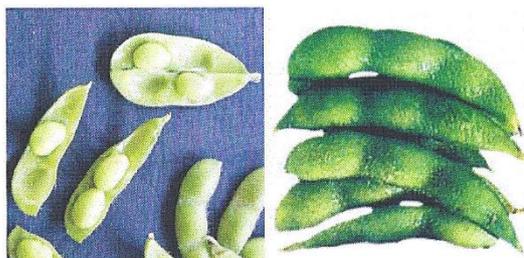


FILTERING THROUGH THE NEWS No. 23

Date : 07-12-2015-rev 4

Attn :



To whom it may concern;

CRUDE COLD & HOT PRESSED OIL SEEDS & MISCELLA FILTRATION:

In the wide range of filter applications found in the array of processing steps of oil seeds we will have identified for you the three main applications of crude oil cleaning where filtration comes in handy. We are certainly not going to pretend that we are going to tell you how to make oil from oil seeds but we have vast knowledge and experience with cleaning i.e. filtration of oils retrieved from oil seeds. As I mentioned to you before it would be best if you could use a continuous separator as offered by GEA Westfalia and Alf Laval because these centrifuges or decanters are continuous however the application and the industry sometimes is asking for oil qualities that simply can't be produced without filtration.

The typical crude oil spec will ask for optically clear, hexane insoluble matter max 0,02 % . Analysis by NEN 6326 or DGF CIII -IIb or NF T 60-202. In case the gums (Phosphatides) found in the oil are going to be used to produce lecithin even more stringent rules apply but this will be mentioned at later stage.

We will try to explain three main filtration applications i.e.:

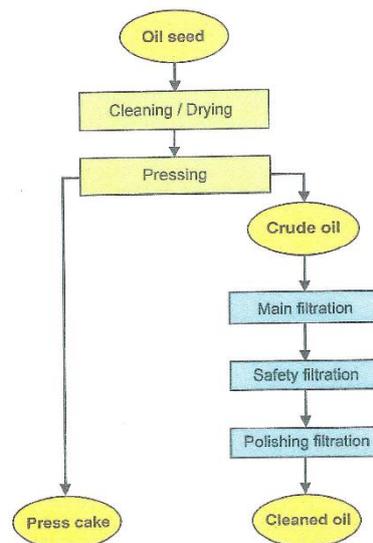
- COLD PRESSED OIL FILTRATION.
- HOT PRESSED OIL FILTRATION.
- MISCELLA FILTRATION



COLD PRESSED OILS:

Cold pressed oils have been around for ages and where the first oils produced from oil seeds. We will skip the stone age and start with the industrial period. The choice that had to be made was simple; Either the seeds were first ground in a windmill before being squeezed in a cotton bag to obtain linseed oil to be used in paint or the oil like mustard seed oil was used in food .

In the current time we see more sophisticated cold press installations where mainly gourmet oils are produced. The most known one is VIRGIN Olive oil cold pressed which is used in salads or even to dip bread in by connoisseurs like we see in the wine industry . A whole range of oils is nowadays cold pressed and like a successful company in Germany (Teutenburger Oil Mill) the oils are sold for a premium price but should not be used as cooking oils .



During the bio fuel crisis we saw a lot of small co-operative pressing plant being built by Reinarz Germany, Skett Germany ,Farmet in Czech Republik , De Smet Rosedowns UK , Mechanique Moderne France , Egon Keller Germany , Karl Stahle Germany and many others.

Europe and specially Germany turned yellow by a new intensive planted crop, Rape seed or (in Canada) Canola.

Cold pressed was pressing and the seed that was handled by the expeller press should be processed with max 40-50 degrC oil temperature. Temperature is a strong phosphatides(P) factor that and needs to be considered The cold pressed oil seeds held considerable more phosphatides than the Hot pressed oils and filtration with these gums present is more of a concern in hot pressed oils .

