symrise

Green Chemistry

Score

Introduction

Green Chemistry at Aroma Molecules

Great fragrances and flavors start long before formulation. They start with responsible chemistry. By applying advanced synthesis routes and lifecycle-minded design, we ensure that the building blocks you work with are high-performing and also aligned with modern sustainability expectations. This mindset shapes how the Symrise Aroma Molecules division develops its broad range of fragrance and flavor ingredients, which serve as essential components in thousands of compositions created both within Symrise and by our customers.

To meet our responsibility toward people and planet, we developed the Green Chemistry Score, a tool that evaluates the environmental impact of our ingredients across seven key parameters derived from the Green Chemistry Principles. It helps us make the sustainability performance of our molecules measurable, transparent, and comparable, enabling better decisions at every stage of the value chain.

The 12 Principles of Green Chemistry, first published by Paul Anastas and John Warner in 1998, provide the scientific foundation of this approach. They promote the design of chemicals and processes that minimize hazards and environmental burdens. These principles apply across the entire lifecycle of a product: from preventing pollution during raw-material sourcing, to optimizing energy and material efficiency in production, to ensuring biodegradability and safe breakdown of the final ingredient.

If you have further questions or would like to learn more about our Symrise Green Chemistry Score, please contact Jörg Thilo Fischer, Carbon and Sustainable Chemistry Expert: *joerg.thilo.fischer@symrise.com*

Principles

12 Green Chemistry Principles

01. Waste Prevention

› Prioritize the prevention of waste rather than treating it afterwards.

02. Atom Economy

› Reduce waste at molecular level by designing synthetic methods that maximize the incorporation of all materials used in the process into the final product.

03. Less Hazardous Chemical Synthesis

› Design chemical reactions and synthetic routes to be as safe as possible. Consider the hazards of all substances handled, including waste.

04. Design Safer Chemicals

› Design chemical products to preserve efficacy of function while reducing toxicity and physical hazards.

05. Safer Solvents & Auxiliaries

› Use innocuous solvents and auxiliary substances where possible.

06. Design for Energy Efficiency

› Minimize energy requirements by choosing the least energy-intensive chemical route to reduce impact.

07. Use Renewable Feedstock

› When possible, use raw materials that are renewable rather than depleting.

08. Reduce Derivatives

› Minimize the use of temporary derivatives such as protecting groups. Avoid derivatives to reduce reaction steps, resources and waste.

09. Catalysis

› Catalytic reagents (as selective as possible) are superior to stoichiometric reagents. They can help to increase selectivity, minimize waste or reduce energy demands.

10. Design for Degradation

› Design chemical products that break down into innocuous degradation products.

11. Real-Time Pollution Prevention

› Monitor chemical reactions in real-time as they occur to prevent the formation and release of any potentially hazardous and polluting substances.

12. Safer Chemistry for Accident Prevention

› Choose and develop chemical procedures that are safer and inherently minimize the risk of accidents. Know the possible risks and assess them beforehand.

Definitions

Description and Rating

Criteria of Single Scores

› Each of the 7 key parameters are evaluated by specific methodologies. Results are translated into a normalized scale between 0 (lowest score) and 100 (highest score). The Green Chemistry Score (GCS) is the mean value of these 7 single scores.
› For a better visualization in this brochure the scores are divided into 4 rating groups (0-3). You will find the respective breakdown for the rating under the description of each parameter.

Renewability

› Indicates the use of renewable feedstock as a starting material in the manufacturing process of a product. It aims on minimizing environmental harm by shifting from petroleum as a feedstock to feedstocks that are truly renewable and recyclable.
› Calculated by dividing the number of carbon atoms from renewable sources by the total number of carbon atoms in the molecule, expressed as percentage.
› The normalized score corresponds to the percentage.

› 100 = 3 = very good
› <100 – 50 = 2 = good
› <50 – >0 = 1 = moderate
› 0 = 0 = poor

Biodegradability

› The process by which carbon-based substances are broken down by living organisms, ultimately to inorganic end products (such as water and carbon dioxide) and biomass.
› Methodologies and interpretation of results are defined according to the OECD 301/310 and 302 Guidelines.
› Normalization is done by an internally defined standard.

› Readily biodegradable
= 3 = very good
› Inherently biodegradable
= 2 = good
› not readily or partly biodegradable
= 1 = moderate
› Not biodegradable or biodegradation not assessed
= 0 = poor

Carbon Footprint

› Calculation of total greenhouse gas emissions generated till the product leaves Symrise's facilities (cradle-to-gate approach). Emissions are calculated following the well-recognized TfS-methodology and normalized to the GCS scale by an internally defined standard.

