STANDARD 10977

First edition
1993-02-01

Photography — Processed photographic colour films and paper prints — Methods for measuring image stability

Photographie — Films et papiers photographiques couleur traités — Méthodes de mesure de la stabilité de l'image

Reference number
ISO 10977:1993(E)

Contents

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland
Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10977 was prepared by Technical Committee ISO/TC 42, *Photography*.

Annexes A, B, C, D, E and F of this International Standard are for information only.

Introduction

This International Standard addresses the stability of colour photographic images and is divided into two sections. The first section covers the methods and procedures for predicting the long-term, dark storage stability of colour photographic images. The second section covers those for measuring the colour stability of such images when exposed to light of specified intensities and spectral distribution, at specified temperatures and relative humidities.

Today, the majority of continuous-tone photographs are made with colour photographic materials. The length of time that such photographs are to be kept can vary from a few days to many hundreds of years, and the importance of image stability can be correspondingly small or great.

Often the ultimate use of a particular photograph is not known at the outset. Knowledge of the useful life of colour photographs is important to many users, especially since stability requirements often vary depending upon the application. For museums, archives and others responsible for the care of colour photographic materials, an understanding of the behaviour of these materials under various storage and display conditions is essential if they are to be preserved in good condition for long periods of time.

The images of most modern colour photogaphs are formed by organic cyan, magenta and yellow dyes that are dispersed in transparent binder layers coated onto transparent or white opaque supports. Colour photographic dye images typically fade during storage and display; they will usually also change in colour balance because the three image dyes seldom fade at the same rate. In addition, a yellowish (or occasionally other colour) stain can form and physical degradation can occur, such as embrittlement and cracking of the support and image layers. The rate of fading and staining can vary appreciably and is governed principally by the intrinsic stability of the colour photographic material and by the conditions under which the photograph is stored and displayed. The quality of chemical processing is another important factor. Post-processing treatments, such as application of lacquers, plastic laminates and retouching colours, can also affect the stability of colour materials.

The two main factors that influence storage behaviour, or dark stability, are the temperature and relative humidity of the air that has access to the photograph. High temperature, particularly in combination with high relative humidity, will accelerate the chemical reactions that can lead to degradation of one or more of the image dyes. Low-temperature, low-humidity storage, on the other hand, can greatly prolong the life of photographic colour images. Other potential causes of image degradation are atmospheric pollutants (such as oxidizing and reducing gases), micro-organisms and insects.

The stability of colour photographs when displayed indoors or outdoors is influenced primarily by the intensity of the illumination, the duration of exposure to light, the spectral distribution of the illumination and the

ambient environmental conditions. (However, the normally slower dark fading and staining reactions also proceed during display periods and will contribute to the total change in image quality.) Ultraviolet radiation is particularly harmful to some types of colour photographs and can cause rapid fading as well as degradation of plastic layers such as the pigmented polyethylene layer of resin-coated (RC) paper supports.

In practice, colour photographs are stored and displayed under varying combinations of temperature, relative humidity and illumination, and for different lengths of time. For this reason, it is not possible to predict precisely the useful life of a given type of photographic material unless the specific conditions of storage and display are known in advance. Furthermore, the amount of change that is acceptable differs greatly from viewer to viewer and is influenced by the type of scene and the tonal and colour qualities of the image.

After extensive examination of amateur and professional colour photographs that have suffered varying degrees of fading and/or staining, no consensus has been achieved on how much change is acceptable for various image quality criteria. For this reason, this International Standard does not specify "acceptable" end-points for fading and changes in colour balance. Generally, however, the acceptable limits are twice as wide for changes in overall image density as for changes in colour balance. For this reason, different criteria have been used as examples in this International Standard for predicting changes in image density and in colour balance.

The actual determination of such changes is made with test strips that have been exposed and carefully processed according to the manufacturer's recommendations to produce at least:

a) an area of minimum density, d_{min};

b) patches of uniform, neutral density of 1,0 above d_{min}; and

c) uniform density patches of cyan, magenta, or yellow dyes having red, green, or blue densities of 1,0 above d_{min}.

To simplify the preparation of test samples and the handling of data, a starting density of 1,0 above d_{min} is specified for both dark- and light-stability tests; although it is recognized that the two types of fading generally have dissimilar visual characteristics [1]. The effects of light fading, both visually and when expressed as a percentage density change, tend to be proportionally much greater in lower density portions of an image (e.g. in the range of 0,1 to 0,5 above d_{min}) than in high density areas. Conversely, in dark fading the visual effects of fading are generally more noticeable in higher densities than in low densities. Density losses in dark fading, expressed as a percentage density change, tend to be more or less equal throughout the entire density range (see annex A). The user may adopt different end-points for light- and dark-stability tests to take into account the visual differences manifested by these two types of fading.

Pictorial tests can be helpful in assessing the visual changes that occur in light- and dark-stability tests, but are not included in this International Standard because no single scene is representative of the wide variety of scenes actually encountered in photography.

In dark storage at normal room temperatures, most modern colour films and papers have images that fade and stain too slowly to allow evaluation of their dark storage stability simply by measuring changes in the samples over time. In such cases, too many years would be required to obtain meaningful stability data. It is possible, however, to assess in a relatively short time the probable long-term fading and staining behaviour at moderate or low temperatures by means of accelerated ageing

tests carried out at high temperatures. The influence of relative humidity also can be evaluated by conducting the high-temperature tests at two or more humidity levels.

Similarly, information about the light stability of colour photographs can be obtained from accelerated light-stability tests. These require special test units equipped with high-intensity light sources in which test strips can be exposed for days, weeks, months or even years, to produce the desired amount of image fading (or staining). The temperature of the samples and their moisture content are controlled throughout the test period and the types of light sources are chosen to yield data that can be correlated satisfactorily with those obtained under conditions of normal use.

Accelerated light-stability tests for predicting the behaviour of photographic colour images under normal display conditions can be complicated by "reciprocity failure". When applied to light-induced fading and staining of colour images, reciprocity failure refers to the failure of many dyes to fade, or to form stains, equally when irradiated with high-intensity versus low-intensity light, even though the total light exposure (intensity × time) is kept constant through appropriate adjustments in exposure duration [2]. The extent of dye fading and stain formation can be greater or smaller under accelerated conditions, depending on the photochemical reactions involved in the dye degradation, on the kind of dye dispersion, on the nature of the binder material and on other variables. For example, the supply of oxygen that can diffuse into a photograph's image-containing emulsion layers from the surrounding atmosphere can be restricted in an accelerated test (dry gelatin is an excellent oxygen barrier). This can change the rate of dye fading relative to that which would occur under normal display conditions. The magnitude of reciprocity failure is also influenced by the temperature and moisture content of the test sample. Furthermore, light fading is influenced by the pattern of irradiation (continuous versus intermittent) as well as by light/dark cycling rates.

For all of these reasons, long-term changes in image density, colour balance and stain level can be estimated reasonably closely only for conditions similar to those employed in the accelerated tests or when good correlation has been confirmed between accelerated tests and actual conditions of use.

Density changes induced by the test conditions and measured during and after the tests include those in the film or paper support and in the various auxiliary layers that are included in a particular product. With most materials, however, the major changes occur in the dye image layers.

This International Standard is based on American National Standard IT9.9[1)] which was the result of 11 years of testing activity in the United States in which there was active participation from Canada, Germany, Japan, Switzerland and the United Kingdom.

---

1) ANSI IT9.9:1990, *Imaging media — Stability of Color Photographic Images — Methods for Measuring*.

This page intentionally left blank