PROVISIONAL PATENT SPECIFICATION

Patents Act 1990 (Cth)

Title of Invention:

AI OxySorb™ - AN ARTIFICIAL INTELLIGENCE-ASSISTED OXYGEN ABSORBER CALCULATION, SELECTION AND PACKAGING ADVISORY SYSTEM

Inventor:

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Applicant:

Wholesale Group International Pty Ltd

Main domain / commercial implementation:

www.oxygenabsorber.com.au

Field of the Invention

The invention relates to active packaging, oxygen absorbers, oxygen scavengers, food preservation, pharmaceutical preservation, shelf-life extension, packaging science, and computer-implemented systems for calculating, selecting and advising on oxygen absorber size, type, capacity and application.

More particularly, the invention relates to a web-based oxygen absorber calculator "AI OxySorb™" and artificial intelligence assistant configured to receive packaging, product, shelf-life and environmental data, calculate oxygen absorber requirements, select an appropriate oxygen absorber capacity, and generate packaging recommendations using a curated domain-specific scientific knowledge base.

Background of the Invention

Oxygen absorbers are used in food, pharmaceutical, nutraceutical, pet food, dehydrated food, freeze-dried food, grain, spice, coffee, nut, bakery and long-term storage packaging to remove oxygen from the packaging environment. Oxygen in a package may promote oxidative rancidity, colour loss, vitamin degradation, microbial spoilage, mould growth, insect survival, flavour deterioration and reduced shelf-life.

Known oxygen absorber sizing approaches are often manual, approximate or dependent on expert consultants. A user may know the size of the bag or container, but may not understand how to calculate the total oxygen load arising from headspace, void volume, dissolved or occluded oxygen, air trapped between food particles, oxygen transmission through packaging film, shelf-life duration, humidity, temperature, water activity, food type and oxygen absorber kinetics.

There is a need for an improved technical system that calculates oxygen absorber requirements and provides scientifically grounded guidance to users through a web interface. There is also a need for an AI assistant that does not merely provide general chatbot answers, but retrieves and reasons over a curated oxygen absorber knowledge base built from decades of scientific publications, technical data, packaging standards, experimental results, food category information and regulatory materials.

Summary of the Invention

The invention provides a computer-implemented oxygen absorber calculation and advisory system comprising:

1. a web-accessible oxygen absorber calculator hosted at or accessible through www.oxygenabsorber.com.au;
2. a user input interface configured to receive packaging, product and shelf-life parameters;
3. a calculation engine configured to determine a required oxygen absorber capacity in cubic centimetres of oxygen absorption;
4. a product selection engine configured to round or map the calculated oxygen requirement to commercially available oxygen absorber sizes, including but not limited to 20 cc, 50 cc, 100 cc, 300 cc, 500 cc, 1000 cc and 2000 cc;
5. an artificial intelligence assistant configured to answer oxygen absorber, oxygen scavenger, active packaging, shelf-life, food preservation, Mylar bag, vacuum sealing, freeze-dried food, pharmaceutical, pet food, coffee, nut, grain, spice, dehydrated food and packaging questions;
6. a curated oxygen absorber scientific knowledge database comprising hundreds of scientific journal papers, reviews, patents, regulatory materials, food law materials,

packaging standards, experimental data and domain-specific technical records accumulated over approximately 35 years of research;

7. a retrieval, ranking or reasoning module configured to identify relevant scientific and technical material from the database and generate a response grounded in oxygen absorber science; and
8. a recommendation module configured to output oxygen absorber size, assumptions, risk warnings, suggested packaging improvements and optional escalation to a qualified food technology or packaging professional.

The invention therefore provides a technical decision-support system for oxygen absorber sizing and packaging advisory work, combining calculation, scientific retrieval, AI reasoning and practical product selection.

Definitions

In this specification:

"Oxygen absorber" and "oxygen scavenger" include sachets, strips, packets, labels, self-adhesive patches, embedded films, inserts, capsules, active packaging materials and other oxygen-removing systems. OxySorb™ is a registered trademark of Wholesale Group International Pty. Ltd. (Australia).

"Capacity" means the nominal oxygen absorbing capacity of an absorber, usually expressed in cubic centimetres or millilitres of oxygen.

