Introduction to PVA Sponge

Updated 2017

I. INTRODUCTION TO PVA SPONGE:

PVA Sponge, sometimes referred to as Polyvinyl Alcohol (formalized) Sponge, is a high tech plastic sponge that has many of the same properties and qualities of a natural sea sponge. All of the cells of PVA Sponge are interconnected, not independent. The major advantages of this physical structure include: high filtering efficiency, its ability to be reused after cleaning (non-medical uses), strong chemical resistance, and its impressive retention of liquids and wicking properties.

Static-free and lint-free, PVA Sponge is hydrophilic with porosities from 55% to 95%. The surfaces of each sponge can be engineered for specific applications – from very smooth pores to large open pores like sea sponges. All deliver an exceptionally high volume and speed of absorption, actually holding many times the volume of liquid compared to a natural sea sponge or sheep-skin chamois. Elasticity and tensile strength properties help provide durability and allow the material to last much longer than other materials.

Its excellent pliancy and elasticity are due to this unique pore structure. This also enables it to capture minute dust. In addition, because PVA Sponge is mainly made of the stable materials, it is strong both physically and chemically. For example, it has excellent resistance to abrasion or ultraviolet rays as well as chemicals.

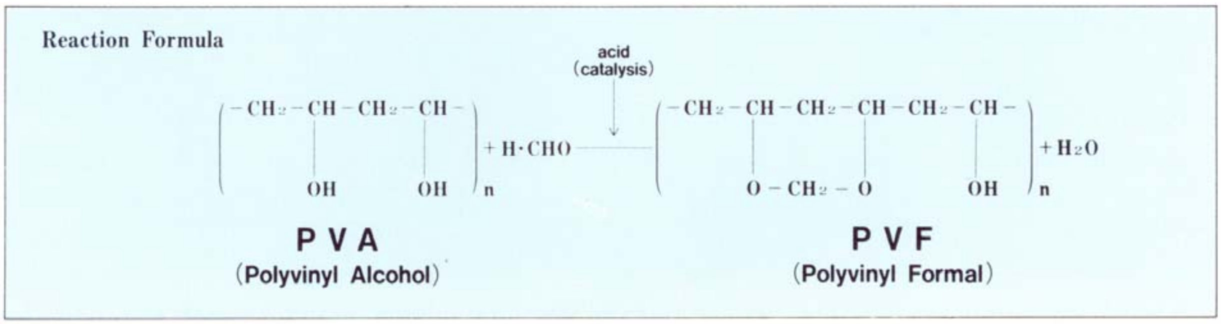
PVA Sponge consists of carbon, oxygen and hydrogen exclusively and does not possess chloride, nitrogen or sulfur which produces noxious gas when burned. Therefore, this sponge burns clean and is safe to incinerate or discard in a landfill since it is biodegradable.

With these excellent properties, PVA Sponge is not only used as a cleaning material for clean sponge but also as cosmetic puffs, mops, wiping material, water absorbing rollers, filter devices, air filters, etc.

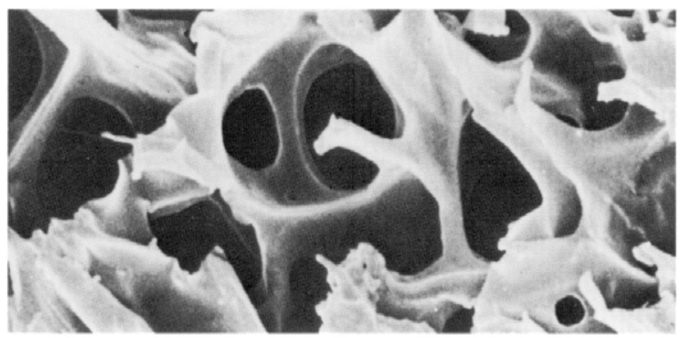
II. HISTORY OF PVA SPONGE:

a. During World War II, British defense scientists discovered PVA Sponge while searching for alternative plastic materials to replace balsa wood. PVA Sponge is very lightweight when dry, but quickly softens when exposed to water or other liquids. Decades later, Japanese scientists discovered a resin treating method to make PVA Sponge resemble balsa wood by remaining lightweight and rigid when exposed to moisture.

b. During the 1950's, a U.S. doctor started testing and trials were made with PVA Sponge for medical applications. PVA Sponge eventually became the chosen material for internal and external surgical procedures, primarily because it would not tear, leave residual debris, could be easily sterilized, and was approved by the FDA.
c. During the past 50 years, many new applications have been found for PVA Sponge for consumer, industrial, medical, and O.E.M. applications. Please see a listing of these applications in section VIII of this report.



