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Environmental Impact

Of Arc Suppression

Lab Note #106 — rev A

ABSTRACT

Electric current arcing causes significant degradation of the contacts in electromechanical relays and contactors. The energy of electrical current contact arc yields Ozone (O_3), along with other compounds such as Nitrous Oxides (NO, NO_x) and many other chemicals and particulates. These chemicals and particulates are most pronounced when operating contactors as they are typically conduct higher contact power and run in the open. Ozone is most easily noticed during operation due to its distinct odor. Other chemicals and particulates are not quite as obvious. The residue of these chemicals and particulates, however, can be seen in their accumulation on the exterior of contactors or inside a translucent case of a relay. (NOTE: This is a follow-on to Lab Note 105: Contact Life—Unsuppressed vs. Suppressed Arcing, found at: www.ArcSuppressionTechnologies.com/LabNotes.aspx.)

PROBLEM

Unless specially sealed, contactors and relays pollute the air and have an immediate environmental impact! Product designers, technicians and engineers are at best only marginally aware of the harmful chemicals and particulate matter created by the operation of electromechanical relays and contactors. In addition, they also have a delayed environmental impact when they go to landfills at the end of their operating life.

TESTS

Operate a Tyco T90 open-frame relay switching a resistive load at 240Vac, 5kW, 1 second cycle time, 50% duty cycle, under two separate test conditions:

I. With no suppression element

II. With a NOsparc MMXac™ arc suppressor connected across the relay contacts

The relays were run at the above duty cycle up to 100,000 cycles (or failure, if that came first).

The tests are more thoroughly described, along with other findings, in ***Lab Note 105: Contact Life—Unsuppressed vs. Suppressed Arcing***. (This and other lab notes may be found at: www.ArcSuppressionTechnologies.com/LabNotes.aspx.) One item not discussed in Lab Note 105 was that the relays under test were covered by a translucent case not related to the relay or any other equipment or components. The cases were used both to prevent foreign materials from contaminating the open-frame relays and to allow for observation of contact arcing during testing.

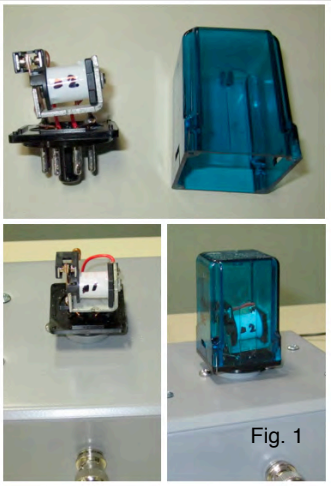

Fig. 1

Electrical contact arcing occurs when relay contacts move from open to closed and back in four distinct states shown in Fig. 2:

1. **CLOSED**
2. **BREAK** (transition state from closed to open)
3. **OPEN**
4. **MAKE** (transition state with “bounce” from open to closed state)

Relay Contact State Table

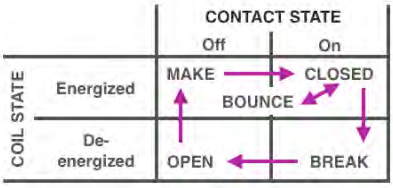

Fig. 2

There are two distinct arcs during the MAKE state: the first is the initial dielectric breakdown (Make Arc), followed by one or more Bounce arcs until the contacts come to rest in the CLOSED state.

The most damaging arc occurs during the contact BREAK state, as it is akin to the process of arc welding. We refer to this arc as the “Break arc,” shown photographed through an inspection lens (x10, PEAK Scale Loupe) in Figure 3.

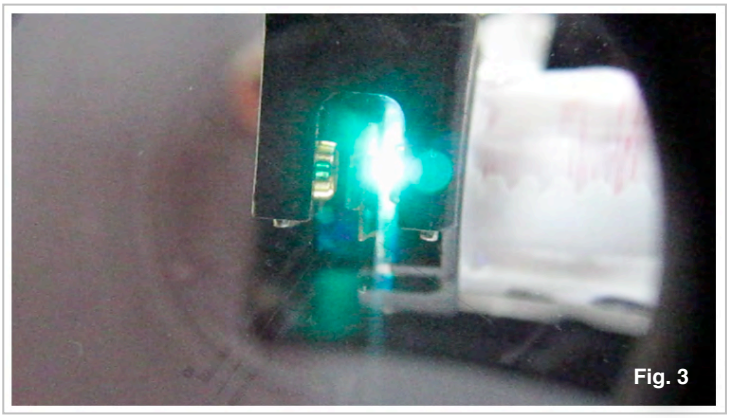

Fig. 3

WARNING: Tests use high electrical power, therefore only qualified personnel should attempt to recreate them.

