EPON® Resin 828

General description

EPON® Resin 828 is an undiluted clear difunctional bisphenol A/epichlorohydrin derived liquid epoxy resin. When cross-linked or hardened with appropriate curing agents, very good mechanical, adhesive, dielectric and chemical resistance properties are obtained. Because of this versatility, EPON Resin 828 has become a standard epoxy resin used in formulation, fabrication and fusion technology.

End-use applications

- Fiber reinforced pipes, tanks and composites
- Tooling, casting and molding compounds
- Construction, electrical and aerospace adhesives
- High solids/low VOC maintenance and marine coatings
- Electrical encapsulations and laminates
- Chemical resistant tank linings, flooring and grouts
- Base resin for epoxy fusion technology

Application and fabrication techniques

The viscosity and cure properties of EPON Resin 828 allows its use under various application and fabrication techniques including:

- Spraying & brushing
- Filament winding
- Pressure laminating
- Vacuum-bag laminating
- Pultrusion
- Casting
- Molding
- Trowling

Sales specifications

Epoxide equivalent weight[a]	185- 192
Viscosity[b], at 25 °C, poise	110- 150
Color[c], Gardner	1 max

Typical properties

Physical form	Clear liquid
Pounds/gallon at 25 °C (77 °F)	9.7
Density, g/ml at 25 °C (77 °F)	1.16
Flash point, °Fd	No flash at 249 °C (480 °F)
Vapor pressure, mm Hg at 77 °C (170 °F)	0.03
Refractive index at 25 °C (77 °F)	1.573
Specific heat, cal/g/°C (BTU/lb/°F)	0.5(0.3)

[a]Grams of resin containing one gram equivalent of epoxide. Shell Analytical Method HC-427D-89 (Perchloric Acid Method).

[b]Shell Analytical Method HC-397A-87 (Determination of the Viscosity of Liquids by Ubbehlode Viscometer).

[c]ASTM method D-1544-80.

[d]ASTM D 93.

Curing agents

EPON Resin 828 can be cured or cross-linked with a variety of curing agents depending on properties desired in the finished product and the processing conditions employed. Some commonly used curing agents, recommended concentrations, typical cure schedules employed in major end-use applications, plus sources for these curing agents are displayed in Table 1.

Table 1/**Curing agents for EPON® Resin 828**

Curing Agent[1]	Physical State	Recommended Concentration range, phr[2]	Typical Cure Schedule Time °C (°F)	Deflection Temperature[3] °C (°F)	Applications[4]	Suppliers[5]
Aliphatic Amines						
1. EPI- CURE® 3223 (DETA)	Liquid	12	7d, 25(77)	120(250)	ABCDEFHI	5
2. EPI-CURE 3234 (TETA)	Liquid	13	7d, 25(77)	120(250)	ABCDEFHI	5
3. EPI-CURE 3200 (AEP)	Liquid	22	24h, 25(77) & 1h, 150(300)	120(250)	BCEFGH	5
4. EPI-CURE 3270	Liquid	75	14d, 25(77)	56(133)	ABCDEFHI	5
5. EPI-CURE 3271	Liquid	18	14d, 25(77)	66(151)	ABCDEFHI	5
6. EPI-CURE 3274	Liquid	40	14d, 25(77)	?	ABCDEFHI	5
7. Jeffamine D-230	Liquid	35	7d, 25(77)	68(155)	ABCDEFHI	1
8. Jeffamine D-400	Liquid	55	30 min, 115 (240)	31(88)	ABCEFH	1
Cycloaliphatic Amines						
9. EPI-CURE 831 (IPDA)	Liquid	23	1h, 100(212) & 1h, 150(300)	146(295)	BC	5
10. EPI-CURE 3370	Liquid	38	7d, 25(77)	56(133)	ABCDEFHI	5
11. EPI-CURE 3382	Liquid	63	7d, 25(77)	63(145)	ABCDEFHI	5
12. EPI-CURE 3383	Liquid	60	24h, 25(77) & 2h, 100(212)	54(129)	ABCDEFHI	5
Polyamides						
13. EPI-CURE 3115	Liquid	120	1h, 100(212)	85(185)	AB	5
14. EPI-CURE 3125	Liquid	90	7d, 25(77)	90(195)	ABCEFH	5
15. EPI-CURE 3140	Liquid	75	7d, 25(77)	115(240)	ABCEFH	5
Amidoamines						
16. EPI-CURE 3015	Liquid	50	16h, 25(77) & 2h, 93(200)	--	ABCDEFHI	5
17. EPI-CURE 3055	Liquid	50	16h, 25(77) & 2h, 93(200)	67(153)	ABCDEFHI	5
18. EPI-CURE 3072	Liquid	35	14d, 25(77)	59(138)	ABCDEFHI	5
Aromatic Amines						
19. EPI-CURE Z	Metastable Liquid	20	2h, 80(175) & 2h, 150(300)	50(300)	BCDGHI	5
20. EPI-CURE Y	Metastable Liquid	25	2h, 80(175) & 2h, 150(300)	160(320)	BCDGHI	5
21. EPI-CURE W	Liquid					5
22.Metaphenylenediamine (MPDA)	Solid	14	2h, 80(175) & 2h, 150(300)	150(300)	BCDGHI	3

