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Mismatched Kits Cause Failures

"Some compressor manufacturers claim nearly 40 percent of compressor warranty returns are attributed to burned-out start windings from incorrect hard start devices installed by service technicians," said Riley Archer, national technical manager, RectorSeal® Corp., who recently presented a session on compressor starting problems as part of the Ohio Construction Industry Licensing Board's HVAC Continuing Education Units Program.

Archer, who conducts free HVACR training classes upon request for contractors and distributors nationwide, spoke to 40 service techs at the Dayton, Ohio, branch of HVACR contractor Service Experts, and 15 techs and countermen at the Dayton branch of nationwide wholesale chain R.E. Michel Co. in April. The North American Technician Excellence (NATE) certified class addressed the harmful effects of heat on compressor motor windings, the benefits of hard start devices, and the dangers of incorrect start devices.

"All service techs should realize the importance of matching hard start devices properly and how critical that first second of start-up is for a compressor's longevity," said Fred Perkins, an R.E. Michel sales representative who organized the training classes.

"Instead of automatically replacing perfectly fine equipment, our company philosophy is to clean up a customer's existing a/c system, make it run more efficiently and employ aftermarket products, such as the two-wire hard start devices explained at the seminar, to prolong compressor life and other benefits," said Fred Fitzsimmons, branch manager, Service Experts —Dayton, which operates 27 service trucks throughout the Dayton area.

About Hard Start Kits

A hard start kit consists of a mechanical potential relay connected to a start capacitor that's wired to the compressor to aid its start-up. According to Archer, hard start kits are invaluable to air conditioning systems that suffer from:

- Low supply voltage;
- Poor quality of power supply;
- Inadequate (undersized) wiring;
- Pressure differential at start;
- Multiple units running at once; or
- Peak energy usage times.

These challenges make hard start devices a great potential aftermarket sales product for a contractor's client base, according to Archer. "Any customer with a computer will appreciate the fact that a hard start device can minimize those voltage changes during air conditioning start-up that cause the lights to flicker or harm computers," said Archer.

Additional selling points include the facts that aged systems typically are more difficult to start and new high-SEER systems have lower torque motors that need additional starting assistance.

"If you have 1,000 service customers, then 1,000 of them would benefit from the installation of a hard start device," said Archer, whose company manufactures a patented two-wire hard start device under the brand of Kickstart® that's recommended by dozens of unitary air conditioning and heat pump equipment manufacturers. "Many hard start device manufacturers offer a sales brochure designed especially to help contractors sell to homeowners."

Shown to the left of the installer's left hand is a Kickstart hard start device.

Properly Matching a Hard Start Device

The HVAC industry offers a variety of hard start devices. Every major compressor manufacturer uses some type of OEM three-

wire hard start kit that typically consists of a potential relay and start capacitor that are connected to dedicated locations. The potential relay is connected between the common, and start in series with the run capacitor. The entire series is in parallel with the run capacitor, causing the circuit to be in series with the start winding.

Since excess heat damages compressors, a critical feature of a hard start device is how it senses counter electromotive force (EMF). A typical start-up requires four to eight times more current to actually start the compressor than what's required to run it. It's essential to select a relay that picks up at precisely the right moment, which is measured in milliseconds, to protect the start windings from overheating, according to Archer.

"Not stopping the energizing process at the right moment is comparable to starting your car's engine, but continuing to engage the starter motor against the flywheel a three-quarters of a second more than needed," Archer said. "Eventually, this will burn out the car's starter. The same damage impacts on an air conditioner compressor motor's windings when multiplying that three-quarters of a second by 30 to 40 start-ups per day during cooling season."

Hard start devices are divided into three distinct classifications, the traditional three-wire designs, two-wire designs that don't use a potential relay, and the more precise approach of a two-wire design that uses a potential relay, the latter which needn't be connected to dedicated locations. Both designs utilize a mechanical potential relay to sense voltage generated during start-up. Three-wire designs measure the counter (back) EMF off the motor start windings, while the two-wire designs utilize a mechanical potential relay to measure counter EMF off the motor start windings and the run windings, according to Archer. EMF is the voltage generated by the motor field as it operates.

There are hundreds of relay and capacitor combinations to accommodate the hundreds of variations of counter EMF generated through the start windings. General Electric, for example, makes more than 100 relays that are calibrated to have a different pick up, drop out, continuous, impulse, and response time voltage.

Consequently, contractors would have to inventory dozens of hard start devices on their trucks to properly match a replacement three-wire device. However, some aftermarket hard start devices come in just two or three universal models based on the compressor horsepower or system tonnage. When the three-wire design is used, it is impossible to use only two or three relays for all equipment on the market, because the start winding voltage varies by hundreds of volts from one compressor model to the next. Additionally, relays only function in a narrow voltage range of around 10 to 20 V. Potential relays are very effective, but they must be matched to pick up in a very narrow voltage range of the equipment's start winding. "We know that the counter EMF running through the start winding varies by hundreds of volts, therefore it's impossible to have a universal three-wire hard start device," said Archer.

Riley Archer, national technical manager at RectorSeal Corp., conducts a training session at a contractor's location.

On the other hand, there is a way to use a potential relay and start capacitor to create a universal hard start kit with only two relays, by sensing the counter EMF from the start and run windings through the run capacitor. "There's a universal underlying voltage generated that will be close to 370 volts if the system has a 370-volt run capacitor or 440 volts if it's a 440-volt run capacitor," said Archer.

Heat damages compressors, therefore the ultimate goal is to eliminate excess heat by starting compressors 50 to 80 percent more quickly. Not all two-wire devices are the same, as some don't have a potential relay, but instead use an electronic circuit board timing device. "Two-wire hard start devices with mechanical potential relays sense counter EMF more accurately than their electronic counterparts," said Archer.

Archer doesn't recommend two-wire devices using a positive temperature coefficient resistor (PTCR). A PTCR doesn't sense the counter EMF, therefore it can potentially cause damage by keeping the motor start windings energized for too long of a period even after the compressor has started.

The No. 1 Service Tech Mistake

Probably the most common mistake service techs make in regards to installing a hard start device is not first checking the system's run capacitor functionality. An improperly functioning run capacitor can damage the hard start device. Run capacitors are measured in microfarads (µF), which can be calculated by determining the amperage from the start terminal on the compressor to the run capacitor and multiplying by 2,654, and then dividing that total by the voltage across both terminals of the run capacitor. A run capacitor measured at 7A and 370V, for example, would calculate as 7A x 2,654= 18,578 ÷ 370V = 50.2 µF. The total must be within 10 percent of the run capacitor's microfarad specification.

The system might not be starting up because of a faulty or weak run capacitor. Some manufacturers claim another 20 percent of compressor returns were misdiagnosed as compressor breakdowns, but were actually due to another component failure. "In many instances, it's not the compressor, but the run capacitor that failed," said Archer.

The training seminar was apropos for Service Experts' Fitzsimmons, whose service techs are continually marketing hard start devices to homeowners that experience residential voltage challenges or have systems showing premature compressor wear.

For more information on RectorSeal's plumbing and HVACR products or free training programs, call 800-231-3345, email marketing@rectorseal.com, or visit www.rectorseal.com.

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