CYTEC

Coating Resins
Renewable Raw Material

Cytec's Contribution to Sustainable Change

Sustainability at Cytec means living our values in a changing world, including development of innovative and environmentally sustainable products that compete in a global economy; achieving the highest standards of safety, health and environmental stewardship; and being responsible to our stakeholders.

Cytec has adopted Anastas and Warner's **12 Principles of Green Chemistry*** in its efforts to develop, manufacture and promote innovative products that meet or exceed our customer requirements for technical performance and eco-friendliness.

Cytec believes in the collective effort of the industry to develop more renewable products that will eventually reduce dependence on extractive resources.

Cytec offers a range of resins containing renewable raw materials that allows formulators to make a difference towards a Sustainable Change in the coatings market. Seeds oils, starch and cellulose from straw and wood are only some of the renewable used in the manufacture of chemical substances and products. By employing physical, chemical and biochemical processes these materials can be converted into chemical intermediates, polymers, lubricants, solvents, surfactants and specialty chemicals to co-replace traditional fossil fuel feedstock.

A Focus on Renewable Raw Materials

Cytec considers sustainability as a pathway of continuous improvement wherein the products and services are developed with progressively less environmental impact - as defined by the American Institute of Chemical Engineers' (AIChE) Institute for Sustainability.

A cross-functional group of employees has been working to increase and advance the company's use of renewable raw materials (RRM). Existing products and their raw materials have been assessed for their content of renewable feedstock and technical exchange between different business units unveiled opportunities and ideas for new products and processes. Interesting to note is that next to the sustainable aspect, also novel performance characteristics are obtained.

To answer our customers' growing demand for Renewable Raw Materials content, Cytec is updating its communication on renewable raw material through this new brochure.

More generally, R&D is continuously challenged to increase the amount of RRMs in all of their developments to reduce products' carbon footprint and improve their sustainability index calculations.

The usage of renewable raw materials also demonstrates higher productivity yield in emerging bio refineries. Life cycle analyses show that emission levels may be reduced with the use of bio-based feedstock in chemical manufacture. The manufacturing process from renewable feedstock could therefore lower Greenhouse Gases (GHGs) by up to 50%, compared to the manufacturing from non-renewable feedstock.

The availability and pricing challenge of renewable raw materials should resolve over the long term as the awareness of the benefits accrued from partnering with customers and suppliers grows. The end result will be greater success in sustainable development within chemical industry in terms of using renewable rather than non-renewable resources.

* P. Anastas, J. Warner in "Green Chemistry: Theory and Practice", Oxford University Press, New York, 1998

3 Industry Drivers for Renewables

The main industry drivers towards a greater reliance on Renewable Raw Materials are:

Responsible Care®: the coatings and inks industry increasingly wishes to demonstrate good product stewardship concerning health and environmental issues.

Sustainability: the industry is becoming more aware of the need to work in a sustainable way. The marketed products must not only be economically viable but also socially and environmentally respectful. Renewable raw material based products can help in achieving this goal of sustainability.

Renewable Resources Definition

Principle stated by the World Commission on Environment and Development (The Bruntland Commission) in 1987: Development that meets the needs of the present without compromising the needs of future generations. Sustainable development is a process of integrating economic, social and ecological goals, and should not mean a trade-off between the environment and development. Sustainable development should imply balance rather than conflict. [European Environment Agency definition (EEA)]

Calculations

The Renewable Raw Material content (RRM%) and the Naturally Derived Carbon content (NDC %) – also called Biobased
Carbon – are calculated accordingly to the formula indicated hereunder.

Functionality: naturally derived materials offer a range of functionalities that contribute to enhance the intrinsic value of these products. A specific example is the improved pigment compatibility obtained with epoxy acrylates modified with naturally derived oils. Another example is the one of energy curable wood primers based on natural oils that provide excellent adhesion and enhance the wood warm color.

$$\text{Weight \% RRM} = \frac{\text{Weight RRM}}{\text{Weight End Product}} \times 100$$

$$\text{\% Biobased Content} = \frac{\text{Amount of Biobased Carbon}}{\text{Amount of Biobased Carbon + Amount of Petroleum Based Carbon}} \times 100$$

DISCLAIMER: The RRM (renewable raw material) and the NDC (naturally derived carbon) content of the products listed here are exclusively based on information received from suppliers for which Cytec cannot be held liable. Cytec makes no representations or warranties as to the accuracy or completeness of confidential information provided in this document.

