

The European UP/VE Resin Association Safe Handling Guide No. 1:

Safe handling of Unsaturated Polyester (UP) Resins



When producing composite parts, all component materials should be used correctly to avoid any adverse impact on the environment or human health.

Since unsaturated polyester (UP) resins contain styrene as the most important monomer, which is a flammable substance, these resins are therefore classified as dangerous goods and certain safety precautions have to be followed with regard to transport, storage and handling.

This information sheet details the generally accepted recommendations for the safe handling of UP Resins and related products such as gelcoats, vinyl esters and bonding pastes.

A **Material Safety Data Sheet (MSDS)** will accompany each delivery of UP resin. An MSDS provides essential information on important aspects concerning the safe handling of UP resins.

Always read the MSDS carefully before starting to work with the product. If the content of the MSDS is not fully understood, consult your supplier for clarification.

For the safe handling and use of UP Resins, strict precautions should be taken against:

- Flammability and explosion
- Spillage
- Contact with skin and eyes
- Vapour emission inhalation.

Flammability

The flash point of styrene is 32°C, which categorizes UP Resins as flammable liquids. They should be treated as such, which means keeping them away from flames and other possible ignition sources.

Smoking is prohibited at the unloading area and in any place inside the workshop. Fire extinguishers must be available and explosion-proof electrical installations are also required where resins are stored and used.

The site must also be equipped with an emergency shower and facilities to rinse the eyes (e.g. an eye-wash station), as well as having all the protective equipment and clothing as specified in the Material Safety Data Sheet (MSDS).

Ensure that your personnel are fully trained regularly in handling fire-fighting equipment.

Spillage

Storage tanks for UP resins should be placed inside an emergency pit, which has a capacity sufficient to hold the complete content of a full storage tank. When a spillage occurs in a tank unloading area, good access to the tank storage facility is important, and the unloading area must be equipped to collect spillage.

Drums of resin, intermediate bulk containers (IBCs) and pails should be stored in a facility with a liquid-tight floor in order to prevent any leakage to the ground water. The collected material must be disposed of in accordance with local regulations.

The spillage must be removed without contaminating the surrounding ground and a proper absorbent material such as vermiculite has to be available in sufficient quantities to take up any spillages.

Static electricity

Static electricity can be generated when handling materials with low electrical conductivity, such as resins and glass fibres. Friction or contact and separation generate static electricity, and, if it's not discharged by proper earthing, static electricity can spontaneously discharge creating a spark of high voltage - especially at a low level of air humidity.

Wherever flammable liquids or gases are present the potential for fire is high, avoid conditions that could cause static electric discharge.

In processing UP resins, static electricity can be generated by various sources:

- A fluid being pumped through a spray gun hose can build up static electricity because of friction. The same applies to fluid exiting the spray tip. It is therefore essential that such fluid handling equipment is properly earthed. Electrical conductivity must therefore be established from the body of the spray gun, through the fluid hoses to the pump and to a known ground. **Check with your equipment supplier for specific procedures to establish the proper earthing.**
- When using so-called flow choppers the generation of static electricity may be higher than with the traditional spray guns. In these cases it is even more important to create proper electrical conductivity and earthing of the equipment.
- Surface charge on mould surfaces is another well-known phenomenon. It can be seen by the formation of dust stars on the surface and static electricity discharge (static sparking) when demoulding a part.
- When using non-conductive moulds, static electricity will only discharge from a local area, so not creating the larger surface charge bleed-off. With conductive surface moulds however, the entire mould surface will discharge in one contact thus providing greater potential for high voltage discharge. When an operator comes close enough the entire mould surface will discharge suddenly. **Conductive surfaces must be earthed to prevent hazardous static electrical discharge.**
- Static electrical build-up by non-conductive glass roving passing through roving guides and choppers can also create a problem.

To reduce potentially hazardous discharges, always use ceramic roving guides. Earth the overhead boom and be sure that the chopper is properly grounded to the spray gun.

General Advice

To reduce the likelihood of a hazardous discharge of static electricity, avoid low humidity in the workshop by keeping the relative humidity above 50%.

