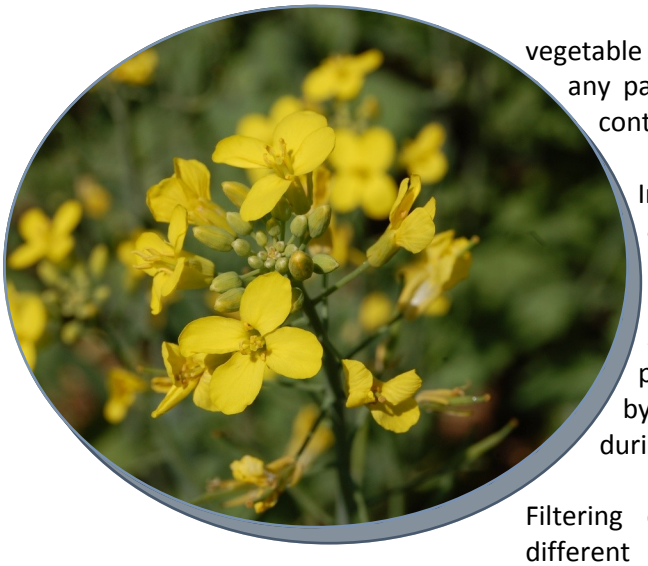
Oilseed Fact Sheet: Oil Filtration



Introduction

As oilseeds 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 (Fig. 1). As an 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.

Fig. 1: Result of using SVO fuel without reliable filtering.

In oil language, the "foots" are the materials removed when cleaning the oil. Oilseed meal and oil are separated during the pressing process, followed by separation of oil and foots during filtration.

Filtering of oil can be done in different ways depending on the cleanliness of oil desired as the final product. Four of the most common filtering methods are:

- Settling
- Bag filters
- Cartridge filters
- Filter press

Settling

The least expensive and simplest filtering is done by settling the particles out of the oil. Settling may be done after the oil is pressed as a separate step, or it may be on-going as oil is collected from the press. Some press operators continually stir the oil coming from the press and do not allow settling to occur in the collection tank. When sediment is collected in the tank, at some point the tank must be emptied so that the sediment can be removed. By gently agitating the oil and keeping particles in suspension, the tank does not accumulate this sediment and does not require occasional cleaning. All of the sediment is removed during filtration.

After a period of time when the oil is considered "clean" the oil is siphoned, drained, or pumped from the tank leaving the residue behind on the bottom of the container (Fig. 2). Different operators settle oil from a few days to a few weeks; it all depends on what size particle is expected to be removed by settling. Small particles will remain in suspension for a longer time than larger particles, so the longer the oil settles the smaller the particles are

1 micron is equal to 1/1,000 of a millimeter. There are 25,400 microns in 1 inch. A human hair measures about 11 microns thick, while red blood cells are 7 microns.

Fig. 2: 100 milliliters of canola oil collected at pressing time shows about 7 milliliters of sediment after 1 week of settling at room temperature

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In this tank pressed oil flows slowly from left to right. The oil passes across two partitions, allowing particles time to settle. Most of the settling occurs within the first partition.

that are left in the oil.

While filtering in this way is inexpensive and relatively simple, it does not do as complete a filtering job as mechanical filtering. Farmers who use settling as their only method of filtering and use the oil as fuel with no further processing find that fuel filters on their equipment still clog earlier than when fueling with diesel fuel. This indicates that particles remain in the settled oil and that additional filtering should be done to provide a clean engine fuel. As a guideline, engine fuel filters used in agricultural equipment are nominally rated at 12—14 microns, so if a fuel filter is plugging relatively quickly it means that particles at least this large are still suspended in the oil.

If the oil is used as a food product, the particulates remaining in the oil may be acceptable and add to the "natural" oil appeal.

Effect of temperature

As with most processes involving oils, a warmer temperature will aid in settling. As the oil is warmed and the thickness (viscosity) of the oil decreases, the heavier particulates will drop more quickly to the bottom of the oil container. Settling of particles will occur faster when the oil is warmed. Filtering through a cartridge, bag or filter press will occur more quickly when the oil is warmed. A precautionary note is, however, that warming the oil also causes more rapid degradation of the oil through oxidation, a process that leads to oil rancidity. If the oil is warmed significantly it should be covered with an inert gas such as nitrogen to reduce the occurrence of oxidation.

