After writing a rather lengthy article for the last newsletter, I am having a bit of a dry spell trying to come up with material for this month's column, so please bear with me.

Winter's last blast?

The past week (first week of March) has seen some 60 centimetres of snow dumped on Carp airport, destroying any hopes for an early start to the flying season.

This time of year, it is appropriate to remind members to stay off the infield area until the frost is out and all the snow has melted. It looks like we will have to wait until May rather than early April this year.

Just a week earlier I had flown via Dash 8 to Fredricton New Brunswick to attend a family wedding, and got to experience the superiority of slower prop aircraft to the regional jet when dealing with nasty weather (freezing rain, and strong gusty cross-winds) in this case. Our Dash 8 easily landed on Fredricton's 4100 foot runway, while the RJ after circling a few times had to return to Toronto and wait for better weather.

This experience reminds me of my job interview in March 1986 at BNR, when I emerged into freezing rain, and after a hasty, somewhat hairy drive to the airport I found nothing was getting in or out, and Air Canada had shut down operations. Canadian kept promising a 737 from Montreal would arrive any time. To make a long story short, the 737 never did arrive, but a Dash 7 from City Express, did make it in, and I got the last seat out to make it back to Toronto.

While driving to and from the Fredricton airport I saw two rows of six TBM Avengers with folded wings that are still used for spruce budworm spraying. I had last seen this sight in 1981 when I was flying my first aircraft, a Beech Musketeer back home from Shearwater Nova Scotia.

February Meeting

Our featured speaker for our last meeting, was **Andrew DePippo** who showed a video of the painting of his **CH-701** via an electrostatic process. Assisting Andrew was a representative of RLD industries, a local firm that specializes in this form of painting, as well as Powder painting, a process for an extremely durable baked finish, ideal for engine mounts and landing gear components. Thanks Andrew for a very illuminating presentation.

In addition to Andrew's presentation, we had a brief presentation on a local enthusiast, **Ken Prevost's** goal to develop a contender for the latest **Kremer Prize**. The Kremer prize is offered for human powered aircraft capable of ever increasing flight duration's and capabilities. The first two prizes were won by Paul McCready and his Gossamer Albatross, and Gossamer Condor. The third prize calls for higher speeds with a 50 foot maximum wingspan, aimed at creating practical human powered sport aviation so to speak, evolving into an Olympic event. Those interested in more information should visit the web site of the Royal Aeronautical Society at "**http://www.raes.org.uk/human-power/index.htm**".

Upcoming Events.

Just a brief reminder that we plan to participate as usual, in at least three major events this year.

The Young Eagles weekend on June 12th, Canada Day celebrations at the National Aviation Museum (both static and flying displays), and of course our fly-in breakfast on August 8th. So please don't be shy about volunteering a few hours of your time when the event organizers come calling.

Also please try and write an article on your project, or current or past flying experiences to share with your fellow members. Charles will be happy to polish your contributions prior to publication, so don't be shy.

Pietenpol to Oshkosh.

Irving Slone plans to fly the Pietenpol to Oshkosh this summer with help from his friends, and is busy poring over some maps I lent him. It seems this is a special anniversary event which will see the Pietenpol highlighted at centre stage. This promises to be a real adventure, and I expect Irving will have material for more than one article when he returns.

Thursday March. 18th Meeting

Our next meeting at the National Aviation Museum will feature a **Getting Started video from EAA** which is aimed at many of our new members, and perhaps some of our existing members who have not taken that first step into homebuilding. . I look forward to meeting you there.

Gary

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Looking for a Fly-in Breakfast Coordinator

The Chapter is looking for a volunteer to step forward and organize the annual Fly-in breakfast on August 8, 1999. We would also like to thank Barney deSchneider for his masterful work in organization our past breakfasts. Fortunately Barney has also developed an efficient procedure to follow which should make the task fairly straightforward for his successor.

The Whys and Hows of Preheating

by Mike Busch

This article originally appeared in the January 1999 issue of Cessna Pilots Association Magazine.

In less than a minute, a single cold start without proper preheating can produce more wear on your piston aircraft engine than 500 hours of normal cruise operation. If it's cold enough, a single cold start can cause the catastrophic destruction of an engine shortly after takeoff. This is serious stuff, folks! AVweb's Mike Busch tells you what you need to know to make it through the cold-weather flying season without damaging your expensive powerplant.

