If the mechanicals don't work,
The biologics can't work.

What We Find

OHIO EPA DIVISION OF SURFACE WATER
COMPLIANCE ASISTANCE UNIT

PREPARED FOR:

OTCO Wastewater Workshop
April 5, 2017

About 20 minutes

Good Parameters

- Ammonia drops from influent to less than 1.0 mg/l at outfall
- Alkalinity above 120 mg/l at clarifier
- Nitrates above 35 mg/l at clarifier if timers not used
- Spins between 2% and 4% in aeration tank
- Settleometer below 800 in 5 minutes
- Coretaker in clarifier 20% or less of total depth

Typical Plant

- Trash trap
- Aeration tank
- Double-hopper clarifier
- Dosing tank
- Two sand filters
- Chlorination and de-chlor
- Outfall to stream

Typical Visit

- Influent ammonia 40 mg/l reduced to 10 mg/l
- Alkalinity 350 influent 80 mg/l in clarifier
- Nitrates 14 mg/l in clarifier
- Aeration tank dissolved oxygen 0.8 mg/L
- Spin 6%
- Settleometer 950 after 5 minutes
- 5’ of sludge in an 8’ clarifier
- One sand filter plugged and the other starting to flood

Where do we start?

Ammonia is high so let’s look at the troubleshooting page first

5 - Things Needed for Nitrification

Ammonia Troubleshooting Guide

1. Do you have enough air (O2)?
   a. You should have over **2 mg/L** in aeration tank.
   b. Diffusers need cleaned?
   c. Air leaks?
   d. Air blower timer programming off?
   e. Power outage?

2. Do you have enough bacteria?
   a. Over wasting sludge…
   b. Susceptible to rain event – wash outs?
   c. Sand filters covered in sludge?
   d. Sand filter dosing tank – check the dosing tank with a core sampler…
   e. Aeration tanks look very light brown in color?
   f. RAS pump plugged – check the clarifier with a core sampler…

3. Do you have enough Alkalinity?
   a. It should be **≥ 120** total alkalinity…
   b. High raw Ammonia (>40 mg/L) can indicate a potential shortage.
   c. Raw NH3 X 10 should be greater than Raw Alkalinity.
   d. Softened water, low flow toilets, tight collection system, mostly urine (ex: schools, Highway rest stops, stores)…

4. Temperature
   a. Should be **≥ 10°C.**
   b. Game over as you approach **5°C.**
   c. Insulated grates will correct this issue – 1” thick blue board.

5. Detention Time
   a. Periodic high flows slugging the plant (EQ pumps, influent pump station, I&I).
   b. If you have an EQ tank, compare gpm from flow control box with design flow in gpm.
   c. Compare average daily flow with design flow

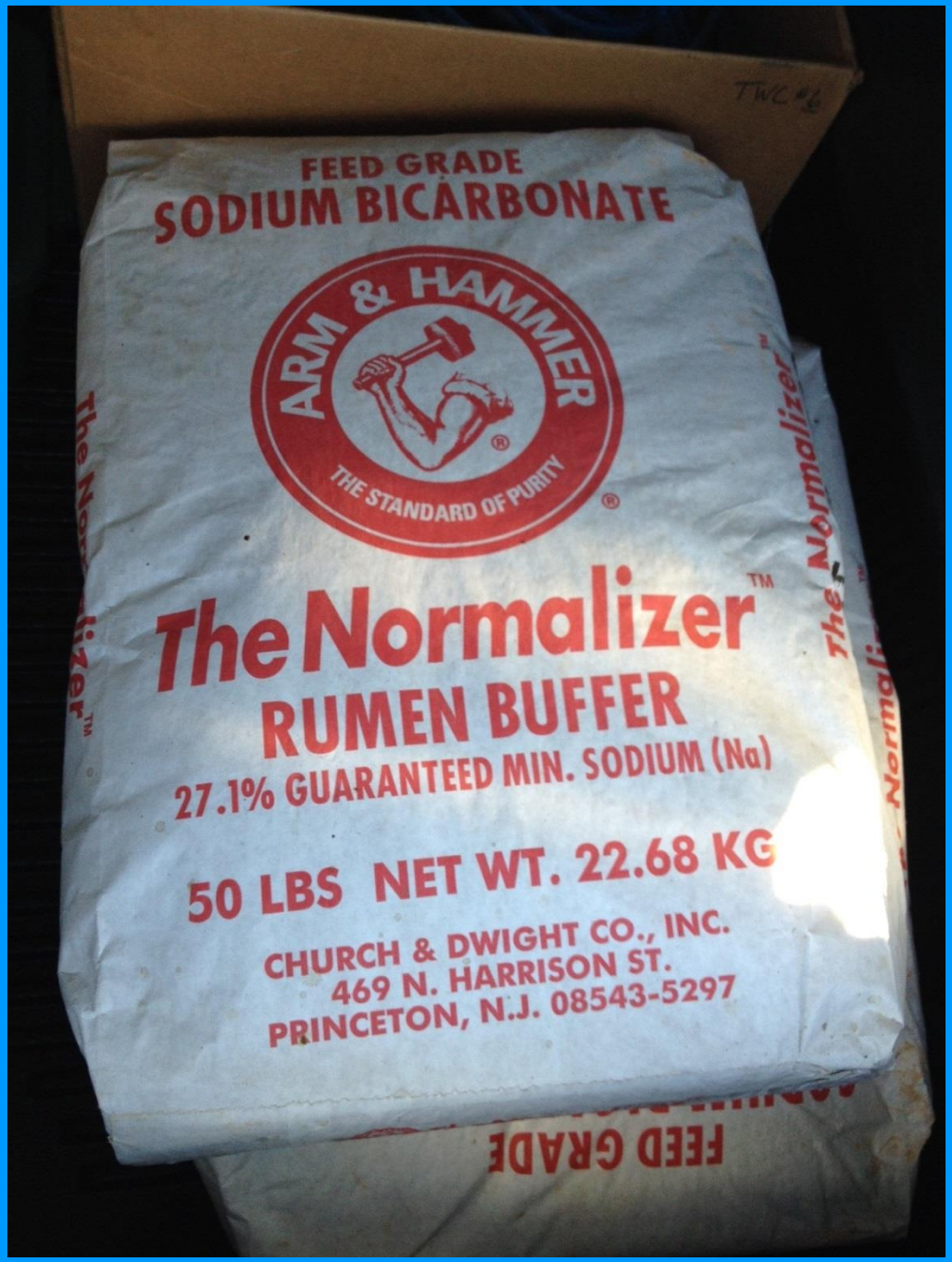
Where to start?

- Low DO, and low alkalinity.
- Alkalinity is 80 mg/l in the clarifier and ammonia is still 10 mg/l.
- Lower than expected nitrates confirms low DO. We have a reading of 14 mg/l instead of over 35 mg/l

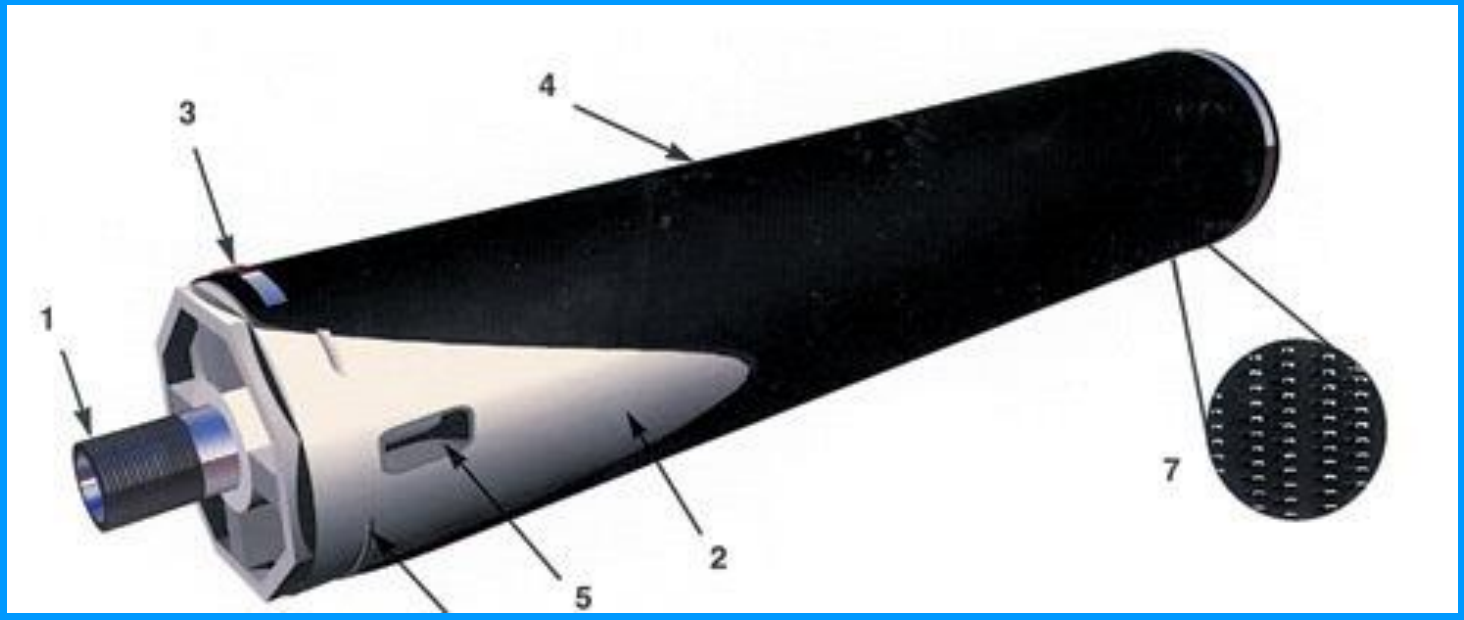
$10 to $16 per 50# bag

PH between 6.8 and 8.6

Min. 120 mg/l alkalinity IF ammonia is less than 1.0



- Low DO?
- Denitrification


4
3
1
7
2
5

Blower analysis

Determine the pressure by multiplying the water depth over the diffusers by .433 to get PSI.

Determine the speed by multiplying the motor speed by the motor pulley diameter, then divide that number by the blower pulley diameter to get rpms of the blower.

Look up the CFMs produced using the curve provided by the manufacturer and available on the internet.

The diffusers we recommended have a happy place between 2 and 9 cfm each, with a maximum of 15 cfm.

A 3” airlift pump consumes about 10 cfm.

Don’t forget other air uses like post-air or digesters.

2% to 4% works!!!!!

Find out what your plant likes best

Don’t grow filaments by keeping too many bugs in your plant

……Unless you really like foam and poor settling

As a general rule:

Less than 800 in 5 minutes

Less than 400 in 30 minutes

Untreated sewage won't settle

If your effluent ammonia is still less than 1.0 mg/l,

Try between 250 and 500 in 5 minutes.

It's all dependent on the organic load incoming!!!!!!

If you have EQ, pump clear water back to the EQ to speed drying times

Check the sludge amounts in the dosing tank several times per year and clean it when needed, <u>especially</u> if the sand filters have just been covered with solids.

