Checking Vacuum in AC/R Systems

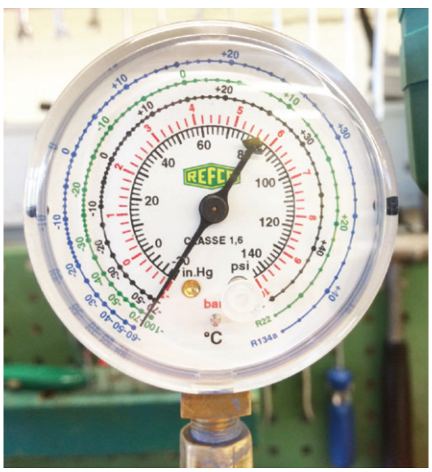
By Sheb Powell Area Sales Manager, REFCO, Manufacturing Ltd., Hitzkirch, Switzerland

Introduction

Most AC/R installers either watch time tick by or they watch the negative side of a compound pressure gauge to determine the level of system evacuation reached. While these system evacuation methods are both very common, unfortunately they are both incorrect. Without a digital vacuum gauge installers have no real idea to what level the system has been evacuated. Measuring a micron vacuum level using inches of mercury (in Hg) on negative side of compound gauge is like trying to measure centimeters using your cars odometer. It simply cannot be done accurately.

Checking Vacuum with a Compound Gauge

For example, please view the picture of the compound gauge below. Can you accurately tell the difference in-between 29.9 inHg and 29.14 inHg using the analog gauge face? The difference in-between these two analog readings would be less than the width of the indicator needle itself. Using traditional analog compound gauges AC/R technicians cannot accurately measure their system vacuum level. It is impossible with such a coarse measurement scale.



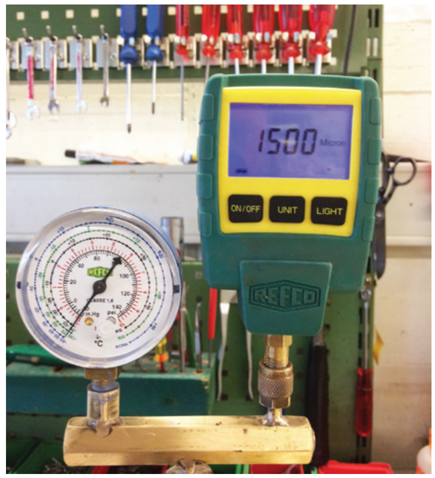
Digital Vacuum Gauge

This is why using a digital vacuum gauge is mandatory equipment for correct AC/R installations. OEM manufacturers like Daikin, LG, Carrier, Voltas and others all require a system evacuation down to 500 microns before any refrigerant is introduced into a new or repaired AC/R system.

MICRON (millitorr)	INCHES HG
760000 (1 atmosphere)	**0 (1 atmosphere)**
750,000	0.42
600000	6.32
400,000	14.22
200,000	22.07
100,000	25.98
45,000	28.15
20,000	29.14
1,000	29.88
700	29.89
600	29.9
500	29.9
400	29.9
300	29.91

Why does every equipment manufacturer recommend pulling a system evacuation down to ±500 microns? It is because they know the compressor life as well as the overall system operating efficiency are both severely degraded if the initial system evacuation is not done correctly.

What happens is, atmospheric air and even worse water vapor (moisture) are both still inside a system that is not evacuated down to 500 Microns. The residual water vapor when mixed with the refrigerant oil and system refrigerant under the pressure and temperature of a compressor will actually create hydrochloric and hydrofluoric acid. These are both very corrosive acids that literally destroy the AC/R system components



from the inside out. These acids will kill your new system.

The overall system efficiency is also degraded because air commonly referred to as non-condensable is left inside the system without a proper system evacuation. When the A/C system runs, this non-evacuated air generally gets trapped in the upper part of the outdoor condenser coil and that is where it stays. If you look at an outdoor condenser coil of any brand and imagine that $^1/_4$ to $^1/_3$ of the condenser coil surface is now unusable, imagine what is happening to the refrigerant that is passing through the outdoor condenser. Remember the function of an outdoor condenser is literally to condense superheated refrigerant vapor down to a subcooled liquid during cooling operation. If we are to lose $^1/_4$ to $^1/_3$ of that subcooling heat transfer condensing coil surface because it contains non-evacuated air, our outdoor condenser has lost part of its ability to properly and efficiently subcool the refrigerant before it goes indoors to the evaporator. This means for the life of the system the building owner will pay more for the operation costs of the A/C system than they would have if it was evacuated properly from the beginning. Further, the system pressures and operating temperatures will both be higher which will accelerate the premature death of the system compressor.

Usually, the first system component to fail is the compressor or the compressor bearings themselves, which is an expensive and inconvenient repair. This premature compressor failure could have been completely avoided if the initial system installer just used a proper digital evacuation gauge to correctly measure system evacuation. Installers who do not use digital evacuation gauges are actually killing new compressors without even knowing they are doing it. When they walk away from a newly installed system it is operating correctly and making cold air. However, what they don't know is how much moisture was left inside the system when they charged it with refrigerant. How could they? There is no way to accurately read the evacuation

