SEKISUI

# A Versatile Performer in Paper and Paperboard Applications

SELVOL™
POLYVINYL ALCOHOL

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## About the Company

The Sekisui Chemical Group is a global company that operates in three major businesses: High Performance Plastics, Urban Infrastructure and Environmental Products, and Housing. Founded in 1947 and currently headquartered in Osaka and Tokyo, Japan, Sekisui strives to deliver a wide range of products and services to enrich people's lives and the social infrastructure.

Architectural Glass

Urban Intrastructure and Environmental Product

## Our Promise

Through prominence in technology and quality, Sekisui Chemical Group will contribute to improving the lives of the people of the world and the Earth's environment, by continuing to open up new frontiers in residential and social infrastructure creation and chemical solutions.

Housing

## Sekisui Specialty Chemicals

Sekisui produces and sells one of the most complete lines of polyvinyl alcohol in the world. Since the introduction of Selvol Polyvinyl Alcohol, we have developed a high level of expertise in both the production and use of PVOH.

Based in Dallas, Texas, Sekisui Specialty Chemicals is a leading polyvinyl alcohol supplier with manufacturing facilities in Calvert City, Kentucky, Pasadena, Texas and Tarragona, Spain. The combined capacity of the three plants makes Sekisui a leading global merchant supplier of polyvinyl alcohol.

Sekisui's commitment to polyvinyl alcohol is especially evident in our research and applications support activities. We have one of the largest technical services, product application, and analytical services groups in the world. Research and application development is carried out at our facilities in Houston, Texas. Sekisui also has a global sales force located in offices worldwide to respond more quickly to the needs of our customers.




SELVOL™ POLYVINYL ALCOHOL

## Introduction

This brochure is intended to highlight the many diverse applications for polyvinyl alcohol in paper. For more detailed information on specific applications or the preparation of polyvinyl alcohol solutions, please refer to our other brochures, visit our website at www.selvol.com, or call our Product Information Center at +1-281-280-3460.

## Environmental, Health, and Safety

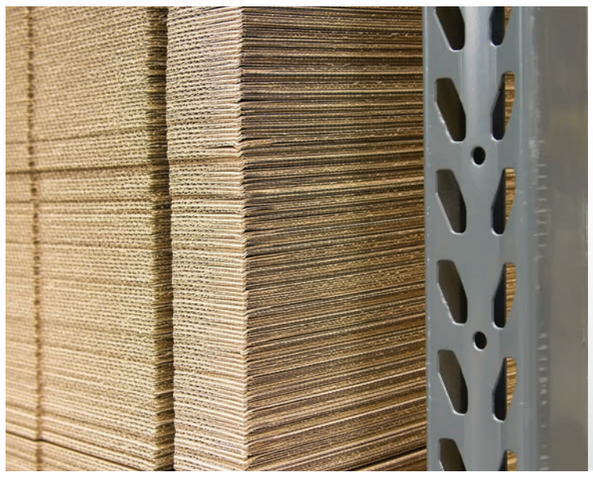
Please refer to our Material Safety Data Sheets (MSDSs) or Safety Data Sheets (SDSs) for information on the safe use and handling of Selvol Polyvinyl Alcohol, including toxicity, fire, and explosion hazards, as well as environmental effects. An MSDS can be obtained online at www.selvol.com.

## FDA Compliance

Polyvinyl alcohol is used in many food contact applications, including food packaging adhesives and coatings for paper and paperboard. For more specific information on the FDA status of any of our grades, please contact our Product Information Center at +1-281-280-3460.

TABLE 1:
Selvol Polyvinyl Alcohol Right-to-Know Information

| Ingredient | CAS Number |
|---|---|
| Selvol Polyvinyl Alcohol<br>• Super and Fully Hydrolyzed<br>• Partially and Intermediate Hydrolyzed | <br>9002-89-5<br>25213-24-5 |
| Water | 7732-18-5 |
| Methanol | 67-56-1 |
| Sodium Acetate | 127-09-3 |



## Selvol Polyvinyl Alcohol

Selvol Polyvinyl Alcohol is a white, granular, water-soluble resin manufactured by polymerizing vinyl acetate and hydrolyzing the resultant polymer to produce the alcohol (Figure 1).

Because PVOH is synthesized from polyvinyl acetate, a variety of different grades of Selvol Polyvinyl Alcohol is available that varies in molecular weight and hydrolysis level. These two factors are the major determinants of the performance properties of PVOH.

