

Deep Vacuum Principles and Application Training



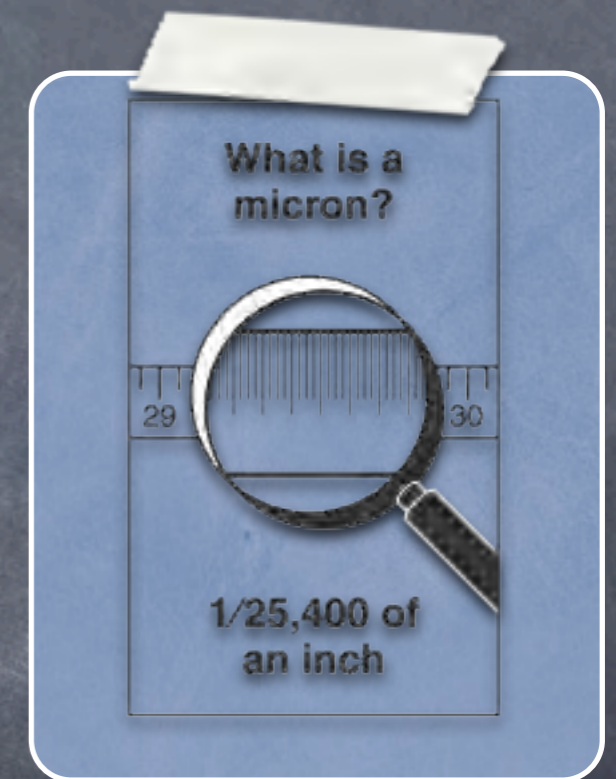
Introduction

- Deep Vacuum Method of evacuation is the only method to use to be sure the system is thoroughly dry and free of non-condensibles and leaks.



Measuring Evacuation: Microns or Inches?

- Micron is a unit of measurement starting from a perfect vacuum (no pressure) that is expressed in linear increments.
- One inch= 25,4000 microns thus one micron= 1/25,400 of an inch.
- When discussing vacuum in terms of microns, this refers to total ABSOLUTE pressure as opposed to GAUGE pressure.



Microns versus Inches

- Microns are more accurate unit of measure.
- Starting from the same measuring point each time (theoretical perfect vacuum).
- Bourdon tube type gauge (analog manifold gauges) cannot read fractions.
- Bourdon tubes use atmospheric pressure as reference point which is under constant change throughout the day.





Deep Vacuum readings via
micron gauges are critical
for High SEER systems.



Digital Micron/ Vacuum Gauges

Tells you positively that the system is non-condensable and leak free.

Calibrated in microns of mercury.

Evacuation is complete when a system holds at 500 microns.

A compound gauge only indicates a vacuum is being produced. A micron gauge is the only device that accurately reads the vacuum pressure needed for deep vacuum.



How the micron gauge works

- Heat sensing device, whereby the sensing element is mechanically connected to the system, generates heat.
- The rate at which this heat is carried off changes as the surrounding gases and vapors are removed.
- The output of the sensing element (either a thermocouple or thermistor) changes as the heat dissipation rate changes.



Micron Gauge: Selection and Accuracy

- Most important: RANGE
- If a micron gauge's range is only 50 to 1,000 microns, you will not be able to determine whether you are pumping against a leak or against moisture. Need one with a range of at least 50 to 9,000.



• Next important: ACCURACY

- Affected by two factors, extreme temperatures and sensor contamination.
- Vacuum sensor is calibrated on air. If refrigerant gas or oil is drawn into the sensor, an erroneous reading will occur.
- Any oil entering into the vacuum sensor via the hose will also affect accuracy. Improper shut down of the pump after evacuation or power loss will suck back oil and contaminate the hose.
- A hose used for charging or testing will contain droplets of system oil spurted into the hose when the Schrader valve is open. If same hose is used for hook-up, oil will collect in the gauge sensor. Use a dedicated hose with o-ring for evacuation.

- JB's DV-22 and Supernova DV-40 reference AVERAGE accuracy readings. Between 250 and 6000 microns, the units are +/- 10% AVERAGE accuracy.
- Means if you take the reading on these units against the MKS Baratron master gauge at each increment displayed on the units, the readings are +/- 10% the average.
- Small differences in ranges are not significant:

Micron Range	Micron Difference
60-100	10-20
200-350	30-40
500-700	50-60
900-1500	80-100
2500-4000	200-300



DV-41 Supernova Micron Gauge

- Accurate from 12,000 microns down to 10
- User defined programs such as backlight duration, shut off, and setting of alarms when system reaches a defined mark
- Brass fitting on lengthy flexible cord
- Large LCD screen
- Factory calibrated and needs no additional calibration



DV-22 Micron Gauge

- Accurate from 9,000 microns down to 20
- Saves last vacuum readout after shut down
- Leak-proof with o-ring coupler to ensure proper register of vacuum
- Reads vacuum in 7 international units including microns, InHg, PSIA, mBars, Pascals, Torr, and mTorr



Evacuating through a Gauge Manifold

- Evacuate through a gauge manifold, ONLY IF, it is an o-ring sealed, piston construction (all of JB's manifolds are manufactured this way). Any other type leak under vacuum.
- Evaluate the center port. In order to handle the full capacity of both the high and low sides, the center intake should have a double-size flow path throughout its length.



