EVALUATION OF STORAGE CHARACTERISTICS OF EMULSION TYPE PRINTING INKS

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Introduction

An important problem in the development and manufacture of printing inks is the control of their consistency characteristics, which are fundamental factors in determining its suitability for printing. The evaluation of rheological properties affords an excellent means of following changes of consistency on storage, and the present paper deals with a study of these characteristics for the emulsion inks developed at the Central Laboratories. The behaviour of the ink after a short period of high-speed stirring has also been investigated to study the possibilities of using this test for the indication of its storage characteristics thereby obviating the necessity of prolonged tests. This method has previously been investigated by R.J. Woodbridge[1] for some types of emulsion paints.

The predominant rheological characteristic of most oil-based inks is thixotropy, and the addition of water to such an ink may lead to (a) straight emulsification of water in the organic vehicle and (b) flocculation of the pigment particles. These two phenomenon may occur separately or together, depending primarily upon the pigment to vehicle wetting relations of the system. Emulsions may therefore show far more thixotropy than oil-based inks.

Experimental Details

The ink was prepared by adding a water solution of emulsifying agent to carbon black dispersed in hydrocarbon oil with the aid of a suitable dispersing agent. In the present study consistency measurements have been made on eight formulations which are given in Table 1, and have been chosen in order to study the effect of:

TABLE 1.—DETAILS OF FORMULATIONS.

No.	Pigment %	Vehicle %	Dispersing agent %	Water containing emulsifying agent %
1	6.0	49.0	0.0	45.0
2	6.0	44.0	5.0	45.0
3	6.0	39.0	10.0	45.0
4	6.0	34.0	15.0	45.0
5	6.0	41.5	7.5	45.0
6	6.0	39.0	7.5	47.0
7	6.0	36.5	7.5	50.0
8	Imported sample containing 42% water.			

*Corresponds to adopted C.I.S.R. formulation.