4 Renewable EBECRYL series

EBECRYL® polyester acrylates with medium to low viscosity have fair to high renewable raw material content. Their excellent pigment wetting and good adhesion to various substrates makes this range very suitable for ink formulations. Some of these products are highly recommended for litho application thanks to their ink-water balance performances.

EBECRYL epoxy acrylates range includes products that are hard, solvent and water resistant, fast curing. In the fatty acid-modification improves the pigment wetting and the ink water balance in litho inks.

PRODUCT	FUNCTIONALITY	VISCOSITY MPA.S @ 25°C	RENEWABLE RAW MATERIAL (W%)	NATURALLY DERIVED CARBON (%)	APPLICATION	TYPE
EBECRYL® 450	6	8600	30	35	Flexo inks	Polyester acrylate which gives excellent pigment wetting and high reactivity.
EBECRYL 452	4	600	24	29	Flexo inks	Polyester acrylate with excellent pigment wetting; enables the production of high concentrated pastes, increasing productivity and process flexibility.
EBECRYL 657	4	125000	42	52	Offset inks	Polyester acrylate with good pigment wetting, ink water balance and misting properties.
EBECRYL 1657	4	125000	42	52	Offset inks	Polyester acrylate with good pigment wetting, ink water balance and misting properties.
EBECRYL 846	6	45000	15	17	High speed offset inks	Polyester acrylate which gives high reactivity and low misting.
EBECRYL 870	6	48000	25	30	Offset inks	Polyester acrylate which gives excellent pigment wetting and high reactivity.
EBECRYL 1870	6	48000	25	30	Offset inks	Polyester acrylate which gives excellent pigment wetting and high reactivity.
EBECRYL LEO 10801	6	45000	24	30	Inks for indirect food contact packaging	Polyester acrylate
EBECRYL 2870	6	48000	25	30	Offset inks	Polyester acrylate with excellent pigment wetting and high reactivity.
RAYLOK® 1621	2+1	520	27	31	Clearcoat for wood	Low viscosity natural oil modified acrylate oligomer. Combining airdrying and UV curing properties, it gives a transparent oil-like natural aspect.
RAYLOK® 1622	3	520	21	23	Clearcoat for wood	Low viscosity natural oil modified oligomer acrylate. It gives a transparent oil-like natural and warm aspect.
EBECRYL 860	3.5	25000	64	74	Overprint varnish	Epoxidized soybean oil for OPV where hot foil stamping is required.
EBECRYL 3608	2	70000	7	16	Inks	Fatty acid modified epoxy acrylate recommended for ink formulations where improved pigment wetting is demanded.
EBECRYL 3702	2	900000	16	16	Inks, litho	Fatty acid modified epoxy acrylate recommended for ink formulations, good litho behavior and very good pigment wetting.

5 EBECRYL bioligomers 5000 series

EBECRYL® bioligomers 5000 series are energy curable products based on renewable resources developed for the US market (not EINECS listed).

These innovative products allow for the formulation of partially renewable inks and coatings without the loss of printability, pigment wetting or performance properties.