PVA Sponge has interconnected cells resembling a natural sea sponge



Magnified picture of sponge structure

III. HOW IS PVA SPONGE MANUFACTURED?

a. PVA Sponge has a porous structure made from water soluble PVA acetalized with an acid catalyst. The finished product becomes PolyVinyl Formal – often referred to as "PVA Sponge". Please see the above "Reaction Formula" chart.
b. During the acetalizing process, the pore forming agent or method (starch or air) is added. After a water soluble porous structure is made, the agent (starch) is extracted. In the case of air pore forming, there is no need to remove any additional material. Please see section IV.
c. The finished product has a three-dimensional, interconnected porous structure. See the above photo for a micrograph of the pore structure. After extensive washing and rinsing of the finished product, it is packed and shipped.

IV. PORE FORMING METHODS FOR PVA SPONGE:

a. Starch Pore Forming Method: Starch creates the pores and is then extracted in the washing process.
   Advantage: Very consistent pore size
   Disadvantage: Residual traces of starch or pore forming material may remain in the material and not recommended for medical applications.

b. Air Pore Forming Method: Gas or air creates the pores.
   Advantages: No residual material remains in the sponge; less expensive to manufacture because less washing is required.
   Disadvantage: Slight variance in diameter of pore sizes may occur.

V. UNIQUE CHARACTERISTICS OF PVA SPONGE:

a. Rigid when dry, soft when wet
b. Very Hydrophilic (it loves water and most liquids)
c. Holds up to 12 times its dry weight
d. Non-linting, non-scratching
e. Mechanically strong, abrasion resistant
f. Cells are inter-connected
g. Easily controlled pore size and shape
h. Material hardness can be varied
i. Non-aging, lasts almost indefinitely (well over 10 years in storage)
j. Withstands sunlight and ultra-violet rays without deteriorating
k. Natural color is white (can be manufactured in many colors)
l. Excellent color fastness (can be dyed or silk screened)
m. Highly resistant to chemicals, including acids, bases, and organic solvents
n. Liberates less metal components. Thus, it is very clean.
o. Can be molded, cut or shaped in almost any configuration
p. Heat resistant to 176^{o}F (80^{o}C) wet, 248^{o}F (120^{o}C) dry
q. Pore size variable between 60 to 1500 microns
r. Warm or hot water softens PVA Sponge faster than cold water
s. Material may be cleaned by washing by hand or in a washing machine
t. Easily sterilized by a variety of methods
u. Can be dried or compressed prior to packaging
v. May be incinerated – burns without toxic gases
w. Biodegradable – safe for landfills

VI. PHYSICAL PROPERTIES OF PVA SPONGE:

Material	Polyvinyl formal resin
Hydrophilic or hydrophobic	Hydrophilic
Pore making method	Particle removal method
Type of pores	Labyrinthal and continuous
Porosity(%)	85~95
Average pore size(μ)	60~2000
Apparent density(g/cm^2)	0.07~0.12
30% compressive stress(g/cm^2)	20~120
Tensile strength(kg/cm^2)	2~9
Tensile elongation(%)	100~300
Abrasion resistance(times before breakage)	1000~2000

Water absorption rate(wt.%)	500~1200
Water absorption speed(sec/cm)	2~15
Condition when dry	Hard
Maximum allowable temperature(℃)	Wet 60 Dry 120
Melting point(※) or decomposition point(℃)	266 (※)JIS.method
Weather resistance	No apparent change with 1000hrs irradiation by a fade-o-meter
Acid resistance	Dissolved by very strong acids
Alkali resistance	Hardened by strong alkalis
Solvent resistance	Weakened with chloroform and dichloroethane
Conditions when burned	No noxious gas

NOTE: Values are not guaranteed and are shown for general reference

PVA Sponge behaves in water as a negatively charged colloid and will strongly absorb metallic cations such as copper or iron. In fact, it acts like an ion exchange resin in this respect. It also has strong affinity for cationically charged organic ions of the quaternary ammonium type.