How well does a filter work?

People are often surprised to learn that a filter does not capture all of the particles larger than the rating of the filter as they pass through the filter. For example, many filter catalogs refer to a nominal rating or an efficiency rating for their filters. Often filter ratings are referred to as a "nominal" rating, meaning the filter will remove most, but not all, of the particles over a particular size. An "absolute" rating of a filter means that the filter will remove all of the particles above a particular size. One example is a manufacturer that rates its filters as 80% efficient, meaning that a 15 micron rating captures at least 80% of the particles larger than 15 microns while up to 20% of those particles will pass through the filter. Expect to pay more for a filter rated as absolute.

Fig. 3: Three bag filters and housings arranged in series.

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Fig. 4: Bag filter without housing

Bag filter

A bag filter (Fig. 3 & 4) is just as it sounds, a bag of a certain porosity material that passes fluid through the bag and captures the particles inside of the bag. One of the simplest and not recommended forms of the bag filter is a pair of old blue jeans with the legs tied off at the bottom.

Bag filters are usually used in conjunction with a bag filter housing, a metal or plastic container that holds the filter. In this way the filter bag is given some rigidity in use.

A difference in pressure is needed to move oil from inside the bag, through the filter material, to the outside of the bag and on to a clean oil container. In general, bag filters work under relatively low pressure. If the pressure becomes to great on the inside of the bag, particles are forced through the bag as well as the oil being cleaned. This defeats the purpose of filtering, so keeping the pressure within the limits suggested by the manufacturer is a good idea. Bag filters are great for liquids like water which is very thin, but for thicker liquids like vegetable oil they may not be the best solution.

As the filter bag collects particles from the oil, it becomes more difficult to push the oil through the filter. A pressure gauge is necessary to know when a maximum pressure has been reached, indicating the need to change the filter bag. The used bag is discarded, and a new bag is installed.

People who use bag filters often install a series of filters. The first filter may take out 25 micron and larger particles, the next filter will remove 10 micron particles and the last filter removes 5 micron particles. In this way particle collection is staggered and bags do not need to be changed as often. Bag filters are not inexpensive, and with the discarding of the bag each time it may be an expensive option if a large amount of oil is to be cleaned.

Cartridge filter

Fig. 5: End (left) and full (right) view of wound cartridge filter

Where a bag filter has only one layer of filtering material, a cartridge filter (Fig. 5) is a depth filter, meaning that the filtered fluid must make its way through many layers of filtering material. Along the way there are many places for particles to be caught and held, thus cleaning the oil.

Fig 6: Cartridge filter with clear housing used as final filter for fueling with straight vegetable oil

Like the bag filter, a cartridge filter fits inside a housing (Fig. 6). The housing may be see through for monitoring the color of the cartridge; as the cartridge catches more particles it becomes darker giving an idea of the life left. The only sure way of knowing how close to the end of its life the cartridge is getting is to install a pressure gauge to monitor the upstream pressure of the filter. As the filter catches more particles, the pressure will rise as it becomes more difficult to push the oil through

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Fig 7: Filter press; a series of filtering plates are pressed together by manual screw or hydraulic pressure.

the filter. Again, manufacturers will give guidelines of how high the pressure is allowed to get before changing out the cartridge.

Cartridges are not serviceable and are discarded after use. If large amounts of oil are to be filtered, this may be an expensive filtration method over time.

Filter press

A filter press (Fig. 7) is a type of filter used in filtering liquids in food processing and other systems. Apple juice is one liquid that uses a filter press for cleaning the final product. Because the relatively inexpensive filtering media is the only part discarded after use, it may be the most inexpensive filtering system over the lifetime of the equipment.

A filter press is made up of a number of plates, each of which is covered with a porous fabric. This cloth is covered with a thin layer of filtering media that becomes the actual filter. The clogging of fuel filters and resulting reduction of fuel to the engine was too common before these operators started using a filter press. Following the adoption of the filter press for cleaning the oil no more fuel filters were clogged.