› 100 – 67 = 3 = very good
› <67 – 33 = 2 = good
› <33 – >0 = 1 = moderate
› 0 = 0 = poor

E-Factor

› Reducing waste in a chemical process can reduce the overall environmental footprint of a product, thereby reducing the overall impact on ecosystems. Furthermore, waste reduction is a measure of manufacturing process efficiency.
› Waste includes both solid and liquid waste and any materials which are not included in the final product, or used for other purposes, such as by-products or recycled materials used for another process.
› The E-factor is calculated by dividing the total mass of waste of a chemical process by the total mass of products, followed by internally defined normalization to the Green Chemistry Score (GCS) scale.

› 100 – 80 = 3 = very good
› <80 – 50 = 2 = good
› <50 – >0 = 1 = moderate
› 0 = 0 = poor

Product Toxicity

› Product hazards are defined by the United Nation's Globally Harmonized System of Classification and Labelling of Chemicals (GHS), grouped in physical (H2xx), health (H3xx) and environmental (H4xx) hazard statements.
› Each hazard statement is assigned a score between 0 and 100. The final score is the average of the lowest sub-score of each hazard group (H2xx, H3xx and H4xx).

Disclaimer

› Regardless of the toxicity ratings stated here, the referenced products are in compliance with the published Code of Practice of the International Fragrance Association (up to and including the current IFRA amendments) provided that they are used in the IFRA Applications at maximum concentration levels as stated in the corresponding IFRA-certificate documents.

› 100 – 75 = 3 = very good
› <75 – 50 = 2 = good
› <50 – 25 = 1 = moderate
› <25 = 0 = poor

Carbon Economy

› The carbon economy indicates the economic use of starting materials used in the manufacturing process. It is calculated by dividing the mass of carbon in the final product by the total mass of carbon in the reactants (starting materials), expressed as percentage, which corresponds with the normalized score.

› 100 = 3 = very good
› <100 – 75 = 2 = good
› <75 – 50 = 1 = moderate
› <50 = 0 = poor

Green Chemistry Process

› This score evaluates the effectiveness and the safety of the production process – by rating three pillars.
› The Green Chemistry Process score is the mean value of the three single scores.

Chemical process

› Compliance of used reactions to favoured processes as outlined in Annex B – "List of chemical and biological processes for derived natural, derived organic, and derived mineral ingredients" of ISO 16128-1 – "Guidelines on technical definitions and criteria for natural and organic cosmetic ingredients and products – Part 1: Definitions for ingredients" as well as use of catalytic reactions.

Process Hazards

› Hazard assessment of all during the production process used starting materials, auxiliaries and solvents based on the United Nation's Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

Yield

› The overall yield of the production process based on stoichiometry.

› The Green Chemistry Process score is the mean value of the three single scores.

› 100 – 80 = 3 = very good
› <80 – 60 = 2 = good
› <60 – 40 = 1 = moderate
› <40= 0 = poor

Total Rating

› The Total Rating in the following table relates to the sum of the sub-ratings of the 7 individual parameters.

› 21 – 17 = 3 = very good
fully compliant with Green Chemistry Principles
› 16 – 12 = 2 = good
widely compliant with Green Chemistry Principles
› 11 – 07 = 1 = moderate
under investigation in order to improve Green Chemistry Score
› 06 – 00 = 0 = poor
slightly consistent to Green Chemistry Principles, needs improvement

Green Chemistry

Scores

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Alcohol C 9	104769								
Alcohol C11	612080								
Aldron®	103190								
Allinat/Allyl Isothiocyanate 98 Toco	633696								
Allinat/Allyl Isothiocyanate BHT	653005								
Allinat/Allyl Isothiocyanate Toco	600311								
Allinat/Allyl Isothiocyanate Unstab.	653012								
Allyl Caproate	611045								
Allyl Cyclohexyl Propionate	690380								
Allyl Heptoate	611041								
Allyl Phenoxy Acetate	690394								
Allylione®	130190								
Amarocit®	197007								
Amberwood® F	600113								
Ambrinol S	690993								
Ambrocenide® 10 DPG	100215								
Ambrocenide® Cryst.	600199								
Ambrocenide® Flakes	606196								
Ambrostar®	903865								
Ambroxide Cryst.	600304								
Amyl Acetate	622110								
Amyl Butyrate N/Iso	195585								
Amyl Salicylate	762343								
Anethol Supra 21,5 Celsius	660017								
Anethole Extra 21/22	762201								
Anethole Synthetic	762437								
Anethole Synthetic Toco	762290								
Anisyl Acetate	611049								
Anisyl Alcohol	654001								

