Study on Adsorption Filtration System to Improve Quality Of Used Edible Fried Oil.

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Abstract—As oil seeds are pressed to separate the oil and meal, particles of the crushed seed are also carried into the oil. While the pressing operation can be modified to reduce the amount of particles in the oil, some cleaning of the oil will be needed to remove these potentially unwanted particles. If used for fuel, particles are nuisances as they clog fuel filters and stop the flow of fuel to the engine. As edible oil, some operators believe that particles in the oil show that the oil is "natural" or locally produced. Other edible oil producers believe that the product should match "store bought" vegetable oil and should not contain any particles or sediment in the container. Cooking oil is purified fat of plant origin, which is usually liquid at room temperature (saturated oil such as coconut and palm oil are more solid at room temperature than other oils). Some of the many kind of different kinds of edible vegetable oils include: Olive oil, palm oil, soybean oil, sesame oil, sunflower oil, peanut oil, grape seed oil, rice bran oil.

Index Terms— Adsorption, adsorbent, edible oil, filtration.

I. INTRODUCTION

Food frying has been used by man since ancient time. It was found to be a rapid way to prepare food. Fried foods are tasty because of the pleasant feeling produced by the oil absorbed in the fried food. The absorbed oil also increases the salivation process, which helps the release of oil soluble flavours from the fried food, making it very appealing to the taster. Fried food is particularly popular in USA, Canada, Mexico, Central America, South America, Europe, India, China, and Malaysia.

Technology of frying has vastly improved through research over the years. Frying is no longer the technique used in kitchen frying. The industry has evolved into large scale industrial frying process that can fry thousands of Kilograms of product per day. Innovation in packaging technology has helped the industrial fried products to maintain their quality over an extended period. In frying, food is dehydrated by using the thermal energy from a bed of hot oil. The oil is heated by electrically or gas heating. The frying process can be divided into three major categories: home frying, restaurant or food service frying, and industrial frying.

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Deep fat frying is analogous to a miniature chemical plant where chemical processes such as hydrolysis, oxidation, and caramelization involving heat, moisture and air take place. During deep fat frying organic solids is placed into an organic liquid at high temperature. This result in the formation of a desired end-product, as well as a multitude of unwanted by-products. With continuous use, the oil ultimately becomes very dark, thicken, foam and smoke considerably. At this stage, the oil may contain sufficient amounts of decomposition products to exert adverse effects on the quality of fried foods. The flavour, colour and texture of foods fried in such oil are often undesired and the foods are noticeably greasy and less crispy than those fried in better quality oil.

Used frying oils from restaurants and food industries have a wide variety of qualities. During the frying process, the oil is exposed to high temperatures in the presence of air and moisture. Under these conditions, it may undergo important changes due to hydrolytic, oxidative and thermal reactions. Changes in the main fat constituents are known, although it is not easy to foresee the rate of oil degradation due to the high number of variables involved in the frying process additives.

- Variables involved in the frying process:

1. Variables linked to the Process:

Temperature, duration of heating, heating pattern (continuous or intermittent), turnover rate etc.

2. Food subjected to frying:

Lipid composition, main and minor constituents of food.

3. Oil used for frying:

Degree of unsaturation, initial quality and additives

Thus, used frying oils can be highly heterogeneous as compared to crude or refined oils. The new products formed during frying are polymers, dimmers, oxidized triglycerides, as well as diglycerides and fatty acids. All these groups possess higher polarity than that corresponding to the initial triglycerides and can be easily quantified by means of adsorption chromatography .Some key parameters were selected for determining the viability of the vegetable oil transesterification process. These parameters include: acid value and FFA content, moisture content, viscosity and fatty acid profile of the used oil.

The German Society for Fat Research suggested that " a used frying fat is deteriorated if, without a doubt, odor and taste are not acceptable, or if, the concentration of petroleum ether insoluble OFA is 0.7% or higher and the smoke point is lower than 170°C, or the concentration of petroleum ether insoluble OFA is1.0% or higher.