How to use a filter press

The use of a filter press is a bit mysterious at first. Once the workings of the filter press are understood, this filtration method is the most reliable of the filtration types. Filtration down to 1 micron is possible on a regular basis.

To prepare the filter press for filtering, a mixture of clean vegetable oil and the filter media (a very fine material that acts as the filter) is pumped quickly into the stack of plates that are pressed tightly together. This mixture of oil and media deposits the media onto the face of the cloth covered plates as the oil passes through, creating a buildup about 1/16 of an inch thick

Fig. 8: Block of foots collected from between two filter press plates. The yellowish colored material is filtering media coating (diatomaceous earth) initially placed on filter plate cloth while the dark colored materials are the foots

on the filtering side of each plate. This media now covers the fabric and becomes the filter; the plates and clothes are re-used numerous times while the media and captured particles are discarded when the filter is no longer passing oil from the dirty side to the clean side (Fig. 8)

To make the clean oil and filter media mixture, the correct quantity of clean oil needs to be saved each time oil is filtered so that it can be used in the next filtering cycle. An auger type paint mixer driven by an electric drill is useful for mixing the oil with the filtering media. This mixture must be pumped quickly into the cavities of the filter plates so that the media is deposited evenly on the faces of the plates. If the mixture is pumped slowly into the cavities, then the cavities between the plates never fill to the top and media is not deposited evenly across the plate surface. For this reason, the pump on a filter press may seem very large for the filtering time. The pump is sized to fill the filter press quickly, then reduces the amount of oil pumped when oil is actually being filtered.

A filter press pump holds constant pressure on the oil/sediment slurry that is going through the filtering process. As sediment builds on the filter plates and media, the pressure on the oil is raised in steps until a maximum pressure is reached. As flow slows at a particular pressure, the pressure is stepped up and flow increases. Any method of holding pressure is acceptable.

A common setup includes an air-operated diaphragm pump (Fig. 9) that is able to quickly pump the initial oil and media mixture into the plate cavities, and then holds pressure as oil is pushed through the media. A source of compressed air is

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Fig. 9: Air operated diaphragm pump on filter press

needed if this type of pump is used.

Another setup uses an electrically driven screw pump (Fig. 10) with a pressure switch and accumulator. The pump runs and builds pressure in the accumulator to a high point, then a pressure switch turns the pump off. Pressure in the accumulator and oil being filtered slowly falls off as clean oil is pushed through the filter plate. When a low pressure is reached, a pressure switch turns on the electric pump again and builds pressure back to the high point when the pump shuts off. This cycle continues as oil is pushed through the media and filter plates.

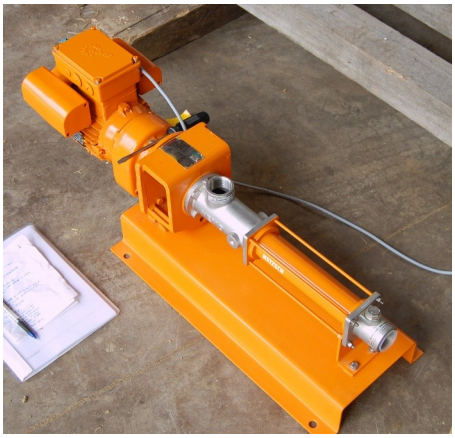

Fig 10: Electric screw pump for filter press

Filtering media

A common filtering media is diatomaceous earth (DE) (Fig. 11). This filtering material is used in swimming pool filters and various food processing applications like the cleaning of apple juice. In food processing terms it is considered GRAS (Generally Regarded As Safe) for filtering. Some processors add other agents to the DE to capture specific particles that they want to remove from the oil as it passes through the filter.

