Tape Baking

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Introduction to Audio Preservation

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Introduction

Of the many formats that may be encountered in a sound archive, magnetic tape is perhaps one of the most common. Magnetic tape was used from the mid-1940s through the early 1990s. Unfortunately, tape is not nearly as stable a medium as more traditional archival materials like paper. Whereas paper has a lifespan of hundreds of years, tape will last for only decades.[1] For this reason, sound archivists must keep an increasingly keen eye on the deterioration of magnetic tape and must stay abreast of techniques to preserve the content of these recordings.

One typical problem affecting magnetic media is sticky shed syndrome, a condition in which a tape begins to produce a sticky residue that can inhibit and even prevent playback. Sticky shed syndrome is a complex phenomenon that is not yet fully understood, and which will be discussed in more detail later in this paper. However, the lack of understanding of the sticky shed problem does not justify inaction on the part of audio archivists, since sticky shed grows gradually worse over the years. Until a full scientific understanding is achieved, archivists must pursue practical solutions to the sticky shed problem. One of the most effective of these solutions is the process of tape baking. In this process, tape is held at an elevated temperature and reduced humidity for a period of time, and then gradually allowed to cool. Experience has shown that baking can make a tape playable again for several weeks, during which time a technician may transfer the content to a different format. As might be expected from a practical

[1] Van Bogart, John W. C. *Magnetic Tape Storage and Handling: A Guide for Libraries and Archives.* Washington, DC: The Commission on Preservation and Access, June 1995. Accessed April 11, 2007 from http://www.clir.org/pubs/reports/pub54/index.html.

technique practiced in many independent studios and archives, there is great variation in tape baking methods and philosophies. It is the goal of this study to examine tape baking techniques and to discuss other scientific and archival topics that underlie the tape baking process. These include tape structure, appropriateness of media and circumstances for baking, the pros and cons of treatment, alternative techniques, types of endangered tape, and the differences between sticky shed syndrome, soft binder syndrome, and loss of lubrication.

Background

Recent years have seen a notable increase in public awareness of audio archives. In a 2004 survey, 78% of academic library respondents indicated that they had experienced an increased demand for recorded sound in teaching.[1] Unfortunately, many of those respondents went on to note that access to their audio resources was restricted due to "the lack of effective and cost-efficient means of treating and reformatting analog originals,"[2] specifically mentioning the "deterioration of magnetic tape" as a prime concern.[3]

Though extensive research into the life expectancy of magnetic tape has not been conducted, engineers and technicians have often found the life of a tape to be far shorter than claimed by the manufacturer.[4] The reasons for tape's relatively short period of

[1] Smith, Abby; Allen, David Randal; Allen, Karen. *Survey of the State of Audio Collections in Academic Libraries.* Washington, D.C.: Council on Libraries and Information Resources, August, 2004. p. 31.
[2] Smith, Abby; Allen, David Randal; Allen, Karen. *Survey of the State of Audio Collections in Academic Libraries.* Washington, D.C.: Council on Libraries and Information Resources, August, 2004. p. 10.
[3] Smith, Abby; Allen, David Randal; Allen, Karen. *Survey of the State of Audio Collections in Academic Libraries.* Washington, D.C.: Council on Libraries and Information Resources, August, 2004. p. 15.
[4] Porck, Henk J. and Teygeler, Rene. *Preservation Science Survey: An Overview of Recent Developments in Research on the Conservation of Selected Analog Library and Archival Materials.* Washington, D.C.: Council on Libraries and Information Resources, December, 2000. p. 34

stability lie in its construction. While early magnetic tapes were made of paper (from about 1947 – 1950) and acetate (from about 1949 – 1960,) the tapes discussed in this paper are made with a base layer of polyester (from about 1960 forward.)[1] The inherent strength and aging properties of the polyester are determined when it is produced, and they are influenced by the resin, additives, and laminates used in the manufacturing process.[2] The polyester in magnetic tape is coated with a binder, which adheres the metallic particles of the tape's top coating to the underlying polyester. One common type of binder is polyester polyurethane, but tape manufacturers were notoriously secretive about their binder formulations, so specific information about this component can be difficult to locate.[3] The top layer of the tape consists of ferromagnetic particles that actually record the audio information. Gamma ferric oxide (Fe3O2) is often used in this layer, but many other proprietary additives may be present[4], which may produce unknown and unexpected interactions between the materials. Manufacturers often also added a lubricant to the tape to facilitate repeated, easy playback. Some tapes also include a thin backing layer underneath the polyester layer to reduce friction and provide even winding.[5]

