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Proposed Guide
for
MAINTENANCE OF TRANSFORMER ASKAREL

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PROPOSED GUIDE

for

MAINTENANCE OF TRANSFORMER ASKAREL

I INTRODUCTION

The term askarel generally describes a widely-used, broad class of non-flammable synthetic halogenated hydrocarbon insulating liquid. As treated in this Guide it applies solely to askarel used in transformers, reactors, and accessory equipment operated at power frequencies. Certain essential properties must be retained if askarel is to perform reliably its dual role of electrical insulation and heat-transfer agent.

It must have adequate dielectric strength to withstand the electric stresses imposed in service. It must retain a sufficiently low viscosity so that its ability to circulate and transfer heat is not impaired. The dielectric losses should not become excessive. It should not be allowed to become so deteriorated or contaminated that it adversely affects other materials in the apparatus.

This guide attempts to assist the power equipment operator in his efforts to maintain askarel in serviceable condition. It recommends standardized tests and evaluation procedures. Methods are outlined for reconditioning and reclaiming askarel whenever necessary.

II ECONOMIC FACTORS

In Section III of this Guide askarel is classified on the basis of significant characteristics. Many of the undesirable characteristics of used askarel can be corrected by reconditioning or reclaiming, if economic considerations justify it. The alternate choice is to replace with new askarel.

A review of the experiences of many users of electric equipment reveals a wide variation in the actual cost data involved in the reconditioning or reclaiming of askarel. This variation can be attributed to the amount and condition of askarel involved, laboratory and shop facilities, whether the work is performed at one central or several distant locations and the availability of qualified personnel.

Askarel that contains water and insoluble contaminants can be reconditioned by mechanical means using a conventional filter press. If soluble and/or colloidal contaminants are present in the askarel, reclaiming can be done with a special filter press that uses minerals such as activated clay, activated alumina or aluminum hydroxide. These processes can be operated at a cost of from 2 to 10 cents per gallon for reconditioning and at a higher range of costs for reclaiming, depending on the quantity involved and the facilities available.

To determine if reconditioning or reclaiming of askarel, where possible, is economically justifiable, a number of factors must be considered. Some of these factors are as follows:

1. Value of askarel being considered for processing
2. Cost of processing materials
3. Total cost of process *vs* quality of end-product
4. Equipment maintenance and amortization
5. Cost of collection and storage
6. Labor and transportation costs
7. Laboratory cost
8. Loss of askarel during reprocessing
9. Cost of scavengers and make-up chemicals if addition is necessary and desirable
10. Cost of disposing of processing material and scrap askarel.

III CLASSIFICATION OF USED ASKAREL

It is extremely difficult, if not impossible, to indicate the value of specific tests and recommended test limits for all possible existing applications of askarel. It should also be recognized that with the present state of knowledge no one test can be used as the sole criterion of condition of askarel. It is possible, however, to summarize the value and importance of current tests and to suggest methods of treatment for the askarel being examined, such methods being based on current industry experience. Askarel may be placed in the following classifications based upon composite evaluation of significant characteristics and on field and laboratory screening tests. (Refer to Section VII—*Testing Procedures*)

GROUP I

This group contains askarel which is in satisfactory condition for continued use.

GROUP II

This group contains askarel which requires only minor reconditioning for further service. (Reconditioning is the removal of moisture and insoluble contaminants. The usual method employed is dry paper filtration.) (Refer to Section VIII—*Methods of Reconditioning and Reclaiming Used Askarel*)

GROUP III

This group contains askarel in poor condition. It should be reclaimed or discarded depending upon economic considerations. (Reclamation involves the use of methods and processes which result in a beneficial chemical change in the askarel. Possible means employed are treatments

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with adsorption agents, aqueous extraction or washing procedures, alkali treatments, etc.) (Refer to Section VIII—*Methods of Reconditioning and Reclaiming Used Askarel*)

GROUP IV

This group contains askarel in such poor condition and requiring such drastic treatment that it is not feasible either technically or economically to attempt reclamation. An example of such a condition would be excessive oil contamination of an askarel.

