Aberdeen And District Soarers

Newsletter No. 59

Hillcrest
Disblair
Newmachar

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Contents

1995 ANNUAL GENERAL MEETING

This year's AGM will be held at the Ferryhill House Hotel on Tuesday 7th November, starting at 7.30. A private room has been reserved for our use and tea and sandwiches will be provided. The Agenda for the meeting is as follows:

1. Chairman's Report
2. Treasurer's Report
3. Election of Committee Members
4. Calder Park
5. A.O.C.B.

Mike Pirie, Bill Sherriffs and Gerry Mitchell are completing their 3 year stint and thus will be retiring from the Committee. Nominations for new committee members or requests for inclusion of items should be made in writing to our Secretary, Gerry Mitchell. Attendance at last year's AGM was very poor so put this date in your diary and make every effort to attend.

FUN DAY AT CALDER

Once again the Club's annual barbecue was blessed with fine weather. A couple of enthusiastic members were out there at 8.30 am taking full advantage of the perfect flying conditions. The club tent arrived just after nine and was erected using the 'just in time' method - just in time for the arrival of the tea urn at about 9.30! A steady trickle of members and visitors ensured a continuation of flying activity throughout the morning with Davy booking his spot at an early stage - half way between the food tent and the launch line!

The wives arrived just as the first burgers were coming off the barbecue (they claim they weren't there just for the food!). Bill's efforts in organising the barbecue and doing the cooking of the burgers and bangers were appreciated by everyone as was the lovely salad bowl prepared by his wife - thanks again Bill!

The winch arrived, and after laying it out diagonally across the field, several gliders enjoyed good soaring conditions and long flights. Disappointingly there was no aero-towing this year. We had the tug, but no gliders to tow! However to compensate, Graham was flying his quarter scale Laser powered Tandem Falke (still no pilot, Graham!).

The wind strength increased for a while and there was a couple of very sudden showers which had everybody dashing about to get their models under cover and to get a place in the tent, but this did not spoil an excellent afternoon's flying. Seen on the flight line were 100s gliders, powered gliders, electric soarers, power sport, scale and vintage. There was also a helicopter and a fine demonstration of petrol power by Gordon Taylor. Back on the scene after an extended period of DIY jobs in the house, was Tom MacPherson - I think he really enjoyed himself. All flying was done under the ever watchful eye of safety officer of the day, Bill Stark - you only broke the rules at your peril!

It was super to see so many people relaxing and enjoying themselves. The good turnout of members ensured a successful day and a good time was had by one and all. Maybe next year we'll see more wives and families - remember it is meant to be a family day, so bring 'em along. Things finally came to a halt at about 5.30 when, after a big clear up, there was some control line fun.

M. A. P.

INDOOR SEASON 1995/96

Dates have been set for next season's indoor meetings at Muirfield School. These together with a provisional programme of activities are as follows:

Monday Oct. 9th 1995	Indoor Flying
Monday Nov. 13th 1995	Indoor Flying
Monday Dec. 11th 1995	Video evening
Monday Jan. 8th 1996	Indoor Flying
Monday Feb. 12th 1996	Indoor Glider Competition
Monday Mar. 11th 1996	Bring a Model
Monday Apr. 8th 1996	Rubber and Fun

Start time for the meetings is 7.30 and there will be the usual cover charge of £1.00 See you there.

M. A. P.

Please rember the last slope event for this year is on October 14th. and the venue will be announced nearer the time

WASHOUT

Washout is a little trick which makes a plane behave better as it stalls. When a wing is perfectly straight, i.e. no twist, and flying straight and level at stall speed, the entire wing will stall more or less at the same time. This will result in an abrupt nose down attitude and loss of altitude (and lunch for those unlucky enough to be onboard).

Things get worse if our straight wing is turning because as we all know the outer wing will be travelling faster than the inner wing and even worse the tip of the inner wing will be travelling slower still. This means the tip of the inner wing will stall first. Since the tip of the wing has tremendous leverage the loss in lift on that tip is often enough to cause a spin. At the very least you get a nasty wing drop which usually happens at the most inopportune times.

The idea of washout is to make the outer portion of the wing (i.e. tips) stall later than the inner portion of the wings. There are a variety of ways of accomplishing this but they basically fall into two categories.

a) make the tip stall later

b) make the root stall earlier

You can make the tip stall later by ensuring that it flys at a lower angle of attack than the root. This is easy to do by simply twisting the tips of the wing downwards a few degrees. Voila. This is known as “washout” (the inverse “washin” is when the tips have a higher angle of attack than the root and is generally an undesirable state of affairs unless you happen to be doing outside loops etc.)

You can make the root stall earlier by simply sharpening up the leading edge at the root. Often you will see small triangular pieces attached to the leading edge root of full sized planes instead of or in addition to washout. These devices will cause a stall to occur at the root well before the mid and outer wing because a sharp leading edge has more abrupt stalling tendencies. Often you will see the tips of aerobatic planes with very sharp leading edges in the last few feet of the wing. This is done to give the exact opposite effect, exceptionally snappy characteristics which are great for good snap rolls and killing oneself while turning onto final.