FIGURE 1:
General Structure of Polyvinyl Alcohol

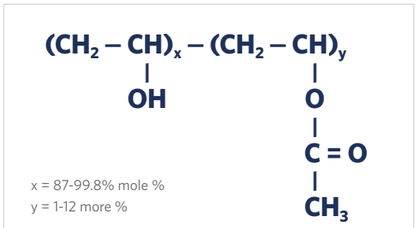



TABLE 2:
Selvol Polyvinyl Alcohol Molecular Weight

| Viscosity[1] (cP) | Viscosity Type | Degree of Polymerization | Average Weight Molecular Weight Range | Number Average Molecular Weight Range |
|---|---|---|---|---|
| 3-6 | Low | 150 - 650 | 13,000 - 50,000 | 7,000 - 23,000 |
| 22-30 | Medium | 1000 - 1500 | 85,000 - 124,000 | 44,000 - 65,000 |
| 45-72 | High | 1600 - 2200 | 146,000 - 186,000 | 70,000 - 101,000 |

1 4% aqueous solution viscosity.

Molecular weight is a measure of polymer chain length and is typically reported as a 4% aqueous solution viscosity (Table 2).

Molecular Structure PVOH

TABLE 3:
Description of the Different Hydrolysis Levels for PVOH

| Grade | Hydrolysis Mole % |
|---|---|
| Super | 99.3+ |
| Fully | 98.0-98.8 |
| Intermediate | 90.0-97.0 |
| Partially | 87.0-89.0 |

Hydrolysis level is a measure of the mole % hydroxyl functionality on the polymer. The hydrolysis level of PVOH is typically categorized as shown in Table 3.





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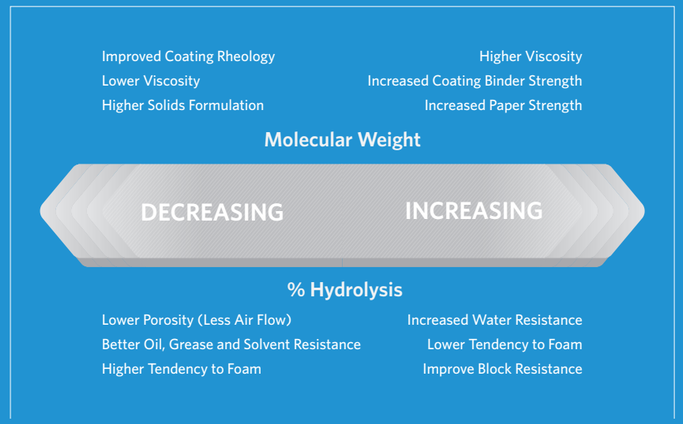
## Selvol Polyvinyl Alcohol Properties

The performance properties of polyvinyl alcohol are influenced by molecular weight (measured as a 4% solution viscosity) and the degree of hydrolysis. The upper portion of Figure 3 shows the variation in properties with molecular weight at a constant degree of hydrolysis, while the effect of hydrolysis at constant molecular weight is given in the lower portion of the Figure 2.

FIGURE 2:
Changes in PVOH Properties with Changes in Molecular Weight and Hydrolysis Level



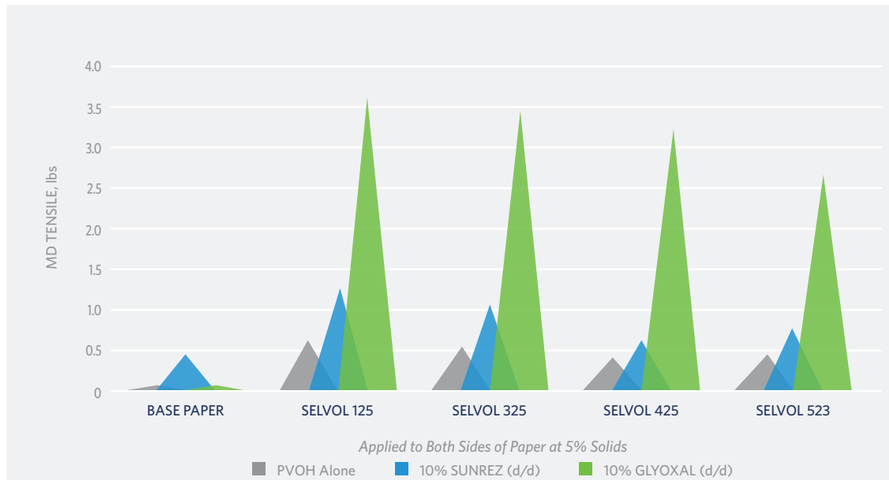

## Solubility

All Selvol Polyvinyl Alcohol grades are readily soluble in water. Conditions for dissolution are governed primarily by degree of hydrolysis, but they are influenced by other factors such as molecular weight, particle size distribution and particle crystallinity.

Optimum solubility occurs at 87-89% hydrolysis. The partially hydrolyzed grades in this range exhibit a high degree of cold-water solubility. For total dissolution, however, they require water temperatures of about 185°F (85°C) with a hold time of 30 minutes.

Higher hydrolysis grades, including intermediate, fully and super hydrolyzed, require progressively more energy to dissolve because of their greater number of tightly aligned, hydroxyl-bearing molecules. For dissolution, these grades require temperatures in the range of 195-205°F (91-96°C), with a hold time of 30 minutes.

