TRISYL®
Silica Gel for Refining Edible Oil
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# Product Range

| TRISYL® | Silica Gel for Refining Edible Oil |
| DARACLAR® | Beer Stabilizers |
| CRYOSIV® | Desiccant for Refrigerant Drying |
| PHONOSORB® | Beaded Absorbents for Insulating Glass |
| SAFETYSORB® | Desiccants for the Pharmaceutical and Diagnostic Applications |
| SYLOSIV® | Molecular Sieve Powder for the Polyurethane Industry |
| SYLOID® | Matting Agents for Coatings |
| SYLOBLANC®/SYLODENT®/ELFADENT® | Abrasive and Thickening Agents for Toothpaste Industry |
| SHIELDEX® | Non-toxic Anti-corrosion Pigments |
| SYLOJET® | Pigments for Ink Jet Coatings |
| LUDOX® | Colloidal Silica |
| SYLOWHITE™ | Titanium Dioxide Extenders for Paints and Printing Inks |
| PERKASIL® | Reinforcing Agents for the Tire and Rubber Industry |
| DURAFILL® | Special Pigments and Fillers for the Paper and Pulp Industry |
| APPERTA® | Can Coatings |
| DAREX® | Can and Closure Sealants |
| SISTIAGA® | Can Coatings |
| CELOX® | Oxygen Scavengers |
| SINCERA® | Closure Sealants |

It’s Clear. It’s Clean. It’s TRISYL® Silica.
The Company

W. R. Grace and Co., is a specialty chemical and materials company with a special focus on silica and silica-based chemistry and technology, with more than 150 years of experience. We are noted for our experienced people, global reach and strong customer relationships.

Our specialty silica and silica-based materials improve product performance or enhance manufacturing processes in a wide range of industrial and consumer applications.

Our key strengths are:

■ Ability to innovate products and processes
■ Manufacturing flexibility and speed
■ Agile supply chain organization
■ Global infrastructures
■ Deep knowledge of our customers’ processes
■ Very high qualified Technical Customer Service (TCS) Group

Safety First

At Grace, our first priority is to ensure the safety of all those who work with us or come in contact with our products.

No matter where your business is located, one thing stays the same – Our Commitment

To protect the environment is our major focus, and we are proud to maintain an outstanding record of leadership in safety standards and good corporate citizenship.

Through the Responsible Care® program, every Grace facility worldwide fulfills both stringent health and safety requirements as well as environmental requirements.
The Edible Oil Industry

In the new Millennium, the Edible Oil industry is faced with immense challenges: while the phenomenal economic growth in the world’s emerging markets fuels the demand for oil and fat products, regulators in almost all countries around the World are putting in place more strict limits on the industry’s environmental impact – carbon footprint, wastes, etc.

Health conscious customers are no longer content with just the “taste” of an oil product but also want the natural healthy components to survive the refining process. Moreover, with competition in the industry intensifying, productivity improvements are no longer “optional” but a “matter of survival”.

For many years, Grace has been dedicated to working on innovative amorphous silica refining solutions to meet the needs of the Edible Oil Industry. TRISYL® Silica Gel has the potential to fundamentally modernize the entire edible oil refining process. Our global product portfolio, coupled with our know-how and global presence, allows our customers to meet the global and local challenges of the Edible Oil Industry.

Purity & Properties

- TRISYL® Silica is a chemically inert engineered synthetic amorphous silica gel; unlike other competitive adsorbents, it does not promote any chemical changes that, in turn, degrade the quality and stability of oils.

- TRISYL® Silica preserves the natural seed oil antioxidants content better than any other activated adsorbents.

- TRISYL® Silica can help you to enhance your process performance and economics, regardless if oils are physical or chemical refined. Rate of improvements is greatly dependent upon several factors such as feed oil quality, product quality requirements and process set up.

- TRISYL® Silica and TRISYL® Silica based processes can greatly contribute to reduce the oil industry environmental footprint by greatly reducing the washing water demand. Water is a precious resource that needs to be preserved and used wisely.

- TRISYL® Silica also adds value to your supply chain by extending edible oil shelf life without resorting to more chemical preservatives.