Thermals And Sailplane Flying Tips

By

Pete Roger

1) Thermal Entry
2) Thermal Escape
3) Early Tow Line Release...When and Why?
4) Hunting Thermals
5) Recognizing Thermals
6) Ground Coverage
7) Efficient Search Patterns
8) When to Know "It's time to go home, the thermals suck!"

As Sailplaning building and flying covers much ground, I will limit these articles to flying. Suffice it to say, building a Sailplane is *really* quite different than building a powered aircraft. The reason: Powered planes benefit from power and this power can cover a multitude of sins. Sailplanes rely heavily on their own abilities and aerodynamics more directly. As there is much ground to cover, (no pun intended) I will split this information into several articles. So; grab your radio and Sailplane and follow me to the "field of steam."

SAILPLANE FLYING

Sailplaning like golf starts with solid fundamentals. Anyone can pilot a sailplane, but only those who grasp these basic concepts will achieve the greater satisfaction. Bad habits learned early are difficult to break. A little about myself for those of you who want to know "Who is this guy and what qualifies him to teach us?" First off; I'm sure there are better Sailplane jockeys out there than myself. In short, I have won LOFT's national competition twice in thermal duration as well as cross country flights. On the local level I have achieved level 8 by the League of Silent Flight's standards. Perhaps more impressive, at least to me, is that I learned from a master, Mr. Jack Smith, three time U.S. team captain to the world competition in Europe. I count it a privilege to have learned from such a man and was fortunate indeed that he lived 4 miles from my home here in northern Indiana. To fully realize the potential of your plane, one must first understand the nature of thermals. Thermals are by definition nothing more than rising parcels of air, warmer than the ambient or average air mass surrounding them. It is this *difference* in temperature that produces the updrafts we pilots ride. Conversely; a cold parcel of air with the average or ambient temperature being warm is also a thermal, although not the type most pilots enjoy. We call it SINK. Many pilots hate sink. This is not something we should hate. Without "sink air" there would not be the really big thermals we seek. Sink air is also denser air, we pilots enjoy the stability as well as using our L:D to advantage. I'm getting ahead of myself and will discuss this more fully later. I have been asked "What does a thermal look like?" This is a good question a deserves a good answer. By knowing the shape of a thermal we can better visualize how to stay in it and where the best updrafts are likely to be found. For some time, many books graphically showed a thermal as a "funnel" shape. While novel, it simply is not the case. You can see the effects of thermals nearly everyday. Look up, see the clouds?, that is what thermals look like. Clouds form and are visible because of condensation, but it is the "Thermal" which shapes the clouds. Some are big, some small, some tall and some short. Some are smoothly defined at their edges, some are rough. Many are wispy and some thick and dense.

One of the greatest demonstrations of thermals at work, the Cumulus Nimbus or thunder head. Awesome updrafts and down drafts as high as 100 M.P.H. or more. How do I know? I've flown in a few and even lost a plane in one once. Found it later when I received a phone call from Ohio. The city was 135 miles from my home. Now that's what I call cross country!

Contrary to popular belief, thermals are *not* rivers of air. If you keep the descriptions of these clouds in mind as you fly, you will have a better understanding why some days are great and some are not as far as thermals go. A hot day does NOT mean it's a good thermal day. So how does one pick a good thermal day?

Some luck does play a part in picking a good thermal day, although, knowing what to look for helps as well. I won't go into all the meteorological basis for what follows as that would be an entirely different subject. The guidelines below do indeed work and should increase your chances for good thermal duration flights.

1) Remember our short discussion on the *difference* in temp that produce thermals? It follows then that a hot humid day will probably *not* be a good thermal day. Notice I said "probably" not definitely. As summer wears on, the high pressures moving through the mid latitudes as well as the temperatures they bring, tend to equilibrate. I have documented stats from clubs throughout the Midwest that show August is one of the worst thermal duration months. I graphed the contest times from 25 clubs during their flying season and August shows a sharp dip, approx. a 35% reduction in average times aloft.

2) Prior to a cold front coming through is a great time to seeking out thermals. Cold fronts are wedge shaped and *lift* the warm air they are replacing. Usually 24 to 36 hrs. before cold front passage is a good time to go thermal

hunting. If you wait too long, the thermals may be good but you now contend with high winds.

3) Springtime is a transition month when winter is forced to give up it's grip of the land and make way for the moderating temps of soon to follow summer. This is probably the BEST time to hit the tow line. Again; my club stats bear this out. April and May are tumultuous months with air currents very active. The thermals themselves are not usually large, but the quantity of them more than make up for their anaemic size. Many a time I have rode these thermals to "out of sight" heights.

4) Well here it is nearly July. HoHum. Not so fast. This is a month that usually has its share of T-Storms. Now I would never advocate flying in a storm, but, prior to the storm can be great. Try 2 to 3 hrs. before the storms rumble in.

