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The Effect of the Sequence of Dilution upon the Potential Brightness of Coated Board

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THE EFFECT OF THE SEQUENCE OF DILUTION UPON THE POTENTIAL BRIGHTNESS OF COATED BOARD

by

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ABSTRACT

The purpose of this study has been to determine the influence of the sequence of dilution upon the potential brightness of coated board. The sequence of diluting a coating slurry was varied and its effect upon the brightness of doubly coated board was noted. Besides the measurement of brightness, the coat weight and scattering coefficients were determined. The brightness was determined on the standard I.P.C. Brightness meter. The coat weight was determined from a modification of Tappi Standard T-627m58 while the scattering coefficient was determined from a table of brightness and scattering power.

The results indicate that diluting a coating slurry after mixing the adhesive and pigment together has the least detrimental effect on brightness, while diluting the adhesive before mixing with the pigment has the most detrimental effect upon the brightness. The above findings are explained in terms of varying degrees of pigment and adhesive bonding.

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INTRODUCTION

In the past several investigations have noted that the method of dilution of a coating slurry has an effect upon the potential brightness of coated paper. These workers have felt that by diluting the adhesive prior to mixing with a pigment slurry has the most detrimental effect on the brightness. The purpose of this study is to investigate the sequence of dilution and its effect upon the potential brightness of coated board.

EXPERIMENTAL DESIGN

A typical high brightness coating formulation was selected for testing since if any differences in brightness were to be observed, the difference would be more pronounced at high brightness levels than at low brightness levels. This coating formulation was also selected due to its relative ease of preparation. See Appendix.

To determine whether dilution has an influence on the potential brightness of coated board, the following experimental procedure was followed:

1) Make dispersion a) pigment and b) adhesive.
2) Make coating at 55% solids.
3) Make coating at 50% solids by
    A. Diluting coating in (2) with water or
    B. Diluting adhesive before mixing with pigment or
    C. Diluting pigment before mixing with adhesive.
4) Same as step 3 but at 45% solids.
5) Same as step 3 but at 40% solids.
6) Same as step 3 but at 35% solids.

The pigment was dispersed always at 67% solids in order to eliminate the effect of shear upon the brightness. By making drawdowns on board at each percent level and at each method of dilution, all the various

possible dilution sequences were obtained.

The drawdowns were made on uncoated board which had a brightness of 53.1%. To obtain two different levels of coat weight the board was coated either with a number 24 coating rod or a number 15 coating rod. Furthermore since numerous irregularities appeared in the coated surface, the board was coated with a second coat. This eliminated a major portion of the deviations in the coated surface. This also had the effect of increasing the coat weight thus lessening the effect of using two different coating rods. After the coating was applied the coating was air dried.

In order to establish a standard testing procedure, twelve samples of standard length and width were cut with the Taber tear test cutter from each board coated at each per cent solids level. This produced a sample 2 5/8" by 1 1/2" which became valuable in determining coat weight later.

One brightness reading per sample was taken and by determining the average of these twelve samples, the brightness at each per cent level and dilution method was determined.

To determine the scattering coefficient, the "S" value of the coated board, a table of scattering power was referred to. By knowing the brightness of the uncoated board and the brightness of the coated board, the scattering power can be interpolated. By dividing the scattering power by the coat weight, the "S" value is determined.

A modification of Tappi Standard T-627m58 was used to determine the coat weight. Four samples in each of three crucibles for each coat weight determination were ashed in a muffle furnace.

After ashing, the ash was heated for one hour on a hot plate in 20 ml of concentrated H_2SO_4 and 9 gm of $(NH_4)_2SO_4$. The ash was then filtered and the dissolved TiO_2 was added to a one liter volumetric flask, diluted and 15 ml of 3% H_2O_2 was finally added. After bringing the volume to the mark, the per cent transmittance of the solution was determined on a spectophotometer at 420 mu. By referring to a graph of per cent transmittance versus grams of TiO_2 per 100 ml, the amount of TiO_2 from the coating itself is determined and therefore the actual coat weight in pounds per 1000 $feet^2$ can be calculated. By taking an average of three, the coat weight for each per cent solid and each method of dilution was obtained.