Benefits of TRISYL® Synthetic Amorphous Silica

- Reproducible quality

- High degree of chemical purity

- Amorphous silica, without crystalline quartz species

- Safe to handle

- Non-dusting, low product loss during handling

- Massive internal particulate surface area

- Small quantity, highly efficient

- No negative effects on oil chemistry

TRISYL® Silica Makes Your Processes Environmentally Friendly.
Conditions, Functions and Use

Optimum conditions for the use of TRISYL® Silica during the refining process are:

- Oil temperature 70 – 90°C
- TRISYL® Silica added under “atmospheric” pressure
- The contact time between the TRISYL® Silica and the slightly moist oil 10 – 15 minutes.
- The moisture in the oil plays an important role in the mechanism responsible for transporting the polar contaminants from the oil to the TRISYL® Silica, where they are then trapped. The moisture content of the oil should be between 0.2 – 0.5%.
- Following this removal of polar contaminants by the TRISYL® Silica, the oil should be dried if clay is to be used in the bleacher.
- During the drying process (drier/bleacher vessel) under vacuum, water is removed from TRISYL® Silica and the silica “sponge” shrinks, leaving a weight-reduced amount (~40% of original weight) of TRISYL® Silica powder or solid adsorbent to be collected on the filter.
- This results in a much reduced quantity of “filter cake” which enables higher filtration flows and a much longer filtration cycle.

Scanning Electron Micrograph (SEM) of TRISYL® Silica Gel Particles
The Cost-Effective Solution to Improved Oil Quality

Conventional Adsorbents perform two basic tasks: color removal and impurity adsorption.

Relatively large quantities of bleaching clays are normally required to perform both these tasks (due primarily to its low surface area). As TRISYL® silica is a far more efficient adsorbent where color removal is not an issue, as well as an adsorbent for polar impurities in lower color oils, TRISYL® silica can easily replace bleaching clay.

In oils for which reduction of color is more critical, the TRISYL® Silica is used in combination with clay, preferably in a two-step addition process:

First, TRISYL® Silica “cleans the oil” by removing polar impurities and, second, a reduced quantity of bleaching clay is left to perform only one function – to bleach, i.e. color reduction.

This significantly reduces the total quantity of adsorbent used and enhances the quality of the oil.

A reduction in adsorbent use results in:

- A lower quantity of filter cake
- Lower waste management and associated disposal concerns and costs
- Reduced oil losses in the filter cake
- Longer filtration cycles
- Improved overall cost-efficiency of the process

It’s Clear. It’s Clean. It’s TRISYL® Silica.

For more details please ask for the product portfolio leaflet.
Increase Your Oil Yield and Reduce Environmental Footprint

TRISYL® Silica Gel can easily be incorporated into different stages of the edible oil refining process, be it enzymatic, chemical or physical refining.

TRISYL® Silica improves your process yield

The concept of NOL (Neutral Oil Loss) on the filter cake is well known by the Oils & Fats Industry. By asking how much oil is entrapped in your adsorbent’s spent cake, it’s quite common to get an answer between 20 and 25%, which is measured according to the standard AOCS method. Unfortunately, this method isn’t able to extract the oil portion that gets polymerized and oxidized. However, when critically analyzing filter cakes, applying hexane which is then followed by chloroform extractions, the typical oil content will be higher. Grace can determine the actual organic matter of any filter cake.

General filter cake composition

TRISYL® Silica helps extend oil shelf life

TRISYL® Silica, contrary to any ABE (Activated Bleaching Earth), has no impact on the intrinsic nature of oil during the treatment step. The use of ABE, in fact, promotes the isomerization of double bonds which are easily prone to oxidize, compromising the overall oil shelf life.

Oil Loss: Oil retention in the Filter Cake (FC)

Production: 300,000 tons

TRISYL® Silica saves environmental costs

The value of oil increases as it passes through the refining process steps. By implementing TRISYL® Silica, oil losses will be effectively minimized. Due to the overall reduced amount of adsorbent using TRISYL® Silica, there will be less NOL and less spent filter cake for disposal, as well as allowing increased filter cycle time. Applying our eco-model, our technical experts can quantify the amount of savings achievable depending upon your specific process configuration and final color specification.

