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ADVANCES IN SOLVENT DEWAXING OF MINERAL OILS AND TARS

By Dr. Karl A. Fischer

ARTICLE V

STATIC CHARGE, FILTER CLOTH, LABORATORY RESEARCH

ARTICLE

STATIC CHARGE, FILTER CLOTH, LABORATORY RESEARCH

There is a problem which has to be touched upon before we can discuss the design of dewaxing plants; that is the influence of the filter cloth upon the results of filtration. Naturally it shall be strong enough when wet to bear the mechanical strain to which it is exposed and which is considerable at the point where the cake is blown off. Obviously it must not consist of artificial fibres which are attacked by the solvent such as polyvinyl derivatives. Paper fabrics, silk, rayon, and some cotton fabrics gave very satisfactory results, but linen and other cotton fabrics which were investigated proved to be unsatisfactory. This evaluation pertains to the ease with which the fabric releases the filter cake and to the obtained pour points. Evidently it should be expected that a heavier and denser fabric will give better pour points in any case. Surprisingly enough this conclusion was found to be wrong. Heavy fabrics could turn out very unsatisfactory pour points, whereas thin fabric with large pores or coarse paper fabric with large pores were able to give excellent results. This problem was worth looking into, for a thinner fabric offers advantages with regard to filtration speed and the paper fabric with regard to price as well. The microphotographs on page 93 give the structure of two textiles which were very different in their behaviour. Although the fabric No. 2 has considerably more and much larger pores than No. 1 and naturally gives better filtration rates, it also produces better pour points.

This cannot simply be explained by the formation of a precoating of wax which acts as a filtering medium, because the finer pores would have a better chance to get the primary coating.

(Magnification 15 times)

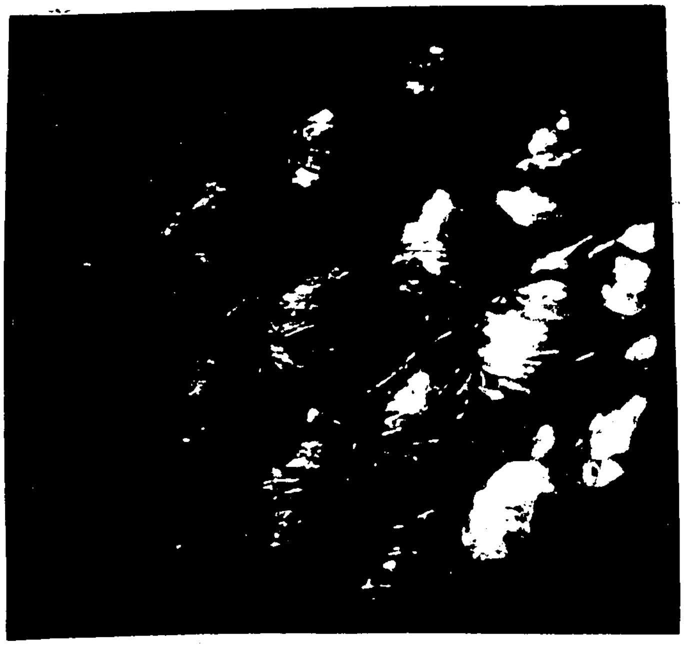
Conditions: Lub. oil residue, Deasphaltized, Temperature $-25^{\circ}C$.,

Solvent $CH_2Cl_2 - C_2H_4Cl_2$

(light from above) (light from below)

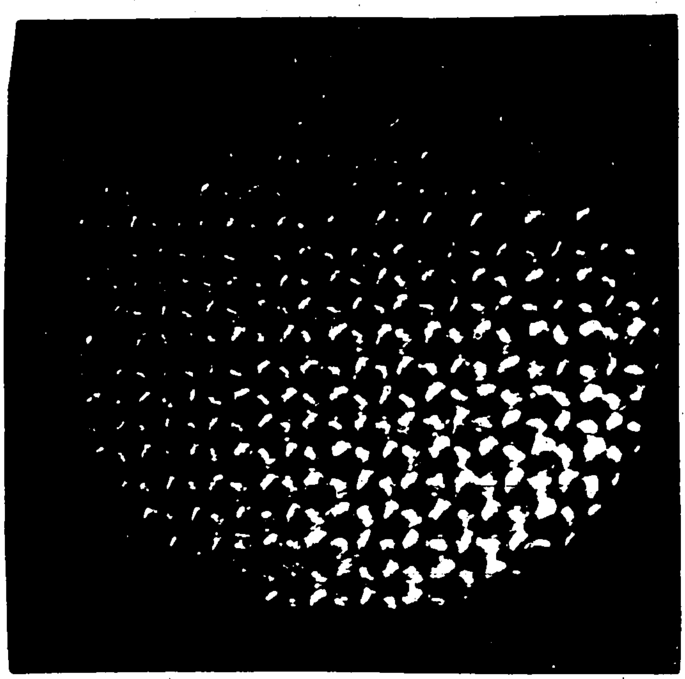
Sail cloth, linen No. 1

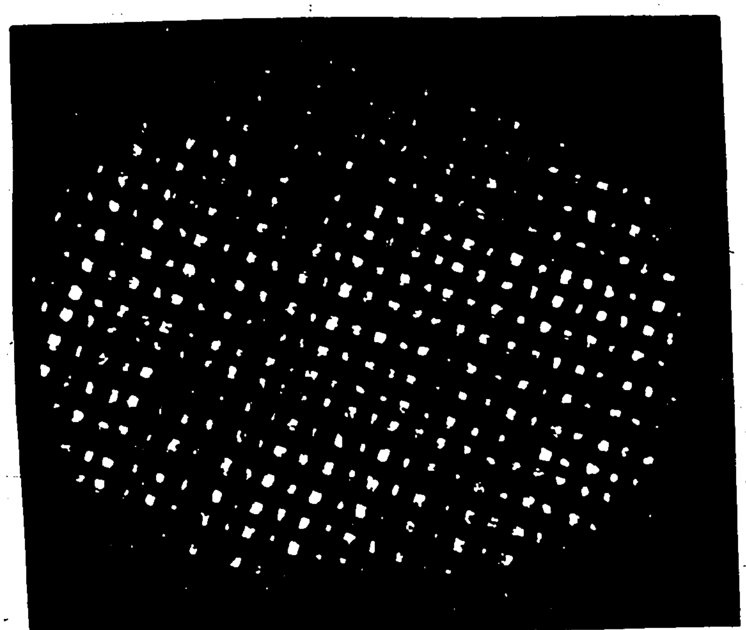
Filtration rate: 25 kg/m^2h
Pour point: $-19^{\circ}C$



Rayon cloth, batiste No. 2

Filtration rate: 35 kg/m^2h
Pour point: $-25^{\circ}C$





It could be proved that static electricity is responsible for this effect. That explains why the material of the filter cloth is of influence and why the size of the pores can be of little importance within certain limits. The size of wax crystals in propane-deasphaltized residual oils is much smaller than the diameter of several filter cloths pores which we tested and yet pour points were mostly very satisfactory. If extremely fine mesh metal fabric was used, however, pour points always turned out to be bad and the explanation for it is obviously that no static charge can build up in metal cloth because it is always well grounded.

