

Solvent cement welding of PVC-U

Basic principle of solvent cement welding

Solvent cement welding is one of the most commonly used jointing techniques for above ground piping. It is a reliable, safe and efficient method of installing PVC-U piping systems. To make a joint, the outside of the pipe and the inside of the fitting are coated with a chemically active solvent cement, softening and making liquid the surface area to be joined. When joined together the two parts bond almost immediately, and the cement cures to give a joint that is stronger than the pipe itself.

Achieving consistent high quality solvent cement joints requires a systematic approach to the cutting, preparation and assembly of the joint. Most joint failures occur because of dry-joints (lack of solvent cement), however most of the recurring problems can be addressed with training which is available free of charge by contacting our technical department.

To consistently make good joints, the following should be carefully understood:

- The joining surfaces must be softened and made semi-fluid
- Sufficient cement must be applied
- Assembly of the joint must occur while the surfaces are still wet and fluid
- Joint strength develops as the cement dries. In the tight part of the joint the surfaces will tend to fuse together, while in the loose part of the joint the cement will bond to both surfaces.

Softening and penetration

These areas must be softened and penetrated by the solvent-based cement, or by the primer and cement

Sufficient application of cement

It is crucial to apply sufficient cement to fill any gaps and to ensure that the joining surfaces are penetrated so that they remain fluid until the joint is assembled.

Assembly while wet

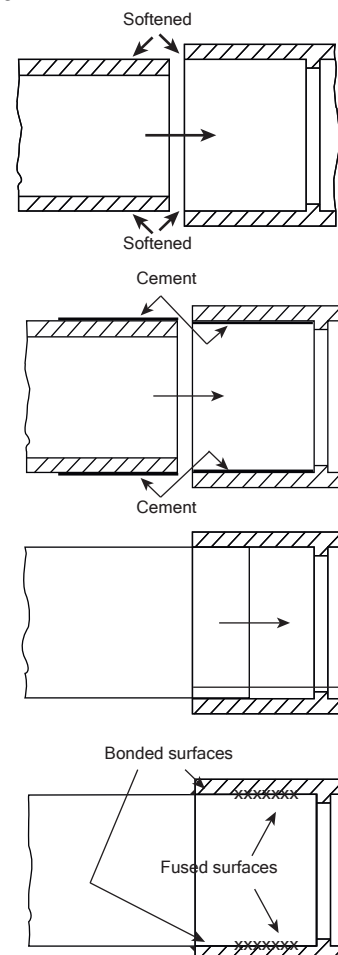
If the cement coating on the pipe and fittings is wet and fluid when assembly takes place, they will tend to flow together and become one layer. If the surfaces are soft they will fuse together in the tight part of the joint.

Developing joint strength

As the solvent dissipates, the cement layer and the softened material will harden with a corresponding increase in joint strength. In the tight (fused) part of the joint the strength will develop more quickly than in the looser (bonded) part of the joint. A good joint will take the required working pressure long before the joint is fully cured and final strength is obtained.

Health and safety

At all time installers should be aware of good safety practices. Solvent cements, primers and cleaners are flammable, so no smoking or other sources of heat or flame is permitted in the work or storage area. Work only in well ventilated spaces and avoid unnecessary skin contact. Users should read and understand the instructions for use and the material safety data sheets.



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Softening and penetration

Installation personnel should be trained and technically competent for this jointing method. Training for installers is available free of charge on request from our technical department.

The tools required for the job should be assembled and checked prior to commencing any work. When assembling longer runs or large size PVC-U pipes, the use of guides, pipe rollers or supports, is recommended to reduce the drag forces involved.

The work crew should be equipped with equipment to enable safe handling of the pipes on site, together with appropriate hand tools. In addition, it is recommended that the following tools are used during the jointing process. Using tools designed specifically for plastic piping systems greatly improves the performance of the installation team and reduces the risk of bad joints being made.