5) Look for a time between Low and High pressure systems. Winds around a low pressure system are "Cyclonic" or counterclockwise. The only problem is that Low pressure usually brings rain, or generally crappy weather. High pressure winds are clockwise. Flying when a high pressure system is centred on your region is not as good as would be expected. Too bad, since high pressure days are usually sunny nice days. THE NOON BALLOON

Now for the Sailplane pilots big and probably most important question. What time is best? As sunrise times change daily, this question is driven by the season. In short 3 hours after sunrise to approx. 2 hrs. past noon. That's right; about 4 or 5 hours of really good thermal time. These are the facts, sorry if it disappoints you. For beginners, the early evening is a good time to test fly. The air is calm and cooling, giving a stable and predictable flight. Thermals are generally unheard of at this time, but I've had 8 to 10 min. flights at 7 or 8 p.m coming off the hi-start.

For the summer months, if you have access to a winch, use it. Mid summer thermals form at a higher altitude than do spring thermals. I use my hi-start up till about early June and then switch to the winch. Why use a Hi-start at all? Well; personally it's more gratifying riding a thermal up, starting at 400 or 500 ft., than winching it up to a thousand. Finally; thermals rotate counter clockwise. This is a scientific fact that can be used to advantage by the observant pilot.

This tip I happened on by observation. (More on this at end of article) I watched the Hawks "thermaling" in my area and began a basic investigation. 90% of the time they turn to their left. Hmmm. Sure. It makes all the sense in the world. They are capitalizing on the additional speed gained by "going with the flow." I now fly into a thermal with a left turn. (90% of the time) Also; ever watch a pile of leaves rotating? Which way? That's right...CCW.

RECAP

1) Visualize the shape of a thermal.

2) Springtime...Springtime...Springtime

3) 3 hrs. after sunrise to 2 hrs. past noon

4) Stay away from hot humid days. (unless you like to perspire)

5) Flying 24 to 36 hrs. prior to a cold front often yields great results.

6) Fly between low and high pressure systems.

This tip is something I've found by simple observation and *does* work. I usually don't share it too often, especially at meets. We all know that when thermals seem hard to find on certain days, a dead giveaway is to fly where the hawks are. Most of us know this who have flown for a while. BUT...

Did you ever consider which is better, the left or right turn when entering the thermal? Watch the hawks, they turn to their *left* 90% of the time. Why? Simply because, in the northern hemisphere winds are *cyclonic* or counter clockwise. This scientific fact is what birds, especially thermaling birds, take advantage of. Watch em', it's amazing.

TIP #2: When thermalling in a left hand turn, keep your air speed up and angle of attack down to maximize your aerofoil. Remember, you are moving in a tailwind, if it's a strong thermal the tail wind can be as high as 15 M.P.H. Some planes this is not as critical, such as the OLY 650 etc... as they don't use efficient foils. My Sagitta and ALL competitive sailplanes like speed! I can't tell you how often I've seen pilots try to "balloon" their plane up in a thermal, it works but not as well as it could be. Remember your L:D ratio.

Resist the temptation to pull the stick back if you think you're losing the thermal. Push a little forward. This will seem odd for some at first. Try it. In a right turn thermal entry, a little nose high is OK. Of course if you live in Australia, the reverse procedure is in order.

Until then, Keep the nose clean and your wings level,

Pete

Slope Sites In Our Area

LOCAL SLOPE SOARING SITES

Listed below is a list of the more popular slope soaring sites used by ADS members together with access descriptions, wind conditions required and relevant comments. Hopefully this will encourage some of our newer members to have a go at slope soaring.

ELRICK HILL

Access is via the A96 Inverurie Road or the A944 Alford Road. Turn off the A96 at Forrit Brae and proceed towards Brimmond Hill or turn off the A944 at the sign to Blackburn and drive round the western edge of Brimmond. Elrick is situated to the north of Brimmond and has a distinctive clump of trees on the top. A small track leads to the foot of the hill, a sign directing you to the footpath taking you to the top.

Wind direction:- 140 - 230 Wind speed:- 10 - 20 knots

There are plenty of picnic spots available. Lift is limited except when wave exists and things become very smooth. It is an ideal hill for quick trips.

BRIMMOND HILL

Access is as for Elrick. There are three car parks available - one on the north-east side, one beside Elrick and one on the west opposite Westhill. There are four slopes on which to fly:-

EASTERN RIDGE

Wind direction:- 070 - 130 Wind speed:- 10 - 20 knots

Care is required to avoid the scatter dishes at the top. Slope lift is limited.

NORTH-WEST BOWL

Wind direction:- 270 - 350 Wind speed:- 5 - 30 knots

This is the most popular slope.

SOUTH-WEST RIDGE

Wind direction:- 200 - 270 Wind speed:- 5 - 25 knots

Slope lift is reasonable but gorse abounds.

