

## Cascophen™ 4001/Cascoset™ 5830 E

### Phenol Resorcinol Formaldehyde Adhesive for Engineered Wood Products

#### Description

Cascophen™ 4001 / 5830E phenol resorcinol formaldehyde adhesive is an exterior, durable liquid-liquid system that is recommended for the manufacture of structural finger joints, I-joists, and glued laminated beams. Properly cured, this adhesive produces a waterproof bond that meets wet use (exterior) specifications. Cascoset™ 5830E is a pre-mixed, ready-to-use hardener that was developed for use with automatic meter mix equipment and direct application extrusion. 4001 / 5830E is specifically formulated for use with conventional heating equipment or room temperature cure above 65°F. To meet the gel and cure speed requirements of each individual mill, the 4001 resin series is offered in nine incremental versions ranging from 4001 to 4001-8. The gel speed increases with increasing extension number (e.g., 4001 is the slowest while 4001-8 is the fastest). In addition, the reactivity of 5830E hardener can be adjusted depending on the seasonal and gluing conditions.

#### Third Party Test Methods

4001 / 5830 has been independently tested and demonstrated to meet the requirements of the following methods.

- ASTM D2559 (Douglas-fir, Southern yellow pine, hard maple)
- CSA O112.7-M1977
- CSA O112.9-10
- EN 301/302 and DIN 68141
- ASTM D7247-07a according to the specifications of ASTM D5055-07

Cascophen™ 4001 / 5830E fulfills all the requirements of ANSI 405-13, "Standard for Adhesives for Use in Structural Glued Laminated Timber"

#### Mixing Instructions

The recommended adhesive mix ratio is 2.5 parts resin to 1 part hardener by weight. The allowable range for the mix ratio is 2.2 to 2.7. The determination of this ratio is critical and should be performed periodically (e.g., at the start of each shift) using a sample that is large enough to minimize errors in the sampling procedure.

#### Density

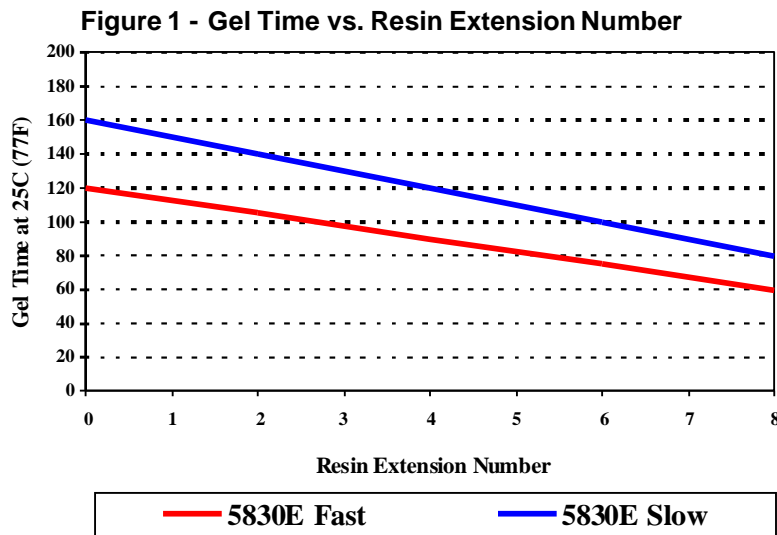
- 4001: 9.60 lbs/gallon (SG = 1.151)
- 4001-4: 9.72 lbs/gallon (SG = 1.165)
- 4001-8: 9.85 lbs/gallon (SG = 1.181)
- 5830E: 10.08 lbs/gallon (SG = 1.209)

## Gel Time of Mixed Adhesive

The gel time of the mixed adhesive is shown in Figure 1 as a function of the resin extension number (i.e., 4001 to 4001-8) and in Figure 2 as a function of the mixed adhesive temperature. In both cases, the adhesive exotherm was controlled so that the temperature was constant throughout the duration of the test.

PRF adhesives are exothermic, meaning that heat is generated as the resin and hardener react together, increasing the temperature and reducing the observed pot life. The actual pot life, or working life, of the adhesive will be considerably shorter than the value presented in Figure 2 because the exotherm is uncontrolled and the temperature steadily increases. Figure 3 provides an estimate of the adhesive pot life as a function of the initial temperature. **Please note the dramatic effect of temperature on the adhesive gel time and pot life.** Resins with higher extension number (i.e., adhesives with faster gel times) will have a greater exotherm and shorter pot life.

The adhesive gel time provides a good indication of assembly time tolerance or cure speed, while the pot life provides an indication of how frequently the meter mix system should be purged.