Use ionized compressed air for cleaning mould surfaces. This will neutralize the danger of a possible surface charge in the mould.

Subsequent rubbing of the mould surface when waxing and polishing will create a charge, so it should be repeatedly treated with the ionized air during the waxing procedure.

Good housekeeping

Safe usage is also a matter of good housekeeping, providing good working conditions, cleanliness, ventilation, plant layout and correct protective clothing, as well as eye and respiratory protections. Provide continuous employee training in safe working procedures and practices. Avoid skin contact and maintain strict cleanliness and good housekeeping.

Minimize contamination of the working area by placing disposable paper or solvent resistant film on tables and floors - which should be removed at least once a day or immediately after a severe spill. All spilled waste, contaminated cleaning paper and rags should be disposed of in a separate fireproof container situated outside of the factory.

Prevent contact with vapours by providing sufficient ventilation of the working area, and by using approved respiratory protection. Ensure that dust from finishing operations is kept under control by collection devices and by effective ventilation.

Environmental risks of styrene

Styrene is readily biodegradable, so there will not be a major environmental risk if styrene enters the soil and groundwater or is evaporated into the air.

In groundwater and in soil, styrene is broken down rapidly into harmless chemicals. Styrene also rapidly degrades in the atmosphere due to the presence of UV light.

Nevertheless, the emission of styrene can be subject to a number of national or local regulations, so it will always be important to reduce the emission of styrene into the environment as much as possible.

Occupational exposure to styrene

The occupational exposure to styrene is strictly regulated in every country.

In most countries a Maximum Allowable Concentration (MAC) or Threshold Limit Value (TLV) has been established which states the maximum concentration in the workplace atmosphere, to which a worker may be exposed during an 8 hour working day (see Safe Handling Guide 3). [The exposure to styrene should be minimized where possible by using proper ventilation in the workshop.](#)

The inhalation of styrene vapour should be avoided, if necessary by using personal respiratory protection. Prevent resins coming into contact with skin and eyes, by wearing appropriate safety clothing such as gloves, coveralls and goggles.

Decanting and mixing of UP resins should be carried out in a separate well-ventilated room, to reduce the likelihood of styrene vapours drifting into adjacent working areas.

Follow the manufacturer's instructions when mixing and blending additives, accelerators, fillers and peroxides. Being reactive materials, certain additives or combinations of additives can cause unwanted reactions.

Residual catalysed resin products in containers can cause self-ignition due to high temperature build-up (exothermic reaction) during the curing reaction. Pails and buckets with residual catalysed resin products should, therefore, always be removed well away from the working area, and placed a safe distance from other ignitable materials (ideally outside and a safe distance from buildings and other combustible materials).

If the buckets are topped up with water, this will absorb much of the temperature build up of the polymerisation reaction.

Waste Handling

Styrenated resin products are regarded as special waste in many regions, and must therefore be handled according to local rules and regulations. UP resin waste should preferably be cured before being disposed of. The curing process of such waste must be done in a controlled way, to avoid self-ignition. Only cure a controllable volume in each container/pail and add no more than the recommended volume of peroxide and possibly accelerator, to prevent it curing too quickly with too high an exotherm. The curing system must be thoroughly mixed into the resin.

Once the curing starts it is recommended that the container is flushed with cold water to control the reaction. Polyester resin products will self-ignite if the resin temperature reaches approximately 480°C. When cured and cooled, the waste can, in general, be treated as non-hazardous waste.

Waste of other styrenated products and additives, such as low profile additives, fire retardant additives and pigment pastes, can be mixed into resin/gelcoat waste in lower volumes. These will then cure into the system when adding accelerator and peroxide.

Safety First!

- In the event of an accident, always consult the relevant MSDS for specific health and safety information on the material/s in question
- Always consult your local authority or environmental officer for proper guidance on safe disposal
- Never mix together organic peroxide and accelerators as this will cause an explosion
- Always keep organic peroxide in a separate fireproof store away from direct sunlight or other heat sources



Always wear the correct safety equipment when handling hazardous materials and decant away from the production area to limit solvent emissions.