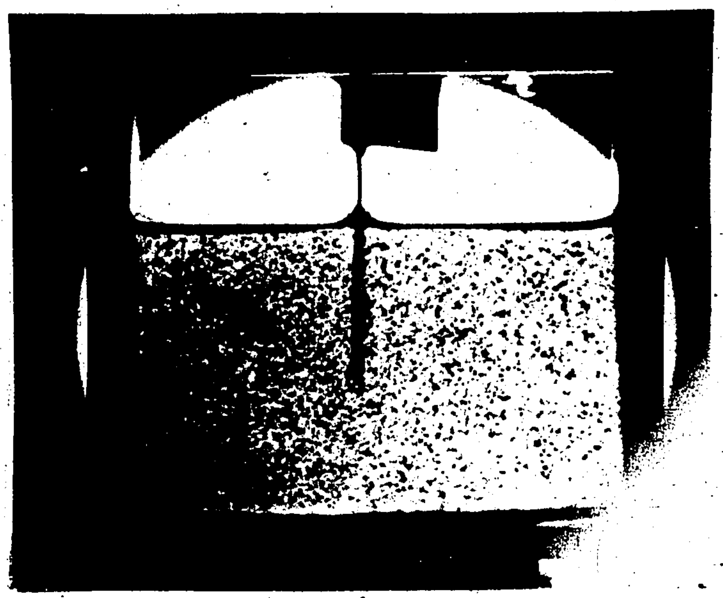
Naturally this conclusion holds true only for solvents that are non-conductors of electricity. Most organic liquids belong to this class, especially so the chlorinated hydrocarbons. If filter cloth is interwoven with metal thread and placed on a glass funnel, and dichloroethane is filtered through, it gets an electrical potential which can be made visible by connecting it with a sensitive galvanometer. The electric current, which could be drawn from this laboratory experiment was very small and in the order of magnitude of 10^{-8} amperes, but voltage can be considerable. The cloth had negative charge and the solvent positive one. The pores of filter cloth have a fraction of a millimeter in diameter only and it is evident that there will be a powerful electric field in them, even so, if voltage is but small. It is under the influence of that field, that the finely divided suspension of paraffin undergoes an aggregation of its particles and it is the agglomerated crystals which are readily held back by the filter cloth, mainly mechanically, partly by electric forces. This primary wax layer acts now as filter aid for the rest of the charging stock.

It was not possible to observe this under a microscope, but two experiments show that there are facts behind that conclusion.

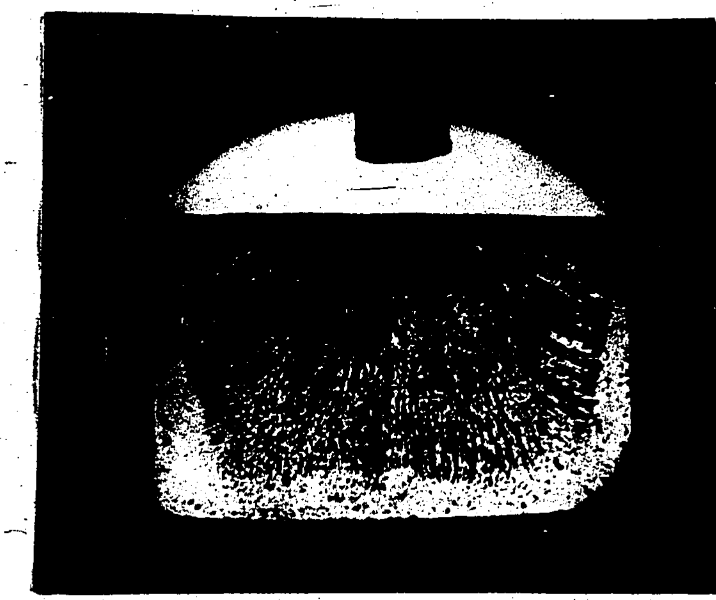
A glass cell 5 x 5 cm and 1 cm wide with plane parallel walls was filled with a suspension of fresh precipitated high molecular paraffin wax and some "Congo-Red" dyestuff to facilitate visibility.

The liquid was carbon tetrachloride. A copper electrode lined bottom and narrow sides of the cell. The second electrode was fixed in some distance from the liquid surface.

Neutral



Under voltage



The opaque suspension which in electrically neutral state was stable for a long time, changed appearance immediately when high tension D. C. was switched on. Under the influence of 2000 - 5000 volts but also under lower voltage there was immediate conglomeration of wax and dyestuff to thick thread-like structure which broke down again, when the electric source was eliminated. That was to be expected, of course, because it is a well-known way to demonstrate the lines of force in an electric field. What was needed was only the confirmation that it works under dewaxing conditions as well. The square of attraction depends now inversely upon distance and it is evident that comparatively low voltage at small filter pore distance will suffice to produce the same effect, which much higher voltage will do with an electrode gap of two inches.

The dominant influence of static electricity in filtration of waxy oils could also be demonstrated in a second experiment. We wound two strips of coarse mesh copper gauze, sandwiching a strip of insulating paper to a narrow coil and squeezed it into the tube of a glass funnel. The two terminals of the high D. C. voltage source were attached to the two wire nets. If a suspension of "Congo-Red" and wax in CCl_4 was poured on the funnel it ran through rapidly without any change. If high voltage was turned on, however, the mixture filtered just as rapidly but the filtrate did not contain any visible trace of dyestuff or wax. All solid components remained sandwiched between the electrodes. Electricity was now switched off and the electrodes were grounded. One single batch of solvent was sufficient to wash down the whole precipitated matter. This also proves the assumptions.

It shows a new way for the design of an electrostatic filter for non-conductive charging stocks. The difficulties which would be met in constructing such an apparatus for large scale conditions must not be under-estimated, however. It is insulating problems chiefly which would offer difficulties. Power consumption would be very low, though, and the abandonment of filter cloth and the exceedingly high filtration rates count from the economic side.

Fibrous structure of filter cloth. Besides material for electric reasons and texture for reason of mechanical strength, it is fibrous structure and surface smoothness which are of great importance ~~upon~~ for filtration efficiency. The filter cloth is supposed to release the filter cake immediately and entirely when filtration and washing is finished. If the cloth surface has many protruding fibers, cross linkage of fibrous surface and filter cake will result and make it difficult to separate the cake from the cloth. Smooth surface on the contrary will let off the cake easily, which is highly desirable. Microscopic examination of the filter cloths checked pretty well the result of experimental filtrations. The experimental study of the problem involves difficulties. Structure and solvent content of filter cakes may vary within wide limits. A wet cake separates from the filter cloth with less difficulty than one which has become dry by excessive suction.

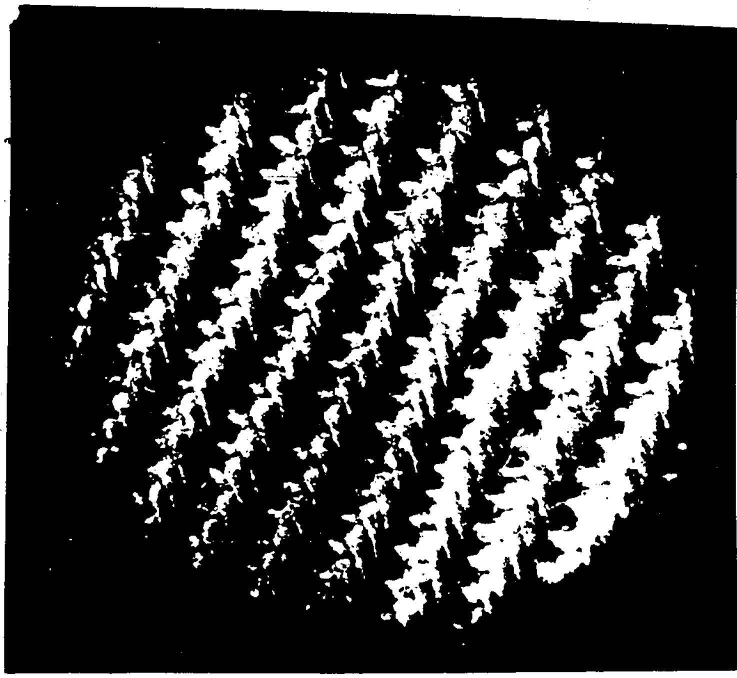
Precautions were therefore taken to obtain comparable cakes. Vacuum was kept constant for all filtrations, but filtration velocity naturally varied for different cloths and oils. The cakes, after filtration, were exposed to suction for drying until the first fissures appeared on the surface. This is in accordance with actual operating conditions of large filter units. Separating the cake from the cloth was effected by turning the filter upside down and tapping it lightly with a plastic hammer. Many experiments showed that in this way results could be reproduced better than by blowing the cake off with air. Pictures were only taken of experiments which could be repeated with the same result. The following pages show the remarkable differences in the separation of a light and heavy wax cake from various filter cloths.