"OTR" means oxygen transmission rate of a package material, film, pouch, bag, container, closure or seal, typically expressed in cc/m²/24 hours or equivalent units.

"Void space" means the portion of package volume not occupied by food or product and includes headspace and interstitial air.

"Knowledge database" means a structured, semi-structured or unstructured database comprising scientific papers, abstracts, experimental results, regulatory materials, technical guides, tables, documents, embeddings, citations, annotations and domain-specific metadata concerning oxygen absorbers and active packaging.

Detailed Description of the Invention

The invention may be implemented as a website, server-side application, cloud-hosted application, mobile application, embedded module, API, chatbot, calculator, spreadsheet-derived engine, packaging platform, e-commerce advisory tool or integrated food packaging decision-support system.

In a preferred embodiment, the system is implemented on the domain www.oxygenabsorber.com.au and includes a user-facing calculator and an AI assistant (AI OxySorb™).

User Input Module

The user input module may request or receive one or more of the following:

a. product type, including bread, bakery, nuts, grains, flour, coffee, tea, dehydrated foods, freeze-dried foods, spices, pharmaceuticals, nutraceuticals, pet food, meat, fish, dried fruit, confectionery, seeds, herbs or other oxygen-sensitive goods;

b. package length;

c. package width;

d. package height, thickness, girth or assumed depth;

e. total internal package volume;

f. product fill percentage;

g. void-space percentage;

h. oxygen transmission rate of the package material;

i. package surface area;

j. number of permeable sides;

k. target shelf-life in days;

l. temperature of storage or distribution;

m. relative humidity or water activity;

n. product weight or density;

o. dissolved oxygen or estimated occluded oxygen in the product;

p. desired residual oxygen level;

q. absorber type, including iron-based, ascorbate-based, enzymatic, label-based, film-based or other oxygen scavenger;

r. sealing method, including heat seal, vacuum seal, modified atmosphere packaging, Mylar bag, jar, can, pouch, tray or bottle;

s. whether vacuum sealing or nitrogen flushing is used;

t. safety factor selected by the user or system; and

u. any regulatory, food safety or application-specific constraints.

Calculation Engine

The calculation engine may calculate total oxygen absorber requirement by combining one or more oxygen load components.

In one embodiment:

Total oxygen requirement = initial headspace oxygen + interstitial oxygen + dissolved or occluded oxygen + oxygen ingress over target shelf-life + safety factor.

The system may calculate package volume:

$V_{package} = L \times W \times H$

where L is length, W is width and H is height, thickness, girth or effective internal depth.

The system may calculate headspace or void oxygen:

$O_{2initial} = V_{package} \times F_{void} \times F_{atmospheric\ oxygen}$

where F_{void} is the fraction of package volume occupied by void space and $F_{atmospheric\ oxygen}$ is approximately 0.209 to 0.21 under normal air conditions.

The system may calculate oxygen ingress through the package:

$O_{2ingress} = OTR \times Area \times Time \times Correction\ Factors$

where OTR is oxygen transmission rate, Area is effective permeable area, Time is the required shelf-life period, and Correction Factors may account for temperature, humidity, pressure, package material, seal integrity, storage conditions or empirical validation.

The system may include a correction for dissolved or adsorbed oxygen:

O_{2food} = estimated oxygen contained within, between, adsorbed onto or dissolved in the product matrix.

The system may calculate a final absorber requirement:

$O_{2required} = (O_{2initial} + O_{2ingress} + O_{2food} + O_{2respiration} + O_{2seal\ allowance}) \times Safety\ Factor$

where $O_{2respiration}$ is optionally used for respiring products such as fruit, vegetables or fresh produce, and $O_{2seal\ allowance}$ is optionally used to allow for imperfect seals or operator variability.

The system may then select the nearest commercially available oxygen absorber size that is equal to or greater than the calculated requirement. Available sizes may include 20 cc, 50 cc, 100 cc, 300 cc, 500 cc, 1000 cc, 2000 cc or other sizes.

In a preferred embodiment, the system errs on the side of overestimating rather than underestimating the absorber requirement, particularly where a user enters uncertain package fill or void-space data.