VII. CHEMICAL RESISTANCE OF PVA SPONGE:

Acetic Acid - 1%> - OK
Acetone - 10%> - OK
Ammonium Hydroxide – 10> - OK
Ammonium Hydroxide - Concentrate – Hardened
Animal & Vegetable Oils, Fats - OK
Benzene - OK
Chloroform - Attacked
Citric Acid - 10%> - OK
Diesel Oil - OK
Diethyl Ether - OK
Dimethylformamide (DMF) - Attacked
Dimethyl Sulfoxide (DMSO) - Attacked
Ethers – OK
EDTA - 10% - OK
Ethanol – 20~90% - Attacked
Ethyl Acetate - OK
Isopropanol – 10~85% - Attacked
Linseed Oil - OK
Methanol – 30~90% - Attacked
Methyl Ethyl Ketone (MEK) - OK
Mineral Oil - OK
Nitric Acid – 1%> - OK
Oxalic Acid – 5%> OK
Petrol - OK
Petroleum Ether - OK
Phenol Solution - 5% - Attacked
Phosphoric Acid - 5%> - OK
Sodium Hydroxide Solution - 5%> - OK
Sodium Hydroxide Solution - Concentrate – Hardened
Sulfuric Acid – 5%> - OK
Tetrachloroethylene - Slight Hardening
Tetrahydrofuran - OK
Tetramethyl Ammonium Hydroxide - 2% - OK

Fluorisol - OK
Formdimethylamide – Attacked
Freon - OK
Hydrochloric Acid - 3%> - OK
Hydrofluoric Acid - 5%> - OK
Hyrdogen Peroxide - 5%> - OK
Toluene - OK
Trichorethane - OK
Trichlorethylene - OK
Tween Detergents - OK
Xylene - Slight Hardening

Remarks: PVA Sponge can be affected by Hypochlorous Acid (HClO) or hypochlorites and by their derivatives, even in a diluted state. Some types of "bleach" – especially granulated bleach – use these chemicals as a component. If it is necessary to use bleach, we recommend using liquid bleach that does not include these chemicals.

NOTE: This chemical resistance information is a guide to compatibility. Always make field tests for at least 24 hours of your specific application with the specific PVA Sponge product prior to use.

VIII. APPLICATIONS FOR PVA SPONGE:

PVA Sponge has many applications, including:

Automotive car shammy
Cosmetic sponges, facial towels, and hair drying towels
Medical sponge for eye, nose, throat, and orthopedic surgery
Pet cooling and drying towels
Sport cooling & drying towels
Mops, sponges, and wipes
Rollers for drying tennis courts or fruit and vegetables
Rollers for coating or drying printed circuit boards
Clean room sponges and wipes for a variety of applications
Non-scratching wipes for photo masks and sensitive plastics
Noduled rollers for scrubbing semiconductors and memory disks
Rollers for automatic pool scrubbing machines
Rollers for drying float glass, flat screen televisions, and auto windshield
Applications for horticulture
Abrasive resin grinding and polishing stones for superfinishing rollers
Abrasive sticks for wet sanding auto finishes, piano finishes, and musical instruments
Self inking stamp pads
High tech water filters, cartridge, and sheet filters
Air filters
Humidifier sponge for humidors and other applications
Shoe sole inserts for odor absorption
Sponge-tipped pen for decorating icing on a birthday cake with food-grade ink

If you have an idea or application, why not contact our staff. We have over 37 years of experience engineering specific PVA products.

IX. PROPER USE AND CLEANING PROCEDURES FOR PVA SPONGE:

a. Identify Type of Water: When first using PVA Sponge, you should identify the type of water being used. Except for ultra pure water, metal ions are always present. As a result, white streaks of metal ions will leave marks after cleaning with PVA Sponge. Simple washing of the material helps avoid many of these issues.

b. Usage with Organic Solvents: When cleaning with organic solvents, dry PVA Sponge doesn't soften even when soaked directly in general organic solvents. First, soften in water or methanol, squeeze out excess liquid, and then soak it in the stated solvent. Only methanol or a solvent mixed with methanol can be used, especially when a water content is not desirable. The organic solvent depends on each user, plant and process. Isopropanol (IPA), Methanol *, Trichlorethylene, Acetone, and Methyl Ethyl Ketone (MEK) can be used. Mixed solvents with these are often used as well. In addition, Freon group solvents are often used for vapor cleaning or ultrasonic wave cleaning. This group has a relatively low boiling point, so it is seldom used for wiping purposes. In general, organic solvent grades are marked as industrial class, first class reagent and special class reagent. In the electronics industries, highly purified EL grade and EEL grade are used. These grades correspond to ultra pure water in purity level. The following organic solvents cannot be used because they dissolve PVA Sponge, render it fragile, or expand it.