Pipe Cutting

| Item | Pipe Diameter | Part Number |
|---------------|---------------|-------------|
| Rotary Cutter | 6 - 63mm | 04124 |
| Rotary Cutter | 10 - 90mm | 04134 |
| Rotary Cutter | 48 - 114mm | 04144 |
| Rotary Cutter | 102 - 168mm | 04164 |
| Rotary Cutter | 159 - 254mm | 04170 |
| Rotary Cutter | 160 - 315mm | 04470 |
| Rotary Cutter | 355 - 500mm | 04475 |
| Rotary Cutter | 355 - 630mm | 04480 |



| | | |
|-----|-------------|-------|
| Saw | Up To 75 mm | 04512 |
| Saw | Up To 100mm | 04510 |
| Saw | Up To 150mm | 04517 |
| Saw | Up To 200mm | 04519 |



Pipe De-Burring and Bevelling

| Item | Pipe Diameter | Part Number |
|----------------|---------------|-------------|
| Deburring Tool | Up To 2" | 04436 |
| Deburring Tool | 1" To 4" | 04430 |

| | | |
|----------|------------|-------|
| Beveller | 40 - 200mm | 04395 |
| Beveller | 40 - 300mm | 04398 |



Large Diameter Joints

| Item | Pipe Diameter | Part Number |
|-------------|---------------|-------------|
| Pipe Puller | 4" - 12" | P0412 |
| Pipe Puller | 14" - 18" | P1418 |

Brushes

| Item | Pipe Diameter | Part Number |
|----------------|---------------|-------------|
| 8mm Round | 6 - 25mm | L-151/R |
| 25 x 10mm Flat | 32 - 50mm | 565/1 |
| 50 x 10mm Flat | 65 - 125mm | 565/2 |
| 75 x 10mm Flat | 150 - 300mm | 565/3 |



For solvent cement joints in diameters 8" (200mm) and larger, consideration should be given to the use of swab or roller applicators that speed up the application of cements on to large diameter pipes and fittings. The work crew should also carry the appropriate quantity of solvent cement, primer and cleaner, together with lint-free cloth or wipes, protective eyewear and solvent resistant protective gloves.

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Preparation of the work area

Solvent cements primers and cleaners contain volatile solvents, with fumes that are heavier than air. Good ventilation in the work area is essential to prevent the buildup of fumes in enclosed spaces. If fume extraction is to be used, it should be positioned at floor level, or immediately below the working area.

Solvent cements are highly flammable. No naked flames, sparks, heaters or smoking can be permitted in the working area. Also, ensure that any discarded solvent cement containers, brushes, paper or clothes containing traces of solvent cement, cleaner or primer are disposed of safely in sealed containers. Do not pour solvent cements into the drainage system. Clean up any accidental spillage immediately, and prevent pipes and fittings from being contaminated by spills.

The area in which the solvent cement welding is to take place should be clean, dry, and at a temperature greater than 5°C. Solvent cements and primers should be stored in sealed tins. If cements are stored in cold conditions, the temperature must be raised by gradual conditioning in the workplace. The use of protective eyewear, and solvent resistant gloves is required.

Always follow the safety instructions on the can, and the guidance provided with the material safety data sheets that are supplied with each product.

Pipe cutting and preparation

Before cutting, pipes should be conditioned to reach the ambient working temperature under which installation and jointing will take place.

Pipe should always be cut to length using tools specifically designed for use with plastic pipe. A rotary pipe cutter with the correct blade or wheel appropriate for the pipe wall thickness is recommended, as they provide a high degree of accuracy in the finished cutting length, and also produce a square cut to the pipe. Power tools such as band saws or circular saws may also be used - however they should have blades that are specifically designed for use with plastic pipe. Handsaws with blades suitable for use with plastic pipe may be used, however it is recommended that a mitre box be used to ensure a square cut is achieved.