PRESSURE CONVERSION TABLE — by :H.Tring/T.Stec

MILLIBAR	TORR (mm of Hg)	MICRON (millitorr)	INCHES HG	PSI Pounds Per Square Inch	PASCAL (Pa)
1013 (1 atmosphere)	760 (1 atmosphere)	760000 (1 atmosphere)	0 (1 atmosphere)	14.69 (1 atmosphere)	101,325 (1 atmosphere)
1000	750	750,000	0.42	14.5	100,000
800	600	600000	6.32	11.6	80,000
533	400	400,000	14.22	7.73	52,300
267	200	200,000	22.07	3.87	25,700
133	100	100,000	25.98	1.93	13,300
60	45	45,000	28.15	0.87 (8.7 x 10^{-1})	6,000
27	20	20,000	29.14	0.39 (3.9 x 10^{-1})	2,700
1.33	1.0	1,000	29.88	0.02 (2.0 x 10^{-2})	133
0.93 (9.3 x 10^{-1})	0.7 (7.0 x 10^{-1})	700	29.89	0.013 (1.3 x 10^{-2})	93
0.78 (7.8 x 10^{-1})	0.6 (6.0 x 10^{-1})	600	29.9	0.011 (1.1 x 10^{-2})	78
0.66 (6.6 x 1^{-1})	0.5 (5.0 x 10^{-1})	500	29.9	0.009 (9.0 x 10^{-3})	66
0.53 (5.3 x 10^{-1})	0.4 (4.0 x 10^{-1})	400	29.9	0.008 (8.0 x 10^{-3})	53
0.40 (4.0 x 10^{-1})	0.3 (3.0 x 10^{-1})	300	29.91	0.006 (6.0 x 10^{-3})	40
0.26 (2.6 x 10^{-1})	0.2 (2.0 x 10^{-1})	200	29.91	0.004 (4.0 x 10^{-3})	26
0.13 (1.3 x 10^{-1})	0.10 (1.0 x 10^{-1})	100	29.92	0.002 (2.0 x 10^{-3})	13
0.09 (9.0 x 10^{-2})	0.07 (7.0 x 10^{-2})	70		0.0013 (1.3 x 10^{-3})	9
0.08 (8.0 x 10^{-2})	0.06 (6.0 x 10^{-2})	60		0.0011 (1.1 x 10^{-3})	8
0.07 (7.0 x 10^{-2})	0.05 (5.0 x 10^{-2})	50		0.0009 (9.0 x 10^{-4})	7
0.05 (5.0 x 10^{-2})	0.04 (4.0x 10^{-2})	40		0.0008 (8.0 x 10^{-4})	5
0.04 (4.0 x 10^{-2})	0.03 (3.0 x 10^{-2})	30		0.0006 (6.0 x 10^{-4})	4
0.03 (3.0 x 10^{-2})	0.02 (2.0 x 10^{-2})	20		0.0004 (4.0 x 10^{-4})	3
0.013 (1.3 x 10^{-2})	0.01 (I.0 x 1^{-2})	10		0.0002 (2.0 x 10^{-4})	1.30
0.007 (7.0 x 10^{-2})	0.005 (5.0 x 10^{-3})	5		0.000096 (9.6 x 10^{-5})	0.70 (7.0 x 10^{-1})
0.0013 (1.3 x 10^{-2})	0.001 (1.0 x 10^{-3})	1		0.000019 (1.9 x 10^{-5})	0.13 (1.3 x 10^{-1})
0.0007 (7.0 x 10^{-2})	0.0005 (5.0 x 10^{-4})	0.50 (5.0 x 10^{-1})		0.0000096 (9.6 x 10^{-6})	0.07 (7.0 x 10^{-2})
0.00013 (1.3 x 10^{-2})	0.0001 (I.0 x 10^{-4})	0.10 (1.0 x 10^{-1})		0.0000019 (1.9x 10^{-6})	0.013 (1.3 x 10^{-2})

micron level on a traditional analog compound gauge face. Remember that a 29.14 inHg evacuation level is only equal 20,000 microns. That evacuation level is not even close to the OEM specified evacuation level of 500 Microns. However, if you looked at an analog gauge face and see the needle buried in a vacuum level of 29.14 inHg, it looks like it is a good system vacuum, right? Wrong! Please review the attached pictures of a typical analog compound pressure gauge mounted in parallel with an accurate digital micron gauge. The pictures tell the story far better than I can say it. Please review the first picture at 500 microns as compared to the last picture at 15,000 microns. The analog gauge shows no discernable difference.

How Water Vapour Kills the Compressor

The new system compressor may last for a year or maybe two, but it will definitely die a premature death from the water vapor that was not correctly evacuated during the initial installation.

Personally, I find the causation linkage in-between the burned out compressor and the incorrect initial system evacuation to be one of the least understood aspects of our industry. This is primarily because the time period between the two events is inconsistent. It can range anywhere between 6 and 24 months. In my opinion, this wide variation of premature compressor failures is due to the different levels of system use, ambient conditions, manufacturer compressor component tolerances, unit capacity, and also how much moisture was originally left in the system during installation. Further, this is exacerbated because the repair service technician who is called out to repair a burned out system is rarely the same service technician who initially installed that particular system.

Conclusion

In earlier decades, AC/R technicians used what they had available. At that time in the 1970-1980s, digital evacuation gauges were relatively rare and expensive, which is why we still manufacture and use compound analog gauges today. Fortunately, those days are now over. Accurate and reliable digital evacuation gauges are readily available from many world renowned tools manufacturers. There is no longer any compelling reason to continue to use long outdated installation methods and tools.

For example, REFCO has introduced the REF-VAC digital vacuum gauge (Part # 4686712) into the world AC/R market. This affordable digital vacuum gauge has a micron range from 0-18,000 Microns. The units of measure include Microns, Mbar, Pascal's, mTorr, Psi, and inHg. With a segmented five digit high resolution backlit display, you can accurately read the actual vacuum level during a system evacuation.