Inspect the chlorine contact tank several times per year.

Cleaning out the sand dust and grass clippings will save chlorine.

If you have found your problems and corrected them, then you can clean the sand filters and expect them to stay clean.

Dirty sand filters are only a symptom of a problem.

Questions?????????

Someone has finally managed to
photograph the pot
at the end of the rainbow

Any More Questions??????????

The Blowers are BIG!

Why can’t I get enough DO?

OHIO EPA DIVISION OF SURFACE WATER
COMPLIANCE ASISTANCE UNIT

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OTCO Wastewater Workshop
April 5, 2017

If we can’t get enough air,

Do we need a new blower?

If we can’t get enough air,

do we need a new blower?

Maybe not.

FIRST!!!!

Do your homework!

According to 10 States Standards (92.331), there must be provided 1.1 pounds of oxygen per pound of CBOD5 at the design peak hourly loading.

Also provide for the nitrogenous load by multiplying the peak hourly TKN load by 4.6 pounds of oxygen per pound of nitrogen.

OR

Provide at least 2050 cubic feet of air for every pound of CBOD5 loading on the aeration tanks. (10 S.S. 92.332b)

THEN

Look up the CFM delivered by the blowers at the current speed and pressure

The blowers are probably large enough

You’ve just lost efficiency.

Troubleshooting 101

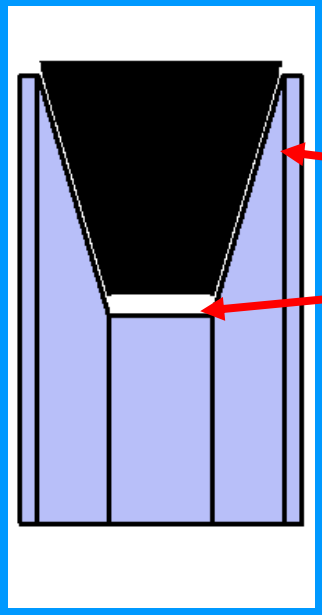
- **A logical Progression**
- **Source to end-use**

Let’s look at the blowers and motor first.

A V belt transfers power by friction and the mechanical advantage of the wedge-shaped section of the sidewalls, not the bottom.

Any contact with the bottom releases contact from the sides and slippage occurs.

Good fit!



Touching the sides.

NOT touching the bottom.

The major cause of motor, belt, and blower failures is improper tensioning of the belts

The major cause of motor, belt, and blower failures is improper tensioning of the belts

All of the power transmission depends on the tension on the belts.

A popular “Rule of Thumb” is to deflect the belt 1/64” per inch of center distance. That is to say, if the center distance between two shafts is 100 inches, the belts should be deflected 100/64” or 1 9/16”.

Recommended Tension for V-Belt Drives

V-Belt Section	Small Sheave Speed Range	Small Sheave Diameter	Deflection Force in Lbs. Speed Ratio 1.0	Speed Ratio 1.5	Speed Ratio 2.0	Speed Ratio 4.0 +
A	**1800-3600**	3.0	2.0	2.3	2.4	2.6
	1800-3600	4.0	2.6	2.8	3.0	3.3
	1800-3600	5.0	3.0	3.3	3.4	3.7
	1800-3600	7.0	3.5	3.7	3.8	4.3
B	**1200-1800**	4.6	3.7	4.3	4.5	5.0
	1200-1800	5.0	4.1	4.6	4.8	5.6
	1200-1800	6.0	4.8	5.3	5.5	6.3
	1200-1800	8.0	5.7	6.2	6.4	7.2
C	**900-1800**	7.0	6.5	7.0	8.0	9.0
	900-1800	9.0	8.0	9.0	10.0	11.0
	900-1800	12.0	10.0	11.0	12.0	13.0
	700-1500	16.0	12.0	13.0	13.0	14.0
D	**900-1500**	12.0	13.0	15.0	16.0	17.0
	900-1500	15.0	16.0	18.0	19.0	21.0
	700-1200	18.0	19.0	21.0	22.0	24.0
	700-1200	22.0	22.0	23.0	24.0	26.0

Figure 26, or calculate as follows:

$$t = C2 - \frac{D-d}{2}$$

Where:

t = span length, in inches

C = center distance, in inches

D = large sheave pitch diameter, in inches

d = small sheave pitch diameter, in inches

Step 3. Calculate the static strand tension (Ts) per belt by the following formula:

Design HP x K

Ts = Q x S + Tc

Where: K = value from Table 29 depending on value of D - d

C

Q = number of belts/ribs on drive

S = belt speed, feet per minute / 1000

Tc = add-on tension allowance for centrifugal force, from Table 31 on page 291.

Note: The value of Ts is for an individual V-belt. If a banded V-belt is used, refer to "Elongation Method."

Step 4. Calculate the recommended minimum and maximum deflection forces (P), in pounds:

Ts + Y (1.5 x Ts) + Y

Pmin =

16

Pmax =

16

Where:

Ts = Static strand tension (from Step 3)

Y = Constant from Table 30 on page 289

Figure 26 — BELT DEFLECTION DIAGRAM

SPAN LENGTH, L

C

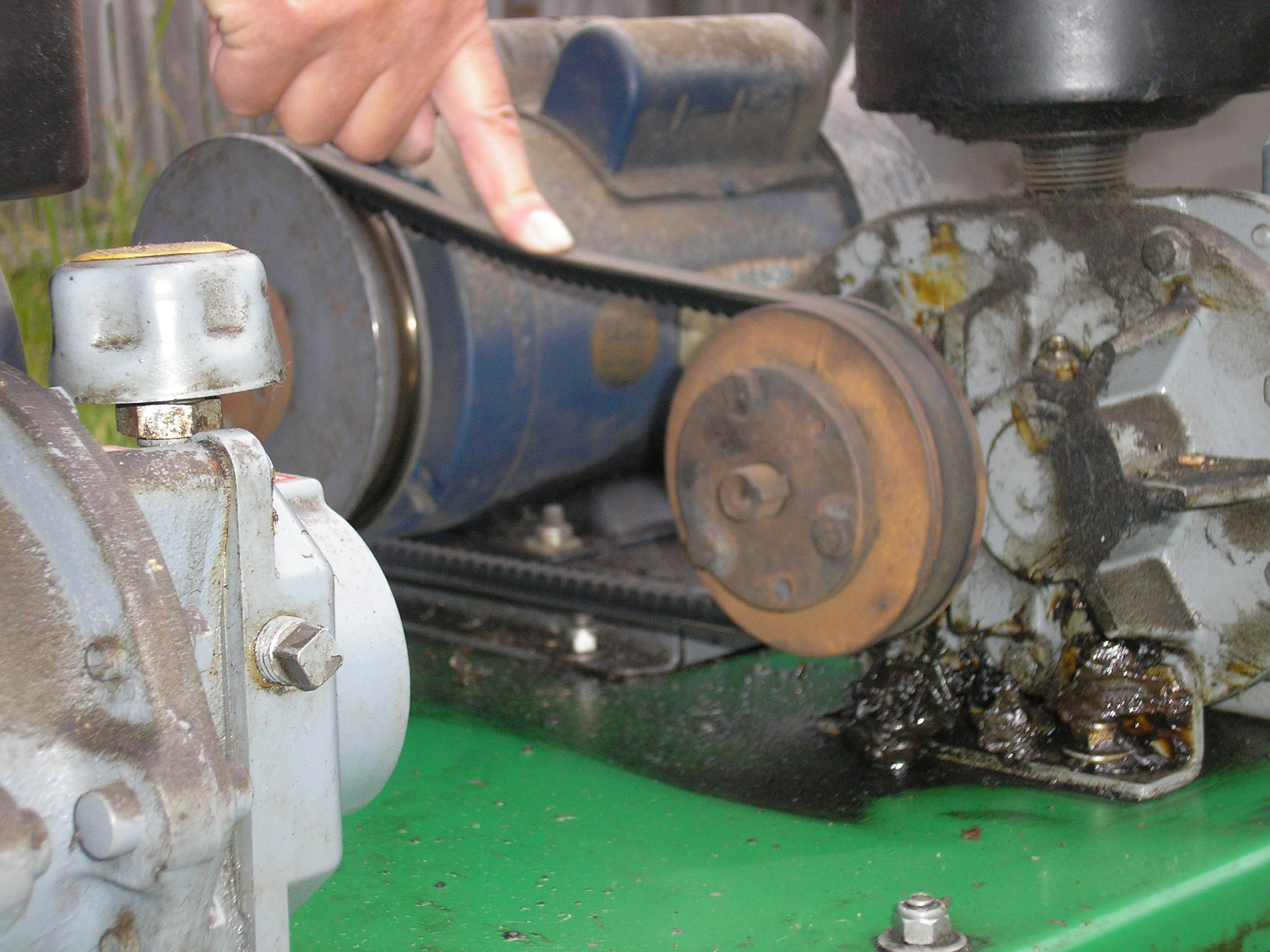
S

DEFLECTION FORCE,p

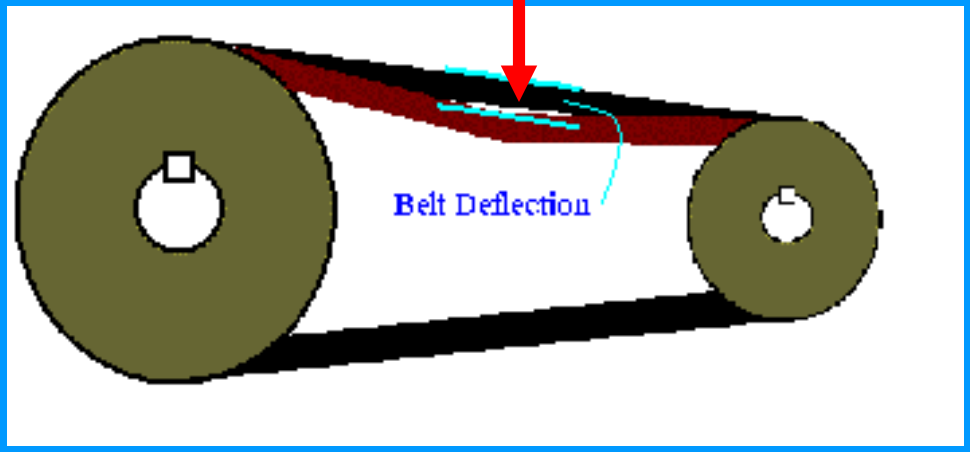
DEFLECTION, q

D

d



4# push deflects about ½”

