

KURARAY POVAL™ 105-88KX SB

New High Molecular Weight PVOH

TECHNICAL INFORMATION SHEET

Introduction

Polyvinyl alcohol (PVOH) is widely used as a stabilizer for the emulsion polymerization of VAM or as a post additive for emulsion. In general, the emulsion with PVOH provides such advantages as, high viscosity, high mechanical stability, high film strength and high heat resistance compared to other stabilizers. But the large dosage of PVOH decreases water resistance of the adhesive (or the film) produced with the emulsion. KURARAY has developed new high-molecular-weight PVOH “105-88KX SB”. The polymer can achieve high viscosity emulsions in a small dosage of PVOH. The emulsion with the new high-molecular-weight PVOH can have better balanced performances than with conventional PVOH.

Advanced characteristics of KURARAY POVAL 105-88KX SB

In the polymerization process;

- Excellent polymerization stability

Performance of the emulsion;

- Shear thinning (Thixotropic) emulsion
- High viscosity emulsion in a small dosage of PVOH
- Excellent adhesive properties for wood and paper
- Cost reduction (ex. PVOH reduction, VAM reduction)

Specification of KURARAY POVAL 105-88KX SB

Table 1

| Grade | | 4% Viscosity ⁽¹⁾ (mPa·s) | DH ⁽³⁾ (mol%) |
|-------------------|----------------------------|--|-----------------------------|
| New grade | 105-88KX SB | 90-120 | 87.0-89.0 |
| Conventional PVOH | DP 3500Type ⁽²⁾ | 95 | 87.0-89.0 |
| Conventional PVOH | DP 2600Type | 60 | 87.0-89.0 |

(1) Measured at 20°C determined by Brookfield viscometer

(2) DP: Degree of Polymerization

(3) DH: Degree of Hydrolysis

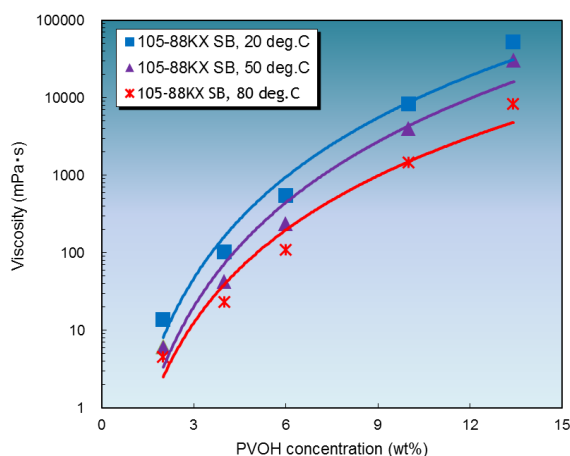


Fig. 1 Viscosity vs Concentration curve

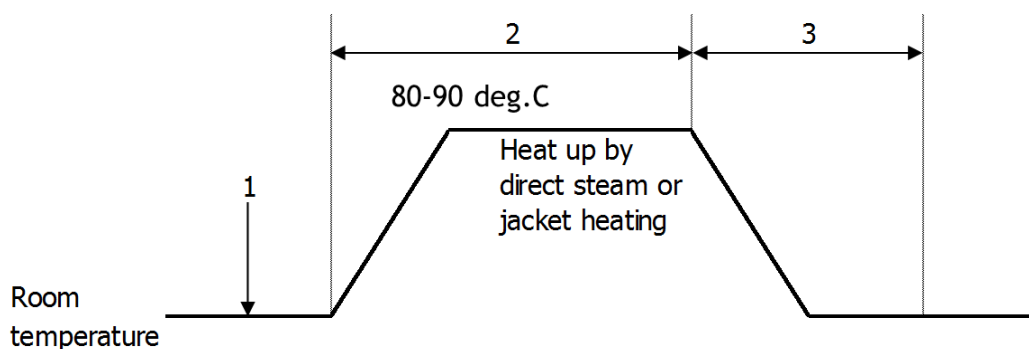
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Dissolving procedure of KURARAY POVAL 105-88KX SB in water

1. Charge KURARAY POVAL 105-88KX SB into room temperature water slowly with agitation.
2. Heat up the solution to 80-90°C with agitation. Keep agitation for 1hour at around 80-90°C.
3. Reduce the agitation speed and cool down the solution gradually



Rheology of PVOH solution

The aqueous solution of KURARAY POVAL 105-88KX SB is more thixotropic than conventional PVOHs.