Output Module

The system may output:

a. calculated oxygen absorber requirement in cc;

b. recommended commercial absorber size;

c. alternative absorber sizes or combinations;

d. assumptions used in the calculation;

e. calculated package volume;

f. calculated initial oxygen load;

g. calculated oxygen ingress over shelf-life;

h. warning if packaging OTR is too high;

i. warning if shelf-life target is unrealistic;

j. warning if food moisture, water activity or anaerobic risk requires professional review;

k. recommendation to use high-barrier packaging;

l. recommendation to validate with laboratory shelf-life testing;

m. explanation of the calculation;

n. product suitability notes; and

o. a prompt to contact a qualified packaging or food technology professional where required.

Artificial Intelligence Assistant

The AI assistant is configured to receive natural-language questions from a user and provide domain-specific responses concerning oxygen absorbers and packaging.

The assistant may answer questions including:

a. what size oxygen absorber should be used;

b. whether oxygen absorbers are suitable for a particular food;

c. whether oxygen absorbers may be used with Mylar bags;

d. whether vacuum sealing is sufficient;

e. whether oxygen absorbers are suitable for pharmaceuticals;

f. how oxygen absorbers affect mould, rancidity, colour, vitamin loss, aroma and shelf-life;

g. how OTR affects shelf-life;

h. how to choose between 20 cc, 50 cc, 100 cc, 300 cc, 500 cc, 1000 cc and 2000 cc absorbers;

i. whether a particular packaging format is appropriate;

j. when to obtain food technology advice; and

k. what scientific literature supports a particular recommendation.

The AI assistant may use retrieval augmented generation, embeddings, vector search, keyword search, semantic search, citation mapping, ranking, summarisation, prompt engineering, rule-based filtering or any combination thereof.

Knowledge Database

The knowledge database may include hundreds of scientific journal papers and technical documents over approximately 35 years of oxygen absorber and active packaging research.

The knowledge database may include:

a. oxygen absorber chemistry;

b. iron oxidation mechanisms;

c. oxygen scavenger kinetics;

d. food category studies;

e. shelf-life studies;

f. mould and microbial inhibition studies;

g. lipid oxidation studies;

h. vitamin stability studies;

i. colour preservation studies;

j. nut, grain, coffee, bakery, meat, fish, fruit, vegetable and pharmaceutical studies;

k. OTR and packaging film data;

l. active packaging patents;

m. food contact material standards;

n. HACCP and food safety materials;

o. Australian, United States, European and international regulatory materials;

p. prior calculator outputs;

q. laboratory validation data;

r. frequently asked questions; and

s. expert annotations by Dr. Simon Cichello or authorised persons.

In a preferred embodiment, each document or item in the knowledge database is associated with metadata including food category, absorber chemistry, storage temperature, relative humidity, water activity, OTR, shelf-life duration, experimental outcome, regulatory jurisdiction, citation information and relevance score.

AI Safety and Technical Guardrails

The AI assistant may include guardrails that prevent unsafe or unsupported recommendations. The assistant may recommend professional review where:

a. the product is high moisture;

b. the product has anaerobic pathogen risk;

c. the packaging is not high barrier;

d. shelf-life is unusually long;

e. the product is intended for infants, medical use or high-risk consumers;

f. pharmaceutical or therapeutic claims may be involved;

g. the user provides incomplete data;

h. the system confidence score is below a threshold; or

i. the answer requires laboratory testing.

The assistant may distinguish between general educational guidance and technical recommendations requiring validation.

System Architecture

The system may comprise:

a. a client device operated by a user;

b. a web server associated with www.oxygenabsorber.com.au;

c. a calculator engine;

d. a product database containing absorber size, type and capacity data;

e. an AI language model interface;

f. a retrieval module;

g. a vector database or indexed document store;

h. a rules engine;

i. a safety and compliance module;

j. a logging module;

k. an analytics module;

l. an e-commerce or enquiry module; and

m. a human expert escalation module.

The system may be implemented using any suitable programming language, database, artificial intelligence model, large language model, embedding model, rules engine or cloud platform.

