Polydicyclopentadiene winning over construction professionals

Polydicyclopentadiene (pDCPD) is used in Reaction Injection Moulding (RIM) technology to produce large parts. Among other key features, designers are praising the ability to mould three-dimensional parts and the possibility of varying the thickness and integrating ribs or inserts.

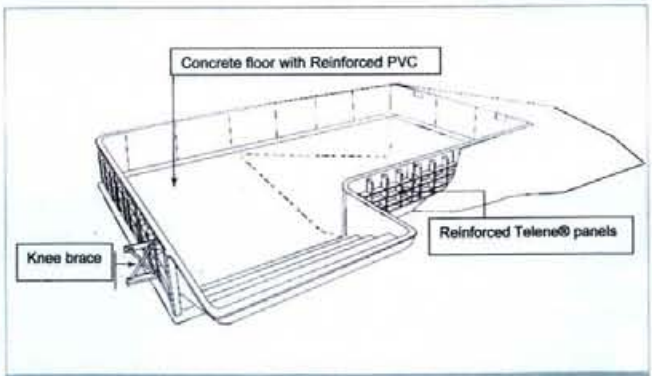
Frédéric Démoutiez
International business development engineer
Telene SAS

Polydicyclopentadiene (pDCPD) is a high-performance thermoset polymer obtained by Ring Opening Metathesis Polymerization (ROMP) of highly purified dicyclopentadiene (DCPD). PDCPD shows an exceptional track record of impact and corrosion resistance, even at extreme temperatures (from -40°C to +160°C). Over the past twenty years, it has been used successfully in sectors such as agricultural and construction equipment, trucks and buses (body panels mainly), the chlor-alkali industry (electrolyser cell covers or butterfly valves) and other fields of applications, e.g. for various types of containers such as individual wastewater systems, waste containers, military boxes, and more.
Telene® is the registered trade name for DCPD resins distributed and developed by Telene S.A.S, Drocourt, France, a company that belongs to Rimtec Co., Japan, a world-leader in the formulation of DCPD resin systems.

New benefits using the R-RIM process

Reinforced Telene® now widens the performance range for DCPD grades and makes it possible for designers and engineers to benefit from twice as much rigidity and an improved dimensional stability, by reducing the coefficient of linear thermal expansion (CLTE).

Thanks to the R-RIM process, the new reinforced material has been qualified in truck applications and in the construction market. The very first breakthrough application of this material in Europe enabled an innovative new concept for the construction of swimming pools.

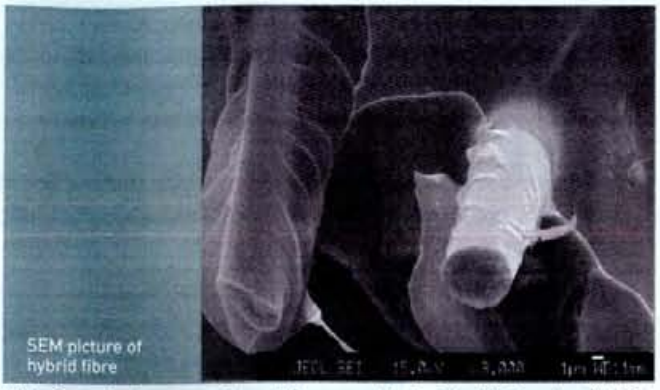


Production of modular swimming pools

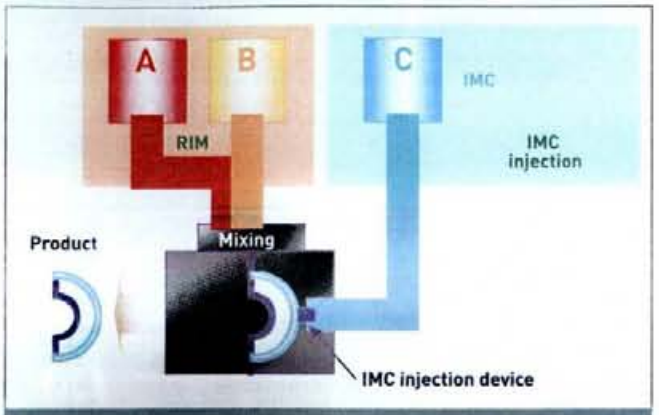
It actually took less than a year of joint efforts between the engineers of the OEM, Terinjec (Aubagne, France), Rimtec and Telene S.A.S. to develop the whole project, which grew out of a two-fold technological advance:

Table: Non-reinforced/reinforced Telene® compared to other materials

Property	Unit	Non reinforced Telene® 1610/1650	Reinforced Telene® 1690		SMC 30% glass fibre	GRP Hand lay-up 30% glass fibre
			Flow direction	Cross direction		
Impact - Notched Izod	kJ/m²	30	10		low	low
Impact - Charpy	kJ/m²	118	42		10-20	80-100
Flexural modulus	MPa	1,850	4,200	2,500	>10,000	>10,000
CLTE	m/m/C°.10 -6	79	35	50	30	30
HDT	°C	118	135		>200	115
Density	Kg/l	1.03	1.23		1.85	2