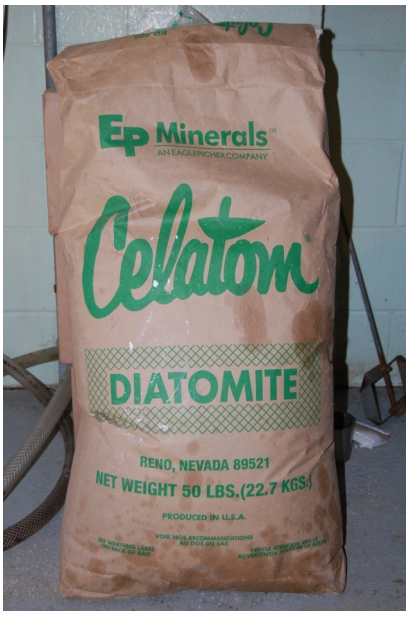

Fig 11: 50 pound bag of diatomaceous earth (DE). For this vendor designation FW-14 works well for filtering vegetable oil

How much oil/media to use

A rule of thumb exists to find the amount of filter media to use. For a typical 1/16 inch buildup on the plates use ~0.15 pounds (68 grams) of DE per square foot (0.09 sq. meter) of filtering cloth area. As an example, for a press that has 12 plates with each plate measuring 10 inches by 10 inches find the DE needed as follows.

Each end plate has one filtering surface and all other plates have two filtering surfaces. In this example there is a single face plate on each end; the remaining plates are double faced. This is a total of 22 faces.

Each face is 10”x10” for a total of 100 square inches. 22 faces x 100 sq. inches/ face is a total of 2,200 sq. inches for the press.

There are 144 sq. inches per sq. foot. 2,200 sq. inches/144 sq. inches/sq. ft. = 15.3 sq. ft on this press.

15.3 sq. ft. x 0.15 lb DE per sq. ft. = 2.3 lb of DE for this press.

How much oil to use is determined by the volume of oil held by the press. Often this is provided by the press manufacturer in the specifications. Slightly more volume of clean oil should be mixed with the required amount of diatomaceous earth. This mixture of clean oil and DE is circulated quickly through the filter press until all of the DE is deposited on the press plates. At this point incoming oil is switched to the oil to be cleaned. It is important to not let pressure drop to zero inside the filter press when switching from

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one source of oil to another. If pressure drops inside the filter press it is possible for the filtering media that has been deposited on the cloths to slough off and drop to the bottom of the filter press cavity.

Why use filter media

If used alone, cloths used in the filter press will only act as a surface filter. As foots are deposited directly on these cloths, the foots quickly fill the available filtering spots. Once these holes are filled, no more oil will pass through the filter. This is called blinding the filter and will occur in seconds if filtering vegetable oil without the use of filter media.

When cloths become blinded they may be washed gently with a pressure washer. Vigorous pressure washing will result in enlarging the holes present in the cloths and will render the cloths unusable. Filter press cloths taken good care of will last a number of years.

Extending the filtering time

Adding filtering media to the bulk of the oil being processed before it passes through the filter press increases the amount of time that the filter press operates before cleaning. Ideally, the cavity between press plates fills just as the pressure reaches the maximum for filtering as suggested by the manufacturer.

Sometimes while filtering the filtering media stops allowing oil through before the cavity fills with foots. Adding and mixing in a small amount of DE to the bulk oil being filtered increases the length of time that filtering occurs. The additional DE keeps pathways open through the foots as they build on the filter cloths, allowing more oil to be filtered before cleaning. The amount of media to add is found by trial and error as it depends on the amount and size of the foots in the oil.

Summary

Filtration of the pressed oil is necessary if used as fuel, and desirable for improved appearance if used as edible oil. Settling is a good first step in filtration, but does not provide a cleanliness standard needed for fuel use. Filter presses have been found to be the most reliable method of cleaning oils.

Resources

Note: This is not an exhaustive resource list nor do any of the oilseed project partners endorse any of the products or companies on this list. It is intended as a resource and starting point for those interested in small-scale oilseed processing.

Filter Press Sources

Ag Oil Press (www.agoilpress.com)
Egon Keller (www.keller-kek.de)
Kern Kraft (www.oelpresse.de)
Komet (www.ibg-monforts.com)
Met-Chem used processing equipment (http://www.metchem.com/index.htm)
Wesco used processing equipment (http://www.wescoequip.com/usedfilterpress.html)
Nebraska screw press (http://www.nebraskascrewpress.com/index.html)

Vegetable oil processing equipment
Tinytech (www.tinytechindia.com)

Northeast Oilseed Information
University of Vermont: www.uvm.edu/extension/cropsoil/oilseeds

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