Precautions need to be taken during spraying to avoid static build-up.

Safe handling of constituent materials used in composite processing



When producing composite products, constituent materials such as organic peroxides, fillers and glass fibres, have varying safety considerations.

This information describes the generally accepted safety precautions relating to the ancillary materials most commonly used in the composite industry.

But, as with UP resins, always consult the MSDS for more specific safety information.

Organic peroxides (catalysts)

Organic peroxides are heat sensitive and thus thermally unstable chemical compounds that have to be stored and handled with great care. They will decompose significantly above certain temperatures, which will vary from peroxide to peroxide. When storing organic peroxides strict rules have to be followed.

Most catalysts used for the curing of unsaturated polyester resins can be safely stored at a maximum 25°C: although some require cooled storage and transportation. Always consult the technical datasheet for the product in question.

Organic peroxides are also sensitive to contamination. Dust from trimming, grinding and any other production waste can start a decomposition reaction so always keep containers closed and use clean vessels to decant peroxide. When removing a quantity of catalyst from its container, never put the excess quantity back into the container. **Organic peroxides should not be allowed to come into contact with any strong oxidizing agents (accelerators and promoters), strong acids and bases, and metals like copper, brass and even rust.**

The following guidelines are recommended for the safe storage of organic peroxides:

- **Store peroxides in a separate building or structure, away from direct sunlight.**
- **The storage area should be designed according to local/national requirements.**
- **Store the peroxide in the original containers and do not use the storage area for discharging operations.**
- **No other materials should be stored in the same room as organic peroxides.**
- **Never put unused or surplus peroxide back into its original container.**

Spills should always be cleaned up immediately. For cleaning smaller spillages paper or rags can be used, but they must be disposed of in fireproof containers. An inert absorbent material, such as vermiculite, should be used for larger spillages. This should be soaked with water after clean-up, and deposited in a fireproof waste container. If peroxide spills onto working cloths, remove them immediately, and when handling peroxides, eye protection must always be worn. Peroxide splashes into eyes are very harmful, so if this occurs, flush immediately with plenty of water for at least 15 minutes, and always seek medical advice.

Small amounts of residual organic peroxides can be used to gel and cure resin waste in a controlled way. Larger amounts can be destroyed through controlled burning, but must be treated according to local regulations and instructions. Peroxide waste must not be stored in closed or air-tight containers. As a general rule, empty peroxide containers should be treated as special waste, and local authorities should be consulted in this respect



Keep peroxides in a separate storage area away from direct sunlight.

Accelerators and Promoters

Various accelerators and promoters, like cobalt compounds, tertiary amines etc, should be handled carefully. Always consult the MSDS for safety information. Accelerators and promoters can react violently with organic peroxides, so keep these products away from direct contact with organic peroxides, and don't store peroxides and accelerators in the same area.

When preparing the resin, always add the accelerators and promoters first and stir carefully. Add the peroxide as the last component.

Cleaning Solvents

New types of environmentally friendly cleaning solvents have been introduced to the composite industry for removing polyester resins from manufacturing equipment's, work surfaces and production floors.

These new types are effectively replacing the traditional more hazardous solvents used by our industry for cleaning like acetone and methylene chloride. Typically these new cleaning solvents are combining good performances, safety in use, regulatory compliance and a low environmental impact.

Please contact your resin supplier or distributor to get information about the different cleaning solvents available. Suitable skin and eye protection should always be worn when cleaning your equipment's.



Water-based cleaning systems require no special storage precautions.

Fillers

Filler materials should be treated with care. Since they have a tendency to pick up moisture, the storage area for such materials should be dry and clean.

The normal fillers used in the composite industry are regarded as inert materials, and can accordingly be treated as inert waste. But always consult the MSDS for the specific filler type for any possible restrictions.

Glass Fibre

Glass fibres must be stored under dry conditions to prevent moisture pick-up. Glass fibre can be a skin irritant, so suitable skin and respiratory protection should be worn when handling the materials.

