



# PUR prepolymer adhesives



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# PUR prepolymer adhesives

## 1. General remarks

Liquid, reactive polyurethane prepolymer adhesives (short: PUR prepolymers) are high-performance adhesives characterised by a broad spectrum of adhesion and bonding properties. PUR prepolymers are established problem-solvers that facilitate the reliable bonding of different materials and material combinations. Due to their benefits, these adhesives are used in many industries, in particular in load-bearing glulam applications, in the wood, construction and furniture industries, in the manufacture of caravans, in shipbuilding, in the automotive sector and in many other industries. Reactive polyurethane prepolymers are chemically crosslinking and curing adhesives, available as one-component or two-component products.

### Benefits of one-component (1C) PUR prepolymer adhesives

- good penetration into the substrate
- no mixing necessary, easy processing
- fast curing at room temperature
- free of formaldehyde and solvents
- emission-free and odourless after complete curing
- good resistance to water and temperature
- high bond strengths

## 2. Jowat services

1. We evaluate the general conditions and factors on site together with our customers to facilitate the choice of a suitable adhesive technology for the specific individual manufacturing process.
2. We offer an interface management between our customers, supervisory bodies and the manufacturers of machines and adhesive applicator units.
3. We support our customers during the planning phase, during new production line start-ups as well as during ongoing production.
4. We have the technical knowledge necessary to generate an added value to your production.
5. As a leading innovator, we constantly invest in new products and innovations.

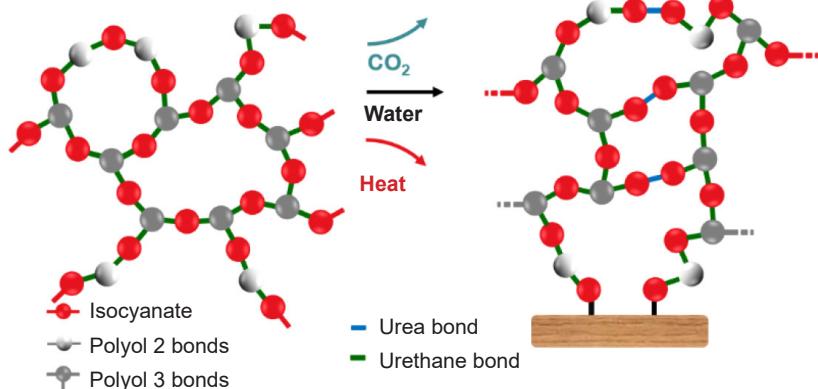
## 3. Chemistry of PUR prepolymer adhesives

PUR prepolymer adhesives are achieved via a reaction of isocyanates with polyols in which urethane bonds are formed. The adhesives have a low to high viscosity and are slightly pasty at room temperature. Moisture-curing PUR prepolymer adhesives are available as one- or two-component products. After complete curing, the adhesives are elastomeric (capable of elastic deformation to a certain degree) with more or less pronounced thermoset properties, depending on the adhesive formulation. The range of applications is wide due to bonding characteristics that can be adapted to a specific application.

# PUR prepolymer adhesives

## One-component PUR prepolymer adhesives

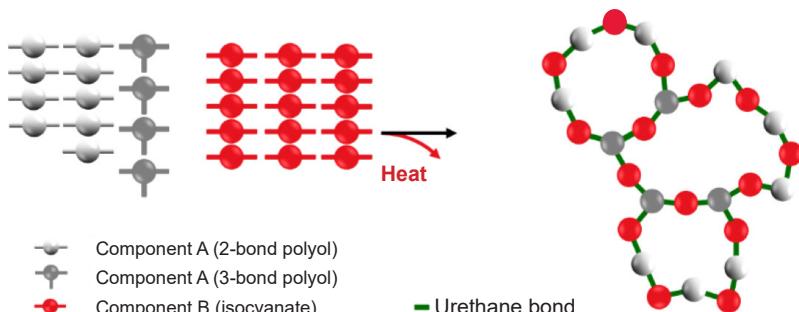
The one-component adhesives contain polyurethane prepolymers with reactive isocyanate groups manufactured from isocyanates and polyols. At room temperature, they react with water molecules from the ambient air, the substrates or from additional fogging. The reaction between the free isocyanate groups (NCO groups) in the prepolymers and the water molecules facilitates the formation of extremely stable urea bridges. The reaction also releases small amounts of carbon dioxide ( $\text{CO}_2$ ), which causes the well-known foaming. Unless it can diffuse through the substrates, the  $\text{CO}_2$  will remain in the bondline.