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[1] Smolian, Steve. "Preservation, Deterioration, and Restoration of Recording Tape." *Association for Recorded Sound Collections, Inc. Journal 19*(2-3), 1987. p. 39.
[2] *The Degradation Mechanisms of Sound Recording.* Accessed April 11, 2007 from http://www.collectionscanada.ca/6/28/s28-1018-e.html.
[3] Ibid.
[4] Ibid.
[5] Van Bogart, John W. C. *Magnetic Tape Storage and Handling: A Guide for Libraries and Archives.* Washington, DC: The Commission on Preservation and Access, June 1995. Accessed April 11, 2007 from http://www.clir.org/pubs/reports/pub54/index.html.

Tape Degradation

Researchers generally agree that the basic problem contributing to sticky shed syndrome is the breakdown of the tape's binder layer. Explanations of this breakdown process can vary, but usually fall into two basic categories. The first explanation states that as the tape ages, the polyurethane in the binder absorbs environmental moisture, which may be present simply from local humidity levels. When this happens, the urethane and water molecules migrate to the tape's surface, creating a sticky substance that clogs playback machines.[1]

A second and somewhat more technical explanation states that the binder layer undergoes hydrolysis, also brought about by moisture and humidity. In this explanation, atmospheric moisture causes long polyurethane molecules to break into parts, which exhibit less strength than the longer chains. This weakened, softened binder creates the stickiness often noted on aging tapes, and can cause the magnetic media to come off the polyester in chunks.[2]

Whatever the chosen explanation for binder breakdown, the effect is the same; tapes experiencing sticky shed syndrome will often produce a squealing sound in playback, and may cause head clogs in the playback machine, stick and slip during playback, and even stop playing entirely.[3] However, it is important to note that not all instances of squealing tape can immediately be diagnosed as sticky shed syndrome and treated with baking.

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[1] Rivers, Mike. *"Baking" Magnetic Tape to Overcome "Stick- Shed" Syndrome.* Accessed April 11, 2007 from http://audio-restoration.com/baking.php.
[2] Van Bogart, John W. C. *Magnetic Tape Storage and Handling: A Guide for Libraries and Archives.* Washington, DC: The Commission on Preservation and Access, June 1995. Accessed April 11, 2007 from http://www.clir.org/pubs/reports/pub54/index.html.
[3] Ibid.

Sticky Shed Syndrome, Soft Binder Syndrome, and Loss of Lubrication

For many years, it was believed that a squealing tape might suffer from either sticky shed syndrome or loss of lubrication. The best way to differentiate between the two problems was by experimentation; if a squealing tape did not respond to baking, then it was probably experiencing loss of lubrication. This condition does not result from binder breakdown, but instead from the gradual loss of the lubricant included in the tape to facilitate smooth playback. Like sticky shed, lubricant loss results from aging and storage conditions, and is prone to occur in higher humidity. It creates a tape surface with increased friction, causing drag on the playback heads and the signature squealing sound. When baking fails to cure these tapes, they can sometimes be temporarily restored to playing condition by generous application of lubricants.[1]

In recent years, a more nuanced understanding of these two conditions has emerged, based largely on the work of audio restorer Richard Hess. According to Hess' research, "loss of lubrication" is actually a misnomer for a problem that has nothing at all to do with lubricant. In fact, tapes previously diagnosed with loss of lubrication actually exhibit was Hess calls soft binder syndrome. These tapes exhibit stickiness and squealing, but do not shed their magnetic layer to any great extent. They also generally do not have the back coating layer that is commonly present in tapes with sticky shed syndrome. In these tapes, Hess posits that playback is not hindered by missing lubricant, but instead by the glass transition temperature of the magnetic coating. This is the temperature at which the material's texture changes from smooth to rubbery. If this temperature in the magnetic coating falls below that of the playback head, the tape will

[1] Gibson, Gerald D. *Magnetic Tape Deterioration: Recognition, Recovery, and Prevention.* Accessed April 11, 2007 from http://www.unesco.org/webworld/ramp/html/r9704e/r9704e11.htm.

become rubbery and cease to play smoothly, causing squealing. Soft binder syndrome is thought to be a widely overarching condition, under which sticky shed syndrome is simply one specific problem.[1]

The difference between these two diagnoses is very significant when choosing an appropriate treatment. For tapes with soft binder syndrome, Hess proposes playback in a reduced temperature environment, like a refrigerator. This would lower the temperature of both the tape and the playback head, supposedly equalizing them enough to facilitate playback. Note that this treatment is quite the opposite of the elevated temperatures used in tape baking. In fact, Hess states that baking tapes that suffer from soft binder syndrome rather than sticky shed syndrome may actually worsen their condition.[2] The underpinnings of and treatments for these conditions are the subject of current research, and understanding in this field may change greatly in coming years.