Leak-Proof Hook-Up

- Deep vacuum has its own unique properties that require a leak-free design- not just the manifold but all components.
- The only connecting lines that are absolutely vacuum tight are soft copper tubing or flexible metal hose.
- Charging and testing hose are designed for pressure therefore, permeation still exists.
- When checking pressure rise, the atmosphere will permeate to the lower pressure in the hoses and the micron reading will slowly rise.



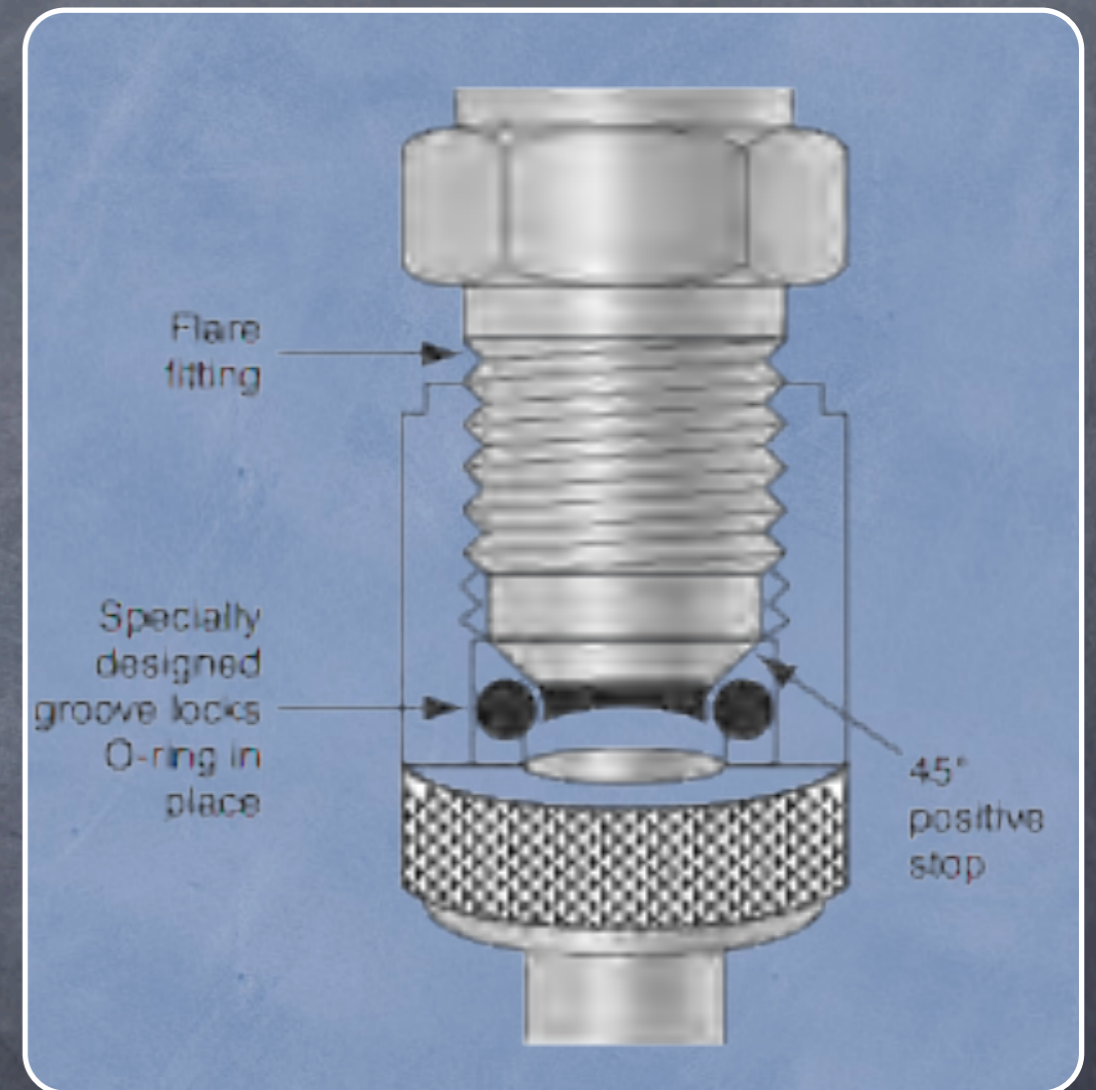
Other Areas of Leaking

Gasket seal in the valve and hose couplers is another source of leakage.

Seal is designed for charging and will not give a perfect seal required in deep vacuum service.

O-ring seals form around any irregularities in the flare fitting.

When coupler is screwed down, the result is a metal-to-metal seat and the o-ring lays around the lip of the flare to give a positive seal.

