Living Dangerously

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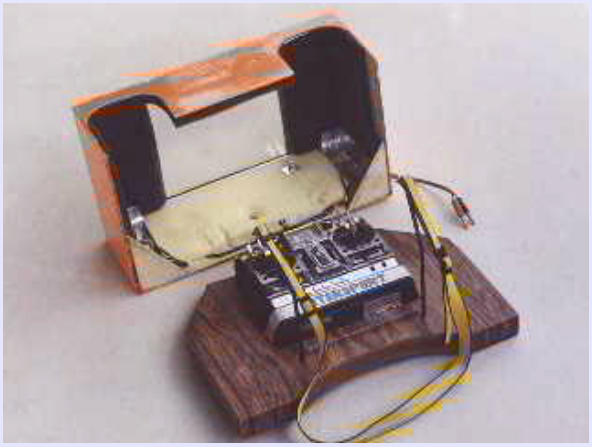
Winter flying

The winter season here in northern Sweden is long, dark and cold, but this is not a valid reason not to fly helicopters! There can be really beautiful days (and nights) in the winter. The picture shows an example of how not to do it - a pilot (me) flying with bare fingers. It's hard to do aerobatics when my fingers turn blue and I lose all feeling, matter of fact it's hard to do anything at all..... HELP I can't land this thing!

This picture is from before I had built my transmitter box. Notice that even the Concept looks nice against white snow covered fields but a bit more sunshine would make it look even better. There are in fact some advantages in the winter flying: The cold air increases the engine power and blade efficiency and it's easy to find suitable airfields everywhere on frozen lakes and snow covered fields. Deep snow will usually make mistakes less expensive (Ed: Presuming that you can find it after the crash...) Let's take a look at some accessories that will make flying in low temperatures more comfortable. Later we will look at the heli and what can be done to keep it from catching a cold.

Electrically heated Transmitter Box

This is my transmitter box. First of all, it works as a wind shelter and for really cold days I have mounted 12V car lamps inside it that work as infra-red radiators. I connect the box via a cable to a sealed lead/acid 12V 6.5 Ah battery that I carry in a small backpacker. It keeps my fingers warm even in temperatures down to -15°C (= +5°F). I don't usually fly in lower temperatures



because I'm not sure if the helicopter can stand it! It's important to check that both throttle and idle up switch are in the right position before starting the engine since the box will make it difficult to reach the throttle quickly. There is also a danger that the box will make it difficult to hear low-battery and other acoustic warnings.

Construction

The box is built of 4mm plywood, insulated with 15mm foam rubber on the inside. I mount the box to my home-made transmitter table and seal all the slots with tape. The window is made out of two transparent plastic sheets (about 2mm each) with approx 5mm spacing between them, reducing heat losses a lot compared to a 'single glass'. I've tried to keep down the size of the box, simply because it is easier to keep a small box warm. It's also important to make the openings for the hands as small as possible. Some

kind of muff would probably reduce draught. The whole design is a bit heavy, so I've been thinking about building a new lightweight box of 10mm styrofoam sandwiched between two sheets of 1.0 mm plywood. I'll keep you informed...

Heating

I use 12V 21W car brake lamps, connected in a series/parallel arrangement (see schematic, next page). The low voltage (6V per lamp) will cause them to emit mostly heat rather than light. The advantage with this system compared to a fan and heater is that the lamp system will start to warm your hands even when the air in the box is still cold. A fan that is blowing around cold air will only make thing worse. I have a switch to select between a high power and a low power setting. The high power is suitable for warming up a cold box, but when it is warm, the low power is sufficient to keep a comfortable temperature. This will save power from the battery and I can keep the box warm for hours. The current consumption is about 2.8 A at high power and 1.2 A at low power so the 6.5 Ah battery will theoretically last for 2 hours and 5 hours respectively. This works so well that if I leave the switch in the high power position it will be too hot in the box after a while! The lamps do get pretty hot, so I have placed them in the corners to minimise the risk of touching them.

The aluminium reflectors behind the lamps are intended to reflect IR radiation back into the box. The reflectors get hot, so it's important to make sure that they don't burn the insulation material used. I have soldered the wires directly onto the lamps. The wires get hot enough to make the PVC-insulation soft, so I have protected the insulation close to the lamp by shrink tubing.