PRODUCT	FUNCTIONALITY	VISCOSITY mPa.s @ 25 °C	RENEWABLE RAW MATERIAL (W%)	NATURALLY DERIVED CARBON (%)	APPLICATION	TYPE
EBECRYL® bioligomer 5500	3	125	21	30	Reactive diluent	Recommend for use in conjunction with the EBECRYL 5000 Series bioligomers, to formulate coatings and inks that contain more renewable resources versus standard diluents without the loss of printability, pigment wetting or performance properties.
EBECRYL bioligomer 5601	3.5	26500	64	74	Overprint varnish (OPV), screen and flexo inks.	Epoxidized soybean oil acrylate alternative with enhanced renewable content.
EBECRYL bioligomer 5610	2	2200	12	12	OPV, clear coatings for paper and plastics, screen inks and wood fillers.	Modified Bisphenol A Epoxy Diacrylate to create coatings which exhibit high gloss, good surface hardness, and excellent chemical resistance.
EBECRYL bioligomer 5801	3	6000	52	58	Flexo inks	Polyester acrylate, excellent to formulate flexographic pigment dispersions and inks for porous and nonporous substrates.
EBECRYL bioligomer 5820	4	66100	51	56	Offset inks	Polyester Tetraacrylate recommended for wet or dry offset inks, formulated for porous substrates. This moderate viscosity product exhibits good pigment wetting, color development and printability.
EBECRYL bioligomer 5821	5	27500	31	37	Offset inks	Polyester pentacrylate recommended for wet or dry offset inks, formulated for porous substrates.
EBECRYL bioligomer 5822	5	29200	34	37	Litho inks, offset inks	Polyester pentacrylate specifically developed for black and pigmented UV/EB lithographic inks. Also recommended for wet or dry offset inks, formulated for porous substrates.

Water-borne Alkyd Resins for Air-drying Decorative Coating System

Product	Application	Type	% RRM in form of delivery	% RRM on solids
RESYDROL® AF 6120w/62WA	Wood interior and exterior - Paint	For primers and wall paints, partner for acrylic systems to improve adhesion and applicability with low yellowing.	58	33
RESYDROL® AY 586w/45WA	Wood external - Stain	Excellent adhesion and penetration on wood, open time and durability.	77	56
RESYDROL AZ 6191w/42WA	Wood internal and external - Trim	For indoor and outdoor application, excellent applicability and high gloss.	72	42
RESYDROL AZ 6190w/43WA	Wood internal and external - Trim	For outdoor and indoor application, quick drying with very good hardness. Early water resistance. High gloss and flow. Shear stable.	71	39
RESYDROL VAF 6111w/60WA	Wall interior paint	For primers and wall paints, partner for acrylic systems to improve adhesion and applicability with low yellowing.	61	37
RESYDROL VAL 5547w/98WA	Wood impregnation	Excellent penetration on wood, low grain rising and oil feeling application.	62	62
RESYDROL VAS 6110w/68WA	Wood external stain	Excellent penetration on wood.	74	62
RESYDROL AY 6705w/44WA	Wood external stain	New generation acrylic modified alkyd resin for all types of woods, which combines excellent penetration with quick drying time. It offers extended durability to deck stains with no flaking.	68	33
RESYDROL AY 6710w/45WA	Wood external stain	New generation of urethane and acrylic modified alkyd resin suitable for all types of wood, to provide very long outdoor durability with no flaking with low dirt pick up and traffic resistance.	68	27
RESYDROL AZ 6711w/40WA	Wood external stain	New generation of urethane and acrylic modified alkyd resin used as co binder to improve penetration into wood, quick drying even on exotic woods and early water resistance.	74	40

Water-borne Alkyd Resins for Air-drying and Forced Dry Industrial Systems

RESYDROL AM 224w/40WA	Monocoat, topcoat Oven drying	Drum coatings.	64	21
RESYDROL AX 237w/70BG	Primer, Air-drying	Humidity and corrosion resistance.	36	36
RESYDROL AY 241w/40WA	Primer, topcoat, monocoat, Air-drying	Fast drying.	60	23
RESYDROL AY 466w/38WA	Topcoat, Air-drying	Humidity resistance. High gloss. Fast drying.	71	44
RESYDROL AY 6150w/45WA	Primer, topcoat, monocoat, Air-drying	Humidity and corrosion resistance. High gloss. Easy application.	66	31
RESYDROL VAY 6096w/39WA	Topcoat, Air-drying	Humidity resistance. Fast drying	66	30