Pre-heating, something most of us first learned about in private pilot ground school remains a subject that's poorly understood even by experienced pilots and aircraft owners. There are a lot of misconceptions about why preheating is important, when it's necessary, and how it should be accomplished. But, by the time you've finished this article, I promise that you'll be an expert on the subject.

How cold is cold?

The first question that invariably comes up is how cold it has to be before preheating is necessary. Of course, there's no hard and fast answer to that question. The degree to which a cold start will damage an engine depends on a variety of things, including the type of engine, its age and condition, what sort of cylinders it has (steel vs. chrome), and what kind of oil is being used.

Interestingly enough, a brand new factory reman is considerably more vulnerable to cold start damage than a tired old engine near TBO. Surprised? Stay tuned and you'll find out why.

As a general rule, we consider any start in which the engine is cold-soaked to a temperature below freezing (32°F or 0°C) to be a "cold start," and any start below about 20°F (-7°C) to be nothing short of a capital offense against your powerplant. The colder the temperature, the worse the crime.

Oil pressure isn't enough!

Most pilots seem to think that the main reason cold starts are bad for engines is that the engine oil is thick and viscous and doesn't flow well. Since it takes longer for oil pressure to come up when the oil is cold, the engine sustains excess wear in the early seconds after start because of inadequate lubrication. That's what my primary CFI taught me when I was studying for my private ticket 35 years ago.

That might have had some validity back then, but not today. Nearly everyone who flies in cold weather nowadays uses multiviscosity oil such as Shell 15W-50 or Chevron 20W-50, and those oils flow extremely well even at 0°F (-18°C) or less.

Consequently, pilots who use multivis oils quickly observe that their oil pressure comes up quickly after starting even in cold weather, and they figure that therefore everything's okay. Big mistake!

Bearings need clearance...

The real culprit in cold-start damage is the fact that our aircraft engines are made of dissimilar metals with radically different expansion coefficients. The crankcase, pistons and cylinder heads of your engine are made from aluminum alloy, while the crankshaft, camshaft, connecting rods and cylinder barrels are made from steel. When heated, aluminum expands about twice as much as steel. Likewise, when cooled, aluminum contracts about twice as much as steel. And, therein lies the problem.

Consider your steel crankshaft, which is suspended by thin bearing shells supported by a cast aluminum crankcase. As the engine gets colder, all of its parts shrink in size, but the aluminum case shrinks twice as much as the steel crankshaft running through it. The result is that the colder the temperature, the smaller the clearance between the bearing shells and the crankshaft. That clearance is where the oil goes to lubricate the bearings and prevent metal-to-metal contact. If there's not enough clearance, then there's no room for the oil, regardless how high the oil pressure gauge reads.

How significant is this problem. Well, take the TCM IO-520-series engines used in many Beech and Cessna singles and twins, for example. The IO-520 overhaul manual lists the minimum crankshaft bearing clearance as 0.0018 inch (that's 1.8 thousandths) at normal room temperature.

What happens to that clearance when you start cooling the engine down? TCM doesn't say. But tests performed in 1984 by Tanis Aircraft Services in Glenwood, Minn. (where it gets mighty cold) indicated that an IO-520 loses 0.002 inch (2.0 thousandths) of crankshaft bearing clearance at -20°F. An engine built to TCM's minimum specified bearing fit at room temperature would actually have negative bearing clearance at -20°F-in other words, the crankshaft would be seized tight!

You've probably noticed how difficult it is to pull the prop through by hand before starting in cold weather. Now you know why. It's not that the oil is thick (because if you use multivis oil, it's not). It's that the clearance between the crankshaft and bearings is tighter than normal. If it's cold enough, you might not be able to pull the prop through at all.

Start an engine in this condition and you're likely to experience accelerated bearing wear and possible damage to the crankshaft journals in the first minute or two of engine operation. If bearing clearances are small enough, it's even possible for the bearing shells to shift in their saddles-a so-called "spun bearing-misaligning the oil feed holes and starving the bearing from lubricating oil.

Ironically, this problem is at its worst with a fresh-from-the-factory engine built to the tightest new-engine tolerances. A tired, loose, high-time engine with worn bearings (or an engine with low time since a sloppy bargain-basement overhaul) might well have plenty of clearance even at subzero temperatures.