Technical Workflow

In one embodiment, the system performs the following steps:

1. receiving user inputs concerning a package, product and shelf-life objective;
2. determining package volume;
3. determining void-space volume;
4. determining initial oxygen volume;
5. determining package surface area;
6. determining oxygen ingress based on OTR and shelf-life;
7. optionally determining dissolved, occluded, adsorbed or interstitial oxygen;
8. optionally applying correction factors for temperature, humidity, water activity, storage condition or product type;
9. applying a safety factor;
10. calculating required oxygen absorption capacity;
11. selecting a commercial absorber size equal to or greater than the calculated capacity;
12. retrieving relevant scientific and technical materials from a curated oxygen absorber knowledge database;
13. generating an explanation and recommendation;
14. displaying the recommendation to the user; and
15. optionally inviting the user to purchase absorbers, submit packaging details, request samples, or book a technical consultation.

Example Embodiment

A user enters package dimensions of 21 cm length, 12.5 cm width and 5 cm assumed thickness. The system calculates internal package volume and total oxygen in the package. The user enters an OTR of 1 cc/m²/24 hours, two permeable sides, a void-space percentage of 20 percent and target shelf-life of 150 days. The calculation engine calculates oxygen transmission and total oxygen absorber capacity required. The system then recommends the next suitable commercial oxygen absorber size, for example a 100 cc oxygen absorber where the calculated requirement is above 50 cc and below 100 cc.

The AI assistant may then explain why the recommendation was made and may state that the recommendation is affected by OTR, seal integrity, void space, dissolved oxygen, moisture, temperature and shelf-life.

Further Embodiments

In another embodiment, the system provides a “quick calculator” requiring only package dimensions and shelf-life.

In another embodiment, the system provides a “structured calculator” requiring detailed OTR, void space, product type, temperature and humidity.

In another embodiment, the system provides an “advanced calculator” for food technologists, including dissolved oxygen, water activity, respiration rate, permeability coefficients, storage temperature, humidity and absorber kinetic data.

In another embodiment, the AI assistant automatically asks follow-up questions where the input data is incomplete.

In another embodiment, the system generates a technical report suitable for food manufacturers, including the assumptions, calculation, recommendation and scientific rationale.

In another embodiment, the system is integrated with an online shop or enquiry form and automatically maps calculated requirements to OxySorb™ products.

In another embodiment, the system logs anonymised calculations and uses them to improve future recommendations.

In another embodiment, the system allows uploading of package specifications, technical data sheets, OTR certificates, product labels or laboratory reports, and extracts relevant parameters for calculation.

In another embodiment, the system includes a patent, scientific or regulatory citation assistant that retrieves oxygen absorber studies from the database and provides references to support recommendations.

Advantages of the Invention

The invention provides several advantages, including:

a. faster oxygen absorber sizing;

b. reduced reliance on manual calculation;

c. improved selection of absorber capacity;

d. integration of scientific literature with practical packaging calculations;

e. reduced under-sizing risk;

f. reduced food waste;

g. improved shelf-life planning;

h. better support for preservative-free food packaging;

i. improved technical guidance for small and large food manufacturers;

j. improved access to oxygen absorber expertise through a website;

k. domain-specific AI advice rather than generic chatbot output;

l. practical recommendations linked to commercially available absorber sizes; and

m. ability to support food, pharmaceutical, pet food, freeze-dried, dehydrated, grain, nut, coffee, spice and long-term storage sectors.

Proposed Claim-Style Statements for Later Complete Application

Although claims are not strictly required for a provisional application, the following claim-style statements are included to assist later complete patent drafting.