DISCUSSION

Graphs 1 and 2 are plots of brightness versus per cent solids using two different coating rods. Both graphs indicate that by dividing the adhesive before mixing with the pigment has the most detrimental effect upon the brightness for both coat weights. By diluting the coating slurry after mixing the pigment and adhesive together or by diluting the pigment before mixing with the adhesive has little effect upon reducing the brightness of the board. Both curves are quite comparable. The brightness of the board is reduced at lower solids levels due to the lesser amount of coating which can be applied at lower per cent solids.

Graphs 3 and 4 were plots of scattering coefficient versus coat weight using two different coating rods. The scattering coefficient, commonly called the "S" value, is the capacity of an object to return incident light by reflection. It is apparent that again diluting of the adhesive before mixing with the pigment has a more detrimental effect upon the "S" value than dilution of the coating slurry after mixing or dilution of the pigment

before mixing with the adhesive.

Graphs 5 and 6 are plots of brightness versus coat weight using two different coating rods. At constant coat weight a lower brightness is obtained by diluting the adhesive before mixing with the pigment than either of the other two methods of dilution.

From the above discussion it is apparent that by diluting the adhesive before mixing with the pigment has the most detrimental effect upon the potential brightness and the scattering coefficient. Although I have done considerable research into this phenomenon, there is little information available about workers who have looked into this problem of "when to dilute"; likewise, whenever this phenomenon is mentioned, no explanation for the results is given.

My theory is one based upon the ability of the adhesive particles to cover a pigment particle. It would appear that the adhesive particles when diluted, are more able to flow around the pigment particles, or as one would say to become in a more intimate position, therefore cover each pigment particle more so than if the adhesive is not diluted or after the adhesive and pigment particle become in contact and then diluted. Since each pigment particle then is surrounded by a thin layer of adhesive and since adhesives generally reduce brightness, the potential brightness of a board coated with this slurry would subsequently be lower than a coating slurry diluted in a normal fashion. In normal operational coating practices when the coating is diluted after the pigment and adhesive are mixed, the adhesive is already bonded to the pigment particle thus the dilution has little effect of causing the adhesive particles to cover each pigment particle further, which in turn does not cause a reduction in brightness.

CONCLUSIONS

The results indicate that the sequence of dilution is an important factor to consider when preparing a coating slurry when high brightness is desired. The highest possible prightness is obtained if the slurry is diluted either after the adhesive and pigment are mixed or by diluting the pigment before mixing with the adhesive. A reduction in brightness occurs in the slurry if the adhesive is diluted before mixing with the pigment. This reduction can be as much as 1.5 points brightness.

APPENDIX

COATING FORMULATION

1. 160 gm Ulšra White 90 clay

2. 40 gm Rutile TiO_2

3. 0.4 gm TSPP

4. 136 Water

5. 18 gm dry soy protein

6. Dow 636 18 gm dry.

7. 2 gm Parez 613.

Mix clay, TiO_2, TSPP and water in waring blender at low speed to wet out, then two minutes on high speed. Add adhesive, dow 636, and Parex 613 and mix for two minutes at low speed.

Soy protein made up as follows:

