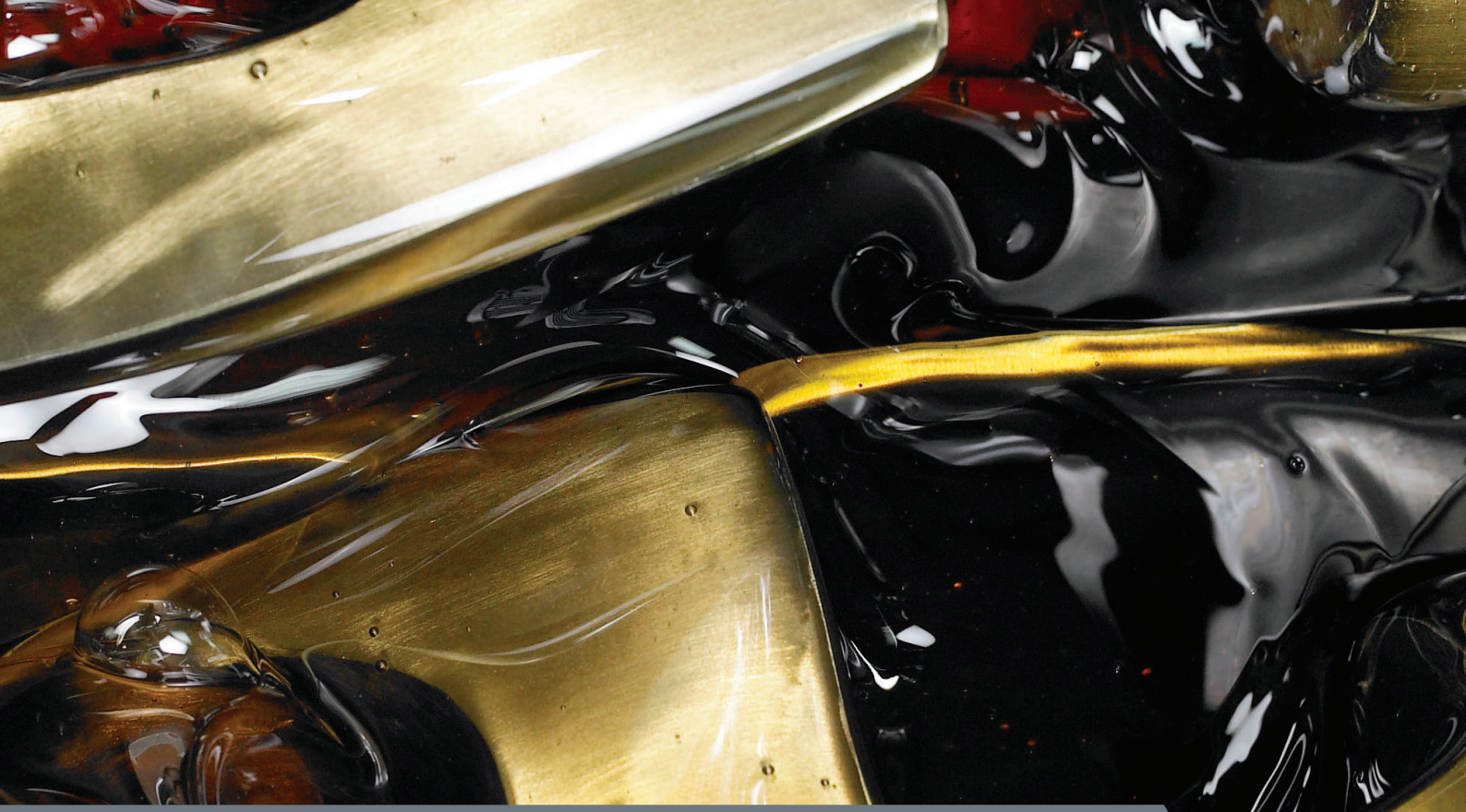

# HiFlow® 1078-1

## Safety & Processing Recommendations for Injection & Infusion

These recommendations along with the applicable Safety Data Sheet and Technical Data Sheet should be followed by all potential users of **1078-1** resin.

All users should make their own assessment when applying these recommendations and products to their own particular equipment, processes and end use. Full scale trials using the applicable equipment should be undertaken before commercial production.

HexFlow® and HiFlow® epoxy resin systems are suitable for liquid composite molding (LCM) because of their low viscosity when heated to the process temperature. It is this low viscosity that allows the reinforcement to be impregnated. Heating the resin also introduces risks associated with the thermal stability of reactive resins which could lead to an uncontrolled exotherm if not properly managed. However, the resin can be processed safely by strictly following the safety and processing guidelines outlined in this document.

