Condition assessment for the Danish Film Archive

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The most prominent task for an archive is to preserve the country's cultural heritage. Whether it is paintings, sculptures, posters, films, etc., it is important for the individual archive to acknowledge the historic importance of the material they receive and to place it in conditions that will insure that generations to come have the opportunity to see the material in its original form or as close to it as possible.

The film collection in The Danish Film Archive is very rich and differentiated, and holds some of the earliest films ever made in Denmark as well as most of the Danish films that are now considered landmarks in Danish as well as international film history, such as Carl Th. Dreyer's *Vredens Dag 1943* and more contemporary masterpieces like Lars von Trier's *Breaking the Waves 1996*.

But sadly parts of this irreplaceable treasure are starting to deteriorate due to poor storage conditions and a thorough investigation is therefore needed.

According to a contract made with the Danish Ministry of Culture, the Danish Film Archive was committed from 1999 to 2002 to conducting a condition assessment of its film collection. The assessment was to be the foundation for a preservation plan, which together with a film historic perspective would be the basis of prioritized work schedule that would aim at saving the most deteriorated films.

Film archivists Mikael Braae, Karin Bonde Johansen and Head of the Danish Film Archive Jesper Stub Johnsen made the assessment.

FACTS AND FIGURES ABOUT THE DANISH FILM ARCHIVE

Our collection is sited in two locations. There is the old fortification in Bagsværd where films are kept under relatively poor climatic conditions, where all the nitrate materials are kept in vaults under some, although not optimal, climatic control. An extensive collection of shorts & documentaries are kept under even worse conditions without any climatic control. The same is the case for a large collection of 35mm safety prints that is also suffering under very poor conditions.

The second location is the new and improved archive in Glostrup where the climatic conditions are as good as perfect. Here we have placed most of our safety preservation materials and an extensive portion of our safety print collection.

A recent count revealed that the entire collection consists of 31,000 filmtitles of which 26,000 are safety material while 5000 is on nitrate material.

THE MATERIAL FOUNDATION OF THE ASSESSMENT

The collection was divided into 4 groups to make the assessment as differentiated as possible and to establish the condition of different materials.

The *nitrate materials* were divided into two groups: the DFI (Danish Film Institute) collection, which is the main collection of the archive and the National Museum collection. The National Museum Collection was received in 1988 and consists of the oldest films in the archive. A small assessment in 1995 showed that this collection was in a worse condition than the other nitrate films in the archive. So to investigate this assumption further the nitrate collection was divided. In both groups there are prints as well as preservation materials.

The *preservation materials* are an obvious choice because they make up the most important materials in the collection, being the most original materials of any film in the collection and consisting of original negatives, duplicate positives, duplicate negatives, sound negatives and archive prints.

The extensive *print collection* is in constant use - either for screenings at the Cinematek, at festivals and so on. This constant use can cause wear and tear to the materials and should be taken into account in a condition assessment. Furthermore, the bulk of the print collection investigated is on acetate material and is therefore susceptible to the much feared vinegar syndrome explained below.

Finally there are the *shorts & documentaries*. This group of films was chosen because as stated earlier it is stored under very poor conditions in the fortification at Bagsværd and because shorts & documentaries are one of the main film historic genres on which The Danish Film Archive is concentrating its preservation efforts. This group consists of both prints and preservation materials, and is on both 16mm and 35mm.

SELECTION

To ensure reliable results a special method of random selection was chosen that would guarantee a significant picture of the condition without checking every single film. Selection is based on the number of films included and the accuracy of the result, while the results depend on the chosen level of confidence and on the chosen level of tolerance.

We chose to select 164 film reels from each of the four groups. According to Table 1[1], which was used as a guideline, this gives a confidence of 80% and a tolerance of 5%. That means that for every 10 surveys we make 8 will be inside the tolerance level of 5%. This would give a fair security of the results from the test and a realistic number of film rolls to check. A special selection for the minor National Museum collection was made because it only consists of 1000 film reels. The statistical accuracy is based on the fact that you can only pick out 100 (or fewer) units when you are dealing with a collection of 1000 units, so 100 film reels were picked for The National Museum collection.

The actual handpicking of the film rolls was different for each of the four groups because the registration of the materials is different.

The 164 nitrate film reels in the archive collection were identified by a different method. The nitrate films are located in 7 vaults. The number of shelves and film rolls were counted in each vault and through random selection we then chose a vault, a shelf and a film reel in 164 cases.

