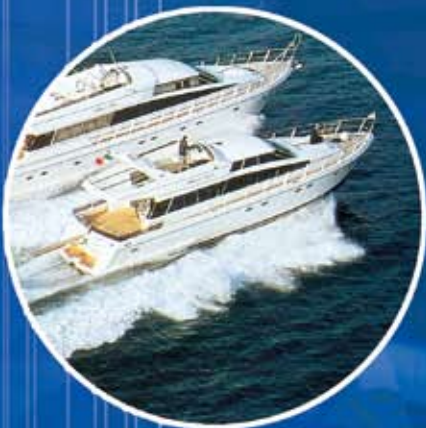




NAN YA

Unsaturated Polyester Resin Vinyl Ester Resin Series

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Ensure total quality management to offer
customer's utmost satisfaction of our products

NAN YA

UNSATURATED
POLYESTER
RESIN

台塑關係企業
FORMOSA PLASTICS GROUP

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台塑關係企業
FORMOSA PLASTICS GROUP

STORAGE

Catalyzed resin will remain stable for three months if stored in the dark and at temperature below 25°C. Stocked cargo should be always away from sun light or steam pipes .Opened drum must be sealed tightly after each use in order to maintain the best quality of the resin.

BUTTON

B SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC	VISCOSITY	GEL TIME	THIXOTROPIC	PROMOTER	WAX
				GRAVITY	CPS/30°C	Min/30°C	INDEX		
				25°C			6rpm/60rpm 25°C		
B3A01	Excellent compatibility with pearl and show gloss, easy to drill and dye.	For centrifugal button fast cure	Pale Yellow	1.12-1.16	1300±130	3±1	--	×	O
B4101		For centrifugal button	Hazen 30 ↓	1.10-1.16	1300±130	3±1	--	×	×
B4201		For Rodmaker button	Pale Yellow	1.14-1.18	3500±350(25°C)	10±2	2.6±0.2	×	×
B4301		For centrifugal button	Hazen 30 ↓	1.10-1.16	1300±130	3±1	--	×	×
B5101		For Perma button	Hazen 50 ↓	1.14-1.18	2500±250	4±1	--	×	×
B6101		Soft grade	Hazen 50 ↓	1.10-1.15	1500±200	4±1	--	×	×

O : With wax/promoter
X : Non-wax/non-promoter

• CURING CONDITION

- 1. Gel test : adds 0.5PHR Promoter NP-10, 1PHR MEKPO(55%).
- 2. These tests are based on JIS-6911, JIS-6901,CNS-9715.CNS-9716.

• PROPERTIES OF THE CURED RESIN

	Casting(B4101)
Hardness, Barcol	45
Impact Strength,Kg-cm/cm	2.6
Tensile Strength,Kg/mm ²	5.5
Flexural Strength,Kg/mm ²	11.8
Flexural Modulus,Kg/mm ²	329
Elongation,%	2.5

CASTING - ONYX

C2 SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC GRAVITY	VISCOSITY	GEL TIME	THIXOTROPIC		PROMOTER	WAX
							INDEX			
							6rpm/60rpm			
				25°C	CPS/25°C	Min/25°C	25°C			
C2P01	Excellent wet-out properties. Higher filler content, good mechanical properties.	Artificial marble & onyx, and vanity top	Transparent-Blue	1.12-1.18	1100±110	11±2	--		O	×
C2P04			Transparent-Blue	1.12-1.18	850±85	14±2	--		O	×
C2Q01			Transparent-Blue	1.12-1.18	1700±170	14±2	--		O	×
C2Q02			Transparent-Blue	1.12-1.18	1700±170	30±3	--		O	×

O : With wax/promoter
X : Non-wax/non-promoter

CURING CONDITION

- 1. Gel test : C2P adds 1PHR MEKPO(55%) .
- 2. These tests are based on JIS-6911,JIS-6901,CNS-9715, CNS-9716.

PROPERTIES OF THE CURED RESIN

	Casting
Hardness, Barcol	4.5
Impact Strength,Kg-cm/cm	2.5
Tensile Strength,Kg/mm ²	6.0
Flexural Strength,Kg/mm ²	9.0
Flexural Modulus,Kg/mm ²	310

CASTING

C3 SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC	VISCOSITY	GEL TIME	THIXOTROPIC		PROMOTER	WAX
				GRAVITY	CPS/25°C	Min/25°C	INDEX	6rpm/60rpm		
25°C	25°C									
C3G01	1. With high or medium reactivity. 2. Possess good transparence, low shrinkage, non-cracking, easy defoaming, excellent wet-out properties.	for medium & large	Light Red	1.11-1.12	300±30	5±1	--		O	O
C3G02		size casting statue	Light Red	1.11-1.12	350±35(20°C)	5±1(20°C)	--		O	O
C3A01		for medium & small	Light Red	1.11-1.12	300±30	5±1	--		O	O
C3A02		size casting statue	Light Red	1.11-1.12	350±35(20°C)	5±1(20°C)	--		O	O

O : With wax/promoter

• CURING CONDITION

- 1. Gel test : adds 1PHR MEKPO (55%)
- 2. These tests are based on JIS-6911,JIS-6901,CNS-9715, CNS-9716.

• PROPERTIES OF THE CURED RESIN

Casting	C3A01	C3G01
	C3A02	C3G02
Hardness, Barcol	48	42
Impact Strength,Kg-cm/cm	2~3	2~3
Tensile Strength,Kg/mm ²	4~5	4~5
Flexural Strength,Kg/mm ²	10~12	11~13
Flexural Modulus,,Kg/mm ²	200~230	220~250

FURNITURE

F SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC	VISCOSITY	GEL TIME	THIXOTROPIC		PROMOTER	WAX
				GRAVITY	CPS/25°C	Min/25°C	INDEX			
							25°C	25°C		
F3401	1. With high reactivity	for PET film to be molded on polyester plywood .	Purple Red	1.12 - 1.15	350±35	3±1	--	O	O	
F3601	2. Good extensibility forfabrication,		Purple Red	1.12 - 1.15	350±35	4±1	--	O	O	
F5401	excellent gloss and lightness.		Purple Red	1.12 - 1.15	550±55	3±1	--	O	O	
F5601			Purple Red	1.12 - 1.15	550±55	4±1	--	O	O	
F7401			Purple Red	1.12 - 1.15	750±75	3±1	--	O	O	
F7601			Purple Red	1.12 - 1.15	750±75	4±1	--	O	O	
FA000			Transparent Yellow	1.12 - 1.15	1100±110	5±1	--	×		
FA001			Purple Red	1.12 - 1.15	1100±110	5±1	-	O	O	
FA002			Purple Red	1.12 - 1.15	1100±110	4±1	--	O	O	
FA003			Transparent Yellow	1.12 - 1.15	1100±110	4±1	--	×	O	
FA400			Transparent Yellow	1.12 - 1.15	1500±150	4±1	--	×		
FA401			Purple Red	1.12 - 1.15	1500±150	4±1	--	O	O	
FA402			Purple Red	1.12 - 1.15	1300±130	4±1	--	O	O	
FA403			Transparent Yellow	1.12 - 1.15	1300±130	4±1	--	×	O	
FA601			Purple Red	1.12 - 1.15	1800±180	5±1	--	O	O	
FA602			Purple Red	1.12 - 1.15	1800±180	4±1	--	O	O	

• CURING CONDITION

1. Gel test : Fa000, FA003, FA400, FA403, add 0.3 PHR promoter POBO and 1PHR MEKPO(55%). Other adds 1 PHR MEKPO(55%).
2. These tests are based on JIS-6911, JIS-6901,CNS-9715,CNS-9716.

• PROPERTIES OF THE CURED RESIN

	CASTING
Hardness, Barcol	50
Impact Strength,Kg-cm/cm	3.5
Tensile Strength,Kg/mm ²	8
Flexural Strength,Kg/mm ²	13
Flexural Modulus,Kg/mm ²	360

O : With wax/promoter
X : Non-wax/non-promoter

GEL COAT

G SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC GRAVITY	VISCOSITY	GEL TIME	THIXOTROPIC		
							INDEX	PROMOTER	WAX
				25°C	CPS/25°C	Min/25°C	6rpm/60rpm		
							25°C		
GC101	1. With high or medium reactivity	For exterior application of ship and FRP products	Transparent-Yellow	1.11-1.20	1180±118	8±2	--	×	×
GC202	2. Excellent compatibility with pig		Transparent-Yellow	1.11-1.20	1800±180	9±1	--	×	×
GC203	ment and show gloss		Pale Yellow	1.11-1.20	6000±900	12±2	5.0±0.5	×	×
GC204	3. The chemical resistance and water		Purple Red	1.11-1.20	6000±900	12±2	5.0±0.5	○	×
GC503	resistance:GC1 is excellent, GC2 is		Purple Red	1.11-1.20	3000±450	12±2	5.5±0.5	○	×
GC603	next, others are GC5, GC6 and GC7.		Purple Red	1.11-1.20	3000±450	22±2	5.5±0.5	○	×
GC703			Purple Red	1.11-1.20	6000±900	12±2	5.0±0.5	○	×

O : With wax/promoter
X : Non-wax/non-promoter

• CURING CONDITION

1. Gel test :
GC101 GC202 GC203 add 0.5PHR promoter P040 and 1PHR MEKPO(55%) .
GC204 GC502 GC601 GC702 add 1PHR MEKPO (55%).
2. These tests are based on JIS-6911 JIS-6901, CNS-9715, CNS-9716.