In previous experiments, I tried to heat the box with common pocket-heaters where a rod of coal is burning (or at least smoking) inside a small box. I've found some disadvantages with these though, viz:

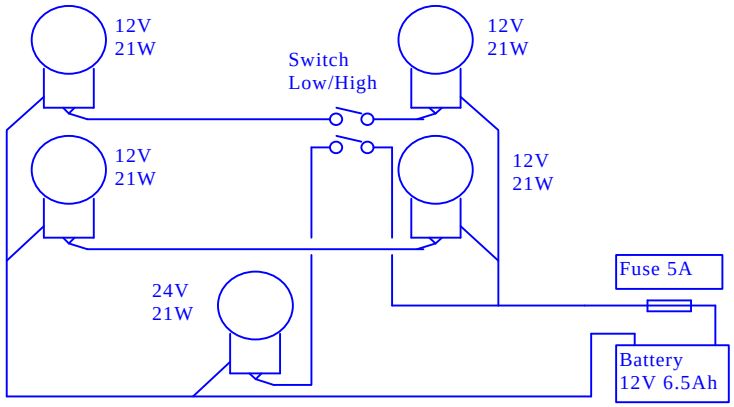
1. The risk of fire when handling fuel

2. The smell

3. Since the smoke smells sulphurous, I guess that the smoke could combine with moisture to form sulphuric acid. This might have a fairly serious effect on the reliability of the transmitter!

So the electrical heating is really much more safe, clean, reliable and easy to 'reload'. The only problem I have found with this idea is that when I fly at night, the light from the lamps is a bit irritating, so I have to cover the upper window with a dark paper where I have cut a small hole to see the display of the transmitter. By the way, don't leave a discharged sealed lead/acid battery in temperatures below 0°C, it will freeze and

Schematics Transmitter box



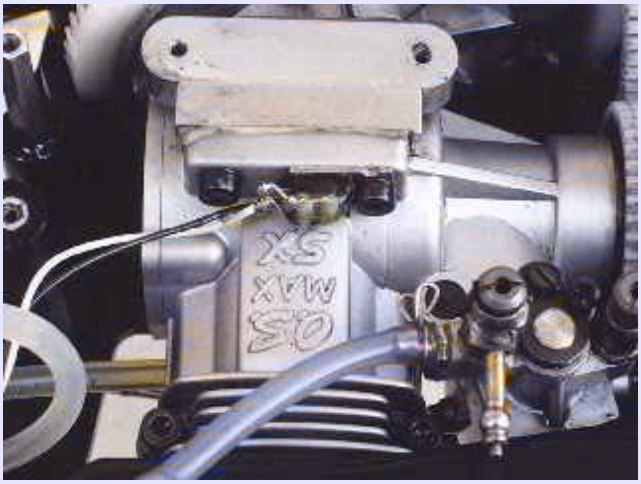
the plastic container will crack when it thaws. A fully charged battery will not freeze. In any case it's a good idea to charge any discharged lead/acid battery immediately to avoid the build-up of sulphate crystals at the battery plates as they will eventually ruin the battery.

Electrical Engine Heater

In these sub zero temperatures, the biggest problem is usually getting the engine running. This type of engine is almost impossible to start in very low temperatures. I still wonder why. Maybe the fuel/air mixture condenses inside the crankcase, I don't know. Anyway, it won't fire no matter how much current there is through the glowplug. Extensive running with the starter might heat it enough by the friction between piston and liner and eventually help it to start, and synthetic engine oil will help because it makes the engine less 'stiff' compared to fuel based on castor oil. A large fully charged starter battery is also necessary. All of these problems can be solved by the use of the simple electrical engine heater described below which uses a power transistor mounted to the crankcase or to the cylinder head of the engine. When running, all needles must be adjusted to richer settings compared to the summer setting and a warmer plug may also be needed.