## Two-component PUR prepolymer adhesives

In two-component adhesives, the chemical reaction takes place between a resin component and a hardener. In general, the two components are mixed together before the adhesive is applied. The resin component contains polyols, catalysts and several other ingredients. The hardener consists of one or several isocyanates and in some cases also other ingredients.

The exact mixing ratio of the products is indicated in the corresponding technical data sheets. When the two components are being mixed together, the hydroxyl groups (OH groups) of the polyols start to react with the isocyanate groups and begin to form urethane bridges. Compared to the moisture-curing process of one-component PUR prepolymers, there is no  $\text{CO}_2$  formation and consequently no foaming.



### Factors influencing the reaction time:

- adhesive formulation
- joint thickness and adhesive application amount
- substrate moisture and humidity
- additional moisture or accelerator (fogging)
- temperature of the substrates, ambient air and adhesive
- type and quality of the substrates
- application method



# PUR prepolymer adhesives

## Characteristics of one-component PUR prepolymer adhesives

### Viscosity

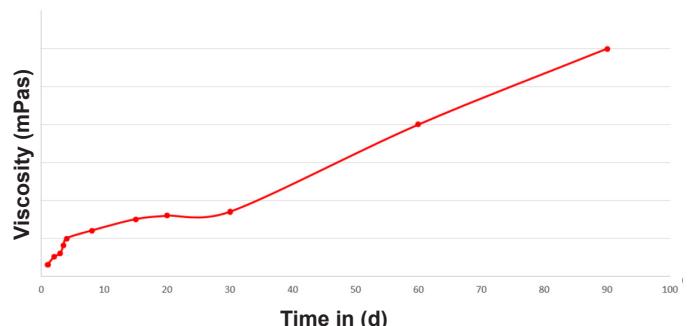
Viscosity describes the flow property of liquids and is a measure of resistance to flowing. Adhesives with higher viscosity are "thicker". Adhesives with a lower viscosity are "thinner".

The viscosity of the adhesive must be adapted to the substrates to be bonded as well as to the application process. The viscosity of a liquid and therefore also of PUR adhesives is generally influenced by the storage and ambient air temperature. The rule of thumb: a temperature increase by 10 °C will reduce viscosity by half. This also applies to the storage of the adhesives and there are several precautionary measures to be observed.

Temperatures below +5 °C may lead to a crystallisation of reactive components in PUR prepolymer adhesives. Therefore, the PUR adhesives should be stored in properly closed original containers, in a dry place, at temperatures between +15 °C and +25 °C. Higher storage temperatures may lead to an increase in viscosity over time and can have a detrimental effect on the bonding properties.

Ideally, the crosslinking reaction should take place with sufficient ambient humidity and at a temperature ranging from approx. +15 °C to +25 °C (for non-load-bearing applications) and from approx. +18 °C to +25 °C (for load-bearing applications).

Viscosity increase in terms of storage time



### Pot life (only for 2-component PUR prepolymer adhesives)

Higher adhesive temperatures will reduce the time within which the resin/hardener mixture must be processed (pot life).

The general rule of thumb:

A temperature increase by 10 °C will double the reaction speed. Conversely, pot life will be reduced by half if the temperature is decreased by 10 °C.

Viscosity, assembly time and minimum pressing time can be influenced among other parameters by the following:

- ambient temperature
- humidity
- moisture content and temperature of the substrate
- surface characteristics
- density in raw state of the substrate
- absorbency of the substrate
- pressing temperature and pressure



# PUR prepolymer adhesives

## Assembly time

Assembly time is the time period starting from when the adhesive is being applied until full pressure is applied. It is largely influenced by the moisture available (from the substrates as well as from the ambient air/humidity) and by temperature (of the materials, adhesive and ambient air).

