NOTAS DE FÍSICA

VOLUME IV

Nº 12

NUCLEAR EMULSION PROCESSING AND LOADING WITH METAL VERSENE COMPLEX

H. G. de Carvalho and A. G. da Silva

CENTRO BRASILEIRO DE PESQUISAS FÍSICAS

Av. Wenceslau Braz, 71

RIO DE JANEIRO

1958

NUCLEAR EMULSION PROCESSING AND LOADING WITH METAL VERSENE COMPLEX

(Development at Isoelectric Point)

H. G. de Carvalho and A. G. da Silva
Centro Brasileiro de Pesquisas Físicas
Rio de Janeiro, D. F.

(received 5th August, 1958)

I. INTRODUCTION

The purpose of the present paper is to show that pre-and-post fixation G-5 nuclear emulsions exhibit minimum swelling at a pH of 4.2. Versene is shown to be a good complexing agent to help the loading of emulsions at suitable pH's, and also as a ferro-complex, to be a satisfactory developing agent possibly causing minimum distortion.

The processing of nuclear emulsions has presented many problems when developing loaded plates and when scattering and other measurements are to be done. Dilworth Occhialini and Vermaesen[1] have listed four requirements for a good processing technique:

1) To obtain uniform grain density throughout the depth of the emulsion.

2) To obtain uniformity among all plates of one batch of emulsion processed at different times.

3) To work satisfactorily with emulsion layers of great thickness.

4) To produce minimum distortion of the emulsion layer.

This last requirement seems very important because Bonetti, Dilworth and Occhialini[2] have stated that "whatever are the precautions which are taken during the processing of plate, it will still contain faults which were introduced in the pouring and drying of the emulsion".

Bonetti et al., listed the causes of distortion as too high temperature, sudden changes of temperature or of salt concentration, violent agitation or handling of the plates. Other causes would be osmotic pressure and pH variations. They have devised methods to check distortions when fixing (using acid hypo), washing (using acetic acid), and drying (using guard rings), the plate. Since nuclear plates are a dispersion of silver bromide grains in gelatin and a fixed plate is mostly gelatin, it seemed important to investigate some properties of gelatin.

II. GELATIN

Gelatin being a mixture of polypeptides, possesses in solution amphoteric properties and thus a pH at which the molecule is neutral, that is, the number of positive and negative charges in it are equal.

At this point, called the isoelectric point, gelatin has most interesting properties. Mees[3] has devoted a whole chapter of his book to the properties of gelatin, and all those causes of distortion cited by Bonetti et al., affect the gelatin least at the isoelectric point. Among those properties minimum swelling was considered very important because of its close relation to minimum distortion.

Determinations of the swelling of pure gelatin used in the manufacture of G-5 nuclear emulsions as well as fixed and regular G-5 nuclear emulsions were made. The results of these determinations most of them using sodium acetate—acetic acid buffer .2M solutions of constant molarity (so as not to effect osmotic pressure), are shown in figure I. Although the isoelectric point of pure gelatin is at a pH of 4.8, pre- and post-fixation G-5 nuclear emulsion has minimum swelling at a pH of 4.25 ± .1 .

III. FERRO-VERSENE DEVELOPER

Even though distortions are thought to occur mainly during fixing, washing and drying, it would be also advisable to avoid them during the development. A solution was sought which could develop at a pH of about 4.3. Amidol was tried at first and it was found to act as a developer even at a pH 4.5 . Ferro-oxalate would be an obvious choice. Ferro-Sequestrene complex seems to be satisfactory. It is a good developer at very low pH's (even at pH 2) yielding very small grains. It has a long induction period (it takes 5 hours to fully develop minimum of ionization tracks) and at a pH of 4.2 diffusion is least hindered by the charge effect[4] of gelatin.

Best results are obtained if development is performed under nitrogen with freshly prepared developing solutions:

Two recipes are particularly good:

$FeSO_4.7\ H_2O$	3 g
Versene (tetrasodium salt)	3 g
H_2SO_4N solution	1 cm^3
Sodium acetate-acetic acid .2 M buffer solution	50 cm^3
Water	360 cm^3

The second is:

disodium salt	3,7 g
Versene tetrasodium salt	2,1 g
$FeSO_4.7\ H_2O$	2,8 g
Water to make	500 cm^3

IV. LOADING

Versene is a very good complexing agent and loading emulsion with sequestrine-Metal complexes is easily done. Picciotto[5] has shown that the pH is of great importance when loading and processing loaded plates. Using one of four salts of Versene (ethylene diamine tetra acetic acid) or sometimes two of them combined to adjust the pH, probably it is possible to load plates with almost any metal. If the pH at which loading is possible is not satisfactory for conventional development, Ferro-Versene complex may be used.

Uranium, Thorium and Bismuth incorporated in G-5 emulsions with the aid of Versene yielded good plates when either amidol or Ferro-Versene were used as developing agents.