Normal glass fibres used in the composites industry have a fibre diameter well above the critical inhalation diameter of three microns.

Composite dust

During cutting, drilling and sanding composite products, dust can be generated which may consist partly of particles with a size well below three microns. These very fine dust particles can penetrate deep into the lungs when inhaled and may create lung damage.

In many countries legal limits are set on the maximum fine dust concentration in the workplace atmosphere. Always use dust extraction equipment that is able to remove these fine dust particles from the air. National legislation should be referred to for compliance details.

Always use skin and respiratory protection suitable for fine dust environments. Under certain conditions, composite dust may be sensitive to dust explosion. It has been observed that waste dust from DCPD resins can self-ignite. It is advised therefore to dampen waste dust in the collection bins of the ventilation equipment and to keep the bins clean and empty.

Titanium Dioxide (TiO₂) is commonly used as a white pigment to colour resins. From September 2021, in the European Union, powdered TiO₂ and dry mixtures will require to be labelled as Carcinogenic by inhalation (Carc2).

Therefore dry powder products containing TiO₂ must be handled with special care to prevent dust formation. Operators should wear suitable protection to prevent inhalation of these dusts. Similar precautions should be taken when sanding cured resins containing TiO₂.

Storage of Unsaturated Polyester (UP) Resins



Unsaturated polyester (UP) resins are reactive materials that can undergo minor changes when stored, like viscosity and gel time drift. Under adverse storage conditions, these changes can result in resins that are no longer within specification. UP resins are sold in various container sizes, ranging from 25 kg pails up to road tankers.

This information sheet gives practical advice on the way UP resins should be stored and handled at the converters production facilities.

The storage and handling of flammable liquids is subject to national or local regulations so always ensure that the storage complies with those regulations. Consult your local authorities if in any doubt.

Bulk or semi-bulk transport of UP

For larger users, UP resins and vinyl ester resins are normally delivered in bulk via road tankers, or tank containers to the customers' bulk storage facilities.

Recommendations by the supplier concerning delivery, receipt of goods, storage and handling, should always be followed in order to ensure optimum quality and performance of the product. Road tankers for the transport of UP resins must be manned by properly trained drivers and all equipment must meet the appropriate international rules. The capacity of the road tankers in general is 25 m³ - 39 m³. However, the maximum load a road tanker can carry is dependent on the actual national transport regulations.

A road tanker is normally fitted with a pump and / or a compressor that is used for pumping the resin to the storage facility at the customer. Some customers may have their own pumping equipment.

The distance between the road tanker and the tank pump connection should preferably be less than five meters. An appropriate and officially approved unloading area or discharging berth should be available when off-loading from a road tanker.

Tank installation

Users should appoint a person who is responsible for the service, safety and maintenance of the tank installation. He/she needs to be fully trained according to ADR regulations for handling and receiving hazardous substances.

When building a tank installation, the following recommendations should be followed:

- The capacity of the storage tank should be large enough to accept a full tanker load on top of any remaining contents at the time of delivery.
- All tanks should be placed inside an emergency retaining pit that can hold 110 % of the largest tank capacity.
- The floor of the emergency pit should be liquid tight and sufficiently sloped to prevent minor spillage remaining below the tank.
- The storage tank should be free-draining. Pumps must be sited outside the emergency pit.



- The tanks and lines should preferably be constructed from stainless steel. Don't use any alloys containing brass, bronze, copper, galvanized metal or zinc.
- The tank should be equipped with a large manhole on top for inspection, maintenance and cleaning purposes.
- The tank must be equipped with an air vent with a minimum (DN 80) 3 " opening.
- The tank should preferably be equipped with a mechanical propeller stirrer, especially when thixotropic or filled resins are stored.
- The contents of a bulk storage tank should ideally be kept at a temperature between 18 and 25 °C. This means fitting the tank with a heating unit or trace heating, and a cooling unit to ensure year-round operational efficiency.
- The discharge end of the filling line should be situated as low as possible in the tank to avoid the build-up of static electricity.
- The discharge suction line should terminate above the bottom of the filling line so as to maintain a liquid seal inside the tank.

