CHAPTER 4

SYSTEM : SODIUM SULPHATE

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P. Walden and Hermulich (1923) did the measurements of conductivity of dilute aqueous salt solutions at 0, 18 and 100°c. At these temperatures, the conductivity curves have been determined for very dilute solutions of NaCl as well as $NaNO_3$ and other salts at 18 and 100°c. The theory of Hertz was employed for obtaining for equivalent conductivity at infinite dilution.

A.R.Gordon (1939) did the extrapolation of conductance data for the univalent nitrates and iodates by means of the extended Onsager-Shedlovsky equation. They found that the equation gives satisfactory results.

C.V.Suryanarayana and others (1956) studied the conductance of concentrated solutions of strong electrolyte. The new concept about concentration potential Cp (the ratio of moles of the electrolyte per 1000 gm of water at a given molality to the moles of electrolyte per 1000 gm of water at saturation at the same temperature) and potential viscosity η_p (the ratio of viscosity of electrolyte solution of a given molality to that of saturation at the same temperature) are introduced and the following equation is formulated

$$\lambda_c = As + A\left(1 - \frac{C_p}{\eta_p}\right)$$

where λ_c is the specific conductance times 1000/Cp. "As" is the specific conductance of saturated solution Ks x 1000 and A is constant from measurement of conductivity and viscosity of aqueous solutions of KCl, KNO_3, NaCl, $NaNO_3$ from 1 molal to saturation at temperature from 30 to 55°c at 5°c intervals. It was found that all plots of λ_c against $\left(1 - \frac{C_p}{\eta_p}\right)$ were linear. A plot of

λ_c against temperature was linear for all solutions except KNO_3. The parameter 'A' was a function of a temperature.

Phillip W. Brewster and others (1959) studied the conductance of the halides, nitrates and nitrites of the alkali metals in anhydrous ethanolamine at 25°c and reported linear plots of λ_c Vs $\sqrt{c}$ approach the Onsager tangent from below. The limiting conductivity data confirmed the Kohlrausch law of independent ion migration in ethanolamine. The usual trend is observed in the limiting equvalent conductivity of salts of a given anion, i.e. Li $<$ Na $<$ K. But for a given cation, the conductivity increases in the order I $<$ Br $<$ Cl opposite to that in methyl formamide and substituted acetamides.

P.I.Protosenku and others (1967) studied the properties of solutions of some univalent and bivalent metal nitrates. Electrical conductivity, viscosity and specific gravity of N solutions of Li, Na, K, Rb, Cs, Ag, Sr nitrates and 0.2 N solutions and of Tl and Ba nitrates are reported for 4 - a_o^o c at 4°c then at 10°c. The solutions were reported with twice distilled water and recrystallised salts. The electrical conductivity of the nitrates of alkali metals is higher than that of the alkaline earth metals, due to the stepwise dissociation of the latter.

Maksimova I.N. and co-workers (1968) determined the electrical conductivity of aqueous solutions of sodium salts at high temperature. The conductivity rises rather linearly with temperature to a maximum or exhibit a break in the curve and then either falls or rises at a slow rate. This is attributed to a change in hydration and thus a change in the inter ionic forces.

D'Aprano Alessandro (1972) studied the association of alkali perchlorates in anhydrous methanol at 25^{o}c and reported about the equivalent conductivity of alkali metal perchlorates. The K values were determined by a new conductivity equation. Association was found for all the perchlorates in different pure solvents in the range of dielectric constant between 80 and 30.

A.M.Shkodin and others (1975) have studied the thermodynamics of 1-1 valence electrolyte dissociation in aliphatic alcohols. The results are discussed in terms of H-bonding of the lower alcohols and association due to dispersion forces with the higher and the balance between these forces and ionic solvation.

Levitskaya and others (1978) studied the viscosity and electrical conductivity of NaI in mixed solvents at 25^{o}c. The results showed that the minima shifts towards lower NaI concentration and at higher concentration of non-aqueous (dioxane) solvent because addition of non-aqueous solvent reduces the alcoholic solvation of ion.

Aleshko-Ozhevskil and others (1979) have determined the temperature and cation radii effect of ion-solvation. The result showed that in the case of alkali metal chloride solutions the increasing temperature affects water in the region of remote (outer-sphere) hydration, while an increase in ionic radius affects the immediate vicinity of the ions.

Vasin S.K. and others (1979) have determined the ion association in aqueous solution of alkali metal sulphate (II) in M_2SO_4 - H_2SO_4 -water system. The study showed that Li^+ occurs as a simple hydrated ion while Na^+, K^+ , Rb^+ , Cs^+ form a solvent separated ion pairs of the type $M^+ - H_2O - HSO_4^-$.

Bamane & Datar (1979) have found that in the case of sodium chloride and potassium chloride the order in which conductivity values vary in aqueous organic solvents is methanol-water $>$ acetone-water $>$ ethanol-water.

Daniel and others (1982) have investigated the formation of complexes between sulphate ion and the alkali metal ions ($M^+ = Li^+$, Na^+ , K^+ , Rb^+, Cs^+) by potentiometrically at 37^oc. The results showed that the order of stability for $[M(SO4)]^-$ complex is $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$.

Abraham Michael H and others (1982) have studied the structure making and structure breaking effect of alkali halide ions from electrostatic entropies of solvation. Entropy data indicate that in water the ions Li^+ ,Na^+ ,Ag^+, and F^- are structure makers,K^+ is on border line and in non aqueous solvents like methyl alcohol, formamide, dimethyl formamide etc. all the above ions are structure breakers.

Ivanov and others (1985) have found the density, viscosity and x-ray data for $LiHSO_4$, $NaHSO_4$ and $KHSO_4$ solution in H_2SO_4 at 298.15^oK. The result found that, the ion solvating capacities are in the order $K^+ < Na^+ < Li^+$.

Vorob'ev and others (1989) have determined the solubility of Na_2SO_4 and K_2SO_4 in dimethyl sulphoxide and aqueous dimethyl sulphoxide at 273 to 313^oK. The result showed that at 298^oK, crystals of K_2SO_4 (un solvated) exist in equilibrium with its saturated aqueous dimethyl sulphoxide solution. At higher water content and at 298^ok Na_2SO_4 crystallises as decahydrates but at higher dimethyl sulphoxide content Na_2SO_4 crystallises as the anhydrous salt.

Towarach K.M. and others (1989) have studied the conductance of Na^+ ,K^+ , Rb^+ , Cs^+ with 1, 13 dibenzo-24-crown-8 in acetonitrile at 15, 20, 25, 30 and 35°c. The binding sequence based on the values of log K at 25°c is $Rb^+ > Cs^+ > K^+ > Na^+$. The enthalpy and entropy values were also been reported.

The following systems have been studied at 6 different temperatures i.e. 5°c, 10°c, 15°c, 20°c, 25°c, and 30°c.

1) 1×10^{-3}M Na_2SO_4 + X% ethanol.
2) 1×10^{-4}M Na_2SO_4 + X% ethanol
3) 5×10^{-5}M Na_2SO_4 + X% ethanol
4) 1×10^{-5}M Na_2SO_4 + X% ethanol
5) 5×10^{-3}M Na_2SO_4 + X%methanol
6) 1×10^{-3}M Na_2SO_4 + X% methanol
7) 5×10^{-4} M Na_2SO_4+ X% methanol
8) 1×10^{-3}M Na_2SO_4 + X% meth acetone
9) 1×10^{-4}M Na_2SO_4 + X% acetone
10) 5×10^{-5}M Na_2SO_4 + X% acetone
11) 1×10^{-5}M Na_2SO_4 + X% acetone

Turbidity was obtained while preparing the following solutions :

