.3%

Procedure:

1. Add alcohol and water to main tank. Start mixing.
2. Add Aquaflex FX-64 polymer and mix until completely dissolved and clear.
3. Add PVP K-30 and mix until uniform and clear.
4. Add the Wacker-Belsil DMC 6031 and continue mixing until homogeneous.

Typical Properties:
Appearance: Clear, slightly yellow, very thin liquid
pH: 5.5 – 8.0
Viscosity: 17 cP (Brookfield, UL Adaptor, 12 rpm)

Packaging
Pump Calmar Mark VI WL31 140mcl

Description
Aquaflex FX-64 provides strong, smooth film properties with superior humidity resistance while **PVP K-30** is added for a 'raspy' texture and 'crunch' to the film property. High humidity curl retention for this formulation is at approximately 90% after 4 hours at 80F/90% RH.

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