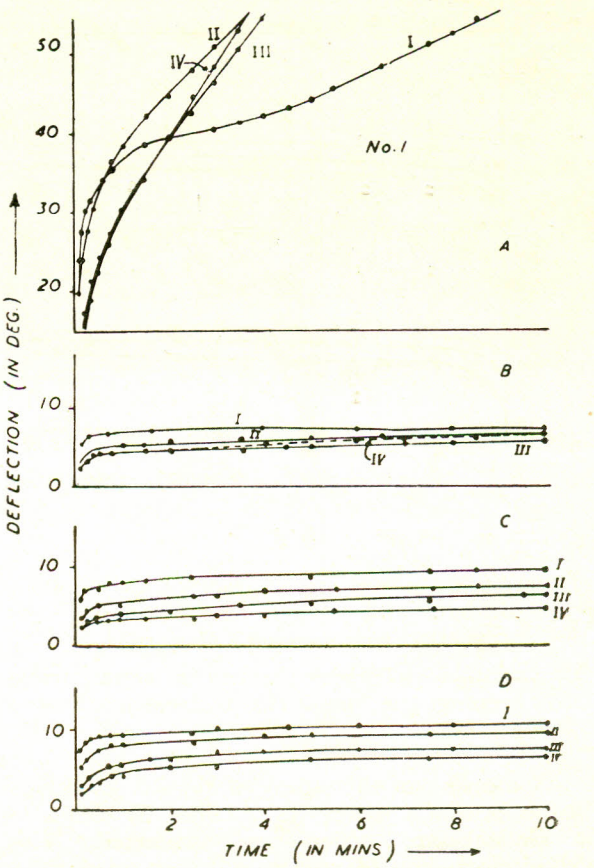

Fig. 1

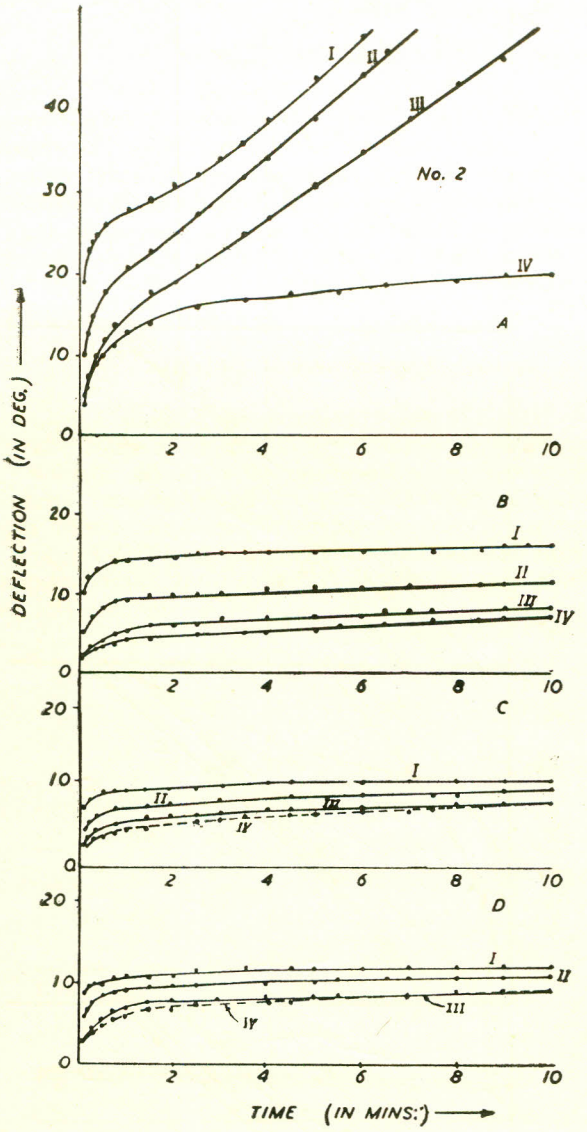

Fig. 2

(i) variation of wetting characteristics between pigment and vehicle by changing the proportion of dispersing agent, and

(ii) variation in the quantity of water, while keeping the quantity of dispersing agent constant.

A measure of thixotropy of the ink, which is in the form of a paste, was obtained by means of a Gallenkamp torsion-wire viscometer. The cylinderical bob (diameter $1\frac{5}{8}''$) susp nded from the torsion wire (30 SWG) was immersed in the material under test, the sample was stirred