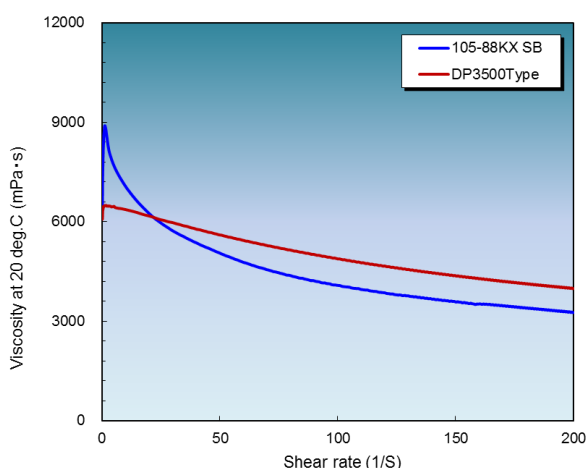


Fig. 2 Shear rate and 10 wt% PVOH solution viscosity curve

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Concept 1: PVOH dosage reduction for emulsion polymerization

Recipe example

The emulsion polymerization of VAM can be conducted with a small dosage of KURARAY POVAL 105-88KX SB as a stabilizer. The scheme example of the emulsion polymerization is as below (Fig. 3).

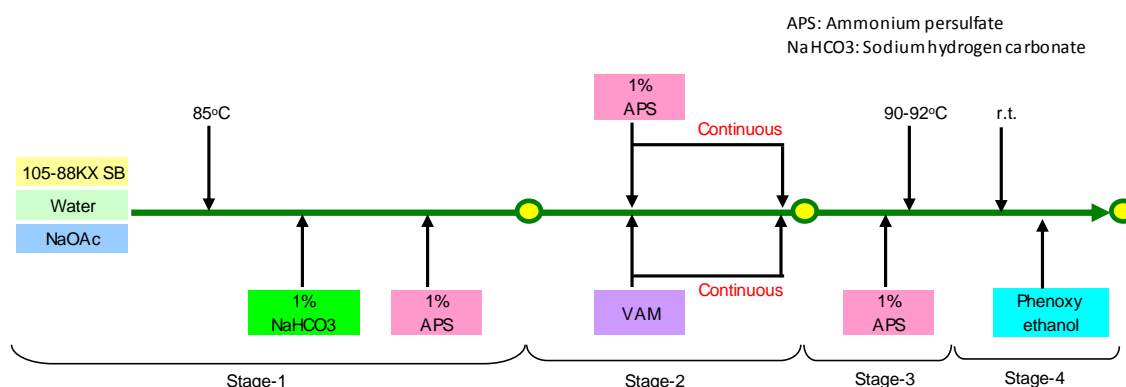


Fig. 3 Emulsion polymerization scheme with Ammonium Persulfate

Table 2 Polymerization recipe details

| | Material | 105-88KX SB | | DP3500Type | | DP2600Type | Remarks |
|---------|-----------------------------------|-------------|------------|------------|------------|------------|-----------------------------|
| | | 10phm | 12phm | 15phm | 17phm | 20phm | |
| | | Weight (g) | Weight (g) | Weight (g) | Weight (g) | Weight (g) | |
| Stage-1 | PVOH | 20.8 | 25.0 | 31.3 | 35.4 | 41.7 | Temperature: 85°C |
| | VAM | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | Water | 694.5 | 694.5 | 694.5 | 694.5 | 694.5 | |
| | Sodium acetate | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | |
| | 1% Sodium hydrogen carbonate sol. | 6.4 | 6.4 | 6.4 | 6.4 | 6.4 | |
| | 1% APS sol. | 23.0 | 23.0 | 23.0 | 23.0 | 23.0 | |
| Stage-2 | VAM | 208.3 | 208.3 | 208.3 | 208.3 | 208.3 | Temperature: 85°C |
| | 1% APS sol. | 23.0 | 23.0 | 23.0 | 23.0 | 23.0 | Time: 2-6h |