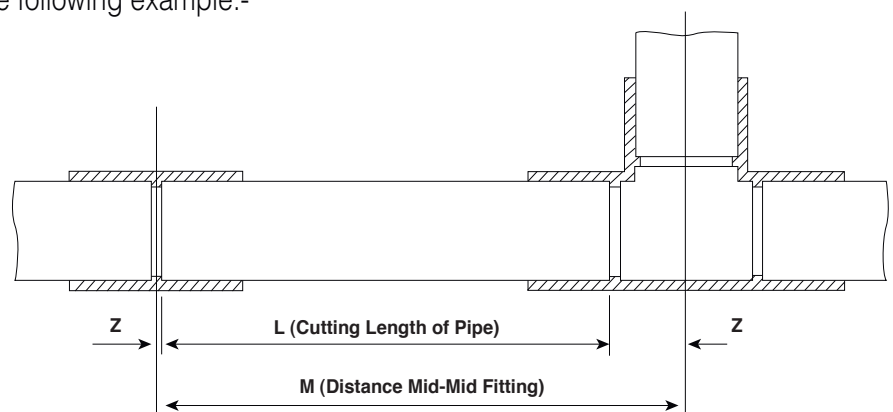
The installation of PVC-U piping systems makes use of so-called "Z" dimension of the fitting. An explanation of the use of the "Z" dimension is shown in the following example:-

Explanation:

M = Distance mid-mid fitting

L = Cutting length of pipe

Z = Z-dimension of fitting



The Z dimension for PVC-U pipe fittings that is used to calculate pipe cutting lengths can be found in the detailed dimensional information.

Once the cutting process is completed, the pipe length should be checked for accuracy, and any internal or external burrs should be removed using a deburring tool specifically designed for use with plastic pipe. Any plastic chips or swarf should also be removed from the inside of the pipe. The jointing area of the parts to be solvent welded must be free from damage or contamination.

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Calculating the required quantity of solvent cement

The following table gives an indication of the number of PVC-U joints that are likely to be made for each litre of solvent cement, primer and cleaner:

| Pipe Diameter | | Solvent Cement Joints Per Litre | Primer Joints Per Litre | Cleaner Joints Per Litre |
|---------------|-----------|------------------------------------|----------------------------|-----------------------------|
| Inch DN | MM DN | | | |
| 1/4" - 1/2" | 6 - 15 | 160 | 320 | 320 |
| 3/4" - 1" | 20 - 25 | 120 | 240 | 240 |
| 1 1/4" - 2" | 40 - 50 | 80 | 160 | 160 |
| 2 1/2" - 3" | 65 - 80 | 60 | 120 | 120 |
| 4" | 100 | 40 | 80 | 80 |
| 5" - 6" | 125 - 150 | 24 | 48 | 48 |
| 8" | 200 | 12 | 24 | 24 |
| 10" | 250 | 4 | 8 | 8 |
| 12" | 300 | 2 | 4 | 4 |
| 14" | 350 | 1 | 2 | 2 |
| 16" | 400 | 0.5 | 1 | 1 |
| 18" | 450 | 0.4 | 0.8 | 0.8 |
| 20" | 500 | 0.3 | 0.6 | 0.6 |
| 24" | 600 | 0.2 | 0.4 | 0.4 |

Applicators for solvent cements and primers

Solvent cements and primers are applied by using natural bristle brushes or special applicators. In the case of a natural bristle brush, this should be sized according to the diameter of the pipes to be joined. Typically, the brush should be equal to approximately half of the pipe joint diameter. Special applicators have been developed to simplify the application of solvent cement and primer, and are often supplied as an integral part of the solvent cement tin lid. For larger diameter jointing, special rollers and applicators should be used in conjunction with large capacity solvent cement containers to speed the jointing process.

Abrading PVC-U pipes and fittings

There is a long tradition of abrading the surfaces of PVC-U pipes and fittings prior to the application of solvent cement. This is a proven method of ensuring penetration of the material by the solvent. However, the integrity of solvent cement welded joints is improved if a tight interference fit occurs between the parts to be fused. Abrasion can cause flat spots in the jointing area to the detriment of the tightness of the fit.

Abrasion will not improve the quality of solvent cement joints - this is only achieved with the correct preparation and application of primers and solvent cements. Abrasion is time consuming, dirty work that can cause contamination to the workplace. The use of Primer as a preparation step in preference to abrasion can improve joint quality, save time, reduce costs, and improve the working environment.