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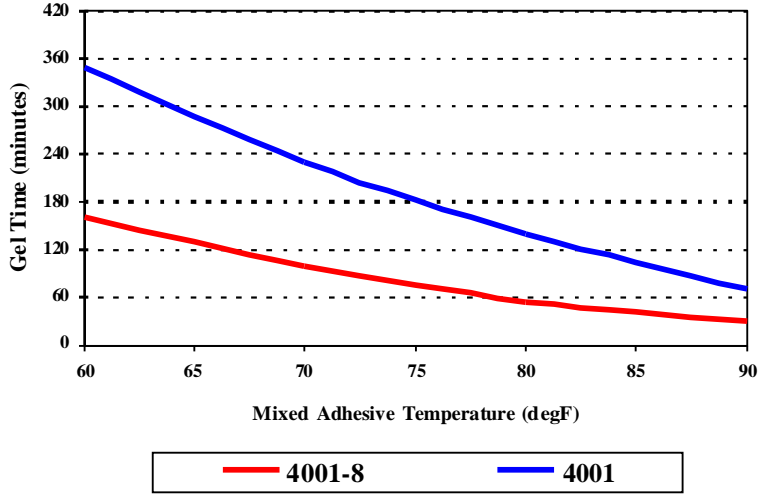
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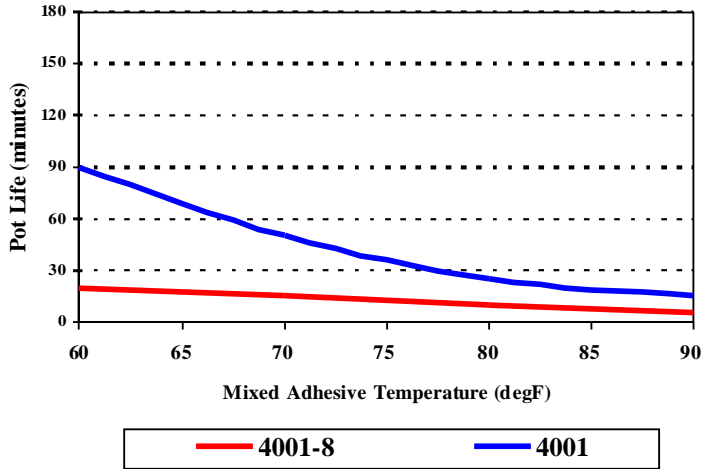
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**Figure 2 - Gel Time vs. Temperature**



**Figure 3 – Pot Life vs. Temperature**



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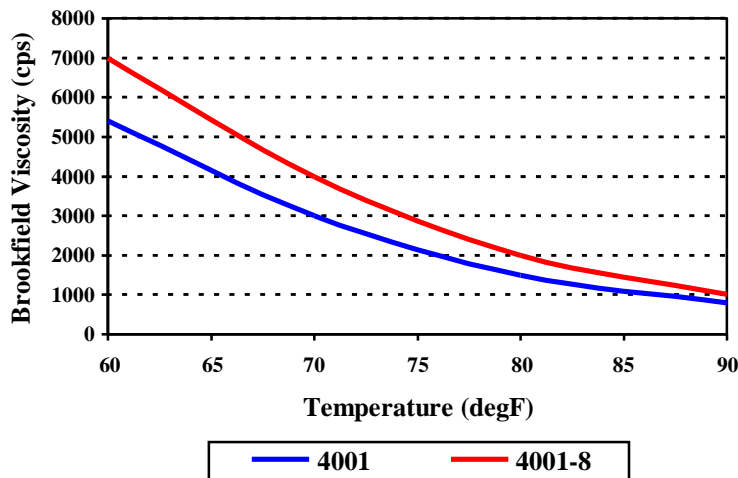
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When using a cup test to check the adhesive gel time, it is critical to use the same amount of adhesive on each test because of the heat (exotherm) that is generated as the two components react together. A larger sample size will generate more heat and result in a shorter observed gel time. It is not recommended that the mixed adhesive ratio be changed in an effort to lengthen or shorten the gel time. Changing the mix ratio does not impact the gel time enough to justify the risk of adversely bond quality.

## Resin Viscosity and Mixed Adhesive Viscosity

Typical ranges for the 4001 / 5830E adhesive include 1500-2500 cps resin viscosity, 3000-6000 cps slurry viscosity, and 3000-8000 cps mixed adhesive viscosity. Resins with higher extension number tend to have higher resin viscosity and lower mixed adhesive viscosity. Temperature has a very strong influence on resin viscosity (Figure 4) and mixed adhesive viscosity (Figure 5). Temperatures higher than 85°F cause the adhesive to become thin and runny, while temperatures below 70°F may cause pumping problems due to the high viscosity. All viscosity measurements are made using a Brookfield RVT viscometer at 20 rpm. Resin viscosity is recorded using a #3 spindle after 1 minute and mixed adhesive viscosity using a #4 spindle after 5 minutes.