| Stage-3 | 1% APS sol. | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | Temperature: 90-92°C |
| | | | | | | | Time: 1hour |
| Total | - | 979 | 983 | 990 | 994 | 1000 | Total solid content: 24-25% |
| Stage-4 | Phenoxy ethanol | 9.2 | 9.3 | 9.6 | 9.7 | 10.0 | 4%/Em solid |
| Total | Final product | 988 | 992 | 999 | 1003 | 1010 | |

*Red character indicates continuous charge

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Emulsion viscosity results

PVOH dosage can be reduced by using KURARAY POVAL 105-88KX SB to achieve same emulsion viscosity level with same total solid content compared with using standard PVOH (Table 3 and Fig. 4). The emulsion by using KURARAY POVAL 105-88KX SB is more shear thinning (thixotropic) (Fig. 6).

Table 3 PVAc-Em viscosity stabilized with 105-88 KX SB

| Grade | | 105-88KX SB | | DP3500type | | DP2600 type |
|------------------------------|-------|-------------|-------|------------|-------|-------------|
| PVOH dosage | | 10phm | 12phm | 15phm | 17phm | 20phm |
| Em Viscosity at 30°C (mPa.s) | 2rpm | 32000 | 40000 | 13800 | 22000 | 22000 |
| | 20rpm | 5700 | 7600 | 3480 | 5350 | 6120 |
| Total Solid Content (wt%) | | 23.4 | 23.7 | 24.2 | 24.5 | 25 |

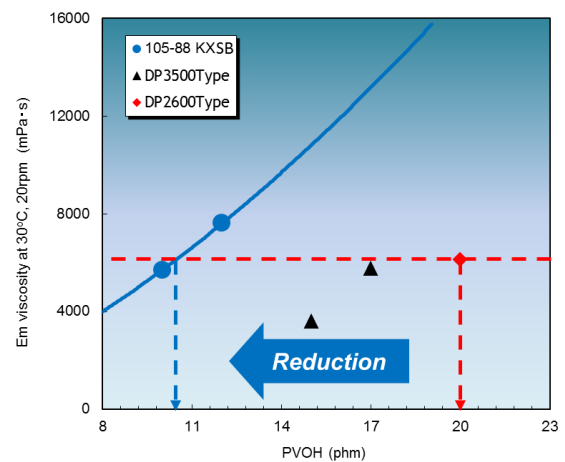


Fig. 4 PVOH dosage and PVAc-Em viscosity curve

Detail property of emulsions

Water resistance of emulsion can be improved by using KURARAY POVAL 105-88KX SB. In addition, rheological property becomes more shear thinning (thixotropic) by using “105-88KX SB”.

