Renewable Value

Recycling Guide

AOC

Trusted Solutions

Renewable Value

OEMs and designers need to have peace-of-mind on the availability of reliable end-of-life solutions for the composite parts and components they create.

The recycling of composite regrind through co-processing into cement proves to be such a reliable solution, bringing substantial benefits in minimizing carbon footprint. This brochure provides you with insight into this recycling route, and its positive impact on the environment.

Managing our footprint

As consumers we are becoming more conscious about the environment, and we are looking for ways to reduce the impact we have on our planet. Buying products and services that bring us convenience and quality-of-life has to come along with an efficient use of the resources offered to us by Mother Nature. Consequently, recycling products at the end of their useful life into valuable materials is important and our commitment to future generations.

Proud about your products

Composite material solutions have a long history of delivering performance where it matters. This includes excellent durability that results in minimized maintenance and continued operation, low weight that allows for reducing fuel use and carbon emissions, as well as elevated mechanical strength for a long life in tough environments.

Also, composites parts can be easily manufactured in large production series, providing security of supply and a promise of a long and useful life.

This means that OEMs and designers can deliver consumers the convenience and quality-of-life they need, while minimizing the impact on the environment.

AOC. Trusted Solutions

In today's world right at the start of developing new products and services, OEMs and designers need to think for the parts they create: "what happens throughout the entire part life cycle?" Your choice for using composite components and assemblies requires the availability of a viable recycling solution at the end of their useful life.

Responsible care

Manufacturers of parts and assemblies are looking for ways to increase production yield and to minimise cost of waste. Instead of putting composite waste into landfill, affordable alternatives are desired that are easy from an operational and logistics perspective. Using established recycling routes for composites regrind therefore, helps you to better run your business and to create a responsible company.

Composites recycling makes sense

Today, the main technology for recycling glass reinforced composite waste is through the cement kiln route, also known as cement co-processing.

This technology is proving to be highly cost effective, is generating valuable materials, and is helping to improve the Ecological footprint of cement manufacturing. Co-processing is the simultaneous use of composite regrind as raw material and as a source of energy in cement manufacturing, replacing natural mineral resources (material recycling) and fossil fuels such as coal, petroleum and gas (energy recovery). In this process, the composite regrind used for co-processing is both an alternative fuel and a raw material.

Glass fiber thermoset composite parts – originating from part manufacturing or end-of-life components – are cut in smaller sections and processed into small chunks. The resulting regrind can be combined with other feedstock materials into an input stream with consistent composition and caloric value.

AOC is a strong supporter of increasing and improving composite waste recycling, through the development of alternative recycling technologies which produce higher value recyclates (both in terms of resin and fiber). Further development and industrialization of alternative thermal or chemical recycling technologies may provide composite using sectors with additional solutions for end-of-life.

Part storage after first mechanical treatment
(Courtesy: Neowa Bremen)

Mobile sawing equipment
to reduce transport costs

Composite recycling in process
(Courtesy: Neowa Bremen)

Facts about composites recycling	Background
Composites are recyclabe	Recycling through co-processing in cement kilns has been technically and commercially demonstrated. Today, companies are setting up logistics and supply chains for ensuring proper handling of regrind and quality consistency of cement manufacturing. Therefore, recycling through co-processing in cement kilns is increasingly used for managing composite regrind because of its technological potential, environmental benefits and cost effectiveness.
Thermoset composites cannot be easily converted into their original raw materials	Composite materials are designed to provide mechanical strength, chemical resistance, and durability. Consequently, by definition they cannot be easily re-converted into their original raw materials.
Composites can contribute significantly to the reduction of Eco-footprint and CO_2 Emissions	Composite components tend to have a better Eco-footprint compared to their equivalent in traditional materials like steel or aluminium. Reduced emissions through lower weight in transportation, easier installation and reduced maintenance in construction, and continuity of operation in industrial applications all contribute to this great performance. After their useful life saving energy and helping to reduce Eco-footprint in many applications, composite regrind can reduce Eco-footprint and CO_2 emissions of cement manufacturing.
Co-processing in cement kilns is clearly different from incineration	Co-processing glass fiber thermoset composites regrind allows the inorganic fraction to act as valuable raw material, while the organic fraction acts as efficient fuel for the calcination process. In the incineration of composite regrind, the inorganic fraction is not re-used, and therefore incineration cannot be considered recycling. In addition the heat generated in incineration cannot be used as efficiently to reduce the amount of fuel required.
Composite recycling through co-processing in cement kilns is compliant with the EU legislation	Recycling through co-processing in cement kilns is fully compliant with the European Waste Framework Directive (WFD) 2008/98/EC providing viable waste management route for the composites industry. Co-processing is both recycling and energy recovery.