SOUTHERN RIDGE

Wind direction:- 150 - 230 Wind speed:- 10 - 20 knots

Virtually an untried ridge. Please check before use

DURRIS

Access to the hill is from the A957 Banchory/Stonehaven road via the road to Durris mast. Turn off at the sign to 'Fountain Forestry'. Proceed up this road and park in a clearing on the right hand side just short of the gate to the mast. A land-rover track takes you over the side of the hill and up to the top where you will see the 'Fuerer's bunker' - a handy shelter when conditions get rough or for having your picnic.

Wind direction:- 280 - 340 Wind speed:- 5 - 30 knots

The lift here is excellent but please note you will often have to share the slope with hang gliders.

CAIRN O' MOUNT

Access is by the B974 Banchory/Fettercairn road, the slope being located at the highest point on the road. Park at the car park just below the cairn on the south side. The slope is immediately in front.

Wind direction:- 130 - 180 Wind speed:-5 - 30 knots

Care is required because of the proximity of the car park and road. Lift is superb. The site is often suitable because of the prevailing direction of the sea breeze which is often not strong enough at the coastal sites. It is also famous for the booming thermals which come through on a warm day.

BENNACHIE

Access is via the Chapel of Garioch road off the A96 north of Inverurie and then to the sign-posted car park. Take the footpath leading to the Mither Tap turning off towards Craig Shannoch. At the turn-off point there is an easterly bowl facing Inverurie. Ten minutes walk takes you across to the north-west bowl overlooking Insch.

Wind direction:- 280 - 350 Wind speed:- 5 - 35 knots 050 - 150 10 - 20 knots

The walk takes about 40 minutes but is not strenuous. Lift in the NW bowl is superb with an easy landing. Can be used as an evening site.

HILL O' FARE

Access is off the A980 Banchory/Torphins road. About 1 mile from the Raemoir Hotel is a sign to the right to Corfeidly Farm. Parking is available at the farm but please check with the farmer. Walk from here towards the Hill of Corfeidly up a distinct track, past a small cottage to the disused quarry. Turn left at the quarry and then climb straight up the hill through bracken and then heather to the top.

Wind direction:- 150 - 240 Wind speed:- 5 - 30 knots

A suberb site but a difficult climb.

HILL O' FARE BOWL

Access is again off the A980, but by turning left beyond Corfeidly at a small shop towards Milltown of Campfield. Park at Braeside Farm, again checking with the farmer. Walk straight to the top.

Wind direction:- 220 - 260 Wind speed:- 5 - 30 knots

The walk is fairly long and steep but is well worth the climb. The bowl can also be reached from Corfeidly by following a track across the top of the hill.

STRATHFINELLA HILL

Access is from the southern foot of the Cairn o' Mount. Take the road that runs through Glenshaugh to Auchenblae. Park opposite the entrance to the Brechin Fishing Area. Walk down the road and across a small ford at the western edge of the loch. Climb the hill immediately in front.

Wind direction:- 270 - 340 Wind speed:- 5 - 25 knots

Note that you have to cross a private area, so please be careful. Lift is good, but the climb is steep.

COASTAL SITES

FINDON

Access is off the A90 Stonehaven road at the Findon turn-off, before reaching Portlethen. Follow the signs for Findon village and on reaching a row of houses running SE to NW at the southern edge of the village, turn right until you reach the Unilever Research Laboratory. Turn left here and drive along until reaching Old Mill Road. Follow this road down a rough track and turn left between the new bungalows. Park next to the 'Cliffs are Perilous' sign. Now walk about 200 yards to the edge of the cliff. Stop.

Wind direction:- 080 - 130 Wind speed:- 5 - 25 knots

There is an extremely deep gully at the northern edge of the cliff, no beach at the bottom. However the flying area is fairly shallow allowing a moderate area for landing in front. **Not for beginners.**

STONEHAVEN

The site is reached from the old south road out of Stonehaven, taking the cliff top footpath from the top of the hill adjacent to the War Memorial. The cliff is to the south of the monument with a large field behind for landing.

Wind direction:- 090 - 150 Wind speed:- 5 - 35 knots

Parking is limited. If in doubt, park at the harbour and walk up the cliff. There is a limited beach at the bottom and the bowl is not very high, so a landing can be achieved at the bottom with care.

ST. CYRUS

Turn left at the craft shop at the northern end of St. Cyrus village. Cross the railway line (disused) and take the road between the church and the Primary School to the cliff edge. The cliff is 300 to 400 feet high, virtually sheer with a small winding track down to the 4 mile long beach.

Wind direction:- 090 - 170 Wind speed:- 5 - 35 knots

Care is required when landing because of the severe 'curl-over rotor' at the edge. The area is a nature reserve. It is also used by hang gliders. Car parking is limited at the edge, so if in doubt park by the church. A superb 'family' site, with shops, pubs, beach etc. Flying is superb.