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Making a solvent welded joint - joint preparation

- Bring the pipes, fittings and solvent cements to the same temperature condition. Ensure that the items to be joined are clean and dry prior to use. Inspect the components for any signs of damage or irregularities. Do not use items that appear not to be correct.
- Cut the pipe ends squarely using tool suitable for plastic pipe. A wheel-type cutter is ideal. If a saw is used, a mitre box is recommended to ensure a square cut. Power saws may be used with care.
- Using a chamfering tool cut a 10° to 15° chamfer on the outside of the pipe. This will help ease the pipe into the fitting and minimize the risk of cement being wiped from the fitting during assembly.
- Remove the internal burr from the pipe, and clean up any cutting debris or swarf.
- Check the dry fit by entering the pipe into the fitting. The pipe should enter the socket of the fitting to between 1/3 to 3/4 of its depth. This is regarded as a good "interference fit". If the pipe bottoms in the fitting with little interference, extra solvent cement should be used during assembly.
- Measure the insertion depth of the socket and mark it on the pipe end. This makes it possible to verify later that the pipe has completely "bottomed out" in the fitting.



Chamfering the pipe



Removing the internal burr



Measuring the insertion depth



Marking the pipe end

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Making a solvent welded joint - completing the joint

- Open cans of cleaner, primer and cement ready for use and loosely replace lids to minimise the evaporation of the solvents. Check that the products are in good condition and not "gelled". Cements that are gelled must not be used. Never thin cements.
- If needed, remove dirt with C-65 cleaner applied using a clean, lint-free cloth or paper towel.
- Using a natural bristle brush or an applicator apply P70 primer to the inside of the fitting socket then to the outside of the pipe, then apply a further coat to the fitting socket. The primer should be worked into the surfaces of the material. Avoid 'padding' the primer in the fitting socket. Do not apply with a rag.
- **While the primer is still wet**, apply the solvent cement using a natural bristle brush of the correct diameter, or a correctly sized applicator. The solvent cement coating on the pipe end should be liberally yet evenly applied to a distance equal to the depth of the fitting socket. A medium even coat should be made on the fitting socket surface. For diameters 4" (100mm) and above, or if the fit was loose, a second coat should be applied to the pipe.
- **While both surfaces are still wet**, insert the pipe into the fitting until the pipe bottoms out fully in the socket. Check that alignment is correct. Hold the joint to prevent pull out for around 20 to 30 seconds (larger sizes may require more time). A bead of solvent cement should be evident around the pipe and fitting juncture. If the bead is not continuous it may indicate that insufficient solvent cement was applied. If this is the case the joint must be cut out, discarded and begun again with new product. Excess solvent cement should be removed from the mouth of the socket using a clean, dry cloth. Replace lids on cleaner, primer and cement cans to prevent the solvent from evaporating.
- Handle the newly assembled joint with care until the initial set time has elapsed (see set and cure times table). Following the initial set period the assembly can be handled carefully, avoiding stresses on the joint. **All solvent cemented joints must be allowed to cure fully prior to pressure testing.**



Applying the primer to the pipe



Brush applying cement of the fitting



Brush applying cement to the pipe



Assembly



Wiping away excess cement

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Set and cure times

The initial set between the pipe and the fitting takes place in a matter of minutes, and joints can therefore safely be handled in a very short time. However, the joint needs to cure before it can be used as part of a pressurized assembly. The time taken to achieve this can depend upon a number of factors, including the tightness of fit as well as the ambient temperature and humidity. In general terms, joints will cure faster on tighter fitting assemblies in warmer, drier conditions, whereas looser fit joints made in cooler and/or humid conditions will cure slower.

As a general guide it is recommended that (wherever possible) joints be left for 24 hours to cure before pressure is applied. However, where this is not possible, consideration may be given to the above factors before determining when joints are put into service. Given average conditions and a working temperature not exceeding 20°C, a safe guide is to allow a cure time of not less than 1 hour for each bar of working pressure for pipe sizes up to 4" (100mm), and 1... hours for each bar of working pressure for larger sizes.

