Rectifier Clinic

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Replacing Thyristors

Thyristors, or silicon controlled rectifiers (SCRs), are used in rectifiers in two basic configurations:

1. In a primary SCR configuration, the SCRs are placed before the main transformer and function as voltage control devices that pass the correct AC voltage to the transformer, which proportionately reduces the voltage to the desired level. The DC conversion (rectification) is performed by diodes wired after the transformer.
2. In a secondary SCR configuration, the SCRs are placed after the main transformer and control both the output level and the rectification.

Types of SCRs

Stud SCRs

After you have determined that you have a defective SCR, it is important to replace it correctly. The first step in the process is to determine what type and size of SCR you have. The first basic type is a stud SCR, which has a threaded post on one end, and a pigtail on the other end (see Fig. 1). Because of this configuration, it is difficult to install it backward.

- SCRs are manufactured in different sizes (package types) depending on the amperage. Generally speaking, the larger the size, the more amperage the SCR will transmit. There are normally eight standard sizes, ranging in nominal amperages from 8–1000 amps, with stud threads varying from a 10–32 ANF to a ¾–16 ANF.
- Each amperage size is manufactured at various voltage ranges, typically 200, 600, 1200, 1800, and 2400 volts. The higher the voltage the more expensive the SCR, so it is important to obtain the proper size for your application. Too high a voltage rating wastes money and increases the resistance of the SCR, which creates more heat. Too low a voltage rating may lead to early failure, if voltage spikes exceed the rating of the SCR. If you are not certain what size you need, you should consult the rectifier manufacturer, or a reputable supplier.
- Stud SCRs usually have two wires coming from the base—one red and one white—that will be attached to a terminal strip adjacent to the SCR's mounting location. These are the gate and cathode wires, and the gate wire is normally white. The SCR functions as a high-speed switch that is turned on by applying a voltage to the gate wire. It is important that you notice which terminal each wire is attached to so that the replacement duplicates this arrangement. It is also necessary that these lead wires be twisted together so that transient currents do not misfire the SCRs.
- After the defective SCR is removed, attention should be paid to the mounting surfaces to ensure that the surface is clean, dry, and flat. If there is chemical residue, it may be removed with a *scotchbrite* or similar product so that the surface is not scored during cleaning. A solvent may also be used, as long as it is used sparingly and does not leave a residue. If the surface of the heat sink has deep scratches, melted material, or other damage, it may be necessary to have the surface machined, or even replace the heat sink, so that the semi-conductor has an adequate surface for heat transfer.
- When the new SCR is installed, a high grade silicon semi-conductor paste must be applied to the surfaces where the SCR touches the heat sink. This will ensure that there is efficient electrical and thermal conductivity between the surfaces. It will also fill minor surface imperfections and prevent corrosion migration between the surface of the SCR and the surface of the heat sink. If you do not have this material, it may be obtained from a reputable rectifier repair service or the manufacturer of the rectifier. Use a thin coat.
- The nut must be tightened on the stud of the SCR to the proper torque specification. If it is too loose, excessive heat will be generated, and arcing may occur. If it is too tight, it may damage the SCR and cause premature failure. Torque specifications should be available from the supplier of the SCR, the rectifier manufacturer, or the SCR manufacturer.

Puck SCRs

The second basic type of SCR is a puck SCR (see Fig. 2). These SCRs are larger and will carry more current than the stud types. Although they may appear symmet-

Fig. 1—Stud SCR.

Fig. 2—Puck SCR.

rical, one side of the SCR has a flange and the other does not. It is critical that the SCR is replaced so that the flange is in the same location as the SCR that was removed.

The previous comments about correct sizing, wires, heat sink cleanliness, and paste apply to puck SCRs as well as stud SCRs. There are some issues unique to puck SCRs.

- Amperage ratings will vary roughly between 600 and 4300 amps depending on package types and the manufacturer. Voltage ranges will vary roughly between 200 and 4400 volts.
- The firing wires on puck SCRs may not be attached to the SCR and may come packaged separately with push-on connectors. Be sure that you duplicate the color configuration of the defective SCR when performing the replacement. Again twist the wires during the installation.
- Puck SCRs have a small hole in the middle of both faces to accommodate a pin protruding from each heat sink. During replacement the SCR must be mounted so that these pins are inserted in the holes in the SCR to ensure proper orientation. If these are not placed correctly the protruding pin will prevent the SCR from being clamped flush to the heat sink. This is one of the most common mistakes performed by inexperienced personnel.
- Because puck SCRs do not have a stud and nut but are clamped between two heat sinks providing the proper clamping pressure, it is more difficult to clamp correctly. This is because the clamps are usually a U-shaped configuration, which means that two nuts must be tightened so that not only is the proper pressure applied, but so that the two heat sinks remain parallel. This is very critical. Many of the clamp assemblies have a strain gauge attached that is used to determine when the proper clamping pressure has been applied. Unfortunately, these are often damaged during disassembly and their accuracy will become suspect.
- If you are uncertain about this procedure, it may become necessary to consult the rectifier manufacturer, or a reputable rectifier repair service. Improper installation will cause premature failure.

SCR Module

The third basic type of SCR which is being used more frequently is an SCR module (see Fig. 3). These modules contain two SCRs—one firing each direction—and are most often used on rectifiers with primary SCR configuration. (This configuration has the SCRs in line before the main transformer for voltage control, and uses diodes after the main transformer for rectification.) These modules are easier to install than either pucks or stud SCRs, but have to be replaced in pairs, because there are two SCRs in each module.

Fig. 3—SCR module.

- The surface must be clean and have paste applied to it for thermal conductivity. The current input and output, however, is accomplished via heavy wires and lugs, which must also be cleaned with the bolts tightened per the specification.
- The SCR wires (2 red, 2 white) will be packaged separately, and each pair will need to be pushed onto the connector, twisted, and connected to the terminal strip.

The following caveat should be considered: Although it is possible that an SCR can fail without a proximate cause, this is unlikely. If the cause of failure is not determined, it is possible that the new SCR will also fail. ***P&SF***

Editor's note: Rectifier Clinic is a new column, provided by Craig Henry of JP Tech, Inc. Questions and comments are welcomed by the author.

Fact or Fiction

Continued from page 27

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