But, even if your engine is approaching TBO, you can't afford to be complacent about cold starts. That's because inadequate bearing clearance is only one of several evils associated with cold starting.

...And pistons do, too

Consider what happens to your pistons and cylinders when you cold-start an engine. Here, the situation is the opposite of the one we just talked about: instead of a steel crank inside an aluminum case, we have an aluminum piston inside of a steel cylinder barrel. So the clearance situation is reversed: piston-to-cylinder fit is loose when the engine in cold, and tightens up as the engine comes up to full operating temperature. (This is why compression tests are normally done when the engine is hot.)

So why would cold starting be a problem for the engine's top end? Several reasons.

When an engine is started cold and comes up to temperature, the piston and cylinder barrel don't warm up at the same rate. The piston heats up very rapidly after start, while the cylinder barrel may take quite a long time to warm up. Why? Well, for one thing, the piston is small and light, while the cylinder his big and heavy, so when both are exposed to the heat of combustion, the piston heats up a great deal faster. In addition, the cylinder has a very effective mechanism for shedding heat-it's covered with cooling fins bathed in what is presumably frigid air-while the piston's only real cooling comes from the splash of engine oil, and the low RPMs of start and idle there's not a whole lot of splash oil available.

The result is that the piston expands to its full operating dimension quite quickly after start, while the cylinder takes a lot more time to expand to its full operating diameter. The colder the OAT, the longer it takes for the cylinder to reach operating temperature. The result is that although the fit of the piston in the cylinder is quite loose when the engine is cold, it may quickly become tighter than normal shortly after starting when the piston has come up to temperature but the cylinder still has a long way to go. If it's cold enough, the piston-to-cylinder clearance can actually wind up going to zero, resulting in metal-to-metal scuffing between the piston and cylinder barrel.

This problem is made worse by the fact that most cylinder barrels are designed with a taper or "choke" in the top one-third of piston travel. This is done to pre-compensate the barrel for the fact that, as the engine comes up to operating temperature, the top of the cylinder (where the combustion process takes place) is a lot hotter than the bottom of the cylinder, and therefore expands considerably more. If cylinders were perfectly cylindrical at room temperature, then they'd become flared at the top when the engine was hot, resulting in loose fit between the piston and cylinder barrel right where a tight fit is most needed-at top dead center. By giving the cylinder barrel a slight taper at the top when at room temperature, the cylinder winds up being cylindrical at operating temperature.

When an engine is started in cold weather, the cylinder choke starts out considerably greater than normal. After start, the piston starts being repetitively forced up into the choked-down area at the top of the stroke. As the piston quickly comes up to temperature but the cylinder is still relatively cold, it's easy to see how severe scuffing can occur at the top of stroke.

As you can see from this discussion, warming up the engine oil is definitely not enough to avoid cold-start damage. All the warm oil in the world won't help if the crank-to-bearing or piston-to-cylinder clearances go to zero. To avoid this, it's essential for a preheat to warm up the crankcase and the cylinder barrels (especially the top of the cylinder barrels near where they mate to the heads).

The world's finest preheat

The best way to accomplish this is to put the airplane in a heated hangar overnight. Why? Because this preheats every part of the airplane to an even temperature. After 8 to 12 hours in a 40°F hangar, the oil is at 40°F, the case is at 40°F, the cylinder heads are at 40°F, the gyro instruments are at 40°F (gyros have their own cold-starting problems, by the way), the windshield is at 40°F (so it won't fog up the minute you exhale), and even the pilot's seat is as 40°F (which solves another problem).

I'm based on the California coast where the weather hardly ever gets below freezing, but when I travel to the cold country, I always try my best to use the overnight-in-a-heated-hangar method of preheating. Most FBOs seem to charge anywhere between $20 and $50 to store my 310 in their heated hangar overnight. Even at

$50, I figure it's quite a bargain compared to the alternative (accelerated wear of my two expensive TSIO-520 engines).

If I'll be staying at a cold-weather airport for awhile, I'm often too much of a skinflint to pay for the airplane to be hangared for the whole duration. Instead, I'll arrange with the FBO to pull the airplane into the heated hangar the night before my scheduled departure. If it's really, really cold out on the morning of departure, I've been known to preflight the airplane in the hangar, climb into the cockpit, secure the door, and then have the line crew open the hangar door and tow the airplane out onto the ramp with me in it. As soon as they unhook the tug, I start the engines before they've had a chance to get cold-soaked.

