

AIR COOLED HEAT EXCHANGER [ACHE] FAN BLADE ADJUSTMENT MANUAL







As presented for use in the Irving Oil Limited – Refinery

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Foreword

What options need to be investigated when air-cooled heat exchangers (ACHEs) fail to meet their expected cooling demands? One particular troubleshooting option is to examine the blade pitch angle. Ask yourself the following questions: What is the actual pitch? Is it the same as originally designed? Is the fan rotating in the proper direction with the leading edge of the blade down? Though many factors may be involved, it can be as simple as whether or not the blade pitch has been measured correctly. The previous inquiry is the focus of this manual.

Every blade for each particular fan model needs to be pitched the same to within a specified tolerance. If not, the fan will be imbalanced and severe vibrations could be detrimental to the fan. Knowing where to take the pitch reading is important. Ensure that the pitch-level tool spans the entire width of the blade or touches all contact points. A long piece of wood or bar may be placed under the pitch-level to get the correct blade angle reading. The blade pitch should be set as designed and determined by proper air flow calculations.

"Don't set blade pitch based on motor amperage. This method rarely results in the fan running in its *sweet spot*. The fan will draw more amperage when it is in stall or approaching stall. Therefore, using amperage as the only reference is not going to give the desired result. This could end up with less airflow and higher power costs. If, however, the fan speed is high enough and the pitch is flat enough, the fan is running very efficiently. If this is the case, amp readings can be used to fine-tune and get the fan running at its optimum pitch and efficiency." – Nick Agius.

Based upon the report authored by N. Agius, Commercial Solutions, Alberta Canada as originally appeared in <u>Hydrocarbon Processing® (July 2006)</u>

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References

1. Hudson Products Corporation

1.1. Tuf-Lite®

Blade Installation

- One piece blade of fibreglass reinforced epoxy resin (black finish).
- To prevent installation problems, work on one blade at a time. Insert blade shank into hub socket to allow blade retainer ring halves to lock into place.
- Install retainer rings. Insert one half of retainer ring into groove and rotate ring with end of screwdriver. Ensure rings are seated properly and that the marks drawn on the ring and socket are aligned. The gaps between upper and lower retainer halves should be equal. Install lock screw into each retainer ring half. Hand-tighten the blade socket cap screws. **DO NOT TIGHTEN JAM NUTS**.



- Mount protractor on a flat bar as a base and place it **APPROXIMATELY 1**" **FROM TIP OF BLADE.**
- Rotate fan 360° and note high and low pitch readings. Set pitch at the location where the pitch reading is at the mid-point between high and low readings.
- Using digital protractor, rotate blade in socket until pitch angle is within ±0.2° of desired pitch angle. Raise and lower end of fan blade and find midpoint of blade travel. Hold blade at the midpoint and pull blade outward so it sits against retainer rings.

- Tighten the four blade socket cap screws by altering tightening sequence. Torque applied to any one cap screw shall be no more than 5 ft-lb greater than the torque on any of the other 3 cap screws during the tightening process. All 3/8" cap screws are to be tightened to 15-20 ft-lb. **DO NOT OVER-TIGHTEN CAP SCREWS.**
- Tighten jam nuts against socket to 15-20 ft-lb.



Track Adjustment

- When bolts are tightened, hold a pencil against top end of blade and mark the level onto a fixed object, such as a pole or the fan ring.
- Install remaining blades at same place as first blade. Adjust pitch angle and mark top end of each blade in the same place the first blade was marked. If marks differ by more than 3/4", adjust blade.



1. Hudson Products Corporation

1.2. Tuf-Lite II®

Blade Installation

- Two piece blade of Dow Derakane vinyl-ester joined with aerospace epoxy.
- To prevent installation problems, work on one blade at a time. Assemble blade clamp halves over groove in blade neck and install into hub.
- Install clamp bolts through hub plates and blade clamp, putting bolt heads on top, lock washers and nuts on bottom. Tighten lightly.