Sulphur is also of concern but the level of Sulphur in the oil cannot be influenced by filtration. Cold pressed expeller cake contains >12% residual oil and this cannot easy be lowered to minimize the losses.

Phospholipid Contents of Selected Vegetable Oils

Oil Type	Phospholipids Content, %	Phosphorus* Content, PPM
Crude soybean oil	1-3	317-950
De-gummed soybean	0.32-0.64	100-200
Crude corn oil	0.7-0.9	222-285
Crude peanut (groundnut) oil	0.3-0.6	95-190
Crude canola oil	1.8-3.5	570-1104
Super-degummed canola oil	0.13-0.16	41-51
Crude sunflower oil	0.5-0.9	159-285
Crude safflower oil	0.4-0.6	127-190
Crude palm oil	0.06-0.95	19-30

*The relationship between phospholipids and phosphorus contents is: Phosphorus (PPM) = [Phosphatides (%) × 10⁴]/31.7

The oil went into direct use as SVO(straight vegetable oil) and was used as fuel into generator , tractors and even diesel cars. It was important however to watch the outside temperature because when in winter the temperature dropped below zero the oil had to be heated before it could be used as fuel . By now we can safely say this application has almost died.

When we get a cold pressed crude oil filter inquiry it is of the greatest importance to have the correct conditions like Viscosity i.e. in rape seed we see at Zero degrC the viscosity is 205 cP while at 35 degrC this is 50 cP and at the normal hot pressed temperature this would be only 15 cP . It is obvious that this will influence the filtration rate . With a specification where cold pressed oil should be filtered we should consider not more than 25-30 kg / sqm / hr flowrate and the size of the filter is often based on the required filter cycle (minimum 2 hr.

The incoming oil is pre-screened but still contains up to 7 % or more FOOT'S (=solids) so the size has to be calculated on both max cake volume and required minimum filtration time.

In many cases the oil producer has chosen to use a cellulose filter aid to make the filtration easier and cake discharge better. The press cake with the cellulose and up to 35 % rest oil can be sold as cattle feed or the cake can be added to the feed into the press(or separate foots press) to bring the oil content down and make the system more economical.

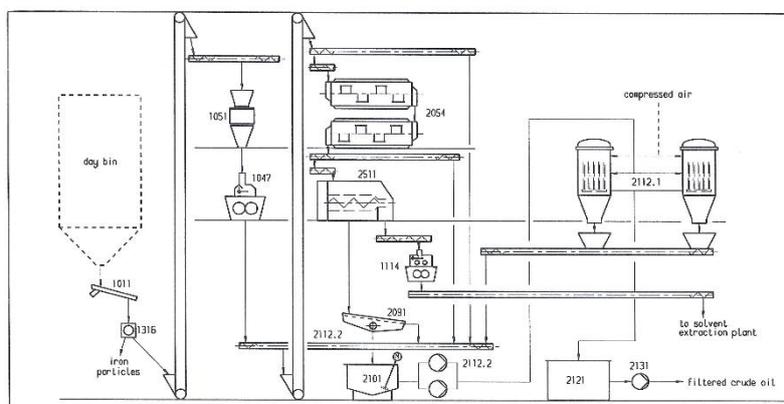
Every oil will behave differently and the cold pressed oil scene is not the same as the list of hot pressed oil clients.

De Smet Rosedowns points out that there are two systems for Palm Kernel oil . One with cold pressed PK oil and the other called Vegetable oil mills for other oil seeds.

HOT PRESSED OILS:

Most oil seed are however hot pressed in order to get maximum yield. At this stage we should also mention that there are three options for the processing of oil seeds nl;

- Pre press oilseed followed by extraction.
- Full press oilseed with max yield .
- Seeds crushed by expanders and extracted only.



Filtration of crude oil or we should say cleaning of the crude oil is essential to remove the remaining foots from the oil before it is send downstream for further processing. It is important to know if this refining is done in house (integrated plant) or is the oil sold with crude oil spec for refining by others?

