



# Fibre Relining of Swimming Pools



Paper by:  
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– NCS Resins



## Overview

1. Why use glass fibre composites for lining swimming pools?
2. What is a composite?
3. What is GRP?
4. What is glass fibre? What is its function?
5. What is resin? What is its function?
6. Finishing? What about colour?
7. Methods of fabrication?
8. Raw material quantities?
9. What standards apply? Quality?
10. Safety
11. Conclusion



# 1. Why use glass fibre composites for lining swimming pools?





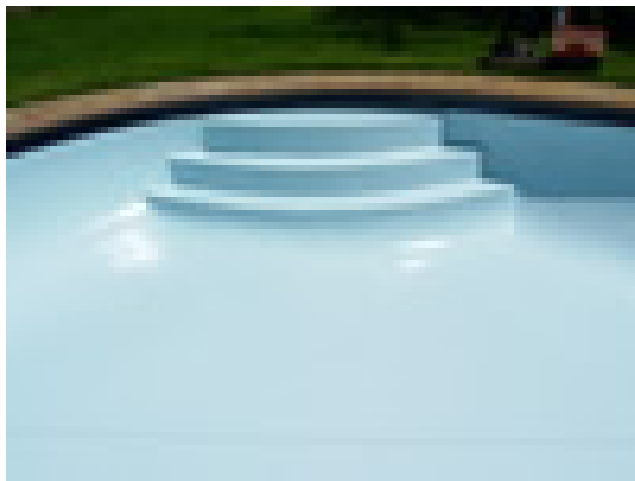
## **Glass fibre linings are:**

- **Waterproof (not impermeable)**
- **Coloured**
- **Adhere well to the substrate wall**
- **Resist attack by water treatment chemicals**
- **Are inherently flexible**
- **Design freedom**
- **Do not contain chemicals that can leach out and affect pool water pH**
- **Cost effective as they require lower levels of pool chemicals than concrete or marble plastered pools**



## The real reasons:

- **Fantastic smooth surface finish**
  - **Ease of maintenance**





## **2. What is a composite?**



**A composite is a material made from two or more dissimilar materials that, when combined, are stronger than those individual materials by themselves.**

Unsaturated polyester resin is strong in compression and relatively weak in tension  
Glass fibre is strong in tension and weak in compression



**By combining the two materials, GRP becomes a material that resists both compressive and tensile forces well.**





## **3. What is GRP?**



Glass fibre reinforced plastic or glass fibre reinforced polyester (GRP) are light weight, astonishingly tough composite constructional materials.

Virtually no size limits eg. Large yacht hulls, wind turbine blades, chimney stacks



## Marine

### Product

**Mirabella V** – worlds largest composite ship  
Length: 75m

### Customer

**VT Shipbuilding, UK**  
World leading exporter of naval vessels.

### Environment

Demanding ocean/sea conditions.

### VE resin used

Dion® 9102-502 - Infusion grade  
Dion® 9100-700 - Hand lay Up  
Offer outstanding toughness, fatigue and lightweight characteristics.

### Fabrication

Hull skins  
VE resin with stitched multiaxial  
E-glass reinforced with several plies of aramid.

### Deck and hull

Foam sandwich structure – VE resin and glass reinforcement , with use of carbon fibre in areas of high loading.

### Internal decks, tanks and interior bulkheads

Comprised of foam-cored sandwich panels which were vacuum infused with VE.



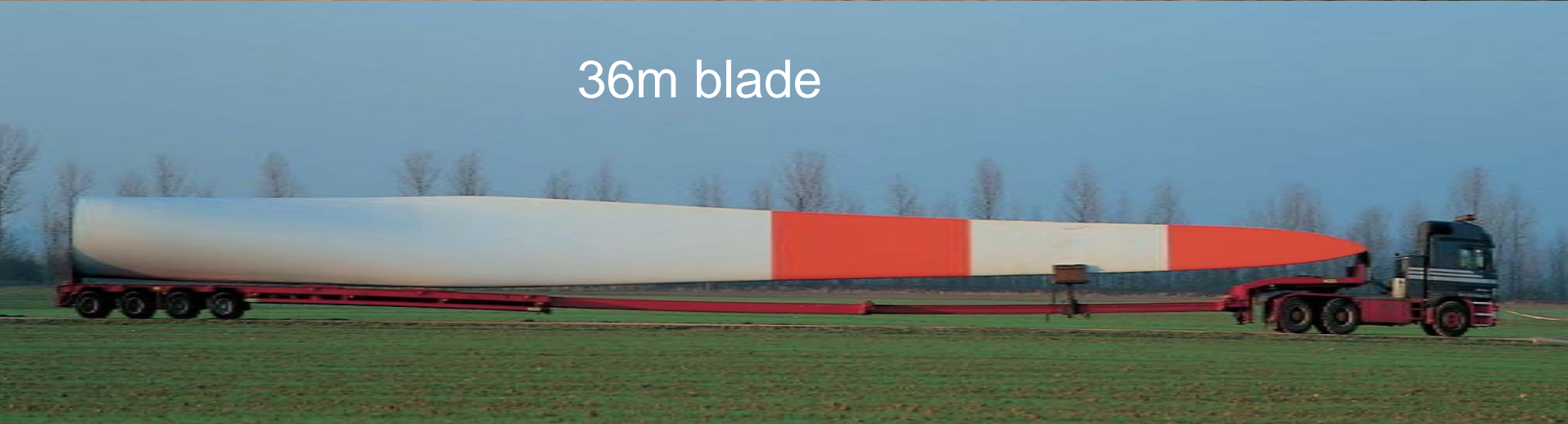
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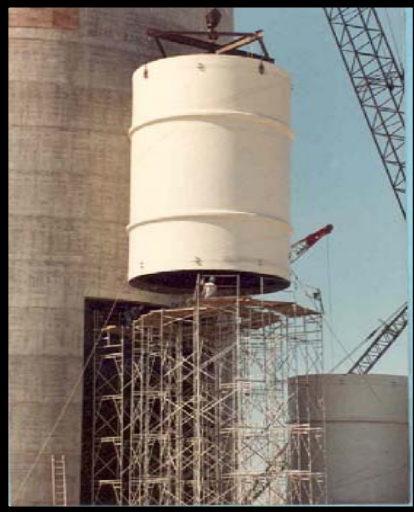
61m blade