Multipoint electric heaters

Short of overnight in a heated hangar, the best preheating method is a multipoint electric heating system that has individual heating elements attached to the oil pan, the crankcase, and each cylinder. By plugging such a system into 115V or 230V power a few hours before departure (overnight is even better), you can at least be assured of warm cylinders, a warm case, and warm oil when you start up.

The best-known multipoint electric preheating systems come from Tanis Aircraft Services in Glenwood, Minn. The Tanis TAS100-series systems cost about $500 for a six-cylinder engine and consist of eight electric heating elements connected by a wiring harness. Six 50-watt cylinder heaters screw into the threaded CHT-probe bosses in each cylinder head. A flat silicone rubber heating pad is glued to the crankcase with high-temp RTV, and another is glued to the bottom of the oil pan. The wiring harness terminates at an ordinary AC plug that is usually mounted near the oil filler door in the cowling. You simply run an extension cord out to the airplane, plug in the preheating system, and let it cook for a few hours.

Although the Tanis TAS100 is a terrific preheating system, one drawback is that its cylinder heaters displace the normal CHT probe. One solution is to change to a spark-plug-gasket-type CHT probe. Another is to use a combined heater/probe element available from Tanis, but this makes the system more expensive, particularly if you have probe-per-cylinder EGT/CHT instrumentation such as a GEM or JPI 700.

In 1992, Reiff Corporation of Delafield, Wisc. entered the multipoint electric preheating market with their novel "HOTBANDD" system. In lieu of cylinder head heaters, the Reiff system uses 50-watt heating elements mounted on large stainless steel clamps that mount on the non-finned portion of each cylinder barrel. As a result, there's no interference with existing CHT instrumentation. The Reiff system also includes an oil pan heater, but not a crankcase heater (the theory presumably being that the crankcase receives sufficient heat by conduction from the oil pan and cylinder heaters). A six-cylinder Reiff system sells for about $400.

Not to be outdone, Tanis recently came out with a new TAS400 preheating system. In lieu of the CHT-boss heating elements, the new system uses a "heated rocker gasket" which fits between each cylinder head and rocker cover, and applies heat directly to the cylinder head. The TAS400 is a significant improvement over the TAS100 system in a couple of different ways. Not only does it solve the CHT-probe interference problem, but it also applies heat evenly to the full circumference of the cylinder head, rather than applying it all at a single point.

Both the new Tanis TAS400 system and the Reiff HOTBANDD system are capable of providing an excellent preheat in a couple of hours. We do not recommend cheaper electric systems that heat only the oil pan. As you now know, heating the cylinders and case is absolutely essential.

Engine and prop covers

If the temperature is not too frigid and the aircraft is being preheated in a tee-hangar or other protected area, then a multipoint electric heating system is all you need to do the job. But if it's really cold, or if you have to preheat outside on an exposed ramp (particularly if it's windy), then you also need some means of insulating the engine compartment and keeping most of the heat from escaping.

At the very minimum, you'll need an insulated engine cover. Although you may be able to make do with a quilted blanket, custom-fitted insulated covers are available from Kennon Aircraft Covers in Sheridan, Wyo., as well as from both Reiff and Tanis and a few other firms.

In intense cold or windy conditions, the propeller becomes a major source of heat loss during preheating. Kennon, Reiff and Tanis all offer insulated propeller and spinner covers to solve this problem. Figure about $300 for a good insulated engine cover, and $100 more to cover the prop and spinner.

Another compelling advantage of insulated engine and prop covers is that using them may eliminate the need for a preheat altogether if you're going to be making a quick-turn. By installing the covers promptly after shutting down, engine heat can be retained for three or four hours even when the airplane is parked outside on a cold, windy tiedown.

Other electric heaters

If you hangar your airplane and use an insulated engine cover, a single-point electric heater can provide an adequate preheat if it is given enough time to do so (e.g., overnight). A simple oil pan heater can do the trick, and even a couple of 100-watt light bulbs stuck up the cowl flaps may suffice if the engine compartment is well covered.

Kennon offers a novel variation on this theme, consisting of a pair of electrically heated plates velcroed to the inside of cowl plugs. Combined with a good insulated engine cover and possibly an oil sump heater, this can do a good job of keeping the engine warm in all but the most frigid conditions.

