

# Flexible epoxy resin curing agent

## RIKACID™ HF-08


RIKACID™ HF-08 is a flexible epoxy resin curing agent developed by our company. The epoxy cured product exhibits excellent flexibility and transparency when used with our acid anhydrides such as RIKACID™ MH-700.

### ■ Feature

- It is a compound having a carboxyl group at both ends of the flexible structure.
- The formulation of HF-08 gives the epoxy cure flexibility while maintaining a relatively high Tg, and can improve impact resistance.
- The epoxy cured product with excellent transparency is obtained, and it is excellent in yellowing resistance during heat aging.
- It does not cause a large decrease in moisture resistance of epoxy cured products.
- It exhibits its characteristics in combination with various epoxy resins such as bisphenol A epoxy resin and alicyclic epoxy resin.

### ■ Typical properties

Table 1. Typical properties of HF-08

Appearance	Clear viscous liquid
Color (Hazen)	<100
Equivalent of carboxyl group	310~360
Viscosity [mPa·s] (100°C)	150~210
CAS RN® 	60806-75-9

※These values are not guaranteed.

<Calculation of equivalent amount when HF-08 is blended.>

In this technical data, the equivalent calculation was performed assuming that one epoxy group and one acid anhydride group or one carboxyl group react.

## ■ Temperature dependence of viscosity of HF-08

Figure 1 shows the temperature dependence of the viscosity of HF-08.

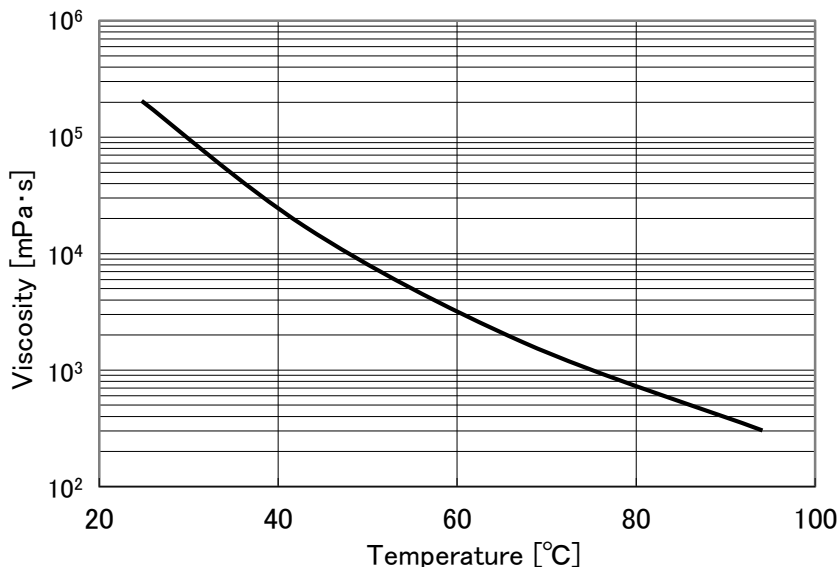


Fig 1. Temperature dependence of viscosity of HF-08

## ■ Foaming suppression effect at curing

Table 2 shows the foam suppression effect by the addition of HF-08.

The addition of HF-08 has the effect of suppressing foaming during curing.

Table 2. Foam suppression effect by the addition of HF-08

Formulation No.		1	2	3	Remarks
Formulation [p.b.w] Equivalent ratio = 1.0	CELLOXIDE™ 2021P <sup>※1</sup>	100	100	100	Epoxy equivalent = 130
	RIKACID™ MH-700 <sup>※2</sup>	126	120	112	Equivalent of acid anhydride = 164
	RIKACID™ HF-08	-	13	28	Carboxyl group equivalent = 336
	TPP-PB <sup>※3</sup>	1	1	1	Accelerator
Blending ratio of HF-08 (wt% / curing agent)		0	10	20	Curing agent = MH-700+HF-08
Foamed state at curing		×	△	○	-

※1 CELLOXIDE™ 2021P: Alicyclic epoxy resin (Daicel Corporation)

※2 RIKACID™ MH-700: 4-methyl cyclohexane-dicarboxylic anhydride/cyclohexane-dicarboxylic anhydride  
= 70/30 (wt%) (New Japan Chemical Co., Ltd.)

※3 TPP-PB: Tetraphenyl phosphonium bromide (HOKKO CHEMICAL INDUSTRY CO., LTD.)

Curing condition: 120°C/1h + 150°C/2h

Equivalent ratio = (Acid anhydride group + carboxyl group) / epoxy group

<Foaming state evaluation conditions>

7 g of the epoxy composition was weighed in a test tube of  $\phi$  15 mm, and after hardening, the rise height from the initial liquid level due to foaming was measured, and the foamed state was visually observed.