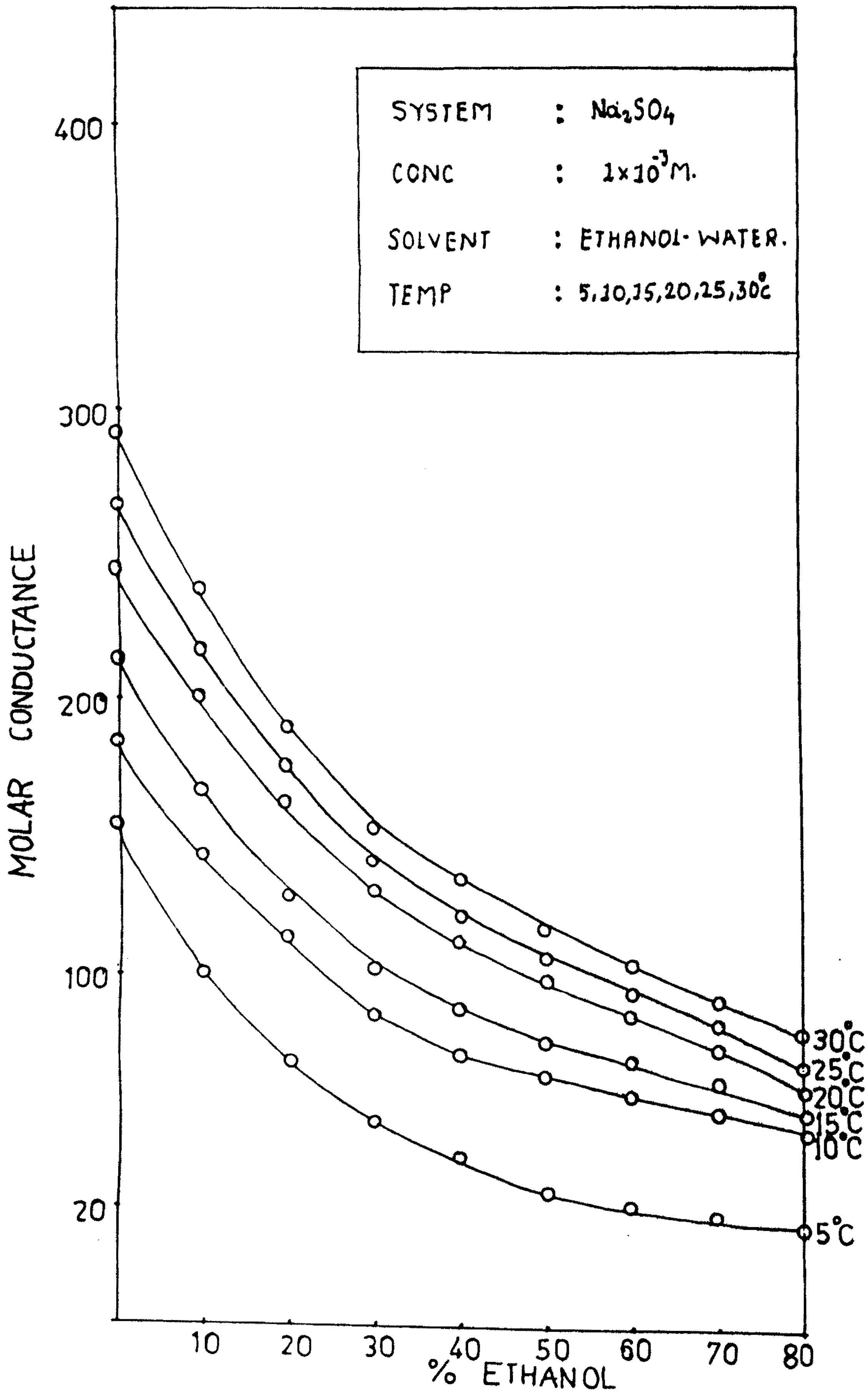
1) 1×10^{-2}M Na_2SO_4 + X% ethanol
2) 5×10^{-3}M Na_2SO_4 + X% ethanol
3) 1×10^{-2}M Na_2SO_4 + X% methanol
4) 1×10^{-2}M Na_2SO_4 + X% acetone
5) 5×10^{-3}M Na_2SO_4 + X% acetone

and hence the above systems could not be studied.

System	: Na_2SO_4
Concentration	: 1×10^{-3} M
Solvent	: Ethanol-water
Temperature	: 5, 10, 15, 20, 25 & 30°C

TABLE 4.1

% Ethanol	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	156.0	185.0	215.0	225.0	254.0	295.0
10	103.0	143.0	186.0	201.0	219.0	240.0
20	72.0	116.0	140.0	164.0	175.0	190.0
30	50.0	87.0	101.0	132.0	142.0	154.0
40	37.0	74.0	90.0	113.0	121.0	136.0
50	25.0	65.0	77.0	101.0	106.0	118.0
60	21.0	60.0	71.0	88.0	93.0	105.0
70	17.0	54.0	63.0	76.0	81.0	91.0
80	14.0	46.0	51.0	60.0	63.0	72.0
90						



SYSTEM : Na_2SO_4
CONC : 1×10^{-3}M.
SOLVENT : ETHANOL-WATER.
TEMP : 5,10,15,20,25,30°C
400
300
200
100
20
MOLAR CONDUCTANCE
30°C
25°C
20°C
15°C
10°C
5°C
10
20
30
40
50
60
70
80
% ETHANOL

FIG - 4.1

System : Na_2SO_4

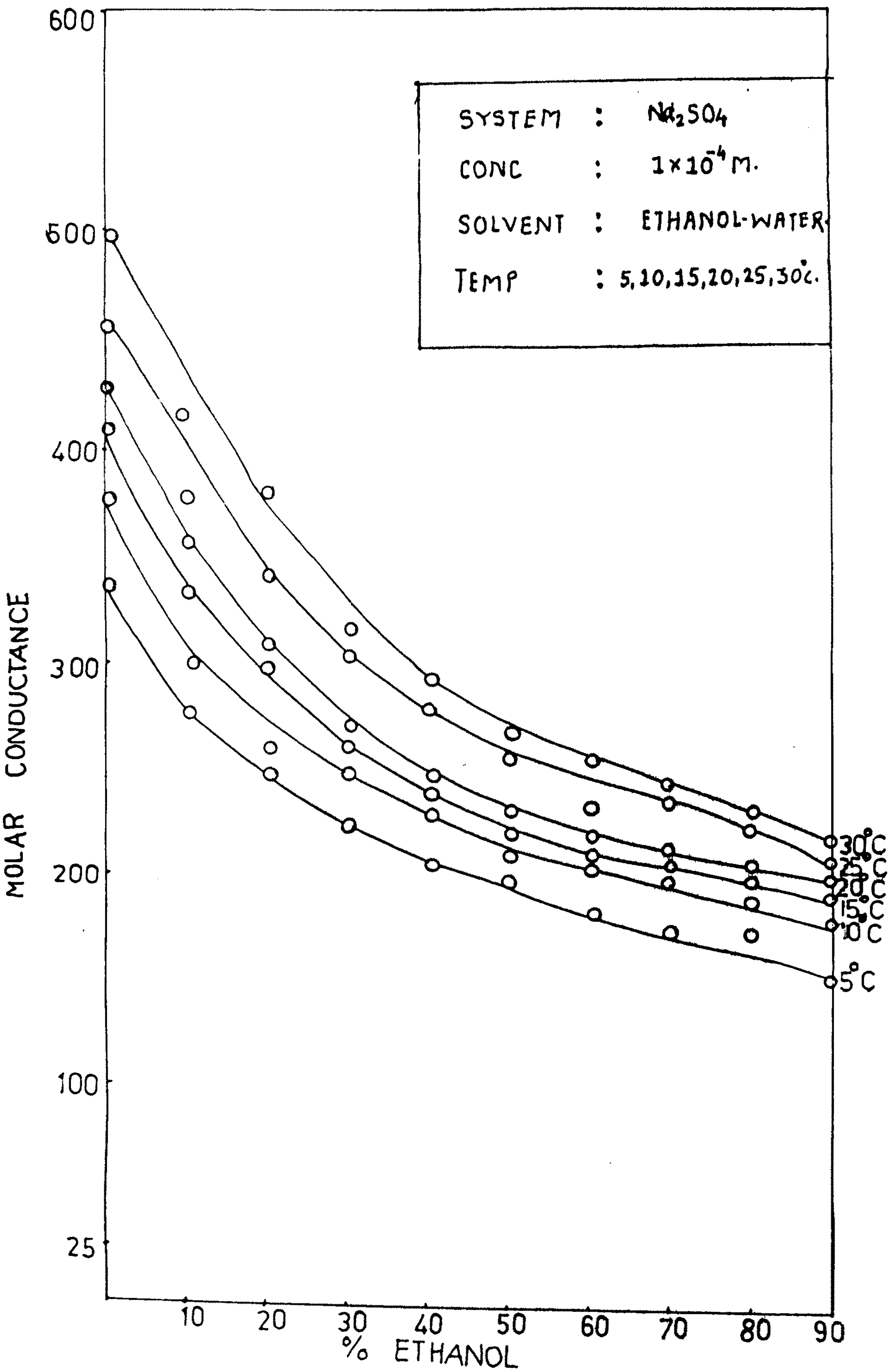
Concentration : $1x10^{-4}M$

Solvent : Ethanol-water

Temperature : 5, 10, 15, 20, 25 & 30°C

TABLE 4.2

% Ethanol	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	340.0	380.0	410.0	430.0	460.0	500.0
10	280.0	300.0	370.0	380.0	420.0	450.0
20	250.0	260.0	300.0	310.0	340.0	380.0
30	230.0	250.0	260.0	270.0	310.0	320.0
40	210.0	230.0	240.0	240.0	280.0	290.0
50	200.0	210.0	220.0	230.0	260.0	270.0
60	190,0	210.0	210.0	220.0	230.0	250.0
70	170.0	200.0	200.0	210.0	220.0	240.0
80	160.0	190.0	200.0	200.0	210.0	220.0
90	150.0	180.0	190.0	190.0	210.0	200.0



600
500
400
300
200
100
25
MOLAR CONDUCTANCE
10
20
30
40
50
60
70
80
90
% ETHANOL
SYSTEM : Na2SO4
CONC : 1×10⁻⁴ M.
SOLVENT : ETHANOL-WATER
TEMP : 5,10,15,20,25,30°C.
30°C
25°C
20°C
15°C
10°C
5°C

FIG-4.2

System	:	Na_2SO_4
Concentration	:	5×10^{-5} M
Solvent	:	Ethanol-water
Temperature	:	5, 10, 15, 20, 25 & 30°C

TABLE 4.3

% Ethanol	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	460.0	524.0	574.0	566.0	704.0	814.0
10	392.0	448.0	482.0	552.0	600.0	626.0
20	334.0	360.0	454.0	456.0	474.0	520.0
30	276.0	312.0	388.0	402.0	424.0	448.0
40	262.0	294.0	350.0	358.0	374.0	402.0
50	224.0	278.0	332.0	340.0	358.0	374.0
60	196.0	270.0	296.0	302.0	326.0	326.0
70	188.0	252.0	274.0	280.0	300.0	310.0
80	194.0	256.0	252.0	264.0	280.0	298.0
90	198.0	258.0	248.0	256.0	274.0	274.0