1. A computer-implemented method for selecting an oxygen absorber for a packaged product, the method comprising receiving packaging dimensions, determining package volume, determining void-space oxygen, determining oxygen ingress through packaging material over a target shelf-life period, calculating a required oxygen absorbing capacity, and selecting an oxygen absorber size equal to or greater than the calculated required oxygen absorbing capacity.
2. The method of statement 1, wherein the selected oxygen absorber size is selected from 20 cc, 50 cc, 100 cc, 300 cc, 500 cc, 1000 cc and 2000 cc.
3. The method of statement 1 or 2, wherein oxygen ingress is calculated using oxygen transmission rate, effective package surface area and shelf-life duration.
4. The method of any preceding statement, further comprising applying a correction factor for temperature, relative humidity, water activity, product type, sealing method or package material.
5. The method of any preceding statement, further comprising estimating dissolved, occluded, adsorbed or interstitial oxygen associated with the packaged product.
6. The method of any preceding statement, further comprising applying a safety factor to reduce the risk of under-sizing the oxygen absorber.
7. The method of any preceding statement, wherein the packaged product is selected from food, beverage, pharmaceutical, nutraceutical, pet food, coffee, nuts, grains, spices, dehydrated food, freeze-dried food, bakery products, meat, fish, fruit, vegetables and long-term storage products.
8. A web-based oxygen absorber calculation system comprising a user interface, a calculation engine, an oxygen absorber product database and an output module configured to recommend an oxygen absorber size for a packaged product.
9. The system of statement 8, wherein the system is accessible via www.oxygenabsorber.com.au.
10. The system of statement 8 or 9, further comprising an artificial intelligence assistant configured to answer natural-language questions concerning oxygen absorbers, oxygen scavengers, packaging, shelf-life and food preservation.

11. The system of statement 10, wherein the artificial intelligence assistant retrieves information from a curated scientific knowledge database comprising scientific journal papers, technical documents, regulatory materials and oxygen absorber research accumulated over approximately 35 years.
12. The system of statement 10 or 11, wherein the artificial intelligence assistant uses retrieval augmented generation to generate responses grounded in oxygen absorber science.
13. The system of any one of statements 10 to 12, wherein the artificial intelligence assistant is configured to provide warnings where insufficient information, high moisture products, anaerobic risk, poor packaging barrier properties or regulatory concerns are detected.
14. The system of any one of statements 8 to 13, wherein the calculation engine produces a technical explanation comprising package volume, oxygen load, oxygen ingress, shelf-life assumption and recommended absorber size.
15. The system of any one of statements 8 to 14, wherein the system maps a calculated oxygen absorber requirement to a commercial oxygen absorber product.
16. A non-transitory computer-readable medium storing instructions which, when executed by one or more processors, cause the processors to perform the method of any one of statements 1 to 7.
17. An oxygen absorber advisory platform comprising a calculator and an artificial intelligence assistant, wherein the calculator generates oxygen absorber capacity recommendations and the assistant generates scientific explanations using a curated oxygen absorber knowledge database.
18. The platform of statement 17, wherein the curated oxygen absorber knowledge database includes metadata relating to food category, absorber chemistry, oxygen transmission rate, temperature, humidity, water activity, shelf-life, microbial inhibition, oxidation inhibition and regulatory compliance.
19. The platform of statement 17 or 18, wherein the assistant generates a packaging recommendation that includes a selected oxygen absorber size, packaging suitability warning and suggested validation testing.
20. A method of reducing oxygen-related spoilage risk in packaged products by using a web-based calculator and AI assistant to determine oxygen absorber capacity and provide product-specific packaging guidance before packaging or commercial distribution.

Abstract

An artificial intelligence-assisted oxygen absorber calculation and advisory system is disclosed. The system receives packaging, product, shelf-life and environmental parameters and calculates a required oxygen absorber capacity by determining oxygen load from headspace or void space, oxygen ingress through packaging material, dissolved or occluded oxygen and correction factors such as temperature, humidity, water activity and safety margin. The system maps the calculated requirement to commercially available absorber sizes including 20 cc to 2000 cc absorbers. The system further includes an AI assistant connected to a curated scientific oxygen absorber knowledge database comprising hundreds of scientific publications and technical materials accumulated over approximately 35 years. The AI assistant generates scientifically grounded packaging guidance, warnings and explanations. The system may be implemented through www.oxygenabsorber.com.au.

Drawings / Figures to be Filed Separately

Figure 1: System architecture showing user device, website, calculator engine, AI assistant, knowledge database and output module.

Figure 2: Flowchart of oxygen absorber calculation method.

Figure 3: Example user interface for quick oxygen absorber calculator.

Figure 4: Example user interface for structured or advanced calculator.

Figure 5: Knowledge database and AI retrieval architecture.

Figure 6: Example output screen recommending absorber size and assumptions.

End of Provisional Specification