Table 4 Detail property of emulsions

| Grade | 105-88 KX SB | DP3500Type | DP2600type |
|---|--------------|------------|----------------|
| PVOH dosage | 10phm | 17phm | 20phm |
| Result of polymerization | | | |
| Total solid content (%) | 23.4 | 24.4 | 25.0 |
| Viscosity (mPa.s), B-type@20rpm 30°C | 5,700 | 5,760 | 6,120 |
| Thixotropic index: (Viscosity @2rpm) / (Viscosity @20rpm) | 5.6 | 4.2 | 3.6 |
| Film properties | | | |
| <Mechanical property> | | | |
| @Dry condition (20 °C 65%RH) | | | |
| Tensile strength (kg/cm ²) | 139.1 | 120.4 | 160.2 |
| Elongation (%) | 509 | 262 | 630.5 |
| @Wet condition (dipped in 20 °C water for 24hour) | | | |
| Tensile strength (kg/cm ²) | 10.5 | 10.0 | Not measurable |
| Elongation (%) | 252.4 | 172.1 | Not measurable |
| <Water resistance, dipped in 20°C w water for 24hour> | | | |
| Water adsorption (%) | 75.2 | 94.4 | 134.6 |
| Elution rate (%) | 5.1 | 9.1 | 8.2 |
| Wood adhesive strength *based on JIS K6852 | | | |
| @Dry condition (20 °C 65%RH) | | | |
| Compressive shear strength (kg/cm ²) | 121.2 | 88.1 | 101.4 |
| Wood failure (%) | 70 | 26 | 75 |
| @Wet condition (dipped in 30 °C water for 3hour) | | | |
| Compressive shear strength (kg/cm ²) | 46.4 | 20.4 | 14.4 |
| Wood failure (%) | 10 | 0 | 0 |

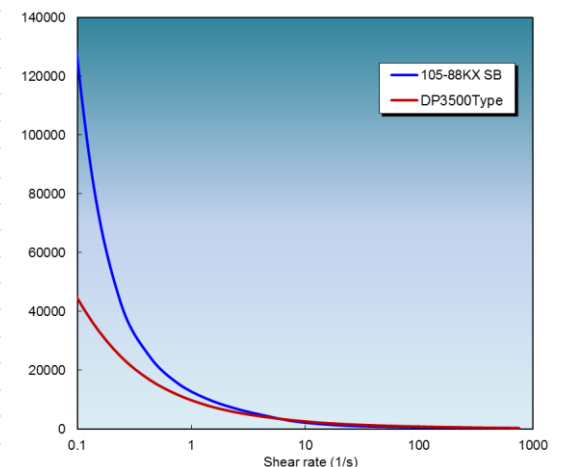


Fig. 5 Shear rate and PVAc-Em viscosity curve

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Recipe example

Table 5 shows the recipes of the emulsion polymerization in detail.

Table 5 Polymerization recipe details

| | Material | 105-88KX SB | | DP3500type | | DP2600type | Remarks |
|---------|-----------------------------------|-------------|------------|------------|------------|------------|-------------------------------------|
| | | 5phm | 5phm | 5phm | 5phm | 5phm | |
| | | Weight (g) | Weight (g) | Weight (g) | Weight (g) | Weight (g) | |
| Stage-1 | PVOH | 16.3 | 20.0 | 18.2 | 20.0 | 20.0 | Temperature: 85°C |
| | VAM | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | Water | 570.9 | 473.8 | 521.2 | 473.8 | 473.8 | |
| | Sodium acetate | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | |
| | 1% Sodium hydrogen carbonate sol. | 10.0 | 12.3 | 11.2 | 12.3 | 12.3 | |
| | 1% APS sol. | 36.0 | 44.2 | 40.2 | 44.2 | 44.2 | |
| Stage-2 | VAM | 326.2 | 400.0 | 364.0 | 400.0 | 400.0 | Temperature: 85°C Time: 2-6h |
| | 1% APS sol. | 36.0 | 44.2 | 40.2 | 44.2 | 44.2 | |
| Stage-3 | 1% APS sol. | 4.2 | 5.2 | 4.7 | 5.2 | 5.2 | Temperature: 90-92°C Time: 1hour |
| Total | - | 1000 | 1000 | 1000 | 1000 | 1000 | |
| Stage-4 | Phenoxy ethanol | 13.6 | 16.8 | 15.2 | 16.8 | 16.8 | 4%/Em solid |
| Total | Final product | 1013.6 | 1016.8 | 1015.2 | 1016.8 | 1016.8 | |
| | Total Solid Content (%) | 34.2 | 42.5 | 38.2 | 42.0 | 42.0 | |

*Red character indicates continuous charge

Emulsion viscosity results

VAM usage can be reduced by using KURARAY POVAL 105-88KX SB to achieve same emulsion viscosity level with lower total solid content.