Level of confidence	Tolerance	Size of the selection	Level of confidens	Tolerance	Size of the selection
99%	0,5%	66358	90%	0,5%	27060
	1,0%	16590		1,0%	6765
	2,0%	4147		2,0%	1691
	3,0%	1843		3,0%	752
	5,0%	664		5,0%	271
	7,0%	339		7,0%	138
	10,0%	166		10,0%	68
95%	0,5%	38416	80%	0,5%	16435
	1,0%	9604		1,0%	4109
	2,0%	2401		2,0%	1027
	3,0%	1067		3,0%	457
	5,0%	384		5,0%	164
	7,0%	196		7,0%	84
	10,0%	96		10,0%	41

Table1. The connection between the level of confidence, tolerance and size of the selection (Johnsen, 1997, s. 53).

The National Museums collection is registered in an old database, a filing system known as *Rapidfile,* and the 100 film reels were simply found by counting titles by random selection.

In the case of the preservation materials we concentrated our investigation on the collection in Bagsværd. They are all placed in specific racks and therefore easy to count and using random selection we quickly found the 164 film rolls to investigate.

As for the prints, the 164 film rolls were picked by random selection from our extensive main cardex system, which contains information of all our prints.

In the case of the shorts & documentaries a specific card index registration was chosen because we knew the exact number of cards and divided it into 164.

THE DAMAGE

The variety of damage to the film material and the relative significance of different kinds of damage to the degree of deterioration of the film is quite wide-ranging.
The different types of damage can be divided into three groups:

- Chemical damage
- Biological damage
- Physical damage

This can also be viewed as a graduation of importance, with chemical damage as the most important indicator of the deterioration of a film. While biological damage also indicates deterioration, the chemical indicators are more prominent and can usually be detected at an earlier stage of the deterioration.

Chemical damage

There are 6 different types of chemical damage associated with both safety and nitrate film:
Vinegar syndrome
Deterioration of the nitrate base
Shrinkage
Silver mirror
Colour change
Tape splices

<u>The vinegar syndrome</u> is only connected to the acetate film material. If kept in an environment of excessive temperature and humidity, the hydroxyl groups, a vital chemical substance of the acetate-base, combine with the water in the atmosphere to make acetic acid, giving the film a very distinctive smell.

Condition (a)	**AD level**	**Colour**	**Smell**	**Level of deterioration**	**Content of free acid**
Level 1	0	Blue	Non	Non	0 – 0,1
Level 2	0,5	Blue/green	Weak smell of vinegar	Weak, not visuable	0,1 – 0,19
Level 3	1	Green	A distinct smell of vinegar	Deterioration has started	0,2 – 0,49
Level 4	1,5	Yellow/green	A strong smell of vinegar	The autocatalytic point, deterioration is rapid	0,5 – The content of free acid escalate
	2	Yellow		Advanced deterioration	1,0
Level 5	3	Yellow			2,0 >

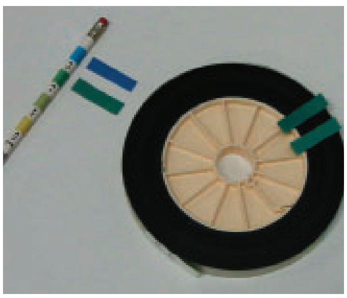
Table 2. AD-level in connection with content of acid and deterioration.

Apart from the smell it is possible to measure the degree of vinegar syndrome. Ph indicators can detect the increasing content of vinegar acid even before you can smell it. We used the pH indicators from IPI called AD-strips (Adelstein et al., 1995a). Two of these indicator papers were placed in a roll of film and left there for 2 weeks to give it sufficient time to react.

The degree of acetic acid was then measured by holding the reacted indicator paper up against a colour scale ranging from blue over green to yellow, with yellow indicating a high content of acetic acid. The AD level goes from 0 to 3 with 0 meaning no deterioration while 3 means the highest level of deterioration has been reached.

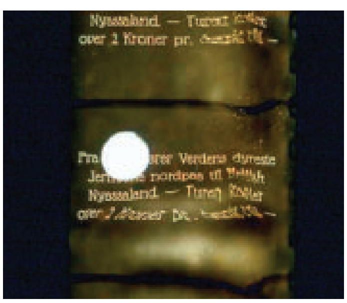
Table 2 shows the connection between the different measurements of the acidic level and the level of deterioration and the different condition levels. It clearly shows that there is a distinct connection between the content of acid and the deterioration of a film. When the deterioration of a film reaches the autocatalytic point there is no chance of stopping it. It's possible to slow down the deterioration process by putting the film into a controlled environment but beyond this "point of no return" the film cannot be saved except by copying.