One of the more widely used and accepted analytical measure of degradation is FFA content. FFA levels correlated well with smoke point and as result smoking is a good measure of oil degradation by kitchen personnel. While OFA, polar materials and FFA cannot be accurately and economically evaluated test in the kitchen, it is relatively fast and easy in the laboratory.

Filtration:

Filtration is the removal of a suspended particle from a fluid, liquid or gas, by passing the fluid through a porous or semi permeable medium.

Filter capture:

There are at least seven mechanisms by which a filter can capture particles. All of these mechanisms are at work in a filter at any given time to varying degrees and may change as operating conditions change. The seven mechanisms of particle capture are:

1. Direct Interception: where the particle runs into a physical barrier and is captured.

2. Bridging: where particles stick together forms a bridge across a pore.

3. Sieving: where the particle is larger than the pore and creates a type of bridge.

4. Inertial Impaction: where particles flow in a straight line caused by the inertia of the flow captured by the media.

5. Diffusion Interception: where the constant random motion of particles.

6. Electro kinetic Effects: where electrical charges on the filter medium or the particles causes capture due to attractive forces.

7. Gravitational Settling: where gravity deposits the particles with mass the same as sediment in a settling tank.

Adsorption:

Adsorption is defined as the adherence of the atoms, ions or molecules of a liquid to the surface of another substance called the **adsorbent**. When molecules of two or more substances are present, that one substance may be adsorbed more readily than those of others. This process is called **preferential adsorption**. Adsorptive retention is when a particle sticks to the filter surface being absorbed as in the methods of "inertial impaction", "diffusion interception" and "electro kinetic attraction".

Adsorbent Filtration removes both particulate and soluble impurities. Adsorbents have charged sites on their surface which attract polar compounds and hold them for removal by filtration. Adsorptive sites may have either acidic or basic character.

Adsorption is sorption operation, in which certain components of a fluid phase, called solutes, are selective transferred to insoluble rigid particles suspended in vessel or packed in a column. Sorption in general term includes selective transfer to the surface and/or into the bulk of a solid or liquid. Thus, absorption of gas species into a liquid and penetration of fluid species into a nonporous membrane are also sorption operations. In a general sorption process, the sorbed solutes are referred to as sorbate, and the sorbing agent is the sorbent.

In an adsorption process, molecules, as shown in figure or atoms or ions in a gas or liquid diffuse to the surface of a solid, where they bond with the solid surface or are held there by weak intermolecular forces. The adsorbed solutes are referred to as adsorbate, whereas the solid material is the adsorbent. To achieve a very large surface area for adsorption per unit volume, highly porous solid particles with small-diameter interconnected pores are used (Seader and Henley, 1998). Miyaki and Nakajima (2003) used adsorption process for improved the quality of used frying oils and to assess the feasibility of recycle.

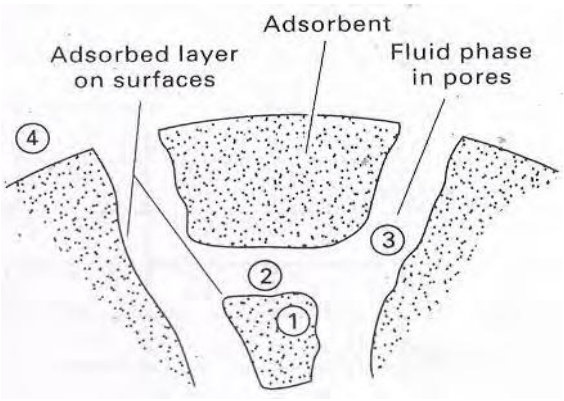

Fig1. Adsorption operations with solid-particle sorbents.