The magnification of the filter cloth pictures is 15 times.

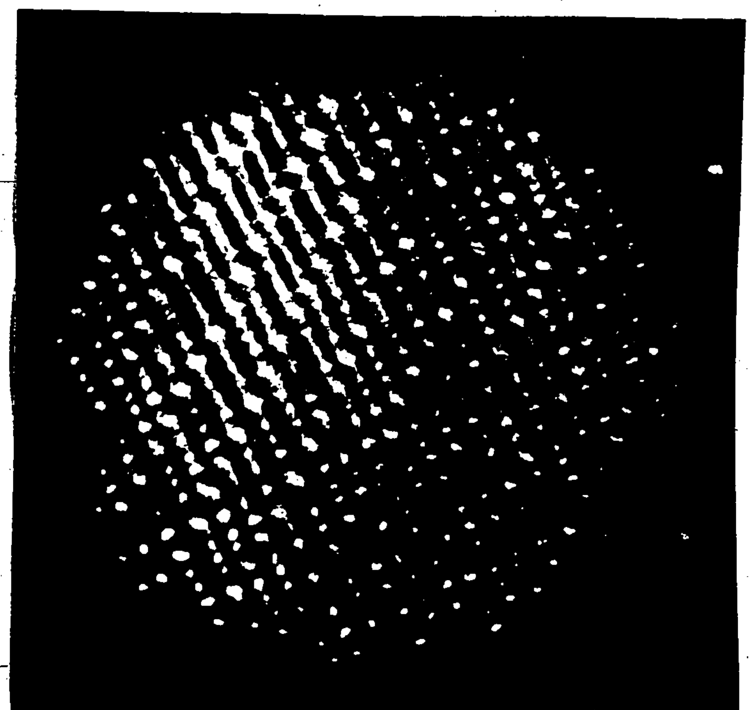
The Buchner funnel pictures which exhibit cake adhesion are reduced 6 : 1 from real size.

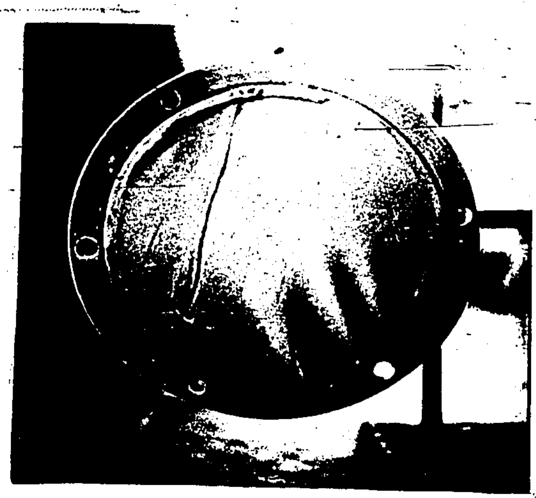
1) <u>Clairtwill</u> is a smooth surface rayon cloth.

Light from above

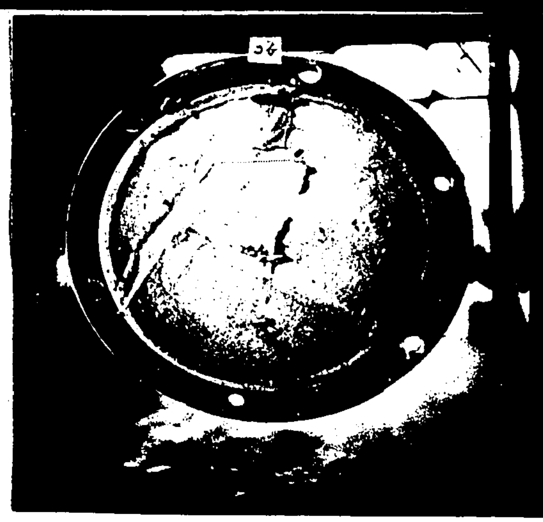


Light from below





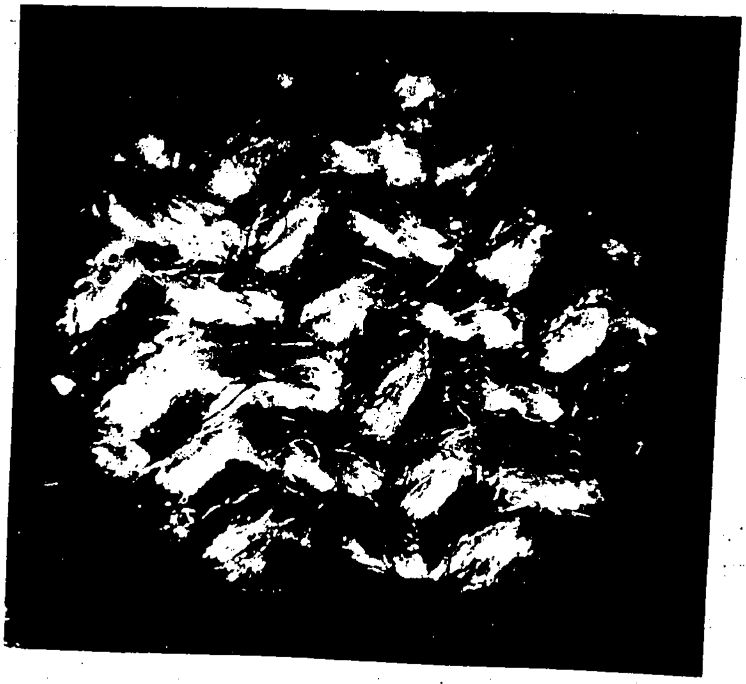
Spindle oil
Cake separates easily



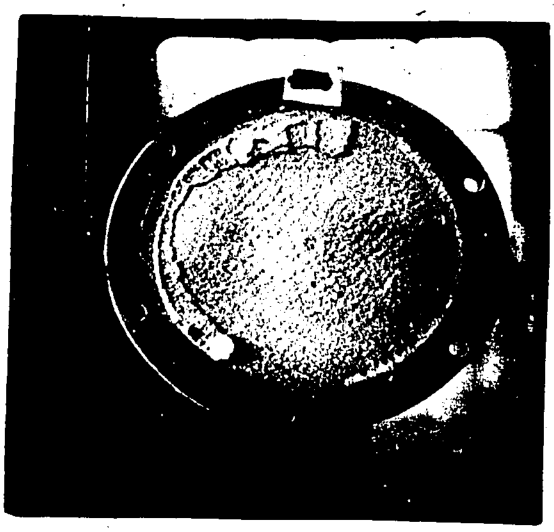
Heavy residue
Cake separates with slight difficulty

2) Cotton cloth has rough texture and fibrous surface. Results were unsatisfactory.