COMMITTEE MEMBERS

CHAIRMAN	James Masson	01224 896794
TREASURER	Michael Pirie	01224 323640
SECRETARY	Gerry Mitchell	01224 324828
SOCIAL SECRETARY	William Sherriffs	01651 862590
COMPETITION SECRETARY	Andrew Thoirs	01224 712008

NI - CAD FAILURE

This year seems to have been a particularly bad one for Rx ni-cad failures. Of four instances that I know of, three have resulted in crashed models. These failures are sudden and are usually caused by the failure of just one of the cells leading to fast run down of the whole battery. Even if the battery is charged the night before and checked before flying, this is no protection against this type of failure. The answer is to renew your ni-cads on a regular bases, say every two to three years. That way you can at least minimise the risk of sudden battery failure. With this in mind please read on!

Some Ramblings About NiCd Batteries

Ken A. Nishimura

Credo #1: Charge control is the key to battery management.

More batteries are destroyed or damaged by bad charging techniques than all other causes combined. Once a battery reaches full charge, the charging current has to go somewhere -- most often, generating heat and gases. Both are bad for batteries.

Q: How does a Ni-Cd battery work?

A: Let us answer this with another question. How does a electrochemical cell work? First, a bit of nomenclature. A cell is a single electrochemical device with a single anode and a single cathode. A battery is a collection of cells, usually connected in series to obtain a higher terminal voltage. Batteries, whether they are primary (use once) or secondary (rechargeable) are devices which convert chemical energy into electrical energy. In the case of the latter, they can take electrical energy and store it as chemical energy for later use.

The key to electrochemistry are the processes of oxidation and reduction. Remember the phrase" "LEO (the lion) goes GER (grr??)" -- Lose Electrons Oxidation -- Gain Electrons Reduction. When one oxidizes a material, it gives up electrons it becomes more positively charged, or enters a higher oxidation state. Likewise, when one reduces a material, one is adding electrons to it and either making it negatively charged or reducing its oxidation state. Now, one can make a cell using two materials, say A and B and immersing them in a solution which can conduct ions, called an electrolyte. (An ion is a charged atom or radical of a molecule capable of transferring electrical charge). Now, let us say that material A is easily oxidized -- it likes to lose electrons, while B is a material that likes to be reduced. When these two materials are immersed in an electrolyte, and a circuit is completed from A to B, A is oxidized and electrons

are released to flow to the circuit. After performing electrical work, the electrons flow into B, where B is reduced. The circuit from B to A is completed by the flow of ions in the electrolyte. A secondary cell can be reversed by forcing electrons into A, and reducing the oxidized A to regain unoxidized A for use again. This, of course, is an oversimplified view, as only certain combinations of materials and electrolytes provides useful and practical batteries. Oh, one more bit of nomenclature: The cathode is where reduction takes place, and the anode is where oxidation takes place. So, in a battery which

is producing current, the positive terminal is the cathode, and the negative terminal is the anode. Yes, this is counterintuitive from our understanding of diodes, where the cathode is negative with respect to the anode...

Now, the NiCd system itself: When the cell is fully charged: The cathode is composed of Nickelic Hydroxide. Now, nickel is one of those elements that has multiple oxidation states -- it can lose a different number of electrons per atom, depending on how hard it is coerced. Nickel is usually found with oxidation states of 0 (free metal), +2, +3 and +4. The +2 state is referred with a -ous suffix, while the +3 and +4 states are referred with a -ic suffix. So, nickelic hydroxide is really NiOOH (the nickel has a charge of +3) or Ni(OH) (the nickel has a charge of +4) 4 The anode is composed of free cadmium metal (zero oxidation). The electrolyte is usually a solution of potassium hydroxide (KOH).

When one connects a load to the cell, as explained earlier, the anode is oxidized and the cathode is reduced. Electrons leave the anode where the cadmium is oxidized and forms Cd(OH) , plus 2 free electrons. 2

These two electrons go to the cathode where they reduce the nickelIC hydroxide to form nickelOUS hydroxide or Ni(OH) (where the nickel has 2 a charge of +2) This reaction can take place until the materials are exhausted. In theory, cells are manufactured so that both anode and cathode are spent at roughly equal rates.

Q: OK, so what happens when cells are charged?

A: Well, in a nutshell, the inverse of the discharge. To charge, one is forcing current back into the cell (opposite of discharge current). Here, electrons are being taken out of the positive terminal, and forced into the negative terminal. This means that the material at the positive terminal is being oxidized (hence is now the anode -- confusing, eh?) and material at the negative terminal is being reduced (now the cathode). In the NiCd system, the cadmium hydroxide is being reconverted into cadmium, and the nickelous hydroxide is being reconverted to nickelic hydroxide. Note that the electrolyte in both charge and discharge is a means to move the hydroxyl (OH-) ions around. Unlike the lead-acid system, the electrolyte really doesn't change in composition too much between the charged and discharged state.

Q: OK, so what's so tricky?

A: The easy part of charging is reconverting the spent material on the plates to the charged condition. The hard part is knowing when to stop. Let us take a moment to think about what happens when we overcharge the battery. Once all the nickelous hydroxide is converted into nickelic hydroxide, and in theory all the cadmium hydroxide is converted into cadmium, the charging current has to go somewhere. As the energy of the charging current cannot go into more chemical energy, it goes into splitting water (water is still the major constituent of the electrolyte). Just like the age old chemistry experiment of splitting water into hydrogen and oxygen, a fully charged NiCd cell does the same thing. You are forcing oxidation at the positive terminal and reduction at the negative. When one oxidizes water (actually the OH-) ion, one produces oxygen. Likewise, at the negative terminal (now the cathode), one produces hydrogen.