○: no foam, no interface rise, △: slightly foam, interface rise  $\leq$  5 mm, ×: foam, interface rise  $>$  5 mm

## ■ Impact resistance improvement

The relationship between the equivalent ratio and the impact resistance when HF-08 is added according to the composition shown in Table 3 is shown in Figure 2. Impact resistance can be greatly improved by adding HF-08. In particular, the effect is maximum around the equivalent ratio of 0.8.

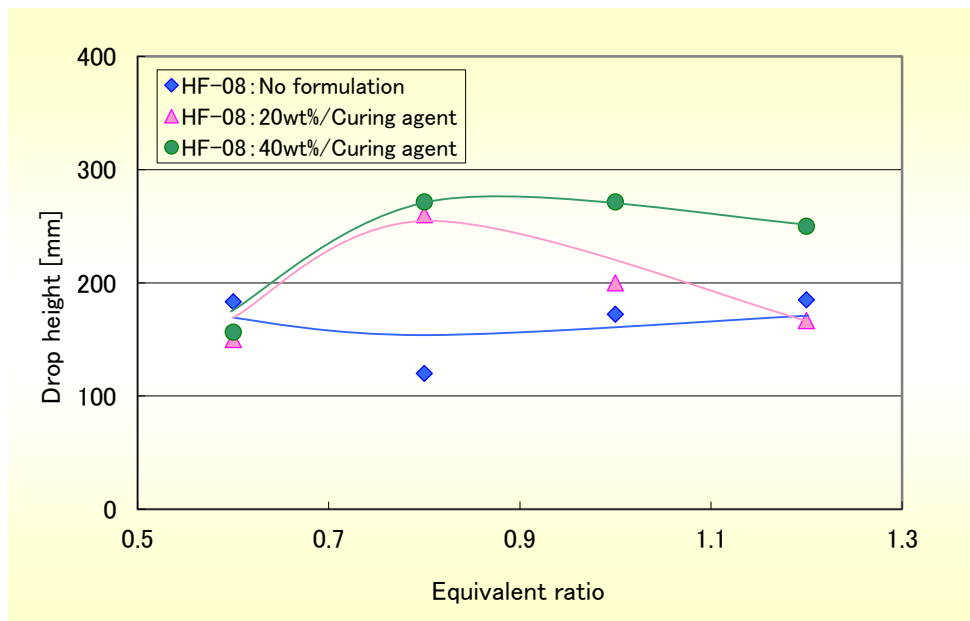


Fig 2. Relationship between impact resistance and equivalent ratio

< Impact resistance test conditions >

- JIS K5600: According to drop impact test
- Drop load: 100g
- Sample: Cured 2.5mm thick, see Table 3 for compounding and curing conditions.
- Measure the drop height where no crack occurs when the weight is dropped.

Table 3. Formulation [p.b.w] (Equivalent ratio = 1.0)

Formulation No.	1	2	3	Remarks
CELLOXIDE™ 2021P※1	100	100	100	Epoxy equivalent = 130
RIKACID™ MH-700※2	126	112	96	Equivalent of acid anhydride = 164
RIKACID™ HF-08	—	28	63	Carboxyl group equivalent = 336
TPP-PB※3	1	1	1	Accelerator
Blending ratio of HF-08 (wt% / curing agent)	0	20	40	Curing agent = MH-700 + HF-08

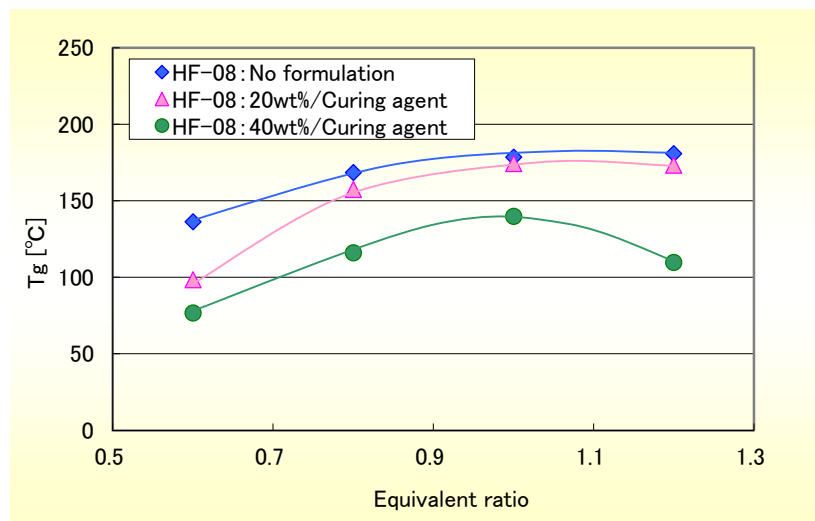
※1 CELLOXIDE™ 2021P: Alicyclic epoxy resin (Daicel Corporation)

※2 RIKACID™ MH-700: 4-methyl cyclohexane-dicarboxylic anhydride/cyclohexane-dicarboxylic anhydride = 70/30 (wt%) (New Japan Chemical Co., Ltd.)