Light from above



Light from below



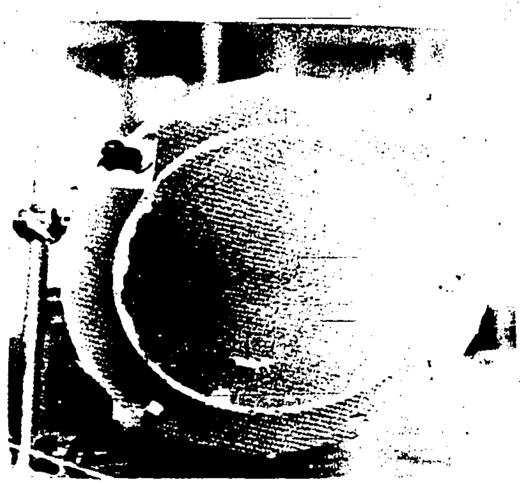
Spindle oil
Cake separates with difficulty

Heavy residue
Cake separates with difficulty

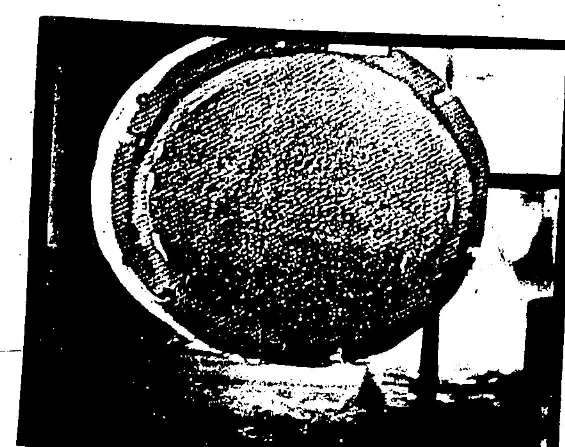
3) Paper cloth, pressed has rough texture but smooth and non fibrous surface.

Results were good with light and heavy oil.

Light from above



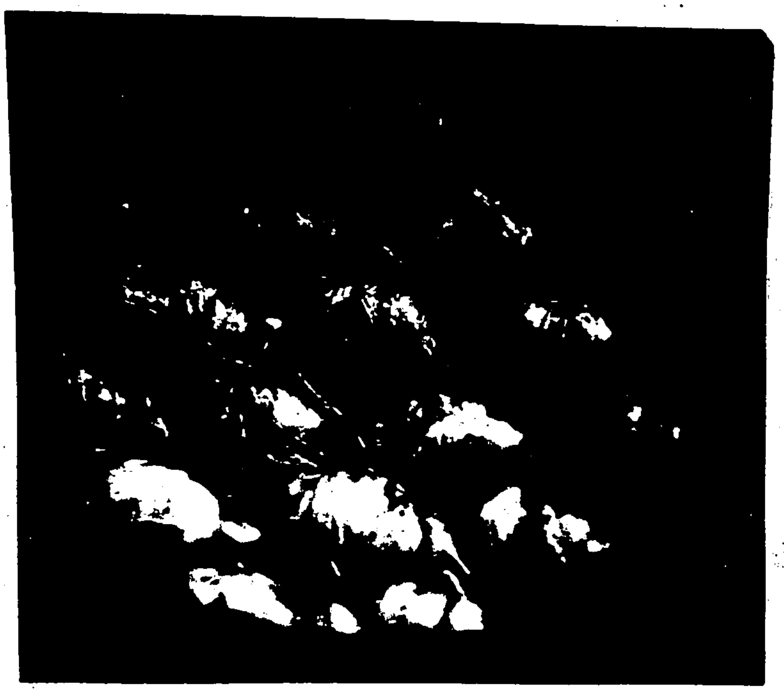
Spindle oil
Cake separates easily



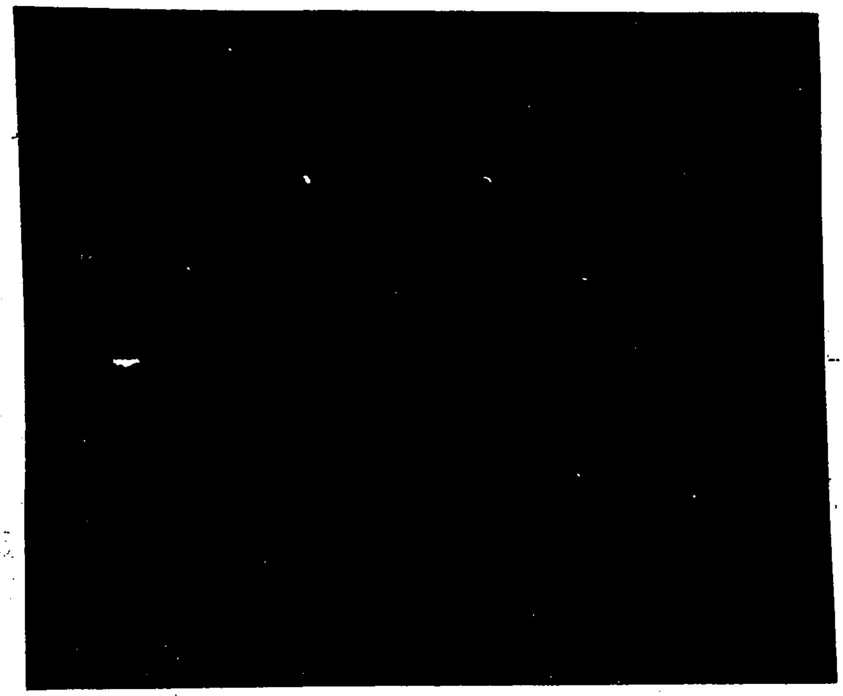
Heavy residue
Cake separates easily

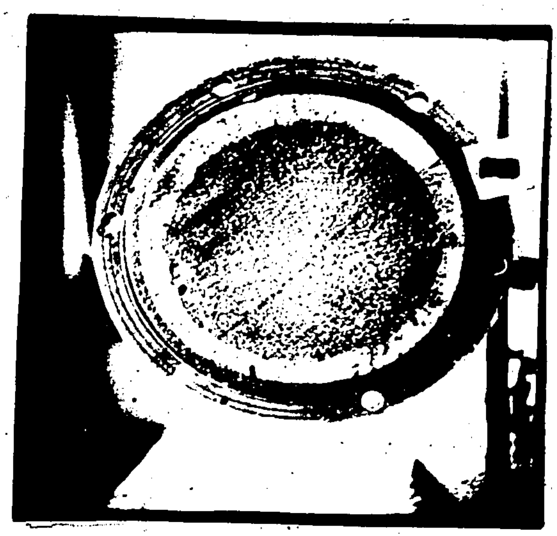
4) Sail cloth, linen has rough texture and fibrous surface. It gave very poor results and was the worst of the tested samples.