European recognition for composites recycling

In June 2012 the European Commission released a Guidance document on the interpretation of Waste Framework Directive WFD 2008/98/EC. The document is intended to help national authorities and companies interpret the Directive.

Among other specifications, co-processing in cement manufacturing is included in the definition of waste prevention and of waste-management options, both under recovery and recycling (Chapter 1.4).

The Guidance notes that: "In certain production processes such as co-processing, waste can be used in an operation combining two waste management recovery options at the same time. The energy content of the waste is recovered (R1 operation) as thermal energy, thus substituting fuels, while the mineral fraction of the waste can be integrated (hence recycled) in the matrix of the product or material produced, e.g. cement clinker, steel or aluminium […]."

Source: Guidance on the interpretation of key provisions of Directive 2008/98/EC on waste, European Commission, Subchapter 1.4.5, June 2012

Reduced carbon footprint of cement by using composite regrind

In the cement manufacturing process several raw material fractions are combined with an energy source and heated up to 1450°C for making cement clinkers. The clinkers consist of four basic oxides in a specific proportion: calcium oxide (65%), silicon oxide or silica (20%), aluminium oxide (10%) and iron oxide (5%). Gypsum (calcium sulphate) and possibly additional cementitious compounds (such as blast furnace slag, coal fly ash, natural pozzolanas, etc.) or inert materials (limestone) are added to the clinker. All constituents are ground into a fine and homogenous powder called cement.

By the very nature of this process, a fair amount of CO_2 is generated. The Cement industry has made significant steps to improve sustainability and the carbon footprint by replacing the traditional fuels such as oil, gas and coal with alternative fuels in clinker production. Glass fibre thermoset regrind is an ideal raw material for cement manufacturing. The mineral composition of the regrind is consistent with the optimum ratio between calcium oxide, silica, and aluminium oxide. Additionally, the organic fraction supplies fuel for the reaction heat, right at the spot where it is needed most.

LCA of clinker manufacturing

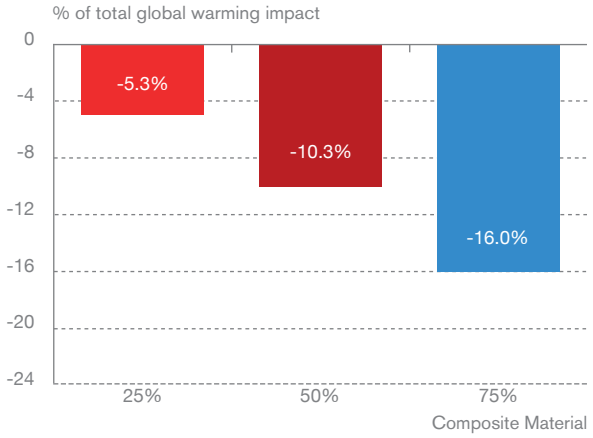
Together with the Swiss Federal Institute of Technology (ETH) in Zürich, Switzerland, a detailed LCA model has been developed describing the clinker manufacturing process. The objective was to better understand the improvements that can be made in terms of carbon footprint by replacing the traditional fuels in clinker production. Key assumptions for this specific case study on composite regrind coprocessing in cement manufacturing are listed below.