※3 TPP-PB: Tetraphenyl phosphonium bromide (HOKKO CHEMICAL INDUSTRY CO., LTD.)  
Curing condition: 120°C/1h + 150°C/2h

## ■ Influence on heat resistance

The relationship between the T<sub>g</sub> of the epoxy cured product and the equivalent ratio when HF-08 is added is shown in Figure 3. When the addition amount of HF-08 is 20wt%, almost no decrease of T<sub>g</sub> occurs at the equivalent ratio of 0.8 to 1.2.

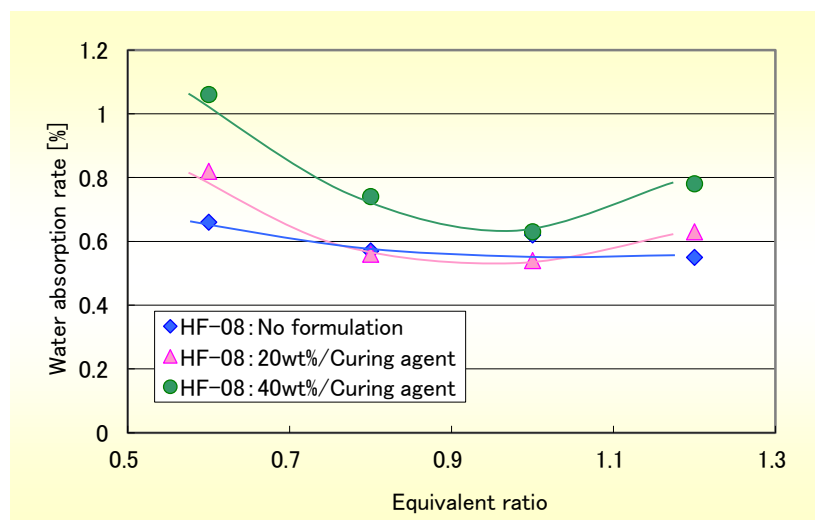


<Heat resistance measurement condition>  
 • Measure glass transition point (T<sub>g</sub>) with DSC.  
 • Compounding and curing conditions are the same as in Table 3.  
 • Heating rate: 20°C/min

Fig 3. The relationship of T<sub>g</sub> and equivalent ratio

## ■ Impact on moisture resistance

Figure 4 shows the relationship between boiling water absorption and equivalent ratio when HF-08 is added. When the amount of HF-08 added is 20 wt%, the moisture resistance hardly decreases at an equivalent ratio of 0.8 to 1.0.



<Heat resistance measurement condition>  
 • Based on JIS K6911  
 • Sample: Cured 3mm thick  
 • Compounding and curing conditions are the same as in Table 3.

Fig 4. Relationship between boiling water absorption and equivalent ratio

## ■ Effect on heat resistant yellowing

Figures 5 to 7 show the relationship between thermal yellowing and equivalent ratio when HF-08 is added. By optimizing the equivalent ratio, clear and colorless epoxy cured products can be obtained.

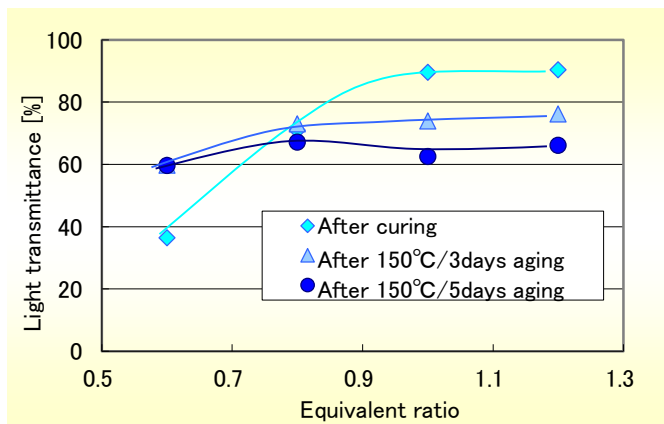


Fig 5. Relationship between heat resistant yellowing and equivalent ratio (HF-08 not included)