Light from above

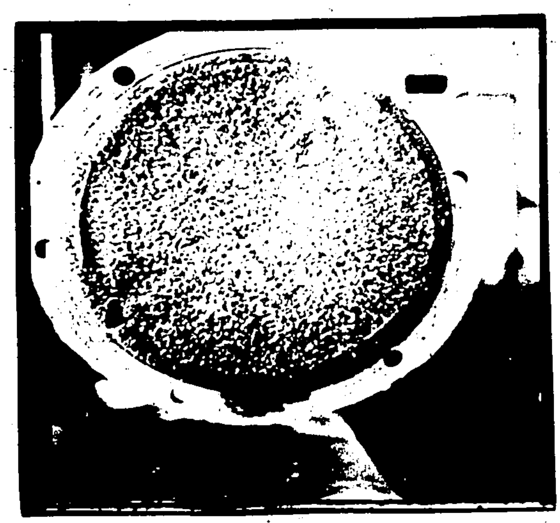


Light from below





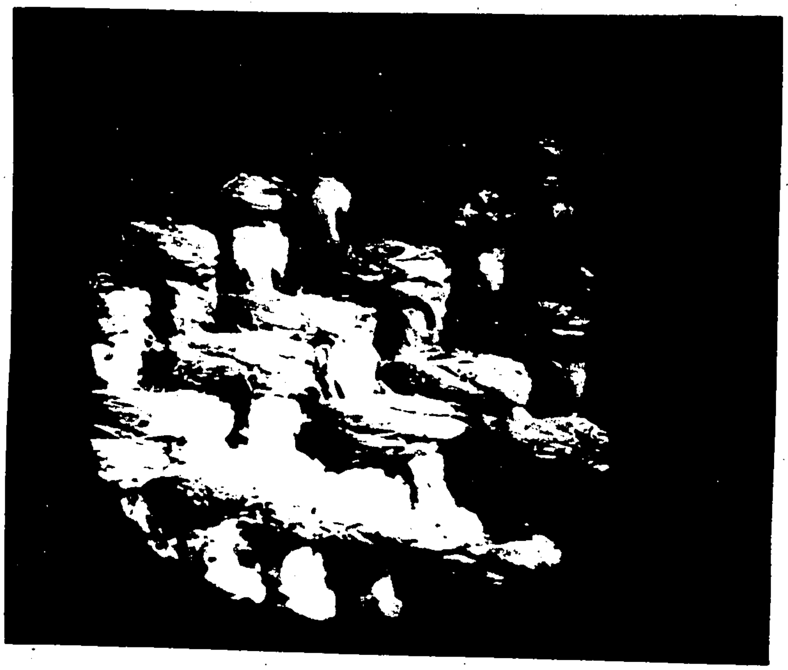
Spindle oil
Cake separates with great difficulty



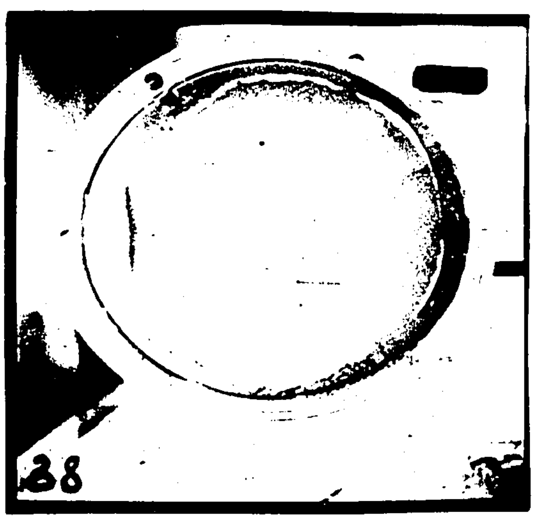
Heavy residue
Cake separates with great difficulty

5) Cotton cloth, copper treated has rought texture like 2 but the chemical treatment removed the undesired fibres from the surface and made it smooth. The results were far superior to 2) and even to 1), which was superior in filtration rate, however.

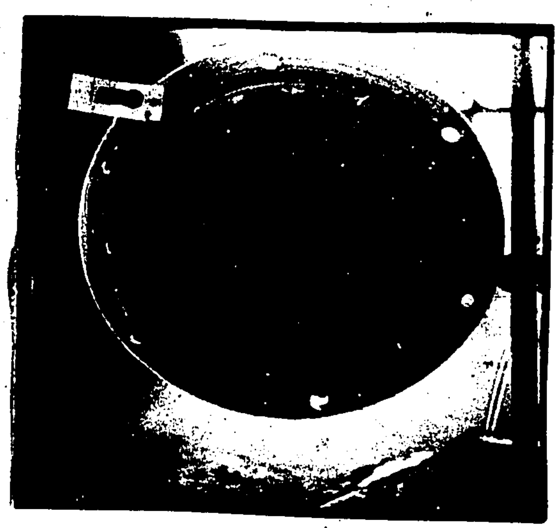
Light from above



Light from below



Spindle oil
Cake separates easily



Heavy residue
Cake separates easily

Conclusions: The material of the fabric is important for electrostatic reasons which influence pour point. Size of pores and texture have decisive influence upon filtration velocity, but probably the most important influence must be attributed to the fibrous or non-fibrous surface condition of the filter cloth. If the cloth does not release the cake completely, when it is supposed to fall off, it will substantially decrease filter efficiency. Cake particles which stick to the cloth will reduce effective filter surface and it seldom happens that they are released in further cycles. Usually active filter surface continues to reduce until finally a hot wash is needed to clean and recondition the cloth. Fibrous material should therefore be abandoned if smooth surface cloth is available. Chemical treatment will substantially improve cotton fabrics. Sulfuric acid or copper solution gave both the desired result. Wire fabrics release the cake easily but they have the above described drawback to give bad pour points. Metal screens under voltage could not be tried out. The effect is doubtful for reason of the cage effect in an inclosed filter. The very good properties of the cheap paper fabrics deserve to be preferably mentioned. They combine low price with mechanical strength, and are excellent from the view point of filtration rate, pour point and cake take-off.

However, no filter cloth can be expected to meet all demands equally well. High porosity and filtration rate go usually with poorer mechanical strength, whereas strong and heavy fabrics are obviously less permeable. Paper fabrics lose their strength in contact with moisture which can hardly be excluded in wax filtration at low temperature. That limits their life-time to 3 to 6 months. But the fact remains, that wise selection of filter cloth under the discussed view points is of considerable importance for plant efficiency and performance.

It might be worth while to study the properties of smooth surface cloth which is metalized on the filtering surface leaving a metal free border strip to avoid contact with the filter pans. Each filter pan is then a condenser with solvent soaked filter cloth as dielectric medium. It may combine advantages in filtration and it may give superior results if the metalized surface is given a high electric potential.

Filtration in laboratory research

Many filtration problems can be satisfactorily answered by laboratory experiments and the results can be transferred immediately upon plant operation. This is particularly the case for the separation of inorganic and organic hard crystals and hard amorphous matter. Parallels can also be drawn for slimy and compressible precipitates, which offer more difficulties in filtration, supposing that the separation in small and in large scale occurs under comparable conditions.

Unlike those filtering problems the wax filtration again offers more difficulties. Indeed, yield and quality of the final products can be accurately determined in small scale experiments, and the same results can be anticipated from an operating plant. However, of the data which interest the designer and the constructing engineer, it is temperature, dilution and quantity of wash liquid only which can be predicted with certainty while the most important figure for the filtration rate is by far less accurate. This figure, expressing throughput of kilos of oil per square meter filter surface per hour, dominantly influences design and capacity of a plant because it determines the number and size of the filters. Fortunately, and without exception, is the filtration rate for any wax and heavy solvent always found lower in laboratory experiments than it will be in actual plant operation, thus allowing for ample flexibility and margin in chilling capacity, solvent recovery and filter surface. The drawback is that for some oils the margin may be small only, whereas it is very large for others, which would naturally lead to poor design and decreased efficiency.