TRISYL® Silica reduces your environmental footprint

The way TRISYL® Silica will benefit your environment is multi-fold. By reducing the spent filter cakes to be disposed, you greatly reduce your environmental impact while improving at the same time workplace safety by mitigating the risks of self-ignition typical of spent bleaching clays. An additional important contribution that you get from using TRISYL® Silica is decreased amount of water needed to run your refining process.

Water is one of the most precious elements on Earth we have to preserve.

675 430 1800

40% Oil on FC
by Hexane Extractables

1150

20% Oil on FC
by Inorganic/Organic Separations

58% Inorganic Residue

2% H2O

40% Hexane Extractable

Organic Matter

Inorganic Residue

2% H2O

Organic Matter・Hexane Extractable・H2O

Production: 300,000 tons

<table>
<thead>
<tr>
<th>Standard Process:</th>
<th>Process with TRISYL® Silica:</th>
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</thead>
<tbody>
<tr>
<td>1% Clay = 3,000 tons</td>
<td>0.6% Clay + 0.1% TRISYL® Silica</td>
</tr>
<tr>
<td>H2O content in Clay:</td>
<td>Clay TRISYL® Silica</td>
</tr>
<tr>
<td>10% (90% dry base)</td>
<td>90% (dry base) 35% (dry base)</td>
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</tbody>
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Inorganic Residue

20% Oil on FC
by Hexane Extractables

40% Oil on FC
by Inorganic/Organic Separations
TRISYL® Silica For Your Process
The major objectives of using TRISYL® Silica in a refinery are to enhance the quality of the refined oil, assist in process optimization and maximize economic value, reducing refining costs.

As there are many different refinery configurations, Grace has developed a variety of novel processes to allow for the easy incorporation of TRISYL® Silica.

- **Sequential Addition (2-Step addition):**
  The addition of TRISYL® Silica (to remove polar impurities) followed by bleaching clay (to remove color bodies).

- **Packed Bed Bleaching:**
  TRISYL® Silica treated oil (upstream) is filtered through filters pre-coated with clay.

- **Modified Caustic Refining (Figure 1):**
  The water wash centrifuges can be eliminated. TRISYL® Silica efficiently removes the increased soaps and phospholipids which otherwise would be carried over to the bleaching step.

- **Post Treatment of Modified Oils/Fats (Figure 2):**
  Based on either oil modification by interesterification or hydrogenation, TRISYL® Silica is used during the post treatment either for soap and salt removal or denickeling.

- **In Enzymatic Processes:**
  TRISYL® Silica for use after enzymatic degumming and/or prior to the enzymatic interesterification.

- **Staggered TRISYL® Silica Tri-Clear Refining Process (Figure 3)**

TRISYL® Silica Tri-Clear Process
It is known that many refineries switch to another bleaching filter before the bleaching clay has been fully spent. Therefore, clay that is still partially active is being disposed.

In response to and in order to assist our customers in optimizing their practices, Grace has developed the TRISYL® Silica Tri-Clear Process. This process not only improves the quality of the final oil, but also significantly reduces the refining costs, as indicated below:

- 40-60% reduction in clay usage
- 40-50% reduction in filter cake generation
- 40-50% reduction in oil loss
- Major reductions in adsorbent costs
- Significant increase in filter cycle time

Upstream, TRISYL® Silica pre-treatment is essential to the success of the Tri-Clear Process. TRISYL® Silica is needed to remove the soaps and phospholipids present in the oil and, thus, prevent the clogging of the “pre-filter” spent clay bed.

Midstream, the already used and considered “spent” clay that is routinely discarded at the end of each filter cycle is still partially active. It is, therefore, used in an additional cycle in combination with TRISYL® Silica, thereby reducing the impurity load on the fresh clay that is added downstream.

Downstream, a much reduced amount of fresh clay is added to the oil in order to achieve the required color specification and at the same time to prepare another “pre-filter” spent clay bed.
**TRISYL® Silica Processing Examples**

**Figure 1: Modified Caustic Refining**

- **Incoming Oil/Fat**
- **TRISYL® Silica**: Pre-Filtration
- **Soapstock**
- **Neutralized Oil**
- **Drying/Bleaching**
- **Redundant**
- **Wash Centrifuge**

**Figure 2: Post Treatment of Modified Oils/Fats**

- **Pre-treated Oil**
- **Acid**
- **Reactor**: Interesterification or Hydrogenation
- **Filter**
- **Storage**

**Figure 3: Staggered TRISYL® Silica Tri-Clear Refining Process**

- **Incoming Oil/Fat**: 15 min, ca. 75°C, Atmospheric or low Vacuum
- **Dryer**
- **Spent TRISYL® Silica/Clay**
- **Buffer Tank**
- **Post-Filtration**
- **Storage**
- **Discharging/Pre Coating**
TRISYL® Silica for Biodiesel Feedstock Purification

Grace Renewable Technologies

Biodiesel demand is expected to double by 2015 as governments around the world mandate its use as a means of reducing greenhouse gas emissions, building energy security, and improving domestic economies.