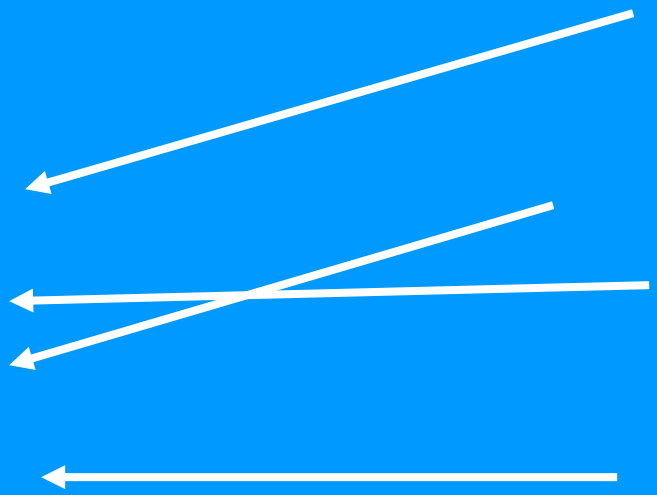


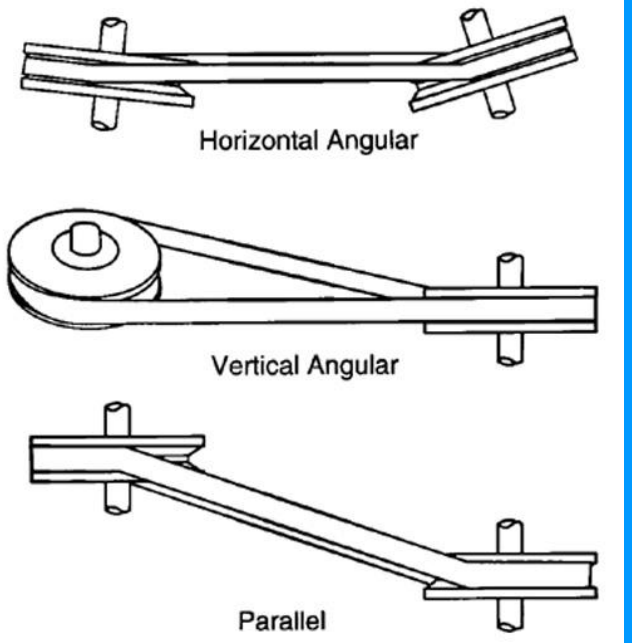
Retension after 24 hours

In the final analysis, **the correct belt tension is just enough tension to keep the belt from slipping under normal load conditions.**

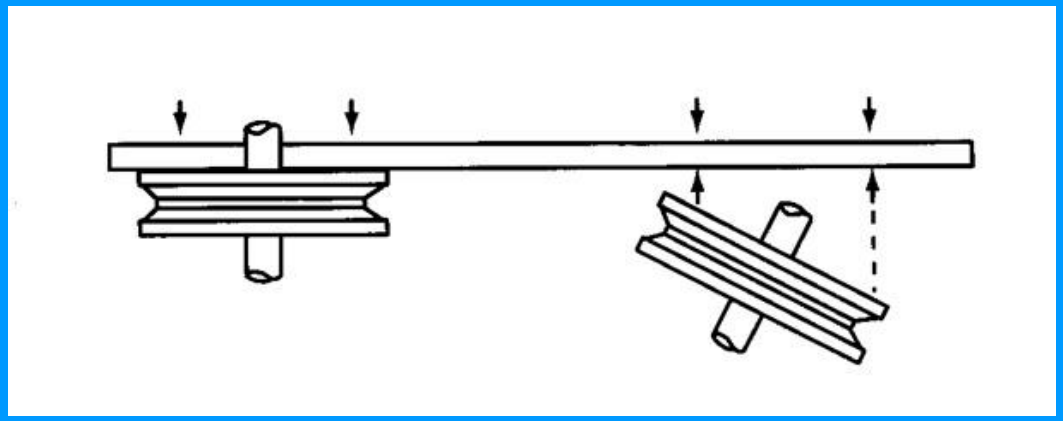
Page 129 of WW Grainger catalog 401

Pitch Dia.	5.0	
3L HP Rating	0.78	
Pitch Dia.	5.0	5.5
4L HP Rating	1.61	1.70
Pitch Dia.	5.00	5.40
5L HP	5.96	6.35
Pitch Dia.	5.00	5.40
B HP Rating	6.16	7.21
Pitch Dia	5.00	5.40
BX HP Rating	8.08	9.19
Pitch Dia	5.60	
C HP Rating	6.94	

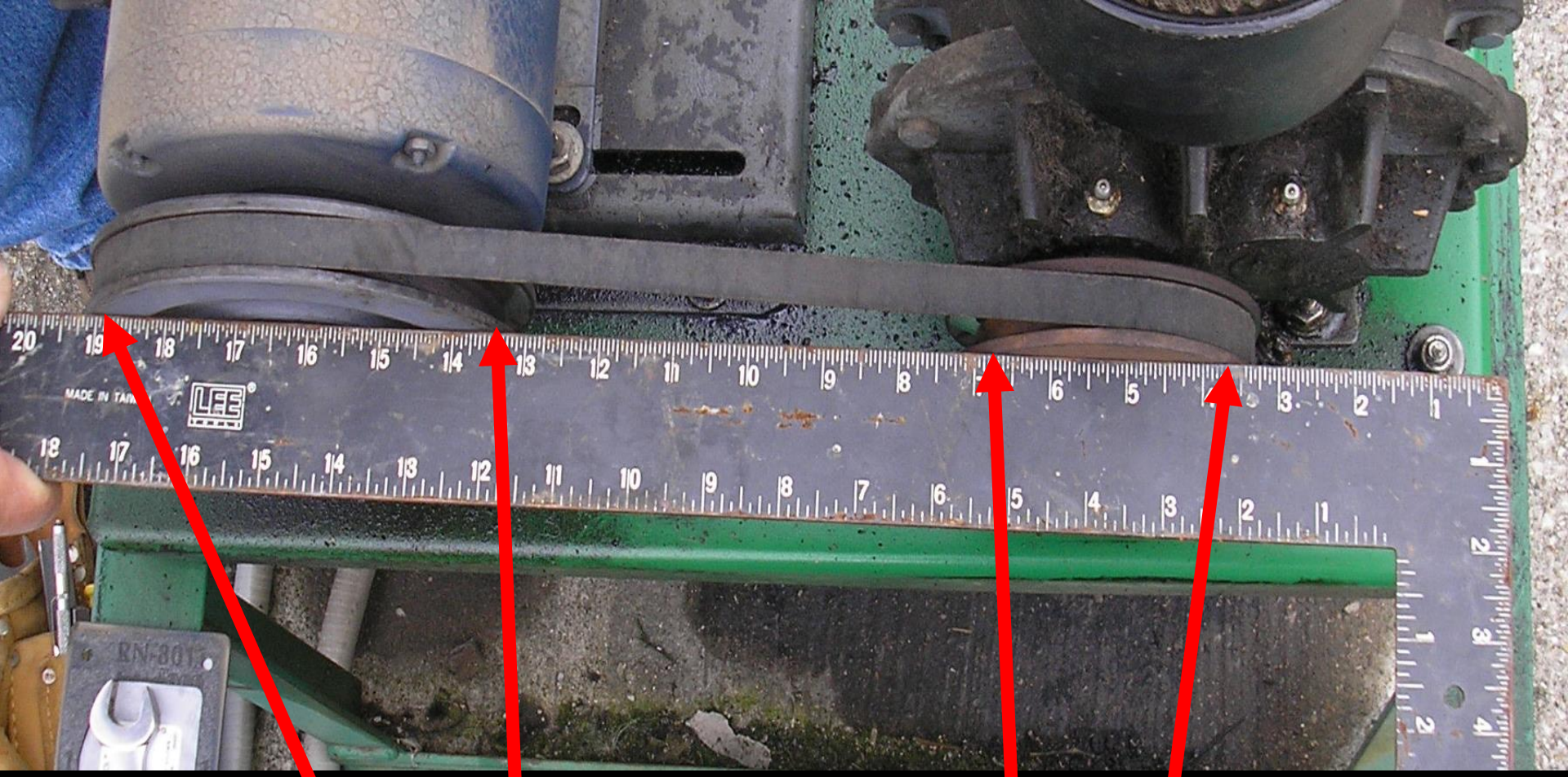




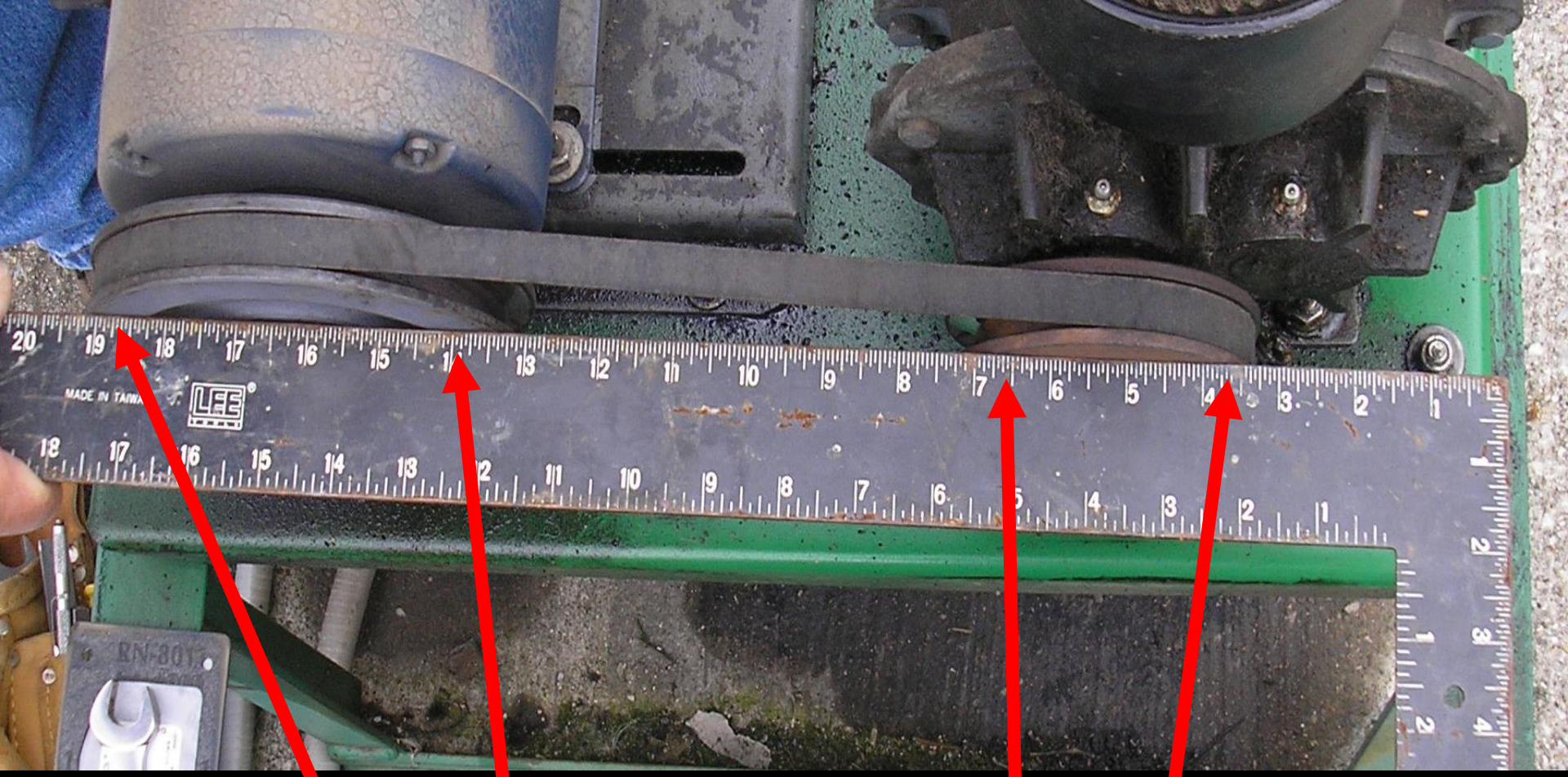
A belt misaligned tries to transmit power using only one side of the wedge.