This peculiar behaviour of waxy cuts in heavy solvents depends obviously on crystal size and on specific gravity. There is usually a large difference between small scale and technical filtration rate of low molecular paraffins, while it may become almost negligible for the heaviest stocks. This finding may be explained by Stokes's law:

$$V = \frac{f \cdot r}{6\pi \cdot \eta}$$

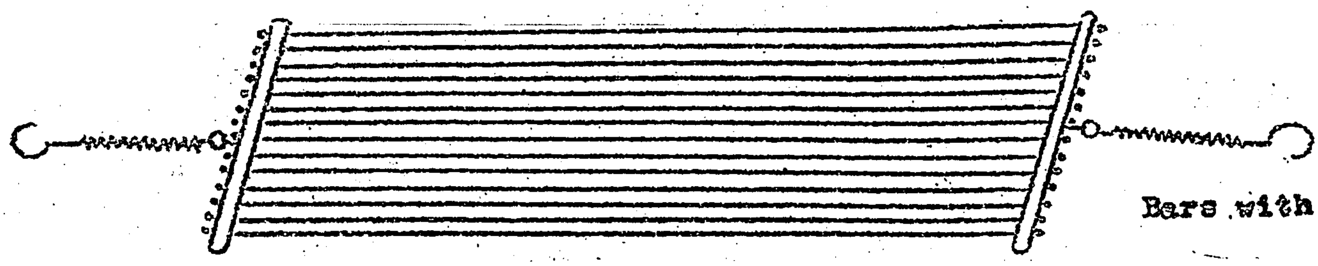
It pertains to globular particles, but in general it also reflects the behaviour of otherwise shaped precipitates. The speed of settling or ascending particles depends at a given viscosity on size of the particles on viscosity and on the driving force. Large crystals ascend in heavy solvents quicker than small ones and it is obvious that small differences in ascension time will cause large difference in the way a filter cake builds up. Fractions of a millimeter in thickness of filter cake influences considerably filtration time, and the chances are that the cake builds up more quickly in small scale batch experiments where the filter stock is poured upon the filter and filtration starts right away in contrast to plant operation, where in continuous and smooth run the pans are charged evenly, with the slurry, and are then uniformly submitted to suction. Needless to say that lower viscosity assists more rapid ascension and that a larger difference in specific gravity gives low molecular waxes a higher buoyancy in chlorinated solvents. This accounts for the scattering results of filtration rate in batch experiments with low molecular wax cuts for its deviation from plant results, and for the higher filter rates in large units. The heavy microcrystalline waxes in heavy fractions, however, need a very much longer ascension time, assisted by the higher viscosity and the lower driving force because of less difference in specific gravity. Therefore small scale and plant results will approach much closer. This assumption could actually be confirmed by experiment, because the filtration rate of low molecular cuts in laboratory filtrations comes much nearer to the higher figures of actual plant results, if the charge on the filter is given a few minutes time before the suction is turned on.

This is of considerable practical importance for the design of plant filters which get also higher efficiency, especially for heavy stocks, if the charge is given more resting time before actual filtration starts. In Edeleanus band filters a small amount of filtrate collects in this time, which was called gravity filtrate. It is usually united with the main filtrate from which it is evidently not different. For low specific gravity solvents, where crystals settle down, there is naturally no advantage in an extended settling period. There are other influences which also cause a certain discrepancy of filtration results in small scale as compared to plant conditions, and which influence heavy or light solvent diluted charging stocks likewise. They can mostly be attributed to crystal growth, which is more uniform from large continuously chilled volumes than from small experimental batches. It seems to be not dissolution of smallest crystals and recrystallization to larger ones, which also exert some influence with regard to better porosity of the filter cake, but wax crystals from large batches or plants are in general more even in size and shape than the same paraffin crystallizing with all possible precautions and under comparable conditions from a small charge. More even arrangement of the capillary spaces in the cake means less bends and therefore less resistance to percolation, equivalent to higher filter rate.

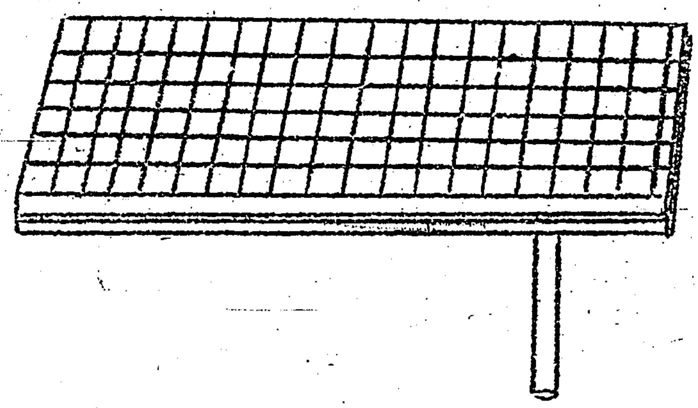
While laboratory experiments to find quality of products, dilution and consumption of wash liquid can be done with only a few 100 cc of waxy oil cut, it is imperative to carry out the determination of filtration rate with charges of at least 1 gallon or more. Laboratory results and plant records of throughput were then fairly close together if the above discussed facts were observed. These conclusions, which are drawn for the use of heavy solvents in combination with pan filters, also hold true for any other wax filtering method with proper regard being given to the changed conditions, but hardly can optimum filtration conditions be met so exhaustively than with solvents of high specific gravity and Buechner funnel type filters. The Buechner funnel which was used in our laboratory for the production of oil free waxes and low pouring oils is described below. Not always are absolutely oil free waxes wanted and it seems sometimes desirable to design a cheaper plant with other filters than the band type. This question also comes up when filtration in 2 steps is considered, producing an oil free hard wax and a soft product which is of inferior value and for which a market will be found even if it contains some oil. It is the rotary filter type which can then be used with advantage for the 2nd stage and a special laboratory practice was developed to get close approximation of small scale and plant results.

Among the several types of rotary filters, one, known as "Imperial" filter, has an outstanding feature in the cake take-off. The filter cake builds up on a multitude of parallel strings, which rest on the filter cloth as long as filtration and washing lasts, but lift off the circumference of the filter drum after washing, moving towards a rotating small diameter drum or shaft, with grooves to keep the strings evently spaced. Naturally the filter cake is carried away, resting on the strings and can easily be removed when the strings reverse direction after passing the second small drum. The adaptibility of those filters to paraffin filtration was studied in detail. That filter type works excellently for hard, fine, or coarse grain material. For paraffin wax it works fairly satisfactorily for low molecular cuts only, whereas it gave poor results with heavy oils. The reason for this is plasticity of the waxy material, and the particular tendency of heavy molecular fine structured waxes to adhere to the filter cloth and to the take-off strings. At each following drum revolution they are then more tightly pressed into the filter cloth, soon causing impermeability and blank spots. As soon as the blank spots appear, the cake removal starts getting irregular, finally closing the vicious cycle of obstructing the filtering pores completely. Obviously, all the drawbacks in inefficient washing which have been discussed for any rotary filter hold true for this filter also. But this method of taking the cake off with strings is a very good idea and permits quick work with small scale discontinuous batch filters which can be frequently washed clean with hot solvent. The laboratory results can also be compared with any rotary filter in which the cake is taken off by pressure and a scraping or deflecting edge.

Such a laboratory filter is suitably a rectangular solid plate, approx. 4 x 6 inches and 1/4 inch thick with pyramid surface. The suction tube is soldered to the rear side, a groove runs around its circumference. The filtering pyramid surface is covered with coarse wire net, with very coarse stiff fabric and finally with the desired filter cloth. This cloth spreads over the edges of the plate and is tightly held in place by hammering a thick string into the groove of the circumference. The filter carries the string equipment which consists of two wooden bars with parallel cotton strings spaced evenly and about 1/4 inch apart, to adapt it better to paraffin filtration. The strings are stretched across the filter cloth and held tightly in place by two metal springs which are hooked to the suction tube.