1. 100 gm Delta protein

2. 500 gm water

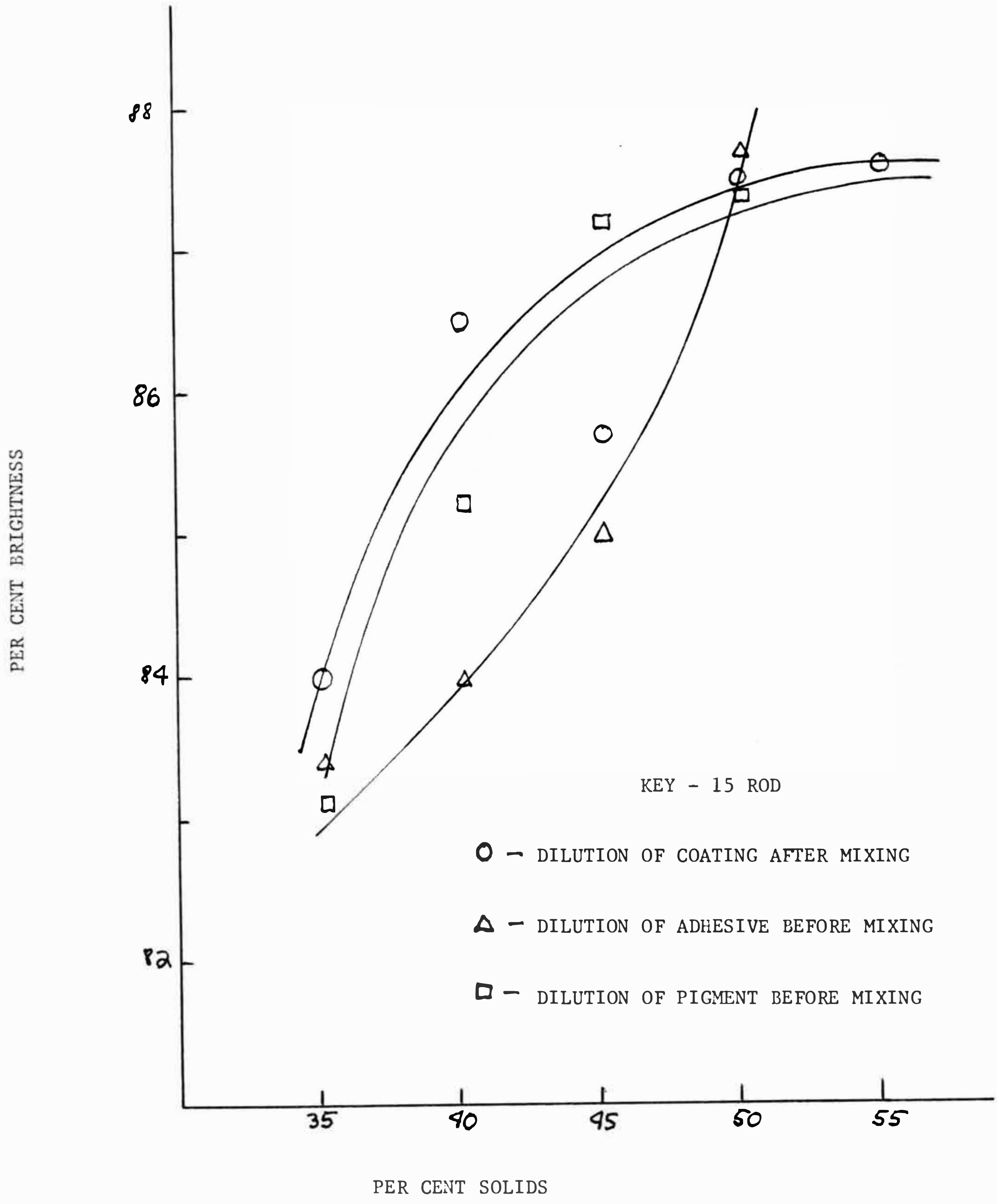
3. 10 gm of 28% NH_3

4. heat to 60 degreės C. before NH_3 is added, then hold at 60 degrees C. for one hour.