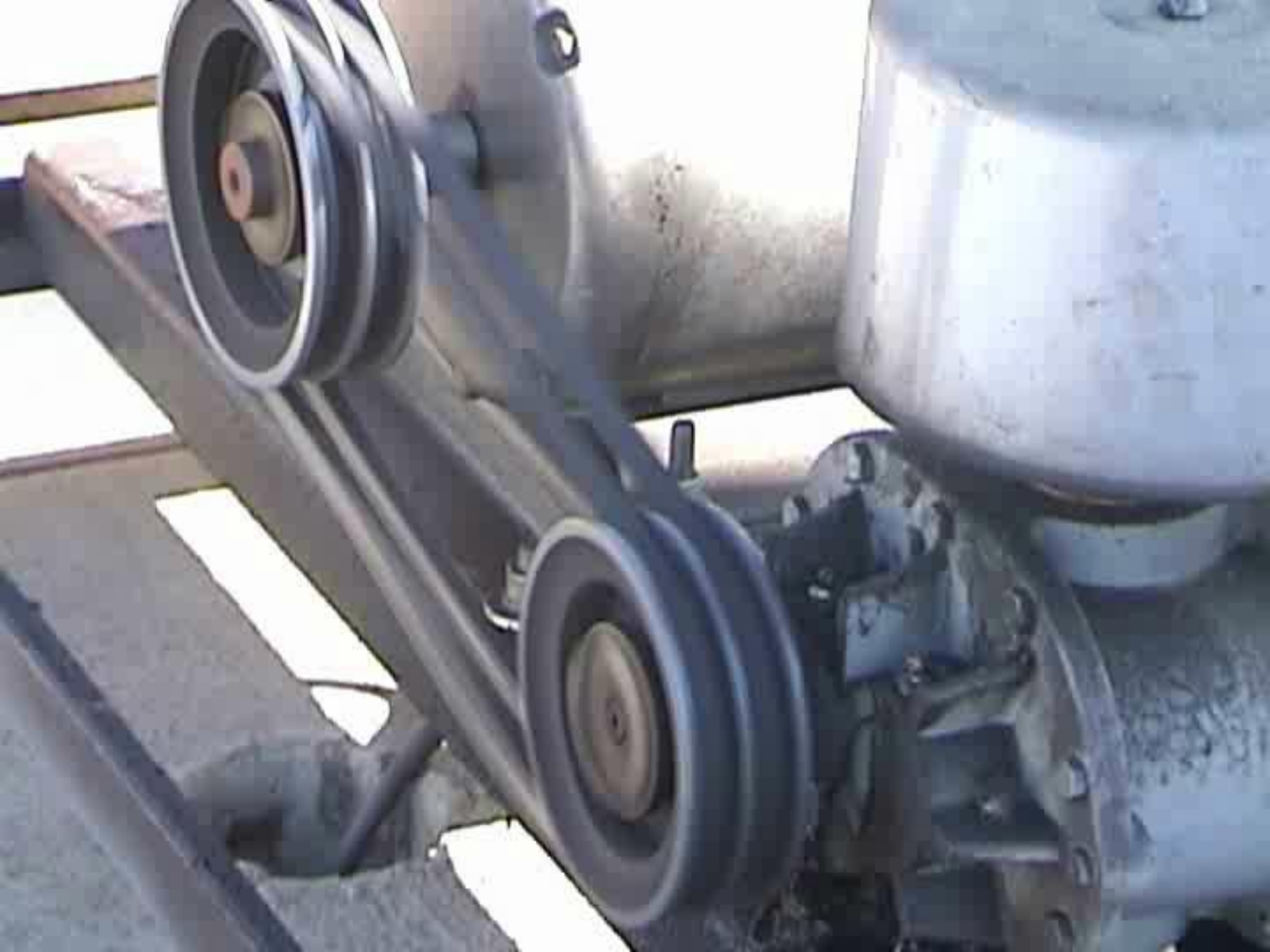
alignment

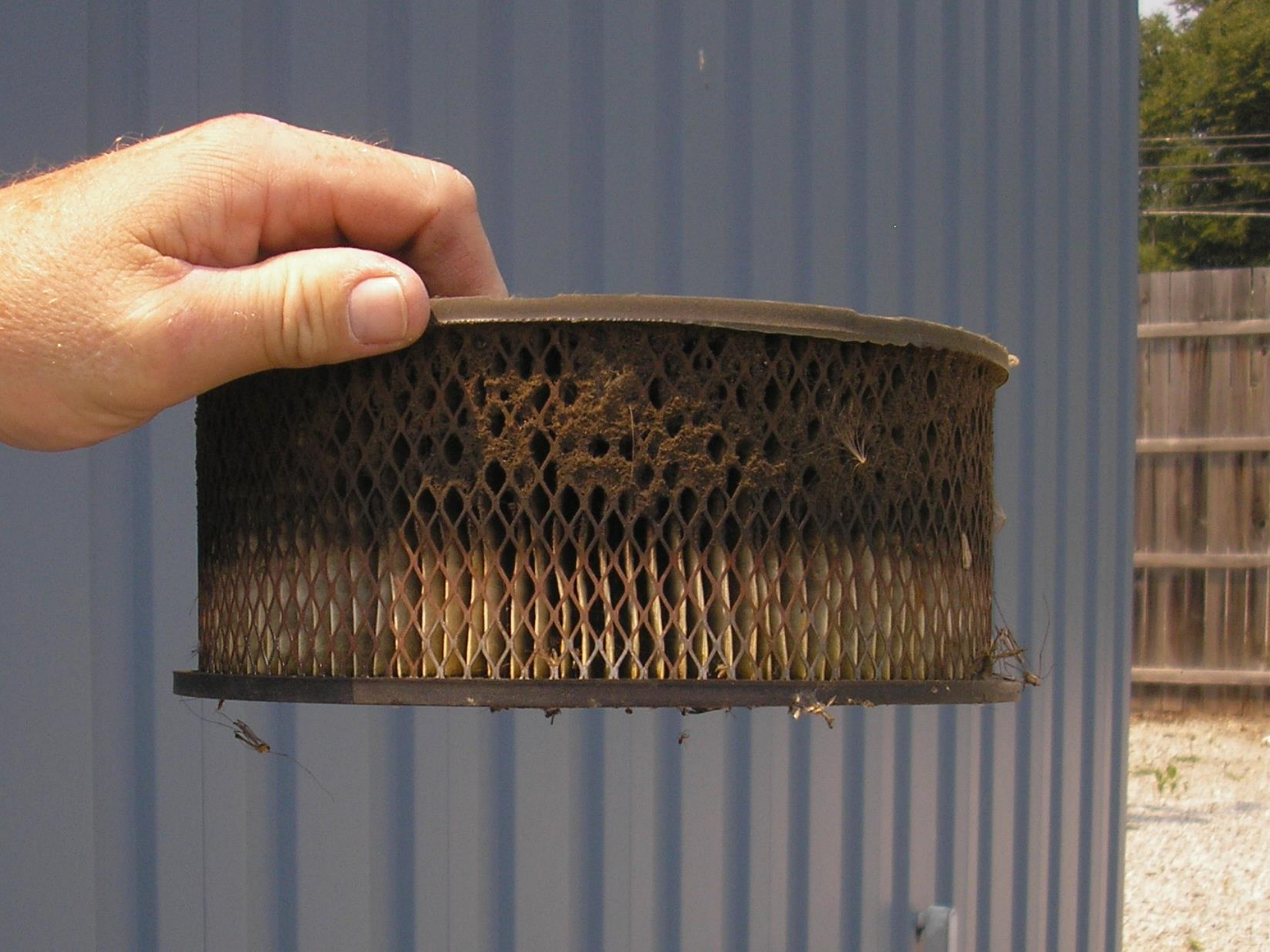


All four points should touch.



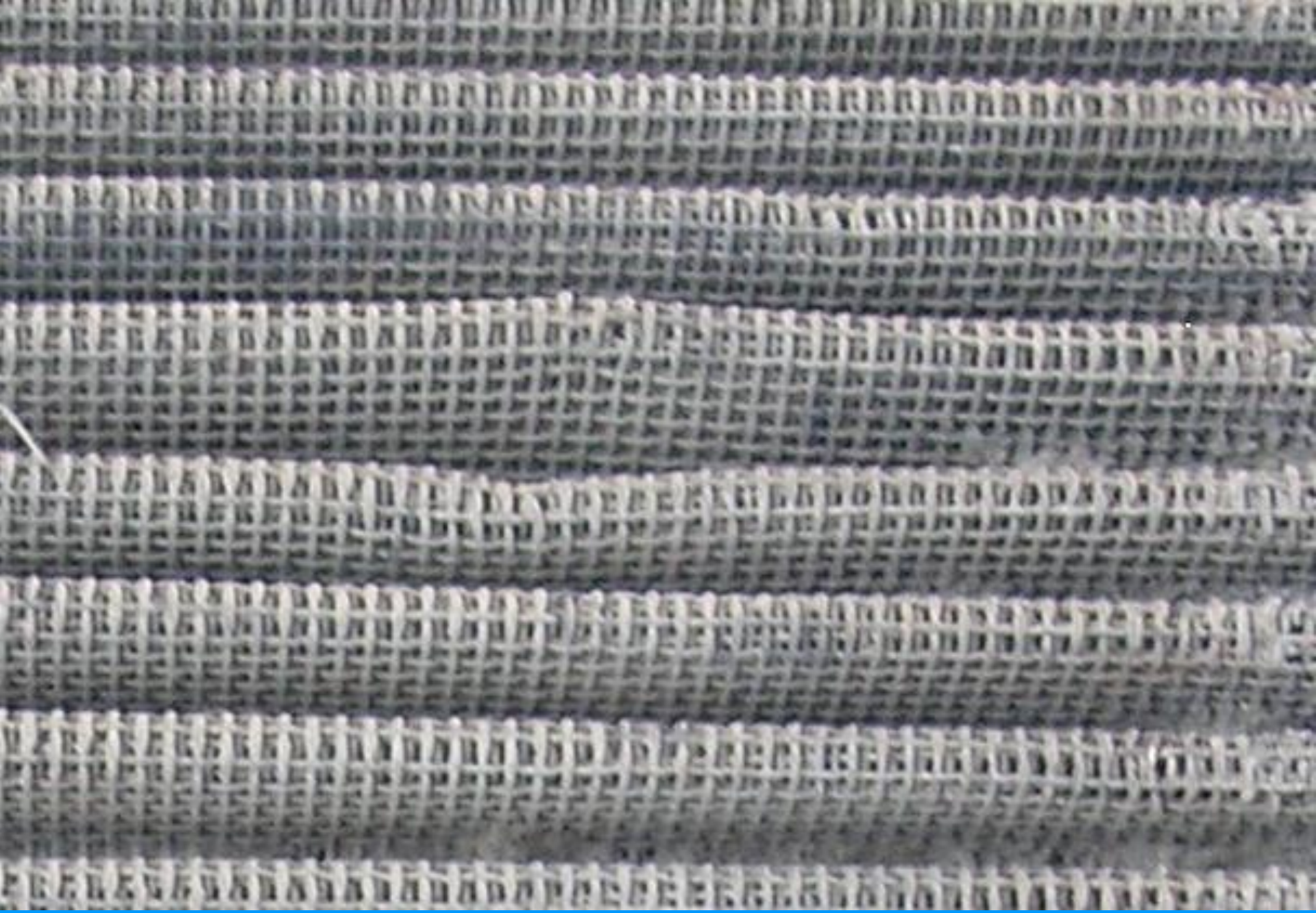
The closer the alignment, the longer the belts last.