Bars with strings



Filter plate

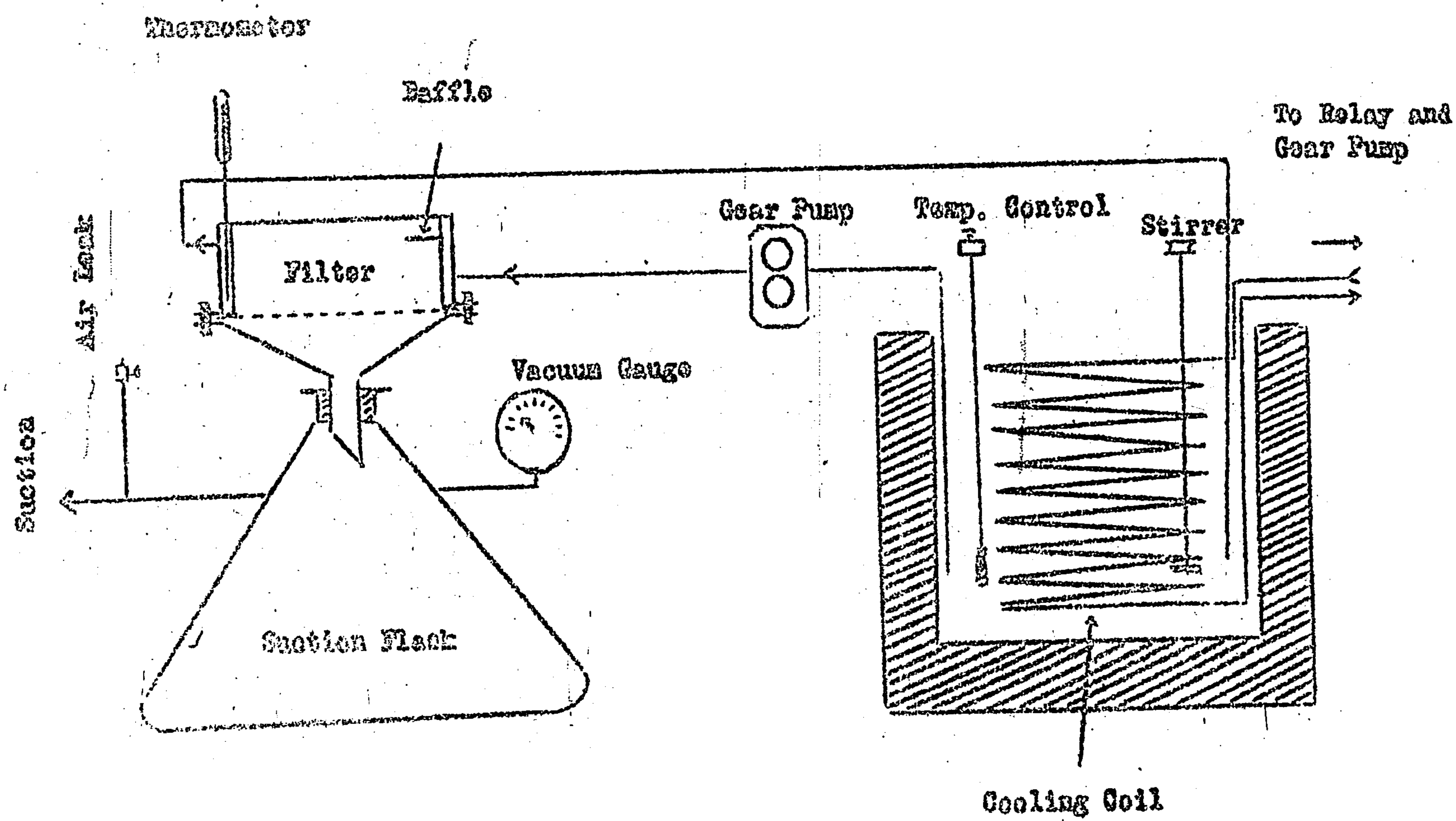
Plate filters of this type, and square or circular shaped, are widely used in filtration practice. But the additional use of the strings speeds work up considerably, which is of importance for the filtration of waxy stocks, because in small scale it is almost impossible to avoid fluctuations in temperature by conduction and radiation. Their harmful influence has been discussed and any means to facilitate and speed up work are therefore desirable. In contrast to Buechner funnel filters it is always advisable to work up large batches with plate filters. This reduces temperature fluctuations and gives better checking results. 2-3 gallons of diluted oil were gradually chilled under agitation until the desired dewaxing temperature was obtained. A special chamber serves suitably for the proper dewaxing. It consists of a large wooden box with double walled front glass plate, designed as a door, and lateral holes fitted with large rubber gloves to enable operation inside the box. The interior is well lighted through the glass top. The bottom of the box holds two one gallon copper vessels, one to take the diluted and chilled wax bearing oil while the other one holds the wash liquid. Both vessels are suspended in thermostat controlled chilling baths. The box keeps moisture away and its atmosphere is conditioned and cooled by large lumps of dry ice, resting on a small shelf inside. The question came up if the carbon dioxide might dissolve in the diluted cold oil and influence the obtained filtration rates. Comparative tests showed that this is not the case. The charging stock is continuously fed to the vat in the box through lagged pipes entering in the rear. They also maintain the level of chilled wash liquid. Filtration can evidently be done in batch operation only, but rapid operation is possible and the filter cake, after washing and suction release, is thrown off into porcelain dishes, from which the solvent can be easily evaporated and the dry cake be weighed back. The operator wears woolen gloves because the operating rubber gloves offer no protection to the low temperature in the box. Evidently this procedure has all the drawbacks of older dewaxing methods, and it is practically only the phase rule considerations which can be observed. The results, however, come very close to actual plant figures with rotary filters. Agitation of the charging stock is done with the filter plate which is immersed into it with filtering face downwards. Washing is effected similarly without agitation. It can be made more effective by fitting a frame around the plate, turning the filtering face upwards after filtration and pouring the wash liquid into the frame from where it can not get away except through the cake. This also helps to avoid contamination of wash liquid with oil, but it is so different from actual operating conditions in plants, that no conclusions can be derived from such experiments. Washing by immersion in the described way is more effective than washing on rotating filter drums anyway and large scale results will be rather worse than better. Filtrate, which collects in large suction flasks, and wax cake are freed from solvent and weighed. For the desired filter cake thickness it is known what time in seconds was required for filtration, washing and drying. The filtration rate can therefore be readily computed:

$$F.R. = \frac{10000 \times (cake + oil)\ g \times 3600}{total\ seconds \times filter\ surface\ cm^2}\ kg/m^2h$$

The figures check fairly well with plant results on rotary filters. These laboratory experiments, which gave very valuable indications when the old benzene-SO_2 dewaxing plants were still being built, could be used later on few occasions only. They are still recommended if a cheap plant with rotary filters is designed for dewaxing oils of low paraffin content in which dewaxing costs must be reduced to a minimum and which may turn out inferior grade wax, and for the production of lower grade soft waxes in two stage filtration. The method is entirely unsuitable, however, if the production of oil free hard or soft paraffins is intended, and for the analytical separation of paraffins as described above, as well as for giving technical and chemical information for modern plants working with the new continuous band filters.

It is a modified Buechner funnel then, which gives conclusive results only, and the working technique with it proved that such an apparatus is also much simpler to operate, in spite of its greater accuracy. There is no need for an insulating wooden box and the charges to be examined can be much smaller. It is for filter rate determinations only that batches of a gallon are recommended. Fewer experiments are usually needed because the results are mostly very near an average and do not stray so much as with the immersed plate filter. The funnel is ordinarily covered with a glass plate which gives perfect vision and permits to watch all operations closely.