GRAPH I

BRIGHTNESS VS PER CENT SOLIDS

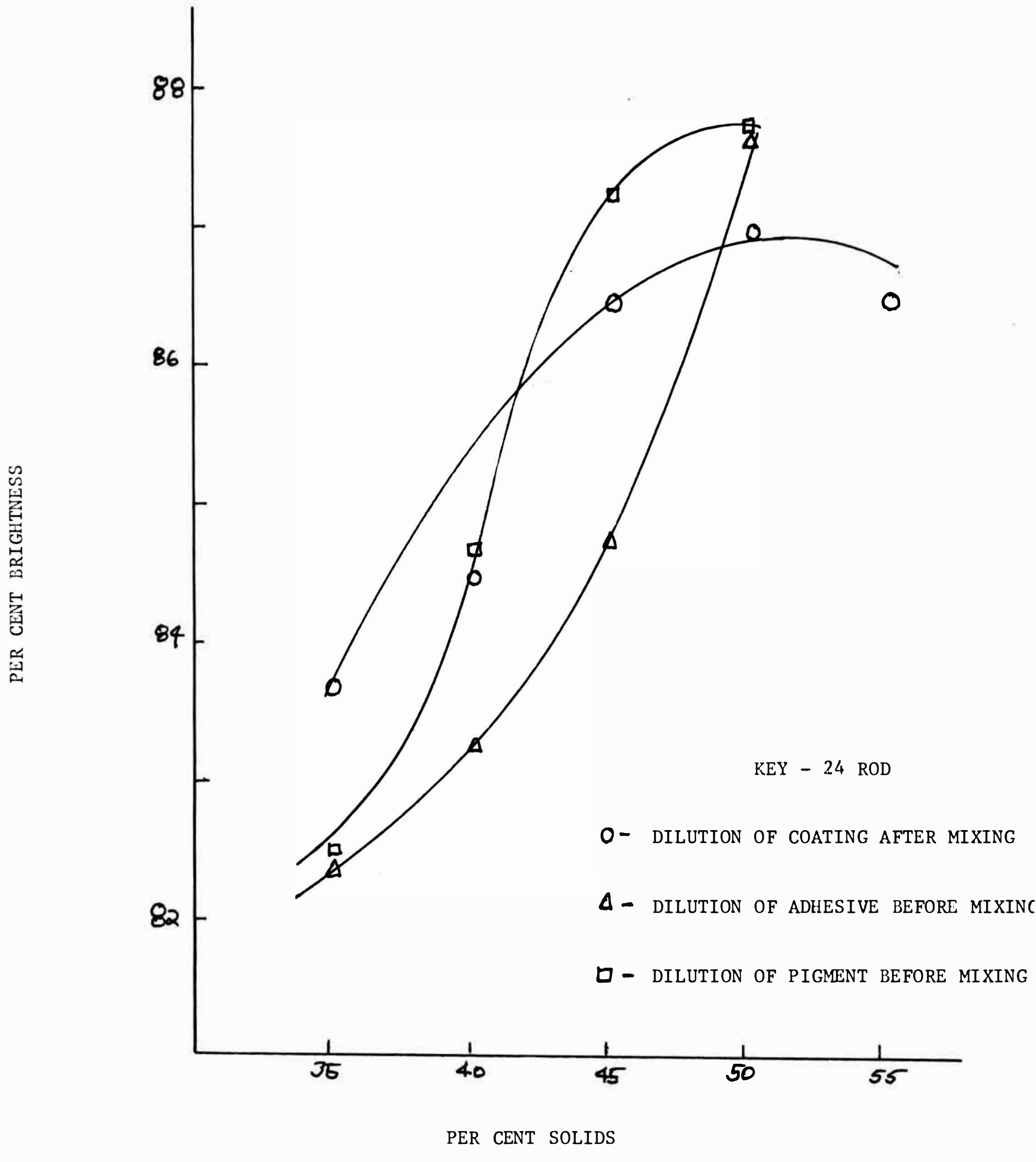
NO. 15 ROD



GRAPH 2

BRIGHTNESS VS COAT WEIGHT

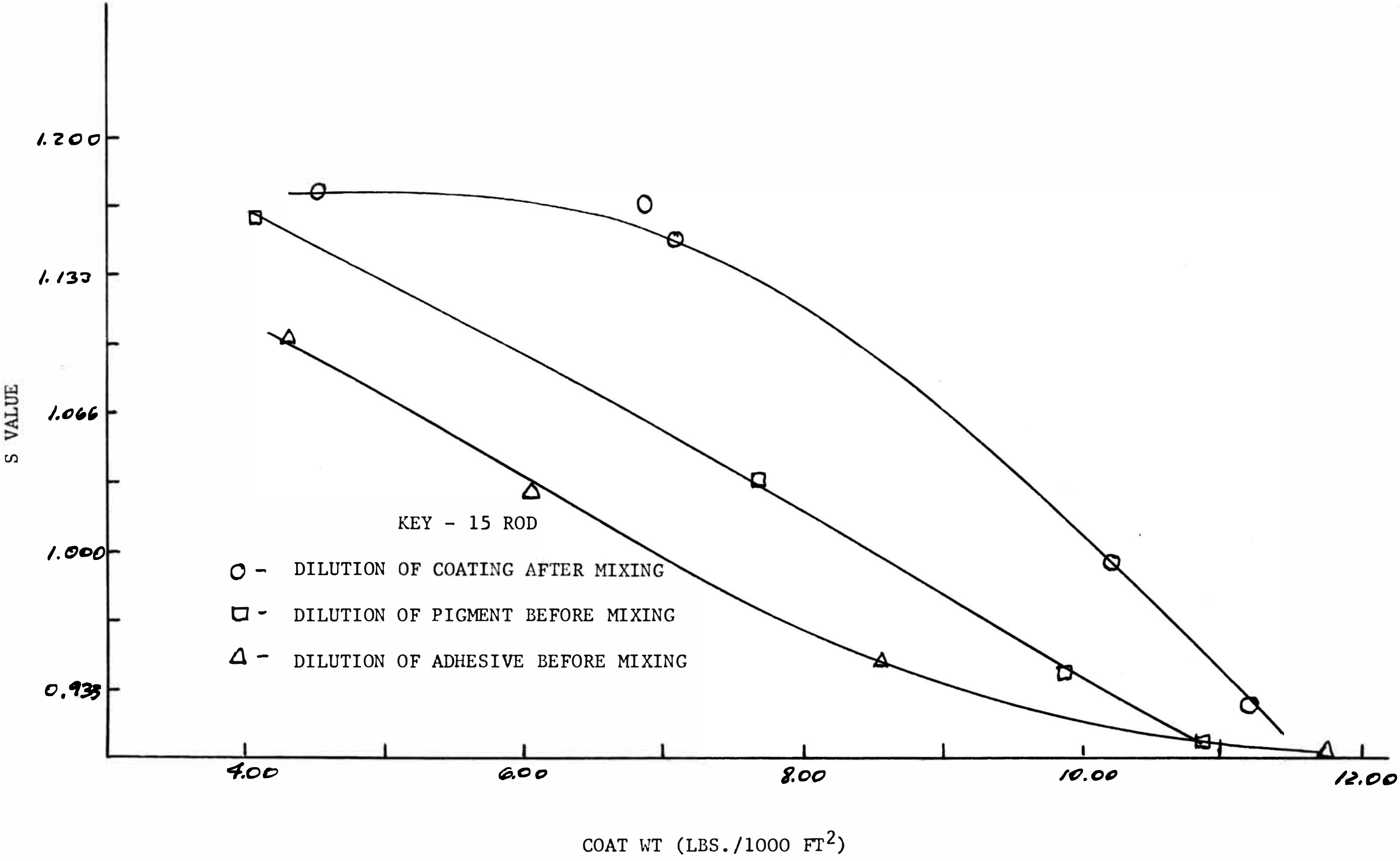
NO. 24 ROD



GRAPH 3

SCATTERING COEFFICIENT VS COAT WEIGHT

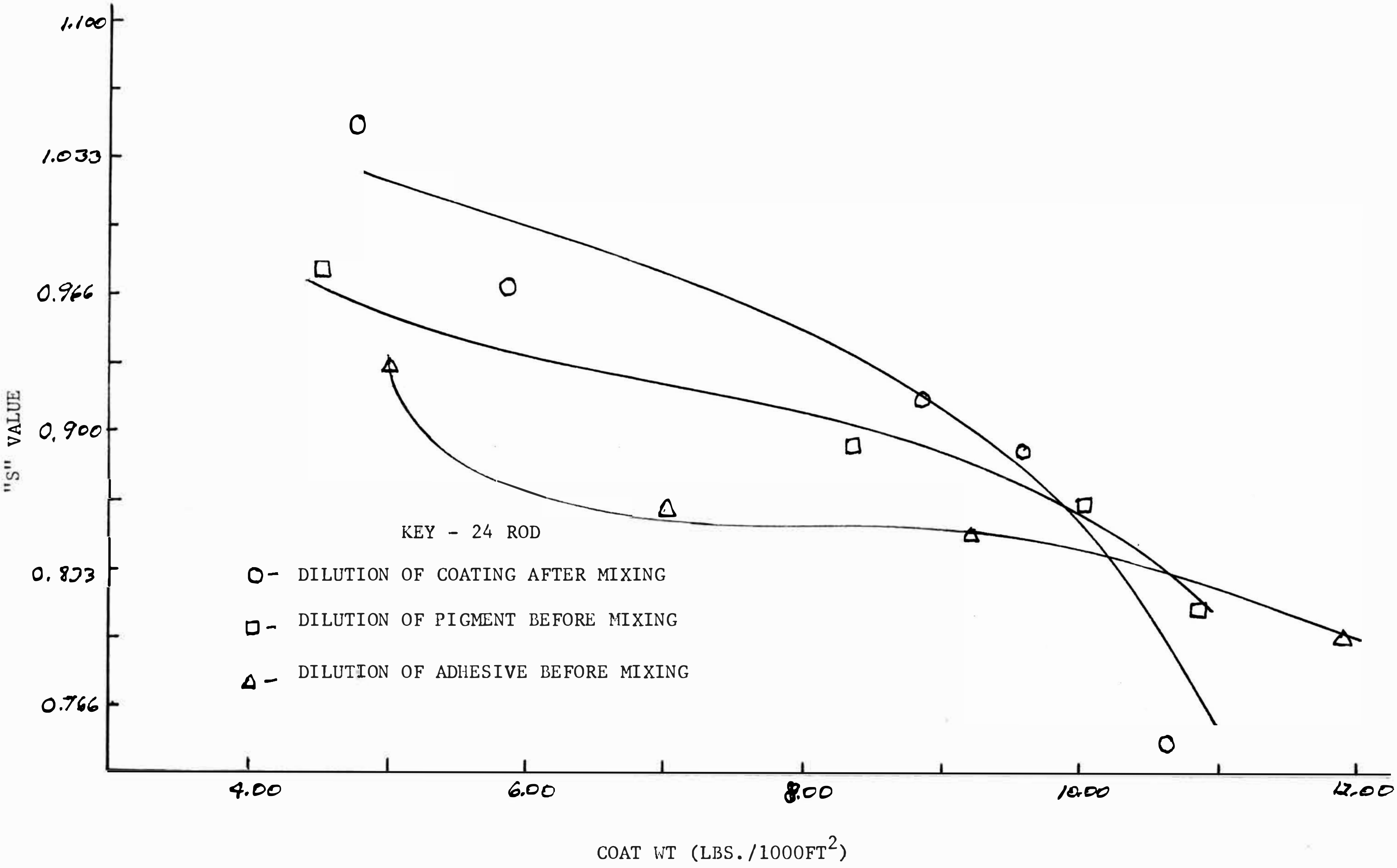
NO. 15 ROD



GRAPH 4