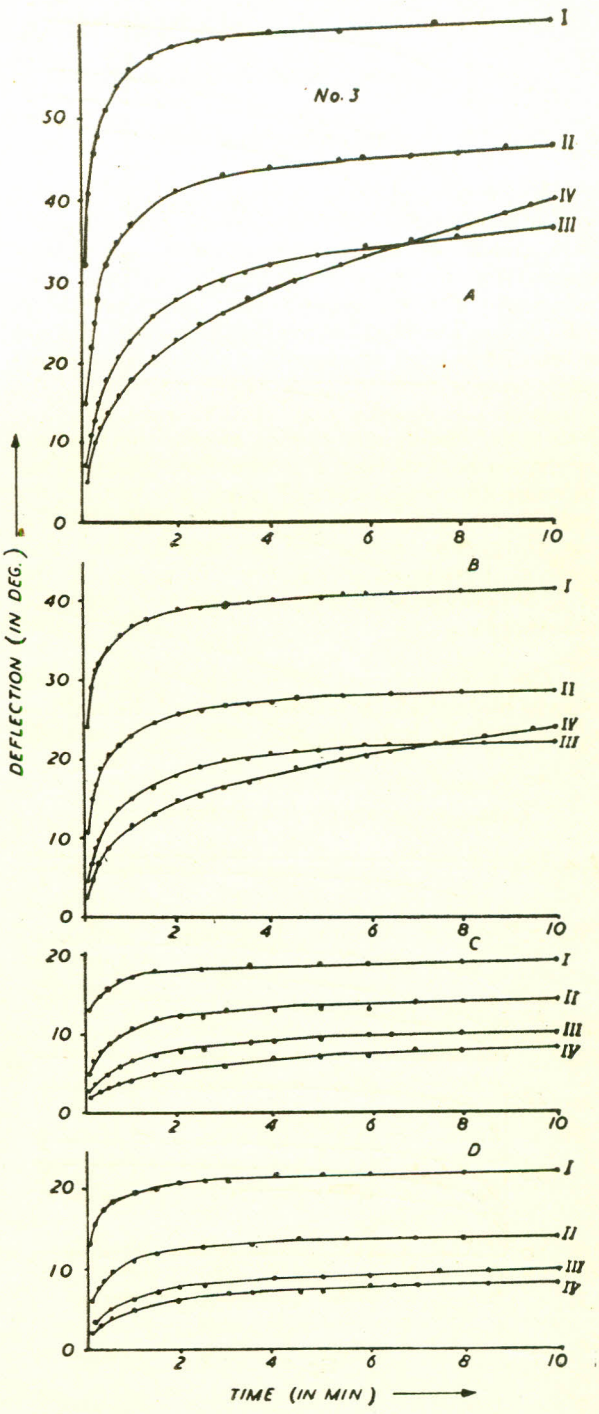

Fig. 3

and after a certain time, the head of the wire was rapidly rotated through 180°C. The rotation of the bob was noted and plotted in term of angular deflection against time. The test was repeated

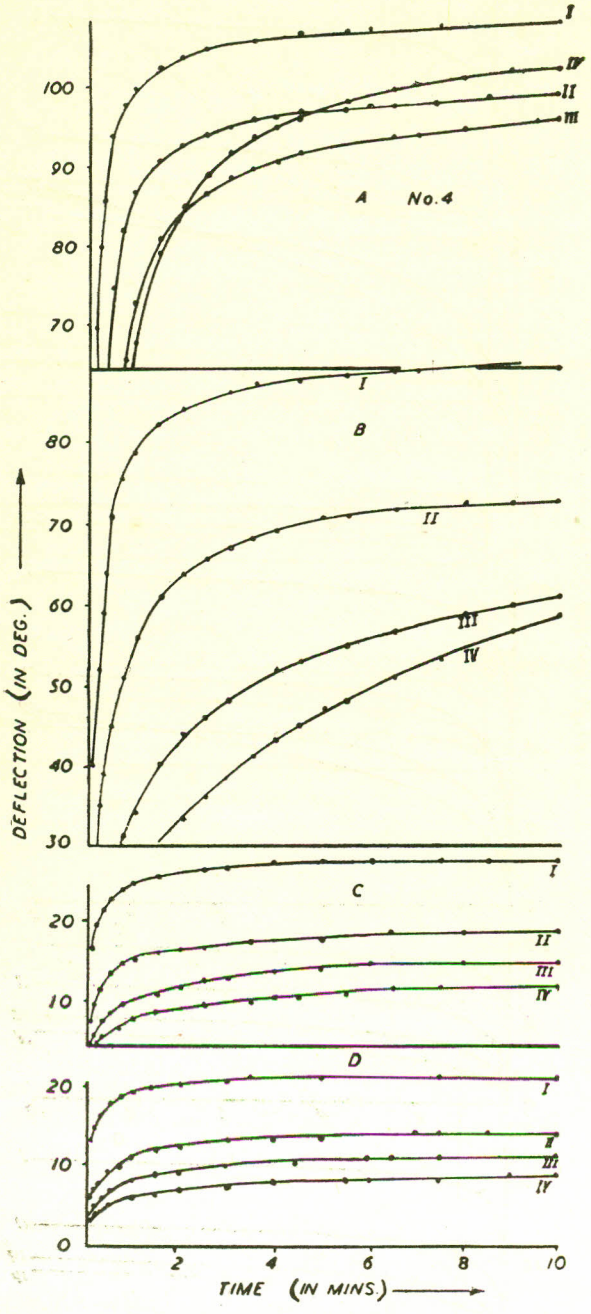
A No.4
B
C
D
I
II
III
IV
DEFLECTION (IN DEG.)
TIME (IN MINS.)