FIGURE 3:
Wet Tensile Strength (3 minute Immersion in Water)






## Strength

Polyvinyl alcohol is widely recognized as the strongest binder in the paper industry. It exhibits superior IGT pick, Mullen burst, Instron tensile and MIT fold properties compared with other natural and synthetic binders. The strength of a specific grade of Selvol Polyvinyl Alcohol is determined primarily by its molecular weight (measured as a 4% solution viscosity). Therefore, high viscosity grades like Selvol Polyvinyl Alcohols 165, 350 and 540 yield maximum strength.

## Water Resistance

Because polyvinyl alcohol is a water-soluble polymer, it is sometimes perceived as having little or no water resistance. However, by proper grade selection, and with the use of crosslinkers, an entire range of insolubilities is possible. The water resistance of a specific grade of Selvol Polyvinyl Alcohol is primarily determined by its hydrolysis. Super hydrolyzed grades like Selvol Polyvinyl Alcohols 125 and 165 yield maximum water resistance. Figure 3 shows the effect of crosslinkers on the wet tensile properties of a paper surface sized with polyvinyl alcohol.

## Foaming

The tendency for polyvinyl alcohol to generate foam is highly dependent upon the degree of hydrolysis. Generally, the higher the hydrolysis, the less tendency to foam. Fully and super hydrolyzed grades are generally used without defoamers, whereas intermediate and partially hydrolyzed grades nearly always require a defoamer.
See Table 4 for recommended defoamers.

The following good practice guidelines can minimize foam in your system:

- Make-up tank should be agitated fast enough to move the water surface, but not so fast as to whip air into the solution.
- Height of the free-fall off the recirculation line should be minimized.
- Polyvinyl alcohol solutions should not be overcooked (e.g., boiled).

TABLE 4:
Recommended Defoamers for Selvol Polyvinyl Alcohol

| Brand or Generic Name | Manufacturer | Level Use |
|---|---|---|
| FC 407 | ESP Enterprises | <1%, d/d |
| Antifoam 116 | Harcros | < 1%, d/d |
| Industrol DF 132 | BASF | < 1%, d/d |

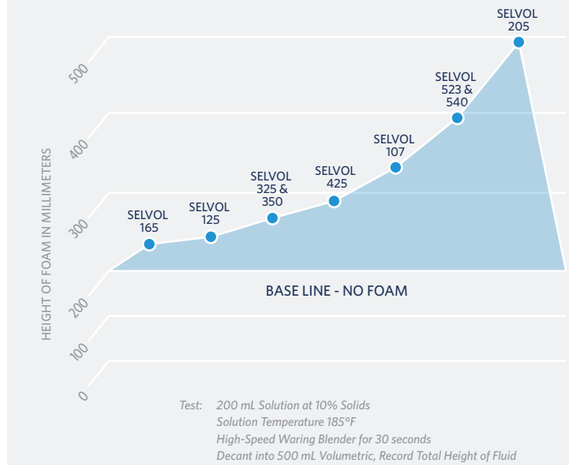



FIGURE 4:
Foaming Characteristics of Selvol Polyvinyl Alcohol



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# Selvol Polyvinyl Alcohol Product Line

The Sekisui Selvol Polyvinyl Alcohol product line, presented in Table 5, consists of 26 standard grades (including E-grades) and several specialty grades. The products are classified by hydrolysis as super, fully, intermediate and partial hydrolyzed. To put into a better perspective, each standard grade suitable for paper application has been portrayed graphically in Figure 5 as a function of viscosity and hydrolysis. Each block on this grid illustrates product location on a linear scale and, by outer boundary, defines approximate specification limits.

Our specialty grades include fine particle sized "S" grades, Selvol Polyvinyl Alcohol 203S, Selvol Polyvinyl Alcohol 205S and Selvol Polyvinyl Alcohol 165SF. The "S" grades are identical to Selvol Polyvinyl Alcohol 203 and Selvol Polyvinyl Alcohol 205 grades, with the exception that they have been mechanically reduced in particle size to >99% through an 80 mesh screen (177 microns). These products are designed for use as "noncook" additives in coating color formulations. Selvol Polyvinyl Alcohol 165SF is a super-fine grind version of Selvol Polyvinyl Alcohol 165 with a particle size of >99% through a 120 mesh screen (125 microns).

Selvol Polyvinyl Alcohol MM-51 is a blend of several Selvol grades with boric acid. The addition of boric acid results in a controlled gelation mechanism as the solution begins to increase in solids after it is applied to the surface of paper. This mechanism provides for superior surface filming on some paper and paperboard substrates.