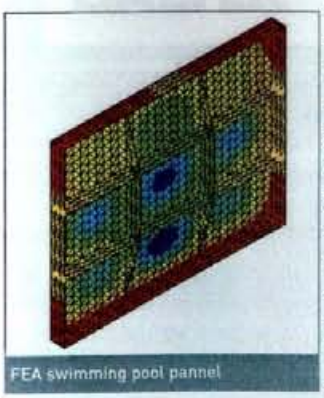


This formulation was adapted for use with In-Mould Coating (IMC) technology, an environment-friendly and cost-effective painting process for reaction-injection-moulded parts.



Schematic view of the IMC process

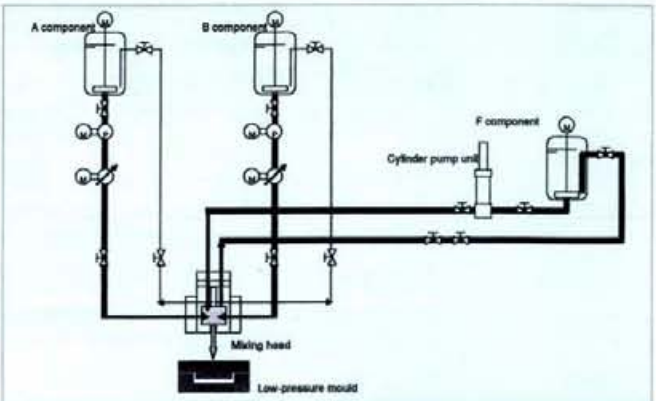
Extra R&D input, including finite elements analysis (FEA), was a key element in fine-tuning the panel design; for instance, with the simulation of the effect of the back-filling.



FEA swimming pool pannel

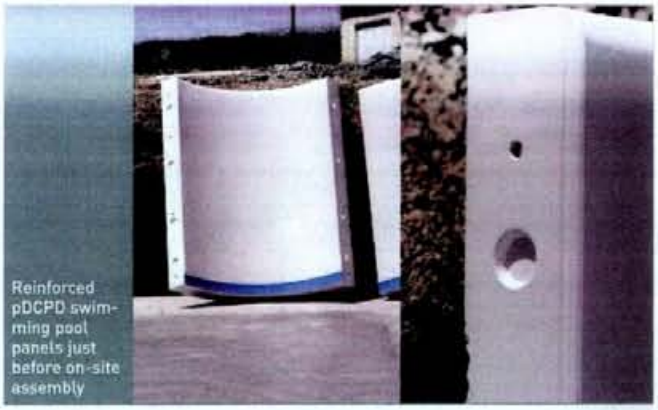
The pool panels can be produced rapidly and easily using reinforced Telene® with R-RIM technology. The reinforced DCPD systems comprise three formulated, ready-to-use components, A, B and F, which are low-viscosity liquids (300 to 500 Cps). These contain a co-catalyst, a catalyst, and the fibre-filled component, respectively. The three components are fed into a high-pressure RIM machine at a 1:1:1 ratio and are then injected into a closed mould, where polymerization starts.

Given the moderate pressures at stake (usually less than 2 bars), moulders generally try to choose a low-cost tooling option that will still provide the surface appearance and tool thermal properties they expect from the most expensive tools. Reinforced Telene® is no exception to that rule.



The R-RIM Telene® process

In this project, a machined aluminium billet was used for the highly polished cavity side, while the core side was made from low-cost machine aluminium casting. The button-to-button cycle time is around 4'30" for the pool panels. Four to five minute cycle times are actually quite typical for almost all the moulded parts, regardless of their size, weight and developed surface. This is possible because the formulation can be tailored to fine-tune its reactivity and viscosity build-up rate.