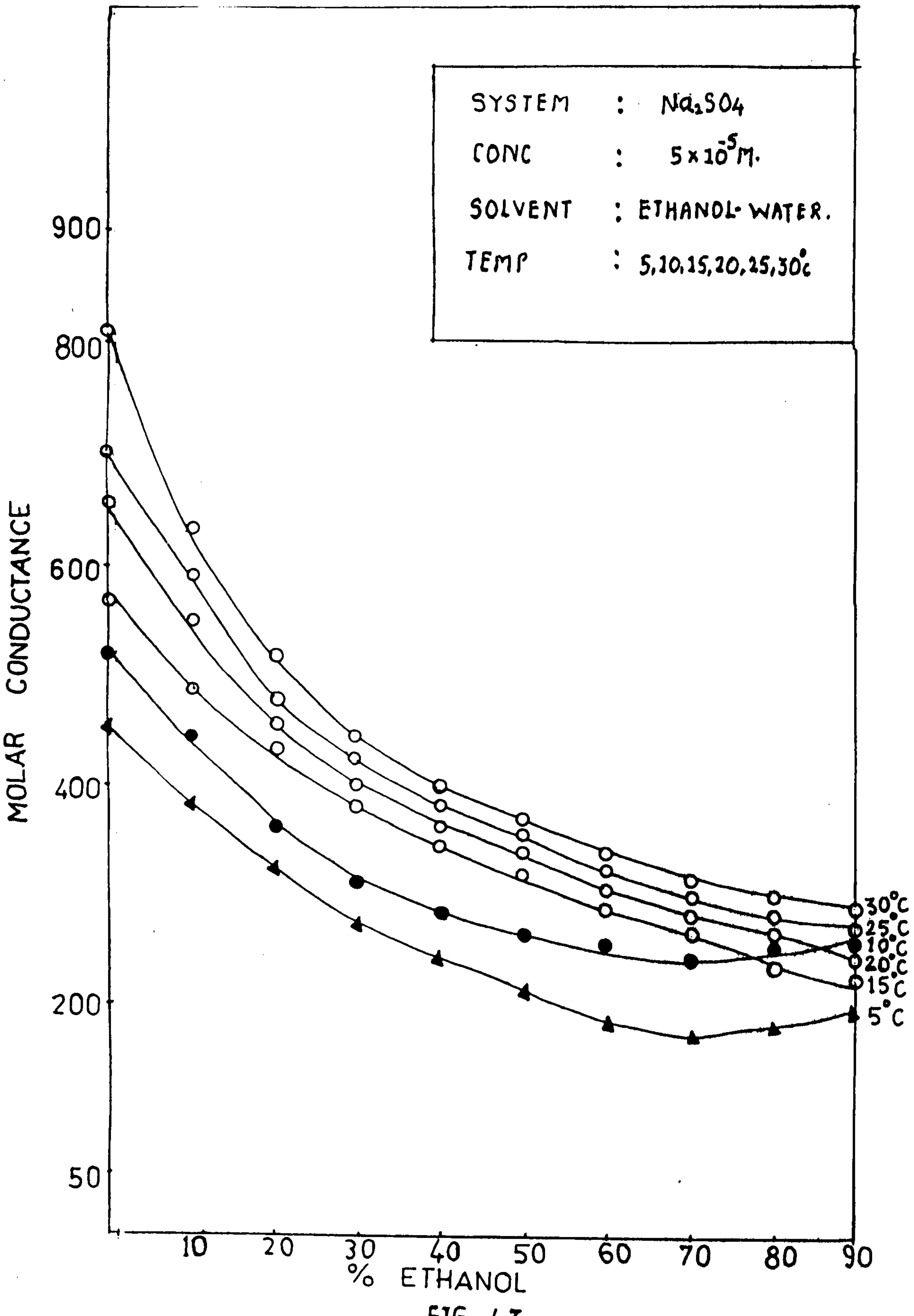

SYSTEM : Na_2SO_4
CONC : 5×10^{-5} M.
SOLVENT : ETHANOL-WATER.
TEMP : 5,10,15,20,25,30°c
MOLAR CONDUCTANCE
900
800
600
400
200
50
10
20
30
40
50
60
70
80
90
% ETHANOL
30°C
25°C
10°C
20°C
15°C
5°C

FIG - 4.3

System	: Na_2SO_4
Concentration	: $1x10^{-5}M$
Solvent	: Ethanol-water
Temperature	: 5, 10, 15, 20, 25 & 30°C

TABLE 4.4

% Ethanol	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	582.0	677.0	817.0	881.0	954.0	1003.0
10	475.0	525.0	650.0	729.0	775.0	850.0
20	413.0	445.0	547.0	560.0	589.0	642.0
30	321.0	369.0	451.0	478.0	492.0	562.0
40	308.0	353.0	402.0	429.0	436.0	490.0
50	262.0	300.0	364.0	375.0	428.0	459.0
60	203.0	275.0	325.0	350.0	376.0	407.0
70	192.0	250.0	300.0	318.0	348.0	382.0
80	168.0	259.0	282.0	300.0	337.0	369.0
90	189.0	292.0	275.0	298.0	325.0	345.0

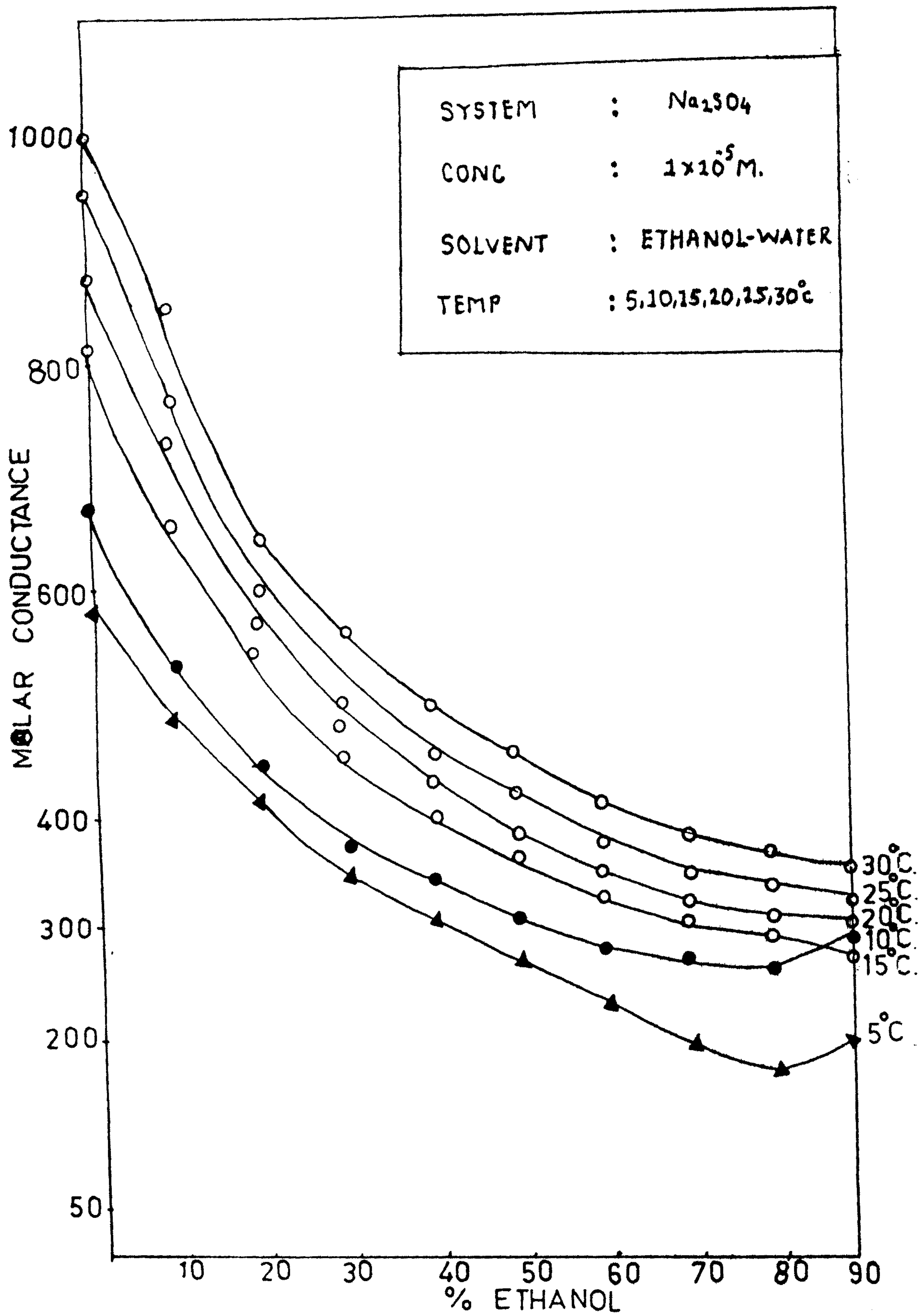
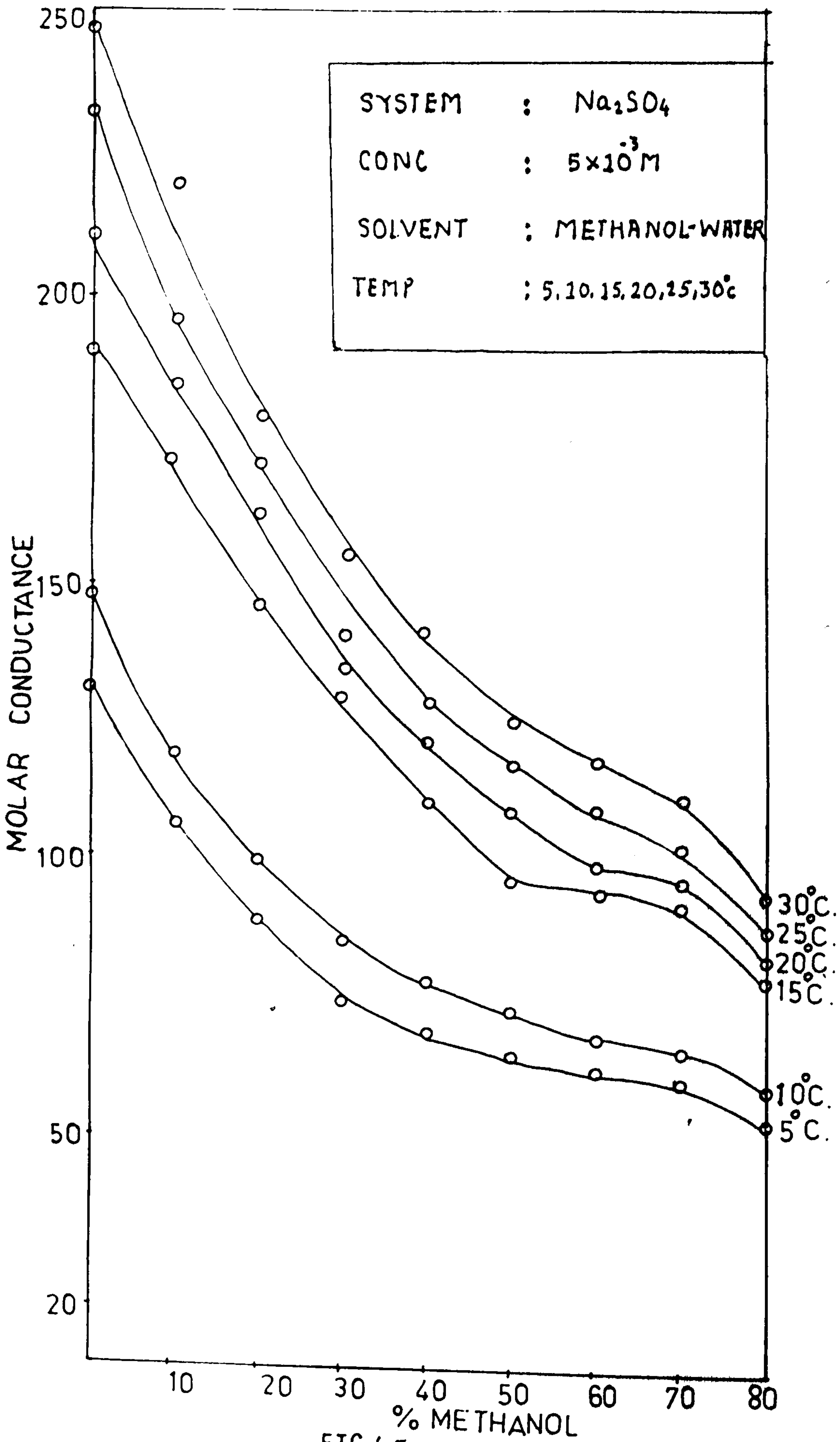