23. Methylene dianiline (MDA)	Solid	27	2h, 80(175) & 2h, 150(300)	160(320)	BCDEGHI	13
24. Diaminodiphenyl Sulfone (DADS)	Solid	25	5h, 125(257) & 1h, 200(392)	170(350)	BCDGHI	2, 13
Anhydrides						
25. Methyl tetrahydrophthalic Anhydride (MTHPA)	Liquid	80	2h, 120(250) & 2h, 150(300)	130(266)	BCDGHI	9, 14, 11
26. NADIC Methyl Anhydride (NMA)	Liquid	90	1h, 120(250) & 2-24h, 260(500)	180(356)	BCDGHI	9, 14
27. Hexahydrophthalic Anhydride (HHPA)	Solid	80	1h, 80(175) & 2h, 150(300)	130(265)	BCDGHI	12, 8, 14
Catalysts and Miscellaneous						
28. 2-Ethyl- 4-Methyl Imidazole (EMI-24)	Metastable Liquid	3	4h, 50(1400) & 2h, 170(340)	170(340)	BCDGHI	15, 16
29. BF_3-Monoethylamine (BF_3-MEA)	Solid	3	1h, 120(250) & 2h, 170(340)	170(340)	BCDGHI	17
30. Diethlaminopropylamine[6]	Liquid	6	30 min, 115(240)	100(212)	ABC	6
31. Dicyandiamide	Solid	4	1h, 177(350)	150(300)	BCDGHI	18, 19

Table 1/**Curing agents for EPON® Resin 828** *(continued)*

[1]Cures can be effected with these curing agents over a wide range of temperatures. Higher temperatures yield shorter cure times and highest T_g.

[2]Parts of curing agent per 100 parts of resin.

[3]Systems cured at room temperature were post cured at elevated temperature to achieve deflection values.

[4]Application codes: A - Coatings; B - Adhesives; C - Castings; D - Moldings; E - Flooring; F - Paving; G - Electrical Laminates; H - Structural Laminates; I-Filament Winding.

[5]Supplier Code:

1. Huntsman Chemical
2. RSA Corporation
3. E.I. DuPont de Nemours & Co., Chemicals & Pigments Dept.
4. Harshaw Chemical Company
5. Shell Chemical Company
6. BASF Corporation
7. American Cyanamid - Industrial Chemical Div.
8. Milliken & Company
9. Lindau Chemicals, Inc.
10. Anhydrides and Chemicals, Inc.
11. Dixie Chemical Co., Inc.
12. Buffalo Color Corp.
13. Air Products and Chemicals, Inc.
14. Lonza
15. Interchem

16. Polyorganix
17. Atotech
18. SKW Trotsbery
19. Ashland Chemical

[6]Dimethylamino propylamine may be substituted at expense of slightly reduced pot life. Sources are 2 and 16.