FIGURE 5:
Sekisui Polyvinyl Alcohol Grades

TABLE 5:

| STANDARD GRADES | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Grade** | **Hydrolysis, %** | **Viscosity, cP[1]** | **pH[2]** | **Volatiles, % Max** | | **Ash, % Max[5]** | **Methanol, wt % Max** |
| **Super Hydrolyzed** | | | | Total [3] | VOC[4] | | |
| Selvol PVOH 125 | 99.3+ | 28.0-32.0 | 5.5-7.5 | 5.0 | 1.0 | 1.2 | 0.9 |
| Selvol PVOH 165 | 99.3+ | 62.0-72.0 | 5.5-7.5 | 5.0 | 1.0 | 1.2 | 0.9 |
| **Fully Hydrolyzed** | | | | | | | |
| Selvol PVOH 103/E 103 | 98.0-98.8 | 3.5-4.5 | 5.0-7.0 | 5.0 | 1.0 | 1.2 | 0.9 |
| Selvol PVOH 107/E 107 | 98.0-98.8 | 5.5-6.6 | 5.0-7.0 | 5.0 | 1.0 | 1.2 | 0.9 |
| Selvol PVOH 310/E 310 | 98.0-98.8 | 9.0-11.0 | 5.0-7.0 | 5.0 | 1.0 | 1.2 | 0.9 |
| Selvol PVOH 325/E 325 | 98.0-98.8 | 28.0-32.0 | 5.0-7.0 | 5.0 | 1.0 | 1.2 | 0.9 |
| Selvol PVOH 350 | 98.0-98.8 | 62.0-72.0 | 5.0-7.0 | 5.0 | 1.0 | 1.2 | 0.9 |
| **Intermediate Hydrolyzed** | | | | | | | |
| Selvol PVOH 418 | 91.0-93.0 | 14.5-19.5 | 4.5-7.0 | 5.0 | 1.0 | 0.9 | 0.9 |
| Selvol PVOH 425 | 95.5-96.5 | 27.0-31.0 | 4.5-6.5 | 5.0 | 1.0 | 0.9 | 0.9 |
| Selvol PVOH 443 | 92.0-94.0 | 53.0-63.0 | 4.5-6.5 | 5.0 | 1.0 | 0.9 | 0.9 |
| **Partially Hydrolyzed** | | | | | | | |
| Selvol PVOH 502 | 87.0-89.0 | 3.0-3.7 | 4.5-6.5 | 5.0 | 1.0 | 0.9 | 0.9 |
| Selvol PVOH 203/E 203 | 87.0-89.0 | 3.5-4.5 | 4.5-6.5 | 5.0 | 1.0 | 0.9 | 0.9 |
| Selvol PVOH 504 | 87.0-89.0 | 4.0-5.0 | 4.5-6.5 | 5.0 | 1.0 | 0.7 | 0.9 |
| Selvol PVOH 205/E 205 | 87.0-89.0 | 5.2-6.2 | 4.5-6.5 | 5.0 | 1.0 | 0.7 | 0.9 |
| Selvol PVOH E 8/88 | 87.0-89.0 | 7.0-9.0 | 4.5-6.5 | 5.0 | 1.0 | 0.7 | 0.9 |
| Selvol PVOH 508 | 87.0-89.0 | 7.5-9.5 | 4.5-6.6 | 5.0 | 1.0 | 0.7 | 0.9 |
| Selvol PVOH 513 | 87.0-89.0 | 13.0-15.0 | 4.5-6.5 | 5.0 | 1.0 | 0.7 | 0.9 |
| Selvol PVOH 518 | 87.0-89.0 | 17.5-20.5 | 4.5-6.5 | 5.0 | 1.0 | 0.7 | 0.9 |
| Selvol PVOH 523/E 523 | 87.0-89.0 | 23.0-27.0 | 4.5-6.5 | 5.0 | 1.0 | 0.5 | 0.9 |
| Selvol PVOH 540 | 87.0-89.0 | 45.0-55.0 | 4.5-6.5 | 5.0 | 1.0 | 0.5 | 0.9 |
| **SPECIALTY GRADES** | | | | | | | |
| **Grade** | **Hydrolysis, %** | **Viscosity, cP[1]** | **pH[2]** | **Volatiles, % Max** | | **Ash, % Max[5]** | **Methanol, wt % Max** |
| **Fine Particle (S-Grade)** | | | | | | | |
| Selvol PVOH 165SF | 99.3+ | 62.0-72.0 | 5.5-7.5 | 5.0 | 1.0 | 1.2 | 0.9 |
| Selvol PVOH 203S[8]/E 203S | 87.0-89.0 | 3.5-4.5 | 4.5-6.5 | 5.0 | 1.0 | 0.9 | 0.9 |
| Selvol PVOH 205S/E 205S | 87.0-90.0 | 5.2-6.2 | 4.5-6.5 | 5.0 | 1.0 | 0.7 | 0.9 |
| Selvol PVOH 513S | 86.0-89.0 | 13.0-15.0 | 4.5-6.5 | 5.0 | 1.0 | 0.7 | 0.9 |
| Selvol PVOH 523S/E 523S | 87.0-90.0 | 23.0-27.0 | 4.5-6.5 | 5.0 | 1.0 | 0.5 | 0.9 |
| Selvol PVOH 540S | 87.0-90.0 | 45.0-55.0 | 4.5-6.5 | 5.0 | 1.0 | 0.5 | 0.9 |