Clean w/gasoline?

Re-oil?



Can this protect the inside of the blower?

If it moves, it will break!

How should you troubleshoot problems?

If it moves, it will break!

How should you troubleshoot problems?

Logical progression

From the Source to the End Use

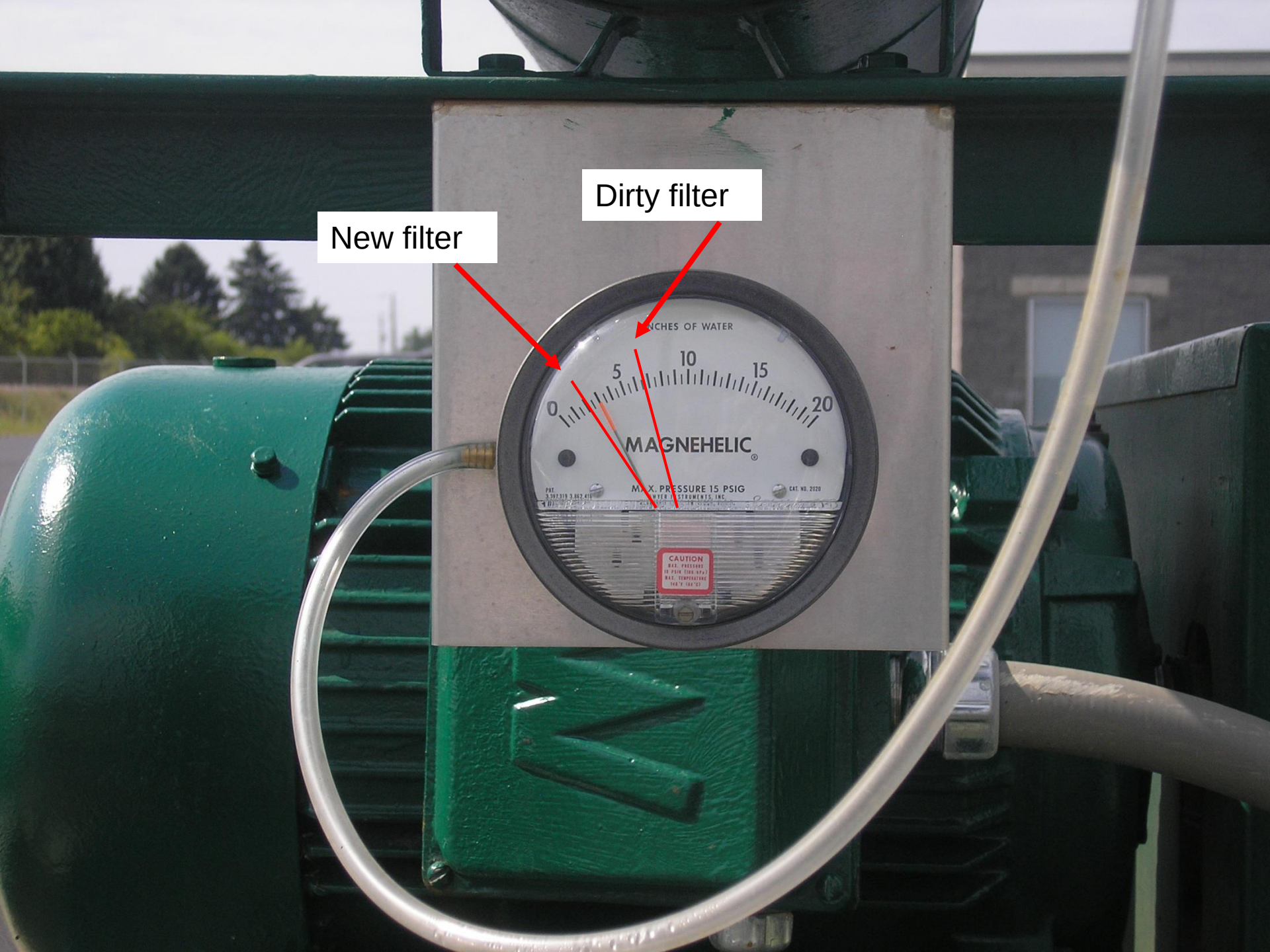
If starting one blower causes the other to rotate, the isolation check valve is bad.

If starting one blower causes the other to rotate, the isolation check valve is bad.

Many times it’s quicker, cheaper, and easier to repair rather than replace.

Heat and vibration kills gauges!

Do you really think that these aeration tanks are 160 feet deep? (68# X 2.31 #/Ft. = 157 ft.)


Dirty filter
New filter
INCHES OF WATER
0
5
10
15
20
MAGNEHELIC
MAX. PRESSURE 15 PSIG
CAUTION

Measure from the top of the diffuser

To the top of the water.

Multiply by 0.433 to get PSI.

Add one-half pound for piping losses.

This is what the pressure gauge should read!

If the pressure reads higher, there is a blockage. Probably plugged diffusers.

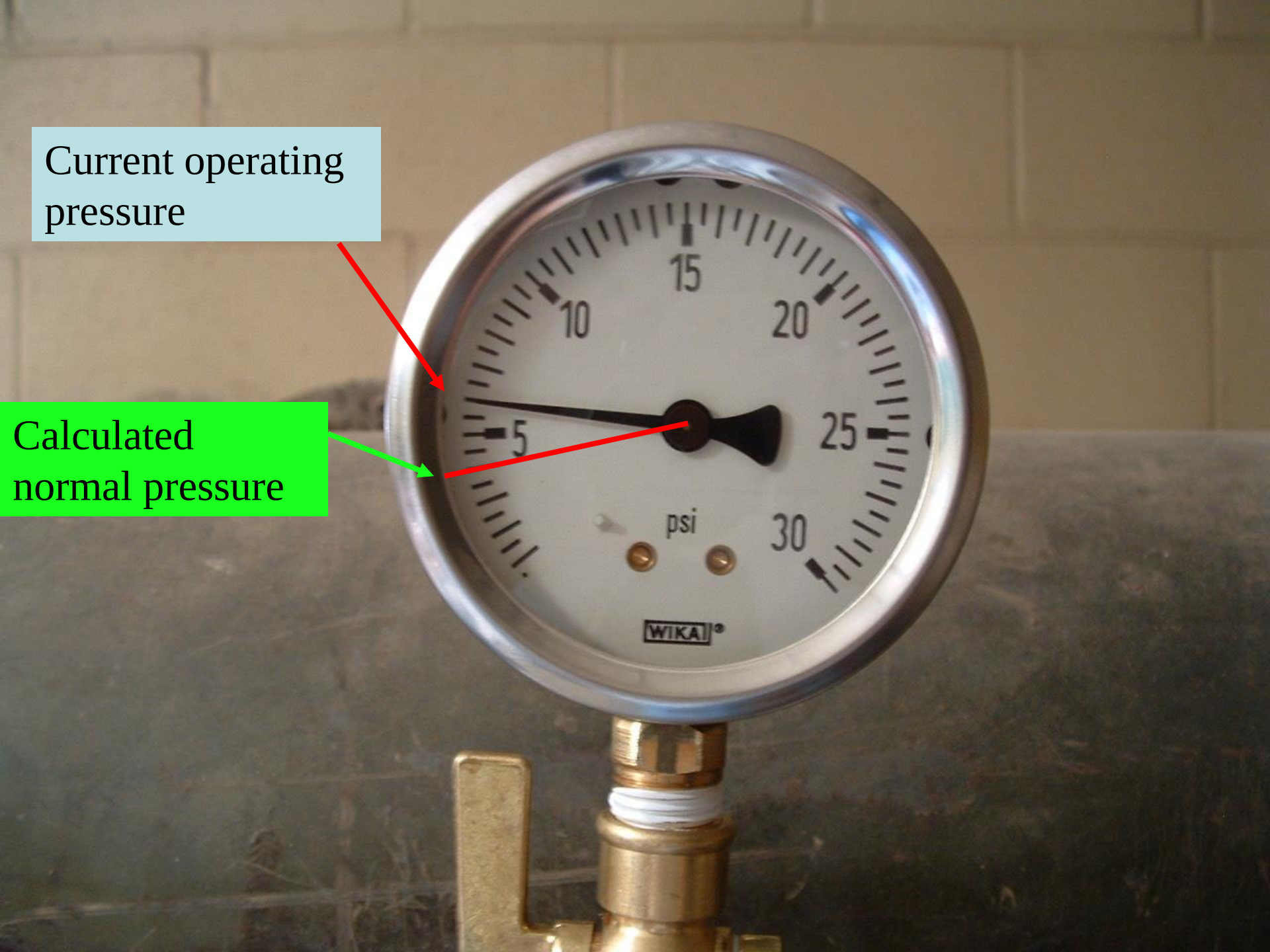
If the pressure is lower, look for leaks or too much air going to EQ or holding tanks.