This of course is bad. Oxygen + hydrogen = BOOM. Cell manufacturers, or at least their lawyers, frown on this happening. So, they cheat. During manufacture, they deliberately oversize the negative plate, and they partially discharge it. That is, they put a fully charged positive plate, but put a slightly discharged, but bigger plate of cadmium in. The amount of free cadmium in the oversized plate is matched to discharge in step with the amount of nickelic hydroxide provided in the positive plate.

Now consider what happens as full charge is achieved. Oxidation of water starts at the anode, but since the cathode is oversized, and has excess hydroxide, the current continues to produce cadmium metal instead of hydrogen. At the same time, the separator (the material used to prevent the plates from shorting) is designed to allow oxygen gas to diffuse through, from the positive to the negative plate. The free oxygen then oxidizes the cadmium metal to form more cadmium hydroxide to prevent hydrogen from being formed. Voila -- a safe battery.

Q: OK, so it looks like batteries are well protected. Now what?

A: Not so fast..... this scheme will work only as long as the overcharging current is limited to a value such that the rate of oxygen liberation at the anode is less than or equal to the rate of diffusion across the separator.If the overcharging current is too high, excess oxygen is produced at the anode, and since not enough oxygen can diffuse across to make up for the reduction at the cathode, the excess cadmium hydroxide is used up. Then, hydrogen is formed. This leads to a dangerous situation, due to both fire and overpressure. Cells are designed to vent when this condition occurs, releasing the excess hydrogen and oxygen to the air before really bad things happen. While this may keep one's cells from blowing up, it does damage them, since one is losing material from one's cell. As one loses water, it upsets the chemical balance inside the cell -- lose enough water, and it stops working.

Another problem is that the process of generating oxygen, and recombining it at the cathode generates heat. With a moderate amount of current,the cell temperature can rise considerably, to 50 or 60 degrees C. If after charging, the batteries are hot, then you have overcharged them -- slap yourself on your wrist..

Credo #2: Heat is the enemy of batteries..

--A NiCd stored, used, or charged under high temperature conditions will die an early death. Heat causes the separator to weaken, the seals to weaken, and greatly accelerates changes in the plate material, some of which cause the dreaded memory effect. So even though the cells may not vent, the heat by-product is wearing down the cells. Specifically, hydrolysis or degradation of the separator material, usually polyamide, is greatly accelerated at high temperatures.> This leads to premature cell failure (see below).

Q: What are battery manufacturers doing to prevent damage from overcharging?

A: Quite a lot. The demand for rapid charging has lead to a great increase in overcharging abuse. Most all NiCd cells can be rapid charged. The trick is to stop charging when it is fully charged. The so called "rapid charge" type of cells just incorporate protection against overcharging at high currents. Most often, this is done with activated carbon inserted in the cell to promote the collection of oxygen and to deliver it to the cathode for recombination. By increasing the rate of oxygen transport, one is increasing the ability of the cell to resist venting. Note however, that heat is still generated. The price one pays for this is reduced capacity. Everything takes space in the cell, and space for carbon means less space for active material. Also, there have been some indications that carbon can cause the cadmium metal to corrode, possibly leading to a shorter life.

Q: How about those high-temp batteries?

A: There are ways to make NiCd cells more resistant to the damaging effects of heat. Mainly, using polypropylene separators and changing the electrolyte to sodium hydroxide makes the cells more durable under high temperatures. However, the cost is higher, and the internal resistance is raised, making high current discharge more difficult. Unless one knows that cells will be used at high temperatures, don't bother -- learn to take care of the cells to avoid overheating them..

Q: What about those super-high capacity cells?

A: Yup, the manufacturers are in a numbers game. It used to be that AA cells were 450 mAh. Then came 500, then 600 mAh. Now, 700, 800 and even 900 mAh cells are available. Next year, Sanyo will introduce a 950 mAh cell. OK, so what's going on? Well, the highest capacity cells use foamy or spongy backing material for their plates. This allows packing more active material into the plates, but the cost is higher resistance. Recall that one of the great virtues of NiCds is their low internal resistance -- this allows large discharge currents for transmitting, for example. So far, the highest capacity sintered plate (best for low resistance) cell I have seen is the Sanyo KR-800 cell, rated at 800 mAh. The Panasonic 900 mAh cell is of the foam type, and may work for a specific application, but expect higher resistance. I also suspect (but am not sure) that the Millenium cells are also foam type. For most consumer applications, the internal resistance isn't an issue -- for high power transmitting (e.g. more than 1A of current), it can be a concern.

Q: Does the memory effect exist.

A : Yes

> A: YES.