IV ASTM ASKAREL TESTS AND THEIR SIGNIFICANCE

There are a number of tests than can be applied to transformer askarel as a basis for their classification as indicated in the foregoing. It is recommended wherever possible that tests be the latest revisions accepted as standards or tentative standards by ASTM. These tests and their significance are as follows:—

Test	ASTM Designation
1. Dielectric Strength	D 901, D 877
2. Free Chlorides	D 901
3. Neutralization Number	D 901, D 974, D 664
4. Viscosity	D 901, D 88, D 445
5. Pour Point	D 901, D 97
6. Volume of Oil (percent)	D 901
7. Fire Point	D 901, D 92
8. Specific Gravity	D 901
9. Refractive Index	D 901
10. Color	D 901, D 155
11. Power Factor	D 901, D 924, D 150
12. Dielectric Constant	D 901, D 924, D 150

1. Dielectric Strength—D 901 and D 877

The dielectric strength of an askarel is the average voltage gradient at which electric failure or breakdown occurs under prescribed conditions. This test is made to determine whether an askarel has adequate electrical strength and may, in certain instances, reveal the presence of deleterious contaminants but is not necessarily an indication of its other properties.

2. *Free Chlorides—D 901

Askarel may contain free chlorides as a result of imperfect refining or contamination from other sources. Such free chlorides are undesirable because of their possible corrosive action or other deleterious effects in the presence of moisture. Aside from extraneous contamination, free chlorides may also result when the material is subjected to an electric arc or heated above a limiting temperature of 200C if the askarel does not contain a scavenger. This test indicates the presence of these free chlorides.

*The wording of the current D 901 pertaining to free chlorides requires revision in order to recognize the general industry usage of scavanger agents.

3. Neutralization Number—D 901, D 974, and D 664

Neutralization number for used askarel is, in general, a measure of their acidic constituents and is measured as the milligrams of potassium hydroxide required to neutralize one gram of askarel under prescribed conditions. Askarel, unlike insulating oil, does not oxidize even under severe service conditions. Consequently, this test will indicate an acid condition obtained either by electric arcing or by contamination from other materials or sources.

4. Viscosity—D 901, D 88, and D 445

The viscosity of an askarel is its resistance to uniformly continuous flow, without turbulence, inertia, or other forces, and is usually determined by measuring the time of flow of a given quantity of the liquid, at a given temperature (37.8C (100F) unless otherwise specified), under controlled conditions. Viscosity is an intrinsic property of askarel dependent upon basic chemical composition and type. Under certain conditions, significant changes in viscosity of askarel in service may indicate evaporative losses of volatile components or contamination from other sources (i.e. mineral oils, sealing compounds).

5. Pour Point—D 901 and D 97

The pour point of an askarel is that temperature at which the liquid just flows under prescribed conditions. The pour point has little significance with respect to minor contamination or deterioration but may be useful for type identification.

6. Volume of Oil in Askarel—D 901

This method covers a procedure for the determination of the percentage, by volume, of oil in askarel. In evaluating used askarel, this test has considerable significance in maintaining prescribed nonflammability characteristics where oil contamination has been indicated by other test procedures.

7. Fire Point—D 901 and D 92

The fire point of a material is that temperature to which the material must be heated in order to support combustion when exposed to the atmosphere under prescribed conditions. Askarel, as such, has no fire point. The test is only of value, therefore, in showing whether the material has the non-flammable characteristics required of an askarel or has a large amount of combustible contaminant.

8. Specific Gravity—D 901

The specific gravity of an askarel is the ratio of the weights of equal volumes of askarel and water at 15.56C (60F). Specific gravity may be useful for type identification or to determine marked compositional changes.

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9. Refractive Index—D 901

The refractive index of an askarel, in common with all light-transmitting substances, may be defined as the ratio of the velocity of light in a vacuum to its velocity in the substance, under prescribed conditions. The refractive index of an askarel varies with its composition, and with the nature and amount of contaminants held in solution. Changes in refractive index on askarels in service may be useful in estimating compositional change and degree of soluble contamination.

10. Color D 901 and D 155

The color of an askarel is determined by transmitted light and is expressed by a numerical value based on comparison with a series of color standards under prescribed conditions. Color is chiefly significant as an indicator of soluble contamination in askarel. However, color in itself has limited value as a measure of serviceability since it may or may not correlate with physical and electrical characteristics of the liquid.