A number of different LCM process technologies can be used for the manufacture of composite parts, and this guidance is provided for the most commonly used process technologies. Each process has its own inherent safety risks leading to some differences in recommendations depending on the process technology considered.



HEXCEL®

# HiFlow® 1078-1
## Safety and Processing Recommendations

1078-1 is a two-component epoxy resin that, when mixed, has the potential to exotherm when heated for an extended period of time. Processing of 1078-1 can be conducted safely by controlling the temperature and heating time and incorporating the following guidelines into the customer's risk assessment of the injection or infusion process.

**General Recommendations for Safe Handling and Contingency for Emergency Planning**

**Procedures:**

- A formal written risk assessment must be completed specifically for any equipment using bulk 1078-1 where heating is applied. To ensure a thorough assessment, cleaning procedures should also be risk assessed.
- Comprehensive process documents must be in place, including emergency plans and operator instructions.
- Operators must be fully trained to use the equipment and be aware of the emergency procedures associated with them.
- The equipment must be manned during the entire operation by trained operators, including loading the resin, infiltration, checking resin outlet traps, decanting excess resin and cleaning.
- Regular preventative maintenance must be conducted to ensure temperature controls, alarms, etc. are working correctly.

**Emergency Procedures:**

To manage stirrer failure or temperature rise, a contingency plan must be in place to provide instructions for safe removal of hot resin from the mixing vessel or any equipment. Typically, the emergency procedure will include the following elements:

- An alarm that alerts the operator that the mixing element or stirrer has stopped or the temperature has risen above the maximum set point.
- In the case of over-heating or stirrer failure, procedures should be established whereby the hot resin can be quickly removed from the equipment and transferred to shallow metallic trays to enable rapid cooling. To expedite cooling, the metallic trays can be placed on a mobile unit, such as a pallet and transferred outside to air cool the resin.
- During emergency decanting there is a risk of splash back from hot, low viscosity resin. Direct contact with the resin can be avoided through the use of suitable personal protective equipment (PPE), such as a full-face visor with a cover to protect the neck and long gauntlet gloves. This should be included in the site PPE assessment and associated program.
- Personal protective equipment and emergency equipment must be available and easily accessible in the work area, in readiness for use in an emergency situation.

**Operator Exposure to Chemicals:**

- 1078-1 contains epoxy resins, which can cause skin sensitization by either direct skin contact with the resin or contact with fumes generated by hot material.

**Personal Protective Equipment**

- A task-specific PPE risk assessment should be completed to determine appropriate necessary protective clothing and materials. Generally, long sleeve overalls, natural rubber or nitrile gloves, and safety goggles or a face visor are recommended when handling resin or conducting cleaning procedures on equipment used to handle 1078-1.

**Engineering Controls**

- When the resin is heated above ambient temperature during processing and cleaning procedures, local exhaust ventilation should be used to avoid operator exposure to processing vapors. Please consult with a ventilation engineer to determine appropriate source control to minimize or eliminate potential exposure to vapors or gases.
- For degassing operations, vacuum pumps should be vented away from both the work area (usually outside) and workers. The operations should also be compliant with environmental permitting requirements and local operating conditions.
- Protective measures need to be in place to avoid operator exposure to processing vapors and gases generated during the curing process.

**Equipment and Process Design:**

Several different process technologies can be used in the manufacture of LCM parts. These guidelines provide generic recommendations for the following process technologies or steps:

- Heating cans or drums of Part A and Part B or mixed resin to reduce viscosity, prior to transferring to Resin Transfer Molding (RTM) and Liquid Resin Infusion (LRI) equipment.
- Two-component resin mixing equipment where resin is mixed in a mixing vessel of up to 50kg capacity.
- Two-component resin mixing equipment where resin is mixed in-line either by static mixer (low pressure) or by an impingement mixing process (high pressure), generally referred to as high pressure RTM (HP-RTM).
- Conventional RTM process where the mixed resin is held in a pressure pot capable of injection pressures up to 7 bar, with a maximum pot size of 50kg.
- Piston injection equipment where mixed resin is held in a cylinder capacity of up to 25kg and injection pressures up to 30 bar.
- In all cases, an alarm needs to be an integral part of the temperature measurement and control to prevent an unsafe temperature being reached.
- Mixing vessels and injection pots must be stirred continuously to ensure good temperature distribution and complete avoidance of hot spots.
- Resin cans and piston type equipment will not generally be stirred, the additional risk associated with this needs to be considered in the risk assessment and process recommendations.
- Pressure relief venting sized for two-phase discharge should be incorporated in the process design. This should also be in accordance with globally recognized methods such as the Design Institute for Emergency Relief Systems (DIERS), which specifies sizing methods based on the worse-case, runaway scenarios identified via suitable process hazard analysis.