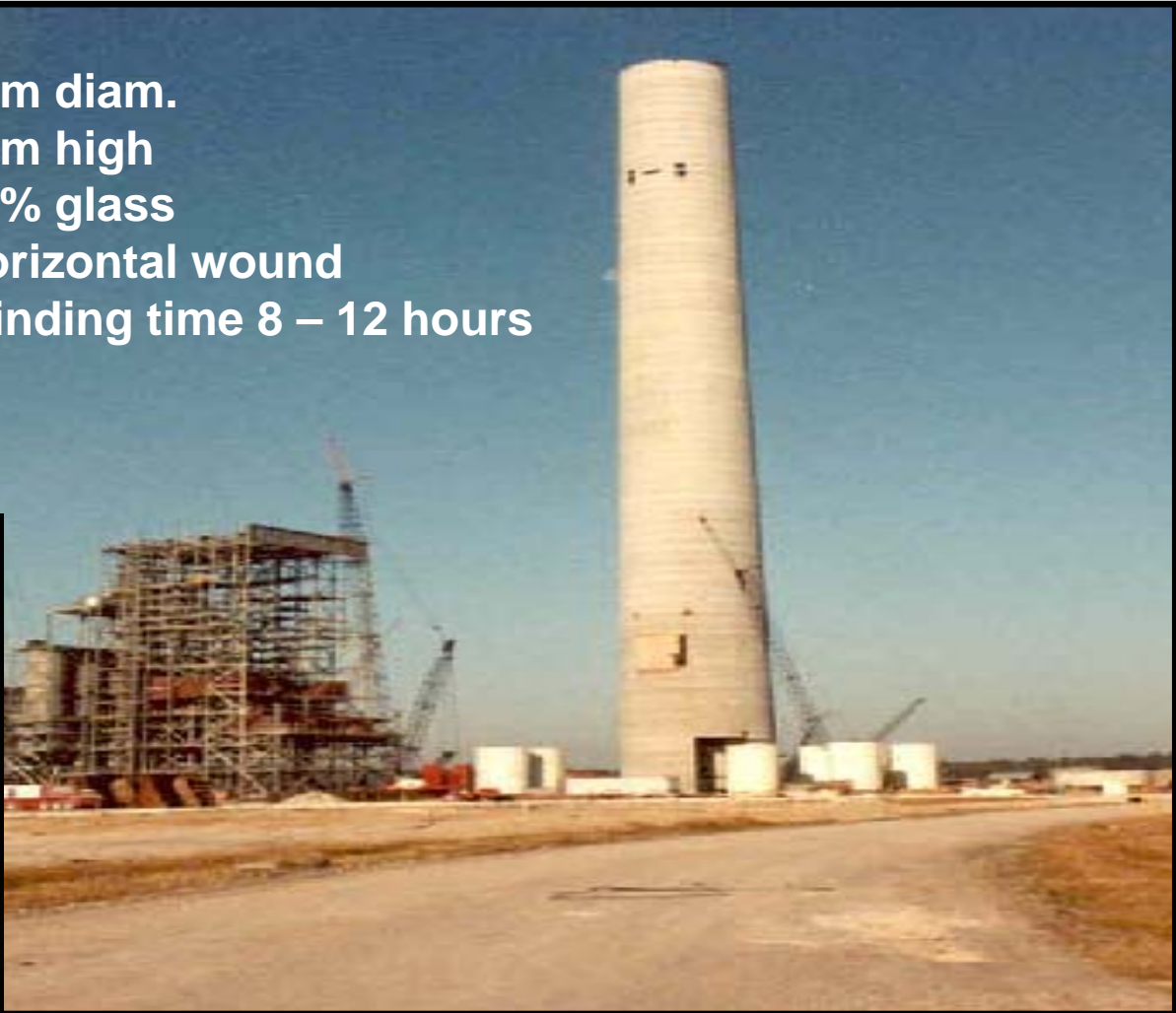
36m blade



# NCS RESINS



10m diam.  
12m high  
60% glass  
Horizontal wound  
Winding time 8 – 12 hours





**4. What is glass fibre? What is its function?**



**Glass fibre is made by rapidly drawing and cooling molten glass.**

**Glass fibre is made from readily available raw materials**

**Glass fibre is among the strongest of all materials**

**Glass fibre is non-combustible and chemically resistant**

**It is the ideal reinforcing material for polymer composites**



**E-glass**, is an alumino-borosilicate glass that is alkali free. This is the most commonly used glass fibre.

**E-CR** glass is a corrosion resistant form of E-glass

**S-glass** is used when the highest tensile strength is required.

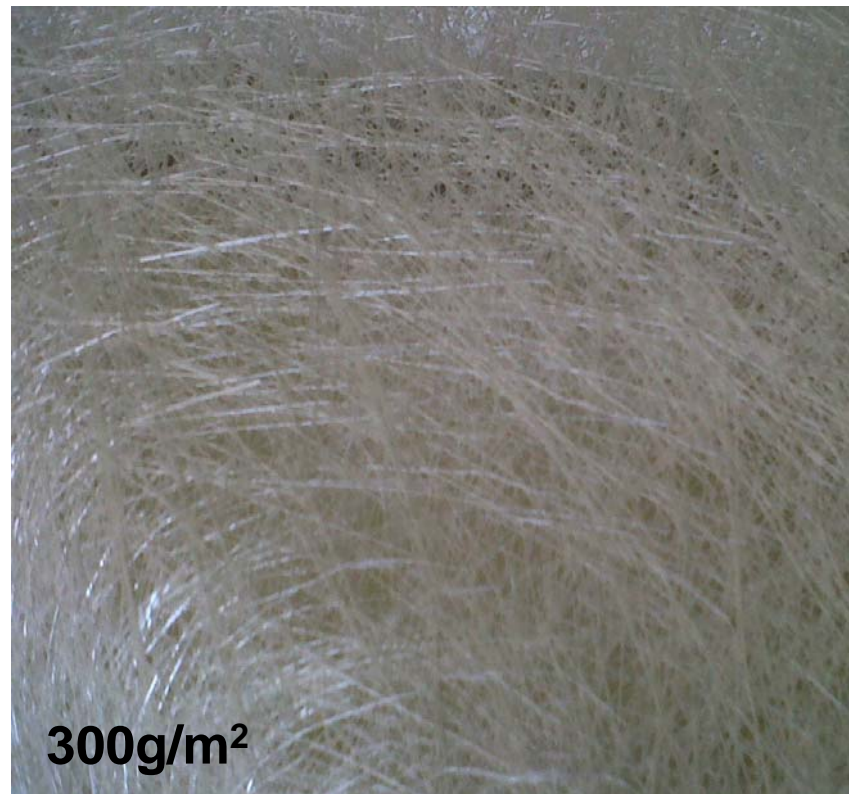
**C-glass** was developed to resist attack from chemicals, mostly acids that destroy E-glass.

**Advantex-glass** has, like **E-CR** glass, significantly improved the performance of **E-glass** in acidic stress corrosion conditions and improved environmental manufacturing conditions.





## Popular CSM types



**M144 'E'- glass fibre chopped strand mat**

**M243 'Advantex'- chopped strand mat**



The benefits of **Advantex** glass fibre made  