SYSTEM : Na_2SO_4
CONC : 1×10^{-5}M.
SOLVENT : ETHANOL-WATER
TEMP : 5,10,15,20,25,30°c
MOLAR CONDUCTANCE
1000
800
600
400
300
200
50
10
20
30
40
50
60
70
80
90
% ETHANOL
30°C.
25°C.
20°C.
10°C.
15°C.
5°C

FIG-4.4

System	:	Na_2SO_4
Concentration	:	$5x10^{-3}M$
Solvent	:	Methanol-water
Temperature	:	5, 10, 15, 20, 25 & 30°C

TABLE 4.5

% Methanol	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	131.4	149.0	189.6	210.0	232.2	249.6
10	105.6	119.2	171.4	183.6	194.6	220.4
20	88.4	100.0	144.6	161.0	170.0	176.2
30	74.0	85.0	130.0	134.2	138.4	154.0
40	70.2	78.4	112.2	121.0	127.8	141.6
50	64.8	74.4	96.4	108.2	117.0	124.0
60	61.6	67.8	94.0	99.0	109.2	117.0
70	60.4	66.0	92.0	94.4	102.0	110.6
80	52.4	58.4	78.4	79.6	86.0	94.0
90						



SYSTEM : Na_2SO_4
CONC : 5×10^{-3} M
SOLVENT : METHANOL-WATER
TEMP ; 5, 10, 15, 20, 25, 30°C
MOLAR CONDUCTANCE
250
200
150
100
50
20
10
20
30
40
50
60
70
80
% METHANOL
30°C.
25°C.
20°C.
15°C.
10°C.
5°C.

FIG-4.5

System : Na_2SO_4

Concentration : 1×10^{-3} M

Solvent : Methanol-water

Temperature : 5, 10, 15, 20, 25 & 30 °C

TABLE 4.6

% Methanol	MOLAR CONDUCTANCE					
	5 °C	10 °C	15 °C	20 °C	25 °C	30 °C
00	178.0	199.0	223.0	227.0	252.0	296.0
10	139.0	162.0	206.0	210.0	220.0	254.0
20	124.0	136.0	176.0	185.0	189.0	218.0
30	107.0	117.0	153.0	156.0	165.0	190.0
40	101.0	105.0	141.0	146.0	155.0	174.0
50	96.0	99.0	133.0	135.0	139.0	161.0
60	92.0	97.0	125.0	127.0	133.0	152.0
70	90.0	96.0	122.0	125.0	129.0	149.0
80	89.0	95.0	117.0	120.0	124.0	144.0
90	102.0	108.0	124.0	128.0	132.0	147.0

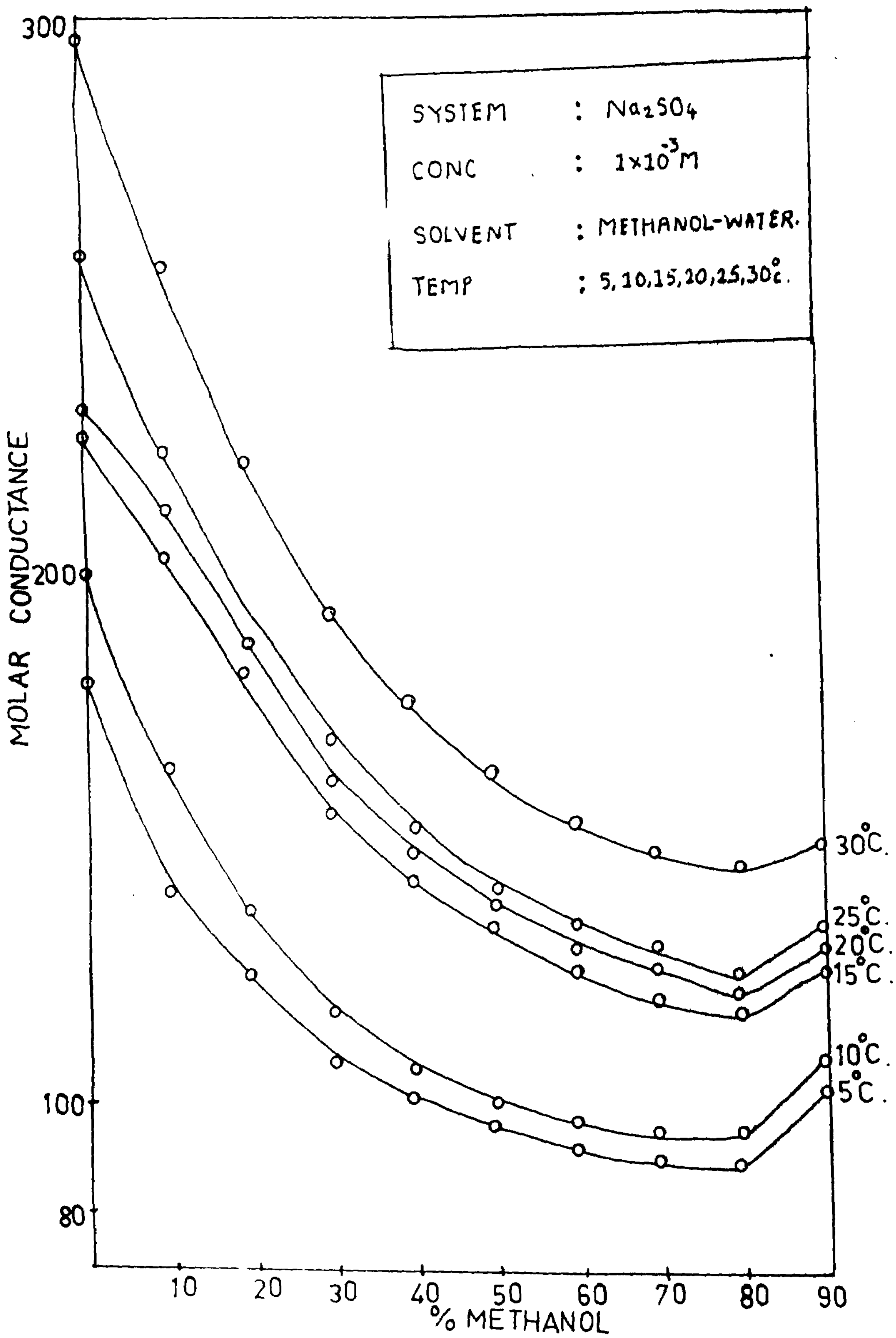

SYSTEM : Na_2SO_4
CONC : 1×10^{-3} M
SOLVENT : METHANOL-WATER.
TEMP : 5, 10, 15, 20, 25, 30°C.
MOLAR CONDUCTANCE
300
200
100
80
10
20
30
40
50
60
70
80
90
% METHANOL
30°C.
25°C.
20°C.
15°C.
10°C.
5°C.