# 1078-1

Typical processing steps:

**Step 1 – Preconditioning and Preheating**

1078-1 may be supplied in cans, Part A (20kg) and Part B (13kg) or 210l drums, Part A (234kg) and Part B (156kg). Components previously stored at +5°C or below will require preconditioning at room temperature for 48 hours prior to the preheating step described below.

1078-1 Part A and Part B require preheating in an oven to reduce the viscosity and enable transfer to holding tanks or a mixing vessel for the mixing and degassing process step. An oven temperature of 60-80°C for Part A and Part B for up to 24 hours is considered adequate to sufficiently reduce the viscosity for transfer.

**Step 2 – Mixing and Degassing**

Part A & B of **1078-1** are required to be mixed and degassed.

When using tanks to hold Part A and B separately, followed by degassing, holding tank temperatures of ≤ 90°C for Part A and Part B for up to 24 hours should be strictly followed. Part A may become self-reactive at higher temperatures.

When batch mixing in a vessel, followed by degassing, a mixing time of 20 minutes at a maximum temperature of 70°C should provide a homogeneous mix. 1078-1 should not be mixed in quantities greater than 50kg.

For quantities greater than 50kg, an in-line mixing system is recommended to avoid the need for holding mixed resin in bulk. This may be a system comprising of gear pumps and a static mixer or HP-RTM equipment utilizing high-pressure impingement mixing. In this case the degassing of A and B components should be done prior to mixing.

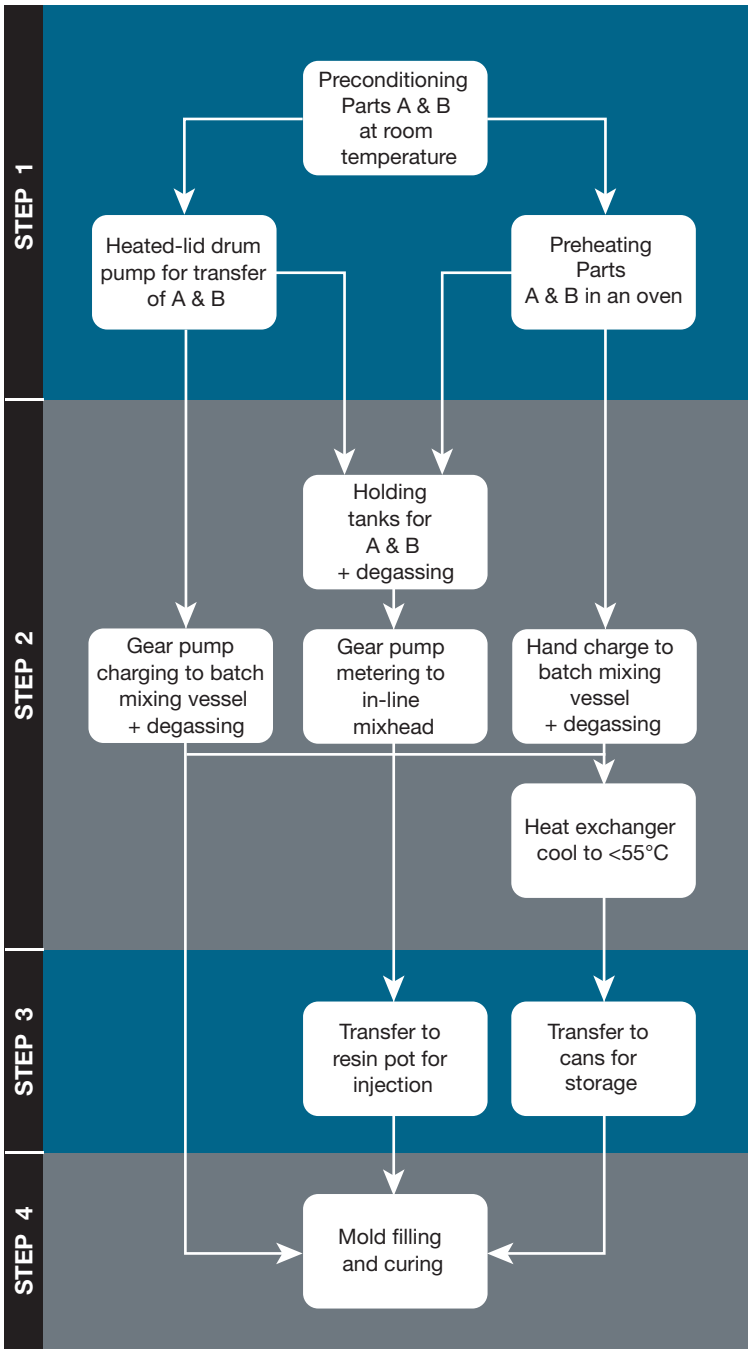


Figure 1–Typical 1078-1 resin processing steps

**Step 3 - Transferring and holding 1078-1 in resin pot prior to infiltration**

Hexcel strongly recommends limiting the resin injection pot size to a maximum of 50kg. Larger vessels have an increased risk of exotherm and greater severity if an exotherm occurs. In cases where more than 50kg of resin are required a system where a 50kg resin pot is refilled by an in-line mixing equipment is recommended. This reduces the exotherm risk associated with holding large quantities of resin at elevated temperatures for long periods of time. The resin pot design should incorporate a stirring device to ensure unified heat transfer to prevent hot spots from forming.

