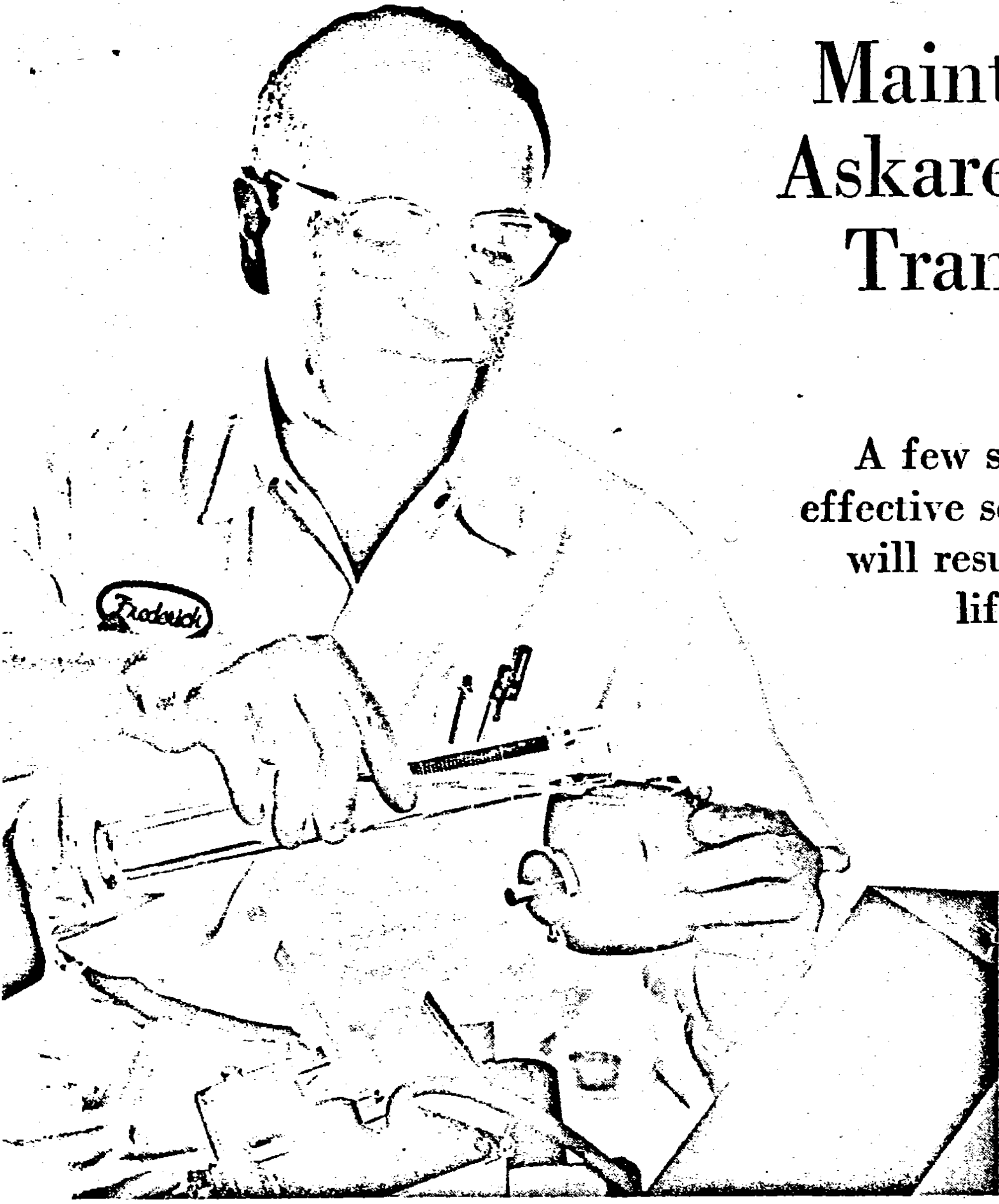

Maintenance of Askarel-Insulated Transformers

A few simple precautions plus effective sealing against moisture will result in almost indefinite life and effectiveness for askarel and the equipment it insulates.

