PVC Composites: Life Cycle Analysis & Recycling including an Australian case study

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Ferrari S.A.

BECOMING A MORE SUSTAINABLE BUSINESS

As a manufacturer of PVC coated products Ferrari S.A. recognised a decade or more ago the need to assume control over the environmental impacts of our business and also influence key suppliers to adopt similar environmental strategies to help position our company to meet emerging ecological sentiment.

Environmental trends in the 1990's, increasing anti-PVC sentiment (fuelled by misguided misinformation) and specifier resistance coalesced into a strategy to future proof our business through the early adoption of multiple environmental practices.

Significant alterations were made to our manufacturing processes and these included catalytic treatment of air from the production facility and the recycling of excess PVC pastes to manufacture a 'low end' tarpaulin fabric for the agricultural industry.

These changes were later to form a part of Ferrari's environmental management process which achieved accreditation under ISO 14001 in **XXXX**.

It was also recognised early in the process that the ability to recycle our materials would have a significant environmental benefit and this led to the formation of a joint venture between Ferrari S.A. and a key raw material supplier Solvay to develop a method of reclaiming the both the PVC and polyester fibres from a composite textile.

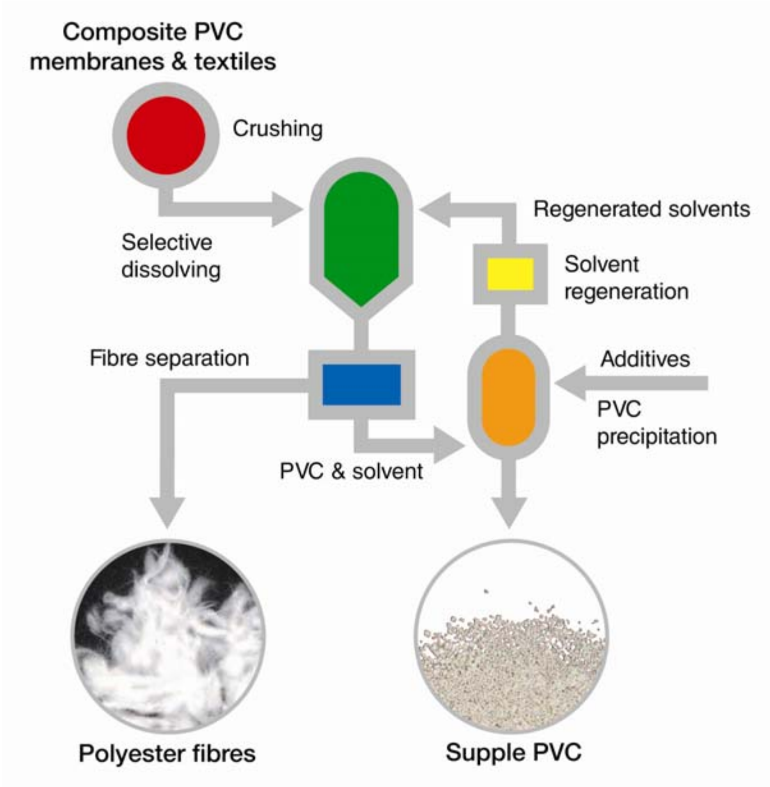
In fact, the investment in and the on-going operating costs of Texyloop may never be returned but without this facility and the other steps being taken it was very likely that our business would struggle for long term survival in the new era of "Environment first".

DEVELOPMENT OF TEXYLOOP

In 2002 a Pilot plant was established to adapt the Vinyloop Ferrara SpA recycling of vinyl to the more complex composite PVC/PES type textiles. One year later a technological test plant was built to prototype and test the scaled down version of the new process which was to become Texyloop.

Pilot in the Laboratory

Technological test 'Plant'



Schematic of the **closed loop** Texyloop process

By 2005 Ferrari's investment had topped 6 million Euros and the Texyloop process was launched as a full scale industrialised plant at a Solvay facility in Ferrara Italy. The plant Vinyloop® Ferrara is a partnership between SolVin itself a joint venture (75% Solvay, 25% BASF), two of Europe's largest PVC producers and Ferrari S.A.