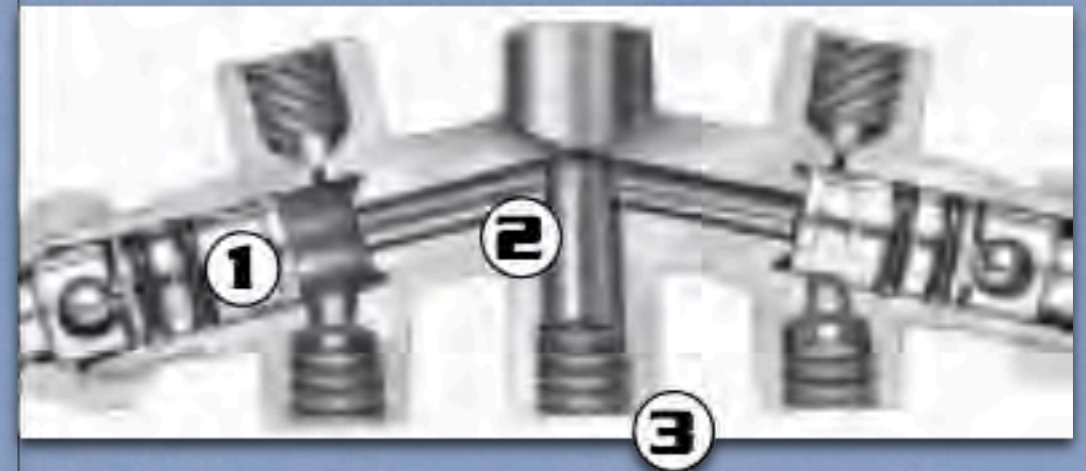


Connecting Lines

- Summary of the hook-up:
- Gauge manifold with two 1/4" I.D. connecting lines to the system and a 3/8" connection to the pump via line or fittings.



J/B Piston Type Manifolds



- 1. Stem seats retract completely from flow path.*
- 2. Double size flow path throughout length of center port.*
- 3. Convert to 3/8" port with 3/8mf x 1/8mp*

Note About Line Size

- Much has been said about line size, which would lead you to believe that the bigger the line used to connect, the faster the job will be.
- TRUE, except for the compressor's service valves orifice is $3/16''$
- Therefore, we only need to keep the connecting lines' I.D. larger than $3/16''$
- This is one of the limiting time factors in evacuation.



Time Savers

- Evacuation should always be done from both the low and high sides of the system.
- Saves as much as 3/4 of the time when evacuating from only one side
- Short connecting lines will save some time, but not nearly what is sometimes stated. In relation to the lengths of tubing in the system, we add very little restriction via connecting lines.



Before You Start

- Always a good idea to attach a micron gauge to the vacuum pump to make sure the pump pulls down to at least 50 microns.
- If it doesn't, your pump oil is contaminated and should be changed.
- Do not shut off the blank-off valve on the pump and expect the gauge to hold a vacuum as the gauge will fall back to atmosphere. (The sensor in the gauge is too close to the pump and does not have time to equalize).

Best Leak-Proof Micron Gauge Hook-Up

- JB's test unit, DV-29 creates a closed system and eliminates any leakage under vacuum.
- The DV-29 consists of: 10" flexible metal line with o-ring quick couplers, 90 deg. male flare with 1/4" o-ring quick coupler, ball valve with o-ring quick coupler, and a valve assembly with 1/4" male flare connections



- When designing your hook-up system, choose from the following hoses, valve and couplers designed for leak-proof service in a deep vacuum environment:
- 1/4" or 3/8" metal hose with o-ring couplers hooked up through the manifold, pump, and micron gauge.
- Quick coupler tee with o-ring seal. Most accurate readings are obtained at compressor's high or low sides, use this arrangement to tee off the gauge.
- Ball valve with o-ring quick coupler to valve off gauge before charging. Depending on the gauge, the sensors of the electronic gauge will not take pressure beyond 1 to 100 lbs. Depending on the hook-up, use this arrangement with a metal hose or coupler.



Dispelling the Argument of "No Deep Vacuum on Heat Pumps"

The word "sublimation", the ability of moisture to go directly from a solid ice to a vapor without passing through a liquid state, is commonly used in vacuum. This phenomenon is observed when wash is hung out in the winter and freezes solid. Still, in time, it dries due to sublimation. If lines are in a cold ambient, it is possible to have ice in the system. It will be removed during evacuation. Of course, the addition of heat (heat gun only) at these cold spots speeds up the job.

Pressure Rise Test

- The only difference between deep vacuum and the methods used in the past is that we can measure what we have done.
- This is done through the pressure rise test.

