THE FAN GUY.CA

GATES POLY CHAIN CARBON

and

AIR COOLED HEAT EXHANGERS

Gates POWERING PROGRESS™

Why Poly Chain Synchronous?

- **Energy or Mechanical Efficiency?**
- **Reduced Maintenance.**
- **Increased Drive Life.**
- **Lower Shaft Load.**
- **Reduced Drive Width.**
- **Enclosed Belt Guards**

Mechanical Efficiency

V-belts slip, look at the belt wrap and worn pulleys. This lowers the speed of the Fan, which will lower airflow and production.

Also this small pulley has 30% more load over the next slide with the Gates Poly chain

The perfect ACHE belt drive, no slip, no airflow loss and 30% less motor bearing load....does it get any better!

Push pulleys higher , lowers brg loads

Do not use anti-seize or any lubricant on bushing bolts. This will crack hub when torque as per bushing instructions

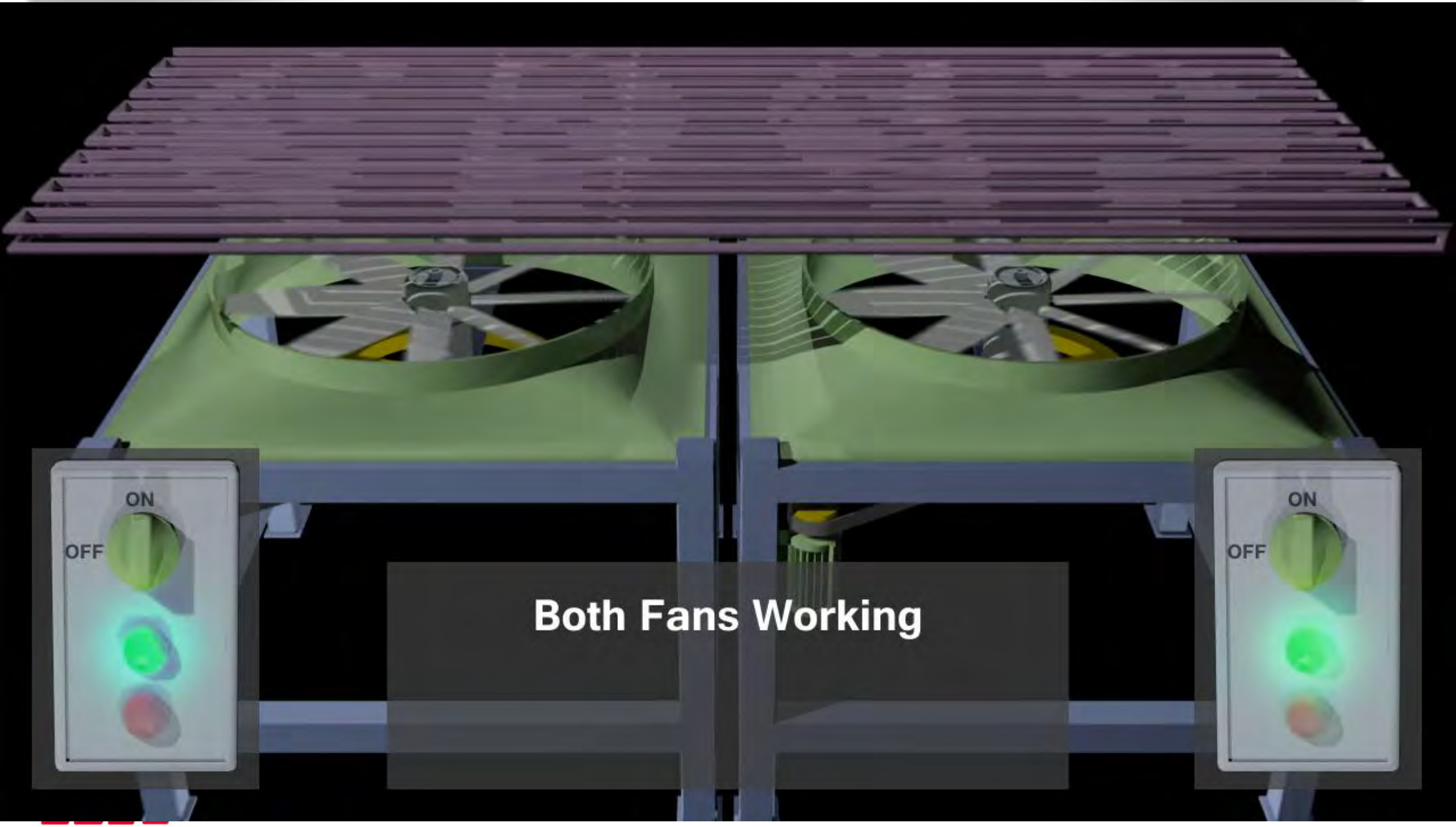
Reduced Maintenance

- **Maintenance Free over lifetime**
  - **No re-tensioning with Urethane**
  - **Lower Shaft load over V-belt**
  - **Reduced Width**
  - **Enclosed Belt Guard**
- **Clean**
  - **No oil or residue**

Qualifying ACHE Drive Conversions

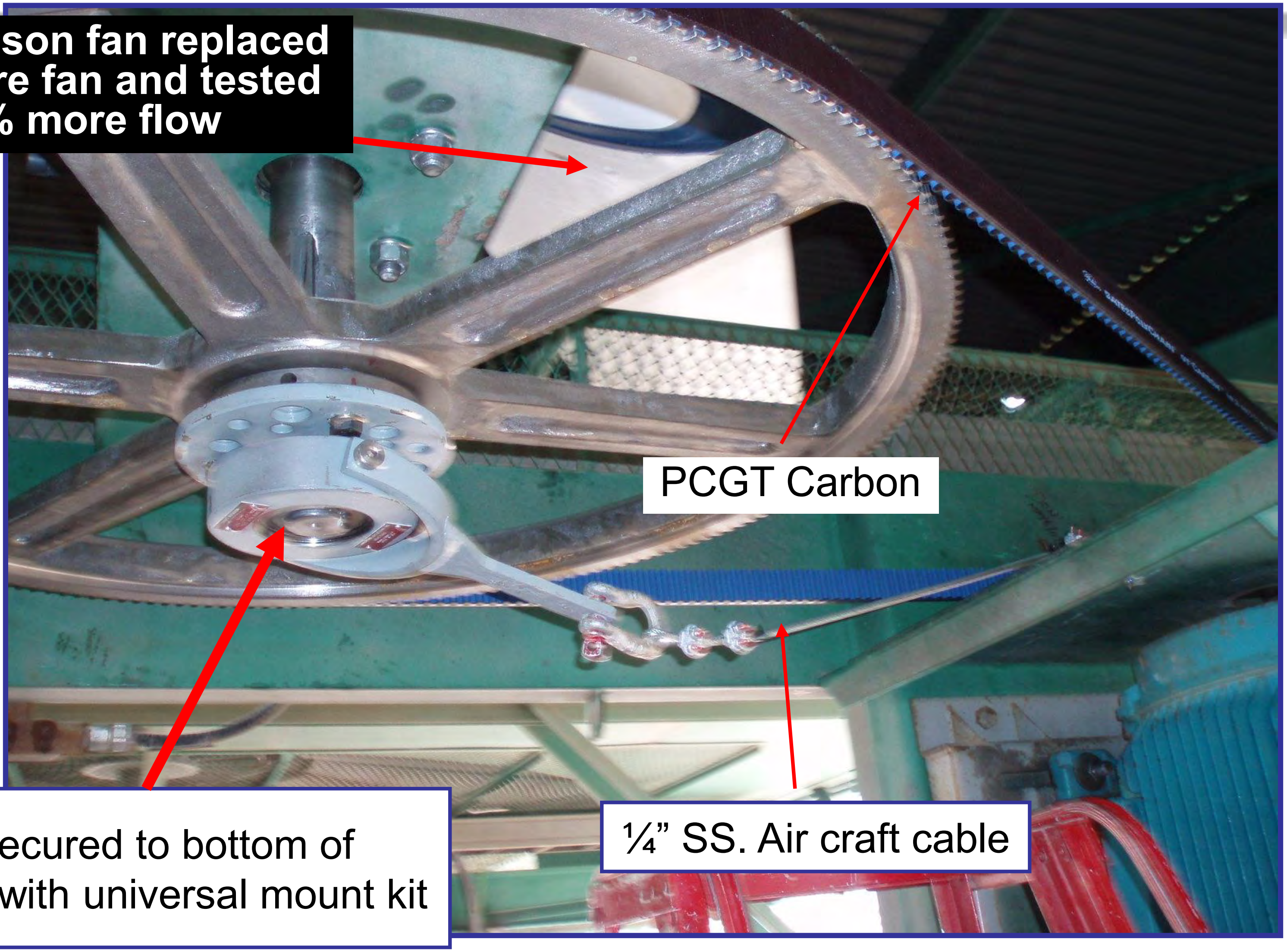
- **Poly Chain drives will work on almost all current ACHE applications.**
- **Ensure frame integrity!**
- **Soft Starts and VFD's are not required!**
- **Anti-rotation devices are always preferred for many reasons but not mandatory!**
- **Determine motor travel for CD (min-max).**
- **Service factors.**

Why fans wind mill backwards



Anti-Rotation device to prevent harmful wind milling of fans

Anti-Rotation



Frame Reinforcement when required on older Hudson units

Critical Installation Practices!

