Instructions for Inerteen® Insulating Fluid P.D.S. 54201 CM and Installation and Maintenance of Inerteen Transformers

Westinghouse Electric Corporation
Power Transformer Division, Sharon, Pa.
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Inerteen® and Environmental Contamination

Inerteen is a synthetic insulating fluid made by the chlorination of a relatively common chemical, biphenyl. The chlorination is necessary to impart nonflammable properties to the Inerteen. The resulting polychlorinated biphenyl (PCB's) are relatively insoluble in water but soluble in fat, and are extremely persistent in the environment. It has been indicated by several laboratories that measurable amounts of the PCB's are present in our general environment and may have some effect on certain species of wildlife. While askarels are generally regarded as being nontoxic to humans, it is reasonable to assume that very high standards of control will be issued by the Government in the overall program against pollution. Therefore, tight control on the usage and disposal of Inerteen must be exercised.

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While the electrical users of askarel type fluids provide sealed systems, there still remains a problem of waste disposal when the equipment exceeds its useful life or undergoes repair.

For scrap Inerteen fluid, Monsanto has arranged for return of this material in sealed drums. Ship prepaid to

Monsanto Company
W. G. Krummrich Plant
Sauget, Illinois

Attn: Supervisor Dept. 246

A charge will be made for all returned Inerteen.

Inerteen soaked coils, insulation scrap, filter cartridges, and other materials must be stored until appropriate methods can be provided to dispose of them properly.

There is considerable work being done at the present time on this whole problem. We will continue the use of Inerteen because of its outstanding performance record and safety features. If modification of the present askarels can be made without sacrificing the nonflammable and other insulating properties, but which still make them less harmful to wildlife, they will be used in our Inerteen.

Westinghouse Electric Corporation
POWER TRANSFORMER DIVISION
SHARON, PA. • MUNCIE, IND. • S. BOSTON, VA.

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Part I — Inerteen® Insulating Fluid

CHARACTERISTICS

Inerteen is a highly pure, synthetic non-inflammable and non-explosive insulating and cooling liquid. Chemically stable and nearly water white in color, Inerteen is not affected by reaction with other materials regularly used in the manufacture of Inerteen apparatus. It is non-oxidizing and non-corrosive at temperatures considerably above those normally obtained in Inerteen apparatus. Inerteen will not sludge under any operating condition. Water is the main enemy of Inerteen and keeping it dry will insure long service life.

The dielectric strength of Inerteen will compare favorably with that of insulating oil when tested under the same conditions. Quality samples of Inerteen tested under laboratory conditions may show a dielectric strength in excess of 40 kv. Care must be exercised in handling and testing Inerteen. Inerteen must be kept in clean, sealed containers to prevent loss by evaporation or contamination by moisture or dirt.

Inerteen exerts a strong solvent action on most varnishes, gums, and paints. Such materials are not used in the construction of Inerteen apparatus. No materials should be used in Inerteen apparatus except those approved by the Westinghouse Electric Corporation.

Inerteen has an irritating effect upon the skin. If it is necessary to handle it, see the caution note on the title page. It should be remembered that mineral oil is completely miscible with Inerteen; in fact, it is impossible to separate mineral oil and Inerteen.

Specific Characteristics of Inerteen

As outlined in "Method of Testing Askarels A.S.T.M. D901," the specific characteristics of Inerteen are:

1. Burn point: None

2. Chemical stability: No generation of free chlorides under normal operating conditions

3. Color: (Maximum) 100 A.P.H.

4. Condition: Clear

5. Dielectric constant:

At 1000 cycles 77°F (25°C), 5.7 to 5.9
At 1000 cycles 212°F (100°C), 4.8 to 5.0

6. Dielectric strength: (Minimum) 77°F (25°C)

At point of shipment, 35 kv
At point of receipt, 30 kv

7. Electrical Resistivity: (Minimum)

500×10^9 ohms/cm^3 (212°F (100°C) at 500 volts d-c)

8. Power factor:

At 60 hertz, 77°F (25°C) 2%
At 60 hertz, 212°F (100°C) 25%

9. Fixed chlorine content: (Minimum) 42 percent

10. Free chlorides: Less than 0.10 ppm

11. Neutralization number: Less than 0.014 mg of NaOH/gram

12. Pour Point: (Maximum) plus 2°F (minus 19°C)

13. Refractive index:

At 77°F (25°C), 1.624 to 1.628

14. Specific gravity:

At 60°F/60°F (15.5°C/15.5°C), 1.381 to 1.392

15. Density: 11.5 pounds per gallon

16. Viscosity:

At 100°F (37.8°C), 82-92 seconds

17. Moisture: (Maximum) 35 ppm

HANDLING

CAUTION

Inerteen is a skin irritant. Unnecessary contact with the liquid or its vapor, particularly

made as to the suitability of the Inerteen for continued use, whether it would be desirable and economical to clean it, and in a general way, the preferred method of cleaning. In submitting samples for this service, the history of the Inerteen represented should be given as completely as possible.