When in house refining takes place the non compliance with the oil spec i.e. to much solids, will be of major influence.

This will add to the loss in the refinery. If the oil is sold however it must comply with the oil spec and this will call for foots/solids < **0,02 % toluene insoluble.**

This stringent low level can easily be reached by filtration but not when decanters or even clarifying centrifuges are chosen.

Despite the better result in cleaning the oil by filtration, one should consider and prefer a decanter or centrifuge when continuous processing is required and the capacity is high (150 mt/day oil and more). A filter is discontinuous and we need 2 or more filters when a continuous system is required.

When chosen a decanter / centrifuge one should consider the yield / loss, equipment cost, maintenance , utility consumption (KW/hr) etc but safe on labour.

Oil type	Flow rate for calculation (kg/m2. hr)	Average cake Thickness (mm)	Remarks
Copra	200 – 220	15 – 20	Very sensitive for moisture
Cottonseed	150	13 – 15	
Groundnut	130 – 150	10 – 15	
Maize germ / corn germ **	40 – 45	10 – 15 (with BF)	Filter aid required
Palm kernel	325 – 350	25 – 30	
Rapeseed	180 – 200	15 – 18	
Safflower (safflower)	130	20 – 25	
Shea nuts	25 – 30 (40)	4 – 5 or 10 – 12 with BF	High viscosity
Sunflower	200 – 250	15 – 18	
Sunflower decorticated*	250 – 280	12 – 15	

*Decorticated: hulls of the seeds have been removed (dehulling). Hulls act as body-aid during pressing and filtration. But also more oil remains in the cake, lowering the yield.

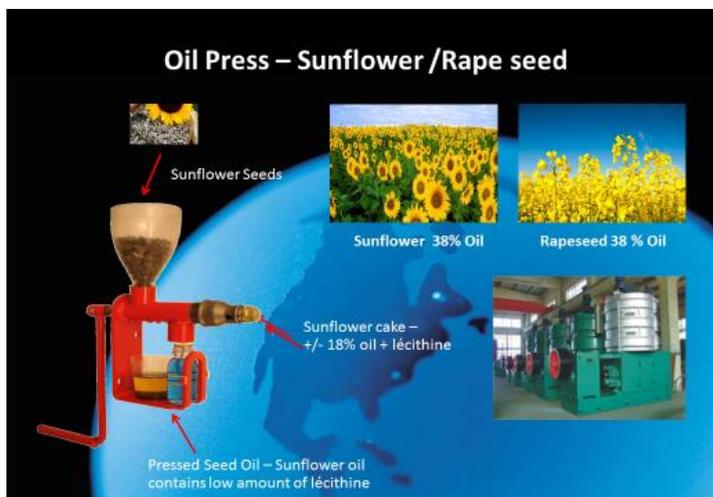
** Corn maize oil will show significant lower flow rate due to fine solids, high sugar and cake behaves like carton sheet difficult to discharge

We will concentrate now on the oil produced by pre –press and full pressed seeds & nuts.

Oils like soy are handled in mega installations as we see in Argentina, Brazil ,USA and Europe(main harbors like Rotterdam ,Amsterdam , Hamburg, etc). It is the protein that they are after in soybean oil. The cake is the product and the oil is a by product .With only 18% of oil compared to sunflower seed with 38% oil this becomes clear.

In the miscella section we will give details about the possible filtration of extracted oils in both miscella phase and as oil after the evaporators. Other oils, and there are many, follow a more traditional oil recovery by expeller or press.

The companies active in fabrication of crushing plants are HF (Krupp) Germany, De Smet Rosedowns (Hull UK), Sket-Crown Germany, Anderson USA, Allocco Argentina and many others. For complete integrated plants with pressed / expanded seeds followed by extraction there are far less and the most used are De Smet Ballestra and Crown Iron Works.