Alignment

&

Tension

Ideal alignment…?

Motor and fan shaft must be within ¼ degrees.

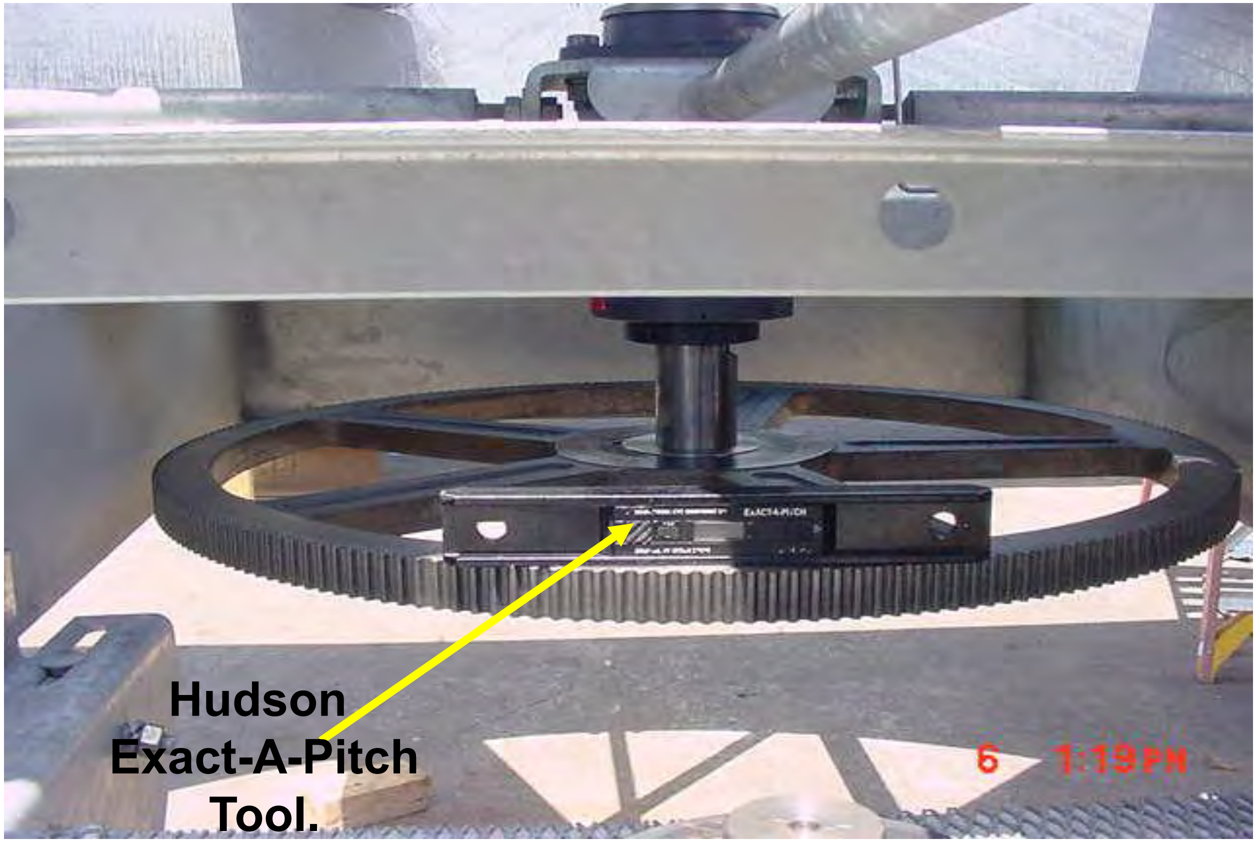
The Easiest way …

Use a digital protractor or level to align the motor to the large fan sprocket!

Step One

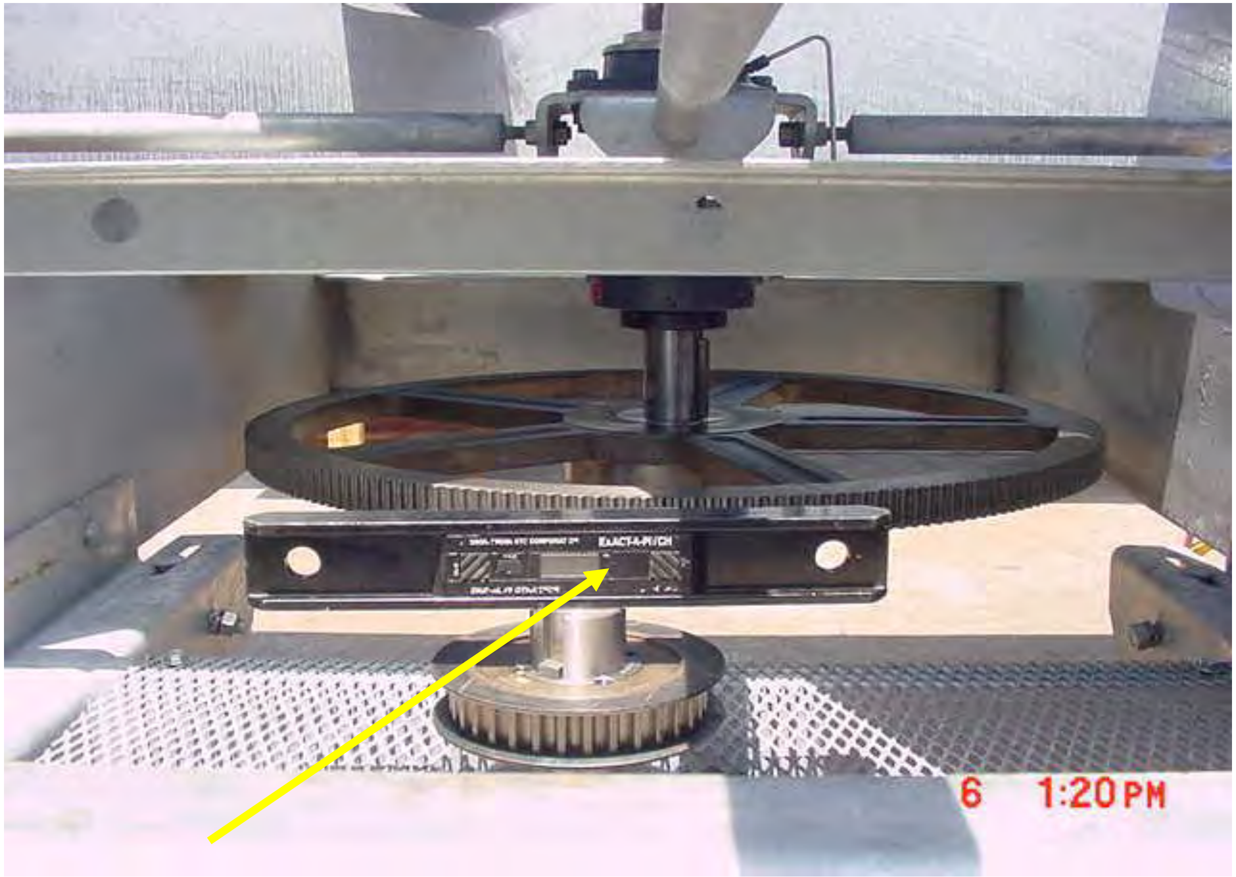
Record the angle of the large sprocket.

The picture below demonstrates proper angular alignment between the fan and motor sprockets using a digital level.