[1] 4% aqueous solution, 20°C.
[2] 4% aqueous solution.
[3] Total volatiles incl. water.
[4] Volatile organic compound, primarily methanol. (max0.9%) with methyl acetate.
[5] As % Na2O, corrected volatiles.
[6] 10% aqueous solution, 25°C.
[7] 10% aqueous solution.
[8] Use of Selvol PVOH 203S is covered by U.S. Patient No. 5,057,570.




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## Polyvinyl Alcohol Business

Important end-use markets for these polymer products include coated paper, ink jet paper, tissue, thermal printing, and specialty applications.

Selvol Polyvinyl Alcohol resins perform well as clear and pigmented sizing agents, cobinder, flurochemical carrier, and stickies control in the paper and paperboard industry. Special properties may be imparted by blending grades or compounding with other ingredients.

To identify specific paper applications please refer to Table 7.


TABLE 6:
Recommended Additives for Selvol Polyvinyl Alcohol*

| Type | Brand or Generic Name | Manufacturer | Use Level |
|---|---|---|---|
| Crosslinkers | Bacote - 20<br>Glyoxal<br>Polycup 172 | Magnesium Elektron, Ltd.<br>BASF<br>Ashland | 2 - 10% d/d<br>5 - 115% d/d<br>5 - 10% d/d |
| Defoamers | FC 407<br>Antifoam 116<br>Industrol DF 132 | ESP Enterprises<br>Harcros<br>BASF | <1% d/d<br><1% d/d<br><1% d/d |
| Biocides | Kathon LX<br>Dowicil 75 | Dow Chemical<br>Dow Chemical | <50 ppm<br>1000-2000 ppm |
| Plasticizers | Glycerine<br>Ethylene Glycol<br>Urea | -<br>-<br>- | 2 - 5%<br>2 - 5%<br>1-5% |

* Note: The FDA compliance status of the recommended additives should be verified with the respective manufacturer.

Special properties may be imparted by blending grades or compounding with other ingredients.
You can see the suggested additives in Table 6.



TABLE 7:

| | WET END | | SIZE PRESS | | | | | | | | CALENDAR STACK | | | | | COATING | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Stickies Control | Dry and Wet Strength | Clear Sizing | Pigmented Sizing | Ink Jet Papers | Optical Brightener Carrier | Oil and Grease Resistance | Flurochemical Carrier | Hydrophobicity | Silicone Holdout | Backend Linting | Oil and Grease Resistance | Flurochemical Carrier | Hydrophobicity | Plybond Adhesion | Cobiner | Ink Jet Papers | Optical Brightener Carrier | Silicone Holdout | Oil and Grease Resistance | Flurochemical Carrier | Towel and Tissue: Crepring |
| **STANDARD GRADES** | | | | | | | | | | | | | | | | | | | | | | |
| **Super Hydrolyzed** | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 125 | | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | | | | | | | ■ |
| Selvol PVOH 165 | | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | | | | | | | ■ |
| **Fully Hydrolyzed** | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 103/E 103 | | | | | | | | | | | | | | | ■ | ■ | | ■ | ■ | ■ | | ■ |
| Selvol PVOH 107/E 107 | | | | | ■ | | | | | | | | | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ |
| Selvol PVOH 310/E 310 | | | | | ■ | | | | | | | | | | ■ | ■ | | ■ | ■ | ■ | ■ | ■ |
| Selvol PVOH 325/E 325 | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | | | | | | | | ■ |
| Selvol PVOH 350 | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | ■ | ■ | | | | | | | | ■ |
| **Intermediate Hydrolyzed** | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 418 | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 425 | | | | | | | ■ | | | ■ | ■ | ■ | | | | | | | | ■ | | ■ |
| Selvol PVOH 443 | | | | | | | | | | | | | | | | | | | | | | |
| **Partially Hydrolyzed** | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 502 | | | | | | | | | | | | | | | | ■ | | ■ | | | | |
| Selvol PVOH 203/E 203 | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | |
| Selvol PVOH 504 | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | |
| Selvol PVOH 205/E 205 | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | ■ |
| Selvol PVOH E 8/88 | | | | | | | | | | | | | | | | ■ | | ■ | | | | |
| Selvol PVOH 508 | | | | | | | | | | | | | | | | ■ | | ■ | | | | |
| Selvol PVOH 513 | | | | | | | ■ | | | | | | | | | | | | | | | |
| Selvol PVOH 518 | | | | | | | ■ | | | | | | | | | | | | | | | |
| Selvol PVOH 523/E 523 | | | | | | | ■ | | | | | ■ | | | | | ■ | | | | | ■ |
| Selvol PVOH 540 | ■ | | | | | | ■ | | | | | | | | | | | | | | | |
| **SPECIALTY GRADES** | | | | | | | | | | | | | | | | | | | | | | |
| **Fine Particle (S-Grade)** | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 165SF | | ■ | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 203S/E 203S | | | | | | | | | | | | | | | | ■ | | ■ | | | | |
| Selvol PVOH 205S/E 205S | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 513S | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 523S/E 523S | | | | | | | | | | | | | | | | | | | | | | |
| Selvol PVOH 540S | | | | | | | | | | | | | | | | | | | | | | |