Water-borne Alkyd Resins for Baking Systems

RESYDROL AF 502w/35WA	Monocoat, topcoat Oven drying	Drum coatings.	78	47
RESYDROL AM 410w/66BPWA	Oven drying coatings	Electrical insulation paints.	93	59
RESYDROL AX 246w/70BG	Primer Oven drying	Dipping paints. Combined with CYMEL 303 LF - offers excellent corrosion resistance.	21	21
RESYDROL AX 247w/70BGMP	Oven drying coatings	Electrical insulation paints.	22	22

Liquid Coating Resins and Additives

Water-borne Epoxy Ester Resins for Primer Systems

Product	Application	Type	% RRM in form of delivery	% RRM on solids
DUROXYN® VEF 2406 w/45 WA[1)]	Tannin/ stain blocking	Universal primers for metal, concrete. Mineral board.	60	13
DUROXYN® EF 2107 w/45 WA[1)]	Tannin/ stain blocking	Universal primers for metal, concrete. Mineral board. Flexible.	58	12
DUROXYN VAX 6127 w/42 WA	Primer, Air-drying	Excellent corrosion resistance.	63	37

Water-borne Polyurethane Dispersions for Industrial Wood Systems

DAOTAN® TW 6440/43 WA	Industrial Wood	Aspect like SB system, quick hardness development and excellent chemical resistance.	69	33
DAOTAN® TW 1252/42 WA	Topcoat, Monocoat, Air-drying	NMP free polyurethane dispersion modified with drying fatty acids. Quick drying time, very high gloss, good water and weather resistance. Quick and high hardness development.	69	29

Water-borne Epoxy Dispersions for Concrete and Metal Systems

BECKOPOX® EP 2384 w/57 WA[2)]	Monocoat (DTM) or Primer Air-drying	Combined with BECKOPOX EH 659 W/50 WA, offers excellent hardness development. Early water resistance.	50	6
BECKOPOX® EP 151	Primers, adhesives and casting compounds	Internally plasticized A-liquid resin, helps against crack building.	43	43
BECKOPOX EM 2120 w/40 WA	Monocoat (DTM) Air-drying	1K epoxy with anti-corrosion performance close to 2K epoxy.	58	14

Dispersing Additives

ADDITOL® XL 255 N	Pigment wetting for SB	Electroneutral wetting additive.	41	41
ADDITOL® XL 251	Pigment wetting for SB	Anionic wetting additive.	66	66
ADDITOL XL 250	Wetting additive for inorganic pigments, SB and WB	Anionic wetting additive.	83	83
ADDITOL XL 6515	Grinding medium for SB	Grinding medium, 100% active.	80	80
ADDITOL XL 6538	Pigment wetting for SB and WB	Anionic, ethanol free wetting additive.	37	37
ADDITOL XL 6514/80	Pigment wetting and anti-settling for SB and HS	Neutralised polymeric wetting and anti-settling additive.	41	51

Defoamers

ADDITOL XW 393	Defoamer for WB	Silicone free polymer defoamer.	15	15

Anti-skinning Additive

ADDITOL XL 109/50 LG	Anti-skinning / anti wrinkling additive	Phenolic anti-skinning additive.	26	51

Legend: 1) Unique RRM content compared to competing technologies for tannin blocking. 2) Unique RRM content compared to other WB epoxy resins.

What Makes Coating Resins Materials Renewable?

Although a large number of raw materials used to produce coating resins are of petrochemical origin, Cytec is striving to increase the use of renewable raw materials for the production of specialty coating resins.

Some product ranges - for instance the water based alkyds – already contain high quantities of renewable raw materials and new developments will allow to increase this even further – types of oils used are mainly vegetable oils like soybean oil, linseed oil, sunflower oil, safflower oil, castor oil and its dehydrogenated form. For special alkyd architecture the corresponding fatty acid of these oils are used and the production processes have been adapted to the kind of the oleochemicals.

Renewable raw materials are also used in the other product groups and efforts are ongoing to increase the contribution of these renewable materials.