Adsorption filtration:

- Removes soluble degradation products by attracting and holding polar products for removal by filtration.
- Slows oil degradation.
- Extends life of frying oil.
- Produces higher quality fried foods

Adsorbents:

- Activated Carbon
- Activated Alumina
- Calcium Silicate,
- Synthetic Magnesium Silicate,
- Synthetic Silica

At the end of 2007, the worldwide filtration market was worth approximately $44 Billion. This figure includes equipment materials, media and after sales. Approximately $21.7 Billion was attributed to media. Approximately 27% of this amount was attributed to nonwoven media ($5.86 Billion). The average growth rate for the entire filtration media market is 5.6%.

II. OBJECTIVES

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1. To Study Adsorption Filtration.

2. To improve quality of used edible fried oil.

3. Analysis of oil quality parameters.

4. Development of Filtration System.

5. Analysis of filtered oil parameters.

III. PROCEDURE FOR OIL FILTERATION

Take 500 ml Fried oil in beaker

⇩

Check the quality Parameters of fried oil

[Free Fatty Acids, Colour of oil, Peroxide Value, Anisidine Value, Taste]

⇩

Heat 200 g of fried oil to 70°C in 500 ml beaker

⇩

Add 1% Magnesium Silicate on the basis of weight

⇩

Put a magnetic Stirrer inside the beaker

⇩

Stirring at 100 RPM for 20 min to ensure

Adsorbent reaction and absorption take place homogeneously

⇩

Filter the treated sample using filter piece

of Whatman Paper No 42 with the help of Vacuum pump

⇩

Check the quality Parameters of fried oil

[Free Fatty Acids, colour of oil, Peroxide Value, anisidine Value, Taste]

⇩

Compare the results before and after treatment of the Adsorbent.

Flow Chart for the Filteration process

After carrying out the process of filteration we took the results of the oil that was filtered and compared the results of the in four different tables and also checked the parameters of free fatty acids, colour of the oil, taste, anisidine value and peroxide value in the oil

IV. FILTERATION OF OIL

1. Filtration of oil with 4% adsorbent treatment

SR. NO	PROCEDURE	PARAMETER
1	Quantity of oil taken	9 Lit
2	Heating of oil	Temp: 95°C

3	Heating of oil	Adsorption filtration system with filter paper envelops.
4	Filter Media	Nylon Fibre 20µ particle size.
5	Filtration Cycle time	30 min.
6	% of Adsorbent	4%
7	Colour Changes after filtration	Dark brown to red.

2. Filtration of oil with 3% adsorbent treatment

SR. NO	PROCEDURE	PARAMETER
1	Quantity of oil taken	12 Lit
2	Heating of oil	Temp: 95°C
3	Heating of oil	Adsorption filtration systems with filter paper envelop.
4	Filter Media	Nylon Fibre 20µ particle size.
5	Filtration Cycle time	30 min.
6	% of Adsorbent	3%
7	Colour Changes after filtration	Dark brown to red.

3. Filtration of oil with 2% adsorbent treatment

SR. NO	PROCEDURE	PARAMETER
1	Quantity of oil taken	18 Lit
2	Heating of oil	Temp: 95°C
3	Heating of oil	Adsorption filtration systems with filter paper envelop.
4	Filter Media	Nylon Fibre 20µ particle size.
5	Filtration Cycle time	30 min.
6	% of Adsorbent	2%
7	Colour Changes after filtration	Dark brown to red.

4. Filtration of oil with 1% adsorbent treatment

SR.NO	PROCEDURE	PARAMETER
1	Quantity of oil taken	36 Lit
2	Heating of oil	Temp: 95°C
3	Heating of oil	Adsorption filtration systems with filter paper envelop.
4	Filter Media	Nylon Fibre 20µ particle size.
5	Filtration Cycle time	30 min.
6	% of Adsorbent	1%
7	Colour Changes after filtration	Dark brown to red.

The above tables indicate the process carried on the oil by adding different percentage of the adsorbent and we can find the change in the colour of the oil and also the taste and fatty acids.

Fig2. Samples of Treated and Untreated Oil.

The above figure indicates the treated and untreated oil samples with percentage of added adsorbent

Fig3. Treated and Untreated Oil

This figure shows the oil before filteration and oil after filteration.