• PROPERTIES OF THE CURED RESIN

	Casting
Hardness, Barcol	40-50
Tensile Strength,Kg/mm ²	6-7
Flexural Strength,Kg/mm ²	11-13
Flexural Modulus,Kg/mm ²	300-350

• RETENTION OF PROPERTIES AGAINST CHEMICAL AGENT,%

Retention of Properties,% =	PRODUCT	Flexural	Acetic	Sulfuric	Hydrochloric	NaOH	KOH	Gasoline	Diesel
Wet Value of Flexural Strength	CODE	Strength	Acid	Acid	Acid				Oil
		Kg/mm ²	(50%)	(50%)	(36%)	(10%)	(10%)	(100%)	(100%)
Dry Value of Flexural Strength	GC1	12.58	48.5%	90.5%	67.2%	92.4%	94.0%	90.1%	92.2%
Wet Value :Test specimens are immersed in chemical solution as following for one month at 70°C.	GC2	13.46	40.2%	87.6%	60.5%	83.1%	88.9%	88.2%	87.4%
	GC5	12.20	15.5%	86.4%	52.8%	77.2%	73.4%	82.3%	85.4%
	GC6	11.87	16.2%	80.2%	48.4%	75.6%	70.2%	77.4%	80.4%
	GC7	11.3	10.4%	74.3%	40.6%	67.0%	68.3%	76.3%	79.3%

LAMINATING

L SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC	VISCOSITY	GEL TIME	THIXOTROPIC	PROMOTER	WAX
				GRAVITY	CPS/ °C	Min/25°C	INDEX		
				25°C			6rpm/60rpm 25°C		
L3A1H	1.With high or medium reactivity 2.Excellent non-sagging and wet out properties, the products show excellent mechanical properties.	For hand lay-up and spray-up open mold fabrication	Purple Red	1.07-1.11	400±40/25°C	7±1	2.3±0.3	o	×
L311H			Purple Red	1.07-1.11	400±40/25°C	7±1	2.3±0.3	o	o
L3B1K			Purple Red	1.07-1.11	350±35/25°C	16±2	1.8±0.2	o	×
L321K			Purple Red	1.07-1.11	350±35/25°C	16±2	1.8±0.2	o	o
L3B1Q			Purple Red	1.07-1.11	320±32/30°C	16±2	2.3±0.3	o	×
L321Q			Purple Red	1.07-1.11	350±32/30°C	16±2	2.3±0.3	o	o
L3C02			Ligth Grey	1.07-1.11	320±32/25°C	16±2	3.0±0.3	o	×
L3C05			Light Grey	1.07-1.11	320±32/25°C	16±2	3.0±0.3	o	o
L4B01			Purple Red	1.07-1.11	400±40/25°C	11±2	1.8±0.2	o	×
L4203			Purple Red	1.07-1.11	400±40/25°C	11±2	1.8±0.2	o	o
L4B02			Purple Red	1.07-1.11	400±40/25°C	16±2	2.3±0.3	o	×
L4204			Purple Red	1.07-1.11	400±40/25°C	16±2	2.3±0.3	o	o
L4B06			Purple Red	1.07-1.11	550±55/25°C	18±2	2.6±0.3	o	×
L4206			Purple Red	1.07-1.11	550±55/25°C	18±2	2.6±0.3	o	o
L4B07			Purple Red	1.07-1.11	550±55/25°C	16±2	2.6±0.3	o	×
L4207			Purple Red	1.07-1.11	550±55/25°C	16±2	2.6±0.3	o	o
L4B08			Purple Red	1.07-1.11	400±40/25°C	11±2	--	o	×
L4208			Purple Red	1.07-1.11	400±40/25°C	11±2	--	o	o
L4B10			Purple Red	1.07-1.11	450±45/25°C	16±2	2.3±0.3	o	×
L4210			Purple Red	1.07-1.11	450±45/25°C	16±2	2.3±0.3	o	o
L7S12			Yellowish Green	1.07-1.11	900±90/30°C	5±1(30°C)	--	o	o
L4Y05	1.With medium reactivity 2.Excellent non-sagging and wet out properties, the products show excellent mechanical properties.	For hand lay-up and spray-up open mold fabrication	Purple Red	1.07-1.11	350±35/25°C	12±2	2.3±0.3	o	×
L4705			Purple Red	1.07-1.11	350±35/25°C	12±2	2.3±0.3	o	o
L4Y06			Purple Red	1.07-1.11	350±35/20°C	12±2	2.3±0.3	o	×
L4706			Purple Red	1.07-1.11	350±35/20°C	12±2	2.3±0.3	o	o

• CURING CONDITION

- 1. Laminated pieces of 30% glass fiber mat.
- 2. Gel test adds 1PHR MEKPO(55%).
- 3. These tests are based on JIS-6911
JIS-6901,CNS-9715,CNS-9716.

• PROPERTIES OF THE CURED RESIN

	Glass Mat	
	Casting	Laminate
Hardness, Barcol	47	55
Impact Strength,Kg-cm/cm	3.0	65
Tensile Strength,Kg/mm ²	6.0	12
Flexural Strength,Kg/mm ²	11	22
Flexural Modulus,Kg/mm ²	450	1010
Elongation,%	2.5	2.0

O : With wax/promoter
X : Non-wax/non-promoter

SMC

M SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC GRAVITY 25°C	VISCOSITY CPS/25°C	GEL TIME Min/80°C	THIXOTROPIC INDEX 6rpm/60rpm 25°C			PROMOTER	WAX
M5F01	1.High reactivity	General purpose	Transparent Yellow	1.1-1.2	1800±150	23±3	--			×	×
M5S01	2.Low Shrinkage, good mechanical properties, moldability, paintability and pigmentability		Transparent Yellow	1.1-1.2	1900±150	12±2	--			×	×
M5G01	Ortho type	General purpose	Transparent Yellow	1.1-1.2	900±100	23±3	--			×	×
M5D01	High reactivity	Class A surface	Transparent Yellow	1.1-1.2	1900±150	39±2	--			×	×
M5A03	ISO - NPG type	For water-resistant	Transparent Yellow	1.1-1.2	1000±100	13.5±1.5	--			×	×
M5C01	ISO - Type low shrinkage	Autamotive grade	Transparent Yellow	1.1-1.2	1800±150	23±2	--			×	×

O : With wax/promoter
X : Non-wax/non-promoter

• CURING CONDITION

- 1. Gel test adds 1PHR BPO(98%)
- 2. These tests are based on JIS-6911
- 3. These tests are based on JIS-6911
JIS-6901,CNS-9715,CNS-9716.

• PROPERTIES OF THE CURED RESIN

Casting	M5F01	M5S01	M5G01	M5D01	M5A03	M5C01
Hardness, Barcol	40~50	40~50	40~50	45~55	40~50	40~50
Tensile Strength, Kg/mm ²	4~5	5~6	4~5	4~5	5~6	5~7
Tensile Modulus, Kg/mm ²	150~200	200~250	150~250	150~250	200~300	250~350
Flexural Strength, Kg/mm ²	9~10	10~11	9~10	9~10	10~12	10~12
Flexural Modulus, Kg/mm ²	300~350	300~350	300~350	300~350	300~400	300~400
Heat Distortion Temp.°C	80~90	80~90	80~90	90~100	75~85	75~85
Water Absorption,25°C, 24hr.%	0.2~0.3	0.1~0.2	0.3~0.35	0.3~0.35	0.1~0.2	0.2~0.3

SHIPPING

S SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC GRAVITY 25°C	VISCOSITY CPS/25°C	GEL TIME Min/25°C	THIXOTROPIC		PROMOTER	WAX
							INDEX 6rpm/60rpm	25°C		
S3B01	1. With medium or low reactivity 2. High impact, low Shrinkage and excellent wet-out properties 3. Approved by DNV Register of Shipping.	For fishing boat, yachts	Purple Red	1.07-1.11	350±35	16±2	3.0±0.3		o	×
S4B01			Purple Red	1.07-1.11	430±43	20±2	3.0±0.3		o	×
S5E01			Purple Red	1.07-1.11	450±45	38±3	3.0±0.3		o	×
R5E01	ISO type (Laminating)		Purple Red	1.07-1.11	500±50	38±4	3.0±0.3		o	×
R4E01	ISO type (Laminating)		Purple Red	1.07-1.11	500±50	38±4	3.0±0.3		o	×
R3F01	ISO type (Vacuum bag)		Purple Red	1.07-1.11	250±30	55±5	1.0		o	×

O : With wax/promoter
X : Non-wax/non-promoter

CURING CONDITION

- 1. Laminated pieces of 30% glass fiber mat.
- 2. Gel test adds 1PHR MEKPO(55%).
- 3. These tests are based on JIS-6911
JIS-6901,CNS-9715,CNS-9716.