- Mount protractor on a flat bar as a base and place it **APPROXIMATELY 1**" **FROM TIP OF BLADE.**
- Rotate fan 360° and note high and low pitch readings. Set pitch at the location where the pitch reading is at the mid-point between high and low readings.
- Using digital protractor, rotate blade in socket until pitch angle is within ±0.2° of desired pitch angle. Raise and lower end of fan blade and find midpoint of blade travel. Hold blade at the midpoint and pull blade outward so that the blade neck flange rests against the back of the blade clamps. Push blade to the right to remove the slack.

• Tighten clamp bolts evenly to 55ft-lb (lubricated) or 60ft-lb (dry). Recheck pitch setting. **DO NOT OVER-TORQUE CLAMP BOLTS.**



Track Adjustment

- When bolts are tightened, hold a pencil against top end of blade and mark the level onto a fixed object, such as a pole or the fan ring.
- Install remaining blades at same place as first blade. Adjust pitch angle and mark top end of each blade in the same place the first blade was marked. If marks differ by more than 1/2", adjust blade.



2. Cofimco Fans

2.1. Adjustable Hub

- Blades are aluminium extruded or FRP pultruded.
- Secure blade retention sleeves to the blade using machine bolts and locking nuts. Tighten 3/8" nut to 40 ft-lb. Position the blade clamp blocks around the blade shank so that the blade droops slightly downward when the blade clamp hardware is tight.
- Position the blade clamps and blade between the hub plates to align bolt holes. Loosely install 5/8" bolts, flat washers and self-locking nuts to secure blades. Finger-tighten all 5/8" nuts.
- On fans where blades overlap at hub be sure to have the leading edge under the trailing edge of the forward blade.
- Pull the blades radially outward until the blade retention sleeve rests against the back side of the blade clamp. Repeat for all blades.



- Mount protractor on a flat bar as a base and place it **APPROXIMATELY 3/16**" **FROM TIP OF BLADE.** Bar must span blade width.
- Select a position on the fan ring and set or check the blade pitch at this position for all blades.
- Blade should be within $\pm 1/4^{\circ}$ of the desired pitch angle.
- Progressively tighten the hardware, 3/8" to 40 ft-lb, 5/8" to 100 ft-lb.
- Recheck the pitch angle after tightening.



2. Cofimco Fans

2.2. U-Style Hub – Series U

- Blades are aluminium extruded or FRP pultruded.
- Place a blade in a blade socket on the hub. Ensure the blade shank safety collar is inboard of the inner hub rim. Finger-tighten the self-locking nut with flat washer onto U-bolt threads. Progressively tighten each leg of the U-bolt until blade is held in place.
- On fans where blades overlap at hub be sure to have the leading edge under the trailing edge of the forward blade.
- Pull blade radially outward so that shank safety collar is in contact with hub inner ring. Repeat steps for larger outer U-bolt. Repeat for all blades.



- Mount protractor on a flat bar as a base and place it **APPROXIMATELY 3/16**" **FROM TIP OF BLADE.** Bar must span blade width.
- Select a position on the fan ring and set or check the blade pitch at this position for all blades.
- Blade should be within $\pm 1/4^{\circ}$ of the desired pitch angle.
- Progressively tighten the hardware, 14mm to 87 ft-lb, 16mm to 138 ft-lb.
- Recheck the pitch angle after tightening.



3. Moore Fans

3.1. Class 10000 HD (Heavy Duty)

- Install one blade. Align hole between resilient mounts and rod end. Insert blade mounting bolt first through resilient mount with the recess for the bolt head and screw in lightly.
- While holding the blade straight out from the hub tube, tighten the bolt to 200 ft-lb.
- After installing first blade, rotate the fan 360° while pushing the blade tip up and down and ensure blade clears the fan ring at all points.
- Install remainder of blades.
- If installed correctly, the blades will return to their undisturbed position if the tips are pressed in the axial directly with a moderate force of 10 to 20 lbs.