RESULTS

Results are shown in pictures taken of each relay's translucent case upon conclusion of the test.
(Note: The results are best seen when this document is either printed in color or viewed online at www.ArcSuppressionTechnologies.com/LabNotes.aspx.).

Baseline Unused Case

Fig. 4

Fig. 4 shows both an unused relay case and the contacts of a fresh out of box, unused relay for baseline comparison with subsequent tests.

Test I

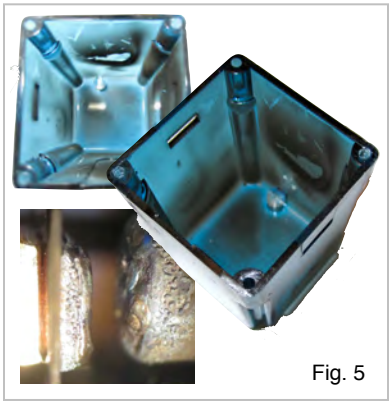

Fig. 5

Fig. 5 shows both the relay case and the contacts of a relay operated to the desired target of 100,000 cycles without arc suppression.

Test II

Fig. 6

Fig. 6 shows both relay case and the contacts of a relay operated to the desired target of 100,000 cycles with a NOsparc arc suppressor connected across the relay contacts.

DISCUSSION

The clarity of the case pictured in Figure 6 clearly shows the NOsparc arc suppressor's Arc Suppression Factor (ASF) of 1250 (i.e., a 1250 times reduction in arc energy) has yielded no obviously visible particulate matter build-up when compared to the case shown in Figure 5. This is because arc suppression significantly reduces airborne pollutants created by the extremely high energies involved in electrical contact current arcing.

Unsuppressed arcing breaks down the chemical bonds of the atmospheric gases surrounding the contacts as well as some of the molten metal of the contact material itself. Free ions in and around the arc recombine to create new chemical compounds (for example, breaking atmospheric Oxygen into single Oxygen [$O_2 \rightarrow 2O$], which then recombine creating Ozone [O_3]).

We strongly suspect that the apparent carbon deposits stem from the electrical contact arc's energy breaking the Carbon Dioxide in the surrounding atmosphere is broken into Carbon and Oxygen [$CO_2 \rightarrow C + O_2$]. The acoustical shockwave (thunder) generated when the arc (lightening) forms, displaces the air in the arc path. This shockwave blasts the particulates out into the environment at supersonic speeds … or in this specific case onto the inside of the translucent cover.

This can also be seen in Figure 7, which shows a contactor (unrelated to this Lab Note and test) with obvious and significant chemical and particulate build-up on both its exterior (upper picture Fig. 7) and interior (lower pictures Fig.7).

In previous lab notes we also discuss that arc suppression makes the contacts of relays and contactors last longer, making the products and equipment they operate also perform better and last longer. A key benefit of this longer life is less product waste from relays or contactors (and sometimes the boards and/or equipment to which they're attached) being prematurely replaced and discarded.

NOsparc arc suppressors are both lead free and compliant with the EU directive on Restriction of Hazardous Substances (RoHS).

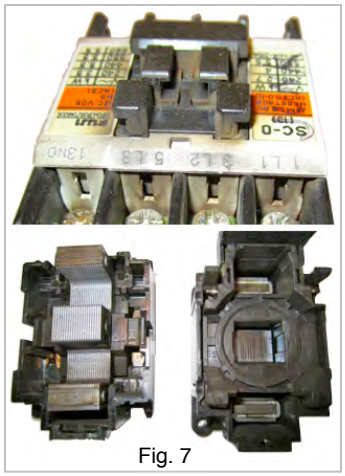

Fig. 7

CONCLUSION

Relays and contactors typically operate vented to increase their operating life by cooling the contacts and dissipating the corrosive, reactive and explosive chemicals and undesirable particulate matter created during arcing into the environment. These chemicals and particulate matter, however, may well contribute to a public health hazard as they often operate in close proximity to people. Arc suppression addresses this issue by significantly reducing pollutants from contactors and enabling relays to operate while sealed in applications that would otherwise have required them to operate vented.