PROPERTIES OF THE CURED RESIN

	Glass Mat	
	Casting	Laminate
Hardness, Barcol	45	50
Impact Strength,Kg-cm/cm	3.0	60
Tensile Strength,Kg/mm ²	6.0	11
Flexural Strength,Kg/mm ²	10	20
Flexural Modulus,Kg/mm ²	350	850
Elongation,%	2.0	2.0

PULTUSION
PT SERIES

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC GRAVITY 25°C	VISCOSITY CPS/25°C	GEL TIME Min/80°C	THIXOTROPIC INDEX 6rpm/60rpm 25°C			PROMOTER	WAX
P5A01	ISO type, excellent mechanical properties, soft & good toughness	For Pultrusion application	Pale Yellow	1.07~1.11	500±50	9±2	—			x	o
P5B01	Ortho type, excellent wet-out properties, good gloss		Pale Yellow	1.07~1.11	500±50	9±2	—			x	o
V1A01	Vinyl ester resin, resistant to a wide range of acids & bases, good toughness		Pale Yellow	1.02~1.06	500±150	12±4	—			x	x

O : With wax/promoter
X : Non-wax/non-promoter

• CURING CONDITION

- 1. Gel test adds 1PHR BPO (98%).
- 2. These tests are based on JIS-6911, JIS-6901, CNS-9715, CNS-9716.

• PROPERTIES OF THE CURED RESIN

	P5A01	P5B01	V1A01
Hardness, Barcol	40~50	40~50	32~38
Tensile Strength, Kg/mm ²	6~7	5~6	7~8
Tensile Modulus, Kg/mm ²	200~250	200~250	250~300
Elongation, %	2.0~2.5	2.0~2.5	5~6
Flexural Strength, Kg/mm ²	10~12	9~11	11~13
Flexural Modulus, Kg/mm ²	300~350	300~350	300~350
Heat Distortion Temp,	70~80	70~80	100~110

FILAMENT WINDING

GRADE	CHARACTERISTICS	APPLICATION	APPEARANCE	SPECIFIC GRAVITY 25°C	VISCOSITY CPS/25°C	GEL TIME Min/25°C	THIXOTROPIC INDEX 6rpm/60rpm 25°C	PROMOTER	WAX
GC208	ISO type, excellent mechanical properties, resistant to acids & bases	Pipes, Tanks	Purple Red	1.07~1.11	300±30	40±4	—	o	x
GC708	Ortho type, easy of processing		Purple Red	1.07~1.11	300±30	40±4	—	o	x
V1A03	Vinyl ester resin, superior acids & bases resistance, excellent toughness		Purple Red	1.02~1.06	500±150	25±5	—	o	x

O : With wax/promoter
X : Non-wax/non-promoter

• CURING CONDITION

- 1. Gel test GC208, GC708 add 1 PHR MEKPO (55%)
V1A03 add 1.2 PHR MEKPO (55%)
- 2. These tests are based on JIS-6911,
JIS-6901, CNS-9715, CNS-9716.

• PROPERTIES OF THE CURED RESIN

	GC208	GC708	V1A03
Hardness, Barcol	40~50	40~50	32~38
Tensile Strength, Kg/mm ²	6~7	5~6	7~8
Tensile Modulus, Kg/mm ²	250~300	200~250	250~300
Elongation, %	1.5~2.0	1.5~2.0	5~6
Flexural Strength, Kg/mm ²	11~13	10~12	11~13
Flexural Modulus, Kg/mm ²	300~350	250~300	300~350
Heat Distortion Temp,	70~80	70~80	100~110



DET NORSKE VERITAS
TYPE APPROVAL CERTIFICATE

CERTIFICATE NO. K-4768

This is to certify that the
Polyester Resins

with type designation(s)
S3B01, S4A01, S4B01 and S5B01

Manufactured by
Nan Ya Plastics Corporation
Engineering Plastics Plant 4th Div.
CHIAYI COUNTY, Taiwan

is found to comply with
Det Norske Veritas' Rules for Classification of High Speed, Light Craft and Naval Surface Craft, Grade 2
Det Norske Veritas' Standards for Certification No. 2.21, Craft, 2008

Application
For use in marine vessels according to stated Rules.

Havik, 2011-09-30
for Det Norske Veritas AS

This Certificate is valid until
2015-06-30

Rikard Törnqvist
Head of Section

DNV local office:
Kaohsiung

Gisle Herstein
Surveyor

DET NORSKE VERITAS AS, Veritasveien 1, NO-1322 Hovik, Norway. Tel: +47 87 87 88 00, Fax: +47 87 87 88 11, Org. No. NO 846 146 801 MVA. www.dnv.com
Form No. 19, 14/11/04. Issue: October 2009. Page 1 of 2

DET NORSKE VERITAS
TYPE APPROVAL CERTIFICATE

CERTIFICATE NO. K-3787
This Certificate consists of 3 pages

This is to certify that the
Polyester Resins

with type designation(s)
R5E01, R4E01, R3E01, R3F01 and R3F02

Manufactured by
Nan Ya Plastics Corporation Engineering Plastics
Plant 4th Div.
CHIAYI COUNTY, Taiwan

is found to comply with
Det Norske Veritas' Tentative Rules for Certification and Classification of Boats 1997,
Grade 1
Det Norske Veritas' Rules for Classification of High Speed, Light Craft and Naval Surface
Craft, Grade 1
Nordic Boat Standard 1990, Grade 1

Application
For use in marine vessels according to stated Rules/Standard.

Place and date
Havik, 2009-06-12
for Det Norske Veritas AS

This Certificate is valid until
2013-06-30

Hoje Oringe
Head of Section

Local Office
DNV Kaohsiung

Jan Weizenböck
Surveyor

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The validity date refers to the Type Approval Certificate and not to the approval of equipment/systems installed.

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Form No. 20/90a Issue: January 08 Page 1 of 3

Lloyd's Register CERTIFICATE OF APPROVAL OF A
POLYESTER RESIN

Certificate No. MATS/3101/1

This certificate is issued to the company named below. The resin described has been examined in accordance with the requirements of Lloyd's Register and is approved for use in constructions built under Lloyd's Register's survey. This approval is subject to Lloyd's Register being informed of any changes in or modifications to the resin and the product being used in accordance with the manufacturer's instructions and with the relevant requirements of Lloyd's Register's Rules and Regulations.

Company	NAN YA PLASTICS CORP TAIPEI TAIWAN, REPUBLIC OF CHINA
Trade name	R SERIES
Resin	R5E01
Application	Laminating resin
Type	Isophthalic polyester resin
Characteristics	Pre-accelerated, Thixotropic, Sprayable
Applicable LR Rules	Rules and Regulations for Classification of Special Service Craft

Valid until 1 February 2010
Date 14 January 2005

J.C. Howson
Surveyor to Lloyd's Register EMEA
On Behalf of Lloyd's Register Asia

THIS DOCUMENT IS SUBJECT TO THE PROVISIONS ON THE REVERSE

Lloyd's Register CERTIFICATE OF APPROVAL OF A
POLYESTER RESIN

Certificate No. MATS/3102/1

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Company	NAN YA PLASTICS CORP TAIPEI TAIWAN, REPUBLIC OF CHINA
Trade name	S SERIES
Resin	S4B01
Application	Laminating resin
Type	Orthophthalic polyester resin
Characteristics	Pre-accelerated, Thixotropic, Sprayable
Applicable LR Rules	Rules and Regulations for Classification of Special Service Craft

Valid until 1 February 2010
Date 18 January 2005

J.C. Howson
Surveyor to Lloyd's Register EMEA
On Behalf of Lloyd's Register Asia

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NAN YA VINYL ESTER RESIN



南亞塑膠工業股份有限公司
NAN YA PLASTICS CORPORATION



Formosa Plastics Group Maoliao Industrial Park

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NAN YA vinyl ester resins are a family of liquid thermosetting resins developed for production of fiber reinforced plastics.

They combine the excellent thermal and mechanical properties of epoxy resins with the ease of processing and rapid curing of unsaturated polyester resins but their chemical resistance are much more excellent than epoxy and polyester resins.

They are an ideal choice for severe applications particularly in highly corrosive environments. They possess outstanding resistance to corrosion by many different chemicals, including both acids and alkalis, at room and elevated temperatures.

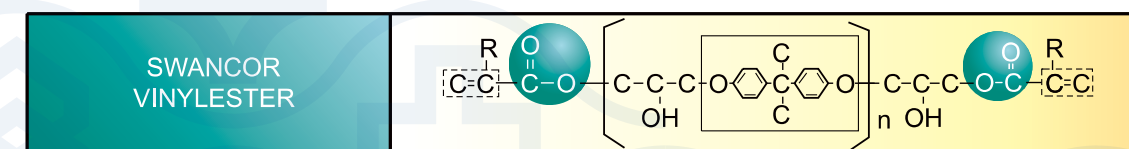
The high strength-to-weight ratio and excellent fatigue resistance of vinyl ester based composites make NAN YA resins a good choice for automotive, military, aerospace, sporting and other applications.