**Figure 4 - Resin Viscosity vs. Temperature**



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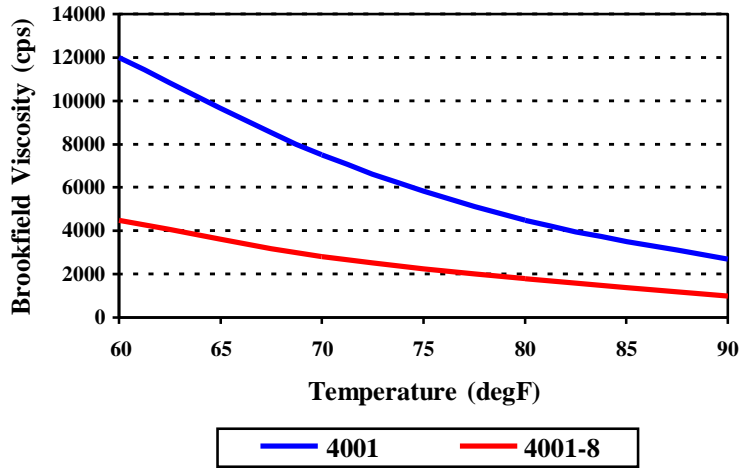
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**Figure 5 – Mixed Adhesive Viscosity vs. Temperature**



**Lumber Moisture Content**

The lumber should be between 5% and 18%\* moisture content to produce satisfactory bonding. Pockets of high moisture content, especially during RF cure, will result in a starved glueline due to excessive squeeze-out and/or over-penetration of the adhesive.

\* Note: Moisture content refers to an allowable range (minimum and maximum that is acceptable) and not an average.

**Lumber Surfacing**

Lumber should be free of dirt and other foreign materials prior to gluing. Southern yellow pine lumber should always be freshly surfaced prior to gluing. While it is not always necessary for Douglas-fir lumber, fresh surfacing is recommended for best results.

All lumber should have a maximum thickness variation of 0.008 inches across the width, with best results achieved at less than 0.005 inches. It is especially important to control lumber tolerances when using RF cure. As with all PRF adhesives that are not specifically formulated, 4001 / 5830E has poor gap filling characteristics.

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## Assembly Time (Definitions)

- *Open Assembly Time*: The time interval in which the surface has been spread but the adhesive remains exposed to the air and subject to evaporation.
- *Closed Assembly Time*: The time period that the spread surface is in close contact with another surface but not under pressure. Evaporation is minimized during this period.
- *Total Assembly Time*: The time interval from the spreading of the first surface until the package is under full pressure.

## Assembly Time (Radio Frequency)

Total assembly times used with RF presses are in general shorter than cold clamp operations. However, the combination of spread rate and assembly time must be tightly controlled in order to prevent excessive squeeze-out of the adhesive. Excess squeeze-out can lead to the generation of arcs, starving of the glue line, and additional waste.

When possible we recommend a total assembly time of 20-30 minutes for best results; however, 4001 / 5830E has been specifically formulated to tolerate assembly times as short as 5 minutes.

## Assembly time (Cold Set)

For best results, open assembly time should be kept as short as possible, while a closed assembly time of 20-30 minutes is generally beneficial. Maximum allowable assembly times are provided in the following tables.

TABLE I

### Maximum Total Assembly Time Using 4001-2 / 5830E (Minutes)

Lumber Temperature	GLUE SPREAD RATE				
	70 lbs/1000 ft. <sup>2</sup>	80 lbs/1000 ft. <sup>2</sup>	90 lbs/1000 ft. <sup>2</sup>	100 lbs/1000 ft. <sup>2</sup>	110 lbs/1000 ft. <sup>2</sup>
60°F	60 min.	70 min.	80 min.	85 min.	90 min.
70°F	50 min.	60 min.	70 min.	75 min.	80 min.
80°F	40 min.	50 min.	60 min.	65 min.	70 min.
90°F	*	20 min.	30 min.	35 min.	40 min.

\* Not Recommended.

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**TABLE II**

**Maximum Total Assembly Time Using 4001 / 5830E (Minutes)**

Lumber Temperature	GLUE SPREAD RATE				
	70 lbs/1000 ft. <sup>2</sup>	80 lbs/1000 ft. <sup>2</sup>	90 lbs/1000 ft. <sup>2</sup>	100 lbs/1000 ft. <sup>2</sup>	110 lbs/1000 ft. <sup>2</sup>
60°F	75 min.	90 min.	100 min.	110 min.	120 min.
70°F	60 min.	75 min.	85 min.	95 min.	105 min.
80°F	45 min.	60 min.	70 min.	75 min.	80 min.
90°F	*	35 min.	50 min.	55 min.	60 min.

\* Not Recommended.