Fig4. Machine developed for the filteration of oil

This is the machine designed and developed for the filteration of the oil.

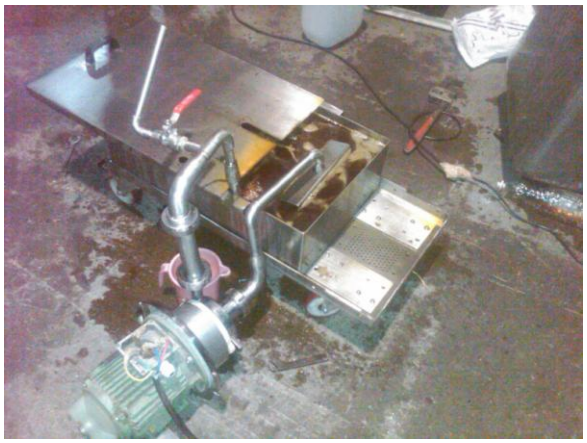


Fig5. Working of the machine during filteration of the machine

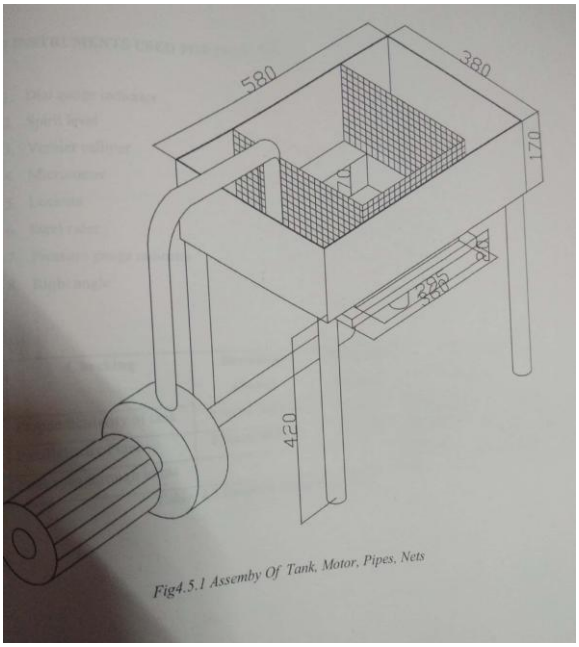


Fig6. CAD Design of the project.

This design was made on the Auto-Cad Software

V. CONCLUSION

The optimized results obtained for used edible oil using adsorbent concentration 1% at 110° c and time of 40 min are tabulated in table 4.10. Results indicate synthetic Magnesium Silicate R60 1% levels significantly reduced the free fatty acid contents of the used oil. Treatment of the used fried oil with synthetic Magnesium Silicate 1% levels was also better than treatment without Synthetic Magnesium Silicate on improving the used fried oil quality. A result shows that the Acid value of used oil is 1.01 and when it treated with 1% Magnesium silicate it reduced up to 0.47. Results indicate that there is 53.46 % reduction in FFA content of used oil.

Result also shows that the peroxide value of used oil is 9.0 and when it treated with 1% Magnesium silicate at 110°C it reduced up to 8.0. Results indicate that there is 11.11 % reduction in peroxide value of used oil.

A result shows that the Anisidin value of used oil is 3.1 and when it treated with 1% Magnesium silicate it reduced up to 2.6. Results indicate that there is 16.12 % reduction in FFA content of used oil.

Result also shows that the PCI of used oil is 50 and when it treated with 1% Magnesium silicate at 110°C for 40 min it reduced up to 11. Results indicate that there is 78.00 % reduction in PCI of used oil.