TRISYL® Silica is recommended for the pre-treatment of feedstock oil in biodiesel production. It enables the economic conversion of biomass to biodiesel by increasing yields and improving fuel quality.

Our global technical support team for biodiesel applications consists of experienced technicians, scientists and engineers with direct experience in a range of biofuel processes.

For more information about our products and processes, please visit grace.com or contact your local Grace representative.

Global Scope
Research & Development, Technical Customer Service (TCS)

Grace is a firm believer in innovation. Our R&D group, staffed by a team of research scientists, continually strives to improve the quality of our products.

We seek ways to broaden our product portfolio, so as to accommodate the increasing wants and needs of our customers.

We have in place a Global TCS group, consisting of experienced professionals, who support our worldwide edible oil business. The team is dedicated to developing technical partnerships with our customers in the effective use of the TRISYL® Silica process.

Our main support activities include: customer interaction and consultation through site visits, video-conferencing and other forms of telecommunication. TCS project work involving our application development laboratories conducts investigative work in co-operation with, or on behalf of, our customers.

The TCS group, while centrally managed, is regionally based, providing both local know-how and global support. The Technical Centers of Excellence are situated in the following locations:

- USA – Baltimore, MD, supporting North America
- Germany – Worms, supporting Europe, Middle East and Africa
- Brazil – Sorocaba, supporting Latin America
- Kuantan – Malaysia, supporting Asia Pacific

No matter where in the world you are located, you can always rely on the same high standard of service and support. This, we believe, is fundamental to develop successful partnerships the world over.

Packaging

We offer a wide range of flexible packaging options for our TRISYL® Silica products, including:

- Specialized multilayer valve bags on pallets
- Customized big bag options
- Silo trucks for bulk deliveries

The prompt delivery of TRISYL® Silica is assured through our global production facilities.

Safety Issues

Safety is a priority at Grace. TRISYL® Silica is approved by a variety of international authorities such as the European Directive 2008/EC for E 551 and the FDA (for indirect food contact) and is fully REACH registered. For further information, our EHS department will offer assistance.

Quality Management

Our Quality Management System takes a customer-centric approach and is based on Grace’s philosophy of continuous improvement in every area of the organization.

- All our facilities are ISO 9001 and 14001 certified, and we implement internal and external audits to find ways to improve our processes and services.
- We employ Statistical Process Controls (SPC) to monitor and analyze production and related work processes.
- Our well-equipped Quality Control department works around the clock to ensure constant product quality.
- We continuously collect and assess customer information and feedback as an important factor in our Quality Management System.

In order to meet the needs and expectations of our customers, the Quality Management program includes the functional groups of marketing, research and development as well as customer service. Our dedicated work force is an important asset and customer satisfaction is our most important objective.

The Six Sigma® Advantage

At Grace, we are committed to a Quality Management System, including the continuous improvement of our processes. To maintain Grace’s high standards, we employ Grace’s Six Sigma® tools. These were designed to investigate process parameters, quantify their effects and optimize these in order to achieve the best possible results. Our Six Sigma® initiative aims at improving both product consistency as well as production flexibility using advanced statistical methods and evaluation procedures. Our customers benefit from products of the highest quality.
Grace is a premier specialty chemical and materials company with more than 6000 employees located around the world. Our products are used by millions of people each day. Among many other things, we ensure the integrity of some of the world’s major buildings and bridges, enhance the performance of your petroleum products and preserve the safety of your food.

Grace has met all REACH requirements for the given deadline for Tier 1, December 1, 2010, and can hereby assure today’s and future customers full REACH compliance of its products. This assurance also includes the very diverse use of a spectrum of our products.