Not mentioned are the many copy cats that have copied a certain design and because of their limitation in skills they offer the increased capacity by multiplying the number of presses from a capacity they know. This is very true at Palm Kernel (PK oil) where we see Chinese, Malaysian, Taiwanese, Indian, Indonesian suppliers offering equipment like presses and filters looking like and even in the color of the original product. Instead of 2 or 3 big presses made by Rosedowns, Anderson or HF for 100 mt per day they have up to 100 pieces of 1 mt/hr capacity. With innovative companies like ourselves you will be ensured to receive always the latest and most optimal equipment for your application. The plant capacity increased from 50 to 2500 mt of oil per day and so did our filter equipment grow in size. The vertical tank models (PLV) were only available in sizes up to 50 sqm and are now built with even 125 sqm filter area in one filter. The horizontal filters (PLH) go as far as 225 sqm per filter for the capacities required. When filtering crude oils it is very important to control the process. When expeller presses with cookers are used the oil after the expeller should not have more than <0,1% moisture(H₂O).

This is true for all oils but oil like Coconut oil are extremely sensitive to moisture. When the moisture in the foots in the oil is measured this should be below 3%. The standard oils like Sunflower, rape seed/canola, palm kernel, ground nut, cotton or linseed are almost the same and the only thing that varies is the throughput. The size and nature of the foods will be the reason for the differences seen. The PKO filtration rate at max 0,35-0,5 mt/sqm/hr is much higher than the crude sun or rape seed oil with 0,280 or 0,20 mt/sqm/hr.

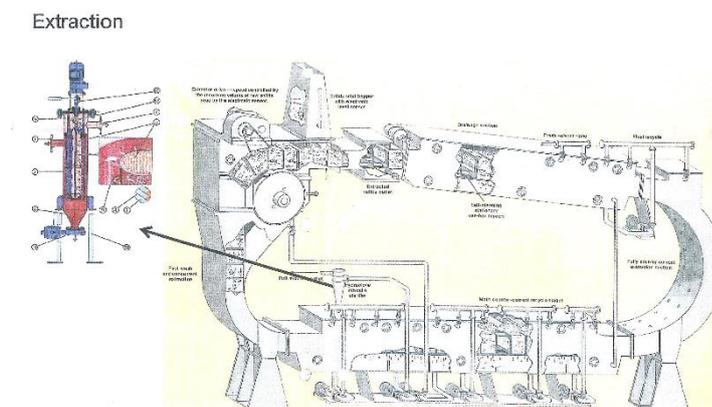
In crude oil after the expeller, the vibrating screen (Sweco or equivalent) or screening tank will still have 5-7 % foots and these need to be removed. The minimum cycle /filtration time requested is 2 hr which will make the amount of solids in the feed the dominant factor in sizing the correct filter. With only 10 kg dry cake per sqm filter area per cycle as max filter filling we will see that the amount of solids and not the flow will be leading in sizing the filter . In most oils the type of solids i.e. the fibrous foot's will result in a direct filtration i.e. the foots will after short re-circulation build a layer tight enough to remove the smallest particles and no extra filter aid is required.

We are aware of some installations that handle corn or maize oil produce oils with a high content of starch (ie gummy, waxy type solids) that plug off the filter screen. Specially in the ethanol plants build in the last few years there are people that also press the germs and the oil is sold to bio-diesel producers to use it as feed stock for FAME. We came across quite a few installations where the crude untreated corn/maize oil gave problems in the methyl esterification.

This resulted in the use of pre-coat and body feed to be able to process the oil . In those plants we had to pre-coat the filters (0,5-1 kg / m²/cycle) with DE ,Perlite or Cellulose and even up to 0,1% body feed was given to prevent the cake from being clogged . We did run tests and confirmed that the above was the only method to clean the crude oil and meet the crude oil spec for their sales dept.

In the pre-press installations the spend filter cake and the press cake was going to be send to the extraction plant to remove whatever oil was left in these cakes.