Clean, dry askarels have excellent dielectric strength ranging from 35 kv to 45 kv as measured with an 0.1″ gap at 25°C.

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The Author . . .

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ASKAREL INSULATING FLUID, besides having an electrical breakdown strength higher than petroleum-based oils, is one of the most inert, chemically stable, heat-resistant, noncorrosive liquids in common use. It is fireproof and will not oxidize or sludge and has good heat-transfer properties. Askarel remains perfectly stable unless broken down by exposure to arcing. Arc-formed gas is not combustible but amount of gas formed by a strong, presistant arc may result in excessive pressure within a tank. Many askarel-insulated transformers are fitted with pressure-relief devices for this reason.

Commonly-used transformer askarels are mixtures of chlorinated biphenyl and chlorinated benzene. A small amount of hydrogen chloride scavenger is added to the fluid to protect the transformer insulation in event of arcing. Only two formulations are used regardless of trade names under which they are marketed by various transformer manufacturers. These two formulas are fully compatible with each other and can be used interchangeably or mixed without difficulty or adverse effects.

The main enemy of askarel is water. If water gets into the transformer tank only a small portion (125 ppm) can dissolve

Table I

TYPICAL VALUES FOUND IN ASKAREL FLUID UNDER VARIOUS CONDITIONS OF USE

	A	B	C	D	E	F
	New askarel	Askarel in properly* built new or rebuilt units prior to use.	After normal operation; a survey of 50 units, most 2-5 yrs. old; some 10.	Non-arced but slightly contaminated askarel in improperly* built units, new or slightly used.	Same askarel as in Column D—after refining.	Heavily arced askarel due to neglect and internal electrical malfunction.
Inspection Check Points						
Color	Light straw	Light straw	Light straw	Can have foreign shades, blue, green, red cast.	Foreign shades remain showing extraction of oil soluble color.	Black
Clarity	Clear, free from particles	Clear, practically free from particles	Clear, trace of particles	Clear, slight amount of particles	Clear, free from particles	Contains carbon particles
Moisture 25°C.	30 ppm	30 ppm	10-70 ppm all dissolved water	20-100 ppm all dissolved water	30 ppm	Near 125 ppm saturation level —plus possible undissolved water
Dielectric Strength 25°C., 0.1″ gap	35 KV minimum	35-48 KV	35-45 KV	30-42 KV	40-45 KV	5-15 KV
Volume Resistivity 100°C., 500 Volts, DC., 0.1″ gap	100 x 10^9 ohm-cm. minimum usually 500-1500	40 x 10^9 ohm-cm. minimum usually at least 100 x 10^9	15-400 x 10^9 ohm-cm.	about 5 x 10^9 ohm-cm.	at least 1500 x 10^9 ohm-cm.	about 3 x 10^9 ohm-cm.
Power Factor:						
100°C. 60 cy.	2-5%	10-25%	10 to near	30 to 100%	2-5%	100%
25°C. 60 cy.	0.05-0.1%	0.5-2%	80% 0.5 to near 10%	about 7 to over 15%	0.1-0.2%	at least 25%

*A properly built transformer is defined as one in which the materials of construction are electrically compatible with askarel.

in the fluid. The rest floats on the top where it can cause trouble. Dielectric strength of askeral drops rapidly as concentration of moisture approaches its saturation point. However, moisture-laden askarel can be restored to its original quality by passing it through dry blotting paper in a filter press.

Severe arcing also reduces dielectric strength of askarels by breaking them down. The fluid turns black due to particles of carbon. It is not economical to reclaim heavily arced askerel and it should be discarded.

Table I shows typical conditions of askarels after various usage.