NAN YA vinyl ester resins are designated by the prefix "V".

- (1) V1 series - premium, high performance
- (2) V4 series - for high-solvency solvents

NAN YA vinyl ester resins are epoxy-based, thermosetting resin that are cured by free radical initiation of polymerization, which is similar to the curing mechanism of conventional polyester resins.

There are numerous types of reactants that make up the vinyl esters, each polymer has its characteristic properties. However, the properties and chemistry can be typified by the most versatile of these resins. NAN YA vinyl ester is the reaction product of a Bisphenol-A epoxy and methacrylic acid, the chemical structure is shown below:

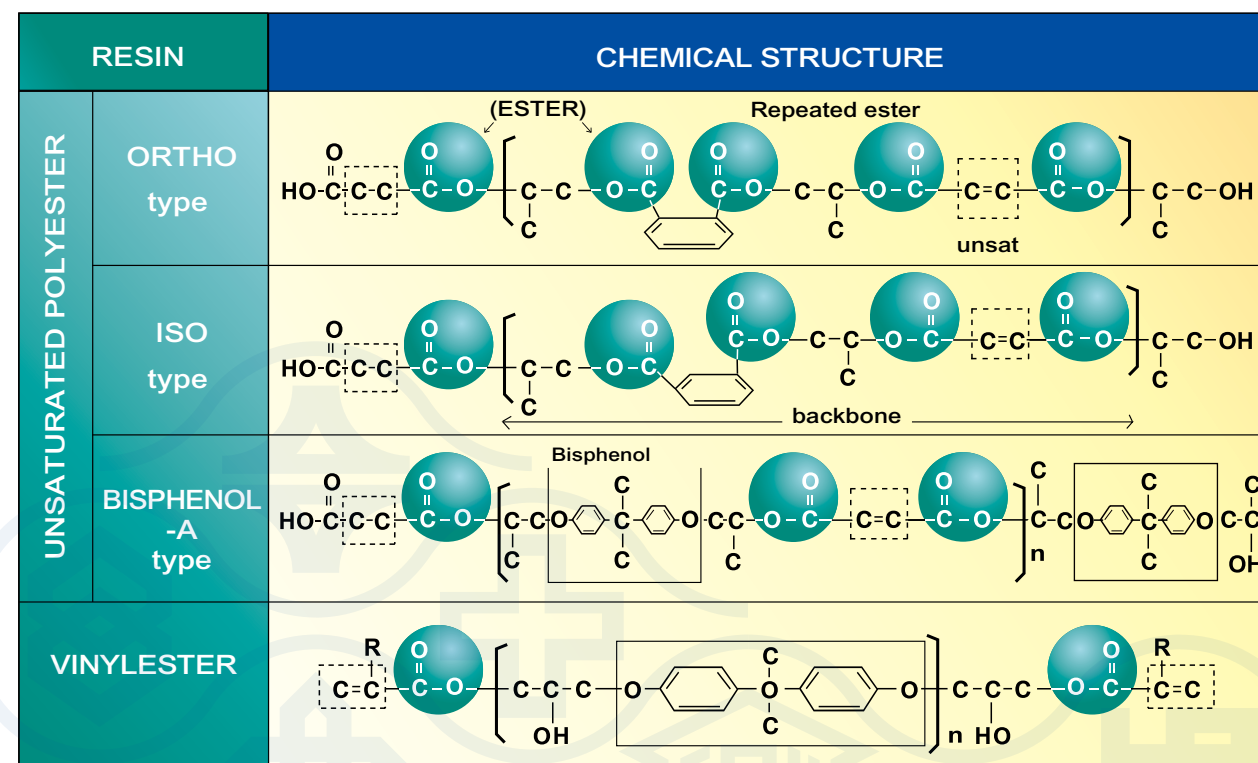


The terminal carbon to carbon double bonds are the reactive groups that enter into the free radical polymerization or cure. In effect, this structure allows an epoxy to react like a polyester. This by itself is very important since epoxy reactions in general are very sluggish compared to the free-radical reactions. Another important feature of NAN YA vinylester resins is that they are diluted in styrene monomer. Since they are low in viscosity, this makes the resins easily worked in the reinforced plastic process. Epoxy resin, on the other hand, are high viscosity materials and require more difficult and expensive processing methods.

Chemical attack on these types of resins occurs through hydrolysis of the ester group or the splitting on unreacted unsaturated bonds through actions such as oxidation and halogenation. In ortho & iso UP, ester linkages occur through the molecular chain, making the chain more susceptible to attack by hydrolysis but for the NAN YA vinyl ester, the ester linkages only exist at terminal, which is more less than polyester. These terminal ester groups are made hydrolytically stable by the hindrance offered by methyl group.

In addition to ester linkage, carbon-to-carbon double also occur randomly through the ortho & iso UP chain, and not all of those bonds react during polymerization. Those unreacted double bonds are susceptible to chemical attack, particularly through oxidation and halogenation. In NAN YA vinyl ester resins, the unsaturated double bonds are all at the terminal, and easily cured. These react completely on curing polymerization, giving an excellent chemical structure.

Figure 1. The comparative chemical structures of NAN YA vinylester and polyesters



From the comparative structure, it is very obvious that the number and arrangement of polar groups on vinyl ester resins make them much less polar than all polyester resins. Therefore, they are less susceptible to the effect of water on curing, and to hydrolysis.

The secondary hydroxyl groups on the backbone also have a benefit effect on the quality of laminate, which result from excellent glass fiber wetting and good adhesion for the higher strength obtained with laminates made of NAN YA vinylester resins.

Because the ether linkage on backbone and the cured vinyl ester resins contain only terminal cross linking, the entire length of the molecular chain is available to elongate under stress and thus absorb more mechanical shocks, which make it higher impactness, and the chemical structure of bisphenol-A can offer NAN YA resin more heat-resistant.

Table 1: List of chemical resistance of thermosetting resins.

Resin \ Chemical	Inorganic Acids	Organic Acids	Oxidized Chemical	Alkalines	Organic Solvents
Ortho-type polyesters	△	△	×	×	×
ISO-type polyesters	○	○	○	△	○
Bisphenol-type polyesters	◎	◎	◎	◎	×
Epoxy room-temp curing	△-○	○	×	◎	△
Epoxy high-temp curing	◎	◎	×	◎	○
NAN YA vinylesters	◎	◎	◎	◎	◎

◎:Excellent ○:Good △:Fair ×:Poor

Product Family

(1) V1A01-Premium, High performance

V1A01 resins are epoxy-modified vinyl esters designed to provide high corrosion resistance, superior toughness and anti-fatigue properties. V1A01 resins are resistant to a broad range of acids, base and salt solutions, commonly up to temperature of 100°C(212°F). V1A01 resins can tolerate heavy design loads without causing failure from resin damage; their toughness and anti-fatigue properties can also provide a broad safety factor for impact damage from process upsets or during shipping and installation. V1A01 also demonstrates excellent adhesive properties to metals and concrete.

It is well-suited for use in fabricating tanks, pipes and process equipments; specifically for filament winding, hand lay-up and spray lay-up, pultrusion, tank linings and coatings where premium corrosion resistance is required.

The standard type of V1A01 has a viscosity of 500cps and contains 40% styrene. Different viscosity resins are available at different styrene levels, all of which have essentially similar properties.

Related products:

- V1A02: 35% styrene with 1000cps viscosity.
- V1A03: pre-promoted grade, fast westing V1A01.
- V1A04: thixotropic grade. especially suitable for making moulds of F.R.P.
- V1A04: thixotropic grade. especially suitable for making moulds of F.R.P.
- V1A05: thixotropic, pre-promoted V1A01, especially suitable for making moulds of F.R.P.



(2) **V4A01**: 42% styrene with 500cps viscosity, a tailor-made resin for high-solvency solvents like ketones, aromatic chemicals.

Table 2:Typical properties of liquid resins

Property	V1A01	V4A01
Non Volatilc(%)	58±2	58±2
Viscosity cps/25°C	500±150	500±150
Specific Gravity	1.04±0.02	1.07±0.01
Flash Point °C	30	30
Gel Time 25°C(min)	20±5*	20±5*
Stability Dark at 25°C(month)	3	3

*55% MEKPO:1.2%
6% Cobalt:0.4%
100% DMA:0.05%

**SPI gel time at 80°C
98%BPO=1.0%

Table 3: Typical clear casting properties

Property	Mehtod	V1A01	V4A01
	Unit		
Tensile Strength	ASTM D638	11000~14000	10000~13000
	Psi		
Tensile Modulus	ASTM D638	4.5~5.0	5.0~5.3
	psi *10^5		
Tensile Elongation	ASTM D638	5.0~6.0	2.0~2.5
	%		
Flexural Strength	ASTM D790	17000~20000	16000~20000
	Psi		
Flexural Modulus	ASTM D790	4.5~5.0	5.5~6.0
	Psi *10^5		
Heat Deflection Temperature	ASTM D648	100~105	150~156
	°C		
Shrinkage	ASTM D2566	8.0	9.5
	%		
Impact Strength	Charpy	5.0~8.0	2.0~4.0
	Kg-cm/cm^2		
Barcol Hardness	ASTM D2583	32~38	36~44
Density	g/cm^3	1.12	1.16

Curing and Handeling

(1). Room temperature curing system.