SCATTERING COEFFICIENT VS COAT WEIGHT

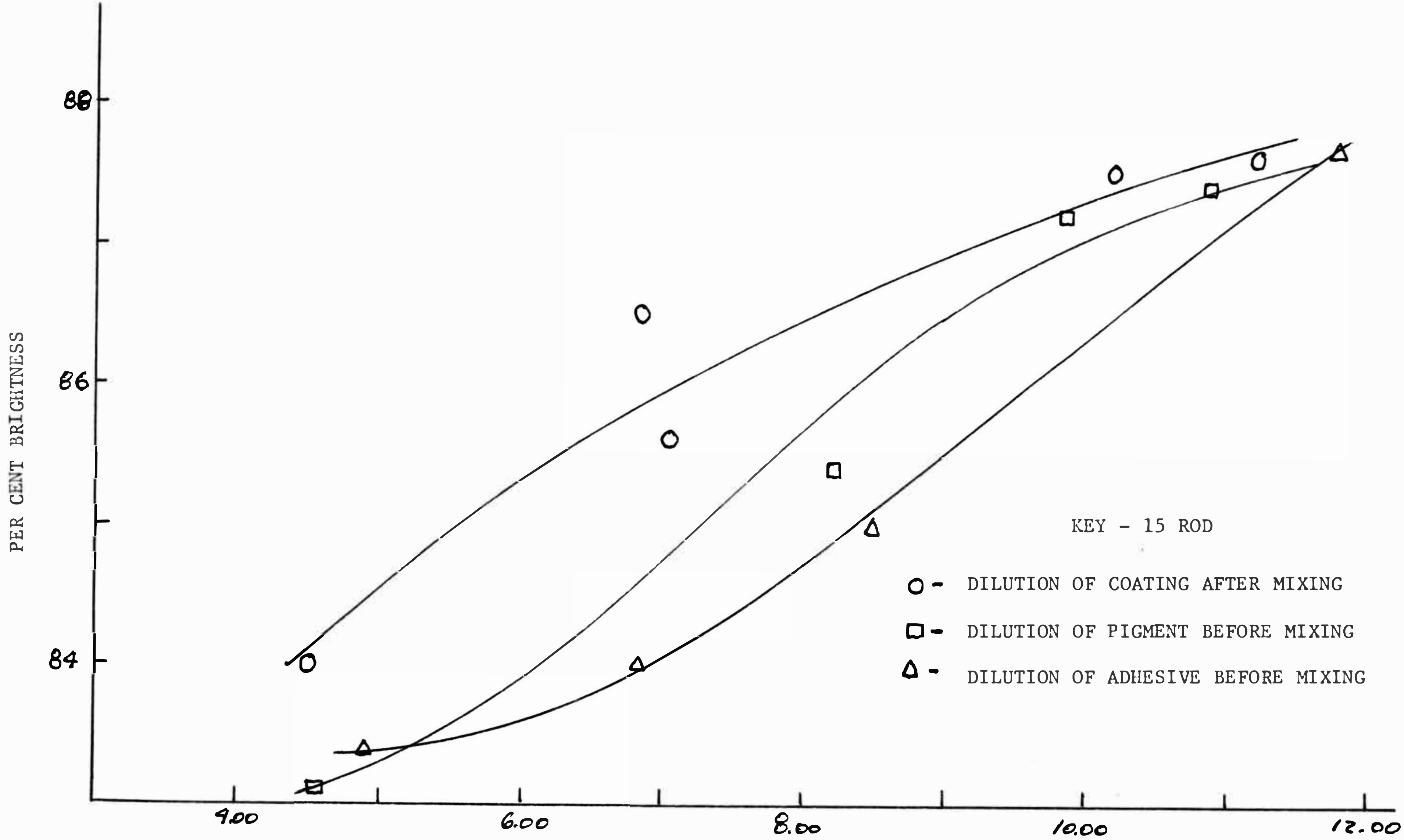
NO. 24 ROD



GRAPH 5

BRIGHTNESS VS COAT WEIGHT

NO. 15 ROD

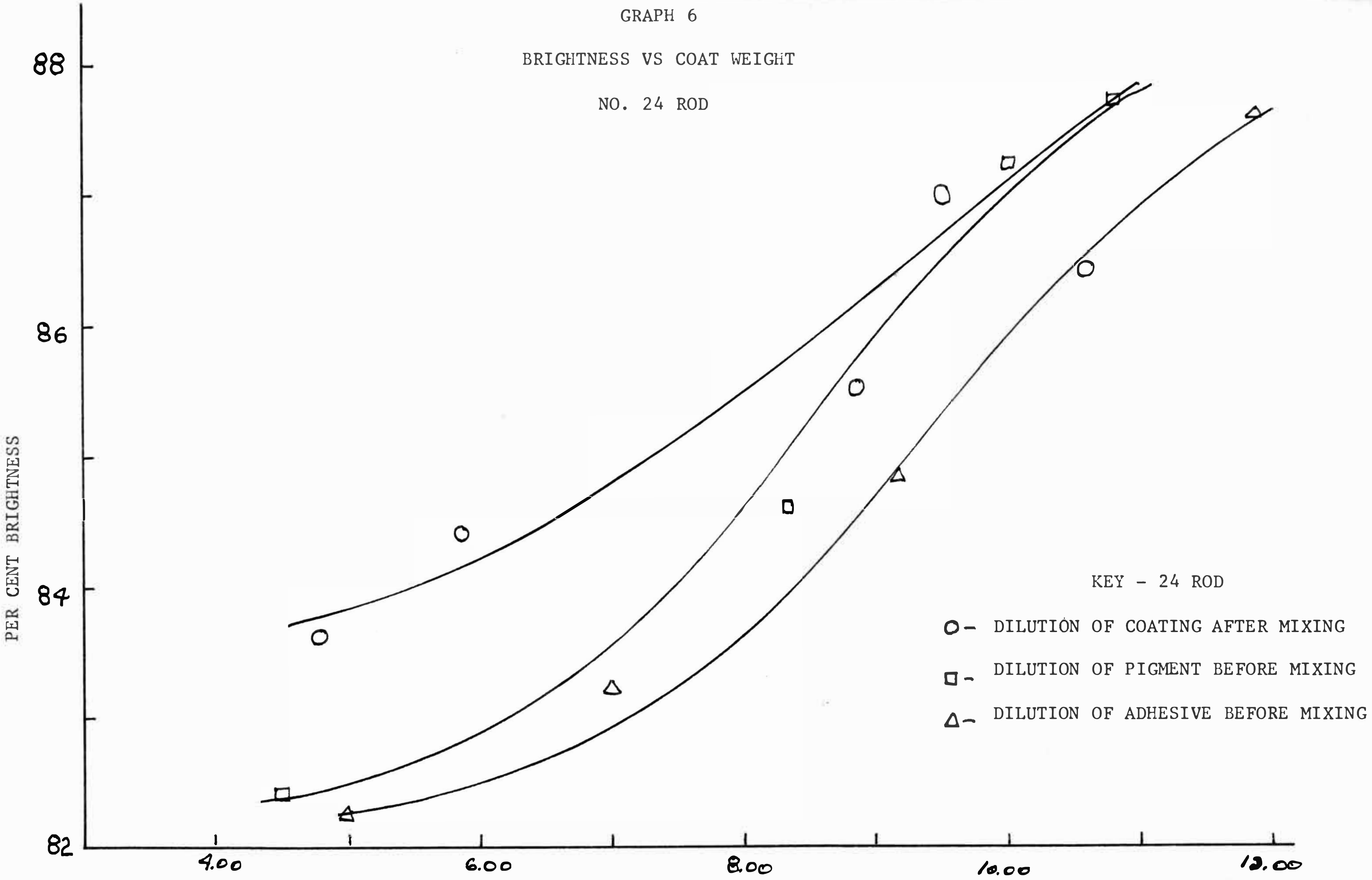


COAT WEIGHT (LBS./1000 FT^2)

GRAPH 6

BRIGHTNESS VS COAT WEIGHT

NO. 24 ROD



COAT WEIGHT (LBS./1000 FT^2)

DATA

Number 15 Rod.

Per Cent Solids	55	50	45	40	35