Only Simple Tests Required to Determine Condition

Any askarel that passes visual inspection and the usual dielectric-strength test can be considered adequate for continued use. It is generally considered good practice to check transformer askarel every six or nine months for clarity and color and to make a breakdown-strength test. Samples should always be taken from top of the liquid rather than from the bottom as is the case with transformer oil as water is lighter than askarel and floats on its surface. These simple checks should be supported by the usual periodic resistivity and power-factor tests on overall transformer insulation.

New askarel has a minimum dielectric strength of 35 kv and maximum moisture content of 30 ppm. If periodic dielectric-strength tests indicate a downward trend or if value has fallen to 22 kv or below as determined by ASTM test D877, moisture content should be determined using Karl Fischer method (ASTM D1533). If moisture content has increased to 70 or 80 ppm, the askarel should be dried using a filter press.

New askarel is clear and light straw in color. It normally darkens somewhat after long use. But

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there is a distinct difference between this darkening and the black color that results when askarel has been arced heavily. In addition, arced askarel contains carbon particles that can be seen in the fluid. Dielectric-breakdown tests and observations of color are adequate tests for such conditions.

Arced askarel should never be reused. After the transformer has been drained, the system should be inspected for evidence of moisture (rusting) and for mechanical defects. The transformer manufacturer should be consulted about any unusual conditions that are found. It will be necessary to clean the unit thoroughly. Usually this is done with a soft nylon-bristle brush using new askarel as the cleaning fluid. After the transformer has been cleaned and repaired, it should be flushed and filled with new askarel.

Quite a different condition is revealed if the askarel turns red, blue, or green. This indicates contamination from construction materials such as from certain types of gaskets, pressboard, core bindings, coatings, or adhesives not compatible with the insulating fluid. Such solutions usually lower resistivity and increase power factor of the askarel. While such conditions are not known to have an adverse effect on dielectric strength of the askarel itself, they should be reported to the transformer manufacturer.

Reconditioning Askarel

Moisture and undissolved solids can be removed effectively from askarel by filtering through dry blotter paper in a filter press. Most operators prefer portable presses that can be taken directly to the job.

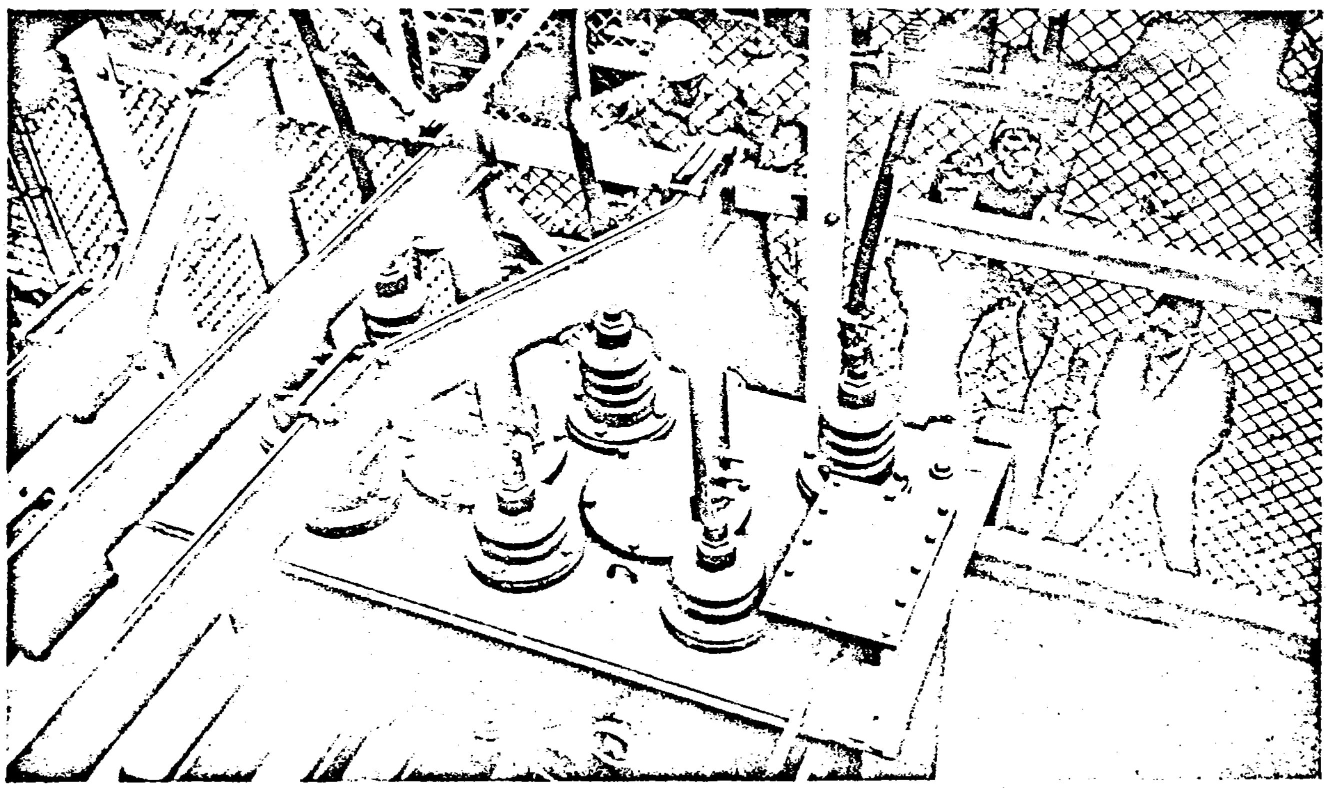
The filter paper must be thoroughly dried immediately before use. For best results the paper must be spread for maximum surface exposure in an oven in which hot air is circulated at 110°C for six to eight hours.