Green Chemistry Score 0 1 2 3

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Aprifloren®	600038								
Aurelione®	600098								
Benzyl Benzoate PH	613140								
Benzyl Butyrate	103937								
Benzyl Cinnamate	613057								
Benzyl Formate	613065								
Benzyl Isobutyrate	104495								
Benzyl Propionate	103932								
Brahmanol®	100204								
Buccoxime®	195583								
Butyl Butyrate	105445								
Canapure®	633699								
Canapure® PH	689383								
Cannabidivarin	664607								
Cannabigerol	664714								
Cantosen®	762348								
Cantryl®	100205								
Caramel Acetate	600104								
Carvomenthone	659431								
Carvone, L-	762207								
Carvyl Acetate Cis L	611468								
Caryophyllene Oxide	600334								
Chrysantheme	600144								
Cinnamyl Acetate	611105								
Citrolime	762324								
Citronellol AJ	762215								
Citronellol Prime	762217								
Citronellyl Butyrate	103596								
Citronellyl Formiate	103597								

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Citronellyl Isobutyrate	131120								
Citronellyl Propionate	103598								
Citronellyl Tiglate	104083								
Citronitrile	611455								
Citryl Acetate	172626								
Citrylal	690980								
Claritone®	600285								
Corps Eglantine	105136								
Corps Racine	600164								
Coumarone	600303								
Cyclodumol Acetate	762319								
Cyclogalbanat®	660567								
Cyclohexyl Salicylate	103360								
Cycloverdyl Acetate	762323								
Cycloverdyl Propionate	762334								
Cymene, Para-, P&F	762218								
Datilat	611417								
Decalyl Acetate Beta	611122								
Decalyl Formate Beta	690600								
Decyl Acetate	611125								
Dihydro Anethole	660556								
Dihydromyrcene Regular	762219								
Dihydromyrcenol	762230								
Dihydromyrcenol RT	762227								
Dimethyl Myrcetone	762335								
Dimethyl Myrcetone Extra	762325								
Ecomusk R	643556								
Ethoxy Ethyl Acetate-1	600036								
Ethyl Acetoacetate FG	106716								

Green Chemistry Score 0 1 2 3

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Ethyl Benzoate	103933								
Ethyl Butyrate	611073								
Ethyl Caprinate	105228								
Ethyl Caproate	611089								
Ethyl Caprylate	106193								
Ethyl Cinnamate	660448								
Ethyl Heptoate	611157								
Ethyl Isobutyrate	131130								
Ethyl Isovalerate	611201								
Ethyl Methyl Butyrate-2	611402								
Ethyl Phenyl Acetate	105951								
Ethyl Phenyl Carbinol	660355								
Ethyl Propionate	103250								
Ethyl Salicylate	105543								
Farenal®	656019								
Farnesol Special	118717								
Filbertone	690986								
Filbertone 1% In TEC	736664								
Floralox	762347								
Florazon	100360								
Floresent	762336								
Floropal	690307								
Formyrcenol	131092								
Fragolane®	103822								
Frambinon® Methyl Ether	131479								
Frutinat	611400								
Furfuryl Thioacetate	600209								
Geraniol BJ	762237								
Geraniol Fine 98% Min	762238								

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Geraniol FP	762239								
Geraniol Prime	762241								
Geranyl Acetate 60	762242								
Geranyl Isobutyrate	131112								
Geranyl Isovalerate	131131								
Geranyl Tiglate	103203								
Glidox 500	762203								
Glidox 500, 55% PHP	762243								
Globalide®	106114								
Globanone®	600317								
Hexenyl Acetate Cis-3	762333								
Hexenyl Salicylate Cis-3	600301								
Hexyl Acetate	611161								
Hexyl Salicylate	103249								
Himalide®	652000								
Hyacintal	198030								
Hydrocitronitrile	611459								
Indoflor® Cryst.	660173								
Intreleven Aldehyde Spec.	658697								
Iraldein Delta	600081								
Irisnitrile	611465								
Isoamyl Acetate	104836								
Isoamyl Butyrate	611025								
Isoamyl Cinnamate	660447								
Isoamyl Isovalerate	611037								
Isoamyl Salicylate	104141								
Isoamyl Salicylate	762326								
Isobutyl Acetate Nat.	600236								
Isobutyl Phenylacetate	105174								