AD-strips



Measurement of acidity by AD-strips (Green strip = AD level: 1)

Decomposed cellulose nitrate, the emulsion is fading.



Sample removed to the Alizarin Red Heat test.

Deterioration of the nitrate base: Although not susceptible to acetic acid the nitrate films are also subject to deterioration. The nitrate base is chemically unstable, and placed in an environment of high temperature and high humidity it will release heat and oxides, which initiate a deterioration of the nitrate film.

There are two well-known ways of measuring the degree of deterioration: the Alizarin Red Heat Test (SMPTE, 1950, pp. 381-383) and The Water-Leach Titration. Both are forms of accelerated aging tests to see how far the deterioration of the film has progressed. Sadly, they are also destructive tests that require a sample of the film in order to check the degree of deterioration. The Alizarin Red Heat test uses a very small amount of film (two punch holes of about 6mm in diameter) compared to the amount used in the Water-Leach Titration and was therefore chosen as the primary deterioration test.

Two holes were punched in the same frame of the nitrate film (preferably near the deteriorated spot, or in a frame where it would do the film as little damage as possible).

The sample was placed in a test tube together with an Alizarin Red coded indicator paper. It was heated up to *c.*134 degrees Celsius and the time it took for the indicator paper to change colour was measured.

As Table 3 shows the connection between the reaction time and the degree of deterioration is that the shorter the reaction time, the higher the level of deterioration.

Condition(*)	**Reaction time of the Alizarin Red Heat Test**
1	Over 2 hours
2	1 og 2 hours
3	30-60 minutes
4	Under 30 minutes
5	Under 30 minutes

*) A more specific description of the different conditions is given in the last chapter of the article..

Table 3 Connection between the condition levels of the assessment and the alizarin red heat test.

Shrinkage: Among other things, film material consists of lubricants and other liquids that are meant to keep it flexible. In poor climatic conditions chemical reactions cause the loss of these liquids which causes the film to shrink. This sign of deterioration is most common in nitrate materials and can also be found in acetate, although not to the same extend. To measure the degree of shrinkage a specially designed instrument is used that gives the exact percentage of how much a film has shrunk.

Silver mirror: Together with the lubricants and the other liquids, the emulsion consists of silver. Under conditions of high temperature and high humidity the silver oxidises and the silver particles flow to the surface of the emulsion to create what is known as silver mirror. Depending on the level of deterioration it may appear as small silver spots or, in the worst cases, as a distinct silver coat.

Measurement of shrinkage

Colour changes. Fading or loss of film colour is caused by the instability of the colours. A colour film consists of three layers:

Magenta Cyan Yellow

These layers are also very susceptible to climatic conditions and begin to deteriorate when they are left in a high temperature, high humidity and oxidizing environment. In particular the yellow and the cyan layers suffer under these conditions, hence the frequency of magenta red pictures in deteriorating films.

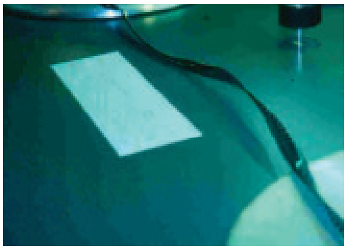
Tapesplices: Instead of cement, tape is often used for splicing a torn film. But the wrong kind of tape contains softeners that may cause dissolution of the base and loss of colours in a picture. If the tape isn't replaced in time the softeners can also leave the tape, resulting in sticky areas that may gather dirt.

Biological damage

Climatic conditions doesn't only play a vital part in the development of chemical damage; the presence of biological damage is also very much the result of an unstable climate. High humidity encourages micro organisms such as mould and mites that can deteriorate the emulsion of a film. The mould appears as white spots on the surface of the film roll and in the worst cases it can deteriorate the gelatine and destroy parts of or entire frames. Mites feed on the mould and resemble small moving grains of dust, although in fact they are tiny living organisms. They are not a direct threat to the film but are an indication of deterioration and can be a health problem for the people handling the film.

Faded colour film.

Mould on top of the film.



The film is twisting.