Susceptible Tapes

While the presence of a backing layer and the physical stickiness of a tape can be good indicators that a tape should be baked, it is also useful to know which brands and types of tape are especially prone to sticky shed syndrome and soft binder syndrome. This knowledge is largely experiential, and is provided by engineers and technicians who have worked with aging tape for many years. The following chart summarizes the tapes that have proven to be susceptible to sticky shed syndrome. Technicians and archivists should be aware that a tape's box may not be original and may not accurately indicate the type of tape.

[1] Hess, Richard. *Soft Binder Syndrome and Sticky Shed Syndrome.* Accessed April 11, 2007 from http://richardhess.com/notes/2007/03/21/soft-binder-syndrome-and-sticky-shed-syndrome/#more-99.
[2] Ibid.

Brand	Type	Years
Agfa	PEM 468[1]	pre-1990
	PEM 469[2]	pre-1990
	type 1 (cassette duplicator)[3]	unknown
Ampex / Quantegy	406[4]	1970s - at least mid-1980s
	407[5]	1970s - at least mid-1980s
	456[6]	1970s - at least mid-1980s
	457[7]	1970s - at least mid-1980s
Audiotape / Capitol	Q15[8]	early 1980s
Scotch / 3M	153[9]	unknown
	206[10]	unknown
	207[11]	unknown
	208[12]	unknown
	209[13]	unknown
	217[14]	unknown
	219[15]	unknown
	226[16]	all years
	227[17]	all years
	806[18]	all years
	807[19]	all years
	808[20]	all years
	809[21]	all years
	Classic DP[22]	unknown
	Classic LP[23]	unknown
	Classic SP[24]	unknown
	Master[25]	unknown
	Master SX[26]	unknown

[1] Sanner, Howard. *Tapes with Sticky-Shed Syndrome.* Accessed April 5, 2007 from http://recordist.com/ampex/docs/misc/sticky-shed.html.
[2] Ibid.
[3] Ibid.
[4] Smolian, Steve. *Squealing Tape.* Accessed April 5, 2007 from http://soundsaver.com/squealingtape.htm.
[5] Ibid.
[6] Ibid.
[7] Ibid.
[8] Hess, Richard. *Soft Binder Syndrome and Sticky Shed Syndrome.* Accessed April 5, 2007 from http://richardhess.com/notes/2007/03/21/soft-binder-syndrome-and-sticky-shed-syndrome/#more-99.
[9] Smolian, Steve. *Squealing Tape.* Accessed April 5, 2007 from http://soundsaver.com/squealingtape.htm.
[10] Ibid.
[11] Ibid.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] Ibid.
[17] Ibid.
[18] Ibid.
[19] Ibid.
[20] Ibid.
[21] Ibid.
[22] Ibid.
[23] Ibid.
[24] Ibid.
[25] Ibid.
[26] Ibid.

As is clear from the chart, an especially large number of 3M tapes exhibit sticky shed syndrome. For this reason, archivists and technicians may wish to examine the chart and background information about the materials used in 3M magnetic tape assembled by 3M researcher Del Eilers in 2000. This information is available online at http://www.aes.org/aeshc/docs/3mtape/aorintr1.html.

For comparison, the following chart summarizes the types of tape that may exhibit soft binder syndrome.