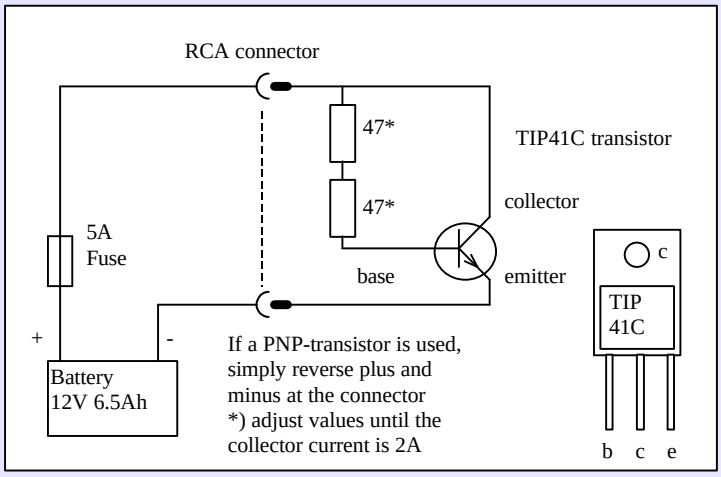
I have mounted the transistor on one of the engine mounting bolts and my colleague Erik Algotsson has it mounted to the rear cover of the engine in his X-Cell. Both solutions work well. When the heater is connected to 12V, a current of about 2 A will flow through it, producing 24W of heat. I connect it 10-15min prior to start (perfect for filling and preflight checks) and the engine is warm when it's time to start it. The poor SX believes it is somewhere in the Caribbean islands and starts immediately!

Almost any power transistor in a TO-220 case will do. All it will need is a suitable bias network connected to the base to get a 2A current through the collector. The bias resistors can be glued to the body of the transistor by silicon rubber. They will produce some heat, but the silicon will sink it into the transistor and the engine. There are two resistors in series just to split the power. Do remember that the tab of the transistor is electrically connected to the collector. That means that the crankcase will carry +12V if you use an NPN transistor (ground, or 0 volts, in case of a PNP transistor). This doesn't matter unless you connect a glow driver to the same battery! The problem is easily solved if the heater is disconnected before the plug is connected, or by using different batteries. Some electric starters have 12V-ground connected to the shaft and this might also cause conflicts so it's wise to fit a fuse anyway in the feed from the battery to the heater. The copper 'tab' of the transistor is quite soft



and easily deformed, so don't overtighten the bolt you mount it on. A washer will help to distribute the load. If the tab is deformed, the silicon chip inside the transistor might crack. Finally, don't mix up the plus and minus leads or the transistor might blow.

I use a 'RCA' phono plug to connect 12V to the helicopter. It's not ideal, but it is working quite well. For a power source I simply borrow the transmitter box heater battery.



What else is needed for these very low temperatures?

Pilot clothing

You will need lots of really warm clothes to stay outdoors for a whole day without freezing. Long underpants are mandatory, even two pairs, plus sweaters, a warm coat, lined trousers, and finally, a warm cap is VERY important. I've read that 50% of the body heat leaves via the head. Insulated boots are also essential. Rubber boots are hopelessly cold! I have a pair of leather boots with inner felt liners that are really good. They are also two sizes too large so I can have lots of wool socks in them. I feel more like an elephant than a human being clumping around in these all day, but they are warm. The lined overalls and boots the snowmobile enthusiasts use are also very good.

On a windy day, its very important to have a wind tight outer layer. I wear gloves during fill-up and starting as it is a really refreshing feeling to get -20°C methanol on your hands and it's even cooler when it evaporates. :-)

Radio

My Futaba radio usually works quite well down to about -15°C but at -20° the servos will slow down. I test the radio by leaving the heli and the transmitter on my balcony for some hours on a cold day just to check that everything is working properly. I also check the range after everything has cooled off.

There are a lot of myths saying that NiCd batteries lose a lot of their capacity in cold weather. This is not strictly true, but the internal resistance will increase slightly. However, stiff mechanics and cold servos will increase the power consumption considerably compared to a summer's day. That's why fresh and fully charged batteries are essential. I prefer to trickle charge the pack between flights just to make sure that the 1800 mAh receiver pack is always fully charged. There is a guy nearby who has flown a helicopter in -30°C (is that -22°F?). However, that was a heli with a scale fuselage, and he heated the interior by leading the exhaust gases around in a metal tube. A good idea but not so easy to accomplish in a bubble and stick type heli.... If I have the opportunity, I prefer to keep the heli in a warm car or indoors until it's time to fly. The radio will not cool down to the outside temperature immediately, so it will work better throughout the whole flight.

It's a good idea to replace the aluminium tips of the joysticks by tips made of wood. That makes them much more comfortable to hold even when they are cold. For the same reason, it is a good idea to cover any surface at the transmitter that contacts your hands with some insulating material. Finally a cautionary note. All the PVC-insulated servo cables will become brittle in the cold. Don't bend them too much or the insulation might break!