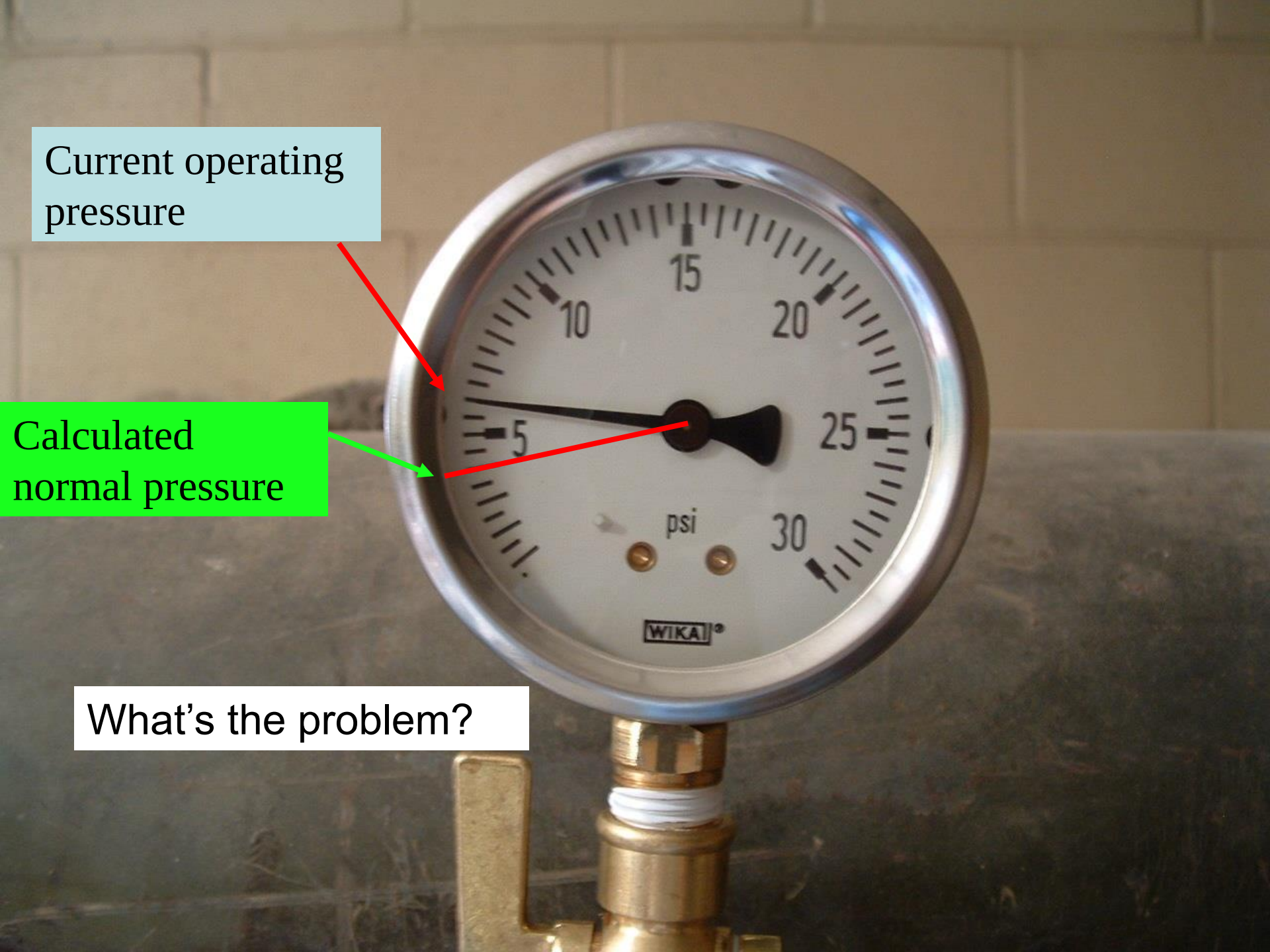
8.3 feet of water depth

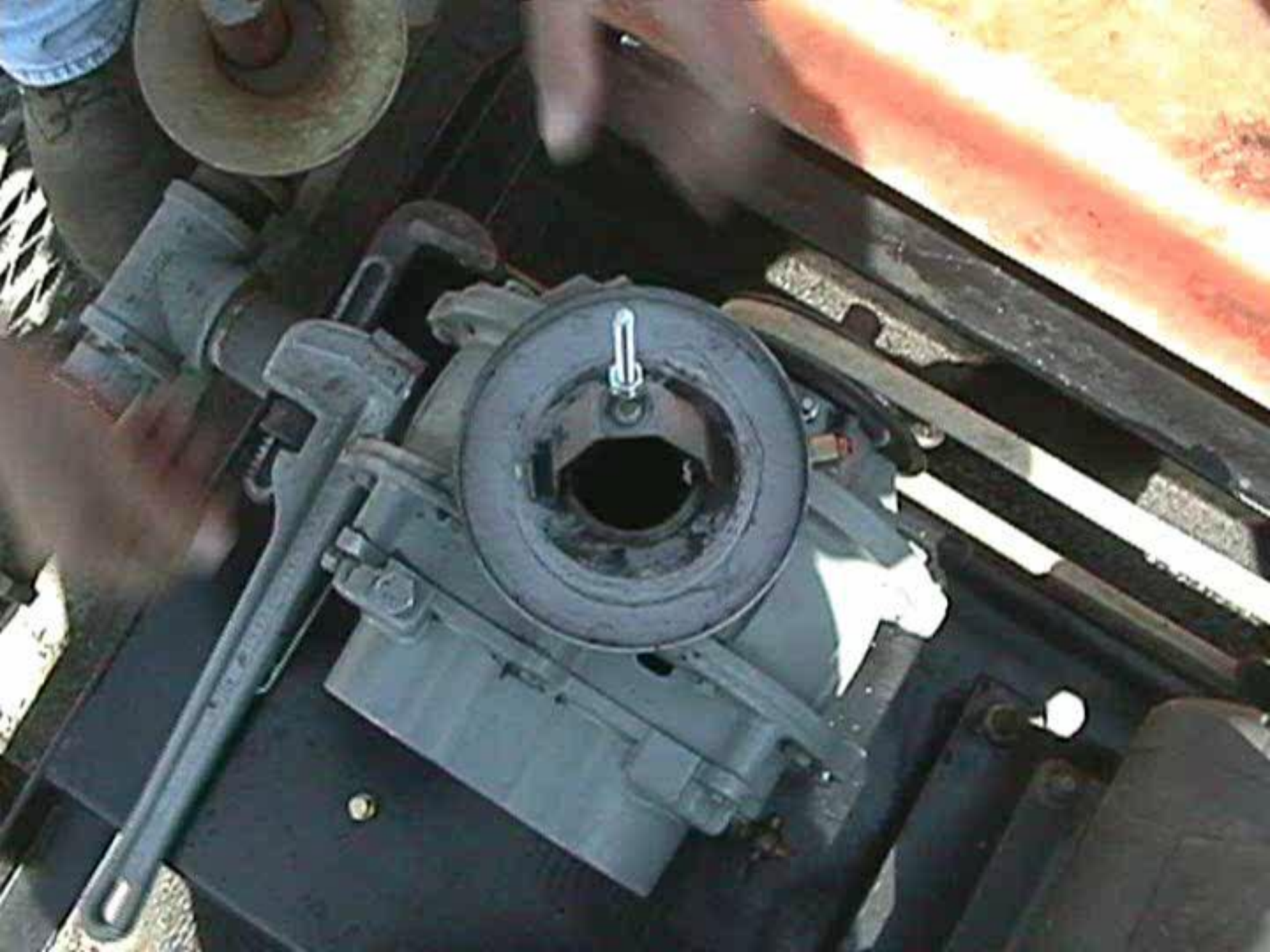
Times 0.433 = 3.6 PSI

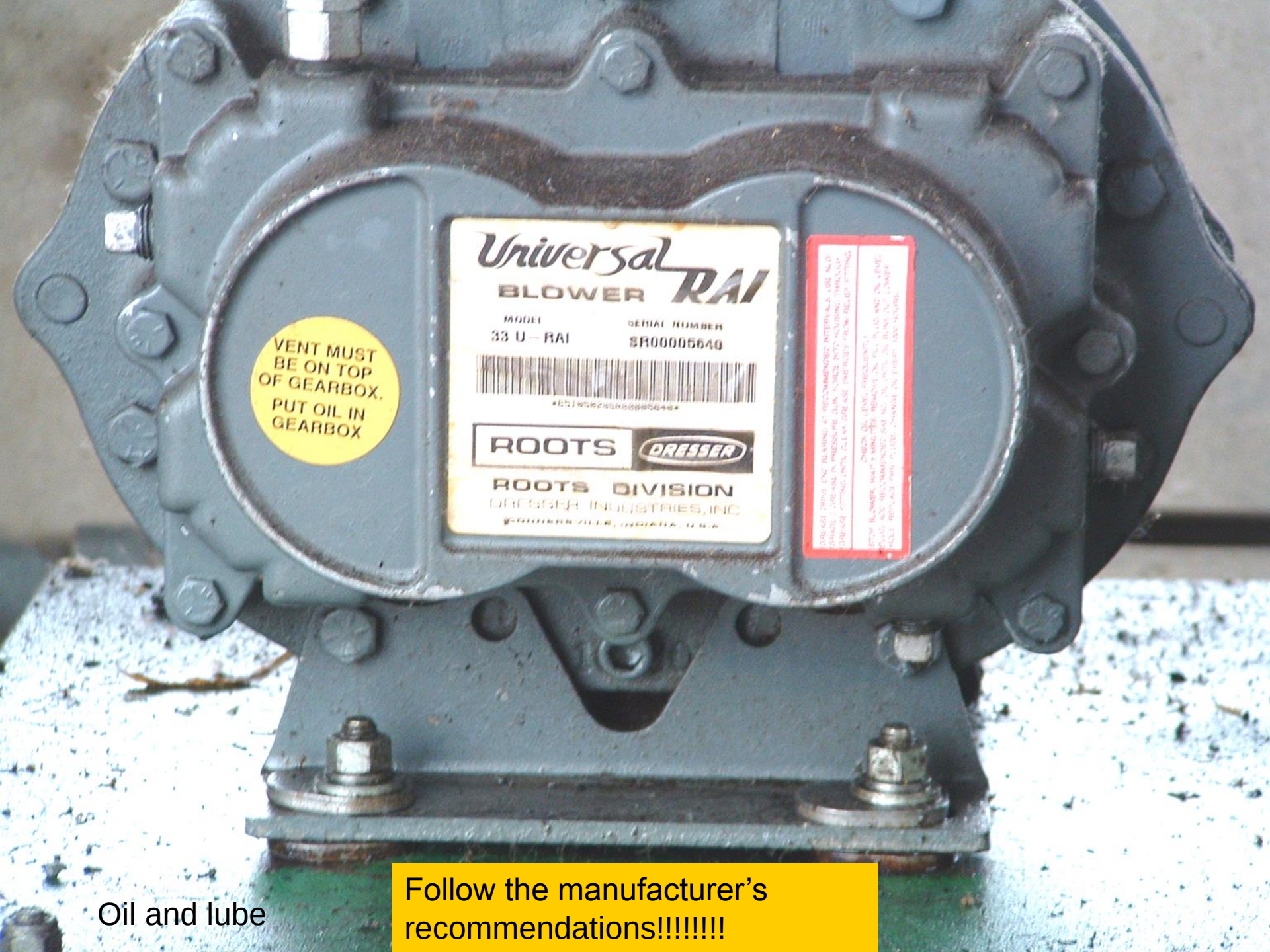
Add ½ pound for line losses = 4.1 PSI

The gauge should read 4 PSI more or less.