11. Power Factor—D 901, D 924 and D 150

Power factor is the ratio of the power dissipated in the askarel in watts to the product of the effective voltage and current in volt-amperes, when tested with a sinusoidal field under prescribed conditions. Since askarel is not subject to oxidation, an increase of power factor value of the askarel in service may be attributed to the presence of moisture or other contaminants. Depending upon type of apparatus and application, high power factor due to contamination other than by moisture seldom impairs the serviceability of the askarel, however, the high power factor may result in excessive heating of the device in which it is used.

12. Dielectric Constant—D 901, D 924 and D 150

The dielectric constant of an askarel is a measure of its relative ability to store electrostatic energy. It may be useful as an indication of composition and purity of an askarel.

V OTHER CRITERIA WHICH MAY BE HELPFUL IN EVALUATING THE QUALITY OF ASKAREL IN SERVICE

1. Visual Condition

This test indicates the presence of free water and sediment such as metal particles, carbon, dirt, solid insulation fragments, etc. Askarels containing metallo-organic hydrogen chloride scavengers may show some precipitation of the scavenger at low temperatures because of limited solubility. Under normal operating conditions, such material readily and rapidly redissolves and does not impair serviceability. One method of visually examining an askarel sample is to observe a representative sample in a clear glass tube or bottle. If the askarel by visual examination is clear, then the appropriate tests should be applied to classify the askarel in the proper group as initially defined above. If insoluble contaminants are present, valuable information may be obtained by filtering the askarel and identifying the residue. The askarel filtrate should be examined and classified in the same manner as a clear askarel sample.

A method for visual condition is currently under investigation by ASTM.

2. Water

Water may be present in several forms. The presence of free water may be disclosed by visual examination in the form of an immiscible layer, separated droplets or a cloud dispersed throughout the askarel. This type of water invariably results in decreased dielectric strength which may be restored by filtration or other suitable means. It is significant to note that free water, less dense than askarel, will separate at the top surface of the askarel. Water in solution cannot be detected visually and is normally determined by either physical or chemical means. One method under ASTM consideration is the Karl Fischer reagent method.

3. Askarel Insoluble Matter

Occasionally samples taken from equipment in service will show insoluble matter which might be composed of many types of material, i.e., fibers, dirt, water, carbon, insulating materials, etc. Under certain circumstances, it may be desirable to subject such residues to laboratory analysis.

4. Hydrogen Chloride Scavengers

Suitable quantitative methods for the estimation of the commonly used scavenger agents are available and at present are under consideration by ASTM.

5. Resistivity

The resistivity of askarel is a measure of its electrical insulating properties under prescribed conditions of test. High resistivity reflects low content of free ions and ion forming particles and normally indicates a low concentration of conductive contaminants.

VI SAMPLING

The sampling of askarel is important from the standpoint of evaluating quality. Particular care must be taken to prevent samples of askarel from coming in contact with moisture or other materials which may contaminate it. It is important that the procedures and the precautions outlined in the latest revision of ASTM Designation D 901 pertaining to the sampling of askarel be followed.

VII TESTING PROCEDURES

The procedures for testing askarel are quite

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similar to those for testing mineral oil and they depend to some extent on the testing equipment available. Most users of askarel find that testing is accomplished best in adequately-equipped laboratories. However, some users of transformers find it desirable to make "Field Screening Tests." Unlike mineral oil, askarel does not oxidize; consequently, sludge tests are unnecessary. Standard methods for testing askrael have been assembled by the ASTM Designation D 901.

(A) Field Screening

Field screening tests are usually made to determine which samples of askarel may require laboratory investigation. Since most tests of askarel can be done best with laboratory equipment and trained personnel, field tests are usually limited to visual inspection and dielectric strength.

No standardized procedure is available at the present time, for performing field tests on used askarel nor for classification.* Portable dielectric test sets have been available for some time and have proved satisfactory. Visual condition is at present a matter of personal opinion when the liquid is viewed in a glass container. (See Section V). In addition to the above tests, some operators with suitable field equipment and trained personnel may wish to gain additional information by use of a power factor test. In interpreting results of these tests consideration must be given to other characteristics of the askarel under test.

(B) Laboratory Screening

Askarel requiring laboratory evaluation will vary widely in condition depending upon the degree of contamination. There are many tests of a research nature which could be applied, but the general use of such tests would be impractical. The following tests, therefore, are believed to be adequate for classifying used askarel and when used should be performed in the order indicated.