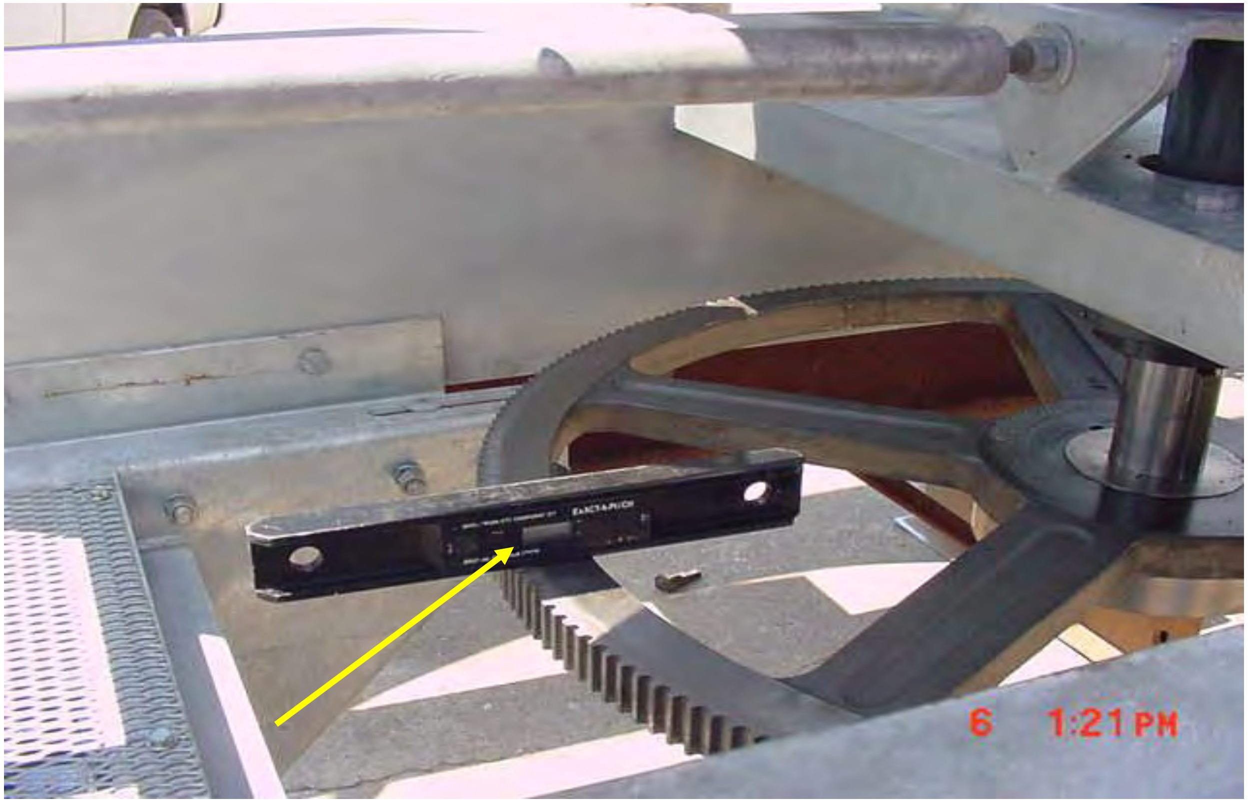
Step Two

Place the digital level on the motor shaft to verify the alignment is within 1/4th of 1° (or 0.25 degrees°) of the large sprocket.



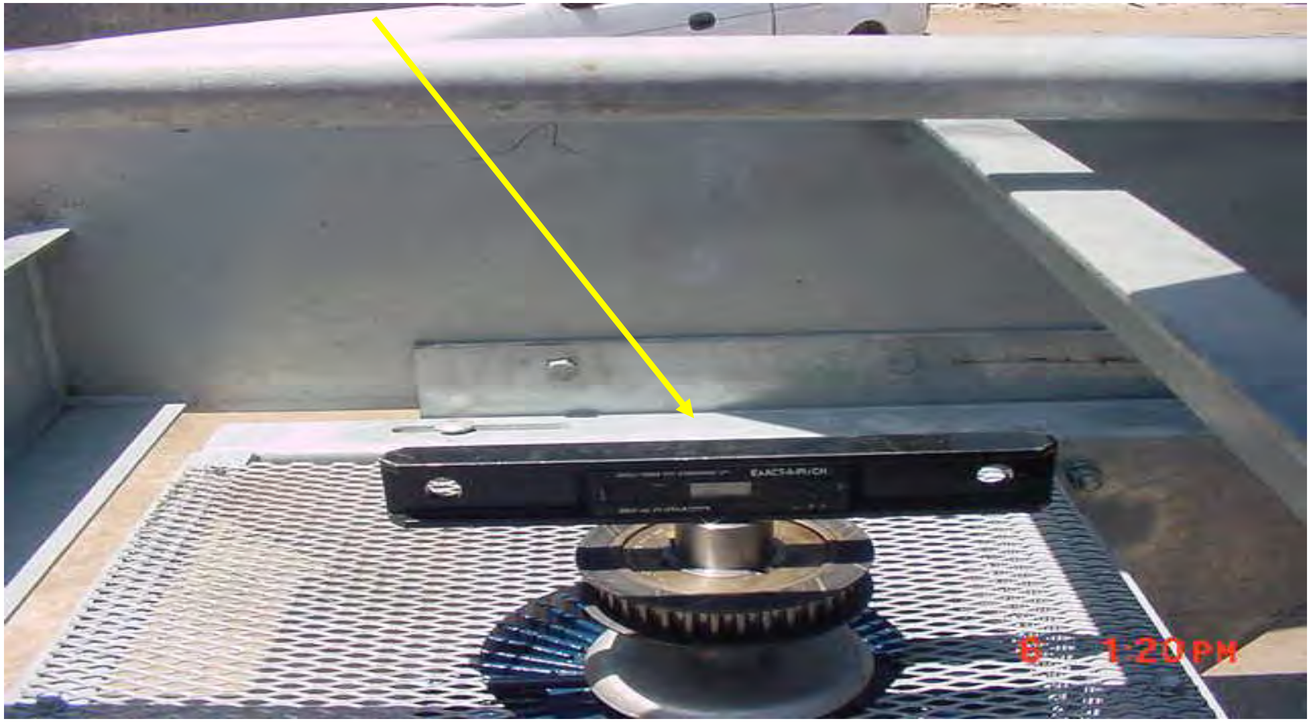
Step Three

The third step is to place the digital level 90° from step one on the fan sprocket. To proceed with the angular alignment, make a recording of this reading for the next step.