FIG-4.6

System	:	Na_2SO_4
Concentration	:	$5x10^{-4}M$
Solvent	:	Methanol-water
Temperature	:	5, 10, 15, 20, 25 & 30 °C

TABLE 4.7

% Methanol	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	206.0	216.0	230.0	252.0	260.0	270.0
10	190.0	194.0	212.0	230.0	236.0	266.0
20	176.0	178.0	204.0	210.0	220.0	260.0
30	156.0	158.0	172.0	194.0	198.0	212.0
40	134.0	142.0	158.0	174.0	182.0	198.0
50	122.0	126.0	144.0	162.0	172.0	182.0
60	118.0	122.0	134.0	152.0	164.0	174.0
70	118.0	120.0	126.0	144.0	162.0	172.0
80	120.0	124.0	136.0	148.0	164.0	168.0
90	130.0	138.0	150.0	156.0	166.0	172.0

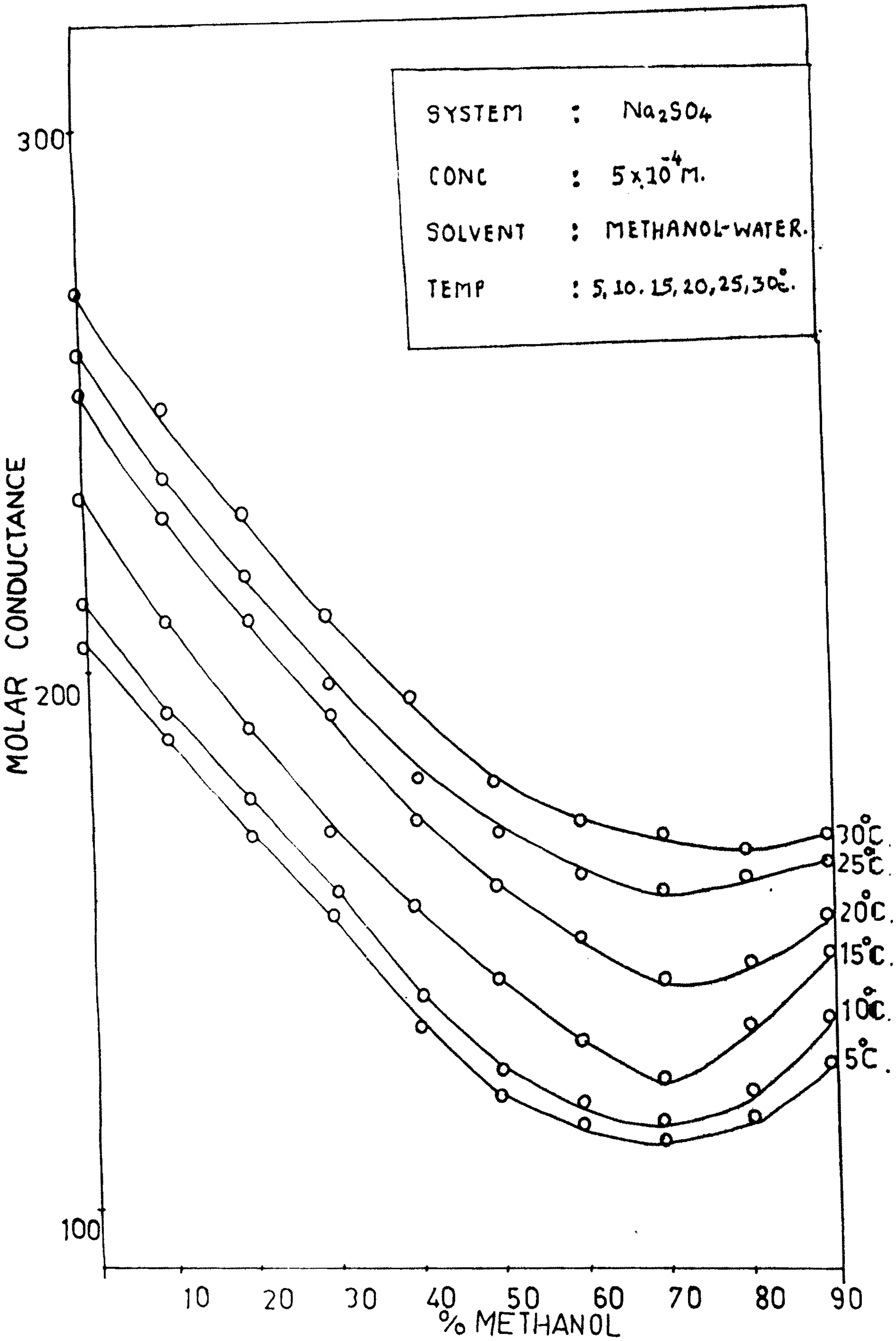

SYSTEM : Na_2SO_4
CONC : 5×10^{-4} M.
SOLVENT : METHANOL-WATER.
TEMP : 5, 10, 15, 20, 25, 30°C.
300
200
100
MOLAR CONDUCTANCE
10
20
30
40
50
60
70
80
90
% METHANOL
30°C.
25°C.
20°C.
15°C.
10°C.
5°C.

FIG -4·7

System	:	Na_2SO_4
Concentration	:	$1x10^{-3}M$
Solvent	:	Acetone-water
Temperature	:	5, 10, 15, 20, 25 & 30°C

TABLE 4.8

% Acetone	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	199.0	219.0	234.0	239.0	250.0	299.0
10	182.0	204.0	214.0	220.0	229.0	256.0
20	168.0	181.0	194.0	199.0	204.0	220.0
30	143.0	159.0	177.0	181.0	184.0	194.0
40	127.0	140.0	152.0	161.0	166.0	175.0
50	110.0	129.0	142.0	143.0	150.0	160.0
60	98.0	114.0	127.0	130.0	135.0	194.0
70	96.0	105.0	111.0	128.0	132.0	151.0
80	90.0	92.0	105.0	110.0	115.0	121.0
90						