Visual Condition
Water Content
Dielectric Strength
Free Chlorides
Power Factor or Resistivity
Neutralization Number
Volume of Oil (percent)

VIII METHODS OF RECONDITIONING AND RECLAIMING USED ASKAREL

A. GENERAL

Askarel can be reconditioned and reclaimed and restored to good operating condition in many instances. Since askarel does not oxidize the problem resolves itself to the removal of free moisture and other insoluble particles (reconditioning) and to the removal of certain soluble or colloidal contaminants such as varnishes, gums, resins, certain plastics, rubber-like materials, etc. (reclamation) with which the askarel may have come in contact. In addition askarel which has been exposed to temperatures in excess of 200C or to an electric arc will liberate hydrogen chloride gas and carbon. Special treatment is required for askarel which has been thus exposed.

There is no practical method of removing insulating oil from askarel. Askarel contaminated with oil sufficiently to affect its non-flammable characteristics must be discarded.

Only metallic hoses should be used in the handling of askarel since rubber and rubber-like compounds are attacked by it resulting in contamination of the askarel as well as deterioration of the hose. When recirculation methods are used the askarel should be taken near the top of the tank and returned at the bottom since free water and most of the sediment are found near the top surface of the askarel. Since such a procedure can introduce air into the askarel, sufficient time (two hours or more) should be allowed for the air to escape before reenergizing the apparatus. It is suggested that further detail be obtained from the manufacturer of the apparatus when desired. Considerable savings can frequently be realized in processing used askarel if it is allowed to remain in its container undisturbed for at least 24 hours so that water and suspended solids can separate from the askarel. Because of the ease with which askarel can be contaminated by insulating oil, reconditioning or reclaiming equipment should be reserved solely for use with askarel.

B. TREATMENT AFTER EXPOSURE TO HIGH TEMPERATURE OR AN ELECTRIC ARC

When askarel has been exposed to an electric arc or high temperature, dry nitrogen should be bubbled through the askarel for four to six hours. Approximately 220 cubic feet of nitrogen should be used for each 100 gallons of askarel. The treatment should be started as soon as practical as any hydrogen chloride liberated in combination with moisture will quickly attack exposed materials in contact with the askarel. This procedure is recommended even though the askarel contains a hydrogen chloride scavenger.

The nitrogen should be admitted at the bottom of the tank or container and the container should only be vented sufficiently to allow the nitrogen to escape in order to prevent the entrance of moisture and the formation of hydrochloric acid. Except while treating with nitrogen, the tank or container should be kept sealed, to prevent the entrance of moisture, until the askarel is removed.

When askarel has been subjected to arcing or high temperature, samples should be promptly taken and tested for color, free chlorides, neutralization number and visual condition. A laboratory check following recommended reclamation meth-

*To be determined by industry questinnaire.

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ods on a relatively small quantity of the askarel will indicate whether it is practical to reclaim it.

C. RECONDITIONING OF ASKAREL

The reconditioning of askarel, that is, the removal of water and other insoluble contaminants may be accomplished with a conventional filter press.

Filter presses vary somewhat in form, but are based upon the principle of forcing askarel under pressure through a series of absorbing materials such as paper. Filters of this type are capable of removing carbon, water, and other solid particles when they are in suspension but paper alone cannot remove them effectively when they are dissolved or in colloidal form. These devices will not remove air but in fact tend to aerate the askarel.

The water-removing ability of the filter press is dependent upon the dryness of the filter papers, and consequently ovens must be provided to dry the paper before use. When filtering askarel containing water the filter papers rapidly come into equilibrium with the water content of the askarel and from that time on the filtered askarel may contain water up to 100 percent of saturation at the temperature at which the filtering is done. Since the amount of dissolved water at saturation increases markedly with increasing temperature, filtering at low temperature is more effective in removing water. However, the temperature should not be so low that any hydrogen chloride scavenger present is precipitated out of solution.

The necessity of changing the filter papers is usually determined by an inspection of papers, an increase in input pressure, a lowering in the dielectric strength or a rise in water content of the filtered askarel.

D. RECLAIMING OF ASKAREL

Methods of reclaiming askarel to remove soluble or colloidal contaminants involve the use of materials such as activated clay, activated alumina, or aluminum hydroxide. While gravity or pressure percolation through activated clay has been used to some extent for reclaiming askarel, most askarel has been reclaimed using special filter presses in combination with activated clay. Figure 1 shows one such device in which a mixing tank is provided and a larger space is incorporated in the frames between sections of filter papers. About one fourth of the clay required to charge the press is mixed with a relatively small quantity of askarel in the mixing tank and the filter then operated to recirculate the askarel and thus deposit a cake of clay on the surface of the paper. Additional clay and askarel are mixed and recirculated until the desired cake has been established. The filter press is then ready to be used for reclaiming the askarel.