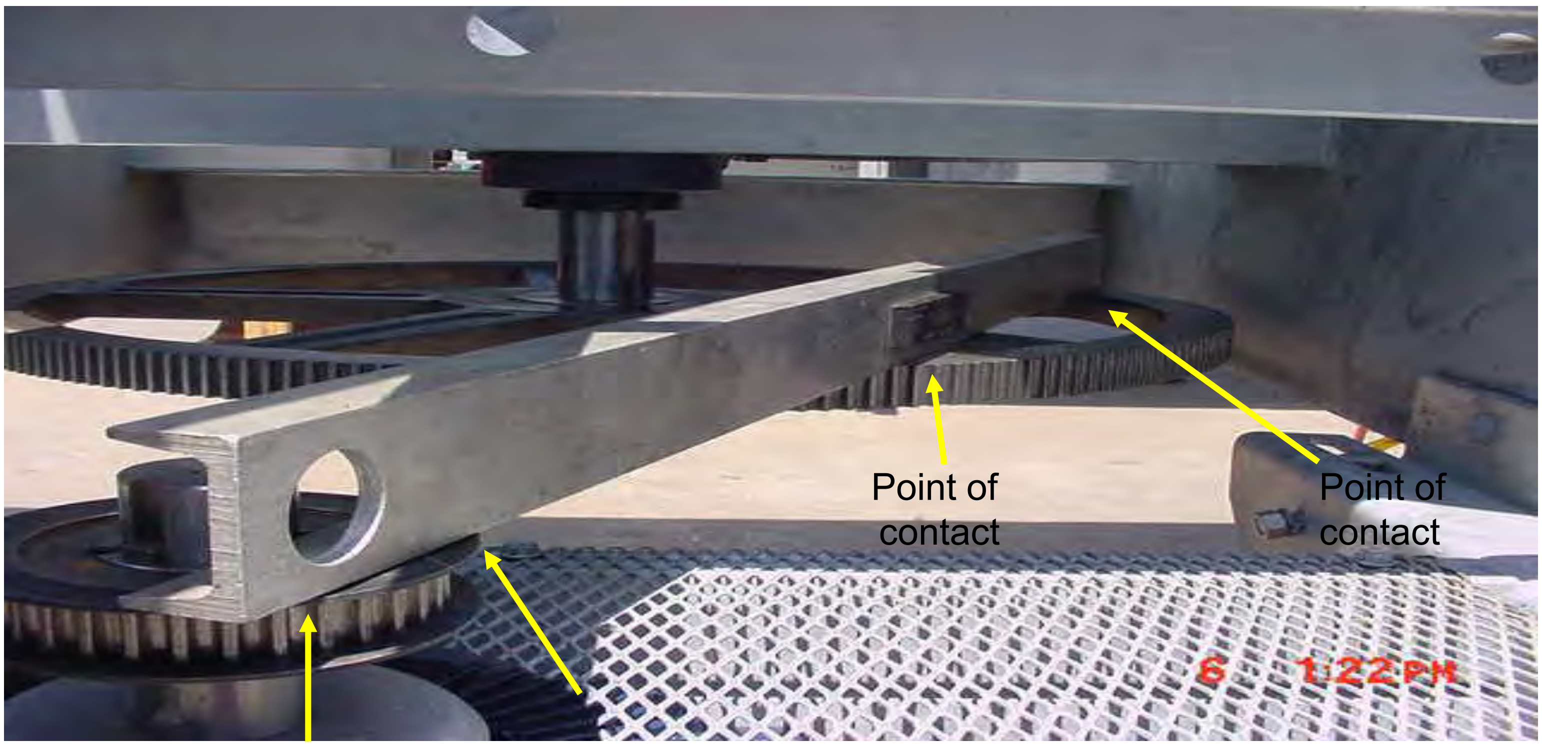
Step Four

The fourth and final step to proper Angular Alignment is to place the digital level on the motor shaft 90° from step two. Verify the alignment is within 1/4th of 1° (or 0.25 degrees°)of the large sprocket reading in step three. This will complete the angular misalignment check.



Not Done Yet

To ensure proper Parallel Alignment, position a straight edge across both sprockets. Confirm the straight edge makes as close to four-point contact on the sprockets (next slide) as possible. If it does not, adjust the small motor sprocket up or down to correct the parallel misalignment.



If you align and tension correctly and the belts will not stay on.....then we can add a bottom flange to each larger fan pulley

Tensioning

Traditional Tensioning Tools

Gates "Pencil" Gauges

Gates 507C
Sonic Tensioner

Design Flex

Design Flex II Printout

For: Joe Engineer
Universal Widget
Middle Nowhere
Smallburg, ST 99999-5555
999.666.1212 Phone
999.666.2222 FAX

From: P. T. Expert
Best Distributor
1 Industrial Drive
Anytown, ST 99999-0000
999.555.1212 Phone
999.555.0101 FAX

Application:

INPUT

DriveR		Belt Drive		DriveN	
Motor HP:	25.00	Speed (Down) Ratio:	1.75 +/- 4%	RPM:	1000
NEMA Standards:	Selected, Min Dia 4.00	Center Distance:	28.00 in. +/- 10%	Max. Diameter:	<not specified>
RPM:	1750	Bushing Type:	Any Bushing Type	Shaft Diameter:	2.1250 in.
Max. Diameter:	<not specified>	Frame Size:	284T		
Shaft Diameter:	1.8750 in.	Max Top Width:	<not specified>		

Design HP: Entered Service Factor: 1.70 Design HP: 42.50

SELECT

DriveR		Belt		DriveN	
Part No:	P40-8MGT-50	Part No:	2000-8MGT-50	Part No:	P72-8MGT-50
Product No:	7708-5040	Product No:	9207-0067	Product No:	7708-5072
Bushing Part No:	TL / 2012	Product Line:	PowerGrip GT2	Bushing Part No:	TL / 2517
Bushing Product No:	7858-2614	Ideal CD:	30.51 in.	Bushing Product No:	7858-3202
Bore:	1.8750 in.	Min Installation CD:	29.07 in.	Bore:	2.1250 in.

TENSION

	New Belt			Used Belt		
	Minimum		Maximum	Minimum		Maximum
Recommended static tension:	570.4	to	611.1 lb. (*)	488.9	to	529.6 lb. (*)
Belt Deflection Force:	37.71	to	40.26 lb. (*)	32.62	to	35.17 lb. (*)
Deflection Distance:	0.476 in.					
Sonic Tension Meter:	2537	to	2718 Newtons	2175	to	2356 Newtons
	62	to	64 Hertz	57	to	60 Hertz

Constants > Mass: 0.550 g/cm² (A/DA), 5.5 g/m/mm (C/FD) W = 50 mm. S = 774 mm.

Tensioning

- Standard tensioning procedures may not always be adequate.
- Proper meshing is far more critical than having the exact theoretical installation tension.
- ACHE drives have large ratios up to 7:1, 168 to 224 teeth.
- Any mis-meshing will result in rapid wear on the belt tooth ("shark fin" appearance).
- Correct meshing will resolve both durability and noise issues.

Effects of Incorrect Tensioning

Synchronous Belts

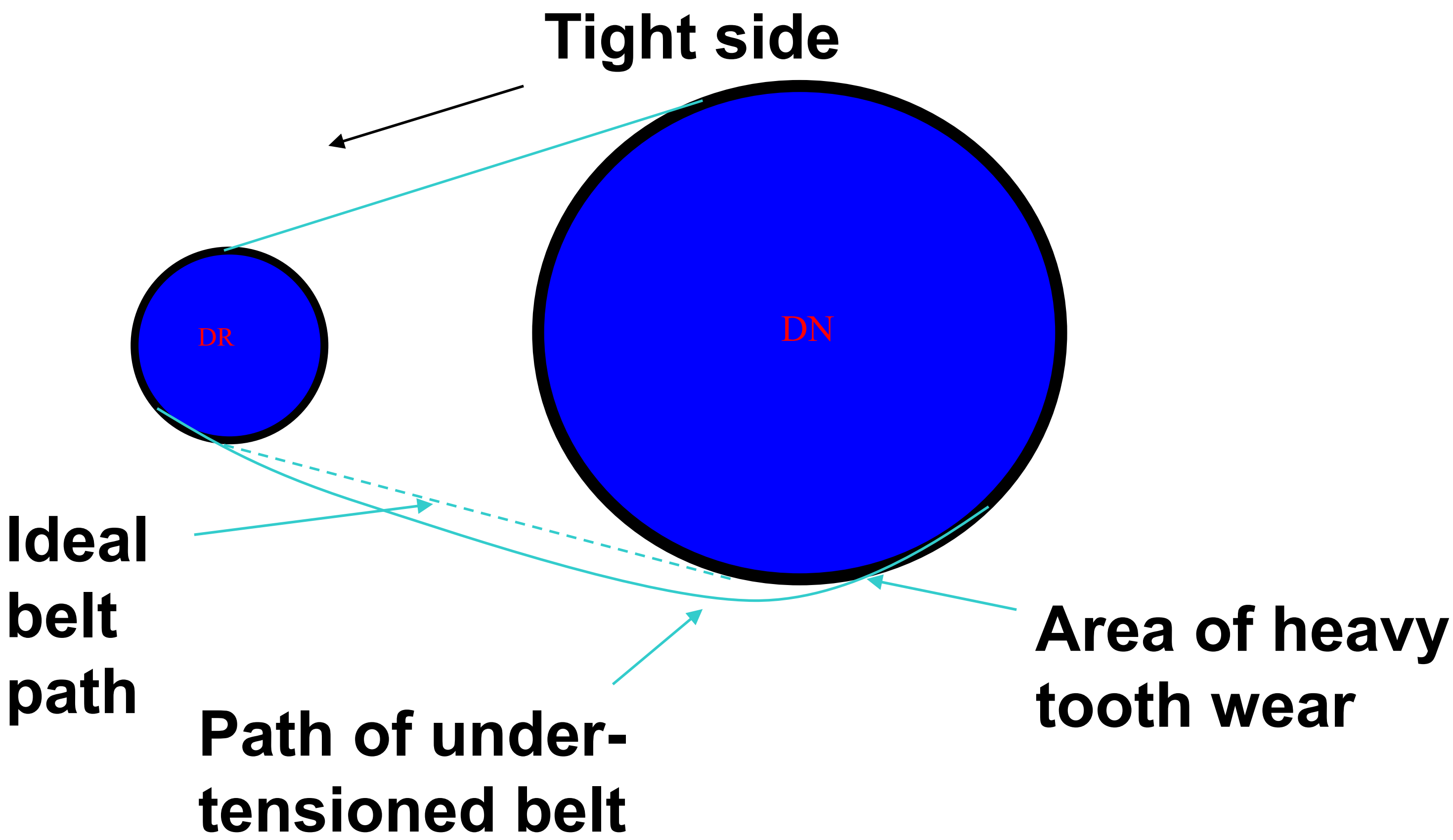
Over-tensioning

- **Irregular tooth wear**
- **Cracking in land area of belt**
- **Bearing issues – Heat - Early failures**
- **Frame or Shaft Damage**

Under-tensioning

- **Irregular tooth wear**
- **Tooth deformation,**
- **Tooth shear or separating**
- **Tensile break resulting from flex fatigue**

Under-Tensioned Belt



Under tensioning gives you…"Sharks fins"

Meshing Issues?