**Cure Time (Radio Frequency)**

The time required to adequately cure an adhesive in an RF press is a function of many variables and, as a result, it is difficult to provide a cure cycle that is applicable to all operations. A general rule of thumb for providing a starting point is that 1 minute of cure time is required per 100 square inches of glueline per kilowatt of RF power.

The glueline temperature following the cure cycle should reach a minimum of 170°F, although a temperature of 190-200°F is preferred. Glueline temperature is affected by many variables, including the stock temperature, stock moisture content, various RF equipment considerations, adhesive formulation, adhesive spread rate, and so on. It might become necessary to compensate in the cycle time for changes to any of these variables. For instance, if gluing cold lumber in the winter it might be necessary to increase the cycle time slightly to adjust for the additional loss of heat into the wood.

Due to its practicality, the most common method for measuring the glueline temperature is with a drill and thermocouple on the exit side of the press. When using this technique it is important to keep in mind that the glueline is very thin, and that the larger the drill bit the greater the influence of the lumber temperature on the measured reading. It is best to use a narrow drill bit, take care to direct it through the glueline, and be consistent in the technique.

**Cure Time (Ambient Temperature)**

**4001-2 / 5830E adhesive will not properly cure at temperatures below 65°F.** If cold wood is used the entire package must be heated so that the glueline reaches at least 65°F for the required amount of time.

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**TABLE III**  
**Minimum Clamp Time When Using 4001-2 / 5830E**

Minimum Clamp Time	65°F	70°F	75°F	80°F
	8 hours	7 hours	6 hours	5 hours

**TABLE IV**  
**Minimum Clamp Time When Using 4001 / 5830E**

Minimum Clamp Time	65°F	70°F	75°F	80°F
	10 hours	8.5 hours	7 hours	6 hours

**Cure Time (Heated I-Joist Chamber)**

The design of industrial cure chambers varies considerably with respect to the direction and flow rate of air and the arrangement of I-joists within the chamber. These factors, in addition to variables such as stock temperature and flange width, will affect the rate of thermal transfer to the glueline at different locations within the chamber.

For the greatest assurance that a high quality adhesive bond will be achieved, Hexion recommends the use of cure conditions that ensure full cure of the adhesive inside the curing chamber and enable strength tests to be conducted soon after exiting the chamber. In order to ensure full cure under all conditions, Hexion recommends that excess heating capacity be engineered into the cure chamber for those occasions when the ambient and stock temperatures severely retard the cure speed.

For chambers in which the dwell time is relatively short (20-40 minutes) a glueline temperature of 130°F will ensure that the adhesive is fully cured. The temperature can be measured by placing a thermocouple wire into the flange groove prior to assembly or by drilling into the center of the flange and inserting a wire as the I-joists exit the chamber. There are of course an infinite number of time/temperature combinations that will fully cure the adhesive, but due to variations in chamber design it is necessary to develop minimum dwell times for each chamber.

If full cure of the adhesive inside the cure chamber is impractical or otherwise cannot be met due to operating conditions, 4001 / 5830E is formulated to continue to post cure at temperatures above 65°F, ultimately reaching a fully waterproof adhesive bond.

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## Pressure

A clamping pressure between 90-150 psi is recommended for face bonding softwood lumber, with the preferred pressure 125 psi.

## Storage Life

The storage life of 4001 resin is at least one year at 70-80°F. Storage life may be extended by storing in a cool place and sealed to prevent evaporation. 5830E hardener can be stored for up to 3 months. Rotate stock regularly, using the oldest material first.

**CAUTION: 5830E should be stored in a cool atmosphere (<70°F) and agitated periodically. Without efficient agitation, solids will settle out of 5830E hardener, but can be re-dispersed by thorough agitation prior to use. Totes and drums that have not been agitated while in storage should be thoroughly agitated prior to use. While in use, periodic agitation is recommended.**

## Storage, Handling, and Cleaning

- Storage tanks, pipes, fittings, etc. for both 4001 resin and 5830E hardener can be made from mild steel, stainless steel, or most common plastics (polyethylene, polypropylene, PVC, Teflon). Avoid extended contact when possible with magnesium, aluminum, zinc, tin, chromium, brass, and bronze.
- We recommend placing a filter between the bulk holding tank(s) and day use tank(s) or meter mix unit. If utilizing a day use tank, we also recommend a filter between it and the meter mix unit. Lastly, in-line filters should be used at the meter mix unit itself prior to the static mix tube. We recommend 20 mesh filters.
- We recommend that the in-line slurry filter at the meter mix unit be removed and cleaned of any debris on a daily basis.
- Rubber gloves and safety glasses/goggles/face shield should be worn whenever the resin, slurry, or mixed adhesive is handled.
- Adequate ventilation should be provided in areas where the adhesive or its components are stored, mixed/applied, or cured.
- Warm water (110-130°F) is used for clean-up of the mixed adhesive while it is still wet. The adhesive becomes brittle when fully cured and can be scraped away.

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