The arrangement shown in Figure 2 is similar except that the full charge of clay is placed in the auxiliary tank and the askarel is forced up through it. The askarel then passes through a wire screen prior to entering the filter press to remove practically all the clay. A relatively small quantity of askarel is used to fill the tank and wet the clay before the unit is ready to use.

Periodic tests on the output of these devices for the characteristic being improved will determine the necessity for changing the filter press papers or recharging with clay. The clay must be thoroughly dried before being used and temperatures ranging from 180C to 300C are recommended. Excessive amounts of clay and a high reclaiming temperature should be avoided since the use of large amounts of highly-active clay at high temperature would be expected to selectively absorb scavengers or stabilizers which the askarel may contain. Amounts of clay up to 0.1 percent by weight of the askarel treated and temperatures up to 60C will have no appreciable effect on the scavenger content.

To judge the sufficiency of reclamation, samples should be tested for color, free chlorides, neutralization number, dielectric strength, water content and power factor or resistivity. After the askarel has been reclaimed it is advisable to test for unreacted and reacted scavenger content in order to determine if scavenger should be added.

Much of the askarel left in the reclaimer can be saved by passing clean dry compressed air or dry nitrogen through the device at the end of the reclaiming operation.

IX ADDITION OF SCAVENGERS

As previously stated askarel which has been exposed to temperatures in excess of 200C or to an electric arc will liberate hydrogen chloride gas some of which dissolves. In order to minimize the effect of soluble hydrogen chloride on apparatus materials, askarel usually contains a small percentage of a certain chemical commonly called a "scavenger" or "getter," to mitigate the effects of the hydrogen chloride. Various manufacturers use different chemicals for this purpose, tin tetraphenyl and phenoxypropene oxide being the most common. Most askarel currently in use contains scavengers, however, there may be cases where the scavenger was not originally included or requires replacement.

Tin tetraphenyl is a white crystalline compound melting at 227C. Phenoxypropene oxide is a colorless liquid at ordinary temperatures. Small concentrations can effectively minimize the damage to apparatus parts which might be caused by the formation of hydrogen chloride. Concentrations on the order of 0.1 percent to 0.2 percent are ordinarily used. These scavengers have good dielectric properties, are nonvolatile and introduce no abnormal fire or explosion hazard.

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Before any scavenger is added to an askarel the manufacturer of the apparatus in which the askarel will be used should be consulted as to the amounts and method of addition. It is extremely important that the scavenger be of approved purity and that it be added in the recommended procedure. In general the scavenger is mixed with a small quantity of the askarel and then poured in the top of the apparatus. Extreme care must be taken to see that any containers, funnels, etc., (used) are clean, dry, and made of materials unaffected by the askarel.

X SPECIAL CONSIDERATIONS

A. Askarel Used Under Light Arcing Condition

Askarel is used, to some extent, in apparatus where it is subjected to light intermittent arcing such as in self-contained induction regulators, where operating switches are continually producing slight arcs, in transformer deenergizing switches etc. Under normal operating conditions deterioration of the askarel is very slight. However, improperly adjusted or defective switches in this type of apparatus can produce excessive and prolonged arcing with accelerated deterioration of the askarel. It is recommended that when askarel is used under these conditions checks of the liquid condition in conformance with manufacturers recommendations be made more frequently than when it is used only as a cooling and insulating fluid. Deterioration of this type is indicated by a blackening of the liquid. It can be reconditioned as previously described. Special attention should be given to maintaining the scavenger at the appropriate level.

B. Hazards

(a) Askarel Under Fault Conditions or Excessive Temperature

When askarel is subjected either to temperatures in excess of 200C or to an electric arc it distintegrates and hydrogen chloride gas is formed. During this disintegration process, portions of the liquid change into a gaseous state and abnormal pressures develop. Consequently it is recommended that, wherever possible, sealed askarel filled equipment be provided with pressure-relief devices. These devices must be large enough to provide immediate relief at a definite pressure and to prevent further build-up of pressure if decomposition continues. It must be remembered that the presence of devices of this sort does not necessarily preclude the rupturing of containing vessels since pressure build-up can be extremely rapid under violent arcing conditions.

