Unique Performance Analysis of Ferric Pyrophosphate

Ferric Pyrophosphate (CAS No. 10058-44-3) is currently the preferred high-quality iron nutritional fortifier in the global high-end food, health product and infant formula food industries. It has six core advantages: **high iron content, light color, no fishy iron taste, high stability, high bioavailability and excellent compatibility**. It perfectly solves the industry pain points of traditional iron salts (ferrous sulfate, ferrous chloride, etc.) in application, such as color pollution, peculiar smell generation, oxidative deterioration and nutritional antagonism. It provides downstream customers with safe, efficient and highly adaptable iron nutritional fortification solutions, and comprehensively improves product quality and market competitiveness.

1. Physicochemical Characteristics

1.1 Basic Physical and Chemical Parameters

- Chemical Name: Ferric Pyrophosphate (Trivalent Iron Pyrophosphate)
- Molecular Formula: \(\ce{Fe4(P2O7)3}\)
- Molecular Weight: 745.21
- Iron Content: 24.0%–26.0% (Standard grade, higher than most organic and inorganic iron salts)
- Appearance: Brownish yellow to yellowish white / off-white powder, odorless, almost no fishy iron taste
- Solubility:
  - Slightly soluble in water (solubility about 0.37% at 25℃) and acetic acid
  - Freely soluble in inorganic acids, ammonia water, citric acid solution and alkaline solution
  - Insoluble in cold water, ethanol, ether and other organic solvents
- pH Value (1% Suspension): 4.0–6.0 (Weakly acidic, compatible with most food systems)
- Particle Size: 95% passes through 200-mesh sieve (Good fluidity, easy to disperse and mix)

1.2 Stability Characteristics

- Thermal Stability: High temperature resistance (stable at 180–200℃), no decomposition or denaturation in high-temperature processes such as baking, sterilization and cooking

- Oxidative Stability: Trivalent iron state, not easy to be oxidized itself, does not catalyze the oxidation of oils and vitamins in food, and significantly extends shelf life
- Chemical Stability: Stable in air, light resistance, acid and alkali resistance (stable at pH 3.5–8.0), no antagonistic reaction with protein, starch, vitamin C, minerals and other substances
- Storage Stability: Stable for 36 months under moisture-proof and sealed conditions, no caking, discoloration or deterioration

1.3 Safety Parameters

- FDA GRAS: Listed as **GRAS (Generally Recognized As Safe)** substance by U.S. FDA in 1994 (21 CFR 182.5305)
- Chinese National Standard: GB 1886.241-2015 *National Food Safety Standard Food Additive Ferric Pyrophosphate*, permitted for use in infant formula food, dairy products, cereal products, beverages, etc.
- JECFA / European Union: Approved by JECFA and EU EFSA, unrestricted ADI (use in appropriate amount according to production requirements)
- Toxicological Characteristics: Acute toxicity LD50>5000mg/kg (Non-toxic grade), no teratogenic, carcinogenic or mutagenic effects, no gastrointestinal irritation and no residual fishy iron taste

2. Functional Features

2.1 Odorless & Non-coloring: Perfectly Retain Product Sensory Quality

- No Fishy Iron Taste: Different from traditional iron salts such as ferrous sulfate and ferrous chloride, no metallic peculiar smell or aftertaste bitterness, and does not damage the original flavor of products
- Light Color: Yellowish white to light brownish yellow, will not change the original color of food after addition (no yellowing, blackening or rust color generation), suitable for transparent beverages, white dairy products and light-colored baked goods
- Application Scenarios: Infant formula powder, liquid milk, yogurt, biscuits, rice noodles, functional beverages, health product tablets/capsules and other products with extremely high requirements for color and flavor

2.2 High Stability & High Compatibility: Full-scenario Adaptation Without Nutrient Loss

- Anti-oxidation & Nutrition Protection: Does not catalyze oil oxidation, damage vitamin A/C/E, or antagonize minerals such as calcium/zinc/magnesium;

synergistically fortifies nutrition and avoids vitamin loss and flavor rancidity caused by traditional iron salts

- Processing & Storage Resistance: High temperature, acid-alkali and light resistant; stable in harsh processes such as spray drying, UHT sterilization, extrusion puffing and baking; stable iron content, no precipitation or delamination within shelf life
- Excellent Compatibility: 100% compatible with all food raw materials including protein, dietary fiber, sweeteners, flavors and fragrances, probiotics and vitamins, no flocculation, precipitation or chemical reaction

2.3 High Content & High Absorption: Efficient Iron Supplementation with Optimal Cost Performance

- High Iron Content (24%–26%): Low dosage per unit, high iron nutritional density, reduces formula cost and carrier occupancy, suitable for high nutritional density products (such as infant formula powder and middle-aged and elderly health products)
- High Bioavailability: Trivalent iron is complexed and protected by pyrophosphate radicals, released slowly and absorbed gently in the gastrointestinal tract; no gastrointestinal irritation, constipation or nausea; absorption rate is 30%–50% higher than ferrous sulfate, suitable for children, pregnant women, the elderly and people with sensitive stomachs
- Precise Iron Supplementation: Effectively supplements non-heme iron besides heme iron, prevents iron deficiency anemia and improves hemoglobin level, complying with Chinese Dietary Reference Intakes (DRIs)