Heli mechanics

My current Concept 60 usually works well in the cold. Some heli's (for example the 'old' Concept 60 and my old Shuttle) have the pushrod to the tail rotor placed in a tube and this can be a source of problems. The tube might be filled with oil and water that will become viscous or possibly freeze completely in low temperatures. In most cases the solution is to use a thicker wire and remove the tube. All plastic parts will become more brittle at low temperatures so a crash might break plastic parts that would usually survive an impact. There are synthetic oils (and even grease) on the market that can withstand low temperatures and still be fluid. It might be a good idea to use them for lubricating the rotor head, tail rotor and all parts that obviously will be cold. The main gear, bearing and parts around the engine will be heated by friction losses and heat from the engine so shouldn't be a

problem.

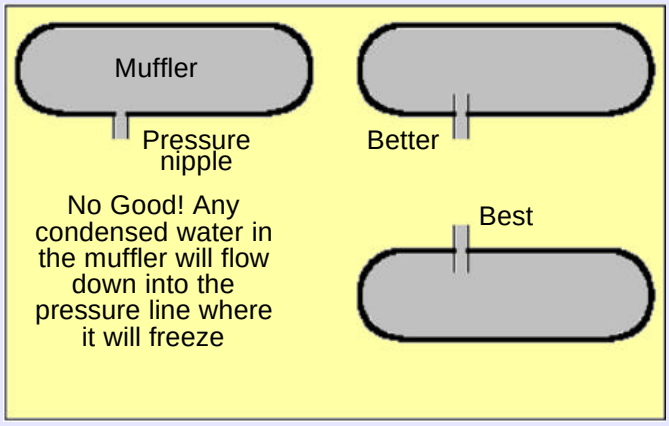
The flap dampers will be stiffer and this might cause a slightly different behaviour initially, but they will warm up and become softer after flying a couple of minutes. Slower servos and increased friction in the mechanics will make the response somewhat different and the gyro suspension might be stiffer in the cold, so there might be a need for some interesting modifications...

Exhaust system

When flying in low temperatures, there is a large risk that condensed water and oil will collect in the muffler or pipe as it's right out in the breeze and will be quite cool compared to a more normal running temperature. This could cause two problems.

1. If this water is allowed to flow into the pressure line to the tank, it is very likely that it will freeze in the tube and cause the engine to quit after a while. This problem is solved by a suitable pressure nipple arrangement. (See sketches)

2. There is also a risk that water might run back into the exhaust port of the engine if the machine is moved too much during transport. This will cause corrosion. To minimise this risk, I prefer to stop the engine quickly when landing after the last flight, while the exhaust system is still hot. Any running at idle might collect condensed water.



Icing

Flying in fog at low temperatures is very likely to cause both rotor and carburettor icing. Wet snow or freezing rain might cause rotor ice and possibly cause the mechanics to freeze and seize up. Ice on the blades gradually reduces lift performance. When there is enough ice, the helicopter is no longer able to hover even at full throttle and if the ice falls off one blade, there might be a severe imbalance *(Ed: and a nasty bruise? :-))* Ice in the carburettor might cause the engine to quit or at least lose power. Watch out for snow being blown from the surface by the rotor downwash as ice crystals might then be sucked into the carburettor and gradually clog it.

Take off and landing on snow surface

A crust on soft snow can be dangerous! Even if the snow surface seems to bear the weight of the heli, there is a danger that the skids will vibrate through the surface and the heli might tip over. It's better to shovel away or pack snow, or to make a safe heli-pad, but be careful that the tail rotor doesn't catch the snow surface. A large piece of plywood will do well as a heli-pad. Some people use floats or skis to keep the heli from sinking down into the snow. On an icy surface, it's very likely that the heli will pirouette when revving up. As long as the tail rotor doesn't hit anything, it's just looks pretty. :-)

My latest crash was caused by the crust (and a bad pilot). I opened the throttle slightly too late when landing, and the tail rotor blades scraped lightly against the crust. "No problem", I thought, and opened the throttle to climb again. I shouldn't have done that. The tail rotor gears were all stripped and I spun into the ground.....

I had to do an auto into deep snow last winter and found that the driven tail has a disadvantage. The tail rotor is still rotating when the heli sinks down in the snow and this will also cause the loss of some teeth in the tail rotor gears.

That's it for this month, it seems as if the temperature is falling. Time to go out for some flying...

See you!

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Co-pilot: Erik Algotsson

More from Erik next month in the January issue of W3MH - if he can get the keyboard into the HotBox. Don't miss it!