Askarel in the uncontaminated state is, of course, non-flammable as is the hydrogen chloride gas that is generated during decomposition. However, if the askarel becomes contaminated with petroleum products flammable mixtures may result. Under these conditions secondary fires may result if relief devices or containing vessels rupture during fault. Consequently some thought should be given to location of askarel-filled equipment in order to minimize the hazard to person and property.

C. Personnel

It is generally accepted that exposure to askarel is not hazardous provided simple precautions are taken. Most people can handle askarel in the same manner as insulating oil without fear of toxic effects. As with insulating oil, some people are allergic to askarel and continued exposure may result in skin irritation, therefore, direct contact should be avoided where possible. Avoiding unnecessary contact with askarel and its vapor, particularly when it is hot, and cleanliness of workmen handling it should constitute adequate safeguards against such effects. Medicinal washes or detergents followed by an application of cold cream have been successfully used to eliminate irritation resulting from askarel coming into contact with an open cut or skin abrasion. A drop of castor oil has been found to neutralize, in most cases, irritation caused by contact of askarel with the eyes. It is recommended that small quantities of cold cream, castor oil, soap and clean water be readily available when askarel is being handled. There is no evidence that ordinary exposure to askarel vapors results in any ill effects. However, like other volatile materials, exposure to concentrated askarel vapors should be avoided, particularly in closed, unventilated rooms. As with many volatile liquids, the vaporization of askarel increases rapidly with temperature. Therefore, ventilation which is adequate for handling askarel at room temperature may not be adequate for handling askarel at elevated temperatures. The gases produced when askarel is disintegrated by very high temperatures or an electric arc in the presence of air or organic insulating materials contain a high percentage of hydrogen chloride and small percentages of carbon dioxide, carbon monoxide, oxygen and in some cases phosgene. Very small concentrations of this combination of gases are very unpleasant and irritating, thus giving ample warning of their presence. The all-purpose gas masks available for use around oil-filled devices are also used for protection from gases liberated from disintegrated askarel. Individual uses may require more detailed precautions in order to conform to local safety requirements pertaining to the specific operating conditions involved.

D. Storage and Handling of Askarel

Transformer askarel is a fluid and can be handled in much the same manner as transformer oil. Since askarel is somewhat more susceptible to contamination by moisture than transformer oil

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and also acts as a solvent on a large number of materials, considerable care must be exercised in its handling. The following general rules should be observed.

1. All necessary steps should be taken to maintain the askarel in a dry clean condition. This involves proper sealing, dryness and cleanliness of all storage containers and handling equipment.

2. Since askarel is a powerful solvent, care should be taken in the selection of materials to be used in contact with it. For example, consideration should be given to such things as the nature and compatibility of gasket materials, pipe-sealing compounds, container and tank linings (such as paints, varnishes, etc.) valve and pump packings and lubricants, the cleanliness and prior service of containers, storage tanks and transport lines. Only metal hoses should be used in handling since rubber and rubber-like compounds are attacked by askarel. It is important to avoid contamination of askarel with mineral oil and similar soluble organic materials. Therefore, handling equipment should be reserved solely for their use.

3. In general, care should be employed in the handling and processing of askarel to maintain it at or near room temperature to prevent undue volatilization of certain compounds and minimize removal of special scavenger additives due to solubility limitations or absorption on treating clays and to assure the most efficient removal of moisture by filtration or other means. All necessary precautions should be taken to provide adequate ventilation and other protective measures to properly protect those working with these materials.

4. Askarel weighs approximately twice as much as transformer oil, consequently thought should be given to size and structure of containing vessels.

5. More detailed information on various phases of these subjects, as generally treated above, is available in manufacturers' instructive pamphlets. These publications should be freely consulted when askarel-filled transformers are used.

E. Underwriters' Laboratories Reports

The Underwriters' Laboratories have exhaustively examined at the electrical manufacturers request the miscellaneous hazards involved in the use of askarel and askarel-filled apparatus. Reports have been issued to the respective manufacturer covering the tradenamed askarel being considered. It is suggested that interested users of transformer askarel contact the manufacturers for this information.