How do you identify the problem?

Rotate the fan and have a look.

•Strobe Tach or a variable frequency stroboscopic light.

•"Freeze" the motion and allow the belt meshing to be viewed.

•If the fan has a VFD this inspection needs to be done at full speed and load.

Explosion risk areas require special permission before any electrical equipment is used - Including Strobe Tachs and Sonic Tension Meter.

Stroboscope Tester

The Monarch Instrument unit is used by the Gates team and found to be perfectly suited for this type of work.

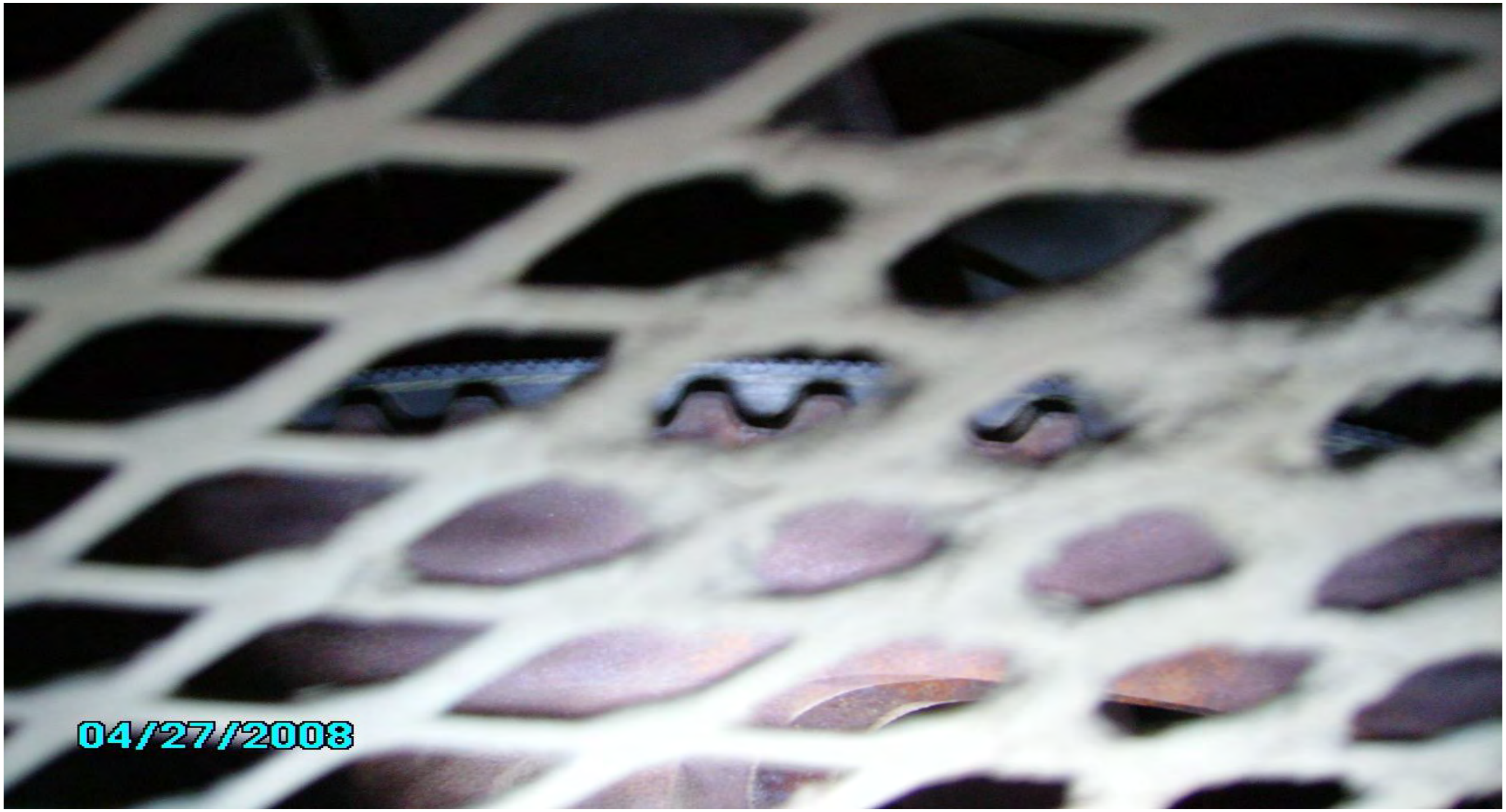
*****Not approved for explosion risk areas.**

Permission must be obtained from the plant operator before use.***

Incorrect Meshing on Driven Pulley

Loaded drive running - photographed with Strobe Light.

Not too bad but could be better…



A Thing of Beauty!

Loaded drive running - photographed with Strobe Light.

Tensioning Tips

Start Up

- …A loud "Bang"? Check the rigidity of the frame!
- On Line starts cause severe shock loads. This may result in frame deflection leading to tension loss and tooth jump*.
- Frame Flex under load does not show-up in the designing process.
- Close observation of the structure will normally reveal excessive structural movement if there is any. (Don't Blink!)
- Pinch the belt span and watch for deflection of shafts.
- The "Structural String Test". Frame to Frame.
- Failure to ensure structural integrity may damage belt, bearing and sprockets.
- ***Variable Frequency Drives and soft-start motors are not required for PCGT2 on ACHE drives.**

Solutions and Assumptions…?

- •Don't over-design the drives.
- •Electric motors are typically running at 60% of their plated power.
- •Most Poly Chain drives are working at well below the belt capacity.
- •Tension is calculated from the actual absorbed power.
- •Proper tension information is also available by using the Gates Design Flex II free of charge online at www.gates.com
- •Use Design Flex to establish a tension starting point.
- •Proper Tensioning tools are a must!

If it looks wrong , it is wrong! Life will be reduced & Tooth Jump can occur!

