Preliminary Test Results – Refrigerant Leak Sealants

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Introduction

For years, the engineers at Qwik**Products™** by Mainstream Engineering Corporation® have been very skeptical about the potential for a refrigerant leak sealant to actually seals leaks. Whenever we asked any of the manufacturers for data, we were always presented with testimonials that the products work, but never any data to prove their effectiveness at sealing leaks or data on the size of the leaks that can be sealed. With the widespread use of these sealants, we believe it is important to determine their effectiveness. While there are many brands to choose from, it is also important to understand that all of the leak sealants are essentially derived from the same formulation. The formulation is derived from expired U.S. patent number 4,237,172 which was awarded to Joseph J. Packo in 1980. Mr. Packo disclosed that aminosilane mixtures could be used to seal leaks in pipes. The reaction to seal leaks is initiated by exposure to atmospheric moisture at the site of a leak.

While the leak sealant formulation is straightforward and the chemicals readily available, the cost, to the trades, of some of these leak sealant products can be unreasonably high. We decided to perform an all-out investigation of the leak sealant chemistry to determine the leak sealant effectiveness and to determine if there was any detrimental effect on system reliability. Our thought was, if the sealants do work, we would establish the limits of their usefulness, and offer a lower cost alternative to the costly products currently on the market.

It is important to note that all the manufacturers, including Mainstream Engineering, agree that the use of a leak sealant is a **last resort**, when all other attempts to find a leak have failed, and these leak sealants should best be used on old systems that are not worth investing too much money to repair. Never add a leak sealer to a new system as part of a preventative maintenance program.

All leak sealants react with water, so all the manufacturers also agree that these sealants should not be used on systems that contain too much water. But how much water is too much water? Tecumseh's guide for the use of R-410A states that 80 parts per million (ppm) is the maximum threshold of moisture allowable in a system. The AHRI 700 purity standard for maximum water in new refrigerant R-22, R-404, R-407, or R-410A is 10 ppm. However, POE oil can contain as much as 2,500 ppm water, so if a drying agent is not used, it is pretty easy to have "too much water" in your system. We selected 100 ppm as the maximum moisture content in the system, and performed all of our life testing with 100 ppm water in the system. Life testing with 100 ppm water is far more water than would be encountered in a system after a drying agent (like Part A of Qwik**Seal**™) was used. Therefore, in addition to leak sealing ability, we needed to determine if the use of a leak sealant would clog an expansion device or ruin a compressor, when 100 PPM water was also in the system.

This short technical brief has been developed to present the data obtained to date. In summary, these leak sealants do work and Qwik**Products**™ is offering a lower cost version of the same formulation, called Qwik**Seal**™ that also includes an effective drying agent (Part A) to remove moisture. The use of a

drying agent is critical to assure that there is no water in the refrigerant or oil which could negatively react with the sealant. An example of Qwik**Seal**™ polymerizing around a leaking compression fitting is shown in Figure 1.

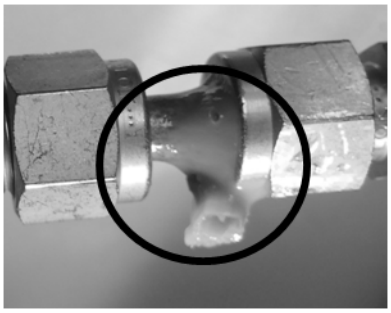

Figure 1. Qwik**Seal™ sealing a leaking compression fitting**

The Qwik**Seal™ Leak Sealant Formulation**

Qwik**Seal**'s two-part formulation is unique because Part A contains an active drying agent to remove any water from the system's refrigerant or oil, before it has the chance to react with the leak sealant in Part B. Since Qwik**Seal**™ does both the drying and the sealing, it saves the technician time and money. The drying agent in Qwik**Seal**™ (Part A) can remove up to 26 drops of water from a system. This means that for a system with an oil charge of 15 ounces of oil, a single half-ounce Part A treatment of Qwik**Seal**™ will drop the moisture level in the oil by about 3,000 ppm. Half the amount of oil means the moisture will drop twice as much. So, unless the system is totally waterlogged, the formulation in Part A of Qwik**Seal**™ is designed to remove any moisture in the system.

Qwik**Seal™ Leak Sealing Experiments**

For the initial leak sealing tests, we introduced Qwik**Seal**™ (Part B), along with a refrigerant/oil mixture into a reservoir connected to a calibrated leak source with a measured leakage rate of 5.8 pounds per year when charged with dry R-410A refrigerant. The vapor leak was created by attaching a 15 micron inner diameter capillary tube that is open to the atmosphere, to the reservoir. The temperature and relative humidity were maintained at 70 °F and 60%, respectively. The leak was completely sealed in less than 5 hours in the presence of the Qwik**Seal**™ leak sealant (Figure 2). Weight loss of the reservoir, due to a loss of charge was used to exactly determine the leakage rate as a function of time for the reservoir with and without Qwik**Seal**™ sealant added (Figure 3). No moisture was added to the refrigerant.