ACKNOWLEDGMENTS

Thanks are due to Professor M. Schein for suggesting and encouraging this work while one of us[6] worked in his laboratory. We wish to thank Dr. T. H. James for suggesting Ferro-Versene-complex as a developing agent. Thanks are also due to Dr. C. Waller who kindly donated the gelatin.

1. C. C. Dilworth, C. F. S. Occhialini and L. Vermaesen. Bull. du Centre de Physique Nucléaire de l'Université Libre de Bruxelles, nº 13ª, 1950. Fundamental Mechanism of Photographic Sensitivity, 297, Butterworths, London, (1951)

2. A. Bonetti, C. C. Dilworth, C. F. S. Occhialini. Bull. du Centre de Physique Nucléaire de l'Université Libre de Bruxelles, nº 13b, (1951).

3. C. E. K. Mees "The Theory of the Photographic Process", 48, Macmillan, New York, (1954).

4. T. H. James, J. Chem. Phys., 12, 453 (1954).

5. E. Picciotto. Bull. du Centre de Physique Nucléaire de l'Université Libre de Bruxelles, nº 4, (1948).

6. H. G. de Carvalho.

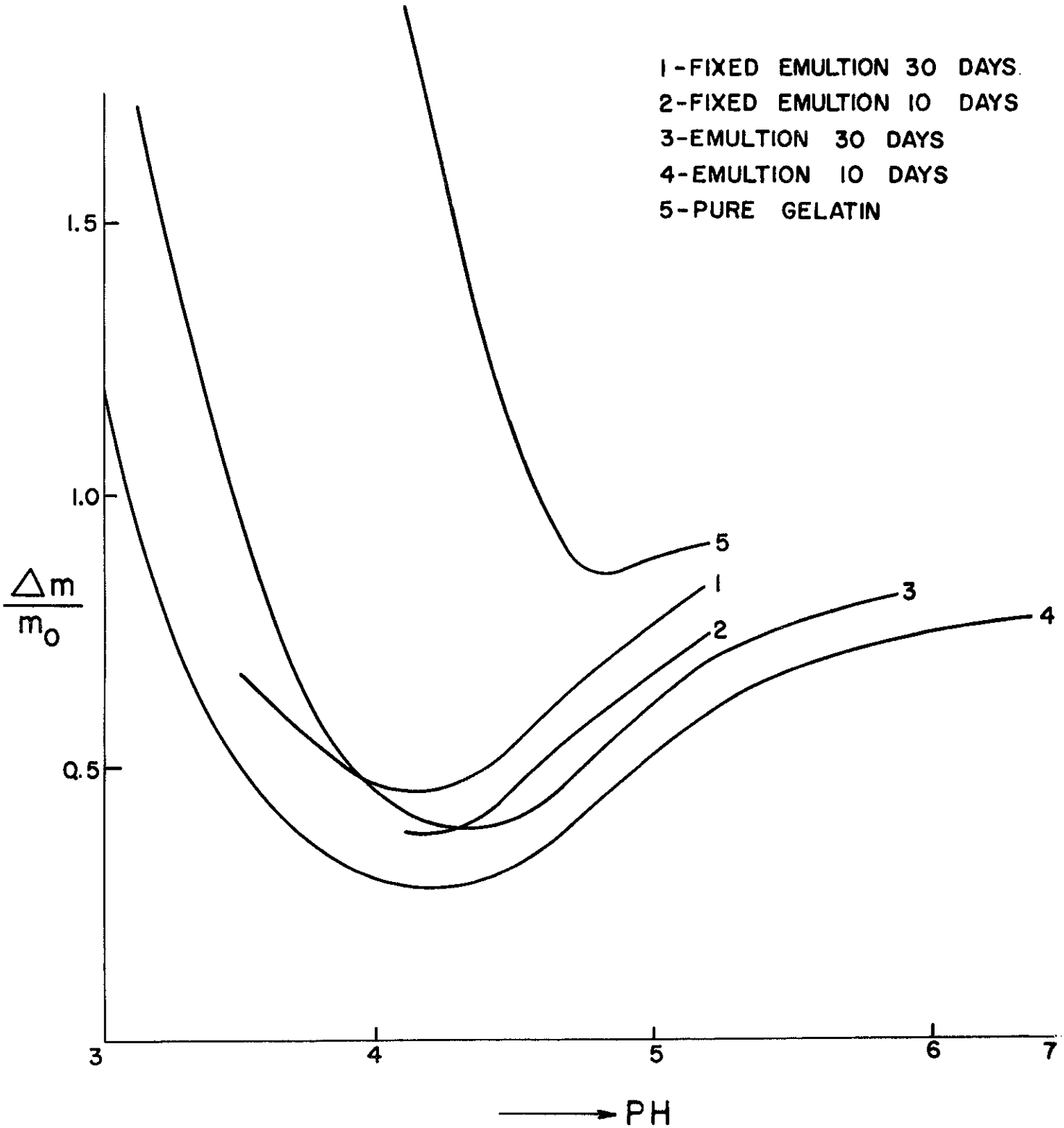

Figure 1

$\frac{\Delta m}{m_o}$ is the relative increase of mass of disks of gelatin immersed in solutions of different pH's.