Physical damage

Physical damage is the most visible and is caused by the wear and tear that comes with everyday handling of the film. It mainly consists of perforation damage, i.e. edge waves, twists, curls, blotches and ferrortyping. The latter is recognisable as small shiny spots on the gelatine layer and is the result of the close contact between the layers in a winded film roll in a humid environment. A sudden increase in humidity or just a constant high humidity can cause changes in the gelatine.

THE CONDITION LEVELS

To give a film an overall condition level it is necessary to grade the different type of damage and place them in a fairly simple diagram. This gives not only a quick overview of the condition of the film but makes it easier to conduct a more thorough analysis when dealing with a large collection.

Two different diagrams were used in our condition assessment: one for acetate and polyester film materials and one for nitrate film materials. The reason for this was mainly due to the different methods used in connection with the vinegar syndrome and the deterioration of the nitrate base.

Figure 1 shows that four condition levels were used in the assessment, ranging from 1, which is the best condition, to 4 as the worst. There exists a fifth condition level but this level is where the deterioration of the base is so accelerated that it can't be examined.

Condition level 1) This is the best condition and is applied to the films where there is a minimum of perforation damage, no detection of mould or mites and where the AD-level is 0, which means no trace of acetic acid.

Condition level 2) If a film is in this condition it is still good but should be monitored because it could be in the first stages of deterioration. There is a small reaction in the pH indicators and there could be signs of ferrortyping. There are signs of mould but only on the surface and there are between 2 and 10 cases of perforation damage and repairs.

Condition level 3) Deterioration has started. Although the acidic level has not reached the autocatalytic point, it is definitely on its way. Cases of physical damage are also increasing with larger numbers of perforation damage, curls, edge waves and twists.

Condition level 4) Deterioration has now reached "the point of no return". The acidic level has passed the autocatalytic point and the dissolution of the base is now visible so the only way to save the film is by copying it as soon as possible.

Condition level 5) Deterioration is now so advanced that the film can't be wound because the base is sticky.

THE INVESTIGATION

The actual examination of the film roll takes place on a winding table where a systematic investigation of each film roll is conducted and the different types of damage encountered are registered in the diagram. A typical record will show damage at the different condition levels, so to give the film roll an overall grade we subjectively weigh the significance of each type of damage against the others and in the end give it a final condition grade.

(1) Good condition:		AD-level: 0	(3) Deterioration has begun. Duplication is advisable.		AD-level: 1
		Shrinkage 0,0 – 0,7 %			Shrinkage 1,0 – 2,0 %
		No or very few perf. damages.			< 10 tears, notches and perf. damages.
		AD-level: 0,5			Lengthy perf. damages
(2) Fair condition. Should be observed.		Shrinkage 0,7 – 1,0 %			Disticnt twisting and curling
		2-10 tears, notches or other perf. damages			Colourshifts, colourfading
		Curls, twists			Silvermirror
		Blotches (effects on the image)			Tapesplices
		Ferrotyping,			Brittleness
		Mould. Only on the surface. Dosn't effect the image.			Mould on the emulsion
					Smell
		Mites	AD = Acid Detecting		
(4) The condition is critical. Should be copied immediately		Sticky because of humidity			
		AD-level:2-3			
		Shrinkage of more than 2,0%			
		Distinct decomposition of the base.			

Visual condition: Physical condition:

Figure 1. Condition description diagram – for acetate film and polyester

There are obviously many ways of conducting such an extensive condition assessment and each archive has to weigh the areas of the collection they want to examine. The main trick in each case is naturally to make it as easy and as conclusive as possible. Whether we have succeeded in this or not will become clearer as the results of our assessment are analysed and discussed.

RESULTS

The overall conditions levels express the final results. For the nitrate films the Alizarin Red Heat Test and the damage are used to decide the final condition level for each film, and for the acetate films the results from the AD-strips and the damage are used.

The Nitrate Collection

For the collection from the National Museum (the oldest nitrate films) 15% of the films need conservation immediately (condition 4+5), because of the dissolution of the base and partial disappearance of the emulsion. For the DFI collection 6% require conservation immediately (Table 4).

		Condition levels:				
	No. of titles	**1**	**2**	**3**	**4**	**5**
National Museum, CN	940	9	36	40	14	1
DFI, CN	4000	4	35	55	5	1

Table 4. The condition assessment for the nitrate films in percentage, ± 5%. (Condition 1=best, condition 5=worst) CN= Cellulose nitrate.

Inspection of film.

Converted into the actual numbers of cans for both nitrate collections, we may expect to find approximately 400 cans with films in condition 4 or 5.