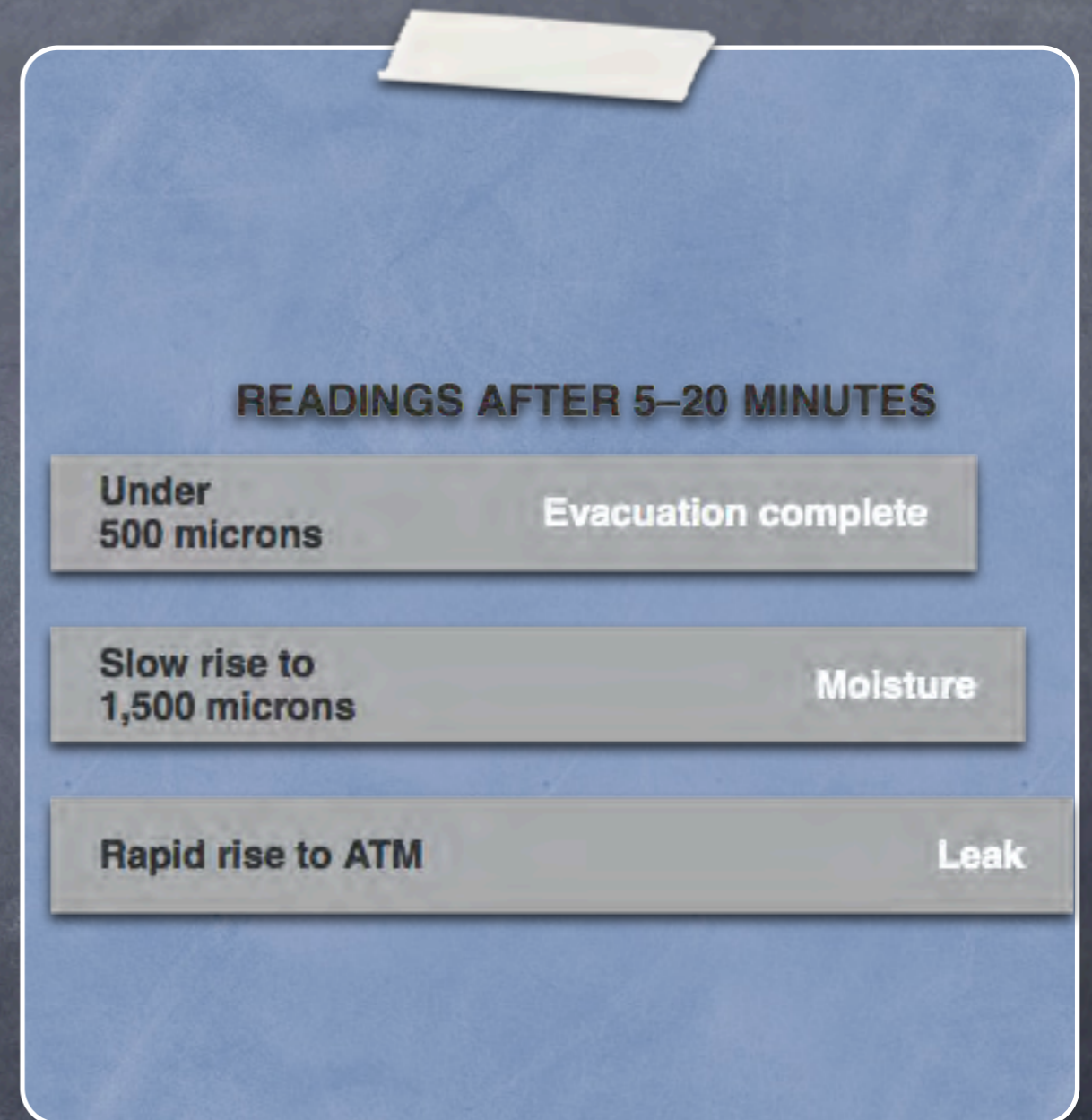


Performing Pressure Rise Test

- Using DV-29, Blank-off the high and low side ball valves attached to the system.
- Using general hook-up method, this includes copper tubing or metal hose to the high and low side, close blank-off valve on pump. This will isolate the gauge from the pump.
- Wait 5 to no more than 20 minutes to allow system pressure to equalize. The reading will be very close to what you actually have in the system.

Interpreting the Reading

- A rapid rise during this test to atmospheric pressure indicates a leak.
- Slower rise to around 1500 microns indicates moisture is present.
- Under 500 microns, evacuation is complete.



READINGS AFTER 5-20 MINUTES	
Under 500 microns	Evacuation complete
Slow rise to 1,500 microns	Moisture
Rapid rise to ATM	Leak

- There are many recommendations regarding evacuation levels, some which state "Evacuate system to below 200 microns". This should NOT be considered. Note that the word "system" is used here because it is possible to evacuate piping or some component other than the compressor to below this level.
- Refrigeration oil has a vapor pressure and, by going below 200 microns, you will de-gas particles of the refrigeration oil. Be aware that if you change the makeup of the oil, it will no longer be a true lubricating oil.

Evacuation brings out the worst in a system

Remember that hydrofluoric and hydrochloric acids (and moisture) can and do collect in oil. They effectively destroy pull down and act as an abrasive. If let sitting idle in a pump, they will rust and corrode internal surfaces. Deep vacuum needs a fill or two for EVERY job.



CHANGE YOUR OIL!!!

In order for your pump to pull a near perfect vacuum, oil must be clean and moisture-free throughout evacuation. After each job drain, flush, and refill. Doing so will keep the pump running at peak performance and maintenance-free for years.



CHECK THE OIL BEFORE TAKING A JB PUMP BACK

JB manufactures all of our pumps here in the USA. 95% of the pumps we see returned to us are due to the end user not changing the oil. Before giving your customer a new pump on the OTC warranty, check for visible signs of damage and change the oil. Simply educating your customer on the importance of changing the oil will save you time and money. Not changing the oil **VOIDS** the JB OTC warranty.