by  
**Owens Corning Vetrotex**



# Fluorides eliminated

- Trad. E-glass formulation

up to 1% Fluorides added (Fiberization aid)

emissions : 0,2 to 1,0 kg/melted ton

- Advantex<sup>®</sup> glass : no added fluorides

current emissions (0.05-0.1) are at level of best available techniques

no investment or energy required to treat smoke



# Particulates reduced

## Trad. E-glass formulation

- contains ~ 6% B<sub>2</sub>O<sub>3</sub>
- 85% of particulates emissions : from borates

## Advantex<sup>®</sup> glass composition : no Boron

- reduced particulate emissions by about 85%.
- no investment, no energy consumption,  
no need to manage collected particulates.



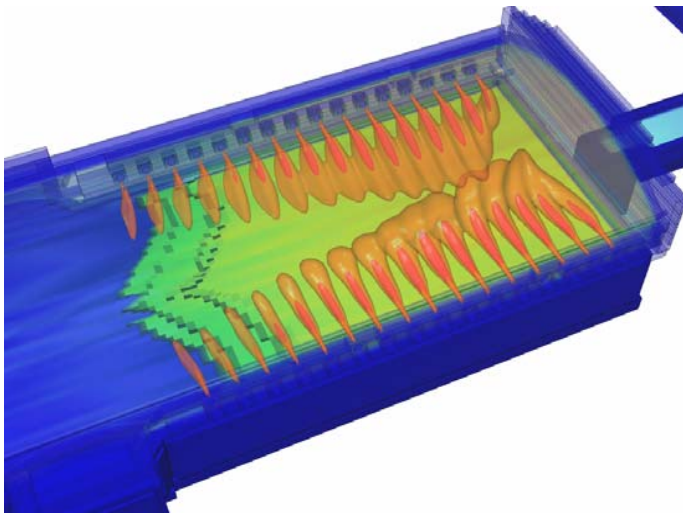
Trad. E-glass Furnace Technology :  
1600°C - with side burners

High energy → fossile fuels  
→ high CO<sub>2</sub>

E-CR glass → higher melting T°

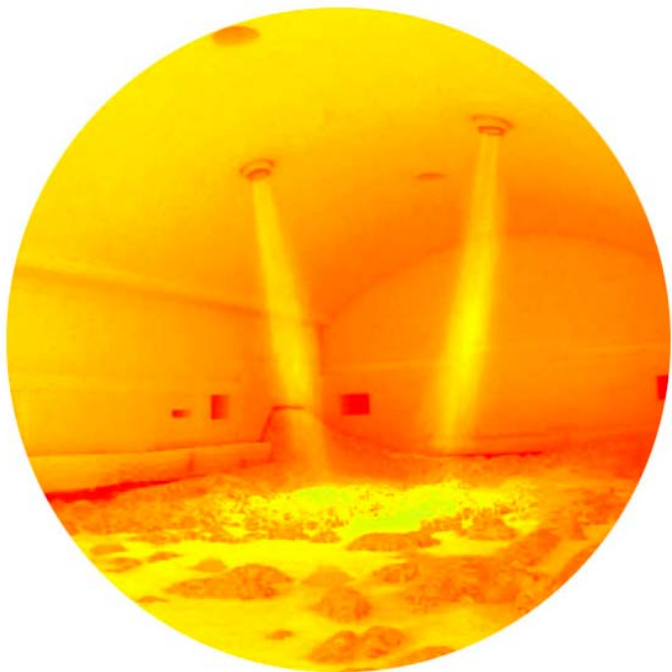
Air as combustion agent → NO<sub>x</sub>