Current operating pressure
Calculated normal pressure
5
10
15
20
25
30
psi
WIKA

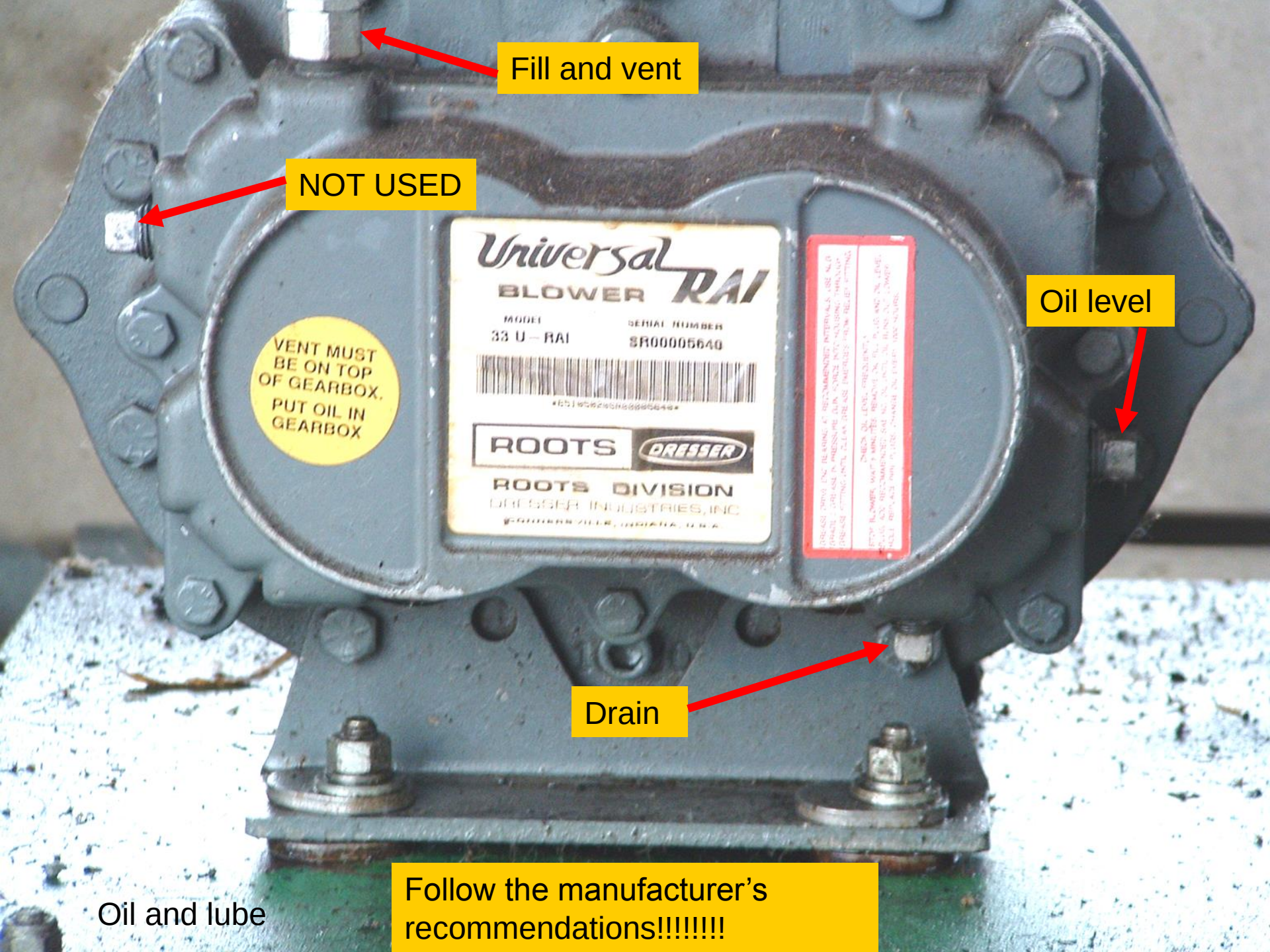

Current operating pressure
Calculated normal pressure
What's the problem?
5
10
15
20
25
30
psi
WIKA





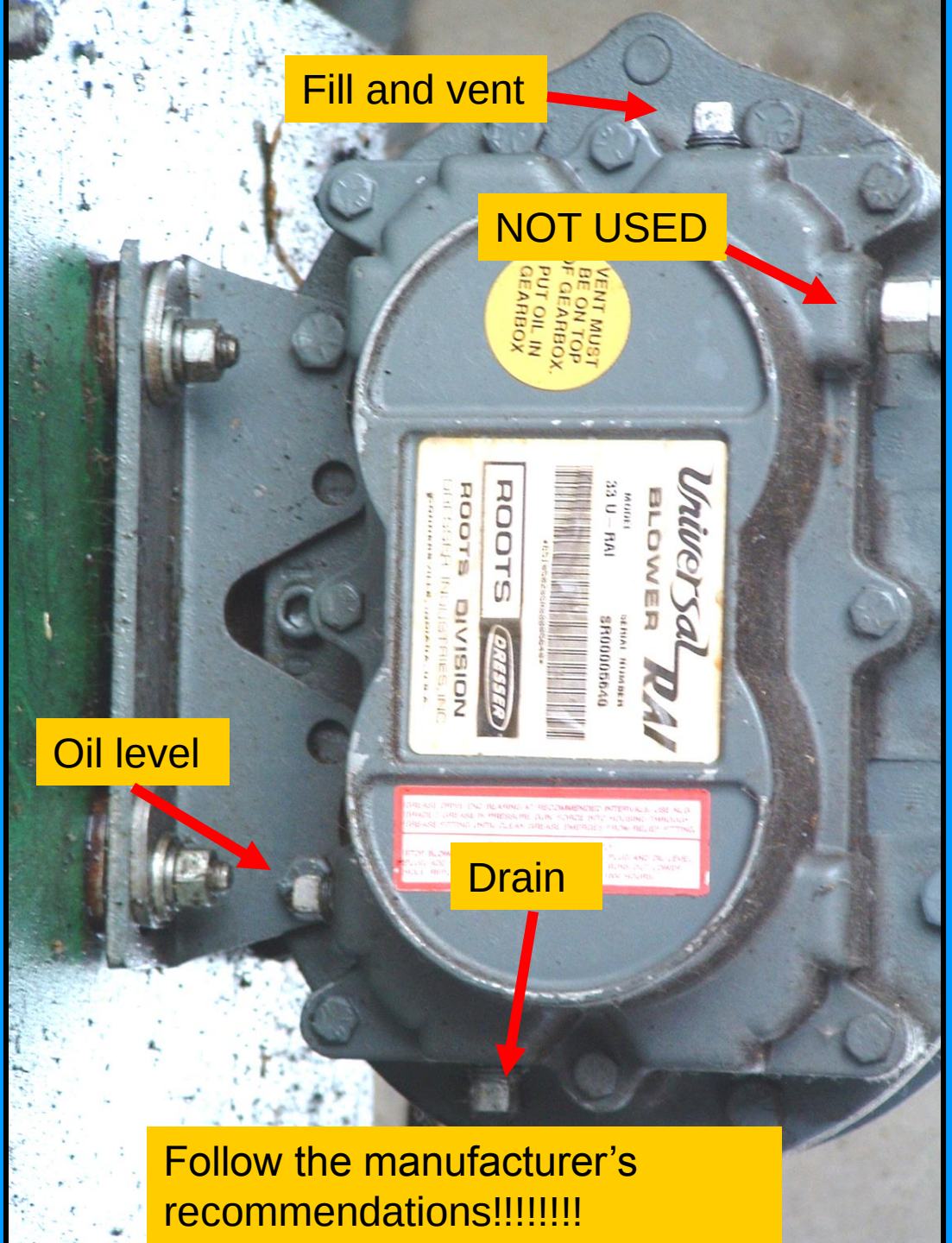
Oil and lube

Follow the manufacturer's recommendations!!!!!!!!



Oil and lube

Follow the manufacturer's recommendations!!!!!!!!


Fill and vent
NOT USED
Oil level
Drain
Follow the manufacturer’s recommendations!!!!!!!!
VENT MUST BE ON TOP OF GEARBOX. PUT OIL IN GEARBOX
Universal RAI
BLOWER
ROOTS
ROOTS DIVISION

Once the blower is clean, oil changed, and lubed, with the new filter installed,……..

Once the blower is clean, oil changed, and lubed, with the new filter installed,……..

Record the pressure, vacuum, and amperage right on the panel.

Once the blower is clean, oil changed, and lubed, with the new filter installed,……..

Record the pressure, vacuum, and amperage right on the panel.

These baseline numbers allow troubleshooting without getting your hands dirty.


What problem does this indicate?

operator notes

How big is a coarse bubble? Medium bubble? Fine bubble?

In theory, if you had a single bubble that measured 1 cubic foot, you would have 6 square feet of surface area in contact with the surrounding water. Obviously, 6 square feet per cubic foot of air is not adequate for facilitating oxygen transfer. Coarse, medium and fine bubble diffusers increase surface contact area between the oxygen in the air and the water by breaking up each cubic foot of air into small bubbles.

Coarse bubbles may be defined as 10 mm and larger. A cubic foot of air made up of 10 mm bubbles has approximately 54,081 bubbles with surface area of 182 square feet.

Medium bubbles fall in a range between 4 mm and 6 mm. A cubic foot of air made up of 5 mm bubbles has approximately 432,650 bubbles with surface area of 365 square feet.

Fine bubbles are 2 mm in diameter and smaller. A cubic foot of air made up of 1 mm bubbles has approximately 54,081,391 bubbles with surface area of 1,829 square feet.

Oxygen transfer is closely related to surface area contact between the air and water. The smaller the bubble, the better the transfer. Simply pumping a prescribed amount of air does not guarantee that you will get the results you want. Diffuser selection and position is crucial to how a system will perform.

AERATION Diffusers

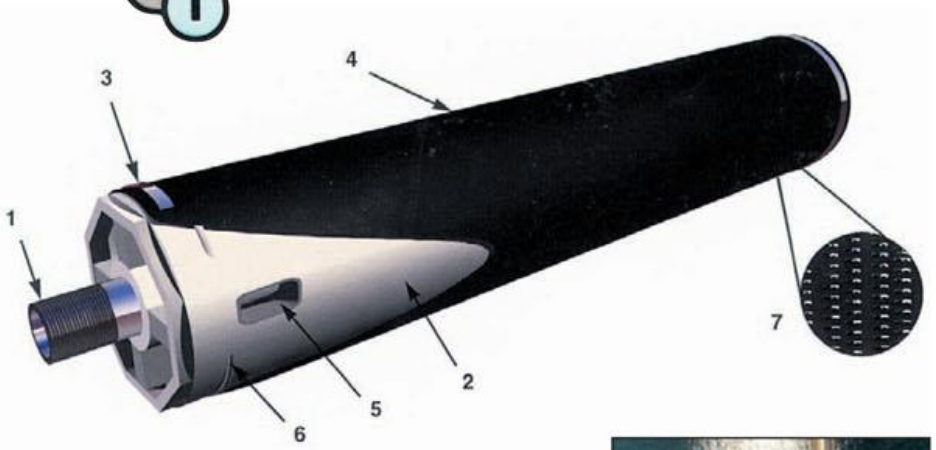
EDI FlexAir™ T-Series Fine Bubble Tube Diffusers

- **Non-buoyant design for stability**
- **Air flow ranges from 0 to 40 cfm**

EDI FlexAir tube diffusers are strong and durable. The diffuser inlet is molded from high rigidity ABS permanently bonded to a PVC membrane support tube to create an integral diffuser body. Mounting connection is 3/4" NPT(M) 304 SS. Standard membrane is field proven EPDM elastomer, which is well suited to most municipal and industrial applications. For applications where excessive amounts of oils and solvents are present, urethane or special polymer membranes are available.