Quality considerations

In order to maintain the quality of the UP resin during bulk storage, a number of precautions should be followed:

- UP resins are viscous liquids and viscosity depends very much on the temperature. At low temperatures the higher viscosity might lead to flow problems during pumping.
- But it can also result in impaired wet-out of the reinforcement during laminating, reduced air release and a lower curing speed of the laminate. At high storage temperatures, the resin viscosity will decrease and sagging may occur during lamination. A high resin temperature will also lead to shorter gel time and high curing speed. Resin temperature should therefore be kept between 18 and 25°C.
- Filled resin systems must be slowly stirred to avoid any deposition of the fillers and to keep the resin formulation homogeneous throughout the contents of the tank.
- Pumping and filling of LSE and thixotropic resins can easily lead to foaming in the tank. When the level in the tank lowers, the foam dries and skinning may occur on the tank wall. These skin particles may loosen and cause contamination of the resin. DCPD-based resins are particularly sensitive to skinning.
- For quality reasons the tank should be cleaned internally once a year. This can be done by filling the tank $\frac{3}{4}$ with water, which is brought to boiling point. The boiling water should be left in the tank for 24 hours - before the tank is emptied and cooled with cold water. Resin residuals can then easily be removed with high pressure cleaning.

Ensure that all safety regulations are followed before any 'man-entry' work is undertaken inside a storage tank.

Unloading a roader tanker

Before unloading into a storage tank ensure that:

- The tank can hold the quantity that is to be delivered. The road tanker is connected to the correct valve.
- The valve is open and the resin can be pumped into the recipient's tank.
- The tanker is earth connected in a safe way and there is no source of fire or ignition in the area.

Unloading must always be performed according to precise unloading instructions that need to be clearly visible to all concerned. Good access to the tank storage facility is important and the unloading area must be equipped to collect spillage.

A proper absorbent such as vermiculite must be available in sufficient quantity to take up any spillage. Fire extinguishers must also be on-hand and the site equipped with an emergency shower and eye - wash facilities as well as having protective equipment as specified in Material Safety Data Sheet (MSDS).

All pipes and fittings shall be clearly labelled to avoid incorrect pumping. Compressed air must be available, and it is essential that the road tanker, storage tank, pipelines and all equipment are statically earthed.

We recommend that the terminal has a pump for unloading the road tanker, and that the necessary couplings, fittings and hoses are available. The MSDS for the product in question must be readily available, so correct procedures can be followed in case of an accident.

The unloading area needs to be clean and orderly and all equipment such as pipe fittings, hoses, couplings maintained in clean condition.

Handling flammable liquids prohibits smoking or the use of open flames in the unloading area.



Storage in pails, drums and 1m³ containers (IBC)

Whenever the resin (or gelcoat, bonding paste, etc) is delivered in smaller containers, the following recommendations should be followed, not only to maintain safety standards but also to maintain the quality of the product.

Due to the low flashpoint of styrene and other monomers, the resins should be packed in antistatic containers. Make sure that all mini bulk containers are antistatic types.

As soon as material is received it should be placed in a clean and dark storage area (away from direct sunlight), preferably in a properly designed warehouse and following the national regulation as regards: fireproofing and extinguishing systems, electrical installations, and containment contingencies in case of spillages or leaks.

The warehouse should be well ventilated to avoid possible accumulation of styrene fumes from the stored materials. It should be air-conditioned to ensure stable temperature (18-25°C is recommended).

If the resin temperature falls below 18°C it should be heated to a minimum of 18°C before use. This can be done in heating cabinets in which two to four drums can be placed at a time. The cabinets can be heated by steam or electricity. Remember that heating a full drum of resin up to operating temperature can take 24 to 48 hours.

Similarly, if the resin temperature is too high, the product will need to be cooled to at least 25°C and checked for possible quality changes before use.

Products delivered in drums and pails should be stored in the original containers with the lids kept tightly closed.