The transformer should be kept under moderate load until just before filtering the askarel. This will keep the fluid and coils above atmospheric temperature to prevent condensation of moisture from the air. Askarel should not be filtered when relative humidity is 75% or higher. Fluid temperature of 55° to 60°C is ideal for filtering because at this range the paper is most effective in picking up moisture and there will not be excessive evaporation of askarel.

Processing should start immediately after de-energizing the transformer., Askarel should be drawn from near top of the liquid level, passed through the filter, and fed back through the bottom transformer outlet. Half a dozen passes through dry blotter paper will reduce amount of water in askarel as high as 120 ppm to 10 ppm. Dielectric breakdown strength will increase as moisture is removed. Filtering should be continued until a value of 35 kv or higher is attained.

Power-factor tests on askarel fluid have no particular significance in revealing its insulation value. Power factors of askarels vary widely from values of 2% to as much as 100% at 100°C and 60 cycles. Use history indicates that askarel power factors will normally be much higher than power factors of mineral oils with no adverse effects so long as breakdown strength remains high.

Power factor and volume resistivity of reclaimable askarel can be further improved after filtration by treatment with conditioned attapulgus clay or Fuller's earth. The clay or earth should be dried



Askarel-insulated transformers require little attention except to keep moisture from entering case.

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and activated by heating for 12 hours in a shallow steel tray at 300° to 350°F immediately prior to use. Amount of earth to be used should be from 0.1 to 0.2% by weight of askarel. Askarel weighs about 13 pounds per gallon.

The earth must be deposited evenly throughout the filter. This can be done by dividing the earth into thirds. Each third, in turn, should be mixed with a small quantity of clean askarel in a clean container and the mixture pumped through the filter. Hot askarel (but not over 55°-60°C) should be passed through the earth-coated filter and recirculated until the fluid is clear and tests show that electrical properties are fully restored.

Only insignificant loss of scavengers in askarels occurs when the fluid is refined by normal treatment with 0.1 to 0.2% by weight of earth.