Just as everyone is running around and saying that the memory effect is a myth, here I am, saying that it is true. OK, so, why is this? First of all, the term memory effect is quite unscientific. People tend to attribute any failure of a NiCd to memory. Let us define memory as the phenomenon where the discharge voltage for a given load is lower than it should be. This can give the appearance of a lowered capacity, while in reality, it is more accurate to term it voltage depression. Memory is also hard to reproduce, which makes it hard to study. Originally, memory effect was seen in spacecraft batteries subjected to a repeated discharge/charge cycle that was a fixed percentage of total capacity-- (due to the earth's shadow). After many cycles, when called upon to provide the full capacity, the battery failed to do so. Since we aren't in space, the above is not really relevant...

Let us look at various causes of "memory" or voltage depression. Memory can be attributed to changes in the negative or cadmium plate. Recall that charging involves converting Cd(0H) to Cd metal. 2 Ordinarily, and under moderate charging currents, the cadmium that is deposited is microcrystalline (i.e. very small crystals). Now, metallurgical thermodynamics states that grain boundaries (boundaries between the crystals) are high energy regions, and given time, the tendency of metals is for the grains to coalesce and form larger crystals. This is bad for the battery since it makes the cadmium harder to dissolve during high current discharge, and leads to high internal resistance and voltage depression.

The trick to avoiding memory is avoiding forming large crystal cadmium. Very slow charging is bad, as slow growth aids large crystal growth (recall growing rock candy). High temperatures are bad, since the nucleation and growth of crystals is exponentially driven by temperature. The problem is that given time, one will get growth of cadmium crystals, and thus, one needs to reform the material. Partial cycling of the cells means that the material deep within the plate never gets reformed. This leads to a growth of the crystals. By a proper execution of a discharge/charge cycle, one destroys the large crystal cadmium and replace it with a microcrystalline form best for discharge.

This does NOT mean that one needs to cycle one's battery each time it is used. This does more harm than good, and unless it is done on a per cell basis, one risks reversing the cells and that really kills them. Perhaps once in a while, use the pack until it is 90% discharged, or to a cell voltage of 1.0V under light load. Here, about 95% of the cells capacity is used, and for all intensive purposes, is discharged. At this point, recharge it properly, and that's it. The more common "memory effect" isn't memory at all, but voltage depression caused by overcharging. Positive plate electrochemistry is very complicated, but overcharging changes the crystal structure of the nickelic hydroxide from beta-Nickelic Hydroxide to gamma-Nickelic hydroxide. The electrochemical potential of the gamma form is about 40 to 50 mV less than the beta form. This results in a lower discharge voltage. In a six cell (7.2v) pack, this means a loss of 300 mV. Trick? Don't overcharge. Leaving cells on a trickle charger encourages formation of gamma nickelic hydroxide. Expect the cells to discharge at a lower voltage.

Summary:

DON'T deliberately discharge the batteries to avoid memory

DO let the cells discharge to 1.0V/cell on occasion through normal use.

DON'T leave the cells on trickle charge for long times, unless voltage depression can be tolerated.

DO protect the cells from high temperature both in charging and storage.

DON'T overcharge the cells. Use a good charging technique.

DO choose cells wisely. Sponge/foam plates will not tolerate high charge/discharge currents as well as sintered plate.

Q: OK, so I need to "properly" charge cells. How do I do that?

A: There are many methods of charging. One is trickle or the old 15 hour method. This involves using a current of about 50 mA (for AA cells) and leaving them on charge for 15 hours. At this current level, oxygen diffusion is more than enough to take care of the excess current once full charge is achieved. Of course, one runs the risk of voltage depression due to overcharge.

The best method is the so called delta-V method. If one plots the terminal voltage of the cell during a charge with a constant voltage, it will continue to rise slowly as charging progresses. At the point of full charge, the cell voltage will drop in a fairly short time. The amount of drop is small, about 10 mV/cell, but is distinctive. There are circuits out there built specifically to look for this. The Maxim MAX712 and 713 ICs are ones that come to mind now. This method is expensive and tedious, but gives good reproducible results. There is a danger in this though. In a battery with a bad cell this delta - V method may not work, and one may end up destroying all the cells, so one needs to be careful. If one ends up putting in more than double the charge capacity of the cell, then something is wrong. Another cheap way is to measure the cell temperature. The cell temperature will rise steeply as full charge is reached. When the cell temperature rises to 10 degrees C or so above ambient, stop charging, or go into trickle mode.

Whatever method one chooses, a failsafe timer is a requirement with high charge currents. Don't let more than double the cell capacity of charge current flow, just in case. (i.e. for a 800 mAh cell, no more than 1600 mAh of charge).

Q: I've seen terminology like "C/n" where n is a number. What gives?

A: This is a method of expressing current as a fraction of the Ah rating of a cell. Simply, a 100 mA current means much more to a small N cell than to a large D cell. So, rather than use absolute units of amperes, cell manufacturers often use fractions of cell capacity, or C. A typical good AA cell has a capacity of 700 mAh, so C = 700 mA. A current of C/10 is therefore 70 mA, while C/2 is 350 mA.

