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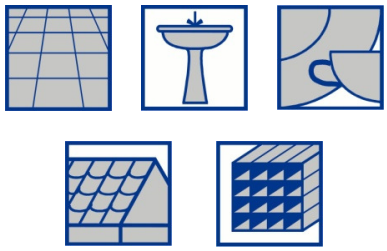

Product information on polyvinyl alcohol preparations

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1. Introduction

Polyvinyl alcohols are used mostly as aqueous solutions. For this reason, their dissolving behaviour is of particular importance. This applies whether aqueous preparations or powders/granulates are recommended. When aqueous preparations are sold, the customer can be given a better picture of the way in which these preparations are produced. When powder products are sold, help can be given with regard to the solution process in the customer's own works.

2. Characterisation of polyvinyl alcohol

Polyvinyl alcohols are polymers of vinyl alcohol; vinyl alcohol cannot exist by itself. This is why all polyvinyl alcohols are produced by polymerisation from vinyl acetate and subsequent alcoholysis of the polyvinyl acetate which is formed.
The technical manufacturing processes are geared to ensure exact values for the molecular weight and residual acetyl content because the application properties depend mainly on these.
Polyvinyl alcohol belongs to the water soluble polymers. In the context of the application, solubility and speed of solution are important characteristics. They are determined mainly by

- **the degree of saponification**
- **the degree of polymerisation**
- **the particle size**

In the production of polyvinyl alcohol solutions, the **foaming tendency of polyvinyl alcohol** must be taken into account.
Polyvinyl alcohols with a low degree of saponification foam particularly heavily. This is due to the reduced surface tension of the water caused by solution of the polyvinyl alcohol which contains hydrophile and lipophile groups.
In the case of more viscous solutions, a fine, stable foam forms, whereas an unstable foam with large pores forms in the case of solutions of low viscosity.
Polyvinyl alcohols with a high degree of saponification foam less because they contain less lipophile acetate groups.
Most of our ready-to-use polyvinyl alcohol preparations contain anti-foam agents.

To the customer who produces his own polyvinyl alcohol solutions we can offer our **anti-foam agents Contraspum conc.** or **Contraspum K 1012**. At the start of the solution process, up to 0.1% of the anti-foam agent should be added to prevent foam from being stirred in. To remove surface foam, more anti-foam agent - up to 0.01% - may be added at the end of the solution process.
Polyvinyl alcohol solutions which are kept for some time should have **preservative** added to them. Additions of up to 0.5 % of our **Noval -** types are suitable for this purpose.
The quantities of both anti-foam agent and preservative to be added are in each case related to the entire solution.

2.1. Degree of saponification or hydrolysis

The degree of saponification is the prime factor that influences the solubility of a polyvinyl alcohol. It shows the percentage of the acetate groups of the starting polymer, polyvinyl acetate, that has been replaced by OH-groups.
The higher the degree of saponification, the lower the solubility and the speed of solution.
The differences are much more marked at low dissolving temperatures than at high ones. This is largely due to the formation of crystalline zones in the polymer which occurs increasingly as the degree of saponification increases. The crystalline zones result from the orientation of the polymer molecules in relation to each other. The orientation tendency of PVA-chains grows with increasing chain structure regularity.

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2.2. Degree of polymerisation

With an increasing degree of polymerisation, i.e. with increasing chain length, solubility falls, **with the polymer concentrations remaining comparable**.

This may be due to the higher viscosity of the solution which makes location changes more difficult or slower. This means that with high molecular polyvinyl alcohols it takes considerably longer for the amount of water required for the movement of the chains against each other to be diffused between the polymer chains.

The degree of polymerisation affects the speed of solution more than the actual solubility.

Low molecular polyvinyl alcohols can be dissolved in much higher concentration than higher molecular ones.

The characterisation of polyvinyl alcohols does not usually include any details of the degree of polymerisation, but the viscosity of the 4% solution is given. This value is much more meaningful for practical purposes because it takes account of the effect of the concentration, of the degree of saponification, of temperature and of time.

2.3 Particle size

The particle size also has a greater effect on the speed of solution than on the actual solubility. As **large** as possible a **specific surface has a beneficial effect on the speed of solution.**

This would suggest that the particles should be as small as possible. However, this involves the risk of agglomeration, which means that the **ideal form is a fine granulate.**

In addition to the low risk of forming lumps, this also means less nuisance caused by dust during the addition, as well as good pourability.