Green Chemistry Score 0 1 2 3

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Isobutyl Salicylate	105683								
Isobutylmenthone	131156								
Isodamascon®	131275								
Isomenthone 8515	633678								
Isomuscone®	600359								
Jacinthaflor®	100216								
Jasmaprunat	690965								
Lactojasmone	660590								
Lactoscatone	104225								
Leafovert®	131380								
Lilessenz	762248								
Lilybelle®	633687								
Linalool Coeur	762253								
Linalool Pure	762258								
Linalyl Acetate Coeur	762260								
Linalyl Acetate Pure	762262								
Macrolide®	600356								
Macrolide® Supra	660539								
Madranol®	600267								
Magnolan®	690304								
Magnolila	600095								
Majantol®	105852								
Mandaril	600135								
Mandarin Aldehyde 10% TEC	199084								
Melonal	140247								
Menthadienole G	600013								
Menthol L Pellets	620009								
Menthol Laevo Dist.	620002								
Menthol Laevo Dist. PH	612524								

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Menthol Laevo Pellets PH	600012								
Menthol Rac	131136								
Menthol Rac PH	107643								
Menthone L/Isomenthone D	600124								
Menthone L/Isomenthone D 8020	613617								
Menthone Rac. 9505	605501								
Menthone/Isomenthone Rac.	620103								
Menthon-L 9505	605494								
Menthyl Acetate L	620020								
Menthyl Acetate Rac.	620021								
Menthyl Acetate RF (Symfresh RF)	620025								
Methyl Benzoate	613018								
Methyl Butyl Acetate-2 Nat.	600237								
Methyl Cinnamate	660449								
Methyl Guaiacol-4	103396								
Methyl Phenyl Acetate	105949								
Methyl Tetrahydrofuranthiole	600156								
Methylpropyl Oxathiane-2,4,1,3	660578								
Methylthio Hexylacetate-3	690982								
Mintonat	142048								
Mugetanol	600092								
Muguetalcohol	659479								
Myrcenate	762330								
Myrcene Extra	762265								
Myrtenol	658961								
Mysore Acetate	659673								
Neomagnolan®	636340								
Neononyl Acetate	611460								
Nerolex	762270								

Green Chemistry Score 0 1 2 3

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Nerolione	600321								
Olivetolmethylester	600112								
Oxanthia 50% In TEC	106171								
Ozonil	611471								
Palisandal	690230								
Palisandin	690165								
Paramenthane	762494								
Parmanyl®	100210								
Passifloran	600300								
Phenirat®	105991								
Phenylacetaldehyde	660354								
Phenylacetaldehyde Dimethyl Acetal	660345								
Phenylethyl Acetate	103248								
Phenylethyl Cinnamate Cryst.	660361								
Phenylethyl Isobutyrate	103934								
Phenylethyl Phenylacetate	103936								
Phenylpropyl Alcohol	660165								
Phenyxol	762337								
Poivrol®	659616								
Prenyl Acetate	601331								
Profarnesal	656079								
Profarnesol	690936								
Projasmone P	660137								
Pyroprunat	611421								
Resedafol	690520								
Resedylacetal	658742								
Rholiate	106108								
Rosaphen®	600064								
Rose Oxide D	131505								

Name	Material	Renewability	Biodegradability	Green Chemistry Process	Carbon Economy	E-Factor	Carbon Footprint	Product Toxicity	Total Rating
Rose Oxide L	130780								
Sensinile	762339								
Sultanene®	100072								
Symcool® Nat.	239467								
Symcool® WS-3 Plastic Keg	762305								
Symcool® WS-5 Plastic Keg	762308								
Symroxane®	109818								
Tabanon	103229								
Terpinene, Alpha CF	762288								
Terpinene, Gamma-	762479								
Terpineol, Alpha-, Supra	762294								
Terranol®	600035								
Tetrahydrolinalool	762296								
Tetrahydromyrcenol	762297								
Tetralol	762300								
Timberol®	198022								
Tolyl Acetaldehyde Para 50% DPG	130706								
Triisobutyl Dihydrodithiazine	600082								
Vertacetal® Coeur	646596								
Vertosine	600271								
Vetikolacetat®	197009								
Vetikon	131014								
Vetival®	105274								
Ysamber® K	107870								

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