- Mount protractor on the FLAT SURFACE OF THE RESILIENT MOUNTS END as shown in the illustration.
- Loosen the clamp nut just enough to allow the blade to be turned. Turn the blade until the desired angle is achieved.
- The maximum recommended blade angle is 30°.
- Tighten the clamp nut to 18 ft-lbs.
- Recheck each blade angle before tightening.



3. Moore Fans

3.2. Class 5500

- Will need to set blade angle prior to installing blades.
- To install blades, align the mount holes in the blade with the clevis ears and insert clevis bolt. Screw nut on loosely with sufficient grease on nut face. Hold blade straight out from clevis and tighten nut to 100 ft-lb.
- After installing first blade, rotate the fan 360° while pushing the blade tip up and down and ensure blade clears the fan ring at all points.
- Install remainder of blades.
- If installed correctly, the blades will return to their undisturbed position if the tips are pressed in the axial directly with a moderate force of 10 to 20 lbs.



- Place a protractor level on the FLAT UPPER OR LOWER SURFACE OF THE CLEVIS as shown.
- Remove each blade from the fan before beginning blade angle adjustment by removing the clevis bolt and nut. Find a hub tube that is horizontal and ensure it is locked.
- Loosen the hub tube bolt just enough to allow the clevis to be turned.
- The maximum recommended clevis angle is 15°.
- Tighten hub tube bolt to 150 ft-lb.
- Recheck blade angle after tightening.



3. Moore Fans

3.3. Class 5400

- Will need to set blade angle prior to installing blades.
- To install blades, align the mount holes in the blade with the clevis ears and insert clevis bolt. Screw nut on loosely with sufficient grease on nut face.
- Raise blade tip approximately 1/2 of the way from the stop-droop position to the horizontal position. Holding blade in this position, tighten the nut to 50 ft-lb.
- After installing first blade, rotate the fan 360° while pushing the blade tip up and down and ensure blade clears the fan ring at all points.
- Install remainder of blades. If installed correctly, a slight resiliency will be noted with a spring effect when trying to lift the blades from the stop-droop position.





- Place a protractor level on the FLAT UPPER OR LOWER SURFACE OF THE CLEVIS as shown.
- Remove each blade from the fan before beginning blade angle adjustment by removing the clevis bolt and nut.
- Rotate the fan while checking the angle of a blade. If the measured angle varies, find two locations, 180° apart, where the angles are identical.
- Loosen the clamp nut just enough to allow the clevis to be turned.
- The maximum recommended clevis angle is 18°.
- Tighten clamp nut to 50 ft-lb.
- Recheck blade angle after tightening.



4. Amarillo-Chittom Airflo

4.1. PowerFlo

- Blade material is 5052-H38 Aluminum.
- Place one of each blade clamp around the shank of the blade. The cut for the blade shank shoulder is deeper on the air discharge side to produce a droop in the installed fan blade.
- The clamps should slide easily within the plate hub. Align holes and tighten the blade clamp bolts just enough that the blade does not slide in the clamps. Use flat washers on either end and a self-locking nut.





- Place a protractor on a straight edge **APPROXIMATELY 1**" **FROM THE BLADE TIP**. Ensure straight edge spans the trailing edge of the blade and the high point of the blade airfoil.
- Mark a location on the fan ring where each blade will be pitched.
- Loosen the blade clamp hardware and rotate the blade in the clamps until you get the desired pitch within ± 1/4°.
- Torque the blade clamp hardware to 50 ft-lbs for 1/2" bolts or 90 ft-lbs for 3/4" bolts. Tighten one nut a turn or two and move over to the other bolts for a turn or two, switching back and forth.
- Recheck the pitch. Repeat this process for each fan blade at the same position in the fan ring.