Catalysts are materials that cause the resin to cure. Promoters and accelerators are materials used to speed up (and control) that cure. Retarders are materials used to extend the gel time.

Three types of catalysts are in general used with NAN YA resins:

·Methyl Ethyl Ketone Peroxide, MEKPO ·Benzoyl Peroxide, BPO

·Cumene Hydroperoxide, CHP

MEKPO and CHP are normally used with promoters,typically

·Cobalt Naphthalene, CoNAP ·Cobalt Octoate, CoOCT

And accelerators typically

·Dimethyl Aniline, DMA

MEKPO is marketed as a 30%~60% active solution. Different brands behave very differently when used with NAN YA resins. This varying reactivity is attributed to subtle differences in monomer, dimmer and trimer content of the peroxide. Users should be thoroughly evaluated before using. Typical amounts of the most common activators used with NAN YA resins are:

·Catalyst(55% MEKPO) : 0.9~2.5%

·Promoter(6% CoNap or CoOct) : 0.2~0.5%

·Accelerator(100% DMA) : 0.0~0.2%

(When room temperature is low than 30°C, DMA is recommended to added.)

Table 4:Typical gel time for NAN YA resins

Temperature	Gel time				
			10~20mins	20~40mins	40~60mins
10~20°C	MEKPO	2.0%	1.5%	1.2%	
	CoOCT	0.5%	0.4%	0.3%	
	DMA	0.15%	0.1%	0.05%	
20~30°C	MEKPO	1.5%	1.2%	1.0%	
	CoOCT	0.4%	0.4%	0.3%	
	DMA	0.15%	0.05%	0.02%	
30°C ↑	MEKPO	1.2%	1.2%	1.0%	
	CoOCT	0.4%	0.3%	0.3%	
	DMA	0.05%	0.02%	0.00%	

The ratio of MEKPO to CoNap(or CoOct) in this system is important to achieve optimum results. A minimum ratio of 3/1(MEKPO/Co) is required. A maximum ration of 10/1 has proven satisfactory. Proportions outside the 3/1~10/1 range may result in poor cure, low hardness and inadequate corrosion resistance protection. Use of DMA as an accelerator diminishes the sensitivity of the lower ratio.

Thorough mixing is also necessary to get optimum results. It is important to mix the activators into the resin by the standard procedure:

·Mix the CoNap(CoOct) and DMA into the resin thoroughly and then add MEKPO.

Elevated Temperature Curing

The same catalysts that are used with polyesters at elevated temperature can be used with NAN YA vinylster resins. Some common catalysts are:

·Benzoyl Peroxide : BPO is commonly used for elevated temperature curing. Used at a level of 1~2%, the pot life is several days, yet rapid cures are obtained at temperature over 80°C.

·Tertiary Butyl Peroxybenzoate (TBPB): TBPB are a liquid form catalyst, its half-life of reactivity is more longer than BPO, and the pot life of TBPB containing resins are also longer than that of BPO.

·Other : other catalysts are commonly used at elevated temperature, for example: Bis(4-t-butylcyclohexyl) peroxydicarbonate, tertiary Butyl Peroxy-2- ethyl- hexanoate.....

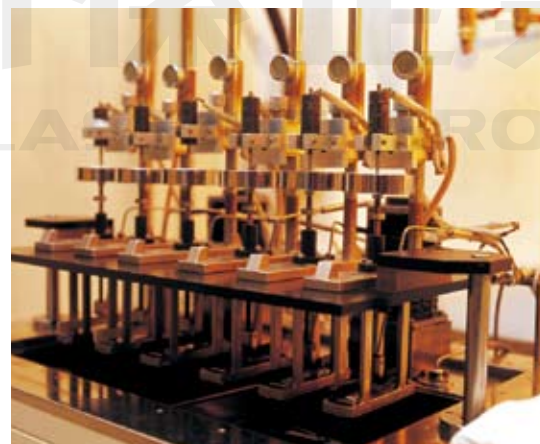
Air Inhibition

Oxygen in the air may inhibit the complete cure of an exposed FRP surface. This inhibited surface may vary in depth, and may result in reduced chemical resistance. To eliminate this, a small paraffin wax (0.2~0.4%) is used in the final top-coat. The small amount of wax is incorporated readily into the system by preparing a master-batch of 6~10% wax-styrene.

Quality Control

Quality Assurance of raw materials and Quality control of processing and final products have become an inevitable routine job for NAN YA. Our testing methods are according to ASTM or CNS, mostly. Some important Q.C. items of our vinyl ester resins are:

- Gel test: Gel test of each batch is basic by cup test for room temperature cure, and SPI gel tests and DSC methods are tested for elevated temperature.
- Shelf life: Since vinyl ester resins are intrinsic unstable, shelf life is tested and monitored batch-by-batch.
- Chemical resistance: NAN YA has established a set of accelerated testing methods for detecting the chemical resistance of resins.
- Mechanical properties: Mechanical properties of NAN YA vinyl ester resins are tested once per three months for each commercial resins.
- Other: Viscosity, appearance, acid value and epoxy equivalent weight of each batch are testing routinely.



Storage and Safety

Storage:

NAN YA vinylester resins are stable at ambient conditions, but if handled improperly, they may slowly gel. At all times they must be maintained below 25°C, and keep away from heat and light. (NOTE: It, which periodically re-fresh or aerate air into NAN YA resins will extend the shelf-life.)

NAN YA vinylester resins are classified as flammable materials under NFPA 30, so they must be stored and handled properly to prevent ignition. If a fire occurs, Fire can be extinguished by conventional means, including foam, dry powder and carbon dioxide. However, water is not suitable for extinguishing fire.

Safety and Health Considerations:

The base vinylester resins are low in toxicity and may be handled openly by observing normal good house keeping practices. Since the styrene is a chemical volatile, it is recommended that good ventilation be provided in working area to keep the styrene level in the area below safety working limits for health and freedom from fire and exposition. If they are accident swallowed, medical attention should be sought immediately, and the condition should be treated symptomatically. Do not induce vomiting. If they accident get into eyes, the eyes should be irrigated with low pressure flowing water continuously for at least 15 minutes, and medical attention should be sought promptly.



Application

NAN YA vinylester resin have superior chemical resistance for most chemicals in many industries as shown in Table 5. They can successfully service in many chemical facilities and equipments at both ambient and elevated temperature. Unlike metals or their alloys, NAN YA resins corrosion, and highly resistant to PH extremes and chemical solvents. In addition to corrosion protection from environment, the maintenance cost is relatively low.

Table 5:NAN YA resins and their applications.

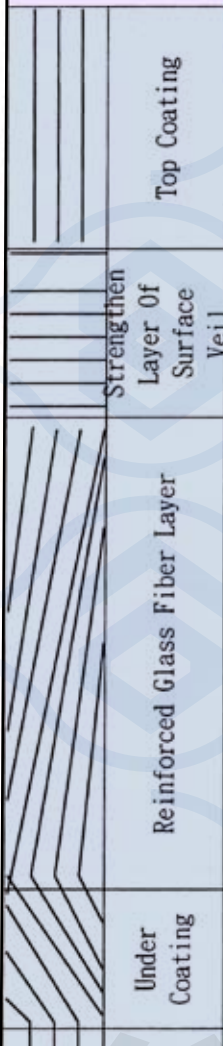
RESIN	FEATURES	APPLICATION
V1A01	• Superior toughness • Resistant to a wide range of chemicals, acids, bases, and bleaches. • Fatigue resistance • Suitable for F.R.P., lining, and flake compounds • Comply with FDA regulation 21 CFR 177.2420	Fabrication methods are versatile: • Hand-lay up • Spray-up • Filament winding • EMatched metal die • EF.R.P. lining • Flake lining • Pultrusion • Centrifugal casting • Resin transfer molding
V4A01	• Superior solvent resistance • Superior high temperature properties • Excellent resistant to oxidizing acids • Comply with FDA regulation 21 CFR 177.2420	Fabrication methods are same as V1A01 • High temperature service • Gas collection equipment • Ducks, Scrubber • Tanks, pipes for organic solvents