Furthermore 40% and 55% of the nitrate films respectively are assessed as condition 3. The deterioration of these films has started – they are brittle, the bases are yellow, the shrinkage is more than 1% and they smell badly. If they are maintained in the present locations in the fortifications at Bagsværd the damage will get even worse within approximately ten years (Johnsen, 2002). Taking conditions 3, 4 and 5 together, almost 60% of the nitrate films require conservation, copying or improved storage.

Recommended storage conditions are pointed out by Bigourdan, J-L. and Santoro, K. (2001) and are necessary to avoid or to minimize further deterioration.

The deterioration of cellulose nitrate varies from film to film (Adelstein et al. 1995 b); some nitrate films degraded rapidly and others last longer than cellulose acetate films. Regular examination of all cans with nitrate films is therefore necessary in order to identify films with ongoing deterioration.

At the present time no testing method for the deterioration of cellulose nitrate is suitable, see below: The Alizarin Red Heat Test.

The result of the condition survey is that the collection of nitrate films is badly preserved and needs huge numbers of working hours if further images are not to be lost.

<u>The Alizarin Red Heat Test:</u> For many years the deterioration of cellulose nitrate has been measured at the Danish Film Archive using the Alizarin Reed Heat Test. The test should be able to detect deterioration at an early stage enabling the material to be copied before the film decomposes. The test was carried out frequently at the Danish Film Archive until the early 1990s but was discontinued mainly due to lack of manpower. To investigate the test, it was included in the condition assessment. In table 5 the results are displayed.

Reaction time:	**More than 2 hours**	**Between 2 and 1hours.**	**Between 30-60 min**	**Under 30 min**
National Museum, CN	86	1	3	10
DFI, CN	98	0	1,2	0,6

Table 5. The Alizarin Reed Heat Test, result distribution in percentage, ± 5%.

A reaction time at more than 2 hours means no deterioration at the moment and reactions under 30 minutes mean that urgent duplication is necessary so as not to lose more information.

The collection of the National Museum has the worst result: 14 % of the films reacted to the test. For the rest of the nitrate collection, only 2 films reacted.
Most of the films do not react to the test. This could mean that decomposition is not pronounced and the collection is in pretty god condition.

But some contrasts were found involving the Alizarin Red Heat Test: The results of the test do not equate with the overall condition of the films. 13 of the films from both of the collections have visible dissolution of the base, but only two of these films reacted to the test. All the punchings were obtained close to the part of the film that is dissolving, so that in some cases the test does not detect the films with visible dissolution.

Another problem is that there is no spread of the results. The purpose for doing this test is to detect films with commencing deterioration, i.e. results in the 2 stages in between. In these stages there are almost no results. There are few results in the final stage, but in some cases it may be too late to detect films in the final stage because they have already decomposed. Often the deterioration will be visible in the final stage and it isn't necessary to test for it.

In conclusion there is little similarity between the test and the general impression of the film, and the purpose of the test - to detect deterioration - has not been achieved. Perhaps continuing to heat the samples would refine the results and result in a wider spread. Another adjustment might be the use of Congo Reed instead of Alizarin Red. In International Standard 10356 this indicator colour is mentioned and it might improve the results. Investigation with better results is needed if the test is to be reintroduced to the archive.

The invention of anon-destructive deterioration detecting method is recommended. For the time being the archive does not have a tool for reliably detecting the deterioration of cellulose nitrate in the same way as cellulose acetate.

The acetate collection

The final condition assessment for cellulose acetate films is divided into 3 groups (preservation materials, prints and shorts & documentaries). This is due to differences in previous storage conditions, size of the collections and stock materials. Compared to the nitrate collection, few cellulose acetate films are assessed as condition 4 or 5, see table 6. The acetate base does not dissolve irrevocably like the nitrate base, and the acetate collection is younger than the nitrate collection.

				Condition levels:		
	No. of titles	**1**	**2**	**3**	**4**	**5**
Preservation mat., CA	6564	28	66	60	0	0
Prints, CA	15000	5	54	39	2	0
Shorts and Doc., CA	3900	10	49	40	1	0

Table 6. The condition assessment for the acetate films, in percentage, ± 5%. (Condition 1=best, condition 5=worst), CA= Cellulose acetate.