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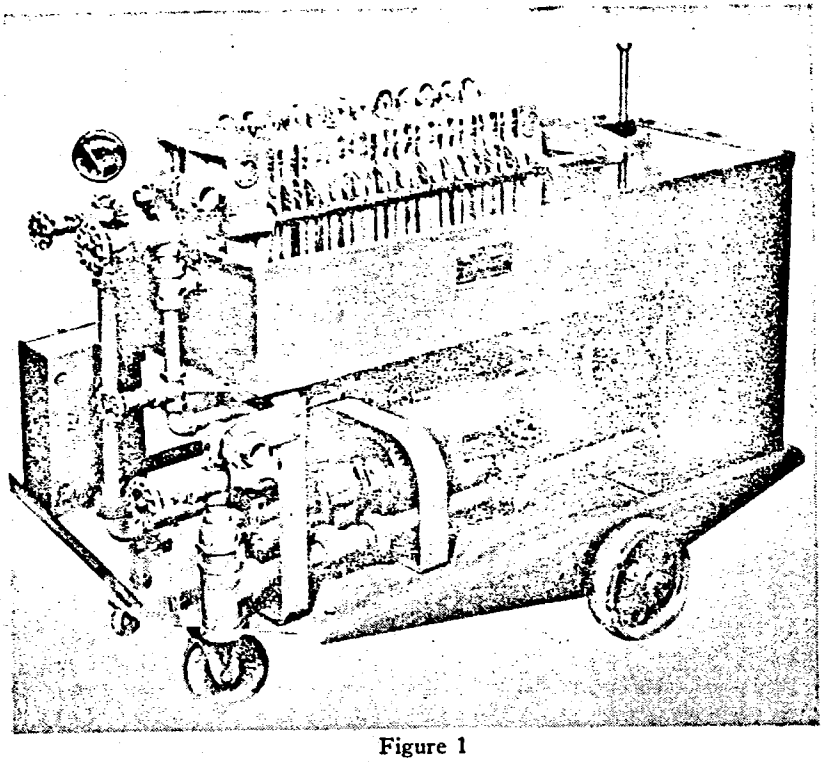


Figure 1
Askarel Filter Press

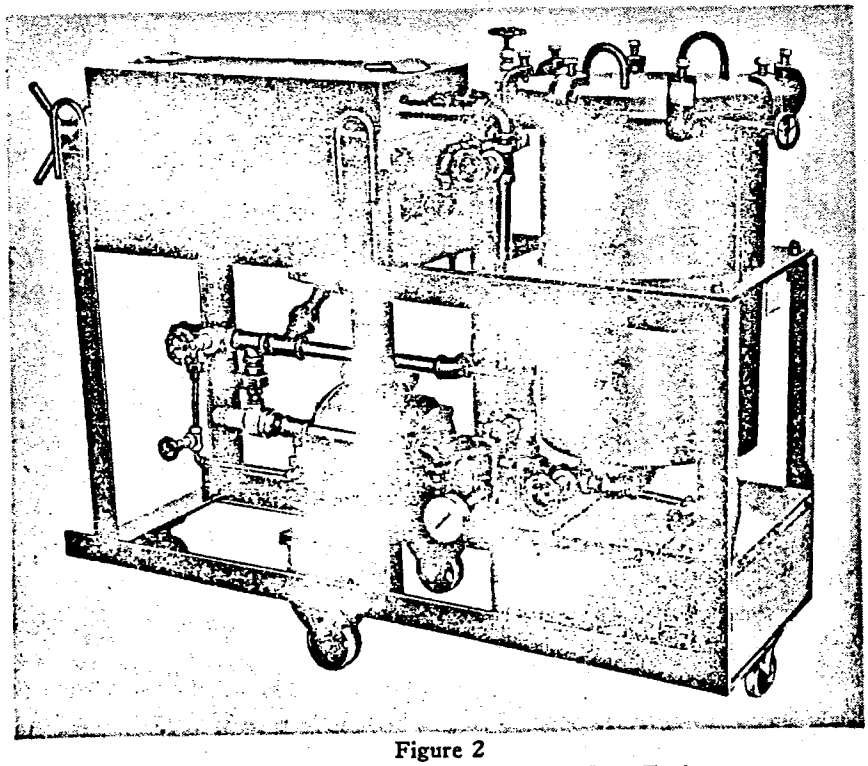


Figure 2
Askarel Filter Press with Auxiliary Clay Tank

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