The Buchner funnel is jacketed. It is turned on the lathe from an aluminum casting, and has inside diameter of six inches and approximately 4 inches useful height. The part below the perforated filter plate need not be cooled but should be lagged. Base and jacketed top are connected by flanges. The flanges bear grooves to permit proper fitting of the perforated disk supporting a coarse mesh wire screen and the filter cloth. Buna rubber rings or other suitable



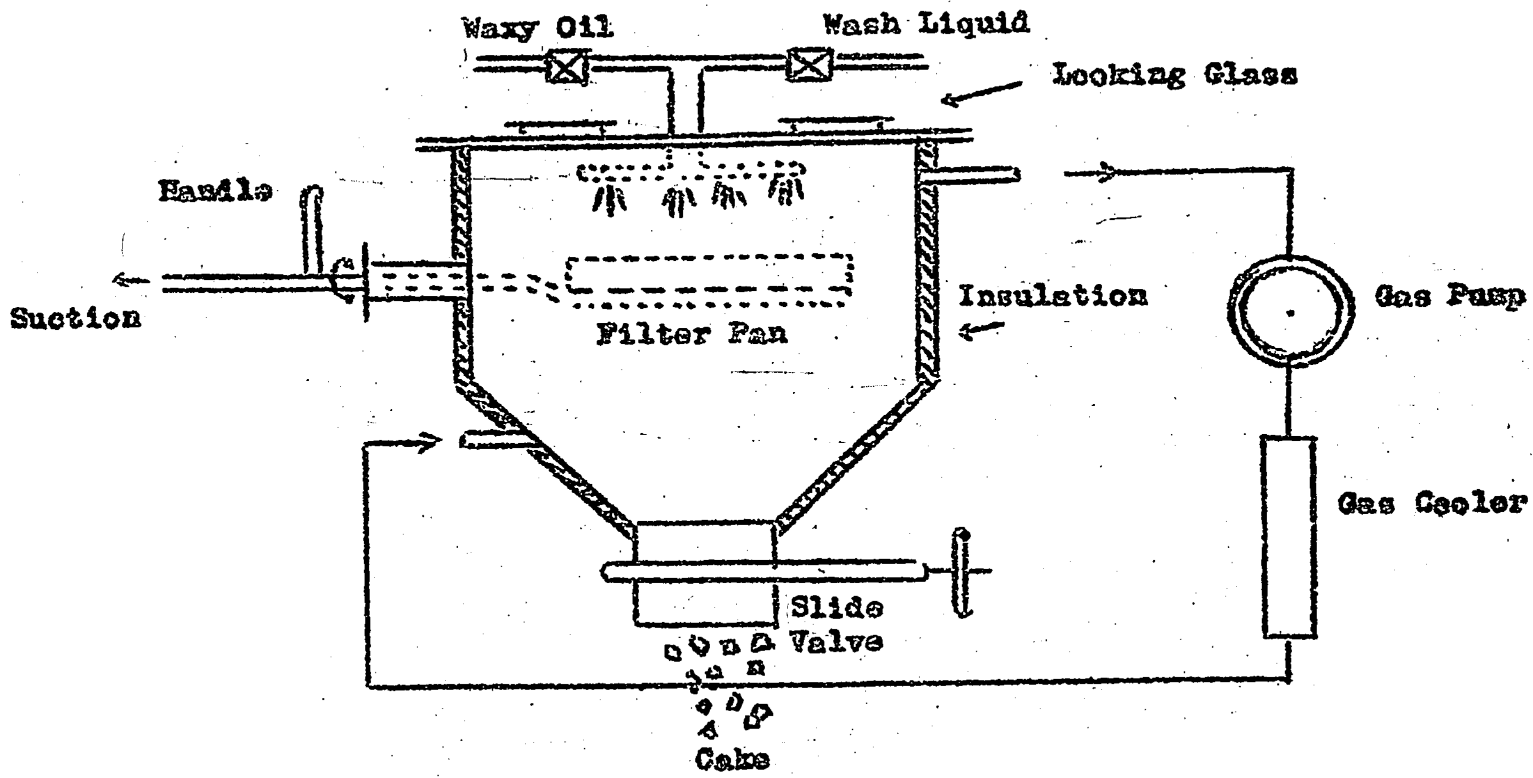
Thermometer
Baffle
To Relay and
Gear Pump
Gear Pump
Temp. Control
Stirrer
Air Lock
Filter
Vacuum Gauge
Suction
Suction Flask
Cooling Coil

gaskets seal the flanges, disk and filter cloth. A gear pump circulates the cooling liquid through the jacket and back to a thermostat controlled cold liquid container. It is this container which also serves to gradually chill the dewaxing mixture. ~~Compare picture on next page.~~

The temperature control acts upon a second gear pump that cycles dry ice cooled liquid through the cooling coils. The charging stock is in a vessel, surrounded by the cooling coils of the thermostat. It is advisable to pour it slowly on the filter by hand, it should not be poured directly upon the filter cloth but on a baffle plate rather which breaks the stream and especially in washing helps to maintain even and smooth surface. The temperature control in chilling is continuously set lower by gear and small motor. That motor is switched off when dewaxing temperature has been reached.

Although this filter gave satisfactory results it did not permit to produce larger quantities of products, which is frequently desired. A semi-technical filter was therefore built which in design was closer to the laboratory filter than to the plant apparatus. It worked discontinuously and consisted of one filter pan such as used in the technical band filter and mounted in a cold lagged pressure shell. The cake dropped to the tapered bottom of the shell if the pan was turned upside down by the handle.

A cooled gas cycle kept temperature within required limits. Filtration, followed by washing was hand-controlled and watched through the looking glasses. Removal of the wax cake through the bottom slide valve was facilitated by rinsing the cake down with clean solvent. The unit permitted to produce 15 - 30 kilos of oil free paraffin per day. Intermittent operation is in such small scale preferable to an expensive continuous midget band filter, which would be unreliable in operation mechanically and chemically.



Summary The main factors which control dewaxing have been discussed. It is only by observation of all of them, that oil free paraffin and low pouring oil can be produced in a single cycle with minimum effort.

Solvent It controls viscosity, specific gravity and therefore settling time of wax, crystal shape, phase equilibrium, solubility. This dominating influence calls for special attention in selecting the solvent. Only Binary mixtures meet all demands. The combination Dichloromethane - Dichloroethane offers great advantages because it combines most favourable physical data with chemical stability and gives plants outstanding flexibility.

Dilution Its influence upon phase equilibrium and viscosity reflects in filtration rate and product quality. The above named chlorinated solvents permit minimum dilution which cuts down treating costs and acts favourable upon pour points. Dilution and solvent blending ratio have to be individually adjusted because they depend on moleculer weight of wax bearing oil and on its chemical character. The percentage of wax in oil matters only with regard to viscosity of the slurry.

Chilling rate and temperature control the growth of crystals and the phase homogeneity. Very slow chilling offers no advantages. Dewaxing temperature shall be close to the phase separation but in the homogeneous field, which gives best pour points and good filtration velocity. Some oil is held by the crystals under those conditions by adsorption, not by phase separation. It can be removed by a final warm wash on the filters. That adsorption is minute with chlorinated solvents.

Filter cloth It has more influence upon successful dewaxing than it is generally believed. Its material may build up static electric charges which help to retain fine particles in filtration, in spite of larger openings between the meshes. The fabric shall have non fibrous smooth surface to release the cake easily. Obviously it must also have sufficient mechanical strength. Paper fabric can work excellently.

Type of filter Its influence is dominating. Filtration methods only are presently capable of producing perfectly oil free wax with least economic effort. The continuous Buchner funnel type filter permits exhaustive washing. No centrifuge or rotary type filter gives equally good results.

Several types of filters were discussed.

A new classification of paraffins was suggested which permits to roughly discern normal and iso-paraffins, cyclanes and hydroaromatics in commercial waxes. (Article II).

The crystal behaviour of waxes was studied with regard to solvent dewaxing. (Article III). Its influence on filtration rate was discussed. A new dyestuff method to find oil traces in wax was discussed.

Phase separation and dewaxing was the subject of Article IV. It was shown which conditions shall be chosen for successful solvent dewaxing.

The following Article VI will deal with a few details in plant design and discuss miscellaneous subjects in dewaxing research.