Of the preservation materials 66% are assessed as condition 2, which is the most disturbing figure in table 6. A greater proportion of the materials preserved had been expected to show no damage. Slight indications of acetic acid (AD level 0,5) are due to the high numbers of preservation materials in condition 2, and it tells us that the deterioration of the acetate base has begun on a large scale.

Another figure to consider in the results for the acetate films is that 40% for both the prints and the short and documentary films are assessed to condition 3. The reason differs for each group. The prints have a mixture of different types of damage, such as twisting, discolouration and physical damage. High acetic acid contents do not dominate the print collection.

For the shorts and documentaries the opposite is true. More than a third of the films have AD level 1, (table 7).

AD levels	**0**	**0.5**	**1**	**1,5**	**2-3**
Preservation materials	40	59	1	0	0
Prints	13	78	8	0	1
Short and Documentaries	39	26	34	1	0

Table 7. The acid content distribution in percentage, ± 5%, measured with AD-strips, AD level 0: no acid content, AD level 2-3: high acid content.

In conclusion many of the cellulose acetate films are beginning to develop acetic acid. Improved storage conditions are essential to prevent the escalation of acetic acid.

Bigourdan, J-L. and Santoro, K. (2001) recommend an environment of -5°C and 20-30% RH for the preservation materials and 5°C and 20-30% RH for prints. The warmer recommended condition for prints is due to the fact that prints are more regularly removed from storage. Time out of storage minimizes the effect of sub-freezing temperatures.

COMMENTARY

The acid content in relation to the age of the film materials

The original age of the preservation materials and the prints are divided into decades and the average of the AD levels is calculated for each decade[2].

The results are displayed in figures 2 and 3. In the case of the preservation materials and the prints alike it can be seen that the acid content is highest for films from the 1970s and 1980s (except for films from 1935-49 which contain of early 16 mm prints, some of them probably made of di-acetate). Notably, it is not the oldest films which have the highest content of acid. The reason is unknown; perhaps it is due to changes in the production of the cellulose tri-acetate.

As expected, for all decades the preservation materials have a lower content of acid than the prints.

The acid content in colour prints

The collection of the prints contains 88 black and white (b/w) and 75 colour prints. The relationship between the acid content of the two groups is shown in figure 4.
More colour prints have a higher AD level than the b/w films. Only 7 % of the colour prints have no acid content.

The average of the AD levels for the b/w prints is 0.454 and for the colour prints 0.513. The difference in the acid content for the two groups isn't big; consider the uncertainty at ± 5%. But statistical calculations[3] on the acid content showed a significant level at 1.4. That means that there is 98.6 % chance that the difference seen in figure 4 isn't a coincidence but that more colour prints do have a higher acid content than b/w prints. Significant levels under 5 are counted as a good, reliable result. In the statistical calculations the age of each film is taken into account, but this can't be shown in the figure.

Out of the 75 colour prints 35% are faded, (see figure 5); only notable fading was recorded. Low levels of fading may be difficult to detect because the colour of the film as printed is unknown. A larger number of the colour films are probably faded.

The fading of the colour films depends on their age. In this survey there are no remarkably faded colour films after 1976. But 50 % of the films before 1976 are remarkably faded. So the old colour films containing acid are in special need of attention and duplication.

In this survey no investigation has been made into the colour stability of the preservation materials. Are the preservation materials as bad as the prints? Experience says not, but we have no overview of the condition of the preservation materials for colour films[4].

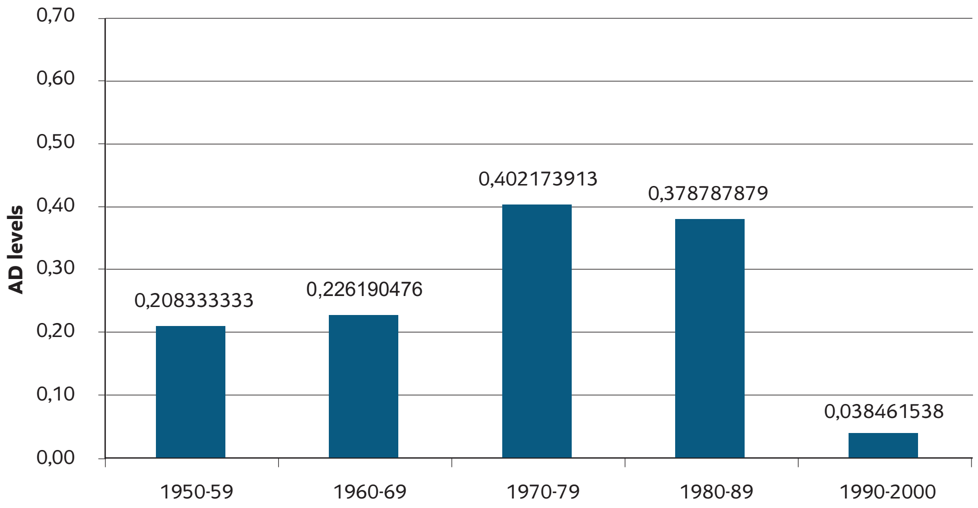


Figure 2. The average AD levels for the preservation materials, divided into decades.