For the first 2 years the plant was successful in the reclamation of the PVC element of composite textiles but it was not until 2007 that the PES polyester component could be separated in a form that was reusable.

Full scale Industrialised Texyloop Unit within the Vinyloop facility

Since 100% recycling of both composite elements commenced in 2007, the plant has recycled 2181 tonnes of membrane materials. These have been collected across Europe via a network of Texyloop 'collection agents' established and monitored by Ferrari S.A.

The PVC reclaimed from the process is returned to Ferrari at La Tour-Du-Pin for raw material replacement in the production of Batyline furniture textiles and the polyester fibres are on sold to other manufacturers for a variety of end products.

LIFE CYCLE ASSESSMENT (LCA)

The Life Cycle Assessment or LCA is a method of calculating and presenting the environmental impact of products from cradle to grave and has been ISO standardised to allow the direct comparison between materials and products that have differing production techniques.

In Ferrari's case a 1 square meter piece of fabric (at a known weight) is the base quantity used to calculate the LCA results. Ferrari employs an external consultant EVEA to conduct these studies and the results are then peer reviewed by worldwide specialists at the CIRAIG Institute in Canada.

The LCA study is performed across multiple criteria and evaluates around 15 different environmental impacts in the full scale study; some of these are water consumption, embodied energy, human toxicity and the depletion of natural resources.

The units of measurement are expressed either;

1) directly

for example * Water consumption is expressed as litres of water per sqm of fabric.

* Energy is expressed as Mega Joules per sqm of fabric.

or

2) by a Equivalent value measurement: **Eq**.

for example * Natural resource depletion is expressed in Kg Sb (Eq)

* Human toxicity is expressed in Kg DB (Eq)

Because manufacturing methods, raw materials and quantities vary in creating two products that might be used for the same application the LCA must find a way to express a given impact using a denominator common to both materials in order to compare the environmental impact of each.

The denominator chosen for natural resources is Antimony ore (Sb) which has a very precisely known TOTAL world resource value. Therefore the LCA converts the consumption of natural resources in a study into the equivalent (eq) of Kg of Antimony ore.

In a similar manner a different common denominator, Dichloro-Benzene is used for Toxicity comparisons. Dichloro-Benzene (DB) is an environmentally harmful chemical the impacts of which are well known and documented. The LCA therefore uses DB to standardise the toxicity impact for different materials.

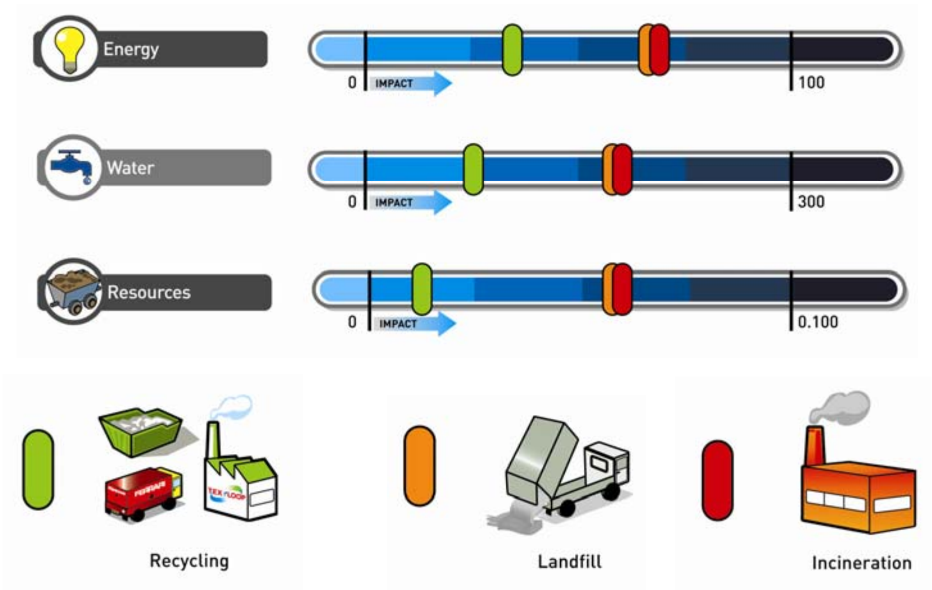
The conclusion we can draw from the Ferrari studies conducted to date is that on average about 80% of the environmental impact of our products are generated at the raw material extraction and processing level.