MISCELLA FILTRATION:



In extraction plants it is common to filter the miscella and both cyclones as well as wedge wire scraper cleaning or back flush filters are used. In a system with cyclones the incoming solids can be reduced from 0,5 % to minimal 0,1 % . Wedge wire automatic strainers will operate at 100-200 micron retention (< 100 micron upon request possible with down to 50 micron in

wedge wire and 35 micron nominal screen retention but very little open area) with back flush type Knecht or Purolator strainers. The incoming solids from initially up to 0,5 % can be reduced down to a < 0,05 % level .

The purpose of this filtrations step is to avoid heavy solids load to foul the miscella evaporator. Typical spec is ca 75 % hexane, 23 % oil, 0,2% water and solids

If the purpose of cleaning the crude oil is to obtain clean gums we generally talk about Soy (GMO) or sometimes sunflower or even rape seed oil (Non-GMO). The question in this case is where to filter.

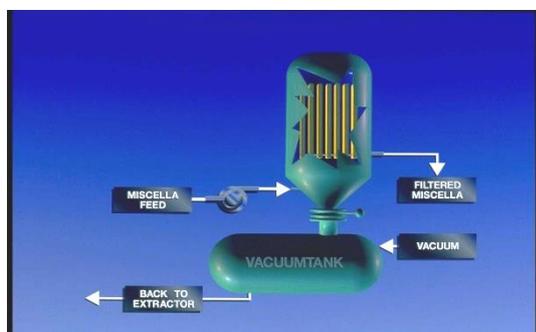
In the most common case with Soybean oil we will have an extraction plant where at the end of the extraction process the miscella needs to be cleaned. As already mentioned the most common system is the use of cyclones or so called "kantenspalt" wedge wire filters

They do the job good enough but never produce a fully clean oil/miscella and certainly do not get to the insoluble level required for clean gums / lecithin.

The miscella from the cyclones/wedge wire filters will have in average approx. 0,1-0,5% solids/insolubles. This has to be <10 mg/litre after filtration and to comply with the conditions requested by commercial lecithin buyers like Cargill (Lucas Meyer),ADM and others.

The main question in getting clean gums is where to filter?

- In Miscella phase (Explosive and expensive but high filtration rate)
- In Oil phase (big filters, more waste and excessive cost filter aid)



In the most common case with Soybean or Sun flower seed oil we will have an extraction plant where at the end of the extraction process the miscella (25/20 % oil and 75/80 % hexane) needs to be cleaned to avoid fouling of the evaporators. With the initial removal of solids/insolubles to a level of < 0,1 % , his has to be 0,3% moisture and volatile mater and insoluble impurities in the crude degummed oil (NOPA Spec) witch will

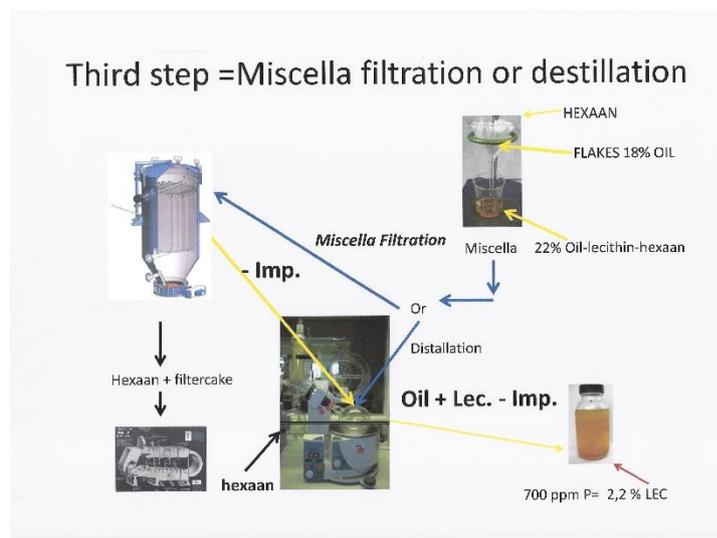
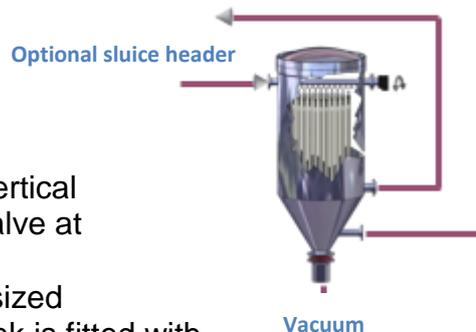
be in line with our obtained < 10 mg/litre after filtration and will comply with the conditions requested by commercial lecithin buyers like Cargill (former Lucas Meyer.)