Table 6 PVAc-Em viscosity stabilized with KURARAY POVAL105-88KX SB

| Grade | | 105-88KX SB | | DP3500 type | | DP2600 type |
|------------------------------|-------|-------------|--------|-------------|--------|-------------|
| PVOH dosage | | 5phm | 5phm | 5phm | 5phm | 5phm |
| Em Viscosity at 30°C (mPa.s) | 2rpm | 53,400 | 58,000 | 34,000 | 70,400 | 42,000 |
| | 20rpm | 11,300 | 23,400 | 7,780 | 17,340 | 11,100 |
| Total Solid Content (wt%) | | 34.2 | 42.5 | 38.2 | 42.0 | 42.0 |

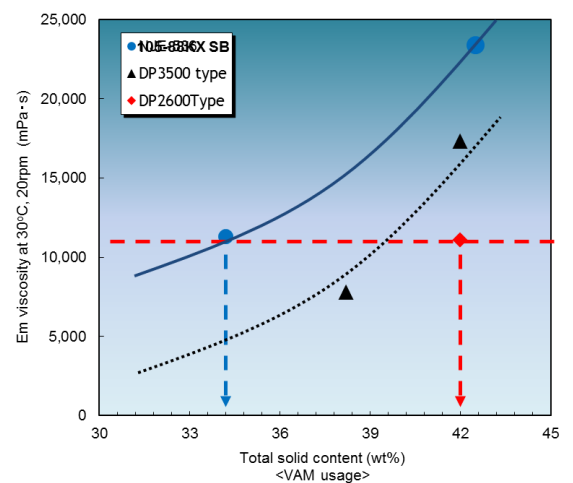


Fig. 6 PVOH dosage and PVAc-Em viscosity curve

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Detail property of emulsions

Water resistance of emulsion can be improved and rheological property becomes more shear thinning (thixotropic) by using KURARAY POVAL 105-88KX SB.

Table 7 Detail property of emulsions

| Grade | 105-88KX SB | DP3500type | DP2600type |
|---|-------------|------------|------------|
| PVOH dosage | 5phm | 5phm | 5phm |
| Result of polymerization | | | |
| Total solid content (%) | 34.2 | 38.2 | 42.0 |
| Viscosity (mPa.s), B-type@20rpm 30°C | 11,300 | 7,780 | 11,100 |
| Thixotropic index: (Viscosity @2rpm) / (Viscosity @20rpm) | 4.7 | 4.4 | 3.8 |
| Film properties | | | |
| <Mechanical property> | | | |
| <i>@Dry condition (20° C 65%RH)</i> | | | |
| Tensile strength (kg/cm ²) | 110.2 | 110.7 | 109.1 |
| Elongation (%) | 590.2 | 610 | 540.2 |
| <i>@Wet condition (dipped in 20° C water for 24hour)</i> | | | |
| Tensile strength (kg/cm ²) | 13.4 | 5 | 2.1 |
| Elongation (%) | 261.1 | 58.3 | 35.5 |
| <Water resistance, dipped in 20oC w ater for 24hour> | | | |
| Water adsorption (%) | 40.6 | 45.8 | 41.6 |
| Elution rate (%) | 3.5 | 4.6 | 5.6 |
| Wood adhesive strength *based on JIS K6852 | | | |
| <i>@Dry condition (20° C 65%RH)</i> | | | |
| Compressive shear strength (kg/cm ²) | 111.4 | 110.2 | 111.0 |
| Wood failure (%) | 50 | 40 | 100 |
| <i>@Wet condition (dipped in 30° C water for 3hour)</i> | | | |
| Compressive shear strength (kg/cm ²) | 55.6 | 30.2 | 19.0 |
| Wood failure (%) | 5 | 0 | 0 |