(typically 4,5 kg/ton E-glass)





## New Advantex® glass furnace technology



Optimized design → higher energy

efficiency → Reduced CO<sub>2</sub> / ton

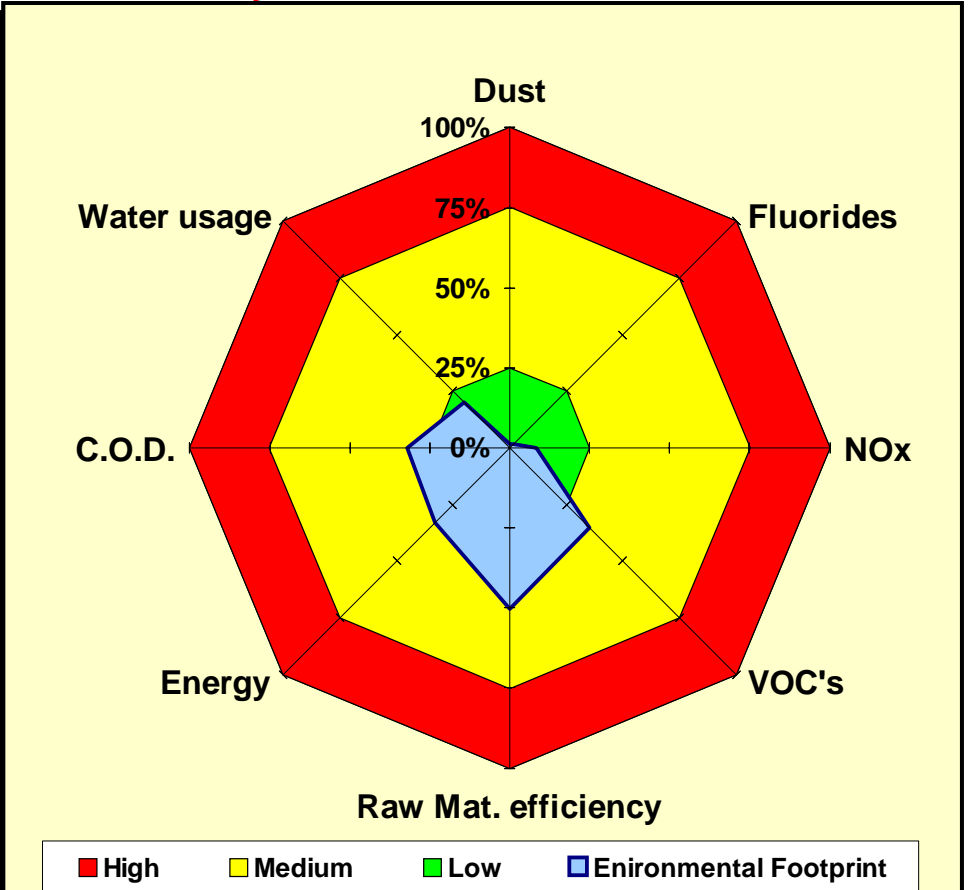
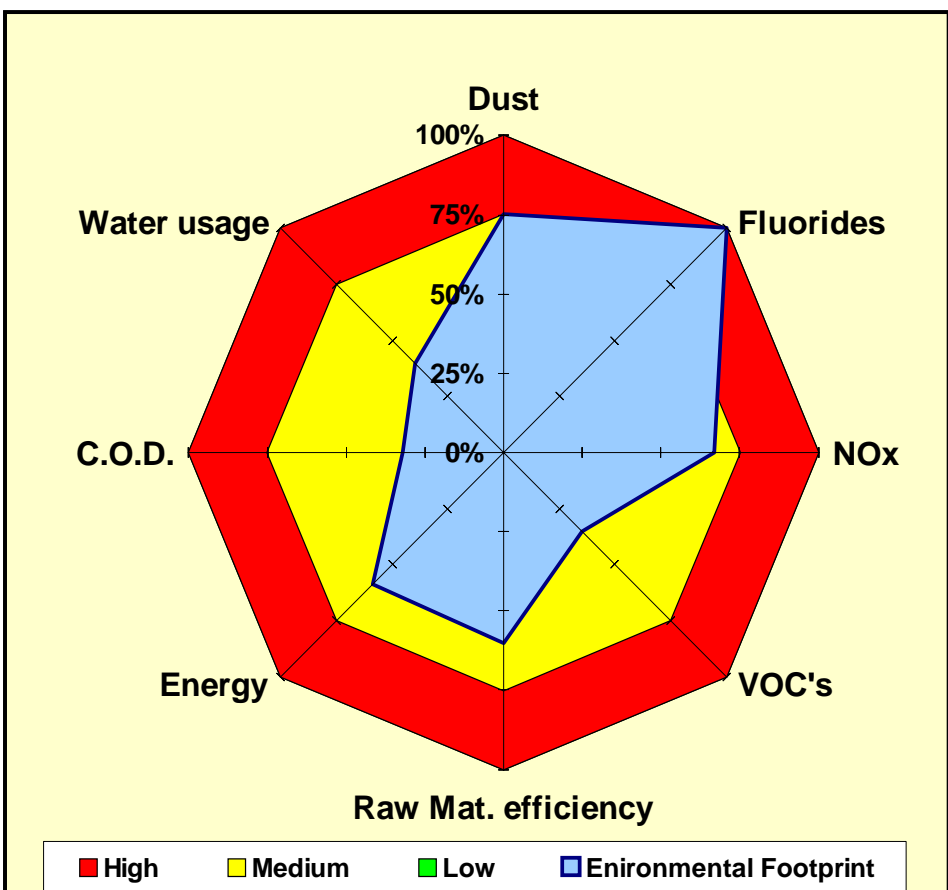
O<sub>2</sub> (instead of air) → Reduced NO<sub>x</sub>  
and CO<sub>2</sub> emissions