Note: These applications may be subject to certain U.S. patents and equivalents issued in other countries. No license is granted with the purchase of Selvol Polyvinyl Alcohol. Please contact your Sekisui sales representative for additional information.

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## Gurley Porosity

Polyvinyl alcohol grades within the hydrolysis range of 88-96% impart much better surface coverage to paper, providing maximum barrier properties for oil, grease, solvents and air. Figure 6 shows how the hydrolysis level of polyvinyl alcohol grades affects Gurley Porosity, and Figure 7 shows how hydrolysis affects Mazola oil penetration on solid bleached board. As expected, the tighter sheet shows a corresponding improvement in oil resistance. However, while the 98% fully hydrolyzed grade (i.e., Selvol Polyvinyl Alcohol 325) resisted Mazola penetration for 30 minutes, the 96% hydrolyzed grade (i.e., Selvol Polyvinyl Alcohol 425) survived the test for 60 minutes. Though an 88% hydrolyzed grade like Selvol Polyvinyl Alcohol 523 also performs well, generally Selvol Polyvinyl Alcohols 425 is preferred as it offers the best balance in porosity reduction and size press runnability (i.e., lower tendency to foam).

FIGURE 6: Surface Effects vs. Degree of Hydrolysis
Gurley Porosity Clear Size Application (4% Solution)

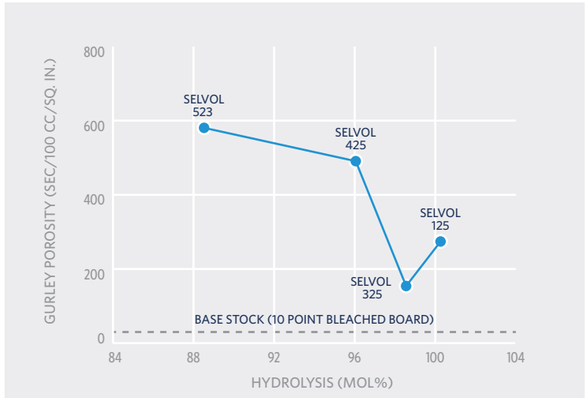



FIGURE 7: Surface Effects vs. Degree of Hydrolysis
Mazola Oil Drop Holdout Clear Size Application (4% Solution)

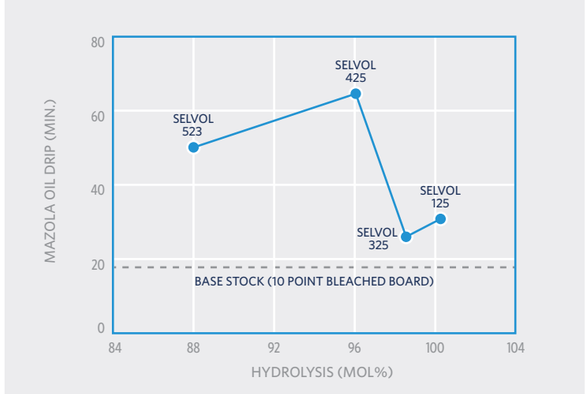
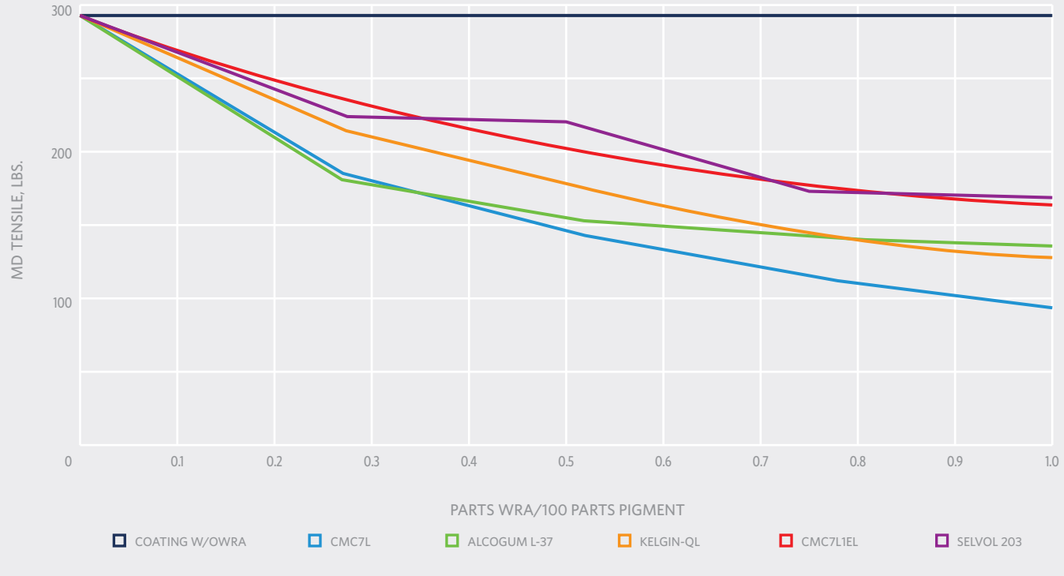