Track Adjustment

- When bolts are tightened, hold a pencil against top end of blade and mark the level onto a fixed object, such as a pole or the fan ring.
- Install remaining blades at same place as first blade. Adjust pitch angle and mark top end of each blade in the same place the first blade was marked. If marks differ by more than 1/2", adjust blade.

4. Amarillo-Chittom Airflo

4.2. Plate Hub – Series 18T & 12F

- Blade material is Aluminium.
- Place one of each blade clamp around the shank of the blade and slide the clamp and blade into the hub. Align the holes and secure the bolts finger-tight.
- Rotate the blade 360° and check for tip clearance with fan ring.
- Insert or remove spacer rings to yield tip clearance of one half of one percent of the fan nominal diameter. To minimize tip clearance, ensure blade has been pulled completely to the face of the blade clamp.
- Once all the blades have been installed, check tip clearance by rotating the fan.



- Place the protractor ATOP RIVET HEADS AT THE POSITION INDICATED BY THE LABEL ON THE FAN BLADE.
- All blade angles must be set with the protractor at the same location on each blade and with all blades rotated to the same position in the fan ring.
- Tap the blade shank with a rubber mallet under the desired pitch is achieved. Tighten the 1/2" bolts in rotation to 55 ft-lbs.



Track Adjustment

• After installing all blades, mark the fan ring at any blade leading (or trailing) edge. Slowly rotate fan to confirm all blades "track" to the mark on the fan ring within the greater of +/- 1/4" or +/- .25% of fan diameter. If not, loosen the clamp bolts and manually adjust blades(s) until tracking is within tolerance.

4. Amarillo-Chittom Airflo

4.3. Cast Hub - Series 5C, 7E, 18T, 12F, ASF & 12GRP

- Blade material: Series 5C, 7E, 18T, 12F (Aluminum), Series 12GRP (Fiberglass).
- Place the blade shanks into the hub sockets. If required, use the supplied spacer rings to shorten the effective blade length. Replace the clamps and bolts and tighten nuts to a snug fit only.
- Pull the blade outward (away from the hub and toward the fan ring) in a rocking motion until the blade shank flange (or spacer ring) is resting firmly against the shoulder of the hub socket.
- Confirm that fan blade trailing edge (thin side) is higher than the leading edge (thick side).



- Place the protractor ATOP RIVET HEADS AT THE POSITION INDICATED BY THE LABEL ON THE FAN BLADE.
- All blade angles must be set with the protractor at the same location on each blade and with all blades rotated to the same position in the fan ring.
- Tap the blade shank with a rubber mallet under the desired pitch is achieved.
- Tighten the nuts in an alternating pattern: 1/2" nuts to 45 ft-lbs, 5/8" nuts to 75 ft-lbs, 3/4" nuts to 90 ft-lbs.
- Recheck blade angle.



Track Adjustment

 After installing all blades, mark the fan ring at any blade leading (or trailing) edge. Slowly rotate fan to confirm all blades "track" to the mark on the fan ring within the greater of +/- 1/4" or +/- .25% of fan diameter. If not, loosen the clamp bolts and manually adjust blades(s) until tracking is within tolerance.

5. Howden/Stork

5.1. Series PFS

Information is limited on Howden/Stork fans. The old style fans in use at the refinery are no longer promoted.

Pitch Adjustment

• Mount protractor on a flat bar as a base and place it **APPROXIMATELY 2**" **FROM TIP OF BLADE.**



6. ADJUSTING PITCH SEASONALLY

6.1. Reasoning for Varying Seasonal Motor Loads

Difference in air density as temperature changes

- WHAT? Cold air is more dense and heavier than warm air. This makes it so that in warmer weather, there is less air / ft^3 than in the cold.
- **HOW?** A motor using say 28.5 amps out of 30 amps in the summer will draw higher current in winter because of the "heavier air" = 32 amps in winter so it trips!!!!