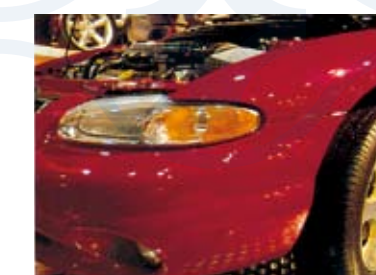


Table 6: The construction of Nan Ya on steel substratum

Anti-Corrosion of F.R.P. Laminated On Steel Substratum		Layers	Materials Selected	Construction Example	Resin Content of Each Layer(g/m ²)	Thickness (mm/layer)	Notice Items
	Top Coating	1	1. Nan Ya Vinylester V1A・V4A	Nan Ya Vinylester V1A・V4A	300	0.29	1. The air-dying agent・for example Wax・ 2. This layer must be wait at least 72 hrs after top coating・
	Strengthen Layer Of Surface Veil	1	1. Nan Ya Vinylester V1A・V4A 2. Surface Veil	Laminated Nan Ya Vinylester V1A・V4A With 30 g/m ² Glass Fiber surface Veil	670	0.6	1. Got rid out of air bubbles・ 2. Keep Surface smoothly・
	Reinforced Glass Fiber Layer	3~10	1. Nan Ya VinylesterV1A・V4A 2. Glass Fiber Mat or Woven Cloth	1. 450g/m ² glass fiber Mat laminated with Nan Ya Vinyl ester V1A・V4A 2. 300 g/m ² Glass Fiber Mat laminated with NanYa Vinyl ester V1A・V4A	1000	0.9	1. Got rid out of air bubbles・ 2. Keep Surface smoothly・
					670	0.6	
	Under Coating	1	Nan Ya Vinylester VIC	Nan Ya Vinylester VIC	300	0.29	1. No oil, dusty and fully dry surface on substratum before the ST primer coating・
	Steel Substratum	1. Steel substratum must be handled with grit-spray and the operation based on NACE STANDARD TW-01-70・ 2. The time of anti-rust paint coating is not over two hours after the grit-spray with the standard Sa 2 1/2・					

Table 7: The construction of Nan Ya on concrete substratum

Anti-Corrosion of F.R.P. Laminated On Concrete Substratum		Layers	Materials Selected	Construction Example	Resin Content of Each Layer(g/m ²)	Thickness (mm/layer)	Notice Items
	Top Coating	1	Nan Ya Vinylester VIA · V4A	Nan Ya Vinylester VIA · V4A	300	0.29	1. The air-drying agent · for example wax, must be added · 2. This layer must be wait at least 72 hrs after top coating ·
	Strengthen Layer of Surface Veil	1	1. Nan Ya Vinylester VIA · V4A 2. Surface Veil	Laminated Nan Ya Vinylester VIA · V4A With 30 g/m ² Glass Fiber surface Veil	670	0.6	1. Got rid out of air bubbles · 2. Keep Surface smoothly ·
		3-6	1. Nan Ya Vinylester VIA · V4A 2. Glass Fiber Mat or Woven Cloth	1. 450g/m ² Glass fiber mat laminated with Nan Ya Vinylester VIA · V4A 2. 300 g/m ² Glass Fiber Mat laminated with Nan Ya Vinyl-ester VIA · V4A	1000 670	0.9 0.6	1. Got rid out of air bubbles · 2. Keep Surface smoothly ·
	Under Coating	1	Nan Ya Vinylester VIB	Nan Ya Vinylester VIB	300	0.29	1. No oil, dusty and fully dry surface on substratum before the ST primer coating ·
		1. Be sure to confirm the concrete substratum is dried and its water content is less than 8% · 2. No paint, dusty and oil on the surface · 3. Keep surface of concrete smoothly ·					



This section lists chemical resistance of NAN YA vinylester resins. It gives the maximum service temperature at different chemicals according to ASTM C581-87, and the justified standardization is :

- The known maximum temperature at which equipments made with NAN YA vinylester resins has given good service.
- Each retention of Barcol hardness, Flexural strength and modulus is applied to use, or not to use under each chemical conditions. If the retention after 6 months is higher than 60%, and then maintain above 50% after one year, it is allowed to use under such condition.

If exposure or contact is intermittent or is to fumes or spills only, it is possible to get good service at temperatures considerably high than those shown.

Some related products of V1A01 · V4A01 are unlisted in the table but the given values apply to all members of the related products. In the following table 7 a blank indicates that no full data are available or under test. "NR" means "Not Recommended", and "ALL" means the chemical is 100% concentration.



Table 8: Maximun service temperature and chemical enviroment of NAN YA resins

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
A			
Acetaldehyde	All	NR	NR
Acetic Acid	0-25	99/210	99/210
	25-50	82/180	99/210
	50-75	65/150	82/180
Acetic Anhydride	All	NR	38/100
Acetone	100	NR	NR
Acrylic Acid	25	38/100	38/100
Alcohol,Buryl	All	49/120	49/120
Alcohol,Ethyl	10	65/150	65/150
	100	27/80	38/100
Alcohol,Isopropyl	10	65/150	65/150
	100	49/120	49/100
Alcohol,Methyl	10	65/150	65/150
	100	NR	38/100
Alcohol, Mehtyl Isobutyl	10	65/150	65/150
Alcohol, Secondary Butyl	10	65/150	65/150
Allyl Chloride	All	27/80	27/80
Alum	All	99/210	121/250
Aluminum Chloride	All	99/210	121/250
Aluminum Fluoride	All	27/80	27/80
Aluminum Hydroxide	All	82/180	93/200
Aluminum Nitrate	All	82/180	82/180
Aluminum Potassium Sulfate	All	99/210	121/250
Ammonia Aqueous	0-20	65/150	65/150
Ammonia Gas		38/100	65/150
Ammonia Liquid		NR	NR
Ammonium Acetate	65	27/80	27/80
Ammonium Bicarbonate	0-50	71/160	71/160
Ammonium Bisulfite	All	65/150	65/150
Ammonium Carbonate	All	65/150	65/150
Ammonium Chloride	All	99/210	99/210
Ammonium Citrate	All	65/150	65/150
Ammonium Fluoride	All	65/150	65/150
Ammonium Hydroxide	5	82/180	82/180
	10	65/150	65/150
	20	65/150	65/150
	29	38/100	38/100
Ammonium Nitrate	All	99/210	121/250
Ammonium Persulfate	All	82/180	82/180
Ammonium Phosphate	All	99/210	99/210
Ammonium Sulfate	All	99/210	121/250
Amyl Acetate	100	NR	49/120

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Aniline	All	NR	21/70
Aniline Hydrochloride	All	82/180	82/180
Aniline Sulfate	All	99/210	99/210
Aesenious Acid	All	82/180	82/180
B			
Barium Acetate	All	82/180	82/180
Barium Carbonate	All	99/210	121/252
Barium Chloride	All	99/210	99/210
Barium Hydroxide	0-10	65/150	65/150
Barium Sulfate	All	99/210	121/250
Barium Sulfide	All	82/180	82/180
Benzene	100	NR	38/100
5% Benzene in Kerosene		99/210	99/210
Benzene Sulfonic Acid	50	65/150	65/150
O-Benzoyl Benzoic Acid	All	99/210	99/210
Benzoic Acid	All	99/210	99/210
Benzyl Alcohol	100	NR	38/100
Benzyl Chloride	100	NR	27/80
Black Liquor Recovery(Furnace gasses)		163/325	204/400
Brass Plating Solution:		82/180	82/180
(3% Copper Cyanide 、6% Sodium Cyanide 1% Zinc Cyanide 、 3% Sodium Carbonate)			
Bromine, Liquid		NR	NR
Bromine Water	5	82/180	88/190
Bronze Plating solution:		82/180	88/190
(4% copper Cyanide 、5% Sodium Cyanide 3% Sodium Carbonate 、4.5% Rochelle Salts)			
Butyl Acetate	100	NR	27/80
Butyric Acid	0—50	99/210	99/210
	100	27/80	49/120
Butyl benzyl phthalate BBP	100	82/180	99/210
Butyl Carbitol BC	100	38/100	38/100
Butyl Cellosolve BCS	100	27/80	38/100
Butylene Glycol BG	100	71/160	82/180
C			
Cadmium Chloride	All	82/180	82/180
Cadmium Cyanide		82/180	93/200
(Plating Solution:3% Cadmium Oxide 10% Sodium Cyanide 、1% Caustic Sode)			
Calcium Bisulfite	All	82/180	82/180
Calcium Carbonate	All	82/180	82/180
Calcium Chlorate	All	99/210	121/250
Calcium Chloride	All	99/210	121/250
Calcium Hydroxide	All	82/180	99/210

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Calcium Hydroxide	All	71/160	82/180
Calcium Nitrate	All	99/210	99/210
Calcium Sulfate	All	99/210	121/250
Calcium sulfite	All	82/180	82/180
Cane Sugar Liquor	All	82/180	82/180
Caprylic Acid	100	82/180	99/210
Carbon Dioxide		99/210	171/340
Carbon Disulfide		NR	NR
Carbon Monoxide		99/210	171/340
Carbon Tetrachloride	100	65/150	82/180
Carbon Acid		65/150	65/150
Carbowax(PEG)		65/150	82/180
Castor Oil		99/210	99/210
Carboxy Methyl Cellulose	10	65/150	65/150
Chlorinated Brine Liquors			88/190
Chlorinated Wax	All	82/180	82/180
Chlorine Dioxide/Air	15	93/200	93/200
Chlorine Dioxide,Wet Gas	Satd.	82/180	82/180
Chlorine Dry Gas	100	99/210	121/250
Chlorine Wet Gas	100	99/210	121/250
Chlorine Liquid		NR	NR
Chlorine Water	All	82/180	99/210
Chlorosulfonic Acid	25	49/120	65/150
	50	38/100	49/120
	Con	NR	NR
Chlorobenzene	100	NR	38/100
Chloroform	100	NR	NR
Chlorosulfonic Acid	100	NR	NR
Chrome Plating Bath:		49/120	65/150
(19% Chromic Acid Sodium Fluorosillicate Sulfate)			
Chromic Acid	20	49/120	65/150
	30	NR	49/120
Chromium sulfate	All	65/150	82/180
Citric Acid	All	99/210	99/210
Coconut Oil		99/210	99/210
Copper chloride	All	99/210	121/250
Copper cyanide	All	99/210	99/210
Copper Fluoride	All	99/210	99/210
Copper Nitrate	All	99/210	99/210
Copper Plating Solutions:		71/160	88/190
(Copper Cyanide : 10.5% Copper 14% Sodium Cyanide 6% Rochelle Salts)			