3. The production of polyvinyl alcohol solutions

3.1 Solution process

Two different processes are suitable for the production of polyvinyl alcohol solutions:

3.1.1 Dispersing in cold water / Swelling and dissolving in hot water

The polyvinyl alcohol **is added by stirring with water of approx. 20 C**.

Following dispersal, the **temperature is increased up to 80°C** while stirring constantly, and is held until the polyvinyl alcohol is **fully dissolved**. Then, again while stirring, the temperature is decreased to below 35 °C and the preservative is added, if applicable. If an anti-foam agent is used, the procedure should be as per item 2.

3.1.2 Dispersing, swelling and dissolving in hot water

The polyvinyl alcohol can also be added to hot water. For this procedure it is particularly important to keep the correct water temperature of approx. 95 °C and to use a most rapid stirrer because otherwise lumps may be formed. After stirring, the water temperature decreases by approx. 10 – 20 °C, depending on the concentration of the solution, so it must be increased again to approx. 85 – 90 °C.

This temperature must be held until the polyvinyl alcohol is fully dissolved. Then, again while stirring, the temperature is decreased to below 35 °C and the preservative is added, if applicable. If an anti-foam agent is used, the procedure should be as per item 2.

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3.2 Solution equipment

Polyvinyl alcohol solutions generally have a slightly acid reaction. For this reason, a **corrosion resistant container** must be used, e.g. one made of VA steel.

The container must be **indirectly heatable**, e.g. by means of a hot water heating jacket. Direct heating is not recommended as this could cause local overheating of the PVA particles which would make these particles difficult to dissolve. An advantageous container would be **a closed vessel** with filling inlet and venting tube since this would ensure that the amount of water put into it can be kept constant.

If the vessel is open, any evaporated water must be replaced. There is also a risk of skin formation, but this can be counteracted by stirring.

The most important criterion regarding the choice of stirring equipment is the **speedy incorporation** of the polyvinyl alcohol. Any air stirred in must be kept to the unavoidable minimum. The stirrers must be arranged and made in such a way that all polyvinyl alcohol particles are dispersed evenly and **lumps do not form**.

4. The use of polyvinyl alcohol preparations in the ceramics industry

The polyvinyl alcohol preparations from Zschimmer & Schwarz have many uses in the ceramics industry as **temporary binders and plastifying agents**. They are suitable for processing various raw materials, such as china mixes, oxide ceramic mixes, metal powders and ferrites. The applications range from household ceramics including the production of tableware, to technical ceramics, such as the production of ignition plugs or insulators.

The polyvinyl alcohol preparations from Zschimmer & Schwarz are in most cases **slip compatible** and are consequently particularly suitable for the **production of spray granulate.**

The **amount added** depends on the ceramic mix, the forming method, the application and, for liquid preparations, on the active substance content.

It is **between 0.5 and 2.0 % for powder preparations** and **between 1.0 and 10 % for liquid preparations**. The quantities to be added are in every case related to the absolute product and to the solid matter content of the mix which is to be processed.

5. Zschimmer & Schwarz product range of polyvinyl alcohol preparations

Zschimmer & Schwarz offers both powder polyvinyl alcohols and ready-to-use aqueous preparations, which contain polyvinyl alcohols of various chain lengths and various degrees of saponification.

The aqueous solutions contain preserving agents and most of them also contain an anti-foam agent.

Both powder and liquid preparations may contain softeners or pressing aids.

The following charts give a summary of the standard polyvinyl alcohol preparations from Zschimmer & Schwarz.

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Overview: solid polyvinyl alcohol preparations from Zschimmer & Schwarz

	Viscosity 20 °C [mPas] (standard value)					Pressing aid	Anti-foam agent
	4 % solution	10 % solution	15 % solution	20 % solution	25 % solution		
OPTAPIX PA 4 G	4	20	100	350	1000	-	-
OPTAPIX PA 20 G	20	600	6000	40000	-	-	-
OPTAPIX PA 42	15	150	1200	7500	-	✓	✓
OPTAPIX PA 138	4	20	70	200	700	✓	✓
PRODUKT KB 2043	5	40	200	700	3000	-	-
PRODUKT KB 2055	8	80	400	2000	8000	-	-
PRODUKT KB 2061	18	350	3000	17000	-	-	-
PRODUKT KB 2100	8	70	450	2000	-	✓	✓