FIGURE 8: PVOH vs. Hydrocolloids - Coating Color Water Retention Aids
ABO AKADEMI METHODOLOGY - FORMULATION: 100 PTS. #1 Clay, 12 PTS. VINAC 884, X PTS. WRA at 65% Solids



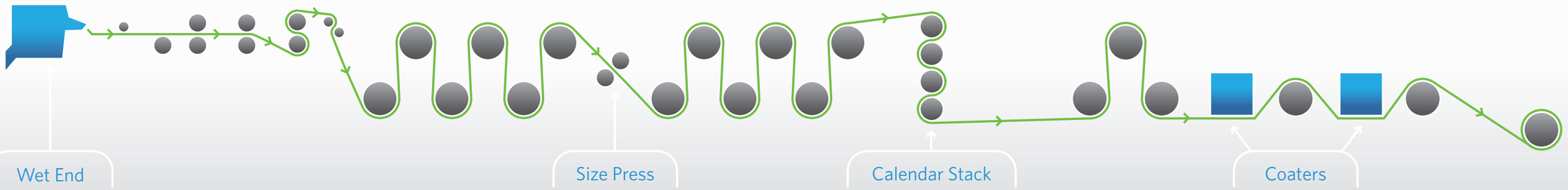

## Water Retention

As a hydrophilic polymer, polyvinyl alcohol exhibits excellent water retention properties. Low viscosity grades like Selvol Polyvinyl Alcohols 103, 107, 502, 203 and 205 are preferred since they provide optimum coating rheology. Figure 8 compares Selvol Polyvinyl Alcohol 203 with other hydrocolloids using the dynamic ABO AKADEMI methodology. In this comparison, polyvinyl alcohol performed well. In addition, polyvinyl alcohol provides much higher binder strength and the ability to boost optical brightener performance.



SELVOL™ POLYVINYL ALCOHOL

# The Paper Machine




## At the Wet End

### STICKIES CONTROL

Polyvinyl alcohol is used to control the deposition of stickies associated with the use of secondary fiber. The polyvinyl alcohol encapsulates the stickies and forms a multilayer shield that effectively covers the surface, rendering it non tacky. Features of this technology may be covered by U.S. Patent 4,886,575 assigned to Betz laboratories.

Polyvinyl alcohol may also be effective in controlling deposition in Kraft, acid sulfite and ground wood papermaking systems. Features of this technology may be covered by U.S. Patent 4,871,424 also assigned to Betz Laboratories, Inc.

### DRY AND WET STRENGTH

Selvol Polyvinyl Alcohol 165SF, a super fine grind version of Selvol Polyvinyl Alcohol 165 (99% of the particles pass through a 120 mesh screen (125 microns)) can be added to the fiber slurry to improve dry and wet strength properties. When mixed with the fiber slurry, the Selvol Polyvinyl Alcohol 165SF particles swell to about three times their original size but do not dissolve. Retention is accomplished through simple mechanical entrapment (polyvinyl alcohol is nonionic). Selvol Polyvinyl Alcohol 165SF particles then dissolve in the first few cans of the dryer section and flow between the adjacent fibers. A release agent can be used to avoid dryer can sticking. Further down the dryer section, the Selvol Polyvinyl Alcohol 165SF particles resolidify and create a very strong fiber/polyvinyl alcohol matrix. Features of this technology may be covered by U.S. Patent 5,328,567 assigned to Custom Papers Group Inc.

## At the Size Press

### CLEAR SIZING

Polyvinyl alcohol finds use at the size press as a clear size to impart surface strength and barrier properties. In this capacity, it is often used to upgrade the performance of starch. Polyvinyl alcohol performs well at this function because it is much stronger and much more resistant to oils, greases, waxes and organic solvents than other surface sizing agents.

### PIGMENTED SURFACE SIZING

Because of its superior strength, polyvinyl alcohol can be formulated at much lower levels than other binders, thus optimizing the brightness and opacity effects of the pigment system.