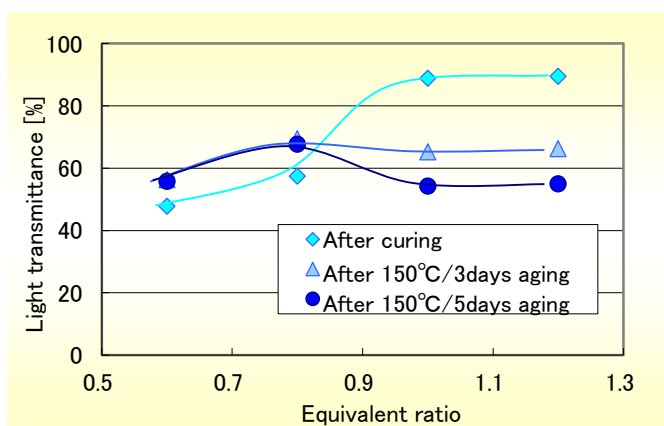


Fig 6. Relationship between heat resistance yellowing and equivalent ratio (HF-08: 20wt% / curing agent)

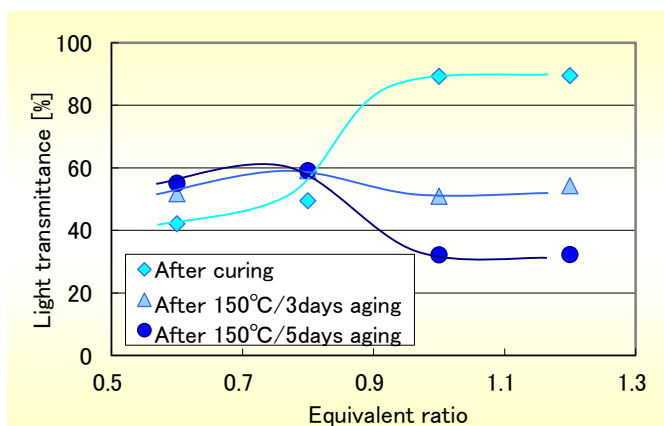


Fig 7. Relationship between heat resistance yellowing and equivalent ratio (HF-08: 40wt% / curing agent)

- < Thermal yellowing measurement condition >
- Evaluate the light transmittance of wavelength 400nm with UV-visible spectrophotometer.
  - Sample: Cured 5mm thick
  - Compounding and curing conditions are the same as in Table 3.
  - Heat aging process: Use 150 °C gear oven

## ■ Physical properties of bisphenol A epoxy resin at curing

Table 4 shows the curing properties when using bisphenol A epoxy resin. By adding HF-08, significant improvement in flexibility is possible.

Table 4. Curing properties of bisphenol A type epoxy resin

Formulation No.		1	2	3	4	Remarks
Formulation [p.b.w] Equivalent ratio = 1.0	jER™ 828※1	100	100	100	100	Epoxy equivalent = 185
	RIKACID™ MH-700※2	86	80	70	50	Equivalent of acid anhydride = 164
	RIKACID™ HF-08	0	15	35	65	Carboxyl group equivalent = 336
	LUVEAK™ DMP-30※3	0.5	0.5	0.5	0.5	Accelerator
Blending ratio of HF-08(wt% / curing agent)		0	16	33	57	Curing agent = MH-700 + HF-08
Thermal shock value (point)		0	1	3	10	C-shaped washer method
Heat distortion temperature [°C]		139	108	84	55	Based on JIS K5600-5-4
Bending strength [MPa]		122	115	106	97	
Volume resistivity (25°C) [ $\Omega \cdot \text{cm}$ ]		$1 \times 10^{16}$	$1 \times 10^{16}$	$1 \times 10^{16}$	$1 \times 10^{16}$	
Boiling water absorption rate [%]		0.23	0.42	0.59	0.82	

※1 jER™ 828: Bisphenol A epoxy resin (Mitsubishi Chemical Corporation)

※2 RIKACID™ MH-700: 4-methyl cyclohexane-dicarboxylic anhydride/cyclohexane-dicarboxylic anhydride = 70/30 (wt%) (New Japan Chemical Co., Ltd.)

※3 LUVEAK™ DMP-30: 2,4,6-Tris(dimethylaminomethyl)phenol (NACALAI TESQUE, INC.)

Curing condition: 120°C/1h + 150°C/2h

<C-shaped washer method evaluation method>

A steel washer of  $\phi$  27 mm was embedded, and the points until the occurrence of a crack when heat cycles were given in the following table were compared. However, when a crack was generated in the step of producing a cured product, it was regarded as point 0.

Point	1	2	3	4	5	6	7	8	9	10	11
Temperature [°C]	25	5	25	-15	25	-35	25	-55	25	130	-55
Time [min]	—	10	30	10	30	10	30	10	30	30	10

## ■ Inquiry

Please contact us at the following address, if you want to ask about these Technical Bulletin.

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