Installing a container of anhydrous alumina or activated clay in the transformer circulating system is another method of reducing power factor and of increasing resistivity of askarels. However, this method is seldom used as these factors are not generally considered important for askarel transformers.

Preventive Maintenance

Adequate seals against entrance of moisture are the prime safeguards against deterioration of askarel. Modern askarel transformers accomplish this with welded construction wherever possible. Modern practice also includes silicone or Viton gaskets properly applied in grooves or held by concentric steel rings or stops as seals for hand-hole, switch, and terminal-compartment covers.

These modern sealing arrangements should be specified if maximum trouble-free operation is to be obtained. However, it is possible to improve sealing of many transformers not completely modernized.

Silicone gaskets as original equipment or for replacement purposes should be from 5/16 inch to 1/2 inch thick and generally rectangular in cross-section. Dow-Corning No. 50 Silastic or equivalent low-compression-set material is not deteriorated by askarel fluid or vapor. It resists weathering, and is thermally stable and flexible at all operating temperatures. No cement is required and a gasket made of this material can be removed with ease and reused. Ample room should be allowed in the groove for the 20 to 25% compression that should be allowed. Silicone swells slightly in the presence of askarel which contributes to tightness of the seal.

When not possible to weld small-size connections such as bushing or radiator flanges, instrument connections, etc., effective seals can be made with Flexitallic stainless-steel rings. Surfaces must be machined and parallel. Filler between stainless laminations of the concentric rings should be either silicone or Viton.

It is equally important to provide effective bushing seals. One satisfactory type is made with rolled-on flanges and two ring seals rolled into a depression in the porcelain. The bushings should be sealed with silicone rings held under compression. Metal-to-glass or metal-to-porcelain sealed bushings are also very satisfactory.

If for any reason the preceding bushings cannot be used, a porcelain or glass bushing with a silicone or Viton gasket retained in a groove makes an adequate substitute. The gasket can be either rectangular or circular in cross-section and usually is ¼ inch to ⅜ inch thick.

Improving Older Transformers

It is possible to improve operation of even considerably older askarel transformers. Many askarel units installed in the early 1930's used cork-nitrile rubber combinations or straight nitrile rubber for sealing main tank covers, handholes, switch and terminal chambers, relief diaphragms, etc. Leaky or deteriorated gaskets on such older units should be replaced and the units made moisture tight. Where straight nitrile rubber gaskets were used, it is probable that grooves were provided to retain the nitrile rubber to protect it against excessive compression and to minimize contact with askarel. It is easy to replace such gaskets with silicone or Viton seals.

It is not possible to use silicone or Viton gaskets if the transformer is equipped with flat flanges and the usual bolting. Holes are required in gasket material to fit over these flange bolts or studs. Replacement gaskets in these cases will probably have to be a cork-nitrile combination type such as Armstrong Cork Co. NC 757 or equivalent. This gasket can be cut from a single sheet or can be made up by scarfing strips of the material and joining them together. The joint should be cemented with dewaxed orange shellac or with an epoxy cement. Excess cement should not be allowed to reach interior of the transformer.

After gasket and cover have been installed and bolted tightly, outside edge of the gasket should be coated thoroughly with an epoxy cement to increase weather resistance. There are a number of epoxy cements readily available and especially suited for this application. Note — such cements and epoxy coatings are not necessary where silicone or Viton gaskets are used.

Temporary repairs can be made on leaky cork or cork-nitrile gaskets when it is not convenient to take a transformer out of service by painting over the leaky area with epoxy cement.

Further help toward eliminating moisture leaks in old transformers can be obtained by maintaining a positive nitrogen pressure within the transformer tank. Nitrogen can be introduced at two or three pounds above atmospheric pressure to prevent ingress of moisture. A compound pressure gage that can read pressures above and below atmospheric can be used to monitor this nitrogen pressure. Leaks causing any sudden pressure drop can be located with a soap solution and repaired with epoxy cement after which nitrogen pressure can be built up again.