When filtering the miscella we have to pre-coat with a layer of filter aid (kieselguhr, cellulose ,perlite or combination) and also a body feed is given with kieselguhr/perlite or cellulose. The broad range of filter aids available will allow us to find a suitable grade for almost any filter application

Miscella filtration is preferred because the filters can be relative small due to the relative high flow rate (1,5-2,5 m³/m²/hr) . The filters have wet/slurry discharge by vacuum extraction form the filter in a vacuum tank from where it is send back to the extractor to ensure maximum recovery . Optionally we can install a oscillating sluice system operated with clean hexane at max 3,5-4 Bar sluice pressure. The wet/slurry cake is discharged back to the extractor and forms a closed loop. Due to explosion danger the filters have to be placed in the ex-proof area are and proper sealing should be ensured.

The already in co-operation with H Schumacher developed system consists of a vertical tank and vertical leaf type filter with conical bottom and a butterfly valve at the bottom (vulcanized viton seat or ABZ high performance valve). This filter is placed on an oversized tank on which vacuum can be applied. The filter tank is fitted with stainless steel 5 ply wire cloth filter leaves (60 mesh twilled weaves or PZ80S) and a cellulose (JRS EFC type) pre-coat with up to 0,05% body feed is applied.

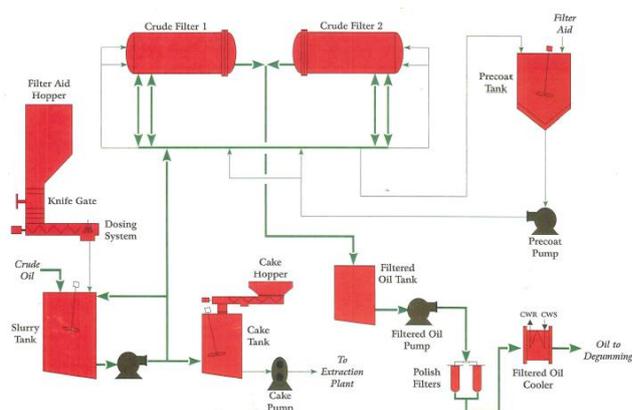
At the end of the filtration cycle when the filter cake has reached max thickens and weight cleaning becomes eminent. The hexane from the filter vessel is partly removed from the filter vessel back to the extractor while the butterfly type discharge valve to the vacuum tank is suddenly opened. The vacuum will result in the hexane still in the cake on the filter leaves starts to boil and remove the cake in an “explosive or shock “ way. The spend cake now assembled in the vacuum tank can be returned to the extractor where the filter aid is absorbed in the meal and the liquid is reprocessed.



Due to explosion danger the filters have to be placed in the ex proof area and proper sealing should be ensured.

If there can be found a way to eliminate the iron effect on the gum quality after filtration this is still the preferred way of working. It will also keep the evaporators clean.

In bleaching there was a similar filter system tried and used only in a few cases. This bleaching filter with clay cake extraction could bring the rest oil down to < 2% but at what cost and effort



Due to the conditions described most filters are used for crude soybean filtration in the oil phase. Big installations at major soy processors are in operation for several years and they are used to obtain the 10 ppm insoluble level with filters in size up to 200 m² per filter unit.