Black Gold Vacuum Pump Oil

Best Oil in the industry

Extremely Pure and non-detergent

hydro-processed from a series of catalytic steps rendering the oil extremely refined, more viscous, and more stable

Alerts to contamination quicker as it becomes cloudy or milky

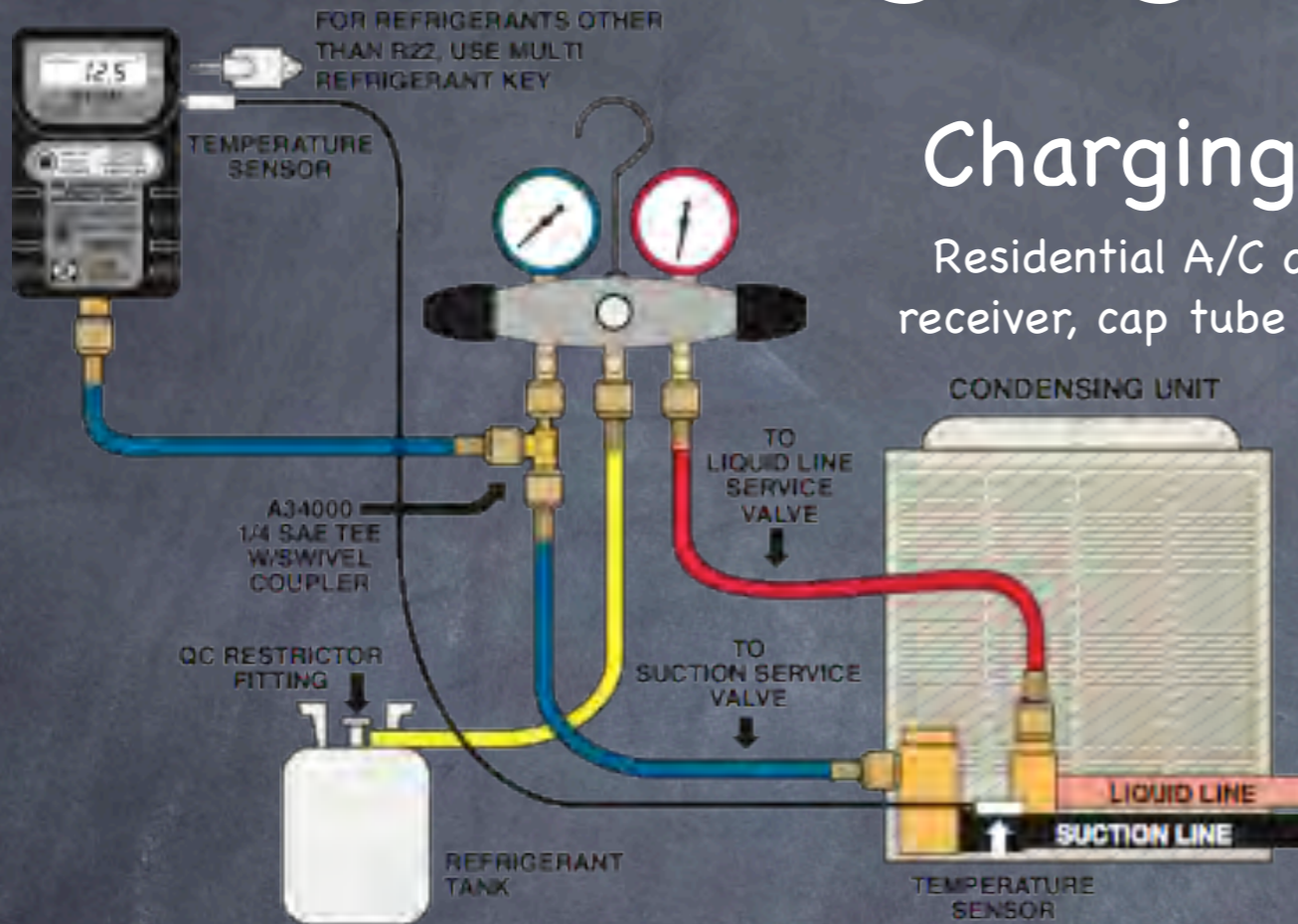
In extreme temperatures, the oil will be more resistant to contaminants