Fig. 4

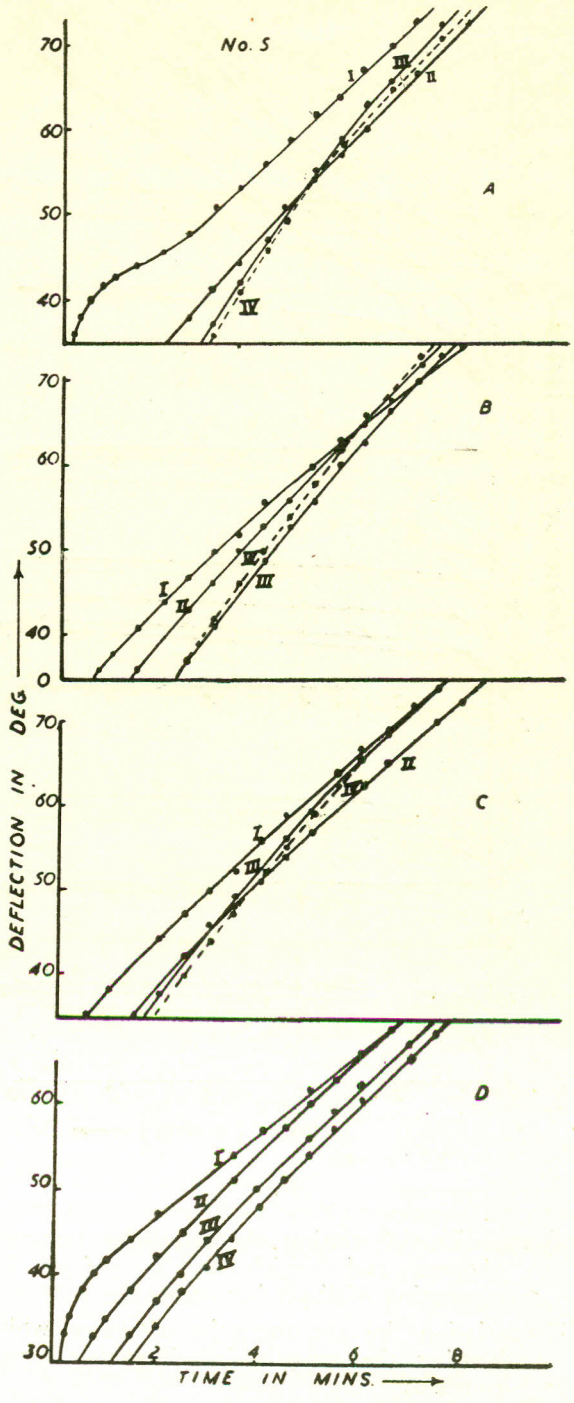
No. 5
A
B
C
D
I
II
III
IV
DEFLECTION IN DEG
TIME IN MINS.