Performance characteristics of cured EPON Resin 828

Mechanical properties

High performance, high strength materials are obtained when this resin is cured with a variety of curing agents. Unfilled systems in common use have tensile values greater than 10,000 psi (69 MPa) with modulus values greater than 400,000 psi (2750 MPa). Such systems are normally very rigid. If greater flexibility is needed systems can be formulated to provide up to 300% elongation.

Adhesive properties

One of the most widely recognized properties of cured EPON Resin 828 is strong adhesion to a broad range of substrates. Such systems exhibit shear strength of up to 6,000 psi (41 Mpa). One factor which contributes to this property is the low shrinkage shown by these systems during cure. Compared to other polymers, epoxy resins have low internal stresses resulting in strong and durable finished products.

Electrical properties

EPON Resin 828 cured systems have very good electrical insulating characteristics and dielectric properties. For example, systems can be obtained with anhydride and amine curing agents having volume resistivities up to 1 x 1016 ohm-cm, dielectric constants of 3-5 and dissipation factors of 0.002 to 0.020 at ambient conditions. Electrical encapsulations, laminates and molding compounds are frequently based on EPON Resin 828.

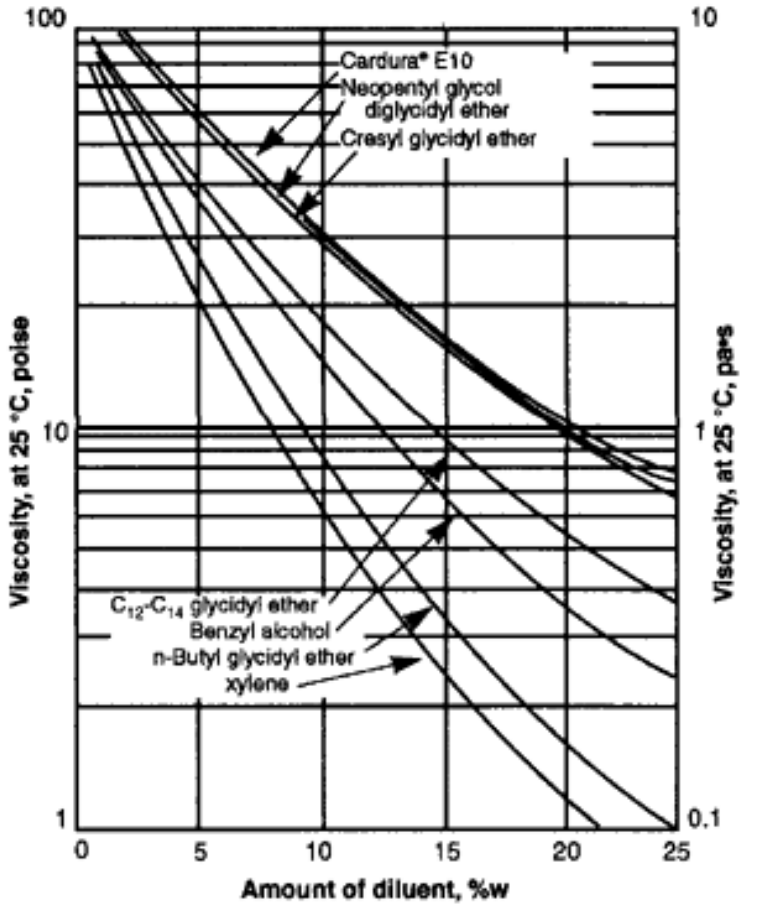
Chemical resistance

Cured EPON Resin 828 is highly resistant to a broad range of chemicals, including caustic, acids, fuels and solvents. Chemically resistant reinforced structures and linings or coatings over metal can be formulated with EPON Resin 828.

Formulating techniques

The primary components of a thermosetting resin formula are the epoxy resin and the hardener or curing agent. However, in practice other materials are normally incorporated to achieve special properties. For example, inert fillers such as silicas, talcs, calcium silicates, micas, clays and calcium carbonate can be added to further reduce shrinkage and improve dimensional stability. Also, reactive diluents can be added to EPON Resin 828

Figure 1/**Viscosity at 25°C of EPON® Resin 828 blends with various diluents**



to reduce viscosity. The effect on viscosity by adding such materials is shown in Figure 1.