The filters are operated with dry cake discharge by means of pneumatic vibrator assemblies and

can be compared with units used in the filtration of winterised oils. For crude oil filtration the filters are pre-coated first with filter aid (JRS FILTRACEL EFC, ARBOCEL, Perlite 4128, Eagle Pitcher type FW 40 or equivalent grade).

This pre coat layer is the actual layer that defines the level of filtration (retention). During filtration body feed is given to keep the process going and to avoid that the solids block the cake in the early stage of the cycle.

In the USA this filter application is more or less a standard procedure in all soy processing plants with extraction and refining. The rest of the world is following since there is an commercial interest in obtaining clean gums / lecithin. Recent installations from the major engineering companies like Crown, De Smet, and from the ABCD companies included crude soybean oil filters model PLH DCD in size up to 225 sqm per filter.

A short repeat on which filter aid to use is as follows;

A) KIESELGUHR (Diatomaceous earth);

DE = fossil plant/animal available in different grades and inert. Has been under suspicion of being carcinogenic but in the past 2 years this has been reversed and it is only recommended to work in dust free environment. Biggest supplier is CELITE (JM) under the name Celite and well known grades are HYFLO SUPERCEL, CELITE 545, 577, FILTER CEL and others. Alternative brands are EAGLE PITCHER (FW 40,60,80 etc). Material is like sand thus abrasive and INERT

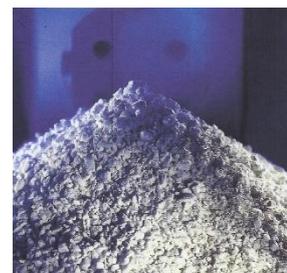




B) PERLITE= volcanic glass like structure available in different grades and inert. Was favoured at the time that DE was under suspicion but is lighter and more difficult to mix into the solution (more floaters). PERLITE = CHEAPEST.

Material is lighter and cheaper. Most famous name is DICALTE and grades are 4128, 428, etc. The 8 indicates that it is from Belgium and when a 6 is used the origin is USA. material is abrasive and inert.

C) CELLULOSE. This is the more recent promoted material. In the past very often the kieselguhr or Perlite was mixed with cellulose to form a dense pre-coat layer / blanket. In more recent years the Solka Flok and Alfa Cel was replaced by Rettenmaier FILTRACEL 450 , 950 & 1250 . The advantage of the cellulose is the fact that it is bio-degradable and it can be incinerated with very little ash (both DE and Perlite are inert , can't be burned and have a high ash content after incineration). Cellulodse material is not abrasive.



D) ACTIVATED CARBON.

Can act as a filter aid but is mainly chosen for its absorptive characteristics.

Our recommendation is always to ensure that the system is universal and can be used with either one of the filter aids mentioned.

In the world of crude oil filtration there are a wide range of oils , techniques and special equipment offered and by no means we are complete in our above options to process the crude oil . We have merely tried to give you a good overview of the systems and techniques available .

When there are any questions or remarks please do not hesitate to contact our company and well trained and experienced filtration engineers will handle your request skillful and with pleasure

Publications also available on this range of FILTERING THROUGH THE NEWS are;

- Winterised and fractionated oil filtration info.
- Hydrogenated oil & oleo chemicals filtration info.
- Detox or activated carbon filtration form edible (fish . Coconut and sunflower oils).
- Filtration steps in bio diesel filtration and the influence of feed stock
- Counter current and Try-clear, Combi Clean or Double Pass bleached oil filtration.
- Cocoa filtration steps.
- Influence of bridging and other problems on leaf damage.
- screen selection in leaf filter usage and breaker bars on leaves with 60 mesh .
- Tallow filtration and the influence of Polyethylene.
- and many more on other filtration issues



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We hope this will guide you through the difficult task to find the most optimal filter, with respect to yield and cost.

In case of any questions please don't hesitate to contact us.

Thank you and personal regards,

VT Wong at PMI Sdn,Bhd. Mail vtwong@pmi-group.com.

FV, rev 4 ; 12/2015