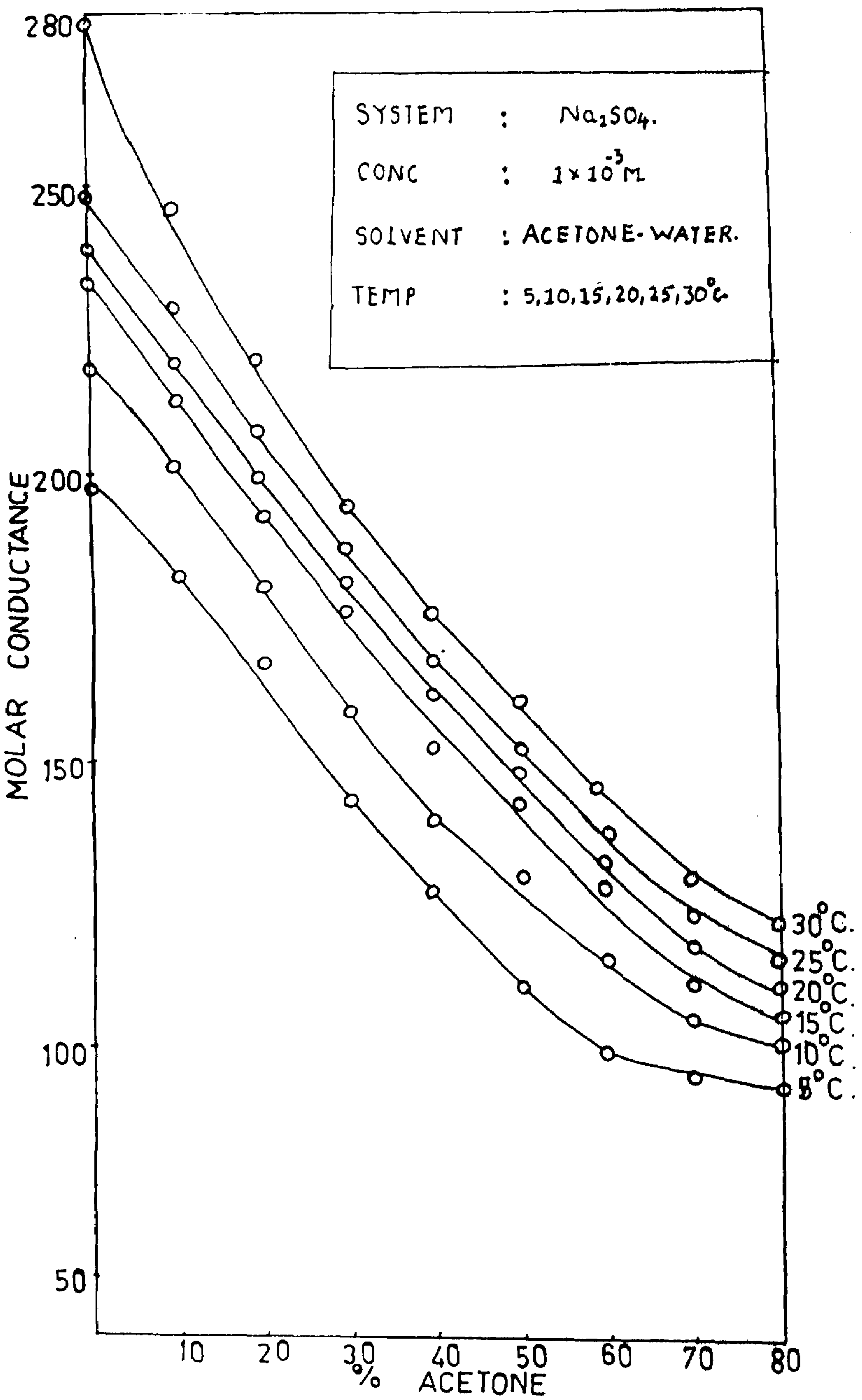
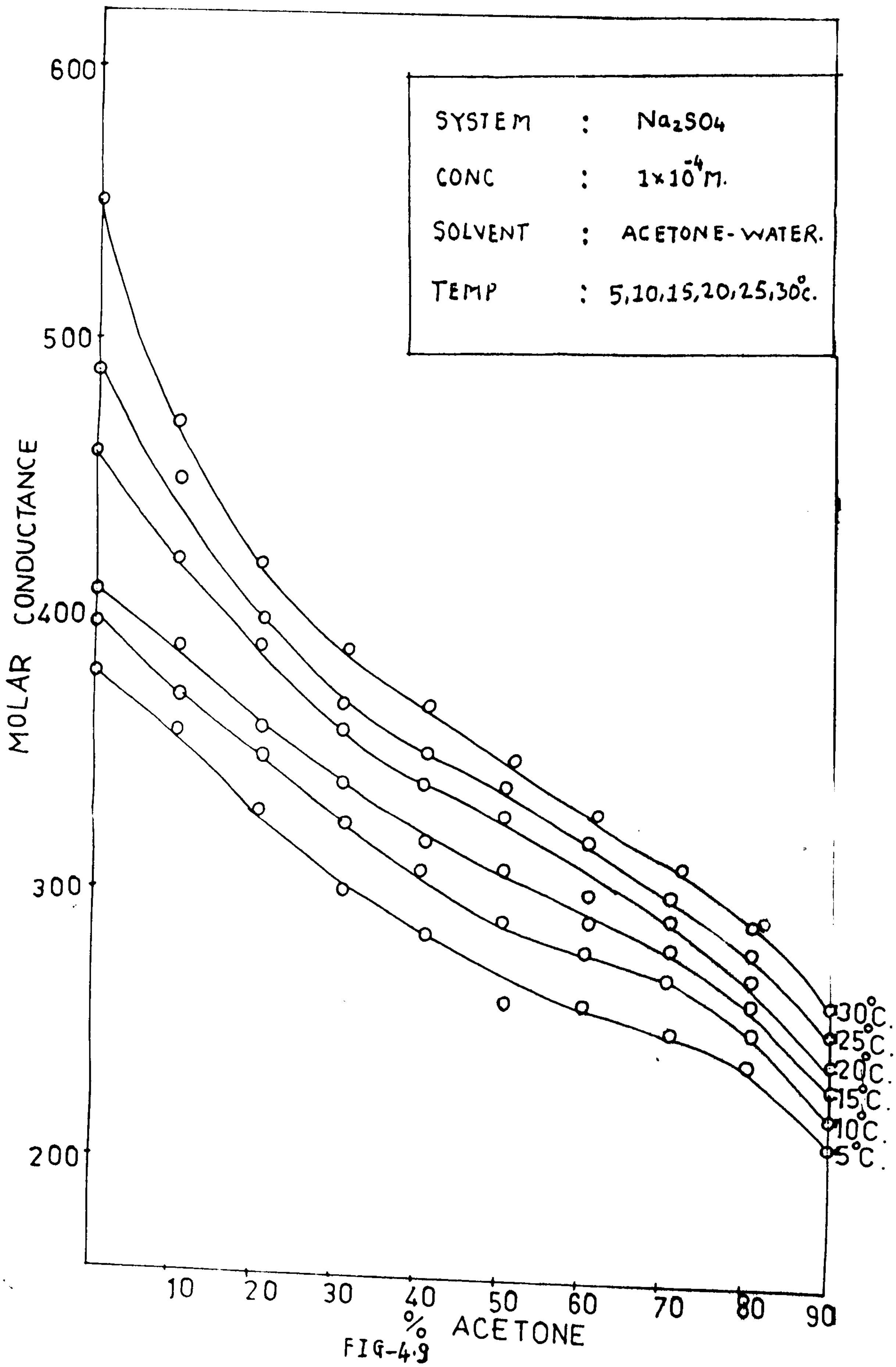

SYSTEM : Na_2SO_4.
CONC : 1×10^{-3} M.
SOLVENT : ACETONE-WATER.
TEMP : 5,10,15,20,25,30°C.
MOLAR CONDUCTANCE
280
250
200
150
100
50
10
20
30
40
50
60
70
80
% ACETONE
30°C.
25°C.
20°C.
15°C.
10°C.
5°C.

FIG-4·8

System	: Na_2SO_4
Concentration	: $1x10^{-4}M$
Solvent	: Acetone-water
Temperature	: 5, 10, 15, 20, 25 & 30°C

TABLE 4.9

% Acetone	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	380.0	400.0	410.0	460.0	490.0	550.0
10	360.0	370.0	390.0	420.0	450.0	470.0
20	330.0	350.0	360.0	390.0	400.0	420.0
30	300.0	320.0	340.0	360.0	370.0	390.0
40	280.0	310.0	320.0	340.0	350.0	370.0
50	260.0	290.0	310.0	330.0	340.0	350.0
60	260.0	280.0	290.0	300.0	320.0	340.0
70	250.0	270.0	280.0	290.0	300.0	330.0
80	240.0	250.0	260.0	270.0	280.0	270.0
90	210.0	220.0	230.0	240.0	250.0	260.0



SYSTEM : Na_2SO_4
CONC : 1×10^{-4} M.
SOLVENT : ACETONE-WATER.
TEMP : 5,10,15,20,25,30°C.
600
500
400
300
200
MOLAR CONDUCTANCE
10
20
30
40
50
60
70
80
90
% ACETONE
30°C.
25°C.
20°C.
15°C.
10°C.
5°C.

FIG-4.9

System	: Na_2SO_4
Concentration	: $5x10^{-5}M$
Solvent	: Acetone-water
Temperature	: 5, 10, 15, 20, 25 & 30°C

TABLE 4.10

% Acetone	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	492.0	548.0	562.0	638.0	654.0	724.0
10	424.0	476.0	526.0	574.0	586.0	662.0
20	368.0	408.0	476.0	522.0	562.0	618.0
30	292.0	376.0	420.0	464.0	514.0	548.0
40	286.0	330.0	356.0	412.0	452.0	516.0
50	250.0	300.0	322.0	402.0	412.0	476.0
60	214.0	294.0	308.0	364.0	384.0	422.0
70	208.0	282,0	286.0	344.0	362.0	386.0
80	204.0	270.0	272.0	308.0	346.0	376.0
90	210.0	276.0	262.0	300.0	310.0	350.0