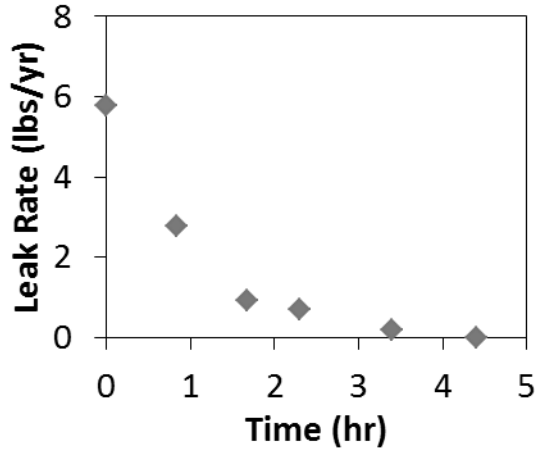

Figure 2. Leak rate through 15 µm I.D. capillary tube with Qwik**Seal™**

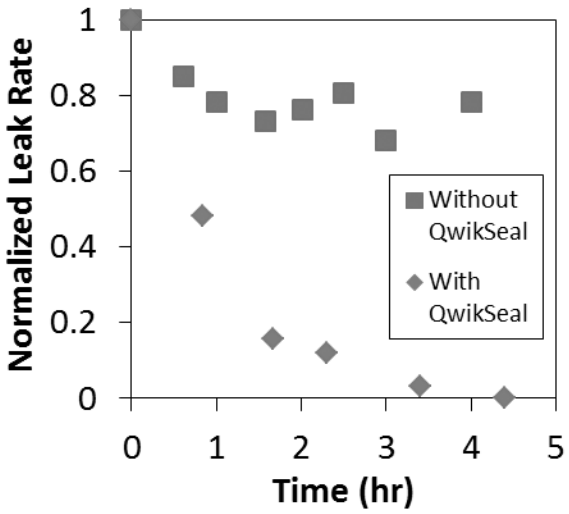

Figure 3. Normalized leak rate through 15 µm I.D. capillary tube with and without Qwik**Seal™**

Given the positive results from these preliminary experiments, the natural next step was to evaluate the sealing capability of Qwik**Seal**™ on operating vapor compression systems.

An R-410A air-conditioning system was fitted with three identical 5-micron inner-diameter calibrated leaks, with one leak in the high-pressure vapor line, a second leak in the low-pressure vapor line, and a third leak in the high-pressure liquid line. These leaks corresponded to a combined total leakage rate of approximately 0.3 lbs/year. Qwik**Seal**™ (Part B) was added to the system and the unit was operated continuously for the duration of testing. A refrigerant sniffer was used to determine if the leaks had been sealed. All three leaks sealed completely within 10 days of operation.

In addition to the continuously operating tests described above, a second round of testing was performed with intermittent operation of the compressor. For these tests, another R-410A air-conditioning system was once again fitted with three identical 5-micron inner-diameter calibrated leaks, once again with one leak in the high-pressure vapor line, a second leak in the low-pressure vapor line and a final leak in the high-pressure liquid line. As in the prior tests, these leaks corresponded to a combined total leakage rate of approximately 0.3 lbs/year. Once again, Qwik**Seal**™ (Part B) was added to the system, however, this time the unit was cycled 45 minutes on then 15 minutes off for the duration of testing. The low-side and high-side vapor leaks sealed completely after two days and the liquid-line leak slowed to being barely detectable after six days. Based on these preliminary results, it appears that the hardest leaks to seal will be in the liquid-line.

One of the plugged vapor-line capillary tubes was viewed under a microscope (100x magnification, Figure 4 and Figure 5) where it was obvious that a coating of sealant had formed on the outside of the tube near the external end exposed to the ambient. The sealant on the outside of the tube was scraped off and the tube was once again viewed under a microscope. As shown in Figure 5, two plugs of sealant are visible inside the clear glass tube sealing the leak passage (Figure 6).