Charging Methods

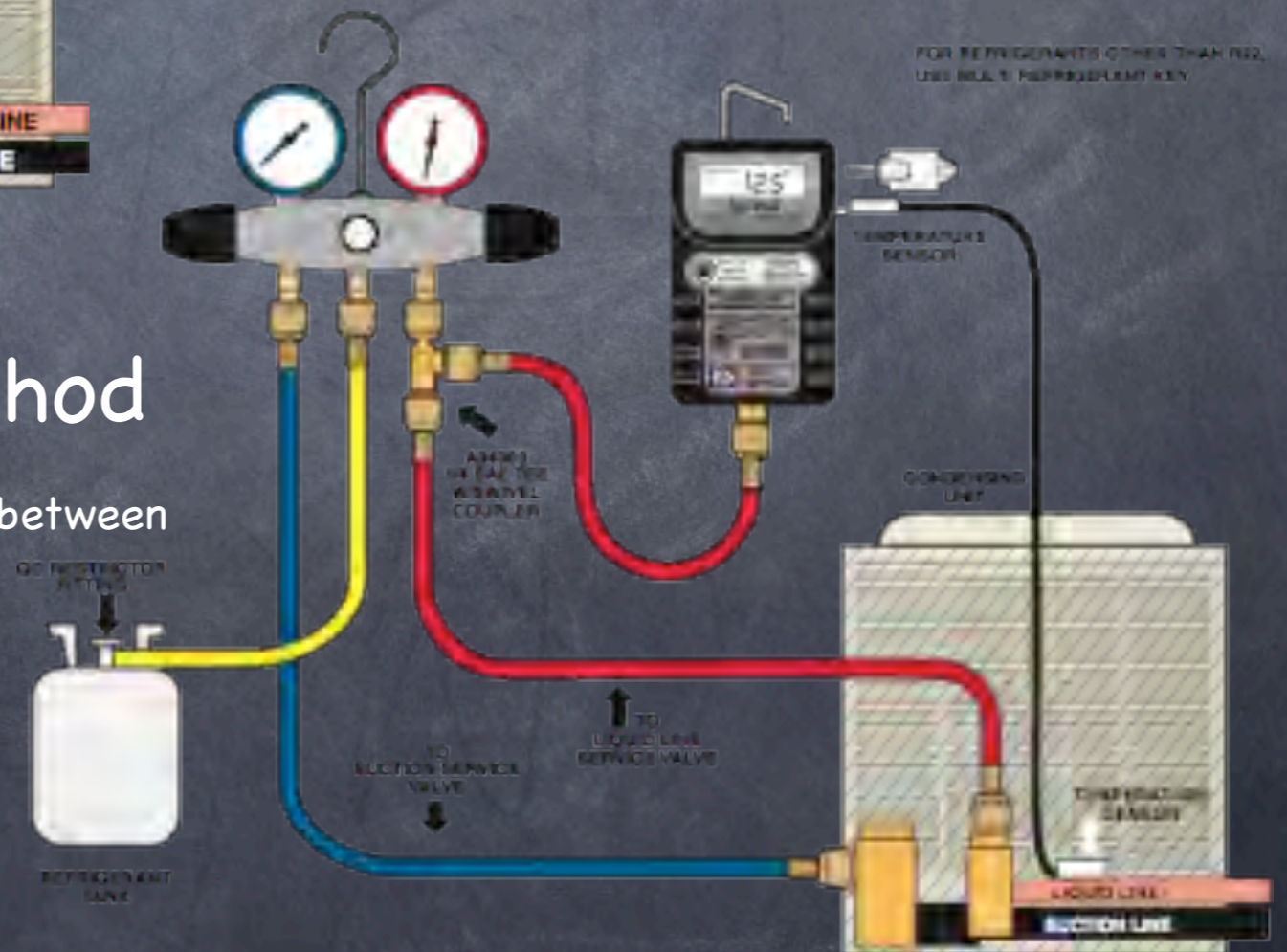
Charging by Superheat Method

Residential A/C or refrigeration systems equipped with TXV and receiver, cap tube or metering device. Contact OEM for Superheat Value.