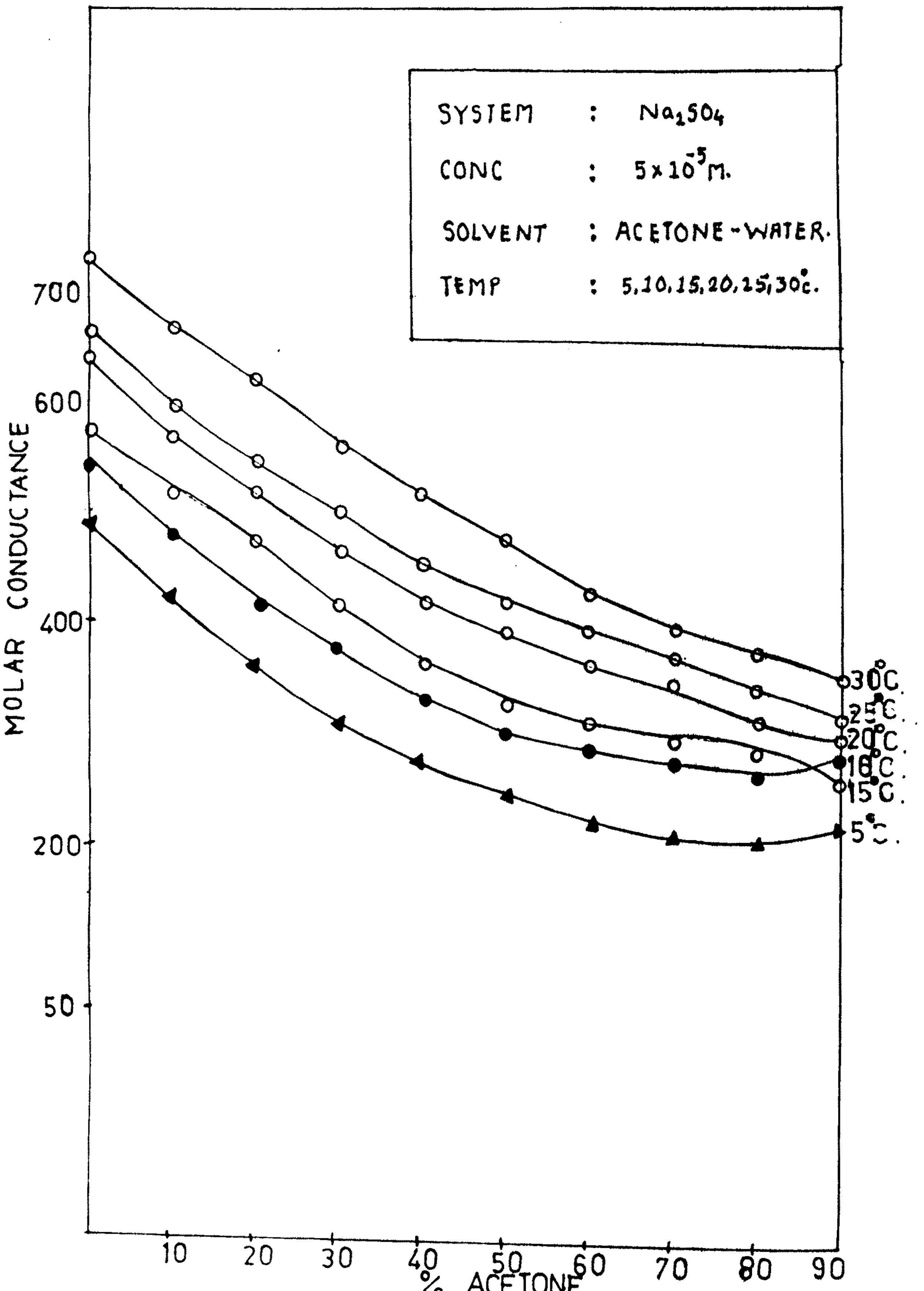

SYSTEM : Na_2SO_4
CONC : 5×10^{-5} M.
SOLVENT : ACETONE-WATER.
TEMP : 5,10,15,20,25,30°C.
MOLAR CONDUCTANCE
700
600
400
200
50
10
20
30
40
50
60
70
80
90
30°C.
25°C.
20°C.
10°C.
15°C.
5°C.
% ACETONE

FIG-4.10

System	: Na_2SO_4
Concentration	: $1x10^{-5}$M
Solvent	: Acetone-water
Temperature	: 5, 10, 15, 20, 25 & 30°C

TABLE 4.11

% Acetone	MOLAR CONDUCTANCE					
	5°C	10°C	15°C	20°C	25°C	30°C
00	617.0	680.0	717.0	825.0	848.0	912.0
10	483.0	600.0	628.0	748.0	786.0	841.0
20	404.0	500.0	572.0	719.0	700.0	822.0
30	315.0	420.0	491.0	560.0	675.0	810.0
40	276.0	343.0	382.0	500.0	540.0	717.0
50	252.0	323.0	350.0	452.0	492.0	650.0
60	221.0	317.0	316.0	418.0	449.0	612.0
70	212.0	307.0	300.0	375.0	400.0	593.0
80	223.0	287.0	276.0	342.0	379.0	500.0
90	255.0	316.0	300.0	325.0	350.0	512.0

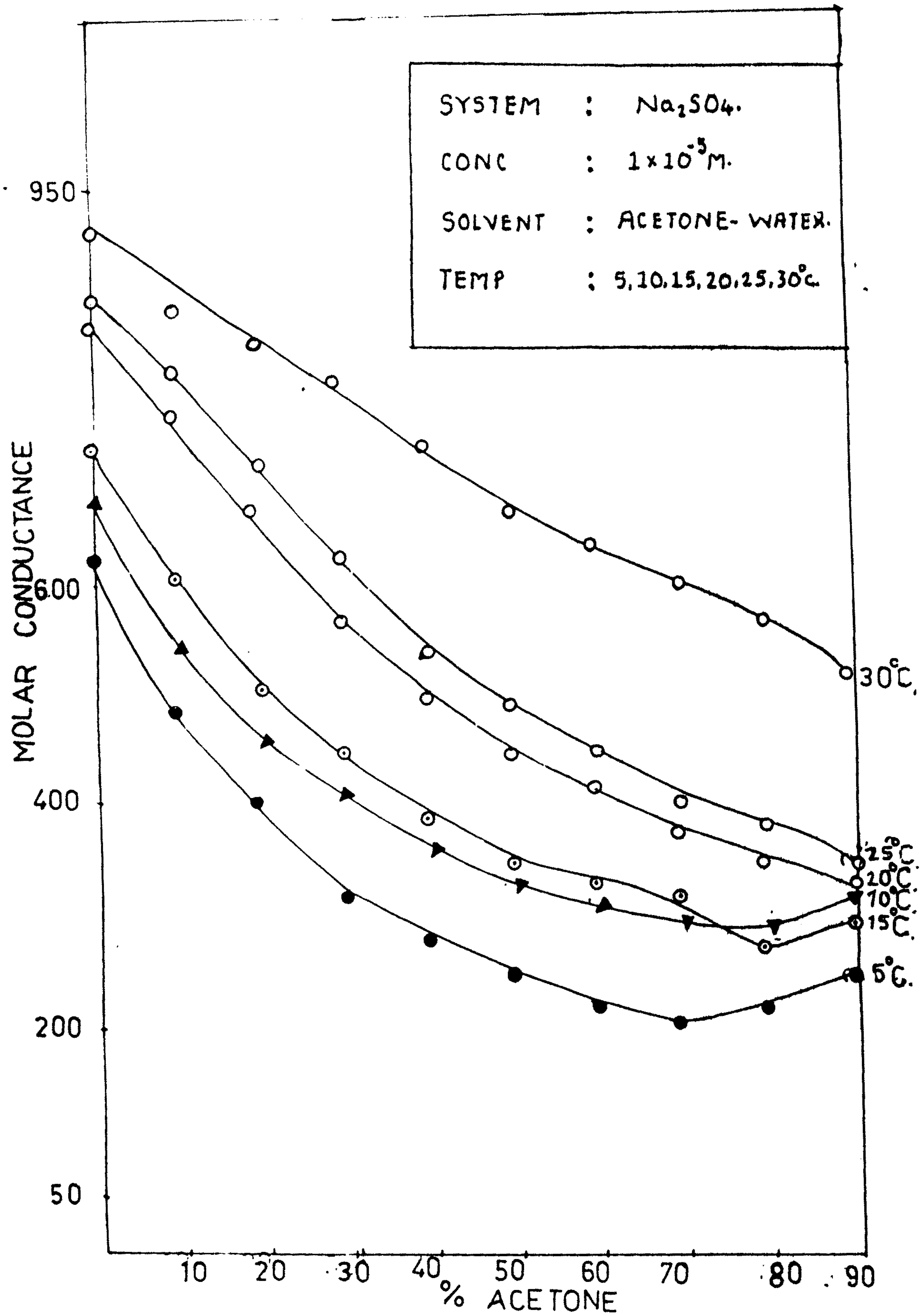

SYSTEM : Na_2SO_4.
CONC : 1×10^{-5}M.
SOLVENT : ACETONE- WATER.
TEMP : 5,10,15,20,25,30°C.
MOLAR CONDUCTANCE
950
600
400
200
50
30°C.
25°C.
20°C.
10°C.
15°C.
5°C.
10
20
30
40
50
60
70
80
90
% ACETONE

FIG-4·11

DISCUSSION

It is observed that the molar conductance of sodium sulphate decreases continuously for the concentrations of 1×10^{-3}M and 1×10^{-4}M in ethanol mixed solvents for the temperature 5, 10, 15, 20, 25 and 30°c. It has further been found that for both the above concentrations molar conductance decreases suddenly beyond 80%.

A minima is obtained at 70% ethanol in ethanol mixed solvents at 5 and 10°c only for the concentrations 5×10^{-5}M and 80% ethanol for m 1×10^{-5}M while there is no minima for 15, 20, 25 and 30°c for the above concentrations.

Similarly the molar conductance of sodium sulphate decreases continuously for the concentration of 5×10^{-3}M at all the temperature studied.

A minima is obtained at 80% methanol for the concentration 1×10^{-3}M and 70% methanol for the concentration 5×10^{-4}M in methanol mixed solvents for the temperatures at 5, 10, 15, 20, 25 and 30°c.

The standard value of molar conductance of sodium sulphate in aqueous solution at 25°c and at a concentration of 5×10^{-3}M available in the literature is 234.54 (cf : reference 46) while the value obtained in the present work is 233.20 for 0% methanol. The vabove value is in very closed agreement with the standard value.

Similarly for the concentrations of 1×10^{-3}M the standard value of molar conductance of sodium sulphate in aqueous solution at 25°c is 248.30 (cf : reference 29) while the values obtained in the present work is 254.00 for 0% ethanol, 252.0 for 0% methanol, 250.5 for 0% acetone.