Power factor test of Inerteen at 60 cycles can be made.

(For details refer to the nearest Westinghouse Office.)

RECONDITIONING

Causes of Deterioration

The principle causes of deterioration of Inerteen are:

1. Presence of water.
2. Arcing.

Arcing or burning in Inerteen produces finely divided carbon and gases which are mostly hydrogen chloride. Hydrogen chloride in the presence of moisture forms hydrochloric acid which may soon damage the insulation in the apparatus and cause rusting of ferrous materials.

Since hydrogen chloride is formed quickly after the arcing occurs, neither the Inerteen nor the apparatus should be exposed to the atmosphere (which always contains more or less moisture) until an attempt has been made to remove the hydrogen chloride.

Reconditioning

Reconditioning will be necessary to remove water, dirt and hydrogen chloride which may be present and contaminating the Inerteen.

The blotter filter press and the Inerteen conditioner will remove water and dirt deposits which may be present. Of the two methods, the Inerteen conditioner is the most effective in removing these two contaminating agents. Any equipment used for filtering Inerteen should first be thoroughly cleaned with benzine or naphtha. Every trace of any material foreign to Inerteen must be removed. If at all possible separate equipment should be used for filtering Inerteen only.

Hydrogen chloride, caused by arcing, may be eliminated by vigorously bubbling dry nitrogen through Inerteen. The nitrogen should be passed through the drain valve at the bottom of the apparatus and allowed to escape through a vent at the top. The nitrogen should be discharged through a pressure regulator attached to a stand pipe above the level of the Inerteen in the apparatus to prevent the Inerteen from flowing into the regulator. The nitrogen should be bubbled through the Inerteen at a rate of one to three cubic feet per minute for a period of four to six hours. This will require from two to eight cylinders (220 cu. ft. each) of dry nitrogen, based on apparatus containing 150 to 2000 gallons of Inerteen.

Immediate application of the bubbling process will reduce the destructive action of the hydrochloric acid on the working parts and insulation, thereby making it likely that the materials not damaged by arcing may be used in repairing the apparatus. Also, use of the process will in most cases make it possible to satisfactorily reclaim the arced Inerteen.

After the hydrogen chloride has been removed by the bubbling process, the Inerteen should be reclaimed by use of an Inerteen conditioner.

There is no commercially suitable method for separating transformer oil from Inerteen.

Short Circuit Amperes in Percent of Load	Maximum Temperature of the Top Inerteen
50%	85°C
75%	80°C
85%	75°C

While the windings of the transformer heat up, do not permit the temperature of the top Inerteen to exceed the value specified for a given percentage of load. This precaution is necessary because the windings will heat up more quickly and operate at a higher temperature than the Inerteen. If the windings are allowed to reach too high a temperature, the insulation will be damaged. The drying of a transformer should be continued until the dielectric strength of samples of Inerteen taken from the transformer test at 30 kv or higher.

The cover should be kept tightly sealed during the temperature run, and until the transformer has cooled down to room temperature to prevent condensation. This also prevents the release of hot Inerteen vapors which are quite objectionable, particularly if the ventilation is poor.

CAUTION

It is not safe to attempt the drying out of transformers unless constant attention is given to the job.

ACCESSORIES AND FITTINGS

Bushings, fittings, and accessories when boxed and shipped separately should be mounted as shown on the outline drawing. Proper installation instructions when necessary are included in the instruction leaflets for component parts. Care must be exercised when these components are fitted to eliminate the accidental introduction of moisture in any form inside the transformer. Where blind flanges are removed before fittings are mounted, the level of the Inerteen must be lowered below the openings that will be made.

FINISH

Any portion of the paint film damaged during shipment or installation must be repaired as quickly as possible.

To do this, clean the damaged portion by means of a scraper or sandpaper, wipe thoroughly with a solvent dampened cloth, apply Westinghouse primer paint and allow it to dry for at least 24 hours, then apply a coat of Westinghouse finish paint.