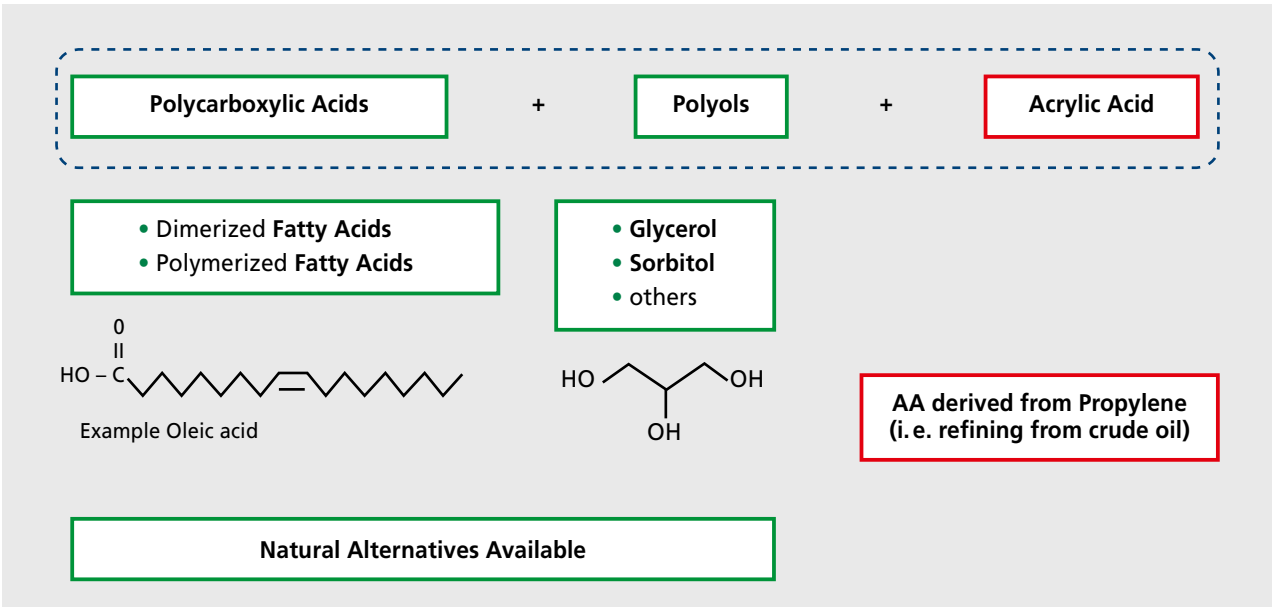
Polyesters are used as a backbone structure for various types of coating resins. They are produced by the condensation reaction of polycarboxylic acids and polyols. Examples of polyols from renewable source are glycerol (a by-product in the production of biodiesel or produced by the fermentation of glucose) and sorbitol.

Renewable polycarboxylic acids are for instance dimerized and polymerized fatty acids and biobased succinic acid.

Radiation curable resins are obtained by reacting these polyesters with acrylic acid. Other UV/EB materials, with a renewable content of over 60%, are produced by the acrylation of epoxidized vegetable oils – such as soya bean oil.

It is important to consider that – at present – the major source of acrylic acid (one of the main raw materials for UV/EB curable resins) is produced in the petrochemical industry by oxidation of propylene, a product from the refining of crude oil. However, work is ongoing to produce acrylic acid from renewable raw materials. Only this step will enable to strongly increase the renewable content of acrylates and reduce oil dependency of this industry.

Example of Polyester Acrylate obtained by Condensation Reaction



Contacts

Europe

Cytec Surface Specialties SA/NV

Square Marie Curie, 11
B-1070 Brussels
Belgium

Tel: + 32 2 560 4511
Fax: + 32 2 560 4521

custinfo@cytec.com

Asia Pacific

Cytec Surface Specialties (Shanghai) Co Ltd

Junyao International Plaza
No. 789, Zhao Jai Bang Road-10 D/F1–F2
Xuhui District,
Shanghai 200032 RC

Tel: + 86 216422 8920
Fax: + 86 216422 1760

custinfo@cytec.com

North America

Cytec Surface Specialties Inc.

1950, Lake Park Drive
Smyrna-30080 Georgia
United States

Tel: + 1770 434 6188
Fax: + 1770 434 8314

custinfo@cytec.com

Pub. No. RAD-0150-B-EN-WW-05C8

www.cytec.com