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The Smell Of Ozone

Webster's new Collegiate Dictionary uses sixty words to define ozone in the following concise and comprehensive statement: "A triatomic form of oxygen that is a bluish irritating gas of pungent odor, is formed naturally in the upper atmosphere by a photochemical reaction with solar ultraviolet atmosphere or *generated commercially by an electric discharge* in ordinary oxygen or air, is a major agent in the formation of smog, and is used especially in disinfection and deodorization and in *oxidation* and bleaching." The Handbook of Chemistry and Physics ranks ozone, chlorine, and phosgene as equally toxic at 1 ppm.

Prior to 1950 cable makers focused attention on the oxidation characteristic of ozone. Even modest resistance to the oxidation effect of ozone was very difficult to achieve with natural rubber based extruded dielectrics. Chemically the backbone carbon chain of natural rubber is unsaturated. These double bond sites are vulnerable to degradation by ozone oxidation. This degradation appears as cracks in the insulation or jackets of cables.

Ozone resistance was a specific requirement in early medium voltage specifications. This requirement has carried over to the present. The transition from natural rubber based compounds to synthetic polymers such as butyl rubber, EP rubber, PE, XLP and Hypalon, has for all practical purposes made possible compounds that are inherently ozone resistant. Now the emphasis on ozone in the cable industry has shifted to the cause and consequences of ozone generation by an electrical discharge, called *corona*.

Corona is not to be confused with *partial discharges* in a cable. Partial discharges occur in voids in the insulation, splices, terminations or at the interface of the conductor stress relief layer and the insulation or between the insulation and insulation shielding system. Sensitive partial discharge detectors are usually required to measure this discharge and the ozone formed is not detectable by smell. In addition medium voltage power cables are routinely inspected to assure that partial discharges are not initiated at operating voltages.

The *smell of ozone* near electrical equipment or cables is usually a sure sign of *corona discharges*. The ozone, of itself, is hazardous as mentioned earlier. Further, it can damage some materials. In the following three cases in the field, the ozone came from electrical equipment:

1. Relays opening and closing in a control room; the ozone was a hazard to operators.

2. Brushes on rotating equipment; the ozone cracked the insulation on power leads to a welder. This could have caused problems.

3. Brushes on an MG set near an open window in a steel mill; the jackets on 600V cables near the window cracked, exposing the insulation. This could have caused problems.

Note: These three examples are similar to a laboratory U-Bend Test, where corona is intentionally generated to evaluate cable coverings.

In the following three examples, ozone was created by a discharge in air between a cable component and ground:

1. A non-shielded varnish cambric insulated cable was installed in a steel pipe; the voltage difference between the surface of the cable (at the conductor voltage) and the ground steel pipe produced corona. The ozone generated would affect people and materials.

2. A non-shielded pigtail from a molded pot-head on a shovel cable (shield being terminated in the pot-head) touched the grounded cabinet of a portable power center in a strip pit. The ozone cracked the molded jacket over the insulated pigtail.

3. The shield of a shielded cable was not grounded; it was floating. As in the first example, there was a

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corona discharge between the floating shield and a nearby ground. However, a floating metal shield collects enough charging current to *electrocute* anyone touching the shield while in contact with the earth. Immediate action should be taken to eliminate floating shields; they are extremely dangerous.

In summary:

1. Ozone itself is hazardous; fortunately, its odor provides a warning.

2. The smell of ozone could also be symptomatic of a potential materials problem or a safety hazard.

3. Don't touch energized MV cables with bare hands at any time, but especially when the presence of ozone is detected — *the shield might be floating;* electrocution could occur.

4. Determine the source of ozone generation immediately. A sonic detector with proper probes for safety can be helpful. Sources of corona or discharge will produce sizzle like that of frying eggs. Hewlett-Packard and Biddle manufacture these instruments. Their cost runs from $500-$800. They are good, too, for checking presence of partial discharges in splices and terminations.

5. If the ozone is being generated by non-shielded cables, consider the use of shielded and properly grounded cables in place of non-shielded cables.

6. If the ozone is being generated by a non-cable source, proper choice of materials — for example, EP insulations and Hypalon jackets — will improve the chances of cable surviving in that environment. Proper ventilation is also necessary to avoid harm to people.

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