The parts to be bonded must be joined and pressed within the assembly time. If the assembly time is exceeded, this will lead to a major decrease in bonding strength. Usually, a skin of already cured product is formed on the surface of the adhesive film or bead. Therefore, a sufficient wetting of the parts to be joined is no longer ensured and the optimum bond strength can no longer be achieved.

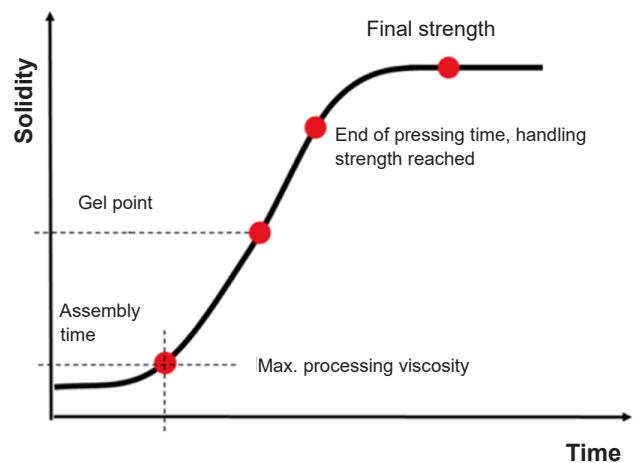
## Pressing time

The pressing times necessary depends on

- the moisture available
- the temperature
- the application amount
- the joint thickness.

Elevated temperatures, higher moisture and lower application amounts will reduce the pressing time. Lower temperatures, less moisture and higher application amounts will increase it.

The pressing time can be accelerated by if the substrate or the applied adhesive are fogged. The moisture applied must not form a closed water film on the surface and should not exceed 5 – 10 % of the adhesive application amount. Conventional one-component PUR prepolymer adhesives usually have an assembly time-pressing time ratio of 1:3. This applies at +20 °C, a humidity of approx. 65 % and sufficient substrate moisture (wood: approx. 10 – 12 %). However, modern PUR prepolymer adhesives of the latest generation have a significantly improved assembly time-pressing time ratio.



When the pressing time is finished, the bonding has reached a handling strength that facilitates the direct downline processing of the bonded parts in most cases. However, the bonded parts must not be exposed to influences/forces (deformation, vibrations, etc.) that can influence the curing process. The final strength, when the bonded parts may be exposed to the final load/stress, is reached only after approx. 24 hours at 20 °C and with sufficient available moisture/humidity (for instance 12 % wood moisture and 65 % humidity).

The pressure chosen must be such that optimum matching of the parts to be joined and thus the thinnest possible joint thickness is ensured.

# PUR prepolymer adhesives

## Directions for processing polyurethane prepolymer adhesives

### Start-up of adhesive applicator units for 1-component PUR prepolymer adhesives

The adhesives are generally applied from drums or reservoirs, using a closed application system. The following points need to be observed to ensure a correct connection:

1. chose a suitable container size depending on the production volume,
2. check the connections (adhesive container and adhesive applicator),
3. make sure the drying cartridges with silica gel are installed correctly,
4. there must be no air in the application system when the container is being connected, and
5. check the operation and start production.



Silica gel consists of small grains of silica that absorb moisture (water), e.g. from the air. It prevents a premature reaction of the PUR prepolymer adhesive during production. To prevent the formation of a vacuum inside the container and to facilitate the dispensing of the adhesive, dry air must be allowed to enter the container during processing. The silica gel in the cartridge can absorb up to 40 % of its own weight in moisture from the air entering the container. The silica

gel is orange when dry and will discolour as it absorbs moisture (see photo on the right). If such a discolouring is observed, the silica gel must be either replaced or dried. Wet silica gel granules can be dried by storing it in a standard oven at max. 110 °C for 5 hours. Microwave ovens are not suitable for drying silica gel!