Fig. 5

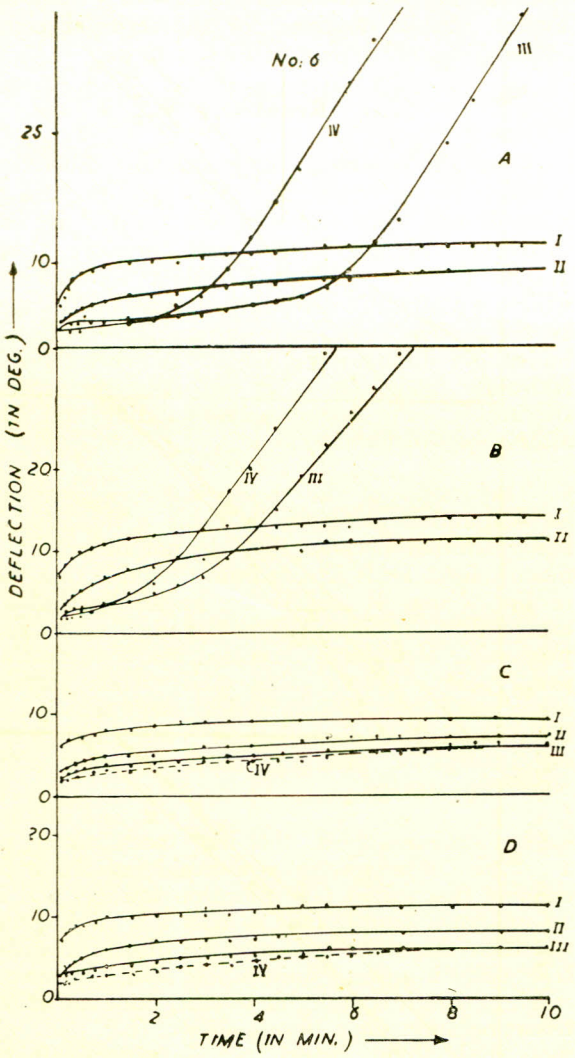

Fig. 6

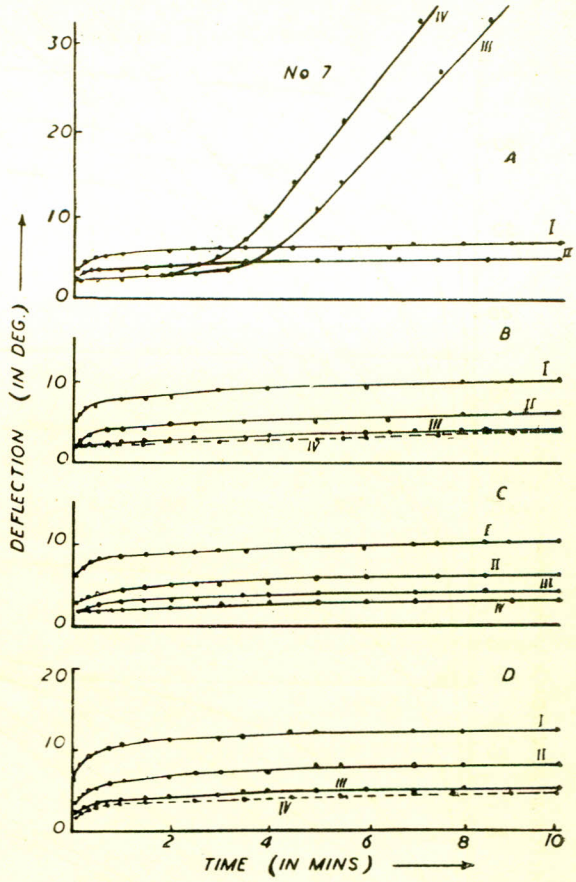

Fig. 7

TABLE 2.—RESULTS OF RHEOLOGICAL MEASUREMENTS.

No.	(A) As made	(B) After high-speed stirring for one hour	(D)* After incubation for 4 days at 40°C.
1	Undefined behaviour	Great increase in viscosity	Same as in test (B)
2	Thixotropic	Increase in viscosity	Greater increase in viscosity than in test (B)
3	,,	Slight increase in viscosity	,,
4	,,	Increase in viscosity	Much greater increase in viscosity than in test (B)
5	Non-thixotropic	Virtually no change	Virtually no change
6	Abnormal behaviour	,,	No change in viscosity. Abnormal behaviour disappears
7	,,	Slight decrease in viscosity. Abnormal behaviour persists	Greater decrease in viscosity than test (A). No abnormal behaviour
8	Non-thixotropic	Virtually no change	Virtually no change

*The results for (C) do not differ significantly from those for (D), and are therefore not given separately.