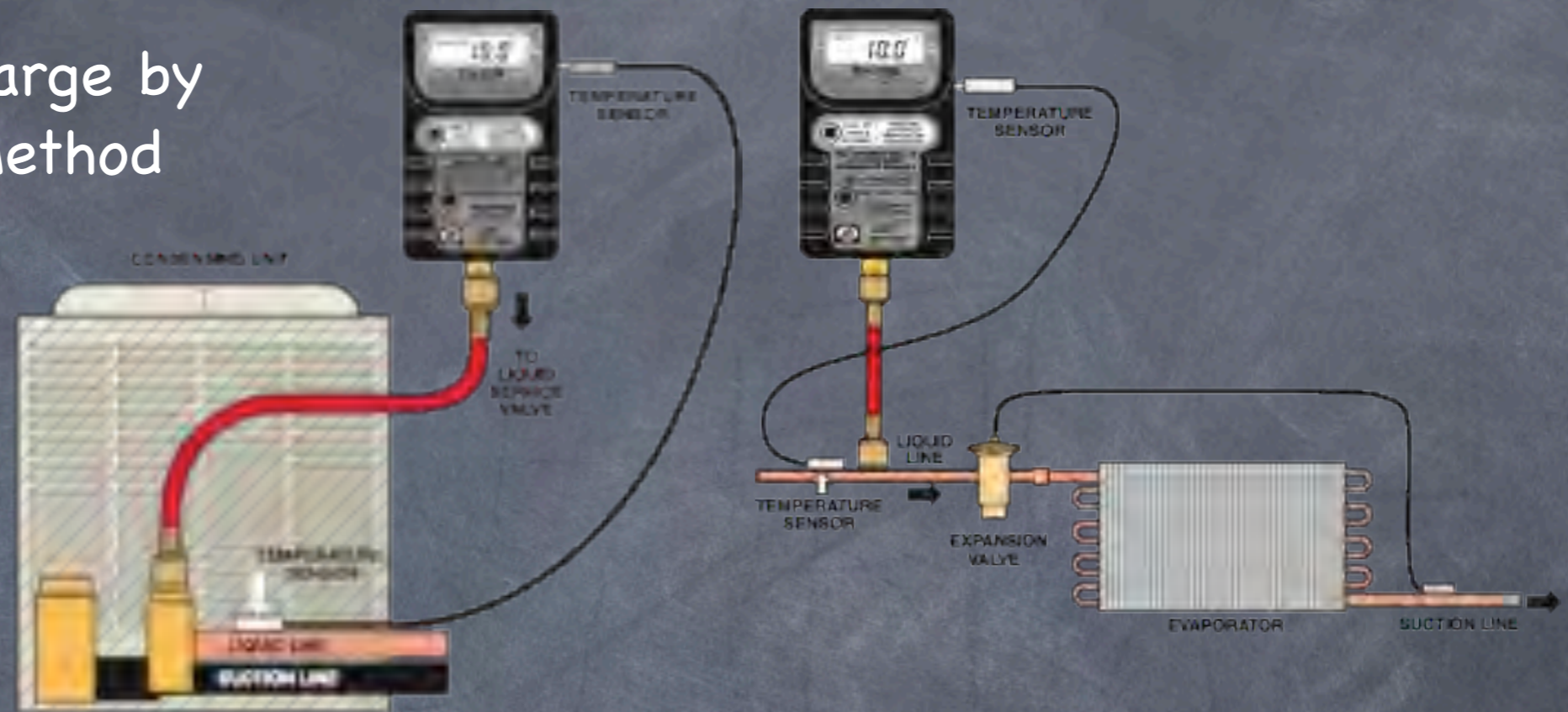
Charging by Subcooling Method

Contact OEM for Subcool Value. Average subcool value is between 10 to 12 degrees F.

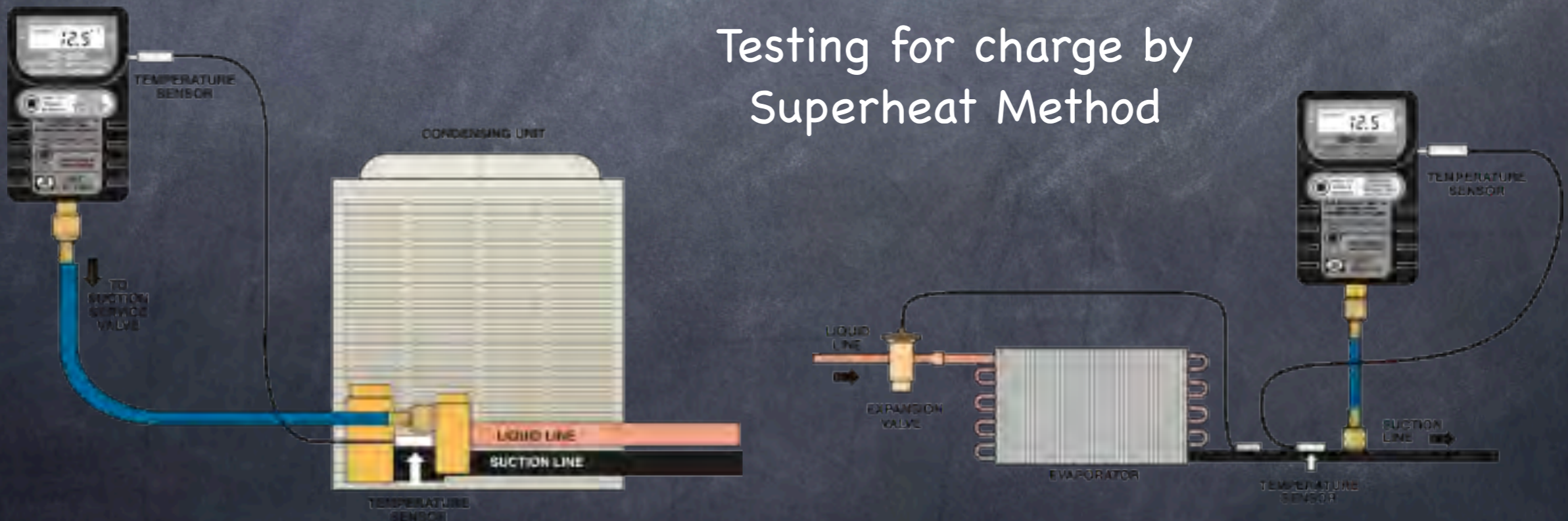


Testing Methods

Testing for charge by
Subcooling Method



Testing for charge by
Superheat Method



Cross Reference of Vacuum Measurements: Boiling Temperatures of Water at Converted Pressures

Cross Reference of Vacuum Measurements

BOILING TEMPERATURES OF WATER AT CONVERTED PRESSURES

<u>TEMPERATURE IN FAHRENHEIT</u>	<u>MICRONS</u>	<u>INCHES OF HG VACUUM</u>	<u>PRESSURE POUNDS Sq. In.</u>
212	759,968	0.00	14.696
205	535,000	4.92	12.279
194	525,526	9.23	10.162
176	355,092	15.94	6.866
158	233,680	20.72	4.519
140	149,352	24.04	2.888
122	92,456	26.28	1.788
104	55,118	27.75	1.066
86	31,750	28.67	0.614
80	25,400	28.92	0.491
76	22,860	29.02	0.442
72	20,320	29.12	0.393
69	17,780	29.22	0.344
64	15,240	29.32	0.295
59	12,700	29.42	0.246
53	10,160	29.52	0.196
45	7,620	29.62	0.147
32	4,572	29.74	0.088
21	2,540	29.82	0.049
06	1,270	29.87	0.0245
-24	254	29.91	0.0049
-35	127	29.915	0.00245
-60	25.4	29.919	0.00049
-70	12.7	29.9195	0.00024
-90	2.5	29.9199	0.00005
	0.00	29.92	0.00000