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Copper Brite Plating Caustic-Cyanide		71/160	88/190
Copper Plating Solution: (45% Copper Fluoroborate 19% Copper Sulfate 8% Sulfuric Acid)		82/180	93/200
Copper Matte Dipping Bath: (30% Ferric Chloride 19% Hydrochloric)		82/180	93/200
Copper Pickling Bath:10% Ferric Sulfate		93/200	93/00
Copper Sulfate	All	99/210	121/250
Corn Oil		82/210	99/210
Corn Starch	Slurry	99/210	99/210
Corn Sugar	All	99/210	99/210
Cottonseed Oil		99/210	99/210
Cresylic Acid	100	NR	NR
Crude Oil, Sour	100	99/210	121/250
Crude Oil, Sweet	100	99/210	121/250
Cyclohexane	100	49/120	65/150
Cyclohexanone		49/120	65/150
D			
Detergents, Sulfonated	All	99/210	99/210
Diallyl Phthalate(DAP)	All	71/160	82/180
Di-Ammonium Phosphate	65	99/210	99/210
Dibromophenol	100	NR	38/100
Dibutyl Ether	100	65/150	82/180
Dichloro Benzene	100	NR	49/120
Dichloroethylene	100	NR	NR
Dichloromonomethane	100	NR	NR
Dichloropropane	100	NR	38/100
Dichloropropene	100	NR	27/81
Diesel Fuel	100	82/180	9/2003
Diethanol Amine	100	49/120	49/120
Diethyl Amine	100	NR	NR
Diethyl Benzene	100	38/100	65/150
Diethyl Carbonate	100	NR	38/100
Diethylene Glycol	100	82/180	93/200
Diethylhexyl Phosphoric Acid(in Kerosene)	20	82/180	82/180
Diethyl Sulfate	100	38/100	49/120
Diisobutylene	100	38/100	65/150
Diisobutyl Phthalate(DIBP)	100	54/130	65/150
Diisopropanol Amine	100	49/120	65
Dimethyl Formamide DMF	100	NR	NR
Dimethyl Morpholine	100	NR	49/120
Dimethyl Phthalate(DMP)	100	65/150	82/180
Dioctyl Phthalate (DOP)	100	65/150	99/210
Dipropylene Glycol	100	82/180	99/210

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
DMA 4 Weed Killer	100	49/120	65/150
DMA 6 Weed Killer	100	49/120	65/150
Dodecyl Alcohol	100	65/150	82/180
Electrosol (Antistatic Agent)	5	65/150	65/150
Epichlorohydrin	100	NR	NR
Epoxidized Soybean Oil	100	65/150	65/150
Esters Fatty Acids	100	82/180	82/180
Ethly Acetate EAC	100	NR	21/70
Ethly Acrylate EA	100	NR	NR
Ethly Benzene	100	27/80	49/120
Ethly Bromide	100	NR	NR
Ethly Chloride	100	NR	NR
Ethly Ether	100	NR	NR
Ethylene Chlorohydrin	100	38/100	38/100
Ethly Glycol(EG)	All	99/210	99/210
Ethly Glycol Monobutyl Ether (BCS)	100	38/100	38/100
Ethyl Sulfate	100	27/80	38/100
F			
Fatty Acids	All	99/210	121/250
Ferric Chloride	All	99/210	99/210
Ferric Nitrate	All	99/210	99/210
Ferric Sulfate	All	99/210	99/210
Ferrous Chloride	All	99/210	99/210
Ferrous Nitrate	All	99/210	99/210
Ferrous Sulfate	All	99/210	99/210
8-8-8 Fertilizer		49/120	49/120
Fertilizer-Urea Amminium Nitrate		49/120	49/120
Flue Gas		163/325	204/400
Fluoboric Acid	All	82/180	99/210
Fluosilicic Acid	10	82/180	82/180
	20	49/120	49/120
Formaldehyde	All	65/150	65/150
Formic Acid	10	82/180	82/180
	All	38/100	38/100
Freon		38/100	38/100
Fuel Oil	100	82/180	99/210
Furfural	5	49/120	65/150
	10	38/100	49/120
	100	NR	NR
G			
Gas,Natural		99/210	99/210
Gasoline,Auto		82/180	82/180
Gasoline,Aviation		82/180	82/180

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Gasoline,Ethyl	100	82/180	82/180
Gasoline,Sour		82/180	82/180
Gluconic Acid	50	82/180	82/180
Glucose	All	99/210	121/250
Glutaric Acid	50	49/120	49/120
Glycerine	All	99/210	99/210
Glycolic Acid	10	82/180	93/200
G	70	38/100	38/100
Glyoxal	40	38/100	38/100
Gold Plating Solution:		82/180	82/180
63% Potassium Ferrocyanide			
0.2% Potassium Gold Cyanide			
0.8% Sodium Cyanide			
H			
Heeptame		82/180	82/180
Hexane		65/150	65/150
Hexylene Glycol		65/150	65/150
Hot Stack Gas		171/340	204/400
Hydraulic Fluid		99/210	99/210
Hydrazine		NR	NR
Hydrobromic Acid	0-25	82/180	82/180
	25-60	38/100	65/150
Hydrochloric Acid	0-20	99/210	110/230
	20-37	71/160	82/180
Hydrochloric Acid Saturated	30	82/180	110/230
Hydrocyanic Acid	ALL	99/210	99/210
Hydrofluroic Acid	10	65/150	65/150
	20	38/100	38/100
Hydrofluosilicic Acid	10	82/180	82/180
Hydrogen Bromide, Wet Gas	100	82/180	82/180
Hydrogen Chloride, Dry Gas	100	99/210	177/350
Hydrogen Peroxide	0-30	65/150	65/150
Hydrogen Sulfide, Dry	ALL	99/210	99/210
Hydrogen Sulfide, Aqueous Hydrogen	ALL	82/180	99/210
Fluoride, Vapor		82/180	82/180
Hydrosulfite Bleach		82/180	82/180
Hypochlorous Acid	10	82/180	82/180
	20	65/150	65/150
I			
Iron Plating Solution			
(45%FeCl2:15%CaCl2 :		82/180	99/210
20%FeSO4:11%(NH4)2SO4)			
Iron and Steel Cleaning Bath:		82/180	99/210
(9% Hydrochloric 23% Sulfuric)			

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Isopropyl Amine	ALL	38/100	49/120
Isopropyl Palmitate	100	99/210	110/230
J			
Jet Fuel		82/180	82/180
K			
Kerosene		82/180	82/180
L			
Lactic Acid	ALL	99/210	99/210
Lasso (50%Chlorobenzene)		NR	49/120
Latex	ALL	49/120	49/120
Lauroyl Chloride	100	38/100	49/120
Lauric Acid	ALL	99/210	99/210
Lead AcetateZ	ALL	99/210	104/220
Lead Nitrate	ALL	99/210	99/210
Lead Plating Solution:		82/180	82/180
(8%Lead : 0.8%Fluorboric Acid : 0.4% Boric Acid)			
Levulinic Acid	ALL	99/210	110/230
Linseed Oil		99/210	110/230
Lithium Bromide	ALL	99/210	121/250
Lithium Sulfate	ALL	99/210	99/210
M			
Magnesium Bisulfite	ALL	82/180	82/180
Magnesium Carbonate	ALL	82/180	82/180
Magnesium Chloride	ALL	99/210	110/230
Magnesium Hydroxide	ALL	99/210	110/230
Magnesium Sulfate	ALL	99/210	110/230
Maleic Acid	ALL	99/210	121/250
Mercuric Chloride	ALL	99/210	99/210
Mercurous Chloride	ALL	99/210	99/210
Methylene Chloride	100	NR	NR
Methyl Ethyl Ketone MEK	100	NR	21/70
Methyl Isobutyl Carbitol	100	NR	NR
Methyl Isobutyl Ketone (MIBK)	100	NR	NR
Methyl Styrene	100	NR	38/100
Mineral Oils		99	121/250
Molybdenum Disulfide	100	93	93/200
Monochloro Acetic Acid	100	NR	NR
Monoethynolamine	100	NR	NR
Motor Oil		99/210	110/230
Myristic Acid	100	99/210	110/230
N			
Naphtha	100	82/180	99/210
Naphthalene	100	82/180	93/200
Nickrl Chloride	ALL	99/210	99/210