Brand	Type	Years
Scotch / 3M	175[1] Melody 169[2]	unknown unknown
Sony	PR-150[3]	unknown
Pyral	unknown[4]	unknown

Appropriate Conditions for Baking

In order to determine whether a tape is a good candidate for baking, it is first necessary to determine whether it is made of acetate or polyester. This task is easily accomplished by a simple test. Hold the tape up to the light and observe whether it appears translucent or opaque. If it appears translucent, it is acetate. If it appears opaque, it is polyester.[5]

The distinction between acetate and polyester is significant because acetate tapes are not suitable for baking. Tapes made of acetate have a distinctive set of problems that cannot be solved by raised temperatures. Acetate was originally introduced as a tape

[1] Hess, Richard. *Soft Binder Syndrome and Sticky Shed Syndrome.* Accessed April 5, 2007 from http://richardhess.com/notes/2007/03/21/soft-binder-syndrome-and-sticky-shed-syndrome/#more-99.
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] *Analog Tape.* Accessed April 11, 2007 from http://www.masterdigital.com/24bit/analogtape.htm.

component in order to replace nitrate, which was highly flammable. Though acetate solved the flammability problem, it soon began to display its own aging difficulties. Over time, acetate can shrink and warp, causing "cupping" and other shaping problems that keep the tape from playing smoothly. As the acetate degrades, it releases acetic acid, which creates the signature smell associated with what is called "vinegar syndrome." Tapes with these problems can sometimes be played back by simply increasing the pressure of the playback mechanism, thus pulling the tape temporarily back into a flat shape. Care must be taken, though, to avoid over-tensioning, as acetate is notorious for becoming brittle and tearing.[1]

This tearing problem was addressed in the 1940s when manufacturers began to move from acetate to polyester, which could be stretched during manufacturing in order to achieve strength, flexibility, and elasticity.[2] Later, in the 1950s, manufacturers further improved tape design by adding a backing layer behind the polyester to help the tape wind evenly and to operate more smoothly in the playback machine.[3] Unfortunately, some modern technicians believe that there may be a connection between the presence of back coating on tape and the advancement of sticky shed syndrome. Some contributors to the AV Media Matters DistList have posited that perhaps it is degraded back coating that sticks to the playback machine and initiates some of the problems associated with sticky shed.[4] It is unclear how this theory fits into the possible diagnoses of sticky shed syndrome, soft binder syndrome, and loss of lubrication, and there is not a one-to-one

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[1] *Analog Tape.* Accessed April 11, 2007 from http://www.masterdigital.com/24bit/analogtape.htm.
[2] Engel, Friedrich Karl. "Magnetic Tape: from the Early Days to the Present." *Journal of the Audio Engineering Society 36*(718), July – August 1988. p. 611.
[3] Engel, Friedrich Karl. "Magnetic Tape: from the Early Days to the Present." *Journal of the Audio Engineering Society 36*(718), July – August 1988. p. 614.
[4] *Detailed Look at History of Sticky Tape Syndrome.* Accessed April 11, 2007 from http://palimpsest.stanford.edu/byform/mailing-lists/av/2002/11/msg00009.html.

correspondence between tapes that are back-coated and tapes that exhibit sticky shed. Nevertheless, it does seem to be true that back-coated polyester tape has higher odds of getting sticky shed, and thus of responding to baking, than other tapes might.

It is tempting to consider a tape's age when deciding whether baking may be an appropriate option. However, the life expectancy of tape ranges widely. The oldest reported playable tapes in archives have been 40 to 50 years old, but some tapes can fail in only 10 years.[1] The reasons for a tape's lifespan can often be traced back to manufacturing and storage issues. Chemical instability in manufacturing or high-humidity storage conditions can dramatically shorten a tape's life. A better determinant than a tape's age of the appropriateness of baking is whether other tapes of the same brand and type have typically suffered from sticky shed syndrome. Regarding this issue, please refer to the tables in the "Susceptible Tapes" section of this paper.

Baking Methods

Since baking methods have been refined in diverse studios and labs by many different practitioners, they vary significantly in terms of equipment, temperature, and duration. The following chart summarizes the methods described in relevant literature in order to convey their notable variability.

[1] *How to Care for Your Audio.* Accessed April 11, 2007 from http://www.nfsa.afc.gov.au/Screensound/Screenso.nsf/AllDocs/CB2BC597A0DB2AE8CA256B5D00152F37?OpenDocument.