This is prior to any Ferrari production inputs so the environmental effect when the Texyloop system puts usable raw materials back into the marketplace the environmental impact of our materials are greatly reduced. (A portion of the results are represented in the following table)

NB. No DB is released or used in the production of Ferrari materials.

Impact category	**Unit**	Landfill Disposal	Texyloop ex France by Truck 500 km
Energy Consumption	MJ-Eq	54,795257	28,845274
Consumption of Resources	kg Sb eq	0,01969347	0,00996065
Global Warming Gases	kg CO2 eq	2,3837158	1,0801669
Ozone depleting CFC's	kg CFC-11 eq	2,37E-07	1,53E-07
Human Toxins	kg 1,4-DB eq	1,5965585	0,39101172
Toxicity fresh water	kg 1,4-DB eq	1,3245972	0,06141713

LCA numeric results part table (full table follows in the Australian case study results)



Pictorial presentation of a LCA study (portion only)

Recycling a PVC Tensile Membrane – An Australian Case Study

Ian Knox

Innova International Pty Ltd

In Australia there are no recycling facilities for PVC/PES composite materials and the likely volume of available material would not sustain the investment in one. This leaves our industry with no options other than landfill or incineration for the disposal of these materials; both choices are correctly deemed to be environmentally unsound in the long term.

Francoise Fournier explained previously the background and nature of the Texyloop / Vinyloop process and the LCA methodology. This supplementary paper looks at a true life Australian case study, pivotal we feel to the long term sustainability credentials of our industry.

We examine how the viability of collecting PVC composite materials locally for recycling in Europe was analysed and subsequently confirmed to be a feasible environmental solution.

Firstly we should acknowledge some of the reasons this study was undertaken. Australian lightweight structure businesses have been participating in a global market place for over 3 decades with Australian Architects, Fabricators, Engineers and Installation experts involved in prestigious projects around the world.

On many of these projects Australians were seen as pioneering and the leaders in the field. This presence overseas and the exchange of ideas and standards between Australian and overseas colleagues keeps our industry moving forward and adapting to the changing world in which we work.

The global focus on the environment has arguably been one of the most influential factors upon the building sector with the introduction of sustainable building guidelines and energy efficiency legislation at many levels of Government both in Australia and overseas.

Voluntary (and in some cases mandatory) environmental schemes like BREEAM, LEED, NABBERS and Green Star are in everyday use throughout our industry and are fast becoming the norm rather than the exception in terms of project focus and on the decision processes of specifiers and their customers.

These issues and the quiet, yet persistent feedback regarding PVC use in Architecture brought forward the timetable for discussions between Innova and Ferrari S.A. to investigate the viability of establishing Australian access to the Texyloop recycling process .

AUSTRALIAN CASE STUDY

To establish the efficacy of the proposal a Life Cycle Analysis (LCA) study was needed to ensure the environmental ‘cost’ of returning material to France did not outweigh the environmental benefit of the recycling itself.

Whilst a computer simulation would have predicted the result it was timely that Innova was contacted by UFS (Universal Fabric Structures) early in 2008 with a request to recycle the membrane from a structure being replaced in the ACT. A case study was proposed to review the complete process and establish a ‘baseline’ for future costing and freight efficiencies.

Universal Fabric Structures (UFS) consulted with Innova International and Ferrari S.A. in regard to recycling the fabric structure and the future recycling of the replacement membrane at the end of its working life.

Olympic Swimming Pool ACT

Deflated structure goes under the knife

Dismantling the pool structure and clearance of the site took 2 men 2 days to complete including the removal of metal and other foreign material from the fabric and then packing the container for despatch to France.