Reduced carbon footprint confirmed

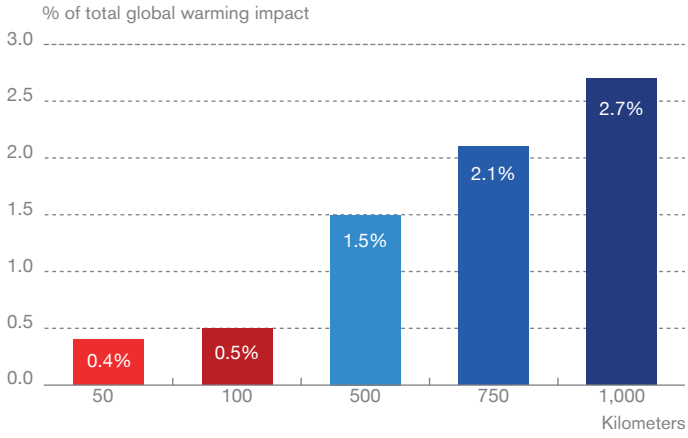
By using glass reinforced Composite regrind in coprocessing a significant reduction of CO_2 emission of the clinker manufacturing process can be obtained. Depending on the quantity of composite regrind included and the specific cement plant technology, the reduction can be as high as 16%. The transportation of composite regrind from its source to the cement kiln will obviously influence the calculation of the Eco-footprint. Nevertheless, it has been confirmed that the impact of transportation is fairly limited on the total CO_2 footprint of the clinker manufacturing process.

Significant emission reduction using glass reinforced composite
0.9 kg CO_2-eq/kg composite
1.8 kg CO_2-eq/kg resin

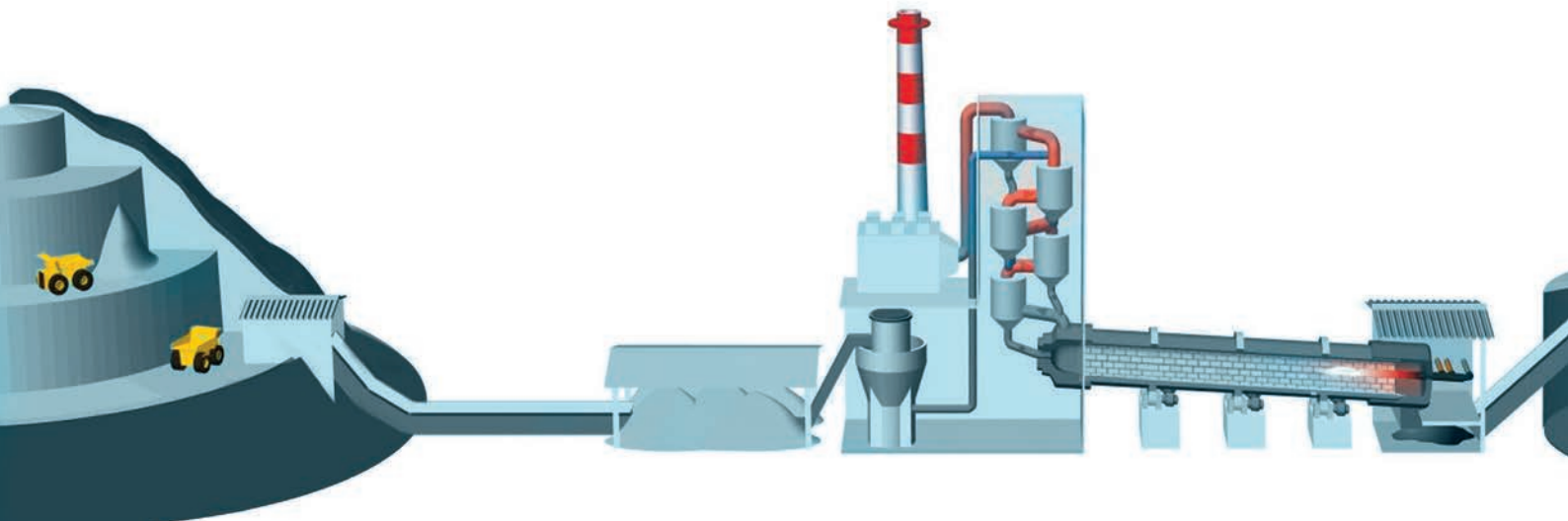
Kiln technology	
Kiln type	Precalciner
DeNOx installation	SNCR (Selective Non Catalytic Reduction)
Dust filter	E-Precipitator
Composite regrind characteristics	
Calorific Value	15.3 MJ/kg
CO_2 emission factor	87.4 kg/GJ
Carbon Content	36.6%
Ash content	46.1%
Electricity consumption for waste preparation	0.04 kWh/kg
Transport distance	119 km
Fuel substituted	
Coal	26.05 MJ/kg