### INK JET PAPERS

Polyvinyl alcohol is the preferred binder for inkjet size press coating formulations using silica pigments. Its superior binding strength controls the dusting which may occur with starch. Polyvinyl alcohol is a hydrophilic polymer which acts in concert with the silica pigment to quickly absorb the water-based ink into the coating layer, thus minimizing wicking, mottle and bleeding.

### OPTICAL BRIGHTENER CARRIER

Compared with starch, polyvinyl alcohol delivers 2.0-2.5 more UV brightness units (or conversely, a reduction in the level of expensive fluorescent dye at equal brightness). This greater efficiency may allow the reduction or elimination of fluorescent dyes at the wet end.

### OIL AND GREASE RESISTANCE

Polyvinyl alcohol exhibits excellent barrier properties to oils, greases, waxes and solvents. It can be used alone or with starch to meet Vanceometer, Turpentine, K&N ink holdout and other specifications. Polyvinyl alcohol is also a very effective carrier for fluorochemicals. Blends of polyvinyl alcohol and fluorochemicals achieve high 3M Kit Ratings at a much lower cost than with the use of a fluorochemical by itself.

### HYDROPHOBICITY

Surface applications of polyvinyl alcohol and alkyl ketene dimer (AKD) blends demonstrate outstanding improvements in Cobb and Hercules Sizing (HST) values on both acid and alkaline papers, with little or no loss in size values upon aging. Unlike starch, a surface application of polyvinyl alcohol does not degrade the internal sizing effect of a wet end additive like AKD or ASA.

### SILICONE HOLDOUT

The ability to significantly reduce porosity makes polyvinyl alcohol a candidate to holdout or extend expensive silicone coatings.

## At the Calendar Stack

### BACKSIDE LINTING

Polyvinyl alcohol is used as a clear or pigment surface size to control the back-side linting associated with recycled board manufacture. It is often utilized to upgrade the performance of starch. Since polyvinyl alcohol is much stronger than starch, it can be used at lower usage levels.

### OIL AND GREASE RESISTANCE

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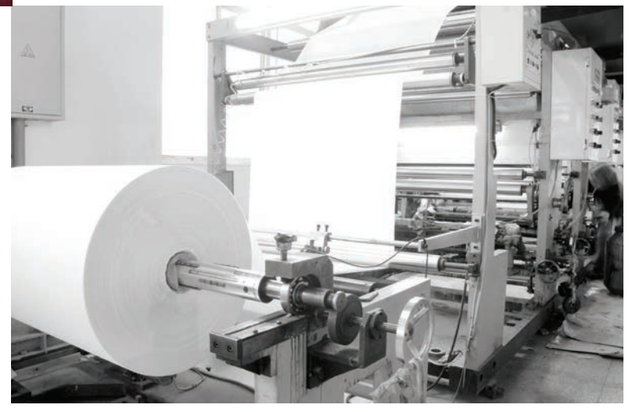

### HYDROPHOBICITY

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### PLYBOND ADHESION

The superior strength of polyvinyl alcohol provides an effective means of achieving plybond adhesion on multiply paperboard.

## At the Coater

### COBINDER

Because of its superior strength, coatings formulated with polyvinyl alcohol can achieve a significant reduction in total binder level. This may provide for substantial cost savings while providing a significant improvement in brightness, gloss and opacity. The water retention properties of polyvinyl alcohol also allow coatings to be formulated with a reduced or zero level of hydrocolloid. Unlike some natural cobinders, polyvinyl alcohol does not require use of a base like ammonia to be solubilized.

### INK JET PAPERS

Polyvinyl alcohol is the preferred binder for ink jet coatings utilizing silica pigments. It provides superior binding strength and improved ink jet print quality versus typical latex binders. Polyvinyl alcohol is a hydrophilic polymer which acts in concert with the silica pigment to quickly absorb the water-based ink into the coating layer, thus minimizing wicking, mottle and bleed.

### OPTICAL BRIGHTENER CARRIER

Polyvinyl alcohol is recognized as the best carrier for fluorescent dyes. The addition of 0.5-2.0 parts (dry) polyvinyl alcohol per 100 parts pigment can boost brightness an additional 4+ units. Such improvements are significant for high 80s/low 90s brightness papers. Polyvinyl alcohol also provides superior binding strength and good water retention properties, enabling reductions in latex and hydrocolloid levels. Selvol Polyvinyl Alcohol 203S, a fine grind version of Selvol Polyvinyl Alcohol 203 (99% of the particles pass through an 80 mesh screen (177 micron)), can be used as a noncook carrier by adding it directly to a pigment dispersion or a pigmented formulation while under high shear agitation for a minimum of 15 minutes.

The concept of using Selvol Polyvinyl Alcohol 203S in coating color formulations as a "non-cook" product, either as a pigment binder or as a carrier for optical brighteners is described in U.S. Patent 5,057,570.





SELVOL™ POLYVINYL ALCOHOL

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