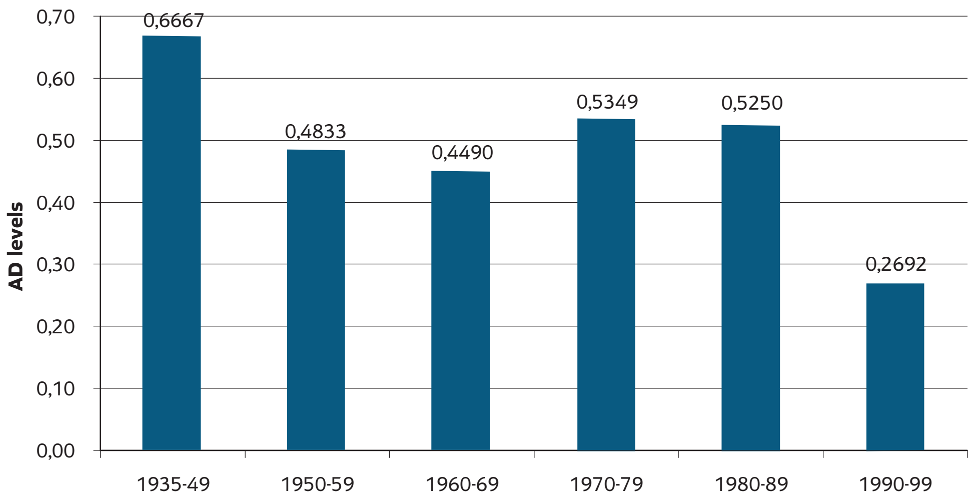


Figure 3. The average AD levels for the prints, divided into decades.

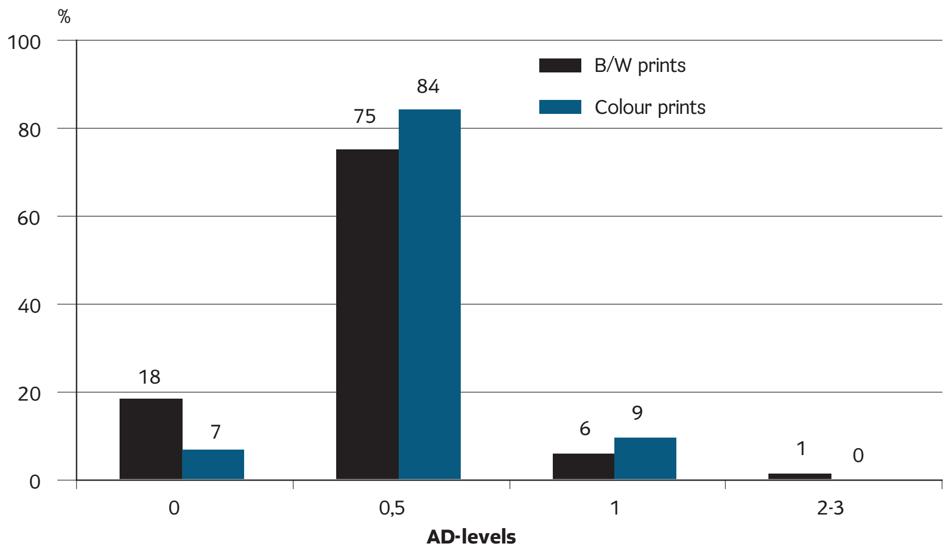


Figure 4. Comparing the acid content of black and white and colour prints, result distribution in percent, ± 5%.

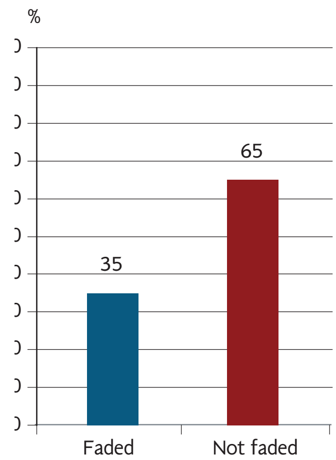


Figure 5. Colour prints divided into faded and not faded, result distribution in percent, ± 5%.