Fusion technology

EPON Resin 828 is the product of choice for a resin chemist using a specific fusion catalyst when processing proprietary solid epoxy resins or epoxy esters. Upon request, Shell can provide EPON Resin 828 exhibiting extremely low hydrolyzable and total chlorine, two end groups that may be deleterious to resin curing and long term performance in electrical uses.

FDA status

Provisions are made in the FDA regulations for the use of EPON Resin 828, when properly formulated, applied and cured, for food contact applications under Title 21 Code of Federal Regulations 175.300. The regulations should be consulted for complete details. In particular, we direct your attention to subparagraph (b) of 21 CFR 174.5 and the general provisions applicable to indirect food additives listed there.

Identification and classification

Chemical Abstract Service Registry Number:
25068-38-6 (EPA/TSCA inventory designation)
Shell Material Safety Data Sheet Number: 23
Generic name: Liquid Bisphenol A Epichlorohydrin based epoxy resin.
Chemical designation: Phenol, 4,4O - (1-methylethylidene) bis-polymer with (chloromethyl) oxirane.

Packaging, storage and shipping

- EPON Resin 828 is an undiluted liquid epoxy resin that is available in tank cars, tank trucks and 500 pound net closed head drums.
- EPON Resin 828 is normally shipped in bulk from 150 °F (66 °C) to 180 °F (82 °C) and can be stored at 120-140 °F (49-60 °C) for ease of handling. The viscosity/temperature profile and the specific gravity/temperature profile for EPON Resin 828 are displayed in Figures 2 and 3 respectively for your guidance.

Figure 2/**Viscosity - temperature profile for EPON® Resin 828**

EPON Resin 828 is susceptible to crystallization upon prolonged storage at normal ambient temperatures. It may be reconstituted by warming to 120-140 °F for 4-24 hours depending on the mass involved.

NOTE OF CAUTION: When checking viscosity of EPON Resin 828 incoming samples, we caution you to make certain that the product is maintained at 25 +/- 0.01 °C before testing. You will note in Figure 4 that EPON Resin 828 can vary in viscosity by 10-15 poise for each degree in temperature the product varies from 25 °C.

- According to the Department of Transportation regulations (Code of Federal Regulations, Title 49), EPON Resin 828 is not classified or regulated as a flammable or combustible material. No

Formulation and application information

- For additional performance characteristics information covering adhesives, laminating, casting and molding applications, consult Shell Chemical Company brochure SC:67, entitled "OEPON® Resin Structural Reference Manual."
- For epoxy resin amine-cured coatings, consult Shell Chemical Company Technical Bulletin SC:193, entitled "Formulating Amine-Cured Coatings with EPON® Resin."

special labeling is required for transportation.