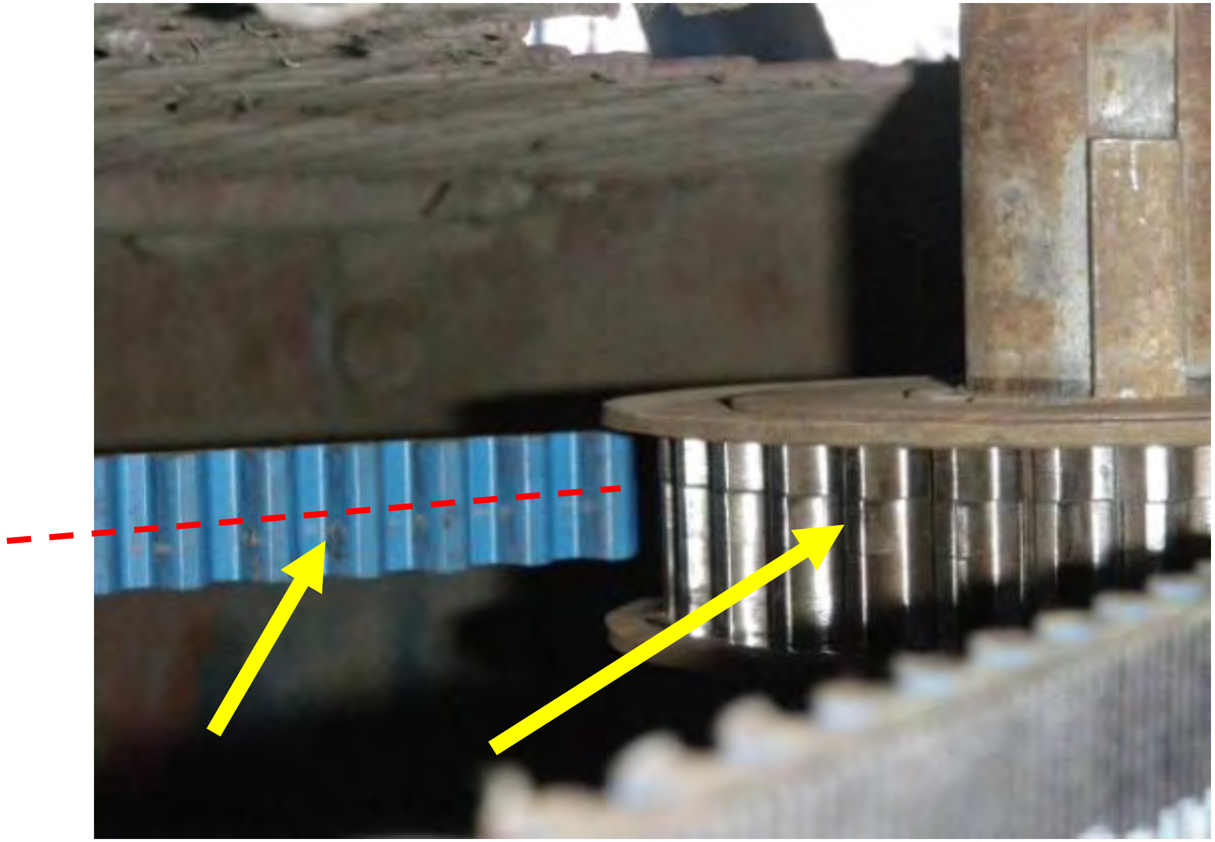
ACHE HTD/CARBON

- **Existing HTD drives with 14MM pitch can be changed to Poly Chain by replacing the small sprocket with a PCGT Sprocket.**
- **No “F” Requirement with Carbon**
- **API Specification requires a 1.8 SF**
- **Do not over design.**

lower belt costs and make alignment

- **<u>Equipment # 59-13-02</u> has existing old HTD belt 85MM wide, rated at 63HP (25HP motor) and the belt costs about $500.00**
- **We can replace that with a new Gates Carbon Fiber belt 20MM wide, rated at 99HP for $300.00**
- **We would need to replace the**
- **small motor pulley/bushing only 14MX29S-20 @ $140.00**

when to replace the small motor pulley!
Also do not roll on new belts!



Gates PRODUCT APPLICATION NOTES

Volume 53, No. 1
January, 2006

Primary Causes of Synchronous Belt Failures (Part 1 of 4)

Synchronous belt failures can occur from a variety of causes, and belt failure modes are sometimes difficult to identify. The purpose of this PA Note is to define, illustrate and diagnose common synchronous belt failure modes so that appropriate corrective actions and preventative measures can be taken.

Normal Belt Wear And Failure

A failure that occurs when a belt reaches its ultimate tensile cord fatigue life, after running for a period of 2 to 3 years, is considered to be normal. Belt tensile failure due to cord fatigue after a long running period is considered to be ideal. Figure 1 illustrates a jagged 45 deg. belt fracture that is typical of tensile cord at the end of its normal fatigue life.

Synchronous belt teeth can also fail, but is considered to be a non-ideal type of belt failure. After a long period of service, belt teeth may appear to be worn, although they should retain their original size and form. Protruding fibers from the jacket may give belt teeth a fuzzy appearance, as illustrated in Figure 2.

No corrective action is needed for belts performing for a normal 2 to 3 year time period. Belt life can vary significantly from application to application due to numerous factors. Factors affecting belt life include the transmitted power level, the environment, belt installation tension, shaft/sprocket alignment, sprocket condition, and even how the belt was handled prior to and during installation.

Figure 1 - Normal Tensile Failure

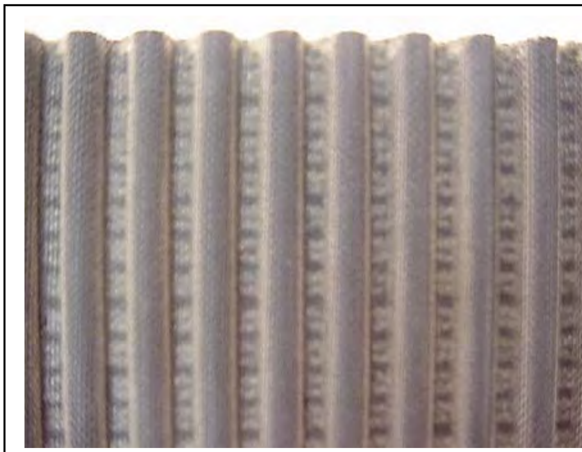


Figure 2 - Frayed Jacket

Belt Crimp Failures

A "Crimp" type belt failure often resembles a straight tensile failure as illustrated in Figure 3. A straight type of break like this may occur when belt tensile cords are bent around an excessively small diameter. A sharp bend may result in large compressive forces within the tensile members causing individual fibers to buckle or crimp, reducing the overall ultimate tensile strength of the belt. Belt crimping damage is most commonly associated with belt mishandling, inadequate belt installation tension, sub-minimal sprocket diameters, and/or entry of foreign objects within the belt drive.

Figure 3 - Crimp Failure

Belt crimping due to mishandling can result from improper storage practices, improper packaging, and belt handling prior to and during installation. *(For more information on proper belt handling, see PA Note Volume 49, No. 5).*

Belts operating in an under tensioned condition may allow belt teeth to ride out of the sprockets until an acceptable belt tension level is achieved. This phenomenon is called "self-tensioning". Self-tensioning can be most clearly observed at the point of lowest dynamic belt span tension, or where the belt teeth are entering the driven sprocket grooves. When a belt is self tensioning, the belt teeth ride up out of the sprocket grooves until increased span tension from the approaching tight side tension forces the belt teeth back down into the sprocket grooves. The point at which the belt teeth are forced back down into the sprocket grooves often results in a sharp, momentary point of bending that can result in belt tensile cord damage. This point of tensile cord damage is referred to as a crimp. If the tight side tension does not force the belt teeth back down into the sprockets grooves, the belt will ratchet. Belt ratcheting can also result in tensile cord crimp and belt tooth damage.

Subjecting belts to sub-minimal bend diameters can also result in belt tensile cord damage, or crimping. This can be caused by sprockets or flat backside idlers in sub-minimal sizes, or even hand bending a belt too sharply.

Foreign objects located between the belt and sprocket can also result in belt crimping. They can lift the belt away from the sprocket at a sharp angle, creating a point of tensile cord crimp. Tools, such as screw drivers or bars, used to force belts on to sprockets can also cause belt cord crimp damage. Belts subjected to foreign objects or improper use of tools during installation may not fail immediately after being damaged; however overall belt life will be reduced.

Shock Load

Shock loading in belt drives occurs when higher than normal intermittent or cyclic torque loads are generated by the driven equipment. These shock loads result in higher than normal belt stresses and can act as a catalyst for belt failure. While conventional V-belt drives may exhibit intermittent slip under peak torque load conditions, synchronous belt drives must transmit the entire magnitude of the peak loads.

Severe shock loads can result in belt tensile breaks with a ragged and uneven appearance as illustrated in Figure 4. The particular belt teeth engaged in the sprocket at the instant of the shock load may also develop root cracks and/or exhibit tooth shear. If the shock load occurred only once, or was cyclical and repetitious at one specific location around the belt, the remaining belt teeth may appear normal. Figure 5 illustrates how root cracks caused by shock loading can propagate through the teeth. Cracks forming at the tooth roots sometimes move towards the tooth tips. Teeth containing multiple cracks may then shear, leaving only a portion of the tooth behind.

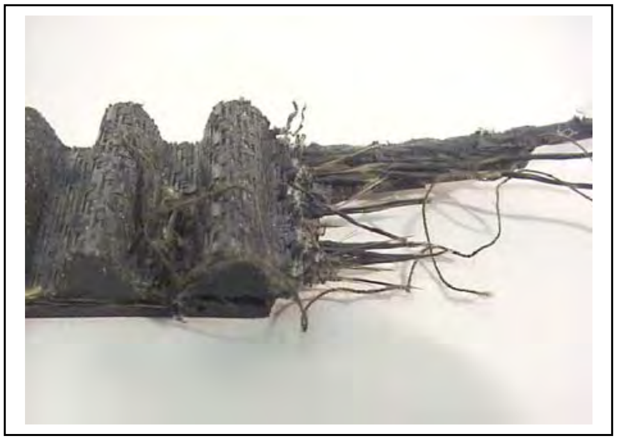


Figure 4 - Shock load Failure

Figure 5 - Shock loaded Tooth Failure

The shock loads generated by the driven equipment may be an inherent part of system operation, or may result from an occasional harsh condition such as jamming. If the drive shock loads cannot be eliminated, the belt tensile strength may need to be increased or the synchronous belt drive replaced with a more forgiving V-belt drive system capable of intermittent slip.

A Gates Representative can provide further assistance with troubleshooting, or with alternate drive recommendations.