Tape Baking Methods

Equipment	Temperature	Duration	Tape Width	Notes
American Harvest Snackmaster Pro FD-50 Food Dehydrator[1]	130 - 140 F	1 - 4 hours	1/4"	Position near top cover.
American Harvest Snackmaster Pro FD-50 Food Dehydrator[2]	130 - 140 F	2 - 5 hours	1/2"	Position near top cover.
American Harvest Snackmaster Pro FD-50 Food Dehydrator[3]	130 - 140 F	3 - 6 hours	1"	Turn tape over each hour.
American Harvest Snackmaster Pro FD-50 Food Dehydrator[4]	130 - 140 F	4 - 8 hours	2"	Turn tape over each hour.
portable consumer convection oven[5]	54 C (129 F)	3 hours	1/4"	10-year-old tape stock.
portable consumer convection oven[6]	54 C (129 F)	4 hours	1/4"	10-year-old tape stock; no shed, squeal, or dB bounce in playback; playback failed 4 months after treatment.
portable consumer convection oven[7]	54 C (129 F)	8 hours	1/4"	10-year-old tape stock; no shed, squeal, or dB bounce in playback; playback failed 4 months after treatment.
portable consumer convection oven[8]	54 C (129 F)	16 hours	1/4"	10-year-old tape stock; no shed, squeal, or dB bounce in playback; playback failed 4 months after treatment.
oven[9]	45 - 55 C (113 - 131 F)	6 - 8 hours	1/4"	
oven[10]	45 - 55 C (113 - 131 F)	up to 36 hours	2"	
convection oven[11]	135 - 150 F	3 - 8 hours	?	Allow tape to cool for 24 hours before playing.
?[12]	125 - 135 F	2 - 8 hours	?	5% - 15% relative humidity. Allow tape to cool overnight.

[1] Ciletti, Eddie. *If I'd Known You Were Coming, I Would Have Baked a Tape.* Retrieved April 5, 2007 from http://www.wendycarlos.com/bake%20a%20tape/baketape.html.
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] Medeiros, D.A., Curtis, J.L, Perry, R.H., & Underwood, J.D. (1993). *U.S. Patent No. 5,236,790.* Washington, DC: U.S. Patent and Trademark Office.
[6] Ibid.
[7] Ibid.
[8] Ibid.
[9] Gibson, Gerald D. *Magnetic Tape Deterioration: Recognition, Recovery, and Prevention.* Accessed April 5, 2007 from http://www.unesco.org/webworld/ramp/html/r9704e/r9704e11.htm.
[10] Ibid.
[11] *Baking Magnetic Recording Tape.* Accessed April 5, 2007 from http://www.unesco.org/webworld/ramp/html/r9704e/r9704e11.htm.
[12] Ibid.

?[1]	125 - 135 F	4 hours	1/4"	Allow tape and oven to cool together.
?[2]	135 - 135 F	7 - 12 hours	greater than 1/4"	Allow tape and oven to cool together.
American Harvest Snackmaster Pro FD-50 Food Dehydrator[3]	?	?	up to 1/2"	
home oven[4]	130 - 175 F	8 hours	?	Use a candy thermometer to monitor temperature. Allow tape to cool for several hours.
a hot car interior[5]	?	a work day	?	"The repairs are not necessarily that scientific."
Farberware T-4850 convection oven[6]	120 - 130 F	8 hours	?	Allow tape to cool for 24 hours before playing.
electric oven[7]	130 F	4 - 6 hours	?	Use an accurate thermometer. Allow tape and oven to cool together. Avoid gas ovens.
a hairdryer blowing into a box[8]	120 - 140 F	4 hours	1/4"	
a hairdryer blowing into a box[9]	120 - 140 F	8 hours	2"	
kitchen oven with 25W bulb and salvaged PC fan[10]	120 - 140 F	?	?	Oven modifications allow needed temperature.
American Harvest Snackmaster Pro FD-50 Food Dehydrator[11]	125 F	4 - 8 hours	1/4"	Low-tech and potentially imprecise.
convection oven[12]	125 F	4 - 8 hours	1/4"	May not reach low-enough temperatures.
Fisher Scientific Isotemp Incubator 516D[13]	125 F	4 - 8 hours	1/4"	Method used at Library of Congress, Syracuse University, and Indiana University.

[1] *Baking Magnetic Recording Tape.* Accessed April 5, 2007 from http://www.unesco.org/webworld/ramp/html/r9704e/r9704e11.htm.
[2] Ibid.
[3] Ibid.
[4] Drozdoff, Nicholas. *Dealing with Sticky Shed Syndrome.* Accessed April 5, 2007 from http://www.geocities.com/Vienna/3941/stickyshed.html.
[5] Ibid.
[6] *Analog Tape.* Accessed April 5, 2007 from http://www.masterdigital.com/24bit/analogtape.htm.
[7] Rivers, Mike. *"Baking" Magnetic Tape to Overcome the "Sticky-Shed" Syndrome.* Accessed April 5, 2007 from http://audio-restoration.com/baking.php
[8] Ibid.
[9] Ibid.
[10] Ibid.
[11] Casey, Mike. *Options for Baking Tapes.* Unpublished manuscript: April 1, 2007.
[12] Ibid.
[13] Ibid.