Q: So, what's the right charge current?

A: Depends. If using an unregulated charger -- one that doesn't do any detection of full charge, then one must restrict your charge current to the overcharge capacity of your cell. All NiCd cells I have seen can handle C/10 (approx. 50 mA for AA cell) indefinitely without venting. This is not to say that one won't get voltage depression, but rather that one won't destroy the cell(s).

If one wants to get a bit more aggressive, a C/3 charge will recharge the cells in about 4 hours, and at this rate, most cells will handle a bit of overcharge without too much trouble. That is, if one catches the cells within an hour of full charge, things should be OK. No overcharge is best of course.Only with automatic means of full charge detection should one use charge currents above C/2. At this current level and above, many cells can be easily damaged by overcharging. Those that have oxygen absorbers may not vent, but will still get quite hot. With a good charge control circuit, charge currents in excess of C/2 have been used -- the problem here becomes reduced charge efficiency and internal heating from ohmic losses. Unless one is in a great hurry, avoid rates greater than C/2

Q: You mentioned cell reversal. What is that, and why is it so bad?

A: In a battery, not all cells are created equal. One will be weaker than the others. So, as the battery is discharged, the weakest cell will use up all its active material. Now, as discharge continues, the current through the dead cell is becomes a charging current, except that it is reversed. So, now reduction is occurring at the positive terminal. As there is no more nickelic hydroxide, it reduces the water, and produces hydrogen. Cell pressure builds, and it vents. The cell has lost water and the life of the cell has been shortened This is the big danger of battery cycling to prevent memory. Invariably, unless one is very careful, one ends up reversing a cell. It does much more harm than the cycling does good. Also, keep in mind that cells to have a finite life. Each cycle is a bit of life.

Credo #3: Take care of your cells, and they will take care of you.

I have a set of cells from 1981 that are still working. Sintered plate, 450 mAh old technology -- originally trickle charged, now rapid charged many times using a delta-V technique.

Q: OK, my cells died. I was nice to them, what happened?

A: All good things must come to an end. No matter how well one takes care of the cells, they will eventually die. There are two main reasons cells fail, other than abuse. One is separator failure, and the other is degradation of the active material. The first is far more common, and the result is a shorted cell. Every time a cell is charged, the active material is redeposited on the plates. Ideally, this occurs uniformly across the surface of the plate. However, in reality, there will be bumps and valleys. When there are bumps on both the positive and negative plates are adjacent, separated only by the separator, the resistance between those two points is slightly less than in other regions of the cell. So, the current density there rises. This means that more material is deposited there, contributing to even more "bumpiness". In reality, needles called dendrites form, and given time, they can force themselves through the separator to short the cell. A cell that appears to self-discharge in a couple of days has dendrite problems, and will soon completely short out. Plan to replace the cell.

Degradation of the active plate material is just a normal aging process of cycling. Both of these mechanisms are very good reasons to avoid cycling the cells after each use. Cells should live to about 1000 cycles if treated properly. Anything over that is gravy.

Q: I've seen people talk about zapping cells to revive them

A: Yup -- a quick fix it. When cells short due to dendrites, the piece of material that is actually shorting the cell is very thin. So, by forcing a huge impulse of current into the cell, one can vaporize the dendrite -- sort of blowing a fuse. This works, and can revive an otherwise shorted cell. However, it is a stopgap measure at best. First, the fact that one dendrite has formed means that another is not too far behind. Second, the material that was vaporized has now permeated the separator material, forming a resistor that shorts the plates. The cell may no longer be shorted, but will still have a poor charge retention. Besides, unless done properly, this can be dangerous as large currents are necessary.

Q: How about self-discharge?

A: Yes, NiCds have a bad habit of going dead when you just leave them Fortunately you can recharge them. The current cells discharge about 1 percent a day, maybe a bit less. Expect them to be mostly flat after 3 months. Unfortunately, the so called 15 hour trickle chargers more than make up for self-discharge. In fact most of the current goes to making oxygen, not making up for self-discharge. If you want to make something to keep your cells from self-discharging, make a 1 to 2 mA current source. That should more than overcome self-discharge.

Q: What about NiMH cells?

A: NiMH or nickel metal-hydride cells are a promising alternative to NiCds. They use hydrides (metals capable of storing hydrogen) as the negative material in lieu of cadmium. They have higher capacity for the same size cell, and don't use toxic cadmium. They also are advertised as not suffering from memory. The downsides: They are expensive (all new technology is). They have a horrible self-discharge rate (I have measured between 3 to 10 percent per day -- useless after 1 month). They are trickier to charge. Delta V works, but the voltage drop is very small (2.5 mV/cell). Better to charge them to a point where the voltage stops rising. And, yes, the same thing goes with hydrides as with cadmium. They can suffer from memory, though it is much harder to see than in NiCds. Expect to see a bit less touting of the "memory free" operation of NiMH cells in the future.

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I hope the above was useful...I enjoyed contributing to the mythology of NiCd cells. :-)

Ken