   Chloroform Dichlorethane
   DMF, DMSO, Phenol Solvents
   40-80% Methanol, Ethanol, Isopropyl Alcohol
   Tetrachloroethylene
   Sodium Hydroxide Concentrate
   Ammonium Hydroxide Concentrate

* can be used alone to wet PVA Sponge.

c. Precautions When Using Acids: PVA Sponge is not effectively resistant to acids like other materials because it is organic. In the electronics industry, it is often used for cleaning spills consisting of Hydrofluoric Acid, Hydrochloric Acid and Sulfuric Acid of high density. In these cases, wash it in water immediately after use. Otherwise, please discard the PVA Sponge. Washing with water prevents it from weakening or dissolving. In case of low density acids of less than 5%, it will not be damaged, but will became acid-dense and weakened if it is left unwashed. Thus, it is necessary to wash it in water immediately after use or throw it away.

.

d. Precautions with Heat: PVA Sponge is very heat resistance. The decomposition point is 180° C (356° F), which is relatively high. But it is easily transformed by heat because of its porous sponge-like structure. The maximum heat resistant temperature is 120° C (248°F) in dry heat, and 80° C (176° F) in wet heat, so avoid boiling in water or a vapor treatment. An autoclave may be used, but requires testing at various times and/or temperatures since PVA Sponge will easily fail except in a very tight range.

e. Washing and Renewal Method: When first using PVA Sponge, please clean by hand using fresh water or deionized (DI) water. PVA Sponge that is packed wet is treated with an anti-mildew and anti-mold solution. This is used to inhibit bacteria or mold growth. Rinse well before initial use. In high tech applications, wash and rinse in pure water by squeezing out five (5) times to totally eliminate any residual chemicals and to liberate anions (Cl, PO4, SO4, and NO3) and/or metal components (Calcium, Chromium, Copper, Iron, Magnesium, Manganese, Sodium, and Silicon).

One of the key benefits of PVA Sponge is that it can be reused after proper washing. If improperly washed, particles may remain and can create problems. It is recommended that particles and dust be removed by hand washing in water; or, cleaning in a washing machine or an ultrasonic machine. Washing PVA Sponge repeatedly is more effective than washing it only once after a long period of time. We do not recommend washing PVA Sponge intended for high tech applications with commercial or consumer soap products because they may contain additives, scents, surfactants, or bleach.

X. STERILIZING PVA SPONGE: In the pharmaceutical and food industries, disinfecting and sterilization treatments should be considered. However, sterilization by boiling and high temperature vapor by autoclave is not advised.

The proper methods are the following:

a. Sterilization by Gas: Sterilization by ethylene oxide (EO) gas is generally used by pharmaceutical companies, medical device companies, and hospitals.

b. Sterilization by Ethanol: 80% ethanol is effective for sterilization.

c. Sterilization by Chlorine: A chlorine ion such as 0.01 – 0.02% hypochlorous aqueous solution may be used. Sodium hypochlorite solution (domestic bleach) may be used but will eventually degrade the sponge.

d. Sterilization by Gamma Radiation

XI. COMPARISON OF PVA SPONGE TO OTHER MATERIALS:

Please see the attached Schedule "A" (2 pages – please print and create oversize document)

XII. COMPANY INFORMATION: Super PVA Sponge is a division of Super Cool Products, Inc. Our company is the world's leading supplier of PVA Sponge - a unique hydrophilic plastic sponge that is used in many consumer and high tech applications. Mr. Kim Ford, President of Super Cool Products, Inc., has over 34 years of experience in engineering, manufacturing, and marketing PVA Sponge for a variety of consumer, industrial, and O.E.M. applications.

Super Cool Products, Inc., its suppliers and distributors, believe the contents of this technical manual to be true and correct. However, we shall assume no liability for typographical errors, incorrect data, or damages caused by statements in this technical manual. Please use this manual as a guideline in making your own extensive tests and evaluations with our products.

For additional details or assistance, please contact us:

Super Cool Products, Inc.
340 W. Butterfield Rd., Suite LLB
Elmhurst, IL 60126 U.S.A.