PRODUCT APPLICATION NOTES

Volume 53, No. 2
February, 2006

Primary Causes of Synchronous Belt Failures (Part 2 of 4)

Identifying the reason that synchronous belts fail can often be difficult. This PA Note focuses on the effects of improper belt tensioning and the appropriate preventative and corrective measures to be taken.

High Belt Installation Tension

Applying excessive installation tension to a synchronous belt may result in belt tooth shear or even a tensile break. Many belts that have been excessively tensioned show visible signs that sprockets have worn the belt land areas. Figure 1 illustrates a belt with crushed land areas and a crack that formed at the root of the belt tooth. A root crack will often propagate down to the tensile member and travel to the next root crack. Individual belt teeth will then separate from the body of the belt and often fall off. Figure 2 illustrates a belt that had been over tensioned on large sprockets. High belt land pressures caused excessive belt land area wear, ultimately revealing individual tensile cords. In order to prevent belt wear problems like these, proper belt installation tension levels must be determined and set accurately.

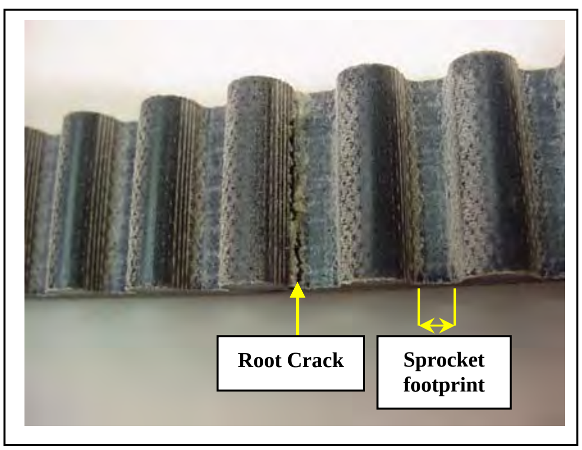


Figure 1

Figure 2

Low Belt Installation Tension

Applying insufficient installation tension to belts operating on moderately to heavily loaded drive systems may also result in premature failures. A common belt failure mode resulting from insufficient belt installation tension is referred to as tooth rotation. Belt tooth rotation can occur as belt teeth climb out of their respective sprocket grooves (self tensioning) and drive loads are no longer applied at their roots. Drive loads applied further down the belt tooth flanks cause the belt teeth to bend (like a diving board), and “rotate”. Belt tooth rotation can result in rubber tearing at the base of the belt teeth along the tensile member. As rubber tearing propagates, belt teeth often begin to separate from the belt body in strips, as illustrated in Figure 3. Failures due to excessive tooth rotation may resemble failures caused by insufficient rubber adhesion to the tensile cords. Failures from insufficient rubber adhesion, however, leave the exposed tensile members clean where the belt teeth were once located unlike tooth rotation failures.

As belt teeth climb out of their respective sprocket grooves to self tension, belt ratcheting or tooth jumping may occur before rubber tearing and belt tooth separation occurs. Belt tensile cord damage resulting from ratcheting can cause premature belt tensile failures. These tensile failures may resemble crimp type breaks (straight and clean) as well as shock load type breaks (jagged and angled). If belt ratcheting does not occur and belts continue to operate while self tensioning, excessive belt tooth wear often occurs. This tooth wear is referred to as “hook wear” and results from improper belt tooth meshing with the sprockets, Figure 4. Hook wear type belt failures result from insufficient belt installation tension, and from weak drive structures that allow center distance flexing while the drive system is under load.

Figure 3

Figure 4

Increasing belt installation tension levels generally prevents premature belt failures due to tooth rotation and hook wear. If increasing the belt installation tension level does not prevent this type of failure, the drive structure may not be rigid enough to prevent deflection. Added structural support may be necessary to improve belt performance. If it is not practical to increase belt installation tension levels, increasing the sprocket diameters will allow higher drive loads to be transmitted with less belt tension.

Proper belt installation tension values can be obtained from Gates drive design software, calculated from Drive Design Manuals, or obtained from a Gates Representative.

Gates®
PRODUCT APPLICATION NOTES

Volume 53, No. 3
June, 2006

Primary Causes of Synchronous Belt Failures (Part 3 of 4)

Identifying the primary reasons that synchronous belts fail prematurely can often be difficult. This PA Note focuses on the negative effects that hardware can have on a belt and the appropriate preventative and corrective measures needed to correct these types of problems.

Sprocket Misalignment

Belts operating on drives with angular shaft misalignment or tapered sprockets often exhibit an uneven wear pattern across the belt tooth flanks and uneven compaction in the land areas (in-between belt teeth) due to the uneven application of load to the belt. Belt failures often occur from tooth root cracks or tears initiating on the side of the belt that is carrying the highest tension and propagating across the belt width, ultimately resulting in tooth shear. One edge of the belt may also show significant wear due to high tracking force, and may even roll up or attempt to climb the sprocket flange(s). Figure 1 shows extreme belt edge wear from a high tracking force.

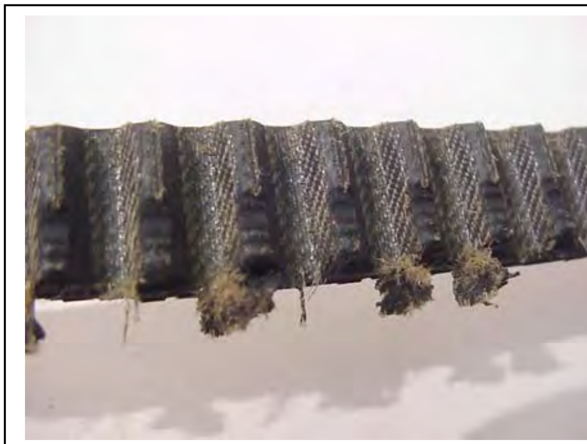


Figure 1 – Angular Misalignment

Belts operating on flanged sprockets with parallel misalignment (offset sprockets) may exhibit excessive belt edge wear on both edges if the belt is pinched between opposite flanges. Belt failures may then occur by tooth root cracks or tears initiating from both edges of the belt. These tears may eventually extend across the entire width of the belt, resulting in tooth shear.

Belts operating on a combination of both flanged and non-flanged sprockets with parallel misalignment may walk or track partially off of the non-flanged sprocket(s). The portion of the belt remaining engaged with the non-flanged sprocket(s) will carry the full operating load and may develop a concentrated area of wear after running this way for a period of time. Figure 2 shows concentrated wear across the majority of the belt tooth face with a portion relatively unworn. A root crack has also developed below the worn area. This may ultimately result in premature belt failure due to either tensile or tooth fatigue.

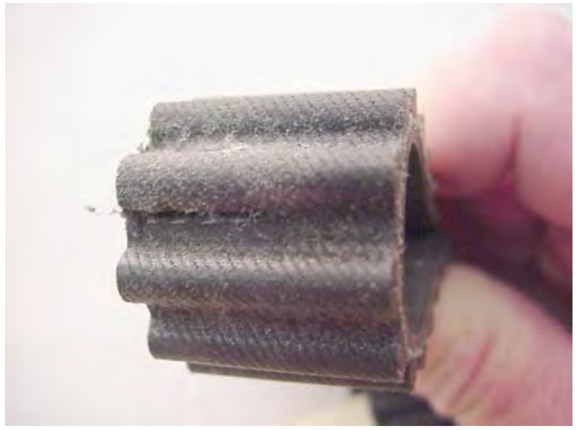


Figure 2 – Parallel Misalignment

Sprocket(s) Out Of Specification

Premature belt failures resulting from sprockets either manufactured or worn outside of design specifications are difficult to recognize. This is partly due to the fact that sprockets are rarely inspected closely when a belt fails. Premature belt failures are often assumed to be the fault of the belt alone.

Belts operating on sprockets that are out of dimensional specification often show a high degree of tooth flank wear with the jacket flank exhibiting a fuzzy or flaking appearance, as shown in Figure 3.

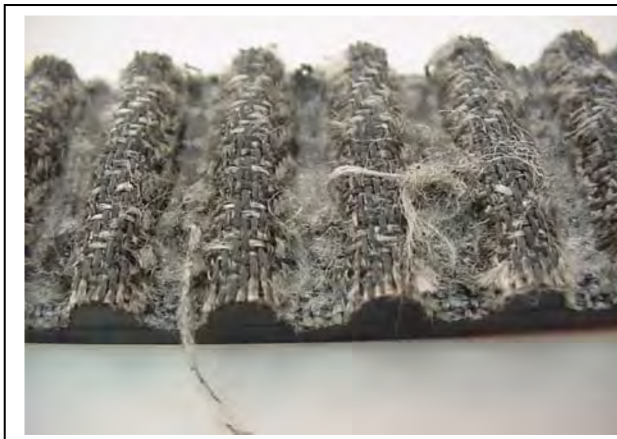


Figure 3 - Belt from Worn Sprocket

Curvilinear (HTD and GT) belts operating on sub-minimal sprocket diameters usually fail by land disintegration, illustrated in Figure 4, and tensile breaks. Trapezoidal (XL, L, H) belts will usually fail by tooth root cracks and tooth shear; however tensile breaks are not uncommon.