The FlexAir diffuser membrane's engineered air release orifices allows full utilization of the membrane surface, even at low airflow operation. This results in improved oxygen transfer efficiency and maximum operating flexibility. All EDI tube diffusers feature an integral "triple" check valve to prevent backflow and clogging due to solids. Tests of EDI membrane diffusers have shown increases in efficiency from 15 to 50% over competitors' units.

FlexAir diffusers are offered in several different diameters and lengths. Standard lengths range from 20 to 40" in either 2" or 3" diameter. Existing treatment plants utilizing the popular 24" x 2" size diffuser can upgrade and maximize system performance by direct retrofitting with larger diameter and/or longer FlexAir diffuser models for greater diffuser capacity and performance. Specialty polymer membrane diffusers are available as special order; contact USABlueBook for more information.



1. SS inlet nipple
2. Diffuser body
3. SS membrane clamps
4. Premium quality membrane: EPDM, urethane or specialty polymer
5. Air inlet to membrane
6. Clamp retainer
7. Membrane perforations

LENGTH	DIA	MEMBRANE MATERIAL	TYPICAL DESIGN AIRFLOW RANGE*	MAX AIRFLOW	STOCK #	EACH	PRICE WITH INSTALL**
24.0"	2.44"	Urethane	2 to 8 cfm	14	**32141**	$ 30.00	$ 28.50
24.0"	2.44"	EPDM	2 to 8 cfm	14	**32142**	30.00	28.50
25.6"	2.44"	Urethane	2 to 9 cfm	15	**32143**	30.00	28.50
25.6"	2.44"	EPDM	2 to 9 cfm	15	**32144**	30.00	28.50
19.75"	3.50"	Urethane	4 to 13 cfm	22	**32145**	34.00	32.30
19.75"	3.50"	EPDM	4 to 13 cfm	22	**32146**	34.00	32.30
30.0"	3.50"	Urethane	7 to 20 cfm	34	**32147**	42.00	39.90
30.0"	3.50"	EPDM	7 to 20 cfm	34	**32148**	42.00	39.90
39.5"	3.50"	Urethane	9 to 27 cfm	44	**32149**	48.00	45.60
39.5"	3.50"	EPDM	9 to 27 cfm	44	**32150**	48.00	45.60

*** Airflow range for best long-term performance is shown. Short-term airflow rates above these typical values may be handled. Normal headloss is 0.3 to 0.4 psi.**

**** Minimum quantity of 100.**

operator notes

Replacing your diffusers?

When mounting a tube diffuser longer than 24", it is recommended that you support the end of diffuser. Many operators find a simple cinder block does the trick.

operator notes

A Short Course on

Aerator Selection

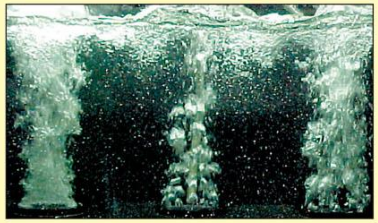
USABlueBook offers a broad selection of aeration products to suit almost any application. Aeration is widely used in water, wastewater and biosolids applications where oxygenation or mixing is desired.

Proper selection of aeration equipment is important to ensure satisfactory process performance with minimal operational and maintenance support. Aeration is the single largest operating cost for a wastewater treatment plant. Aeration products provide a wide range of operating efficiency, and depending on your selection, the operating cost for aeration equipment can vary by a factor of almost 3:1.

The following selection guide may be used to assist you in evaluating the proper aeration device for your application.

Product Type	Product Capabilities	Clean Water	Wastewater	Biosolids*
Coarse Bubble (Open Design)	Moderate oxygen transfer efficiency. Clog resistant (rags can be a problem). Continuous operation preferred.	Yes	Yes	Acceptable
Coarse Bubble (Self-sealing membrane)	Moderate oxygen transfer efficiency. Clog resistant. May be operated intermittently (on-off).	Yes	Yes	Yes
Ceramic (Rigid) Fine Bubble	High oxygen transfer efficiency. May clog over time internally and externally in presence of particulates. Requires continuous operation to prevent sediment penetration of external surface.	Yes	Yes	Not Recommended
Membrane (Flexible) Fine Bubble	Highest oxygen transfer efficiency. Clog resistant. Can be operated at very low air rates and may be operated intermittently.	Best	Best	Best
Mechanical Aerator	Moderate to low oxygen transfer efficiency. Clog resistant. May be operated intermittently. Cools water and may be susceptible to ice damage.	Yes	Yes	No
Jet Aerators	Moderate oxygen transfer efficiency. Clog resistant. May be operated intermittently.	Yes	Yes	Not Recommended

*** High solids applications (>3% solids) may require specialized designs. Contact USABlueBook for application engineering information.**



Coarse bubble or fine bubble?

It is a common misconception that coarse bubble diffusers should always be used where mixing is a major requirement in a basin requiring aeration or oxygenation. Coarse bubble diffusers have been the traditional diffusers for mixing and have demonstrated excellent mixing capabilities, but they require significant energy levels in aeration basins. High energy levels are required because of the limitations of oxygen transfer from coarse bubble diffusers. Coarse bubble diffusers also create substantial surface turbulence because of the air volume or energy in the basin, and this turbulence may be confused as mixing (pumpage of liquid).

Fine bubble diffusers reduce energy consumption for oxygen transfer because of the small bubble size and high surface area of the air volume introduced to the tank. Fine bubble diffusers create maximum oxygen transfer efficiency, plus the fine bubbles also create maximum pumping action **per cfm** of air applied. **Therefore, fine bubble diffusers operating at the same air volume in an aeration basis provide better mixing (pumpage) vs. coarse bubble diffusers.**

In summary, mixing is a function of type of diffusers, diffuser layout and volumetric energy rate. In general, uniform configuration provides better mixing over non-uniform configurations. For proper layouts with proper volumetric energy rates, all diffuser products can provide similar mixing performance. Fine bubble diffusers, when properly applied, can offer major benefits in mixing as well as major benefits in oxygen transfer or energy conservation!

USABlueBook and Environmental Dynamics, Inc. can provide a system evaluation of coarse bubble diffusers or fine bubble diffusers and identify potential benefits for converting to EDI advanced technology fine bubble diffusers using your existing blowers and existing piping. Contact USABlueBook for more information.

Double your oxygen transfer with no piping changes!

FlexAir™ High-Capacity 9" Fine Bubble Diffusers

- Replace coarse bubble diffusers for improved oxygen transfer
- Higher rate of airflow with fine bubble diffusers improves mixing
- Glass-filled polypropylene body with EPDM membrane

Customers continually ask us for a fine bubble diffuser that can replace standard 3 to 4" diameter coarse bubble diffusers to provide improved oxygen transfer. The EDI FlexAir High Flow diffuser combines fine bubble oxygen transfer efficiency with mixing capability associated with high air volume.

It is a proven fact that fine bubble diffusers have superior oxygen transfer efficiency, which means that you have the option of reducing blower output to save energy. On the other hand, if you maintain the same cfm output currently utilized by your coarse bubble diffusers, you will get approximately 100% greater oxygen transfer with improved mixing. FlexAir high-capacity fine bubble diffusers offer the best of both worlds.

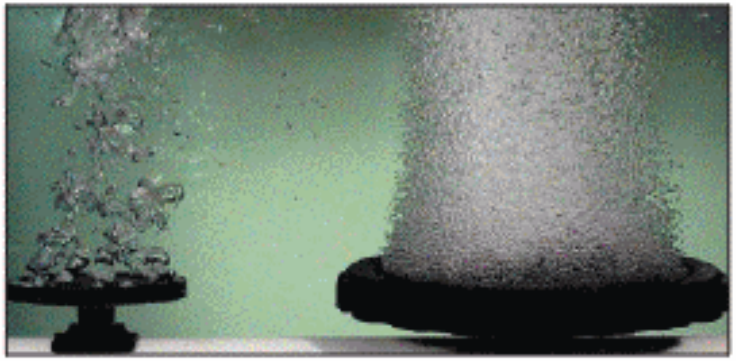
Retrofit your existing system

FlexAir high-capacity disc diffusers have a continuous operating range of 1 to 8 cfm and up to 11 cfm for intermittent service. This mirrors the performance specifications of popular coarse bubble diffusers. You can therefore retrofit with FlexAir diffusers one-for-one without adding extra units to your system or adjusting your blower speed, as long as you don't exceed 5 cfm per diffuser.

If you are not sure of the output of your blower, tell us (1) the make and model of your blower; (2) the diameter or part number number of your blower and motor sheaves; (3) the horsepower and rpm of your motor, and (4) system operating pressure. If you don't have a pressure gauge, tell us the height of water column over your diffusers.

Other considerations include making sure that your existing diffuser spacing will accommodate the larger overall diameter of the housing, which is 10.63". For peak performance the recommended maximum solids content should not exceed 3% and the temperature at the diffuser should be <200°F. Connection is 3/4" NPT(M)

DESCRIPTION	STOCK #	EACH	QTY 25-100	QTY 100+
FlexAir High-Capacity 9" Diffuser	MC-32186	$16.00	$ 15.52	CALL



Upgrade your 3" or 4" diameter coarse bubble diffusers (pictured above left) with high-capacity 9" diameter fine bubble diffusers (above right)—no piping changes required!

operator notes

Bubble Surface Area Calculations

The table below indicates the bubble surface area and average number of bubbles for various sizes of bubble diffusers. **Note: High-capacity fine bubble diffusers average about double the number of bubbles of coarse bubble diffusers!**

Bubble Size dia. (mm)	Surface Area (sq. ft.) per Cubic ft of Air	Number of Bubbles
1	959	28,252,382
2	479	3,531,548
3	**320**	**1,046,385**
	Average for Fine Bubble High Capacity	
4	240	441,443
5	192	226,019
6	160	130,798
7	137	82,368
8	**120**	**55,180**
	Average for Coarse Bubble	

Bubble Size dia. (mm)	Surface Area (sq. ft.) per Cubic ft of Air	Number of Bubbles
9	107	38,755
10	96	28,252
11	87	21,226
12	80	16,350
13	74	12,860
14	68	10,296
15	64	8,371
16	60	6,898
17	56	5,751
18	53	4,844
19	50	4,119

5/64”

Hammered drops


Our “Bottom Line” is the stream.
“We only borrow this land and water from our grandchildren”


All Done
Questions?

Maintenance Basics

Course one

Mechanical Troubleshooting

OHIO EPA DIVISION OF SURFACE WATER
COMPLIANCE ASISTANCE UNIT

PREPARED FOR:

Campground Owners Association Training Conference
Columbus March, 2011

OEPA – S507745 – OM 2.5 Hours

The Blowers are BIG!

Why can’t I get enough DO?

OHIO EPA DIVISION OF SURFACE WATER
COMPLIANCE ASISTANCE UNIT

PREPARED FOR:

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OEPA – S507745 – OM 2.5 Hours

If the mechanicals don’t work,

The biologics can’t.