Reduction of CO_2 footprint for this specific clinker manufacturing plant with composite regrind, in comparison to a process without alternative fuels based on coal as fuel (Courtesy: Holcim)



Contribution of CO_2 footprint associated with composite regrind transportation as a percentage of the total CO_2 footprint for this specific clinker manufacturing plant, as a function of transportation distance (Courtesy: Holcim)



Delivering Innovation

AOC experts will help you push the limits of part performance and component manufacturing. Together we will work together to literally shape our world with products that are lighter, stronger, versatile and more competitive.

AOC takes an integral approach to new product development, using our full expertise in polymer science, manufacturing, testing and component manufacturing. Industry specialists at AOC's R&D centers around the world support customers with state-of-the-art equipment, including resin synthesis, mechanical property testing capabilities and analytical testing laboratories.

Our scientists are continuously working on new solutions to help you be more competitive today. And, they are creating the innovation to drive your success in the future.

Quality

You need consistent and reliable materials that you can trust, day after day. Your customers are counting on you. AOC produces the highest quality and most consistent products in the industry. Manufacturing expertise, proprietary equipment and automated process operation systems provide you with the consistency you can trust. AOC delivers the products you need and brings peace of mind so you can focus on your business and your customers.

Your trusted partners

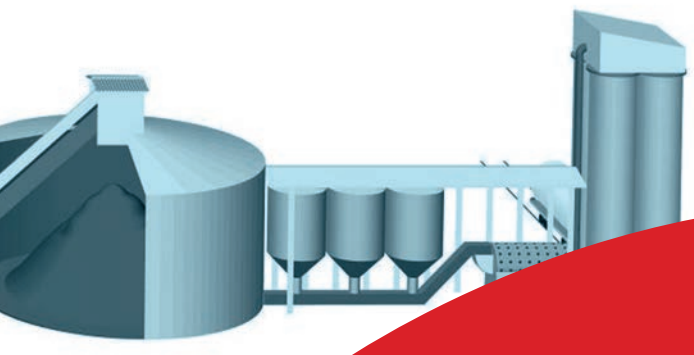
The AOC team is dedicated to finding the right solutions to help drive your success. We understand your business and will work together to determine how AOC products and service can help optimize your part performance and meet your customers' requirements.

AOC experienced professionals are experts in both product performance and manufacturing processes. From our polymer scientists, manufacturing, technical service and sales experts, the AOC team will be a true partner for your business.

A world of experience

AOC's foundation began more than 60 years ago. Through the decades, AOC has been focused on creating innovation, producing quality, and developing the type of partnerships that have helped our customers grow their businesses and expand their markets. With facilities and global experts around the world, AOC is ready to work with you to find the solutions you can trust.

Previously serving the market under the names Aliancys, AOC Aliancys, and DSM Composite Resins, AOC has transformed the industry and has earned the position of the leading global supplier.



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