Patented and proven technology



Continually Shrinking Environmental Footprint – Example of an OC plant  
 Actual savings may differ slightly from plant to plant

Less Impact on the Environment



High Medium Low Environmental Footprint

High Medium Low Environmental Footprint

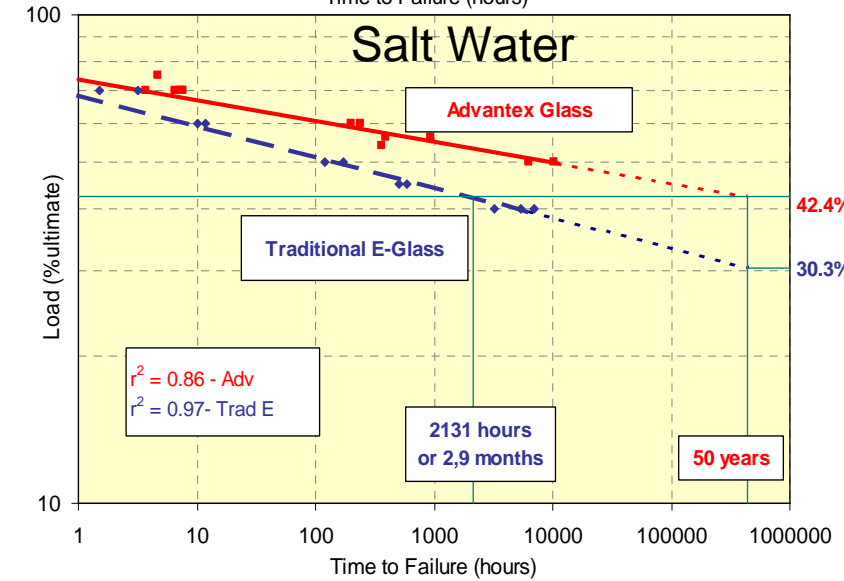
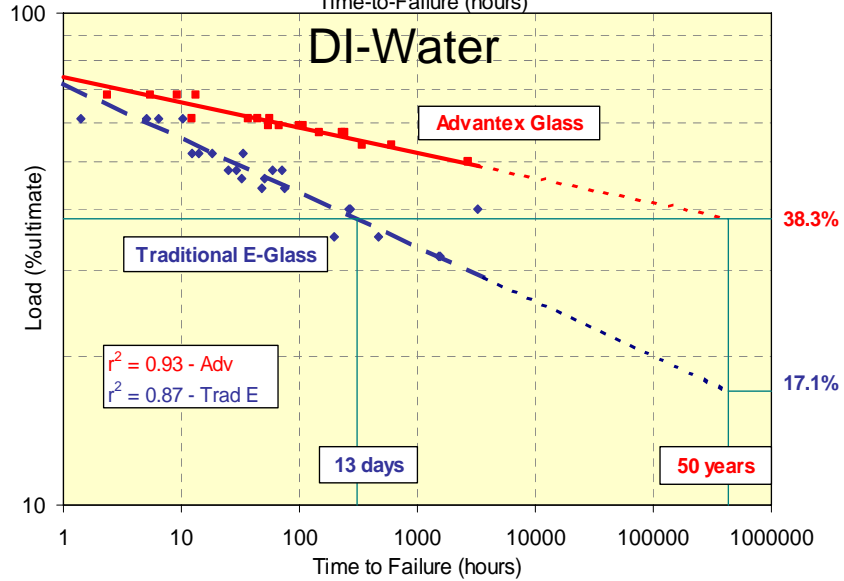
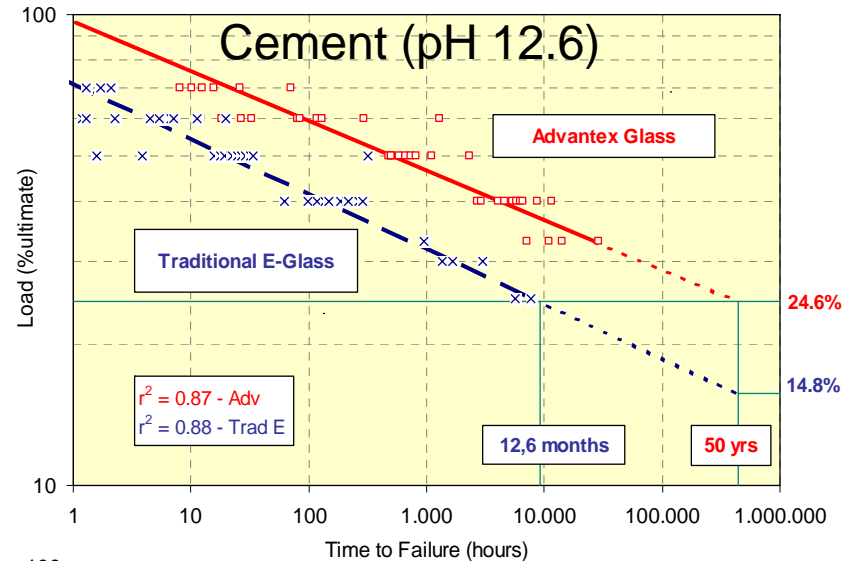
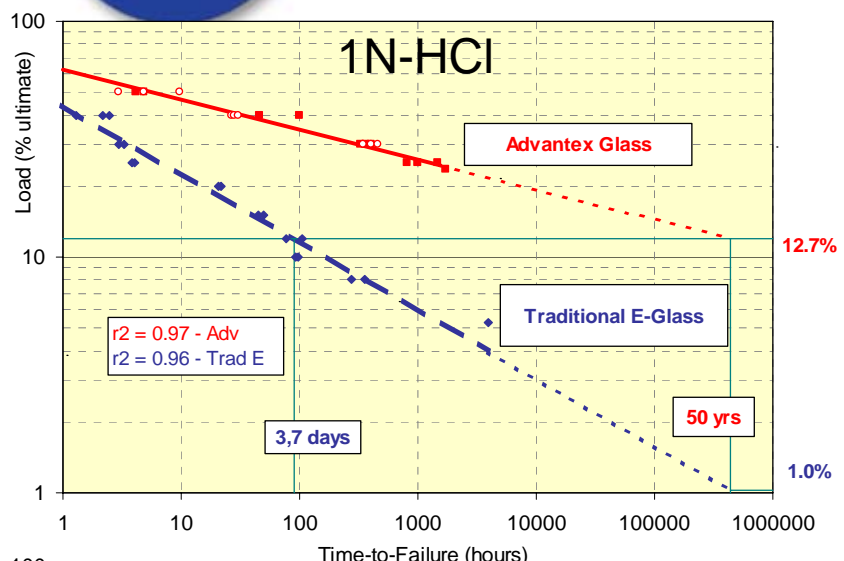