Vacuum Pump and How to Select the Pump

The first mistake usually made in selecting a pump:

“The larger the pump, the faster I can do the job”

Pump Capacity has very little to do with evacuation time in refrigeration systems. Let's review the reasons why:



Bigger isn't always Better

- Refrigeration systems are constructed of several feet of small diameter tubing.
- These small tubes also have return bends and metering devices that offer restriction during evacuation.
- Add to that, service valves have 1/4" male flare ports with only 3/16" orifices.
- The only way to get more flow through a given orifice is to increase the pressure across that orifice.
- A vacuum pump DOES NOT create pressure that increases flow



Remember these two basic principles:

1. A vacuum pump creates a void toward which the system pressure flows.
2. As pressure decreases in the system during evacuation, flow also decreases. Therefore, it is **IMPOSSIBLE** to increase the pressure or flow through a gauge port with a larger pump.



- Pumps in the 1.5 to 10 CFM class are adequate to handle 99% of air conditioning and refrigeration work.
- CFM rule of thumb: CFM squared = maximum system tonnage. Thus a 7 CFM pump is rated for 49 tons; a 3 CFM pump is rated for 9 tons.
- Depending on the system line sizes of large-tonnage systems, it is better to put two smaller, easily handled pumps, at different locations.
- This will overcome some of the pressure drop problems and actually be faster than a single, large pump.



Vacuum Pump Construction

- Rotary-vane deep vacuum pumps are best suited for air conditioning and refrigeration service.
- Piston-type pumps, due to the clearance necessary between piston and head, are incapable of producing deep vacuum.
- Single-stage compressors, similar to hermetic compressors, will not evacuate a system into a micron range nor condense any moisture vapor in the system.



- Two stage pumps have the ability to produce consistently lower pressures and are efficient at removing moisture vapor.
- The pump should have a blank-off valve or attach an external blank-off valve in order to perform isolation tests (pressure rise) required in deep vacuum procedures.
- The gas ballast should be on all pumps used in refrigeration. At the start of evacuation, water vapor is quickly removed. If a system is laden with moisture, the oil gets contaminated fast.
- The gas ballast is a fine metering device connected to the second stage of the pump that allows a small amount of relatively dry, ambient air in to help prevent moisture vapor from condensing in the oil.



Summary of Pump Needs

- Two-stage, Rotary Vane
- 1.5 to 10 CFM with blank-off valve (or purchase external one) and gas ballast (needed for refrigeration)
- Systems are evacuated to 300–400 microns, so pump should be able to produce a vacuum in the low micron range with a safety factor of at least 25 microns total absolute.
- Lightweight and rugged construction. This is a large dollar purchase so invest in this product. You can buy a pump that is not repairable and buy a new one every time something breaks, or spend a little more money and have a pump that will last through the years.



JB Eliminator VS. Platinum





PLATINUM

- Micron Rating **15**
- Warranty 24 month
- 100% Made in the USA
- 100% Field Repairable
- 1/2" Exhaust
- 2 stage direct drive, 1/2 HP 1725 RPM motor
- **GAS BALLAST**
- **BLANK OFF ISOLATION VALVE LIFT RING**
- **Finned Aluminum Housing (reduces heat)**
- **PUMP YOUR RIDE**

ELIMINATOR

- Micron Rating 25
- Warranty 24 month
- 100% Made in the USA
- 100% Field Repairable
- 1/2" Exhaust
- 2 stage direct drive, 1/2 HP 1725 RPM motor

JB Pumps Vs. The Rest

JB Pumps

- Micron Rating 25
- Warranty 24 month OTC*
- 100% Made in the USA
- 100% Field Repairable
- 2 stage direct drive, 1/2 HP
1725 RPM motor
- JB Pump Days from JB reps
provide service and cosmetic
parts on JB pumps

Others

- Most made overseas and are
disposable
- There are no repair parts to fix
pumps
- Difficult warranty
- No customer service or Pump
Days for support

JB Eliminator Vs. Chinese



- Micron Rating 25
- Warranty 24 month OTC*
- 100% Made in the USA and 100% Field Repairable
- 2 stage direct drive, 1/2 HP 1725 RPM motor
- All metal construction and brass caps
- Much larger oil capacity than the import pumps
- JB Pump Days from JB reps provide service and cosmetic parts on JB pumps
- Micron Rating 40
- Made overseas and are disposable
- There are no repair parts to fix pumps. Oil drain is a plug rather than a drain
- Smaller motor-3400 RPM runs too fast to be durable. Runs faster and hotter.
- Fan needed to keep motor cool. Fan and shroud always break
- Plastic Caps and Construction allows for cracks around electrical circuit
- No customer service or Pump Days for support

For Questions or Further
Technical Assistance
please visit our website
www.jbind.com or call
our Technical Support
line at 800-323-0811