### Cleaning

Cleaning must always be carried out in accordance with the instructions by the machine manufacturer. Slightly cured adhesive can be removed using the PUR cleaner and PUR dissolver **Jowat® 402.38**. The cleaner can damage plastic parts and seals and any contact should therefore be prevented. Fully cured adhesive can be removed only mechanically.

Presses, working surfaces, etc. may be coated with the release agent **Jowat® 901.10** (paste-like) or **Jowat® 901.20** (liquid) to prevent the adhesive from adhering to the surfaces.

## PUR prepolymer adhesives

In general, the flushing of hoses and ducts is to be avoided. Should the flushing be necessary, for instance due to an adhesive change, units can be flushed with the flushing and soaking liquid **Jowat® 403.30**. All remnants of flushing agent must be removed from the machine before production is started again.

Any application nozzles, combs, etc. that are no longer need after production (or during prolonged standstills), can be immersed in the flushing and soaking liquid **Jowat® 403.30**. The reaction of the adhesive will be stopped immediately. The soaking liquid should be replaced from time to time.

Solvent-based cleaners may damage or destroy seals and parts and should therefore be avoided.

When changing to another adhesive, remnants of the old adhesive can be flushed out from the machine using the new product. Prior to the flushing, the two adhesives must be tested for compatibility to prevent any undesired reactions.

Process step	Remarks
Checking the compatibility of the adhesives	Important: Preliminary compatibility tests. If the two adhesives start to react with each other, this can cause substantial damage to the adhesive applicator unit.
Empty connected adhesive containers	Adhesive remnants start to react as soon as moisture enters the systems.
Flush out all adhesive with adhesive!	It must be ensured that all adhesive remnants have been flushed out. It is imperative to thoroughly flush with the "new" adhesive.
Operational check and production start	If the machine parameters have been set and checked, production can start again.

### The following supplementary agents from Jowat help ensure a smooth operation and reliable processing

Product	Description
<b>Jowat® 403.30</b>	Flushing and soaking liquid
<b>Jowat® 402.38</b>	Cleaner
<b>Jowat® 901.10</b>	Release agent – paste-like
<b>Jowat® 901.20</b>	Release agent – liquid
<b>Jowat® 972.09</b>	Silica gel refill kit
<b>Jowat® 972.11</b>	Silica gel cartridge for IBC
<b>Jowat® 972.00</b>	Silica gel cartridge for drums

# PUR prepolymer adhesives

## 4. Machine and process technology

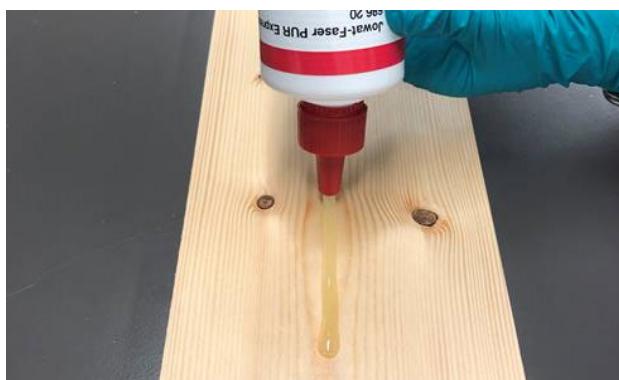
### Adhesive application

The adhesive and the adhesive applicator must be adapted to each other. In manual applications, the adhesive is usually applied with a spatula, a roller or other small applicators. Each small processor handles the manual adhesive application differently and therefore special attention must be paid to the characteristic values of the adhesive.

If the adhesive has to be applied on large surfaces, this is usually done with special bead applicators. The adhesive is pumped from big containers and applied onto the substrate in bead form via several nozzles.

These applicator units ensure that the adhesive is protected from moisture all the way from the container to the applicator head and prevent a reaction of the adhesive with moisture inside the system.

Automated industrial units may also use roller applicators.



Manual application



Nozzle applicator



Curtain coating



Roller applicator

### Adhesive application amount

The application amount depends on the joint thickness, the application method, the surface characteristics and the absorbency of the substrates, the viscosity and density of the adhesive, as well as on the application itself. Every joint must be completely filled with adhesive and both bonding partners must be wetted sufficiently.