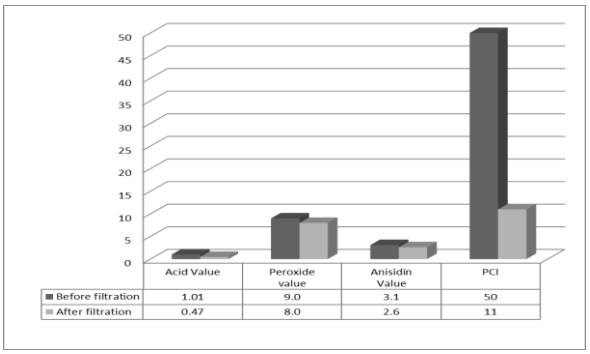
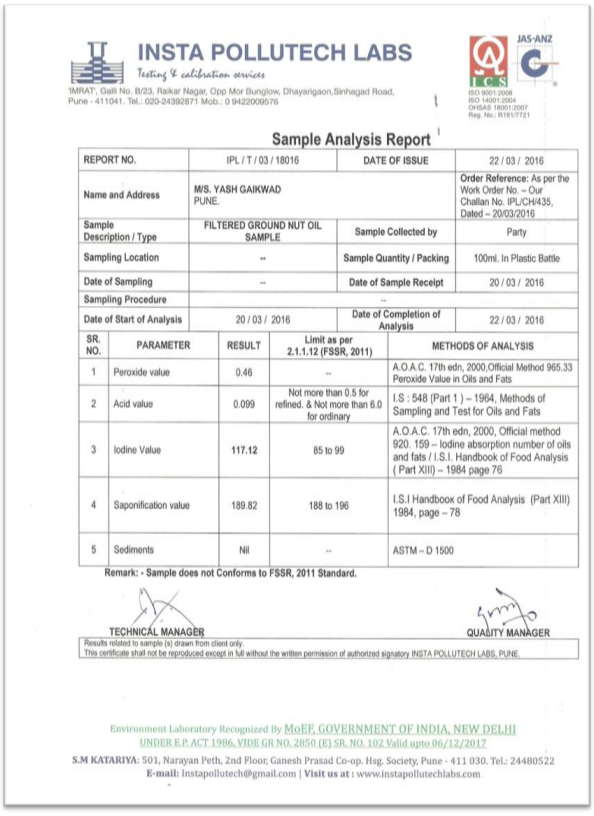


Fig6. The above figure shows the graph of before filteration and after filteration and values which are reduced after filteration.



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Sample Analysis Report

REPORT NO.	IPL / T / 03 / 18016	DATE OF ISSUE	22 / 03 / 2016
Name and Address	M/S. YASH GAIKWAD PUNE.		Order Reference: As per the Work Order No. – Our Challan No. IPL/CH/435, Dated – 20/03/2016
Sample Description / Type	FILTERED GROUND NUT OIL SAMPLE	Sample Collected by	Party
Sampling Location	--	Sample Quantity / Packing	100ml. In Plastic Battle
Date of Sampling	--	Date of Sample Receipt	20 / 03 / 2016
Sampling Procedure	--		
Date of Start of Analysis	20 / 03 / 2016	Date of Completion of Analysis	22 / 03 / 2016

SR. NO.	PARAMETER	RESULT	Limit as per 2.1.1.12 (FSSR, 2011)	METHODS OF ANALYSIS
1	Peroxide value	0.46	--	A.O.A.C. 17th edn, 2000,Official Method 965.33 Peroxide Value in Oils and Fats
2	Acid value	0.099	Not more than 0.5 for refined. & Not more than 6.0 for ordinary	I.S : 548 (Part 1) – 1964, Methods of Sampling and Test for Oils and Fats
3	Iodine Value	117.12	85 to 99	A.O.A.C. 17th edn, 2000, Official method 920. 159 – Iodine absorption number of oils and fats / I.S.I. Handbook of Food Analysis (Part XIII) – 1984 page 76
4	Saponification value	189.82	188 to 196	I.S.I Handbook of Food Analysis (Part XIII) 1984, page – 78
5	Sediments	Nil	--	ASTM – D 1500

Remark: - Sample does not Conforms to FSSR, 2011 Standard.

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Fig7. Lab Report showing the analysis of the filtered oil and unfiltered oil.

As per the report the properties of the filtered oil are similar to the oil that we use to eat and the taste also is same of the filtered oil.

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