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Nickel Nitrate	ALL	99/210	99/210
Nickel Plating (8% Lead 0.8% Fluoboric Acid 0.4%Boric Acid)		82/180	82/180
Nickel Plating (11%Nickel Sulfate 2%Nickel Chloride 1%Boric Acid)		82/180	82/180
Nickel Plating (44% Nickel Sulfate 4%Ammonium Chloride 4% Boric Acid)		82/180	82/180
Nickel Sulfate	ALL	99/210	99/210
Nitric Acid	5	65/150	82/180
	20	49/120	60/140
	52	NR	NR
Nitric Acid Fumes		71/160	82/180
Nitrobenzene	100	NR	38/100
O			
Oakite Rust Stripper		82/180	82/180
Octanoic Acid	100	82/180	99/210
Oil,Sour Crude	100	99/210	99/210
Oil, Sweet Crude	100	99/210	99/210
Oleic Acid	ALL	99/210	99/210
Oleum (Fuming Sulfuric)		NR	NR
Olive Oil	100	99/210	121/250
Oxalic Acid	ALL	99/210	99/210
P			
Perchlorethylene	100	27/80	49/120
Perchloric Acid	10	65/150	65/150
	30	38/100	38/100
Peroxide Bleach		99/210	99/210
Phenol	100	NR	NR
Phenol Sulfonic Acid	100	NR	NR
Phosphoric Acid	ALL	99/210	99/210
Phosphoric Acid Fumes		99/210	104/220
Phosphorous Pentoxide	0-54	99/210	99/210
Phosphorous Trichloride	100	NR	NR
Phthalic Acid	ALL	99/210	99/210
Pickling Acids, Sulfuric And Hydrochloric		99/210	99/210
Picric Acid, Alcoholic	10	NR	38/100
Polyvinyl Acetate Latex PVAC	ALL	99/210	99/210
Polyvinyl Alcohol(PVA)	100	49/120	49/120
Polyvinyl Chloride Latex			
With 35 parts DOP		49/120	49/120
Potassium Alum Sulfate	ALL	99/210	121/250
Potassium Bicarbonate1	0-50	65/150	65/150
Potassium Bromidee	ALL	99/100	99/120

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Potassium	ALL	65/150	65/150
Potassium Chloride	All	99/210	99/210
Potassium Dichromate	All	99/210	99/210
Potassium Ferricyanide	All	99/210	99/210
Potassium Ferrocyanide	All	99/210	99/210
Potassium Hydroxide	0-25	65/150	65/150
Potassium Nitrate	All	99/210	99/210
Potassium Permanganate	All	99/210	99/210
Potassium Persulfate	All	99/210	99/210
Potassium Sulfate	All	99/210	99/210
Propionic Acid	20	93/200	93/200
	50	82/180	82/180
	100	NR	38/100
Propylene Glycol	All	99/210	99/210
Pulp Paper Mill Effluent		82/180	82/180
Pyridine	100	NR	NR
R			
Rayon Spin Bath		65/150	65/150
S			
Salicylic Acid	All	60/140	71/160
Sebacic Acid	All	99/210	99/210
Selenius Acid	All	99/210	99/210
Silver Nitrate	All	99/210	99/210
Silver Plating Solution: (4% Silver Cyanide 7% Potassium Cyanide 5% Sodium Cyanide 2% Potassium Carbonate)		93/200	93/200
Soaps	All	99/210	99/210
Sodium Acetate	All	99/210	99/210
Sodium Aluminate	All	49/120	49/20
Sodium Alkyl Aryl Sulfonates	All	65/150	65/150
Sodium Benzoate	100	82/180	99/210
Sodium Bicarbonate	100	82/180	82/180
Sodium Bifluoride	All	49/120	49/120
Sodium Bisulfate	All	99/210	99/210
Sodium Bisulfite	All	99/210	99/210
Sodium Bromate	10	60/140	65/150
Sodium Bromide	All	99/210	99/210
Sodium Carbonate	0-25	82/180	82/180
	35	71/160	82/180
Sodium Chlorate	All	99/210	99/210
Sodium Chloride	All	99/210	99/210
Sodium Chlorite	15	65/150	65/150
Sodium Chromate	50	99/210	99/210
Sodium Cyanide	All	99/210	99/210

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Sodium Dichromate	All	99/210	99/210
Sodium Diphosphate	All	99/210	99/210
Sodium Ferricyanide	All	99/210	99/210
Sodium Ferrocyanide	All	99/210	99/210
Sodium Fluoride	All	82/180	82/180
Sodium Fluoro Silicate	All	49/120	49/120
Sodium Hexametaphosphates	10	49/120	49/120
Sodium Hydroxide	5	82/180	65/150
	10	82/180	65/150
	25	82/180	82/180
	50	99/210	91/200
Sodium Hydrosulfide	All	99/210	99/210
Sodium Hypochlorite	0-5	65/150	82/180
	5-15	82/180	82/180
Sodium Lauryl Sulfate (SLS)	All	82/180	82/180
Sodium Mono-Phosphate	All	99/210	99/210
Sodium Nitrate	All	99/210	99/210
Sodium Nitrite	All	99/210	99/210
Sodium Persulfate	20	54/130	54/130
Sodium Silicate	All	99/210	99/210
Sodium Sulfate	All	99/210	99/210
Sodium Sulfide	All	99/210	99/210
Sodium Sulfite	All	99/210	99/210
Sodium Tetra Borate	All	93/200	93/200
Sodium Thiocyanate	57	82/180	82/180
Sodium Thiosulfate	All	82/180	82/180
Sodium Tripolyphosphate	All	99/210	99/210
Sodium Xylene Sulfonate	All	82/180	82/180
Sorbitol Solutions	All	71/160	82/180
Sour Crude Oil	100	99/210	121/250
Soya Oil	All	99/210	99/210
Stannic Chloride	All	99/210	99/210
Stannous Chloride	All	99/210	99/210
Stearic Acid	All	99/210	99/210
Styrene	100	27/80	49/120
Succinonitrile	All	27/80	38/100
Sugar,Beet and Cane Liquor	All	82/180	82/180
Sugar, Sucrose	All	99/210	99/210
Sulfamic Acid	0-25	99/210	99/210
Sulfanilic Acid	All	99/210	99/210
Sulfated Detergents	All	99/210	99/210
Sulfur Dioxide, Dry or Wet SO2		99/210	121/250
Sulfur Trioxide /Air SO3	All	99/210	149/300

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
Sulfluric Acid	0-50	99/210	99/210
	50-70	82/180	82/180
	75	49/120	49/120
	Over 75	NR	NR
Sulfurous Acid	10	49/120	49/120
Superphosphoric Acid	105	99/210	99/210
T			
Tall Oil		93/200	104/220
Tannic Acid	All	99/210	99/210
Tartaric Acid	All	99/210	99/210
Tetrachloroethylene	100	27/80	38/100
Tetrasodium Ethylene-diaminetetra			
acetic Acid	All	49/120	49/120
Textone-50% Aqueous Sodium Chlorate		99/210	99/210
Thioglycolie Acid	10	27/80	38/100
Thionyl Chloride	100	NR	NR
Tin Plating		93/200	93/200
(18%Stannous Fluoroborate 7% Tin			
9% Fluorboric Acid 2% Boric Acid)			
Toluene	100	27/80	
Toluene Sulfonic Acid(PTSA)	All	99/210	49/120
Transformer Oils :			99/210
Mineral Oil Types		99/210	149/300
Chloro-Phenyl Types		NR	NR
Trichloro Acetic Acid	50	99/210	99/210
Trichloroethane	100	38/100	54/130
Trichloroethylene	100	NR	NR
Trichloromonofluoro-Methane	100	27/80	38/100
Trichlorophenol	100	NR	NR
Tricresyl Phosphate (TCP)	100	71/160	71/160
Tridecylbenzene Sulfonate	All	99/210	99/210
Triethanolamine	100	49/120	49/120
Trimethylene Chlorobromide	100	NR	NR
Trisodium Phosphate	All	99/210	99/210
Turpentine	100	65/150	82/180
Tween Surfactant	All	65/150	82/180
U			
Urea	0-50	65/150	65/150
V			
Vegtable Oils		99/210	99/210
Vinegar		99/210	99/210
Vinyl Acetate VAC	100	NR	NR
Vinyl Toluene	100	27/80	49/120

CHEMICAL	CONCENTRATION (% by weight)	MAXIMUM RECOMMENDED TEMPERATURE (°C/°F)	
		V1A01	V4A01
W			
Water			
Deionized		99/210	99/210
Demineralized		99/210	99/210
Distilled		99/210	99/210
Fresh		99/210	99/210
Salt	ALL	99/210	99/210
Sea		99/210	99/210
White Liquor(Pulp Mill)		82/180	82/180
X			
Xylene	100	27/80	49/120
Zinc Chlorate	ALL	99/210	149/300
Zinc Nitrate	ALL	99/210	99/210
Zinc Plating Solution:		82/180	82/180
9% Zinc Cyanide			
4% Sodium Cyanide			
9% Sodium Hydroxide			
Zinc Plating Solution:		93/200	93/200
49% Zinc Fluoborate			
5% Ammonium Chloride			
6%Ammonium Fluoroborate			
Zinc Sulfate	ALL	99/210	99/210

Certificate





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