To summarize, the most common equipment is the American Harvest Snackmaster Pro FD-50 Food Dehydrator, followed by some form of convection oven. Generally, technicians seem to agree that a temperature of 120 – 140 F is preferable, along with a baking time of 4 – 8 hours. Note that these standards are most firmly established for ¼" tape. Though wider tape requires longer baking time, a lack of information makes it difficult to generalize about exactly how much time is required for each tape size. Some baking methods mention letting the tape cool for a specified period of time, such as 24 hours or overnight. Other accounts do not mention cooling at all. Further, two general concerns are expressed throughout the literature. One is a belief that a gas oven is not acceptable baking equipment, as the gas could harm the tape. The second is a concern that baking for too long could cause print-through, a pre- or post-echo heard in playback that occurs when a weak magnetic impression from one layer of tape appears on the neighboring layer in the reel. This concern about print-through appears to be unsupported, although it is possible that instances of tape baking print-through have simply gone undocumented.

Best Practice and Acceptable Practice

Based on analysis of the foregoing tape baking methods, the following best practice is recommended for ¼" tape:

Equipment: Fisher Scientific Isotemp Incubator 516 D

Temperature: 125 – 130 F

Baking Time: 4 – 8 hours

Cooling Time: 24 hours

Should this best practice prove to be unattainable within budgetary or resource constraints, a second-tier, acceptable practice is recommended for ¼" tape:

Equipment: American Harvest Snackmaster Pro FD-50 Food Dehydrator or a commercial convection oven

Temperature: 125 – 130 F

Baking Time: 4 – 8 hours

Cooling Time: The length of the bake – 24 hours

The Fisher Scientific Incubator is recommended as the equipment of best practice because it provides evenly calibrated, easily measurable heat, and it is designed to operate to research laboratory standards. It is also currently in use for tape baking at the Library of Congress, Syracuse University, and Indiana University. However, since a new Fisher Scientific Incubator has a list price of $879,[1] it may not be a realistic option for many archives. Accordingly, both the American Harvest food dehydrator and commercial convection ovens are recommended as equipment for acceptable practice. Though these choices may not offer the precise control of the Fisher Scientific Incubator, they are widely used in the field and produce acceptable tapes for many technicians.

The recommended baking temperature and time are the same for both the best practice and the acceptable practice. Baking ¼" tapes at 125 – 130 F for 4 – 8 hours is a very common standard throughout the field. Note that the variability in the baking time stems from varying possible degrees of sticky shed syndrome; more deteriorated tapes will require longer baking. Note also that wider tapes also require longer baking time,

[1] Casey, Mike. *Options for Baking Tapes.* Unpublished manuscript, April 1, 2007.

but too little data is currently available to make specific recommendations about baking ½", 1", and 2" tape.

Cooling time is somewhat variable among methods, and little research appears to document its effectiveness. Given this lack of information, it is the best practice to take a conservative route and let the tape cool for a full day. However, many practitioners cool tapes for less time and achieve useful results. Therefore, it is acceptable practice to cool tapes for the length of the bake, 4 – 8 hours.

Pros and Cons of Baking

The advantages of tape baking are as follows:

- It allows playback for approximately one month after the bake, perhaps longer.
- It is a relatively simple method achievable with minimal investment and training.
- It can improve user access to audio archives by enabling digitization efforts.

Unfortunately, the disadvantages of tape baking have not been carefully studied. Though baking a tape often improves access to audio content temporarily, engineers have little knowledge about how exposure to increased heat may impact the tape artifact itself. Since high temperatures like those of tape baking are also used in accelerated aging testing, an urgent priority should be placed on researching the effect of baking on tape's polyester, binder, backing, and magnetic particles. Without such research, technicians lack the information to judge whether they may be harming tape in the long run, whether that possible harm is an acceptable loss, and whether today's playback is a fair trade for future degradation.