Large diameter jointing

Solvent cement jointing on pipe sizes 6" (DN 150mm) and larger is a two-person operation. To ensure that primers and solvent cements are applied at the correct speed they should be simultaneously applied to both pipe and fitting. Applying a thorough coating of cement is critical at these sizes both to ensure a good weld and to ease the pipe into the fitting.

For sizes 10" and larger it is recommended to use a ratchet driven pipe puller to ensure that the pipe fully penetrates the fitting. These tools may be hired if required.

One-step cements

Specially formulated PVC-U solvent cements are available to provide solutions to specific applications or to solve installation difficulties. Examples include transition cements to make joints between flexible and rigid PVC, and Wet 'R Dry, a product designed to make solvent welded joints in wet conditions and/or where quick pressurization of the system is required.

One-step cements do not require the use of a primer in the welding process and generally work best on pipe sizes up to 3" (DN 65). In all cases, strictly follow the instructions supplied with the product.

Chemical resistance of solvent welded joints

A well-made solvent cement welded joint will provide excellent chemical resistance characteristics, in the same way as that of the parent piping material. However solvent welded joints in systems handling the following chemicals can be degraded and require the use of Weld-On 724 solvent cement to ensure chemical compatibility:-

Hydrochloric Acid 25%+ concentration

Nitric Acid 20%+ concentration

Solvent welding of dissimilar materials

As a general guide, solvent welded joints between dissimilar materials are not recommended. Where possible, a mechanical transition joint should be used, such as a union, flange or threaded connection.

If a solvent welded joint is unavoidable, it may (depending upon the conditions) be possible to make a reliable joint provided that a suitable solvent cement is used:

| Materials To Be Joined | Recommended Solvent Cement |
|------------------------|----------------------------|
| PVC-U to PVC-C | Weld-On 724 |
| PVC-U to ABS | Weld-On 719 |

Please note that in all cases we recommend contact with our technical department who will be able to provide assistance with specific applications and on recommended jointing methods.

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Making solvent cement welded joints in cold weather

It is sometimes necessary to make solvent cement welded joints in cold temperatures, and this can be successfully achieved even at sub zero temperatures. In cold weather, solvent cements penetrate and soften the plastic surfaces more slowly, and it is therefore more important to use a primer. In addition, the solvent cement will evaporate much more slowly, which means that a longer cure time will be required.

For all practical applications, good solvent cement welded joints can be achieved in very cold conditions by following these guidelines:

- Whenever possible, prefabricate as much of the system in a heated work area
- Store solvent cements and primers in a warmer area when not in use and make sure they remain fluid
- Take special care to remove moisture, ice or snow from the surfaces to be joined
- Use a primer to soften the surface before applying solvent cement. Note more than one application of primer may be required.
- Allow a longer cure period before the system is used. A heat blanket may be used to speed up the set and cure times.
- Read and follow the solvent cement welding instructions before commencing with the installation.

Making solvent cement welded joints in hot weather

There are occasions when solvent cement welded joints have to be made in hot temperatures, and this can be successfully achieved if special precautions are taken. Solvent cements for thermoplastic piping systems contain high strength solvents that evaporate more quickly at elevated temperatures. If the pipes to join have been stored in direct sunlight, then the pipe surface may be considerably warmer than the ambient temperature. Solvent cements will attack these hot surfaces faster and deeper, especially inside the joint area. Therefore, it is very important to avoid puddling the cement inside the fitting socket and to wipe off any excess cement outside the joint.

For all practical applications, good solvent cement welded joints can be achieved in hot conditions by following these guidelines:

- Store solvent cements and primers in cool or shaded areas before use
- Whenever possible, store fittings and pipe - or at least the ends to be joined - in a shaded area before solvent cementing takes place
- Warm surfaces can be cooled by wiping with a damp cloth. **Be sure that the surface is dry before applying solvent cement**
- Make sure that the surfaces to be joined are still wet with solvent cement when assembling the joint. For larger diameter joints, it may be necessary to increase, the number of personnel required to make the joint.
- Using a primer and solvent cement with a high viscosity will provide a little more working time in hot conditions.
- Read and follow the solvent cement welding instructions before commencing with the installation.