These approaches work fine so long as you have plenty of time to preheat, but don't expect them to heat a cold-soaked engine to safe starting temperature in an hour or two. For that, you'll definitely need a multipoint electrical heating system, or a forced-air preheat.

Leave it on all the time?

There has been considerable controversy about whether or not it's a good idea to leave an electric preheating system plugged in continuously when the airplane isn't flying. Both TCM and Shell have published warnings against leaving engine-mounted electric preheaters on for more than 24 hours prior to flight. However, these cautions are really applicable primarily to single-point heaters such as oil pan heaters.

The concern of TCM and Shell is that heating the oil pan will cause moisture to evaporate from the oil sump and then condense on cool engine components such as the camshaft, crankshaft or cylinder walls, resulting in accelerated corrosion of those parts. However, if the entire engine is heated uniformly by means of a multipoint heating system, or because the engine and propeller are covered with insulated engine and prop covers, such condensation is very unlikely to occur.

In fact, using an insulated cover and a multipoint preheating system that is plugged in continuously is one of the most effective methods of eliminating internal engine corrosion, particularly if the aircraft is kept in an unheated hangar rather than outdoors. If the entire engine is maintained above the dewpoint, condensation simply cannot occur.

Forced hot air

Most FBOs in the cold country use large forced-air preheating units like those manufactured by Aerotech-Herman-Nelson in Winnipeg, Canada. Smaller hot air heaters fired by propane, kerosene or gasoline are also available from a number of sources, including Kennon Aircraft Covers.

Forced-air preheating can do an effective job, provided the machine has sufficient BTU output for the job (some small propane-fired heaters simply don't), and the machine is left hooked to the airplane for enough time to heat the engine thoroughly. Unfortunately, if you're depending on an FBO for a hot-air preheat one chilly morning, chances are a bunch of other pilots are, too. Unless the FBO is willing to devote sufficient time to preheating your aircraft (and how long that is depends on both the capacity of the heater and the OAT), you may wind up with a partially-heated engine that has hot spots and cold spots.

How can you tell whether you've received an adequate preheat? It's not easy, but if you can manage to get your hand inside the engine compartment and if all the rocker covers and the crankcase feel warm to the touch, you're probably okay.

Classifieds

Place your ads by phone with Charles Gregoire @ 828-7493 or e-mail to cbg@nortel.ca
Deadline is first of the month.
Ads will run for three months with a renewal option of two more months.

Irving Slone's ad in last month's issue (Feb99) of Carb Heat omitted the fact that he is looking for someone to accompany him in the Pietenpol to assist in flying it to Oshkosh this coming summer. Oshkosh 99 is featuring the 70th anniversary of the Pietenpol. A large turnout of Pietenpols is expected, (20 so far) and will be parked together in the showplane area. A multi-media presentation on the legendary designer and his aircraft will be presented at the theatre of the woods. If interested call Irving Slone at
722-0359 (res) or 230-2100 (office) 03/99

A limited number of WearCheck engine oil analysis (SOAP) kits at $28 each. Price includes analysis for 17 wear elements, additives and contaminents, percent fuel dilution, water concentration and diagnostic recommendation, plus debris examination (if present). SOAP has been used for at least 30 years and is the most widely accepted method of internal engine health monitoring and can often pinpoint impending engine failure.
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Large HF radio (ex Otter), good ham project $25.00, Large Radar Screen (possible coffee table???) $25.00, Beech 18 oil cooler, new (possible rad??) $50.00, 6 Gal. J-3 wing Tanks (2) $200.00, Box of VW engine Parts (possible 1/2 vw project) $50.00, New autopilot , 12 volt trim servos and stuff $25.00, Air Path and Pioneer 3 1/8 compass cores $75.00/ea, Shark Fin pitot tube 24volt, new in box $25.00, Beaver U/L Lotus float rigging (spreader bars, etc.) $25.00, Continental prop. spacer (O.E.M. alum) $50.00
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Light weight starter & bracket for Lycoming O320 or O360.

Control wheel yoke assembly from Piper Tomahawk

Engine, VW 1600cc completely rebuilt
Garry Fancy (613)-836-2829 01/98

Articles Wanted

I am always interested in receiving submissions for this, your Newsletter. You may bring articles to the monthly meetings or mail information to the post office box or send me an e-mail attachment at:
cbg@nortelnetworks.com 01/98

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