## Stress-Corrosion of Composite Rods with Advantex® Glass



iso-polyester pultruded rods ( $\text{Ø}$  6.35mm)  
glass contents (mass)  $\sim$  75 %







## **5. What is resin? What is its function?**



## **Thermoplastics**

- soften and melt when heated**
- process is reversible on cooling**

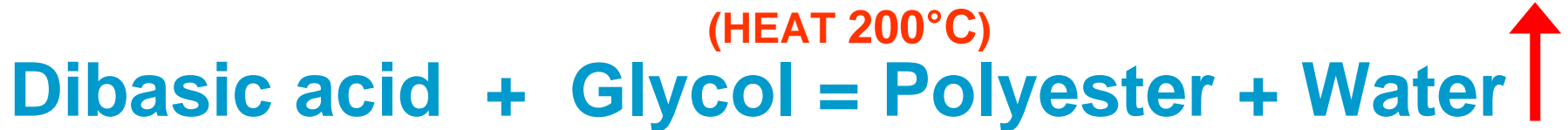
## **Thermosets**

- soften at HDT, but do not melt because during their formation they have undergone a chemical cross-linking reaction**



**Raw materials are derived from oil and coal**

**Reaction:**



**Polyester is dissolved in styrene monomer to produce usable unsaturated polyester resin**



**The function of resin in the composite is to provide the medium in which very high strength glass fibres are supported.**

**The resin protects glass fibres from damage through compression, abrasion, contact with water and other harmful substances.**



**Types of unsaturated polyester resin:**

**Orthophthalic polyester – general purpose**

**Isophthalic polyester – higher performance and corrosion resistant (Preferred for pools)**

**Isophthalic/neopentyl glycol – better chemical resistance than isophthalic polyesters (Preferred for primers, Poolcoats and gelcoats)**



## **6. Methods of fabrication?**



## Hand lay-up:

The simplest process to use - chopped strand mat (CSM) and catalysed resin are applied directly onto a primed substrate.

**Tools required:** Lambs wool rollers, brushes, measuring containers, buckets, mixing equipment, cleaning solvent, etc.





## Spray lay-up:

**Glass fibres rovings are chopped to length and applied simultaneously with catalysed resin onto a suitably primed substrate.**

**Equipment required: MVP Chopper gun,  
Suitable compressed air supply.**

**Tools: As for hand lay-up.**



## **Factors that make unsaturated polyester resins gel.**

- **Time in the container**
- **Heat**
- **UV light**
- **Initiators (Catalysts)**



**MEKP (Methyl ethyl ketone peroxide) is the universal initiator (catalyst)**

**BUTANOX M50 or M50VR MEKP initiator (catalyst)**

**Hydrogen peroxide – gel time**

**MEKP Type 4 – Initial cure**

**MEKP Type 3 – Final cure**

- Activated by heat**
- Delayed response**



**CURE means cross-linking**

**Too little initiator (catalyst) results in insufficient cross linking taking place to cure the resin.**

**Too much initiator (catalyst) results in the formation of polystyrene which reduces the cross-linking potential of the resin.**

**Both these conditions are not good for **Cure** and hence water resistance**



**Use MEKP in the range**

**1 – 3 parts per hundred resin**

**Never less nor more.**

**If it appears that conditions require more or less MEKP catalyst, ask your supplier for advice.**



**Temperature plays a major part in activating and assisting MEKP to cure the resin.**

**Safe temperature range for curing**

**15°C - 35°C**



## **Tests to determine the state of cure of a GRP laminate**

- Barcol hardness tester – field test**
- Residual styrene content – Lab test**
- Glass transition temperature – Lab test**



# **MINIMUM Cure time before filling a relined pool with water**

**Summer (high temperatures)      5-7 days,**

**Winter (lower temperatures)      10 days**





## Summary

- **Use between 1 and 3 phr of MEKP. Be sure to measure this accurately.**
- **Be sure to stir the MEKP into the resin so that it is uniformly dispersed**  
– **USE BUTANOX M50VR.**
- **Do not work with resin below 15°C or above 35°C (MEKP goes to sleep below 15°C).**
- **Remember that UV light has the effect of speeding up gellation and reducing potlife.**
- **Allow time to cure before filling pools with water. Heat helps to achieve good cure.**