## Processing considerations

In addition to the adhesive parameters already mentioned above, there are several other aspects to be observed. Before bonding, it must be ensured that the surfaces are free of oil, dust and grease.

Wood must be planed or undergo similar preparation before bonding. Planing must be carried out 24 hours or less before bonding. If wood species are used that are difficult to bond, e.g. wood with a high resin content, the surface has to be planned within six hours before bonding. A minimum moisture content is essential for the complete curing of one-component PUR prepolymer adhesive. Therefore, the lowest acceptable percentage of wood moisture of the surfaces to be bonded is 8 %. A minimum wood temperature of 10 °C (non-load-bearing applications) and 18 °C (load-bearing applications) has to be maintained during the manufacturing process.

Metal surfaces require preliminary bonding tests. Metal surfaces may be degreased, sanded or coated with a primer to improve the bonding properties. The surfaces must be cleaned of any sanding dust before bonding. It must be ensured that any cleaners used do not leave any residues.

## 5. Quality assurance measures for processors

### Adhesive application

To ensure a reproducible quality of the bonding process, it is important to follow the regulations and standards applicable for the application process.

The applicable standards are EN ISO 9001 in general and DIN 2304 in particular for bonding processes in Europe. All load-bearing glulam applications are subject to special regulations and standards. Compliance with those requirements is verified by the competent authorities and institutes.



1. Adhesives must be tested before use to ensure that they are fit for purpose and meet all requirements for the bonded part.
2. The processor defines the requirements for the adhesive bonding depending on the product's future place of use.
3. Compliance with the requirements is verified through the definition of the qualified preliminary testing and random inspections by the processor.
4. The establishment of an own testing lab or own testing possibilities facilitates continuous quality control and improvement.
5. The manufacturing process should be documented and monitored accordingly (keeping a gluing log).
6. Machines and machine parts must be maintained and serviced in regular intervals.
7. Ensure a regular training of employees responsible for adhesive bonding.

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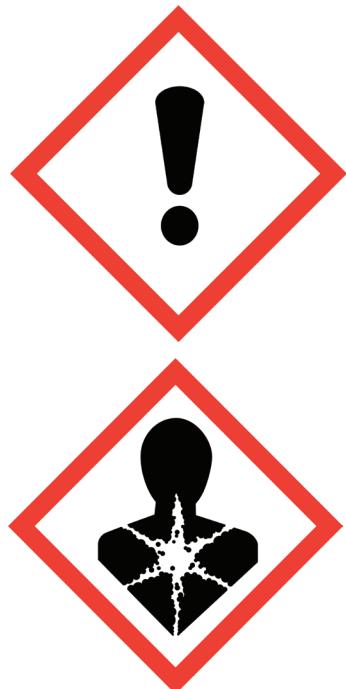
## Labelling and disposal

In accordance with the European Regulation (EC) No. 1272/2008 (also referred to as CLP regulation), PUR prepolymer adhesives are categorised "harmful" in non-cured state. For the classification of individual products, please refer to the corresponding safety data sheets (section 2).

Direct skin contact with non-cured adhesive must be prevented. The wearing of appropriate personal protective equipment (gloves, safety goggles and clothing, etc.) is therefore absolutely necessary. Further information about personal protective equipment is provided in section 8 of the corresponding safety data sheets. Safety data sheets are the basis for working instructions created by the processor on how to process PUR prepolymer adhesives.

When the adhesive is applied by spraying, small particles can have a harmful effect on health if inhaled. This also applies to the processing of PUR prepolymer adhesives at temperatures above +40 °C. An appropriate respiratory protective device must be worn. Further information is also provided in the corresponding safety data sheets for the adhesives and cleaners.

Non-cured polyurethane adhesives must be disposed in accordance with the requirements for hazardous waste. Spilled **Jowapur®** adhesive can be absorbed with sawdust. It is recommended to place a container with sawdust or water under the applicator units. Smaller amounts of cured adhesive can be disposed with commercial waste. For larger quantities, please contact your local waste disposer (further information on disposal is provided in section 13 of the corresponding safety data sheets).



GHS 7 + GHS 8: Danger

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