Figure 3/**Specific gravity - temperature profile for EPON® Resin 828**

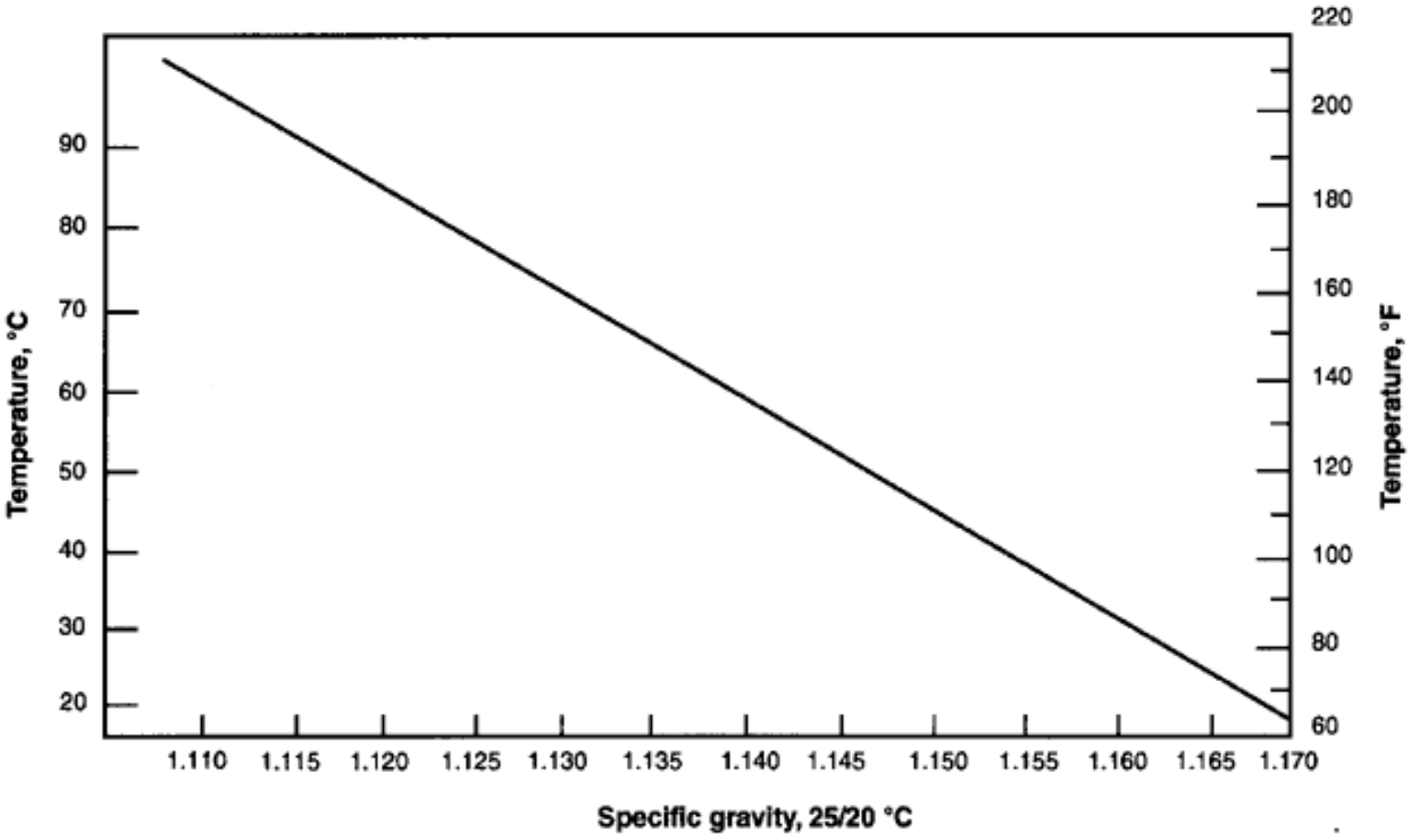
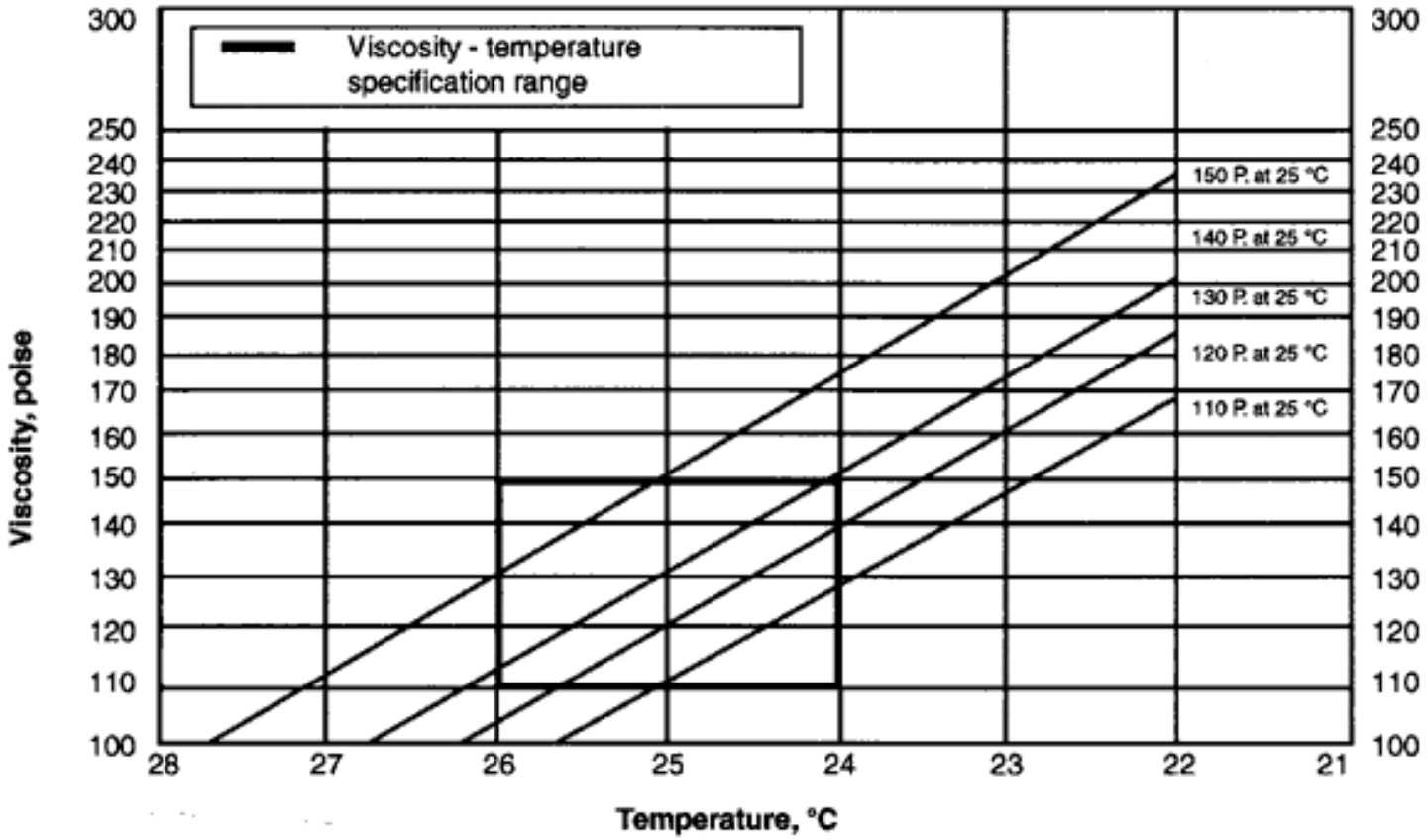