## **7. Finishing - What about colour?**



**The coloured finish that makes a swimming pool attractive is applied as the final layer when the Poolcoat is applied.**

**Use 600g/m<sup>2</sup> as a minimum.**

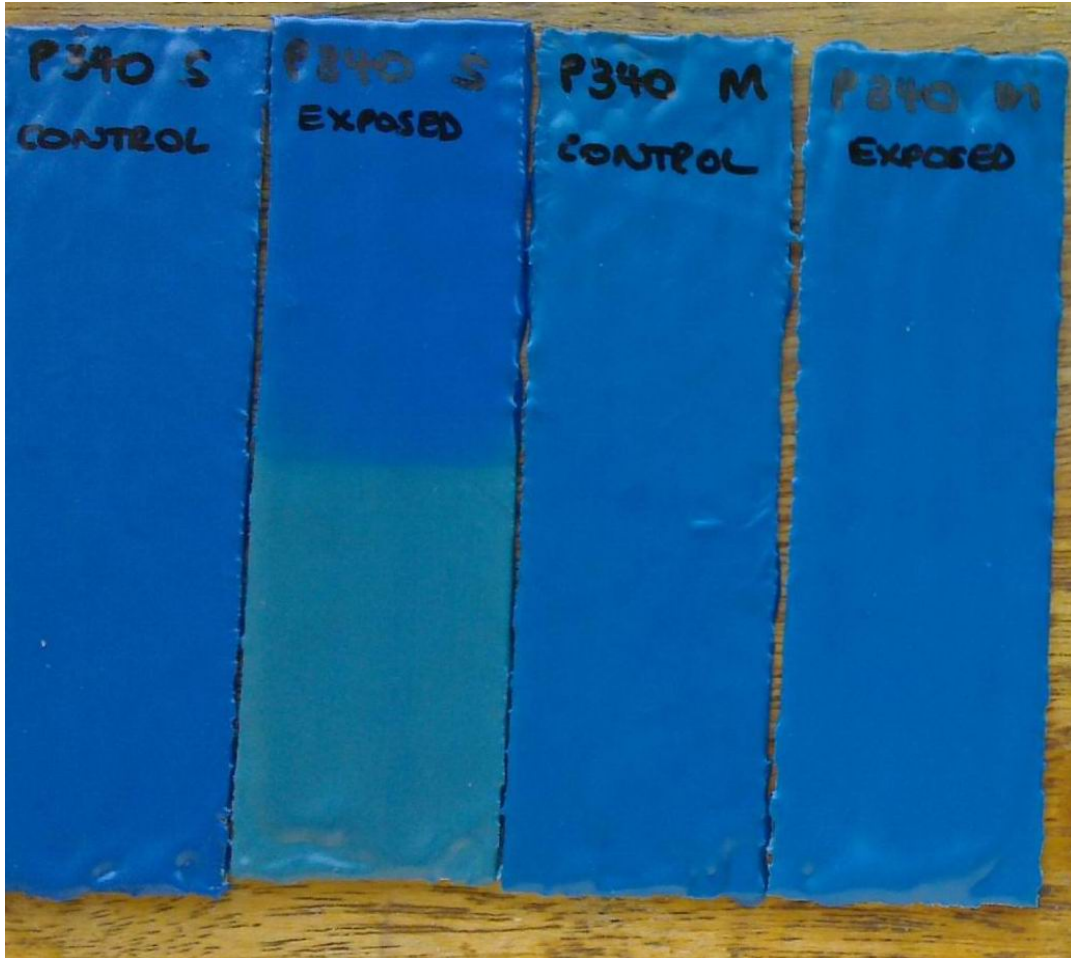
**Careful selection of pigments for swimming pools is essential. HTH, often used in swimming pools is a powerful bleaching agent.**

**Not all pigments are able to resist bleaching.**



**The Australian and New Zealand GRP swimming pool standard AS/NZS 1838:1994 Appendix E contains a useful test method that assists with selection of colours suitable for swimming pools.**

**The following example illustrates this point**



**Example**

**NCS Poolcoat 73P340PA was tested with two different pigments.**

**P340 S is the standard and P340 M is the modified pigment formulation.**

**This effect takes place in 18h at 60°C.**



## **8. Raw material quantities?**



How much resin to use for each laminate layer can be calculated by using the simple formulae below.

Primer mass = (Recommended kg/m<sup>2</sup> of Poolcoat) x (pool surface area, m<sup>2</sup>) kg

Mass of glass fibre mat = (Glass mass, kg/m<sup>2</sup>) x (pool surface area, m<sup>2</sup>) kg

Mass of resin required = (Total glass mass/kg) x 3kg

Mass of surface tissue = (Tissue mass, kg/m<sup>2</sup>) x (pool surface area, m<sup>2</sup>) kg

**NOTE 1:** All these amounts should be increased by 10% to allow for waste and overlaps.

**NOTE 2.** Use a resin to glass ratio of 3:1. ie 25% glass content

**NOTE 3.** Use a resin to surface tissue ratio of 10:1.



**Remember:**

**Resin is designed to protect the glass fibre reinforcement and bind it together.**

**It is essential that the laminate is thoroughly wet with resin and that air bubbles are removed or kept to a minimum.**

**A “dry laminate” cannot perform as the desirable properties of a composite do not exist.**

**Similarly an under cured resin laminate will not perform as the resin in an uncured state cannot protect the glass reinforcement as expected.**





## **9. What standards apply? Quality?**



# **SANS 10209:2004 Edition 1.4**

## **Appendix F**

### **Guidelines:**

**Wits Composites Facility Recommendations  
NCS Resins – Suggestions for lining swimming  
pools with glass reinforced polyester resin**