Phone: 1-877-574-2669 (1-630-563-0178)
Fax: 1-877-889-4182 (1-630-216-0614)
Email: sales@super-cool-products.com
Website: www.pvasponge.com

SCHEDULE "A" – Left Page

	PVA sponge	Natural sea sponge	Viscose sponge
Material	Polyvinyl formal resin	Natural sea sponge	Viscose
Hydrophilic or hydrophobic	Hydrophilic		
Pore making method	Particle removal method	Natural pores	Particle removal method
Type of pores	Labyrinthal and continuous	Continuous	
Porosity (%)	88 ~ 94	90 ~ 97	90 ~ 95
Average pore size (μ)	60 ~ 2000	100 ~ 1000	150 ~ 200
Apparent density (g/cm^3)	0.07 ~ 0.095	0.06 ~ 0.08	0.04 ~ 0.06
30% compressive stress (g/cm^2)	20 ~ 90	30 ~ 60	20 ~ 30
Tensile strength (kg/cm^2)	2 ~ 6	2 ~ 4	5 ~ 7
Tensile elongation (%)	100 ~ 300	100 ~ 200	20 ~ 30
Tear strength (kg/cm^2)	1 ~ 5	2 ~ 4	0.5 ~ 2
Abrasion resistance (times before breakage)	1000 ~ 2000	500 ~ 1000	500 ~ 800
Water absorption rate (wt. %)	900 ~ 1500	1000 ~ 1300	900 ~ 1500
Water absorption speed (sec/cm)	2 ~ 15	2	2 ~ 4
Condition when dry	Hard	Slightly hard	
Maximum allowable temperature (°C)	Wet 80 Dry 120	150	140
Melting point* or decomposition point (°C)	180	200	180
Weather resistance	No apparent change with 1000hrs irradiation by a fade-o-meter	Weakened with 500hrs irradiation by a fade-o-meter	Weakened with 200hrs irradiation by a fade-o-meter
Acid resistance	Dissolved by very strong acids		Dissolved by less strong acids
Alkali resistance	Hardened by strong alkalis	Good	Weakened by strong alkalis
Solvent resistance	Weakened with chloroform and dichloroethane	Good	
Conditions when burned	No noxious gas		No noxious gas and low temperatures
Remarks	Good hydrophilic properties. Effective in water retention and in durability Different sizes of pores can be obtained depending on the purpose. Extremely small pores can be acquired.	Excellent physical properties. Limited production places and quantity. Unstable quality. Inappropriate as an industrial material.	Few varieties in pore diameters and springiness.

SCHEDULE "A" – Right Page

Rubber latex	Polyurethane foam(ether)	Polyurethane foam(ester)	Polyethylene foam	Polyvinyl chloride foam
Synthetic rubber	Polyether urethane resin	Polyester urethane resin	Polyethylene resin	Polyvinyl chloride resin
Hydrophobic				
Foaming method				
Independent				
80 ~ 90	95 ~ 98	96 ~ 99	90 ~ 97	95 ~ 98
100 ~ 500	100 ~ 500	100 ~ 500	100 ~ 500	100 ~ 500
0.2 ~ 0.5	0.01 ~ 0.03	0.02 ~ 0.05	0.03 ~ 0.04	0.08 ~ 0.1
50 ~ 100	30 ~ 40	20 ~ 30	60 ~ 100	60 ~ 120
3 ~ 6	1 ~ 2	1 ~ 3	4 ~ 7	4 ~ 5
200 ~ 300	200 ~ 400	150 ~ 400	100 ~ 200	200 ~ 250
2 ~ 5	0.7 ~ 1.5	1.0 ~ 1.5	2 ~ 5	2 ~ 5
100 ~ 200	100 ~ 150	50 ~ 100	500 ~ 1000	500 ~ 1000
600 ~ 900	900 ~ 1300	1000 ~ 1500	less than 10	less than 10
No positive water absorbing ability				
No change				
70	Wet 90 Dry 120	Wet 100 Dry 130	80	60
100	200	200	*100 ~ 120	*120
Weakened with 100hrs irradiation by a fade-o-meter	Weakened with 150hrs irradiation by a fade-o-meter	Weakened with 100hrs irradiation by a fade-o-meter	Weakened with 200hrs irradiation by a fade-o-meter	
Dissolved by very strong acids			Good	Dissolved by very strong acids
Good				
Weakened with general organic solvents	Weakened with ketone group		Good	Weakened with general organic solvents
A nasty smell at high temperatures	Noxious gas at high temperatures		Black smoke at high temperatures	Noxious gas with chlorine. Hard to burn.
These hydrophobic foams are generally used in dry conditions. Has high foaming rates and light in weight. Effective in heat retention and springiness. Used as cushion materials and heat insulators.				