If the plan is to deviate from the guidelines provided in this document, it is highly recommended to work with a safety consultant prior to using 1078-1. By doing so, the proposed processing parameters can be evaluated and recommendations for safe operating and processing conditions can be made.

For additional support, Hexcel Technical Support may be contacted.

The recommended holding temperatures for the mixed resin are in Table 1. These temperatures will provide low viscosity for processing and a safe working time of up to 12 hours. The safe working time should not be exceeded.

| Process | Recommended Heating Temperature (°C) for a maximum of 12 hours |
|---|---|
| 10kg or 25kg can in oven | 60 - 70 |
| Piston injector (<25kg) up to 30 bar pressure | 60 - 80 |
| Conventional RTM resin pot (<50kg) with stirring, up to 7 bar pressure | 60 - 80 |

Table 1– Recommended heating times for different processes

The safe working time of 12 hours and recommended heating temperatures have been developed based on thermal stability data and kinetic modeling together with heat transfer models. This data is available on request to support customer's own risk assessments. It should be noted that the safe working time includes all processing steps where 1078-1 is heated, including preheating prior to transfer to the process equipment and holding time in the process equipment. This guidance is based on the use of 1078-1 that has not been previously heated and mixed from Parts A and B within their guaranteed shelf life. This is because the resin has a thermal memory, repeated cooling and heating will reduce the time to exotherm, compromising the safe working time. **Therefore, if previously heated resin is used, prior heating temperatures and durations must be taken into account, so the total heating operations do not exceed the safe working time of 12 hours.**

In the case of direct injection into the tool, resin is not held in bulk and a process temperature of 80°C may be used for the resin mixing stage by a static mixer or impingement mix-head (HP-RTM).

All data and guidance are based on freshly mixed resin however, guidance is sufficiently conservative to be applicable for the use of mixed resin up to the end of its designated shelf-life. Note that resin aging within the scope of these recommended heating times may reduce the process window of the resin compared to that of fresh resin.

**Step 4 – Mold filling and curing**

During mold filling and curing, the risk of runaway reaction is reduced but not eliminated. Resin is typically spread across a large tool area with good thermal conductivity and heat losses to the tooling. For thicker cross-sections and insulating reinforcements such as glass fibers, however, there is still a risk of runaway reaction. Careful attention must be made to match resin cure cycles to the geometry of the part to be manufactured. Resin rich areas, such as inlet and feeding canals, must be carefully evaluated and dimensioned. Further advice on cure cycles should be sought from Hexcel Technical Support.

For isothermal processing where the mold is held at the curing temperature during resin injection, an assessment should be made based on part design to determine if there is a risk of thermal runaway in the tool or resin trap. Hexcel Technical Support should be contacted for further advice.

**Supporting documentation**

Users are also strongly advised to follow the Safety Data Sheet and Technical Data Sheet for these products. Documents are available from the Hexcel website and Hexcel Technical Support who are happy to discuss any questions or concerns.

All information has been prepared with reasonable skill and care, but is given without acceptance of liability. All users should make their own assessment of the suitability of the products for their equipment and process, and the purpose required.

# Hexcel Product Family

**HexTow® Carbon Fiber**

**HexFlow® Resins**

**HexMC®-i Molding Composite**

**HexForce® Reinforcements**

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**HexWeb® Honeycomb Core**

**HiTape® Advanced Reinforcements**

**Modipur® Polyurethane**

**HexWeb® Engineered Core**

**HexPly® Prepregs**



**HexBond® Adhesives**

**HexTool® Tooling Material**

**HiMax® Multiaxial Reinforcements**

**HexAM® Additive Manufacturing**

**For more information**

Hexcel is a leading worldwide supplier of composite materials to aerospace and industrial markets. Our comprehensive range includes:

- HexTow® carbon fibers
- HexForce® reinforcements
- HiMax® multiaxial reinforcements
- HexPly® prepregs
- HexMC®-i molding compounds
- HexFlow® RTM resins
- HexBond® adhesives
- HexTool® tooling materials
- HexWeb® honeycomb
- Acousti-Cap® sound attenuating honeycomb
- Engineered core
- Engineered products
- Polyspeed® laminates & pultruded profiles
- HexAM® additive manufacturing

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