Figure 4/**Viscosity - temperature profile (for 5 samples of EPON® Resin 828 ranging in viscosity from 110-150 poise)**



Handling precautions for systems based on EPON Resin 828

The recommendations for material selection made in this technical bulletin are based on Shell's experience and research and are believed to be sound technical approaches to the applications or end uses for which they are presented. However, these recommendations are directed solely toward technical performance and should not be taken as recommendations pertaining to health, safety, or the environment.

EPON Resin 828 and the auxiliary materials used in typical formulations are capable of producing adverse health effects ranging from minor skin irritation to serious systemic effects. Exposure to these materials should be minimized and avoided if feasible through the observance of proper precautions, use of appropriate engineering controls and proper personal protective clothing and equipment, and adherence to proper handling procedures. Each of these preventive measures depends on responsible action by adequately informed personnel.

A Material Safety Data Sheet (MSDS No. 23) is available for this product from Shell Chemical Company. Transportation, storage, handling and use of this product should not occur until handling precautions and recommendations, as described in the MSDS, are understood by all persons who will work with it. Questions and requests for the MSDS or other information should be directed to your Shell Chemical Company Sales Office. Information on non-Shell products should be obtained from the respective manufacturer or vendor.

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Shell Epoxy Resins 50 Years

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Other countries	713-246-8295
Facsimile inquiries	713-241-1606
Email inquiries	cheminq@shellus.com

For immediate technical literature via fax, call toll-free:

1-800-FAX-EPON
(1-800-329-3766)

For product prices, availability, order placement or samples, call our toll-free customer service number at:

1-800-USA-SHELL
(1-800-872-7435)

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