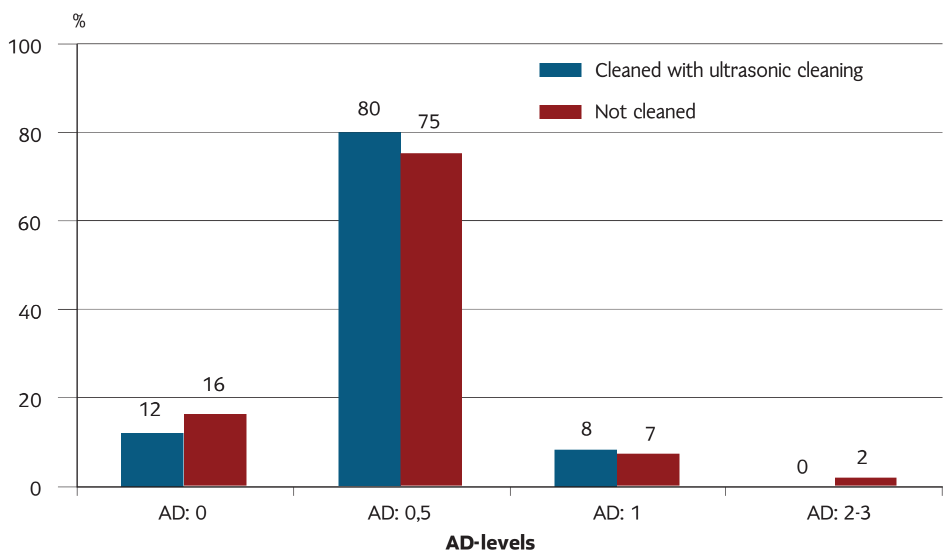


Figure 6. AD levels in films cleaned with ultrasound and films not cleaned, result distribution in percent, ± 5%.

Ultrasonic cleaning

The effect of ultrasonic cleaning was also investigated by the survey. Is it possible that ultrasonic cleaning provokes the vinegar syndrome in the long run or might it actually prevent deterioration?

Over the years it has been noted if the material in the collection of the prints has been ultrasonically cleaned, as and if so, how many times and the years in which cleaning took place. The acid content for films which have not been cleaned and films which have been cleaned was compared. In figure 6 only very small differences are displayed and the statistical calculation didn't show any significant difference. So according to the information provided by this survey, ultrasonic cleaning does not increase the development of acetic acid, and it does not prevent it either.

The accuracy of our ultrasonic cleaningrecords is not clear. They go back 40 years.

CONCLUSIONS

The condition assessment provides a methodology useable for any archive to investigate the general condition of the films. The results from the assessment indicate the best ways to prioritise future work.

In addition, a survey, which is scientifically grounded, is an excellent argument in the search for financial aid.

- The condition of the film collection at the Danish Film Archive was stated as: The nitrate collection is in a bad preservation state, it requires a huge numbers of working hours and improved storage conditions. We have today no satisfying warning test to detect commencing deterioration of nitrate films.

- A great part of the cellulose acetate films are beginning to develop acetic acid. Improved storage conditions are essential to prevent escalation of acetic acid.

- Prints and preservation materials from the 1970's and 1980's have a higher acid content, than films from the 1950' and 1960's.

- AD levels are higher in colour prints than the b/w prints, and colour prints have a higher frequency of a high AD level than b/w prints.

- This survey shows that ultrasonic cleaning does neither increase nor decrease the development of acetic acid.

NOTES

1. The Table shows the relationship between the size of the selection and the level of confidence and the tolerance based on a formula for random selection made by Carl M. Drott (See Drott 1969 pp. 199-225)
2. The age of many of the shorts and documentaries is unknown, and so they have not been included in these calculations.
3. The used method is call logistic regression.
4. Investigations have shown that negative materials have greater durability than print materials. The emulsion of negatives is thicker, which has a protective effect. The emulsion acts as a barrier to the diffusion of plasticizer and also as an alkaline buffer if acetic acid has developed (Allen et. al, 1988, p. 709). But these investigations concentrated on the film base, and the dyes don't necessarily follow the same pattern.

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