They must be stored upright to prevent leakage and, when stored on a standard pallet, avoid stacking more than three high. For the same reason, mini bulk containers mounted on standard pallets should not be stacked more than three high.

Avoid using resin / gelcoat storage areas for any discharging blending or mixing processes.

Uploading an Intermediate Bulk Container (IBC)

When unloading an IBC, care should be taken to prevent the build-up of static electricity and loss of material by improper use of the discharge valve. An IBC can be emptied in two ways: by gravity or by using a pump. Follow the guidelines below for the safe discharge of an IBC.

Preparation:

- Check the label and the batch numbers
- Read the material safety data sheet first
- Site the IBC on a stable surface, preferably slightly inclined in such a way that the discharge valve is at the lowest point.
- Make sure that the IBC is properly earth connected
- Wear protective clothing, chemical safety boots, gloves and goggles.

Operation:

- Touch the metal frame of the IBC with bare hands to discharge any static
- Remove the lid of the discharge valve
- Connect the discharge hose or pipe or activate the pump (if appropriate)
- Open the ventilation on the charge opening of the IBC
- Open and close the discharge valve manually, DO NOT USE bars or wrenches
- Clean the valve and remove any remaining resin.



One cubic metre Intermediate Bulk Containers (IBCs)



Resin delivery options: drums, IBCs and tankers

Uploading a drum

Unloading a drum is the same basic operation as described above for the IBC. Full drums should preferably be moved with the aid of a fork-lift truck. We recommend using a dip pump to discharge a drum instead of discharging by gravity.

Follow the guidelines as outlined for discharging IBCs.

After emptying, leave the drum closed and arrange for empty drums to be collected by a certified drum handling and cleaning company.

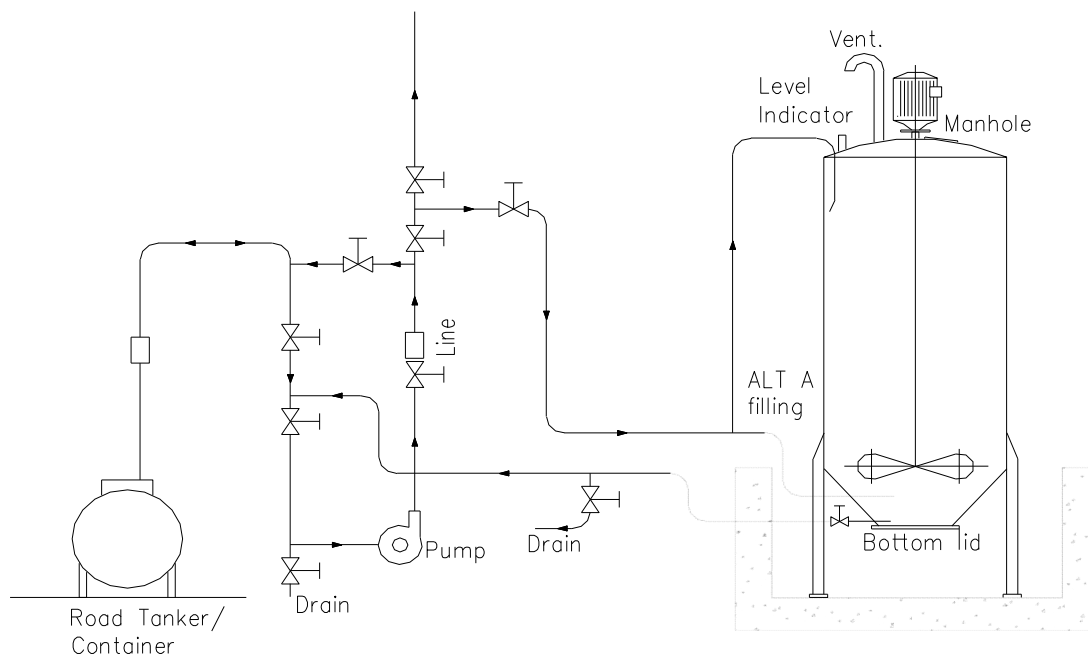


Diagram: Road tanker and storage tanks pipe lay-out



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