FILLING

Use only all-metal hose or pipe when filling, since the lining of most other types of hose may be soluble in Inerteen and will contaminate it in a short time. All joints should be tight; where practical, fill through the drain valve to keep aeration to a minimum and vent the top of the tank to allow the air to escape. Be sure that valves and pipe connections between the main tank and any Inerteen filled compartments are open for free circulation of gas and liquid. Otherwise, trapped air or gas may cause the Inerteen level in some parts of the transformer to be below the safe operating level.

If it is necessary to fill a transformer out-of-doors, particularly on a damp day, care should be taken to prevent the entrance of moisture. In order to avoid condensation the temperature inside the unit should be kept several degrees above the outside air temperature.

The tank and compartments, if any, should be filled at ambient temperature to the point on the gauges marked "25°-Liquid Level." If the ambient varies greatly from 25°C (77°F) when filled, the Inerteen level should be checked when the average fluid temperature is 25°C; sufficient Inerteen should be added to or drained from the tank to bring the level to the proper height. The transformer should never be operated or left standing even out of service without the Inerteen level being indicated on the gauge.

Filling Under Vacuum

Entrapped air is a potential source of trouble in all liquid filled transformers. Therefore, it is desirable to fill all Inerteen transformers under a full vacuum. This is done for the transformers shipped from the factory and should be done where practicable when transformers are filled in the field, providing the transformer cases have been so designed. If the cases have not been designed for full vacuum and it is imperative to

MAKING CONNECTIONS

A diagram, usually on the metal instruction plate attached to the side of the case, shows the proper power terminal connections to be made for various voltages. Care should be taken to see that all connections and only those shown are properly made, for a wrong connection may cause severe damage.

Some installations require an auxiliary source of power or control leads to be wired to terminals at the transformer; a wiring diagram, either a separate drawing or included as part of the outline drawing, shows the connections to be made.

Voltage Application

When voltage is first applied to the transformer, it should, if possible, be brought up slowly to its full value so that any wrong connection or other trouble may be disclosed before damage can result. After full voltage has been applied successfully, the transformer should be operated without load for a few hours. It should be kept under close observation during this time and also during the first few hours while loaded.

INSPECTION

It is desirable that periodic inspections of Inerteen apparatus be made and that samples of Inerteen be taken from each and from all compartments of any apparatus and tested after a short period of service (approximately three months for transformers). Following this, when operating conditions permit, routine sampling and testing of the Inerteen at intervals of six months to one year are suggested. Accurate records should be kept of such inspections and tests and if the Inerteen shows a dielectric strength of less than 28 kv, it should be conditioned. If facilities are not available for testing Inerteen, see "Westinghouse Inerteen Testing Service," P.L. 45-825. When an appreciable amount of Inerteen is removed from any apparatus, it should be replaced with an equal amount of new Inerteen so that the liquid level in the apparatus is maintained. The Inerteen used for replacement purposes should have a dielectric strength of not less than 30 kv.

Any increase in operating temperature at normal load should be investigated and if the cause cannot be determined, the transformer should be taken out of service and given a thorough inspection.

Any symptoms, such as unusual noises, high or low Inerteen levels, operation of relief device, etc., should be investigated at once.

Transformers which have been subjected to unusually severe operating conditions, such as overloads, frequent short circuits, or special units should be inspected at least once a year. This can usually be done adequately by lowering the Inerteen level and inspecting with a light through the manhole. Before this inspection is made, the Inerteen should be allowed to cool to reduce the amount of Inerteen fumes given off which are quite objectionable and should not be inhaled.

During periodic inspection, all accessories should be inspected to see if they are operating properly.

SAMPLING INERTEEN

All sampling and testing equipment must be thoroughly dry and clean. It is recommended that sampling and testing equipment used for handling Inerteen and servicing Inerteen be used for no other purpose. Care must be used in taking samples of Inerteen and sealing them prior to testing. It is desirable that samples of Inerteen be removed from any container on clear days only, and when the temperature of the Inerteen is at least as high as the temperature of the surrounding air.

Use only tin containers with screwed metal caps or glass bottles with Inerteen-resistant stoppers to hold Inerteen samples. If it becomes necessary to use other than factory sampling containers, they should be rinsed with clean naphtha, washed with strong soap suds, and rinsed thoroughly in hot water, and then dried at approximately 110°C for four hours with neck down in a circulating air oven. If the containers are not used immediately after cleaning, they should be sealed tightly and stored in a dry, clean place.

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