• **Bad Part:** Also, if a motor uses say 25 of 30 amps in winter, it will only use maybe 18 of 30 in summer. This means the motor is NOT BEING USED TO IT'S CAPACITY!!!

WHAT TO DO?

- 1. Adjust the fan blade pitch seasonally. Set the pitch lower for winter, and higher for summer to optimize air flow and maximize motor hp usage.
- 2. Install <u>Variable</u> <u>Frequency</u> <u>Drives</u> on the fans so that the pitch is constant but the fan will automatically speed up or slow down to satisfy cooling requirements, and allowable motor loads.
- 3. Set the pitch aggressively for the winter months to maximize summer cooling. This is done knowing that maximum cooling in summer will not be achieved but seasonal pitch adjustment is not required.

ADJUSTING PITCH SEASONALLY 6.

6.1. Seasonal Pitch Adjustment Procedure

People Required:

- 1. **Operations**
- 2. Electrician
- 3. Millwright

<u>Setting Pitch in the Winter (Colder than -5 Degrees C)</u>

- 1. Contact operations and adjust the fan box temperature using the recirculation louvers / tempering coils to achieve the design air temperature (typically 60-100 F) for the fan. Refer to fan / exchanger datasheets if this temperature is unknown. Caution: Setting / adjusting the pitch of the fan blades for ambient air temperature during cold weather months will significantly reduce fan capacity during summer month operation when maximum cooling is desired.
- 2. Have an electrician perform an amp check on the drive motor.
- 3. Set the fan blade pitch "AT THE VENDOR RECOMMENDED ANGLE"
- 4. Again, have the amps checked at which point they should be (FOR WINTER **APPLCIATIONS ONLY)** ~90% of Full Load Amps which is shown on the motor name plate.
- 5. If the amps read lower or higher than 90% of FLA, adjust the blade pitch in small increments to a maximum of +/-3 degrees of the "vendor recommended pitch" until 90% FLA has been achieved.

Record this blade pitch and use it as a start point for remaining identical fans.

NOTE: IF AN INCREASE OF >3 DEGREES FROM DESIGN IS REQUIRED CONTACT ENGINEERING, DO NOT INCREASE PITCH GREATER THAN 3 DEGREES FROM THE VENDOR RECOMMENDED SETTING.

Setting Pitch in the Summer Months

- 1. Contact operations and adjust the fan box temperature using the recirculation louvers / tempering coils to achieve the design air temperature (typically 60-100 F) for the fan. Refer to fan / exchanger datasheets if this temperature is unknown.
- 2. Have an electrician perform an amp check on the drive motor.
- 3. Set the fan blade pitch "AT THE VENDOR RECOMMENDED ANGLE"
- 4. Again, have the amps checked at which point they should be (FOR SUMMER **APPLICATIONS ONLY**) ~80% of Full Load Amps can be found on the motor name plate or in MCSII.
- 5. If the amps are lower or higher than 90% of FLA, adjust the blade pitch in small increments to a maximum of +/-3 degrees of the "vendor recommended pitch" until 80% FLA has been achieved.

Record this blade pitch and use it as a start point for remaining identical fans.

References

In no way should the information provided in this document be used as a sole reference when making adjustments to the fan blades for any particular fan. Various fan models exist outside the scope of this manual and the subtle differences in fan characteristics may require more detailed installation instruction. Always refer to the original installation instruction pertaining to the fan in question.

Internet Resources

www.hudsonproducts.com www.cofimcofans.com (now a division of Hudson Products Corporation) www.moorefans.com www.amarillochittom.com www.howden.com

Installation Manuals

Hydrocarbon Processing® (2006). Optimize Air-cooled Heat Exchanger Performance.
Hudson Products Corporation (November 2006). Tuf-Lite® Installation Manual 3000B
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Armarillo Chittom Airflo (n.d.). 12F/18T Plate Hub Installation Instructions