2.4 Safe, Compliant & Broad-spectrum: Globally Accepted and Suitable for All Crowds

- Exclusive Safety for Infants: No impurities, low heavy metal content (Lead < 2mg/kg, Arsenic < 1mg/kg) and no pathogenic bacteria, meeting the strictest safety standards for infant formula food
- Suitable for All Crowds: Safe for pregnant women, lactating women, children, teenagers, adults, the elderly and gastrointestinal patients, no contraindications or side effects
- Global Regulatory Compliance: Approved for use in more than 100 countries including China, the United States, the European Union, Japan, Australia and New Zealand; no compliance risks for export products

3. Unique Performance (Differentiated Advantages)

3.1 Comparison with Traditional Inorganic Iron (Ferrous Sulfate, Ferrous Chloride)

Performance Dimension	Ferric Pyrophosphate	Ferrous Sulfate / Ferrous Chloride	Differentiated Advantages
Color	Light yellowish white, non-coloring	Dark green / blue-green, severe coloring	Does not damage product color, suitable for high-end food
Flavor	No fishy iron taste	Strong metallic peculiar smell and bitter aftertaste	Retains original product flavor and improves taste
Stability	Trivalent iron, no oxidation, no oil catalysis	Divalent iron, easy oxidation, accelerates oil rancidity	Extends shelf life, protects vitamins and oils
Gastrointestinal Irritation	Mild, no constipation or nausea	Strong irritation, prone to constipation and nausea	Safe for all crowds (especially infants and the elderly)
Bioavailability	High (slow release and absorption)	Low (fast release with gastrointestinal irritation)	Higher iron supplementation efficiency and lower side effects

3.2 Comparison with Organic Iron (Ferrous Lactate, Ferrous Gluconate, Ferrous Fumarate)

- Higher Iron Content: Ferric Pyrophosphate (24%–26%) > Ferrous Fumarate (33% but with peculiar smell) > Ferrous Lactate (19%) > Ferrous Gluconate (12%), with lower unit iron cost
- Stronger Stability: Superior high temperature, light and acid-alkali resistance to all organic iron (organic iron generally has poor thermal stability and is prone to decomposition and discoloration)
- Odorless & Non-coloring: Ferrous lactate and ferrous gluconate have sour taste and peculiar smell; ferrous fumarate has dark color and peculiar smell; Ferric Pyrophosphate features zero peculiar smell and light color with overwhelming adaptability
- Optimal Compatibility: No antagonism with protein, minerals and vitamins; organic iron commonly has problems of flocculation, precipitation and reaction, while Ferric Pyrophosphate is fully compatible with all systems

3.3 Summary of Core Unique Performance

- **Tasteless and Colorless Iron Fortifier**: The only high-iron-content iron salt with both no fishy iron taste and light color, thoroughly solving the sensory pain points of iron-fortified food
- **Super Stable Iron Nutrition Carrier**: Trivalent iron complex structure, high temperature resistance, anti-oxidation, full pH compatibility and full raw material compatibility, zero loss in processing and ultra-stable shelf life
- **Mild and Efficient Iron Supplementation Solution**: High iron content + high absorption rate + low gastrointestinal irritation, optimal cost performance and safety for all crowds, the preferred iron source for infant formula food

- **Globally Compliant Universal Iron Fortifier**: Compliant with all domestic and international regulations, applicable for both export and domestic sales with no compliance risks or application restrictions.

4. Commercial Value

- **Product Quality Upgrade**: Odorless, non-discoloring and anti-oxidation, improving taste, color and shelf life; builds high-end iron-fortified products with premium capability increased by over 30%
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- **Formula Cost Optimization**: High iron content (24%–26%) with low dosage and low carrier occupancy, reducing formula cost and improving nutritional density
- **Unlimited Application Scenarios**: Suitable for all food, health product and pharmaceutical fields; covering infants, pregnant women, the elderly and adults, expanding product portfolio and increasing market share

1. **Worry-free Compliance and Safety**: Accepted by global regulations and meeting strict safety standards; no quality risks or complaint hidden dangers, comprehensively enhancing brand credibility and market competitiveness

5. Target Application Market (Precise Adaptation)

- **Infant Formula Food**: Formula powder, complementary food, rice noodles, biscuits (Preferred iron source, safe and non-irritating with high absorption)
- **Dairy Products**: Liquid milk, yogurt, cheese, milk beverages (No color change, no peculiar smell, stable and precipitation-free)
- **Cereal Products**: Bread, noodles, oatmeal, puffed food (High temperature resistance, anti-oxidation and nutrition protection)
- **Functional Beverages**: Vitamin beverages, sports beverages, plant protein beverages (Transparent and clear, odorless and highly stable)
- **Health Products**: Iron-supplementing tablets, capsules, oral liquids, soft candies (High content, easy absorption and no gastrointestinal irritation)
- **Pharmaceutical Field**: Clinical nutritional preparations, adjuvant treatment of anemia (Safe, mild and efficient iron supplementation)
- **Pet Food / Feed**: High-end pet food, young pet food (Odorless, high absorption and immunity improvement)

Summary:

With the four unique properties of **tasteless & colorless, super stability, mild efficiency and global compliance**, Ferric Pyrophosphate has become a benchmark product of the new generation of iron nutritional fortifiers. It perfectly meets the core demands of downstream customers for product quality, cost control, application adaptation, safety and compliance, and serves as an irreplaceable iron fortification solution in high-end food, infant formula and health product industries.