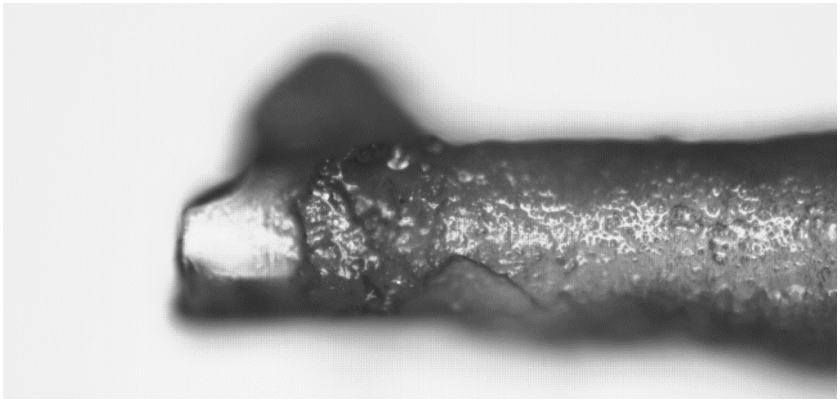

Figure 4. Sealed capillary tube at 100x magnification showing hardened sealant around outside of the tube

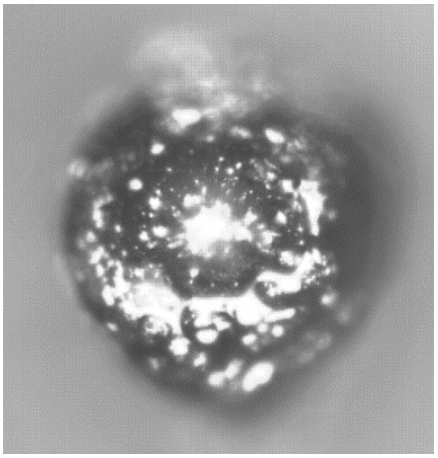

Figure 5. Sealed tip of capillary tube at 100x magnification

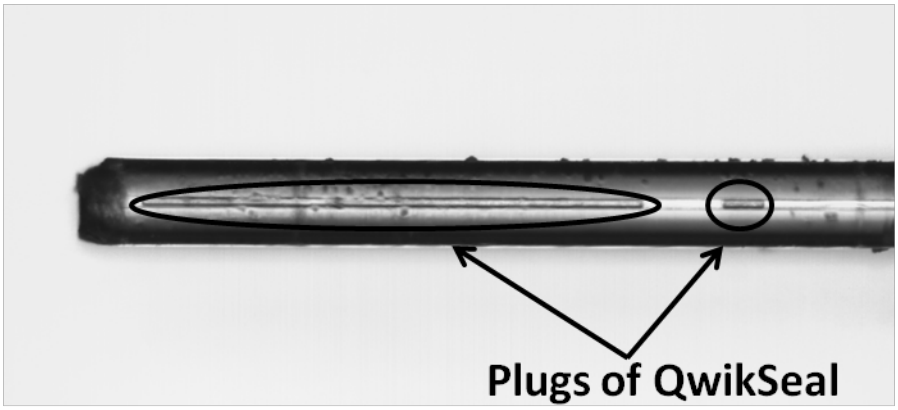

Figure 6. Sealed capillary tube at 50x magnification with visible plugs inside

Life Testing

Since all leak sealants react with water, the potential life limiting concern is the reaction of the leak sealant with existing water in the system which could then produce particles that might clog the expansion device or introduce wear particles into the lubricant. Since Qwik**Seal**™ Part A is an effective drying agent, moisture levels in the system should never reach 100 ppm, when QwikSeal™ is being used properly, and therefore 100 ppm moisture represents a worst possible operating condition. While the leak sealant has been shown to seal in less than several hundred hours, our life testing (with Qwik**Seal**™ Part B and 100 PPM moisture added) has already surpassed thousands of hours of continuous operation without any failures. While this life testing is continuing, the testing to date has already far exceeded the time that is necessary for the leak sealant to react with moisture in the system and potentially seal an expansion device or create wear particles in the lubricant. At this time both R-22 and R-410A systems have been running (with Qwik**Seal**™ Part B and 100 PPM moisture added) for thousands of hours of continuous operation with no observed degradation of the lubricant.

Conclusion

While more testing is being performed, these preliminary results are sufficient to say that Qwik**Seal**™ has been shown to completely seal leaks in vapor lines as large as 5.8 pounds per year however, leaks in the liquid line greater than 0.1 pound per year may not completely seal. The sealing process can take as little as 10 minutes, but it could also take as long as a week to completely seal. Higher oil circulation rates and higher system temperatures (and possibly higher humidity) may accelerate the rate of sealing, but this has not yet been confirmed.

Qwik**Seal**™ (QT2540) is available as a two-part formula and each part (A and B) is introduced into an operating system with a reusable half-ounce Qwik**Injector**® (QT2510). The use of a drying agent is mandatory and is part of the Qwik**Seal**™ formulation (Part A), to assure the sealing agent (Part B) does not react with moisture in the lubricant. Clearly, any reaction with moisture in the lubricant would destroy the lubrication quality of the oil or create sealant deposits in the lubricant. Finally, remember leaks sealants should only be used as a last resort, on old systems, where other attempts to find the leak have failed, and the system is not worth spending too much money to repair.