Straight Dilution					
% Brightness	87.6	87.5	85.7	86.7	84.0
Coat Weight	11.20	10.20	7.05	6.80	4.50
"S" Value	0.927	0.990	1.150	1.165	1.170
Dilution of Pigment before mixing.					
% Brightness	-	87.4	87.2	85.2	83.1
Coat Weight	-	10.86	9.85	8.20	4.06
"S" Value	-	0.905	0.940	1.033	1.16
Dilution of Adhesive before mixing.					
% Brightness	-	87.7	85.0	84.0	83.4
Coat Weight	-	11.85	8.50	6.80	4.40
"S" Value	-	0.900	0.950	1.034	1.10

Number 24 Rod

Straight Dilution					
% Brightness	86.4	86.9	86.4	84.4	83.6
Coat Weight	10.62	9.55	8.86	5.82	4.75
"S" Value	0.752	0.893	0.915	0.967	1.055
Dilution of Pigment before mixing.					
% Brightness	-	87.7	8712	84.6	82.4
Cot Weight	-	10.80	10.00	8.30	4.50
"S" Value	-	0.810	0.862	0.890	0.970
Dilution of Adhesive before mixing.					
% Brightness	-	87.6	84.7	83.2	82.3
Cot Weight	-	11.90	9.20	7.00	5.00
"S" Value	-	0.800	0.850	0.860	0.930

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