Figure 4 - Sub-minimal Sprocket Belt Failure

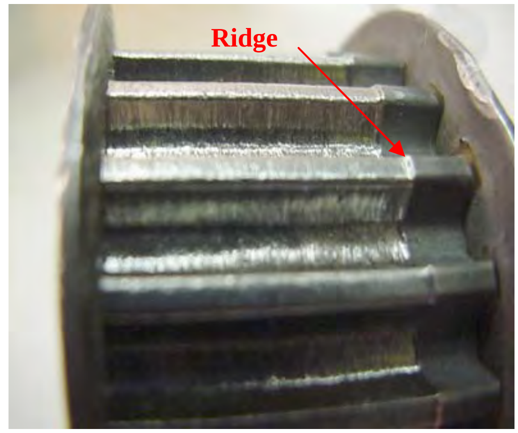


Figure 5 - Worn Sprocket

A higher rate of sprocket wear may occur from belts that have been installed with excessive installation tension. Belts that have been in operation for a long time have sometimes had the tooth facing or jacket completely worn away. Belts in this condition indicate that significant sprocket wear may have also occurred. Belts worn to this point also sometimes allow belt tensile members to contact the sprockets resulting in a grooved wear pattern around the outside circumference.

A good indication of sprocket wear is when a ridge along the tip of sprocket teeth becomes visible, as illustrated in Figure 5. It is best to use a screwdriver to feel for the ridge in order to prevent finger cuts. **Caution - Severely worn surfaces on sprocket faces may become very sharp.** When a ridge on the sprocket face is detected, the sprockets should be replaced.

The most rapidly and severely worn sprockets are most commonly found in abrasive atmospheres. Severely worn sprockets often exhibit groove wear as well as a reduction in the outside finish diameter. A typical belt failure on worn sprockets exhibits polished land wear and may have teeth worn to the point of serious dimensional distortion (hook wear). Sprockets plated with a hard chrome finish can be used to extend the sprocket life in abrasive atmospheres.

Another indication of severe sprocket wear is when replacement belt life is noticeably reduced from previous belts. When this occurs, sprockets should be examined closely for excessive wear.

Excessive Sprocket Run-Out

Belts operating on sprockets with radial run out are subjected to a cyclic rise and fall in belt tension as the sprockets rotate. The greater the run out, the higher the peak belt tension grows. Belts subjected to significant cyclic peak tensions exhibit land areas with a crushed appearance. Crushed land areas and tooth shear are both visible in Figure 6. A crushed land area condition may appear similar to belts operating on moderate size sprockets under excessively high tensions. Belts subjected to extreme cyclic belt tension variations often fail from either tooth shear or tensile break.

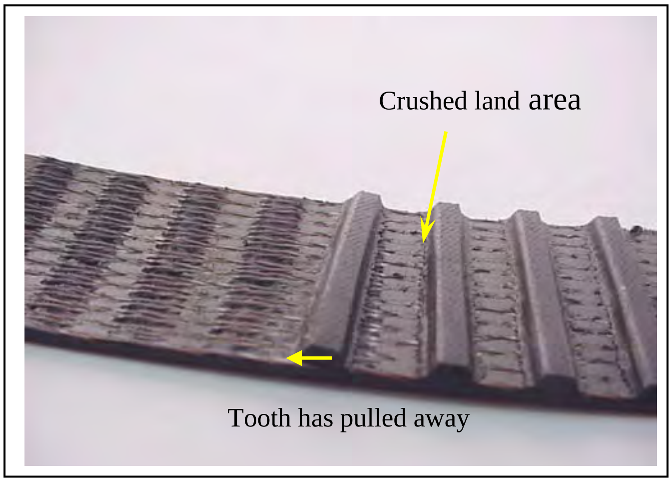


Figure 6 - Sprocket Run-Out

Excessive sprocket run out is most often observed when sprockets are mounted improperly on bushings, or when minimum plain bore sprockets are improperly re-bored and mounted. Sprocket re-boring instructions and shaft / bore fit recommendations are published in the Poly Chain GT2 Drive Design Manual (17595) and the PowerGrip GT2 Drive Design Manual (17195).

PRODUCT APPLICATION NOTES

Volume 53, No. 4
August, 2006

Primary Causes of Synchronous Belt Failures (Part 4 of 4)

Identifying the primary reasons that synchronous belts fail prematurely is not always a simple task. This PA Note focuses on the negative effects that environmental conditions can have on synchronous belts and the appropriate corrective and preventive measures needed to correct these problems.

ABRASIVE ATMOSPHERE

Belts operating in abrasive atmospheres on applications like foundry shakers, taconite processing equipment, and phosphate mining conveyors, often exhibit a high degree of belt land and tooth flank wear. Worn areas frequently have a polished appearance. Figure 1 illustrates a severely worn Poly Chain GT2 belt that ran in a highly abrasive environment. Sprocket wear is generally rapid in abrasive environments; therefore sprockets should be replaced along with belts. To extend the life of belts and sprockets, a sealed guard that is pressurized with clean air can be installed to help keep out abrasive dust and contaminates.

Figure 1- Belt Wear From Abrasive Atmosphere

HEAT DEGRADATION

When rubber belts operate at elevated temperatures (greater than 185°F) for prolonged periods of time, the rubber compound gradually hardens resulting in back cracking due to bending. These cracks typically remain parallel to the belt teeth and usually occur over land areas (in between belt teeth), as illustrated in Figure 2. Belts generally fail due to tooth shear which often leads to tensile cord fracture.

High temperature rubber belt constructions are available for belt drives that must operate in high temperature environments. These special belt constructions help to improve belt service. To determine if a special high temperature belt construction will improve the belt performance in specific applications, contact a Gates Representative.

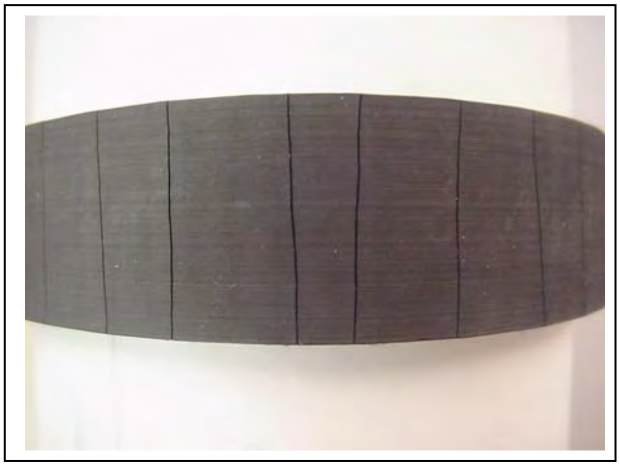


Figure 2 - Rubber Cracking Due To Excessive Heat

The body material used in urethane belts such as Poly Chain GT2 is thermoplastic (has a melting point). When subjected to environmental temperatures in excess of 185°F, the teeth may begin to soften and deform. In addition, the tensile cord to urethane adhesion loses its integrity. Figure 3 illustrates a Poly Chain GT2 belt that was exposed to a high environmental temperature.

Figure 3 - Poly Chain GT2 Failure Due To Excessive Heat

CHEMICAL DEGRADATION

Rubber belts subjected to either organic solvent vapors or ozone will resemble belts that have been subjected to high environmental temperatures. The rubber compound will harden and belts will exhibit back cracking. The cracking pattern will differ, though, in that the compound hardening occurs mostly at a surface level allowing cracks to form in both lateral and longitudinal directions. A "checkered" appearance may result.

FOREIGN OBJECTS

The introduction of foreign objects between a belt and sprocket often damages both belt teeth and tensile cords. Tensile cords often fracture internally (Figure 4) or fail later due to crimping (bending too tightly) (Figure 5). Once a portion of the tensile cords have fractured, the remaining tensile strength of the belt has been reduced considerably. This often results in a dramatic reduction in belt life. If belt damage from debris is noticeable, the belt should be replaced and the sprockets checked for damage. Damaged sprockets should also be replaced.

Figure 4 – Tensile Cord Failure From Debris

Figure 5 – Tensile Cord Crimp Failure