In October 2008 the container of PVC Tedlar coated material was placed aboard a vessel bound for France. This was the successful culmination of the 12 month tender and review process by the ACT Government for the removal and replacement of this 22 year old fabric structure built over the Canberra Olympic Swimming Pool.

Removing ‘foreign’ Components

Cleared site ready in 2 days

The Canberra project was then subjected to a life cycle assessment study by EVEA to determine the overall environmental benefits of the project and a financial review to calculate future recycling proposals.

It was finally determined by EVEA to the surprise of many in France that the return of material into the Texyloop process in Europe for recycling was clearly a viable environmental alternative to local landfill or incineration.

Australian EVEA Life Cycle Assessment results

Impact category	**Unit**	Landfill Disposal	Incineration	Texyloop ex Australia (Boat)	Texyloop ex France by Truck 500 km
Energy Consumption	MJ-Eq	54,795257	54,803092	29,961823	28,845274
Consumption of Resources	kg Sb eq	0,01969347	0,01970745	0,01042963	0,00996065
Global Warming Gases	kg CO2 eq	2,3837158	2,5889976	1,1514945	1,0801669
Ozone depleting CFC's	kg CFC-11 eq	2,37E-07	2,37E-07	1,61E-07	1,53E-07
Human Toxins	kg 1,4-DB eq	1,5965585	1,6244988	0,442853	0,39101172
Toxicity fresh water	kg 1,4-DB eq	1,3245972	1,2367931	0,06331648	0,06141713
Toxicity Land	kg 1,4-DB eq	0,00992803	0,00958778	0,0069615	0,00677965
Photochemical oxidation	kg C2H4	0,00056176	0,00051784	0,00028252	0,0002255
Acidification	kg SO2 eq	0,00666674	0,00673857	0,00595891	0,00416474
Phosphates	kg PO4 eq	0,00262842	0,00192842	0,00058945	0,00044517
Water Consumption	litres	169,86185	170,40887	4,2429986	3,5763136
Bulk waste	kg	0,69806699	0,35037485	0,13086838	0,13131371
Hazardous waste	kg	0,00107809	0,00107863	-1,26E-05	-1,31E-05

Comparison of the different disposal methods per square meter of composite membrane material and results of the 13 main environmental impact areas

BENEFITS FOR AUSTRALIAN FABRICATORS AND SUPPLIERS

The Australian collection centre will be made available to participants in the lightweight structure industry as a resource for fabricators and installation specialists using PVC composite fabrics. The aim is to provide specifiers, architects and designers a clear environmentally responsible alternative to conventional materials and construction methodologies.

RECYCLING RECEIVAL GUIDELINES

The Texyloop process has strict guidelines in regards to the nature of the textiles that can be processed without contamination of the solvents used to dissolve the PVC compounds in the recycling plant.

To date the process is limited to PVC composites originating in or manufactured to European standards due to the strict controls that exist for the manufacture and nature of additives used in these fabrics.

Composites not complying with the European standards may contain substances that would contaminate the solvents used to dissolve the PVC from the polyester. A contamination would result in the need to dump both the solvents and the materials and flush the plant, both environmentally and financially undesirable.

Other guidelines in place include separation requirements for colour, fire retardency treatments. In addition to separation heavy soiling needs to be removed for quarantine and contaminant reasons as does metal and other foreign matter.

ESTIMATED COSTINGS (CURRENT COSTS 2009)

Based on current costs and exchange rates indicative pricing has been provided to customers for the recycling of membrane materials for a number of replacement tenders. One of these is a fabric of German origin from a 19 year old structure due to be replaced at Phillip Island in Victoria.

The proposed costs for recycling are planned to fall between A$1.25 to A$1.45 per kilogram. These will vary slightly with exchange rates and ocean freight cost fluctuations.

Packing efficiency in the export containers will also have an effect upon the overall costs and environmental impact of the shipping component and every effort will be made to reach maximum capacity to minimise the impact of this element.

NB. There are some handling restrictions in Europe that are yet to be clarified which may result in a revision of these initial calculations.