Overview: liquid polyvinyl alcohol preparations from Zschimmer & Schwarz

	Active matter [%]	Viscosity 20 °C [mPas]	Softening agent	Pressing aid	Anti-foam agent	Preservative
OPTAPIX PAF 2	ca. 20	ca. 4000	✓	-	✓	✓
OPTAPIX PAF 35	ca. 35	ca. 1300	✓	-	✓	✓
OPTAPIX PAF 60	ca. 20	ca. 4000	-	✓	✓	✓
PRODUKT KB 2046	ca. 25	ca. 1000	-	-	✓	✓
PRODUKT KB 2212	ca. 20	ca. 4000	✓	-	✓	✓

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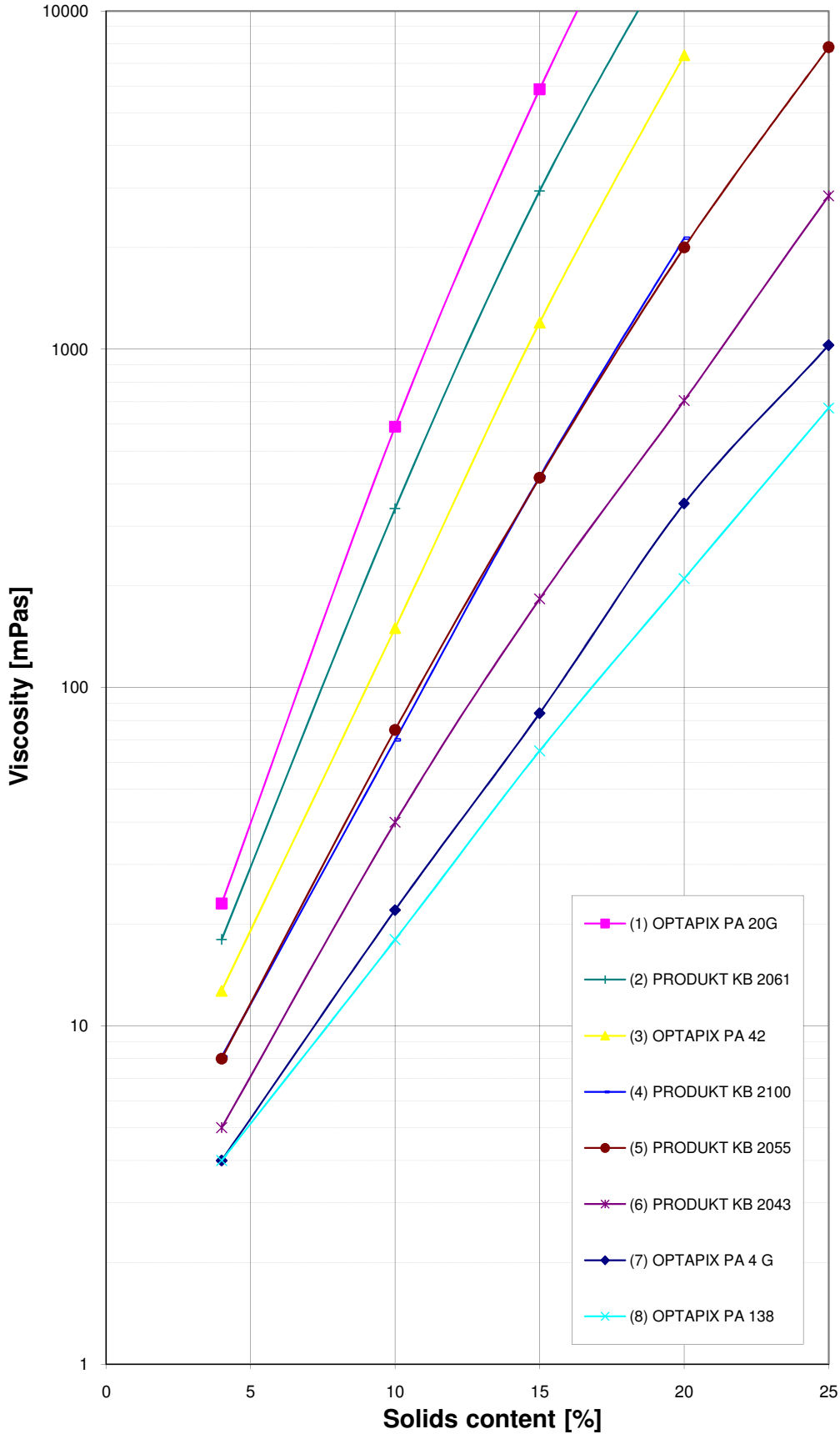
Viscosities in comparison



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