



MONOSODIUM CITRATE

Monosodium citrate as an endothermic blowing agent

GENERAL INTRODUCTION

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Material foaming is an essential process in the plastic industry for producing lightweight, more cost-effective materials.[1] The selection of an appropriate foaming agent is critical for achieving the desired density, morphology, and mechanical performance. There are 2 classes of blowing agents: physical and chemical ones. Physical agents produce foam by vaporizing or expanding under processing conditions, while chemical ones decompose or react chemically to generate gas during processing.

In simple terms, blowing agents help to create tiny gas bubbles inside plastic materials during processing. Blowing agents are typically mixed with the polymer at a low temperature or incorporated in a mixture with various carriers.

When the temperature is increased, gaseous reaction products form within the polymer matrix, resulting in a foamed structure. This can be done in different processing steps, such as extrusion,

molding, or compression. However, gas generation alone does not determine foam quality, whereas cell structure must also be retained during expansion.

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Why monosodium citrate?

Monosodium citrate, combined with sodium bicarbonate, is typically able to guarantee this dual functionality. By applying heat, the acid-assisted chemical and thermal decomposition produces carbon dioxide gas and water vapor. Monosodium citrate is known as an endothermic blowing agent, withdrawing heat during the foaming process. As a result, finer cellular structures are formed, improving appearance and physical properties as compared to exothermic blowing agents. Indeed, azodicarbonamide, sulfonyl semicarbazide, or hydrazine derivatives are more difficult to control, may produce non-uniform bubbles, can produce nitrogen and ammonia gases, and often leave toxic residues or byproducts that can harm equipment or end products.[2] On the contrary, monosodium citrate produces CO₂ instead of harmful gases, is biodegradable and derived from citric acid, which is naturally occurring.

In summary, it can be concluded that monosodium citrate has following advantages as a blowing agent:

- endothermic blowing agent (easier to control)
- non toxic (allowance for food contact material)
- biodegradable and produced with a sustainable production process (less environmental impact) [5]

Usage and technical specifications

Additionally, there is a whole range in solution rates possible with monosodium citrate, whereas differences in granular size give rise to differences in solution rate and thus in release of gases.

Different granular sizes are listed below: [3]

Type	Particle size	Mesh	Limits
Monosodium Citrate Granular	> 425 µm	40	max. 10%
	< 75 µm	200	max. 30%
Monosodium Citrate Powder	> 250 µm	60	max. 5%
	< 75 µm	200	min. 65%

Typical concentrations ranging from 0.5 to 4% can be applied with a range of thermoplastics, especially polyolefins and styrenics, due to matching decomposition temperatures with processing windows (typically 160-270 °C).

Common compatible polymers include [1]:

- Acrylonitrile butadiene styrene (ABS)
- Ethylene-vinyl acetate (EVA)
- Polyamide (PA)
- Polybutylene terephthalate (PBT)
- Polycarbonate (PC)
- Polyethylene (PE, LDPE, LLDPE, HDPE)
- Polyethylene terephthalate (PET)
- Polyoxymethylene (POM)
- Polyphenyl ether (PPE)
- Polyphenylene oxide (PPO)
- Polyphenylene sulfide (PPS)
- Polypropylene (PP)
- Polystyrene (PS, GPPS, HIPS)
- Polyvinyl chloride (PVC)
- Styrene-acrylonitrile resin (SAN)
- Thermoplastic olefin (TPO)
- Thermoplastic polyurethane (TPU)

Regulatory specifications

Sodium citrate from Citribel is allergen-free, odorless, nonflammable, and complies with the highest food purity criteria (food additive E331) [4]. It is perfectly suitable for food contact products such as food packaging, labels, fine sheet products, monofilaments, films, and boards.[1] Besides, it is also regulated under REACH registration, allowing for industrial applications [3].

Conclusions

To conclude, the advantages of using monosodium citrate as a blowing agent are:

- Non-toxic and food contact safe: No hazardous decomposition products: only carbon dioxide and water are released.
Suitable for food contact products such as food packaging, labels, fine sheet products, monofilaments, films, and boards
- Improved process controllability due to the endothermic, slow release of gases [1]:
decomposition temperature of ± 217 °C
gas yield of 185-240 mL g⁻¹,
- Formation of uniform and fine cell structures with better surface quality at low dosages [1]:
At 0.5-1% active loading in the polymer, it can achieve 12-32% density reduction
- Colorless crystals or powder:
allowing its use in opaque and translucent products without interfering with the product color:
- Environmentally friendly [5]:
Produces CO₂ instead of harmful gases
biodegradable and derived from citric acid, which is naturally occurring

[1] G. Wypych, Handbook of Foaming and Blowing Agents, ChemTec Publishing, Toronto, 2017.
[2] T. Garbacz, P. Palutkiewicz, Cellular Polym. 2015, 34, 189-214.
[3] Monosodium Citrate Manufacturer | Citribel | Granular & Powder
[4] CL2008R1333EN0330010.0001.3bi_cp 1..3
[5] Sustainability-report-2025.pdf



Derived from nature,
refined by innovation



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