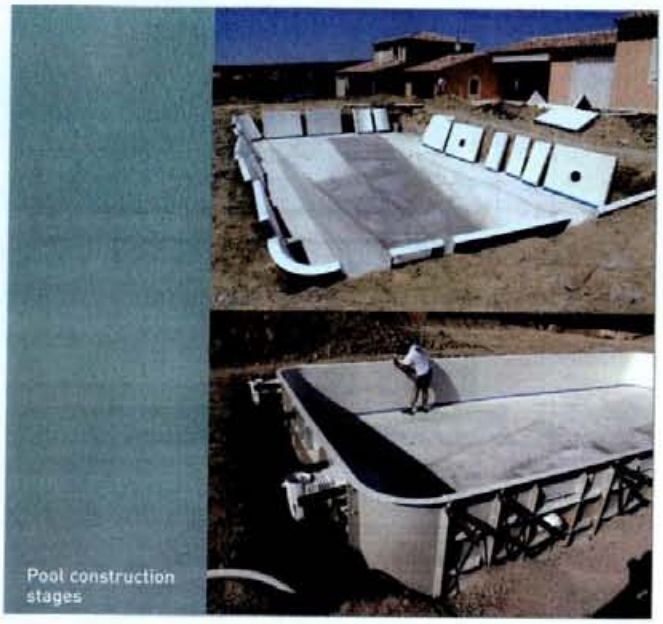


Reinforced pDCPD swimming pool panels just before on-site assembly

The resulting panels facilitate pool construction: with only five different panels (flat, 90°-in and 90°-out panels), modularity is almost endless, and because the shape flexibility makes it easier to adapt the pool to the building site, there are no longer terrain limitations. Transporting the lightweight modular panels (density 1.23 g/cm³) to the installation site is much easier than for one-piece pools, so accessibility is no longer a problem, either.

The high surface quality of the panels is another key element in the material's success for this particular application, as it eliminates the need for wall liners. The new panel concept also offers the possibility for pool decoration, until now limited to concrete pools. For instance, ceramic tiles can be glued to the panels to decorate the water line.

As far as installation is concerned, the panels are fastened to a concrete screed with dowels. Water tightness is guaranteed by an initial sealing strip applied on the edge of the panel before assembly



Pool construction stages

and backed up by a second one at the panel joints. This doesn't affect the assembly's aesthetics. The lining on the pool bottom is made perfectly continuous by means of a co-laminated sheet fastened to the bottom of the panel, to which a reinforced PVC sheet is welded. Once earthwork is completed, it takes two workers only a day to install a 10 m x 5 m swimming pool. This development has led to the submission of 17 patent applications.

Linerless swimming pool with Telene® side panels

Other building and construction applications

Thanks to its unique mix of properties, pDCPD has been used in building and construction for quite a while. Significant examples include:

- a scaffolding access door with a perfect mix of properties due to a combination of mechanical and anticorrosion properties with resistance to concrete and to other specific materials that can be found on a building site. In this particular application, a supple polyurethane hinge is overmoulded. The part's lifetime is multiplied many-fold compared to previous non-polymer or polymer-based solutions;

Scaffolding access door

- a manhole for a gas tank, where the ability to withstand the load of a car on the upper part, in combination with other properties, led to the choice of pDCPD as the right material;

Gas tank manhole

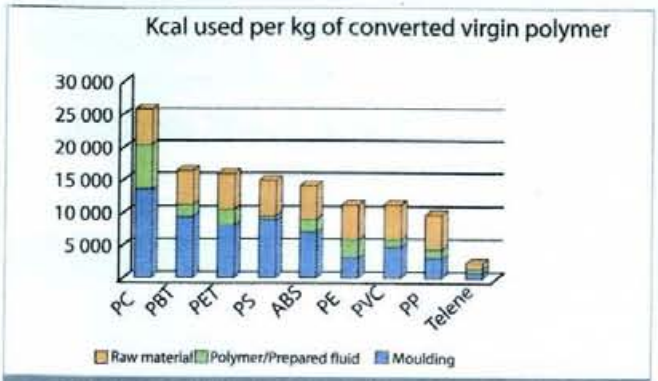
- individual wastewater systems combining the superior toughness of pDCPD with easier handling and installation provided by the intrinsically low weight of the non-reinforced material (density 1.03 g/cm³); shells can be nested in each other, so storage and transportation are facilitated. The large parts (55 to 65 kg per shell) can be produced in a button-to-button cycle time of only 4'30" for a single shell;

- bathroom elements for which several new developments were combined to develop interesting new concepts. It is possible to laminate low-CLTE decorative resins onto reinforced Telene®. One application in Japan has been the substitution of SMC for a modular bathroom floor, where a top-quality artificial marble acrylic resin was combined with a reinforced pDCPD substrate.

Added to its other more traditional properties, pDCPD's low weight, good creep behaviour, and excellent natural adhesion to

Reinforced pDCPD floor of a bathroom unit with decorative laminate

polyolefins (PE, PP) will undoubtedly qualify this material for numerous demanding applications in the rapidly developing field of swimming pools, and might even lead to spinoff applications such as water ponds, overflow weirs, etc. Last but not least, investing in the DCPD RIM process can be done in incremental stages, giving shorter times to market and lower risk than is the case with compression moulding or injection moulding.



Life cycle assessment table for various polymers

Favourable energy balance

PDCPD offers a favourable energy balance compared to standard thermoplastic polymers. For instance, producing one kilogram of moulded part using pDCPD requires one-fourth the energy as it would using polypropylene and only one-tenth as much as when using polycarbonate.

A new generation of resins

Telene® high-performance DCPD resins have already demonstrated their suitability for a new-generation swimming pool concept. The continuous development trend in the DCPD field is expecting to lead to an even newer generation of resins that will open up completely new applications and markets, also with different converting processes. ■

More information: www.telene.com
www.nouvellespiscines.com
www.groupe-courbis.com/ mastershock.htm

Contact: info@telene.com