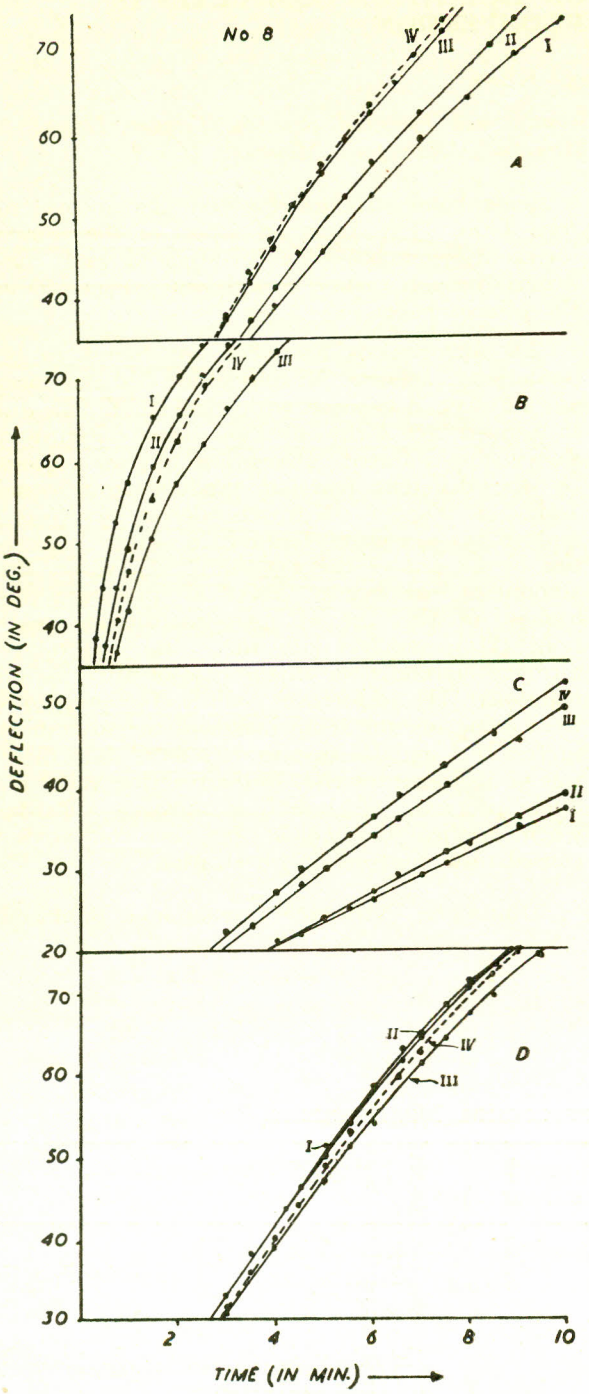

Fig. 8

with varying periods of rest, from 0 to 5 minutes. Typical graphs obtained for the series of eight formulations are shown in Figs. 1 to 8.

Results

Generally speaking, the greater the difference between the extreme graphs (i.e. no rest and 5 minutes rest after stirring), the greater is the thixotropy of the system and therefore these graphs provide comparative data for testing, which are useful in assesssing changes on storage. In the present work, each formulation was tested under four different conditions: (A) when the ink is freshly made, (B) after one hour high-speed stirring, (C) afte further 4 days standing, and (D) after 4 days incubation at 40°C.

The results of the rheological measurements for A,B and D are given in Table 2, those for C being omitted because they do not differ significantly from D. It is seen from the table that the results of tests B and D are essentially similar, except that the formulations 6 and 7, where the proportion of water is increased nearly to saturation point, behave abnormally when freshly made and in test B. In practical user's tests it has been found that formulations Nos. 3 and 5 are satisfactory for printing purposes, even after 18 months storage.

It therefore appears that high speed stirring of a sample under test gives a rapid indication of changes that might take place on storage, and if an unknown sample fails to pass this high speed test then the other tests may be dispensed with. If however it appears quite stable after high speed stirring, then it is desirable to carry out incubation tests, because some formulations (e.g. No. 4) show only slight increase in viscosity after high speed stirring test but significant increase after the incubation test.

Acknowledgements

The authors are grateful to Dr. M M. Qurashi for his continued interest in the problem and to Mr. S. Malik for help with some of the experimental work.

Reference

1. R.J. Woodbridge, J. Oil & Colour Chemists' Assoc., **38**, 286, (1955).