**Quality means conforming to requirements**

**Find out what the customer wants and meet that requirement consistently**



# 10. Safety?



**Resins, catalysts and cleaning solvents like acetone are hazardous chemicals.**

**TREAT THEM WITH RESPECT**

**Read the material safety data sheet for each product.**

**Teach your staff the hazards of each material.**

**Read the hazard warning printed on containers and take the warnings seriously**



## **General rules:**

**Work clean**

**Do not smoke**

**Avoid: open flames, sunlight and heaters**

**Never mix peroxides with accelerators or other substances**

**Leave peroxides in their original packaging and close the packaging after use**

**Use for weighing and handling only equipment compatible with peroxides (stainless steel, polyethylene (PE), polypropylene (PP) and polytetrafluoroethylene (PTFE))**



**Avoid skin contact - MEKP is harmful to the skin and makes painful burns on prolonged contact.**

**Wash hands with soap and water. Wear gloves.**

**Contact with eyes – Hold eye lids open and flush with large amounts of water for at least 15 minutes and get medical attention.**

**If inhaled – remove to fresh air immediately.**

**If swallowed – Do not induce vomiting. Call a physician immediately.**

**Protective clothing:  
Use safety shoes,  
gloves and safety  
glasses when  
working with  
catalysts.**

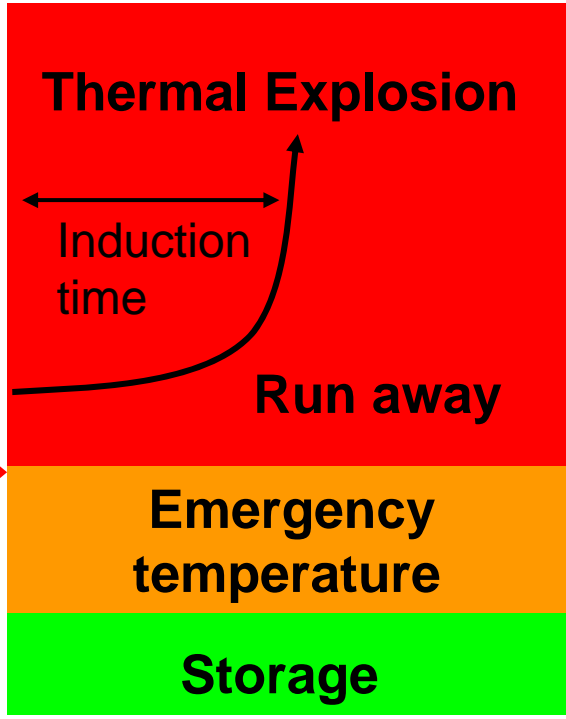






The self activating decomposition temperature (SADT) for MEKP is 60°C

Temperature ↑

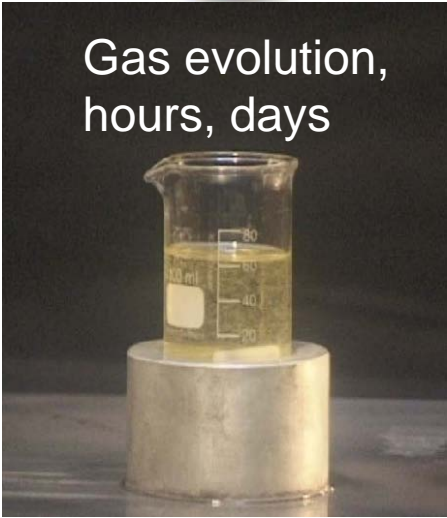


Unstable  
Quality loss gassing  
Stable

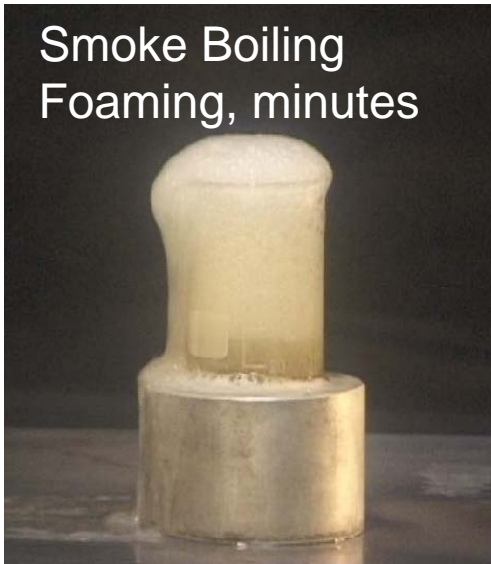
TIME →



Gas evolution,  
hours, days



Smoke Boiling  
Foaming, minutes



**Explosion !!!  
or Fire**



**MEKP does not ignite easily, but once it begins burning it burns with an intense flame and heat.**

**Peroxide fires cannot be extinguished by smothering because as they decompose they generate oxygen that fuels the fire.**



**Burning rate**

**Acetone  
0.5kg/min.m<sup>2</sup>**

**Butanox M50  
5.3kg.min.m<sup>2</sup>**



**Extinguish a small fire with powder or carbon dioxide fire extinguishers and use water to prevent reignition.**



**In case of a large fire  
CALL THE FIRE BRIGADE!!!**



# 11. Conclusion.



**For lasting trouble free swimming pool lining use:**

**Apply laminates with minimum voids – Quality**

**Iso polyester resin NCS 994, 995 or 993**

**Butanox M50VR catalyst**

**M243 'Advantex'- chopped strand mat**

**E-CR or C-glass surface tissue**

**NCS Poolcoat 73 PA**



**Remember to work safely**

**and that**

**CURE** is the key

**Thank you for listening.**