Alternative Treatments

Since the possible dangers of tape baking have not been fully investigated, audio archives may wish to explore alternative methods of improving playback in tapes with sticky shed syndrome, soft binder syndrome, or loss of lubrication. One such method is to apply isopropyl alcohol to the tape, which can sometimes allow playback in recordings that do not respond to baking. Because the process of applying isopropyl alcohol to large amounts of tape is time- and effort-intensive, a machine has been developed by New Zealand technician Marie O'Connell to simplify the method. O'Connell has outfitted an open reel tape player with an IV bag that will drip isopropyl alcohol onto the playing tape at a specified rate. While only two of these machines currently exist, O'Connell may pursue a patent on the technology in the future.[1]

A more elaborate usage of the isopropyl alcohol cleaning system is employed in the Reserex system. This mechanized process targets the tape's backing as the source of playback problems. Isopropyl alcohol is applied in order to actually remove the backing, specifically avoiding the magnetic media. Then, a dry cleaning process is used to clean the remaining backing residue from the back and front of the tape, where it accumulates in winding and storage. The Reserex system claims to restore tape fully and permanently.[2] However, it has not been proven that sticky shed is always directly related to tape backing, and playback problems in tape may relate as much to deterioration of the

[1] O'Connell, Marie. *Wet Playing of Reel Tapes with Loss of Lubricant – A Guest Article by Marie O'Connell.* Accessed April 11, 2007 from http://richardhess.com/notes/2006/03/09/wet-playing-of-reel-tapes-with-loss-of-lubricant-a-guest-article-by-marie-oconnell/.
[2] Richardson, Charles. (2004). *U.S. Patent No. 6,797,072.* Washington, DC: U.S. Patent and Trademark Office.

magnetic media as of the backing.[1] Further, the long term effects of isopropyl alcohol on tape have been researched as little as those of elevated heat. Thus, technicians should remain alert and cautious about the application of any of these methods, and should watch for relevant research in the future.

Finally, the best alternative methods to tape baking are handling, playback, and storage practices that can delay and prevent degradation in the first place. Regarding storage, it is best to keep tapes in archival quality, inert plastic boxes, stored upright to prevent shifting of the tape. Cool, dry, and steady atmospheric conditions are best; the Library of Congress recommends 65 – 70 F and 45 – 50% relative humidity for tape storage of 10 years or more, and 45 – 50 F (or colder) and 20 – 30% relative humidity for permanent storage of valuable tapes.[2] Clean storage areas will discourage dust buildup that can clog playback heads. Strong magnetic fields, such as those potentially produced by loudspeakers, should be avoided.

Proper handling and playback will also increase a tape's life. Tapes should be handled by the outer edges of their reel flanges and the center hubs only in order to avoid physical damage.[3] Checking tapes for a smooth and consistent wind will help ensure that no edges are exposed and endangered.[4] Ensuring that playback machines are in good order can avoid unnecessary harm to archival materials. Further, whenever possible,

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[1] *Ampex and Sticky Shed Syndrome.* Accessed April 11, 2007 from http://palimpsest.stanford.edu/byform/mailing-lists/arsclist/2004/12/msg00141.html.
[2] *Cylinder, Disc, and Tape Care in a Nutshell.* Accessed April 11, 2007 from http://www.loc.gov/preserv/care/record.html.
[3] Ibid.
[4] Lindner, Jim. *Magnetic Tape Deterioration: Tidal Wave at Our Shores.* Accessed April 11, 2007 from http://www.vidipax.com/articles/tidal.html.

label each tape with notes about the recording method used. This can help future technicians choose appropriate machines and playback speeds.[1]

Conclusion

Tape baking is a simple and cost-effective method for improving playback of deteriorating tapes. The tapes best suited to baking show symptoms like squealing and even stopping in the playback machine, which may be caused by conditions such as sticky shed syndrome, soft binder syndrome, and loss of lubrication. Current research by Richard Hess aims for a better understanding of the mechanisms behind these conditions. However, further research is needed to better understand the long-term effects of treatments like baking and cleaning with isopropyl alcohol. While tape baking is a feasible current solution for sticky shed tapes, audio archivists are cautioned that this and other techniques may cause future tape degradation problems that are not yet fully understood.

[1] Lindner, Jim. *Magnetic Tape Deterioration: Tidal Wave at Our Shores.* Accessed April 11, 2007 from http://www.vidipax.com/articles/tidal.html.

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