Similarly for the concentrations of $5x10^{-3}M$ the standard value is 234.30 while the value obtained in the present work is 232.2 for 0% methanol (cf : reference 29).

For acetone-water system the molar conductance decreases abruptly for the concentrations $1 \times 10^{-3}M$ and $1 \times 10^{-4}M$ and for all the temperatures studied.

While a minima is obtained at 80% acetone for the concentration $5 \times 10^{-5}M$ and at 70% acetone for the concentration $1 \times 10^{-5}m$ and for the temperatures 5 and $10^{o}c$ only.

Minimum in conductivity at 5 and $10^{o}c$ indicates that sodium sulphate is structure breaking.

Structure of water is broken when organic solvent like ethanol is added to it and simultaneously new hydrogen bonds are established in order to form water ethanol clusters and this clustering effect may be maximum at 70 or 80 percent of ethanol in ethanol-water mixture in presence of sodium sulphate.

This clustering effect may be maximum at 70 or 80 percent of methanol in methanol mixed solvents and at same percent for acetone mixed solvents.

It has been found that variation in molar conductance with the concentration of electrolyte for various compositions of solvents has same nature.

It has also been observed that the molar conductance of sodium sulphate in mixed organic solvents obey the following order :

acetone-water $>$ methanol-water $>$ ethanol-water

upto 70% of non-aqueous solvent. Beyond 70% the order changes as :

methanol-water $>$ acetone-water $>$ ethanol-water

To study the effect of temperature, the system has been carried out at 5, 10, 15, 20, 25 and 30°c. It is seen that the molar conductance changes linearly with temperature. This is well illustrated by summary graphs.

Comparison of molar Conductances of sodium sulphate in mixed solvents at $5^{o}C$ and at $1x10^{-3}M$ concentration

TABLE 4.12

% Non aqueous solvent	$1x10^{-3}M$		
	Ethanol-water	Methanol-water	Acetone-water
00	156.0	178.0	199.0
10	103.0	139.0	182.0
20	72.0	124.0	168.0
30	50.0	107.0	143.0
40	37.0	101.0	127.0
50	25.0	96.0	110.0
60	21.0	92.0	98.0
70	17.0	90.0	96.0
80	14.0	89.0	90.0
90	-	102.0	-

Comparison of molar Conductances of **sodium sulphate** in mixed solvents at $10^{o}C$ and at $1x10^{-3}M$ concentration

TABLE 4.13

% Non aqueous solvent	$1x10^{-3}M$		
	Ethanol-water	Methanol-water	Acetone-water
00	185.0	199.0	219.0
10	143.0	162,0	204.0
20	116.0	136.0	181.0
30	87.0	117.0	159.0
40	74.0	105.0	140.0
50	65.0	99.0	129.0
60	60.0	97.0	114.0
70	54.0	96.0	105.0
80	46.0	95.0	92.0
90	-	108.0	-

Comparison of molar Conductances of **sodium sulphate** in mixed solvents at $15^{o}C$ and at $1x10^{-3}M$ concentration.

TABLE 4.14

% Non aqueous solvent	$1x10^{-3}M$		
	Ethanol-water	Methanol-water	Acetone-water
00	215.0	223.0	234.0
10	186.0	206.0	214.0
20	140.0	176.0	194.0
30	101.0	153.0	177.0
40	90.0	141.0	152.0
50	77.0	133.0	142.0
60	71.0	125.0	127.0
70	63.0	122.0	111.0
80	51.0	117.0	105.0
90	-	124.0	-

Comparison of molar Conductances of **sodium sulphate** in mixed solvents at $20^{o}c$ and at $1x10^{-3}M$ concentration

TABLE 4.15

% Non aqueous solvent	$1x10^{-3}M$ Ethanol-water	Methanol-water	Acetone-water
00	225.0	227.0	239.0
10	201.0	210.0	220.0
20	164.0	185.0	199.0
30	132.0	156.0	181.0
40	113.0	146.0	161.0
50	101.0	135.0	143.0
60	88.0	127.0	130.0
70	76.0	125.0	128.0
80	60.0	120.0	110.0
90	-	128.0	-

Comparison of molar Conductances of sodium sulphate in mixed solvents at 25°c and at 1×10^{-3}M concentration

TABLE 4.16

% Non aqueous solvent	1×10^{-3}M		
	Ethanol-water	Methanol-water	Acetone-water
00	254.0	256.0	259.0
10	219.0	220.0	229.0
20	175.0	189.0	204.0
30	142.0	165.0	184.0
40	121.0	155.0	166.0
50	106.0	139.0	150.0
60	93.0	133.0	135.0
70	81.0	129.0	132.0
80	63.0	124.0	115.0
90	-	132.0	-

Comparison of molar Conductances of **sodium sulphate** in mixed

solvents at 30^{o}_{C} and at $1 \times 10^{-3}M$ concentration

TABLE 4.17

% Non aqueous solvent	Ethanol-water	Methanol-water	Acetone-water
00	295.0	296.0	299.0
10	240.0	254.0	256.0
20	190.0	218.0	220.0
30	154.0	190.0	194.0
40	136.0	174.0	175.0
50	119.0	161.0	162.0
60	105.0	152.0	154.0
70	91.0	149.0	151.0
80	72.0	144.0	121.0
90	-	147.0	-

SYSTEM: Na_2SO_4 (0·001M), SOLVENT: ETHANOL-WATER. [1×10^{-3} M]

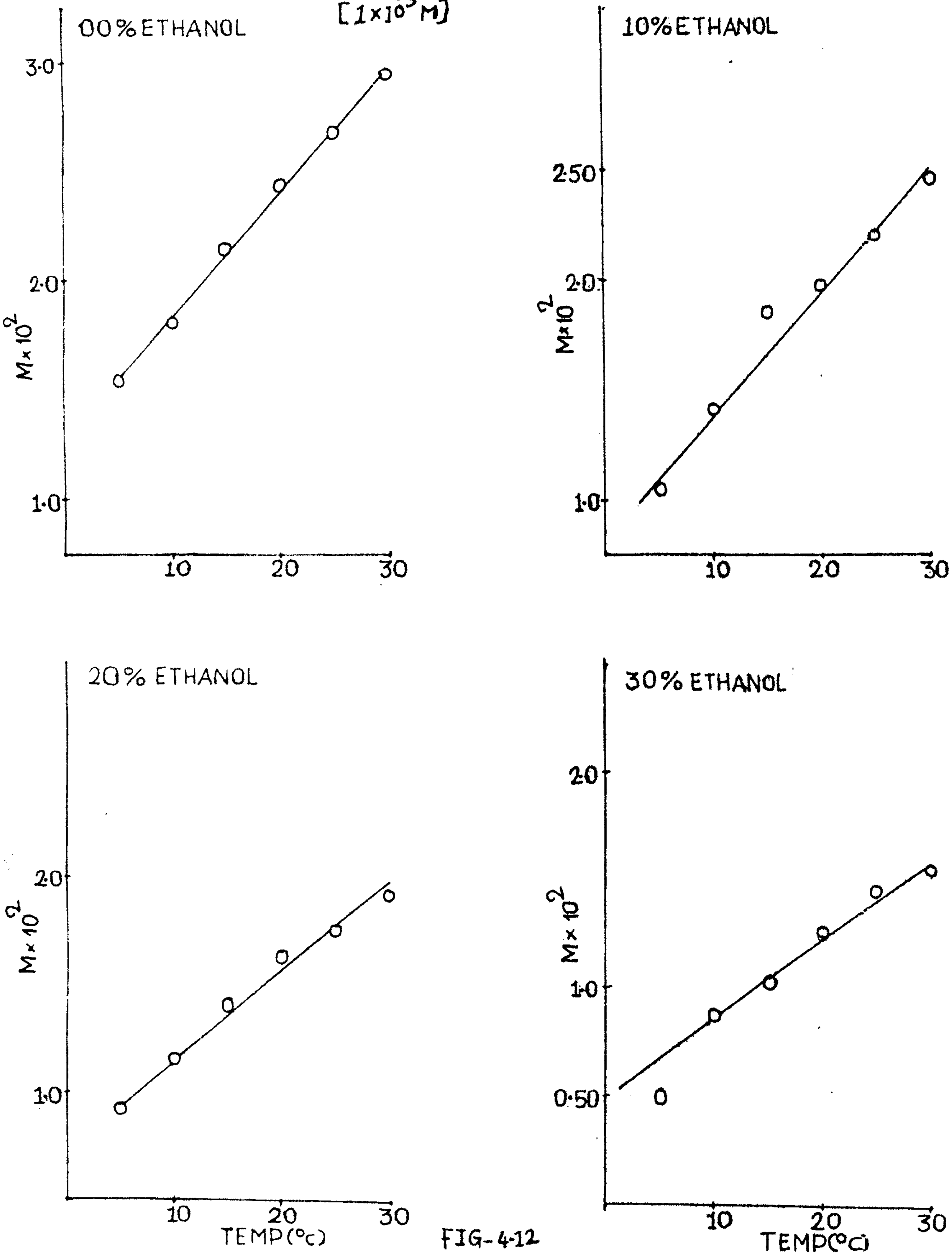


FIG-4-12

SYSTEM : Na_2SO_4 (0·001 M), SOLVENT: ETHANOL- WATER.

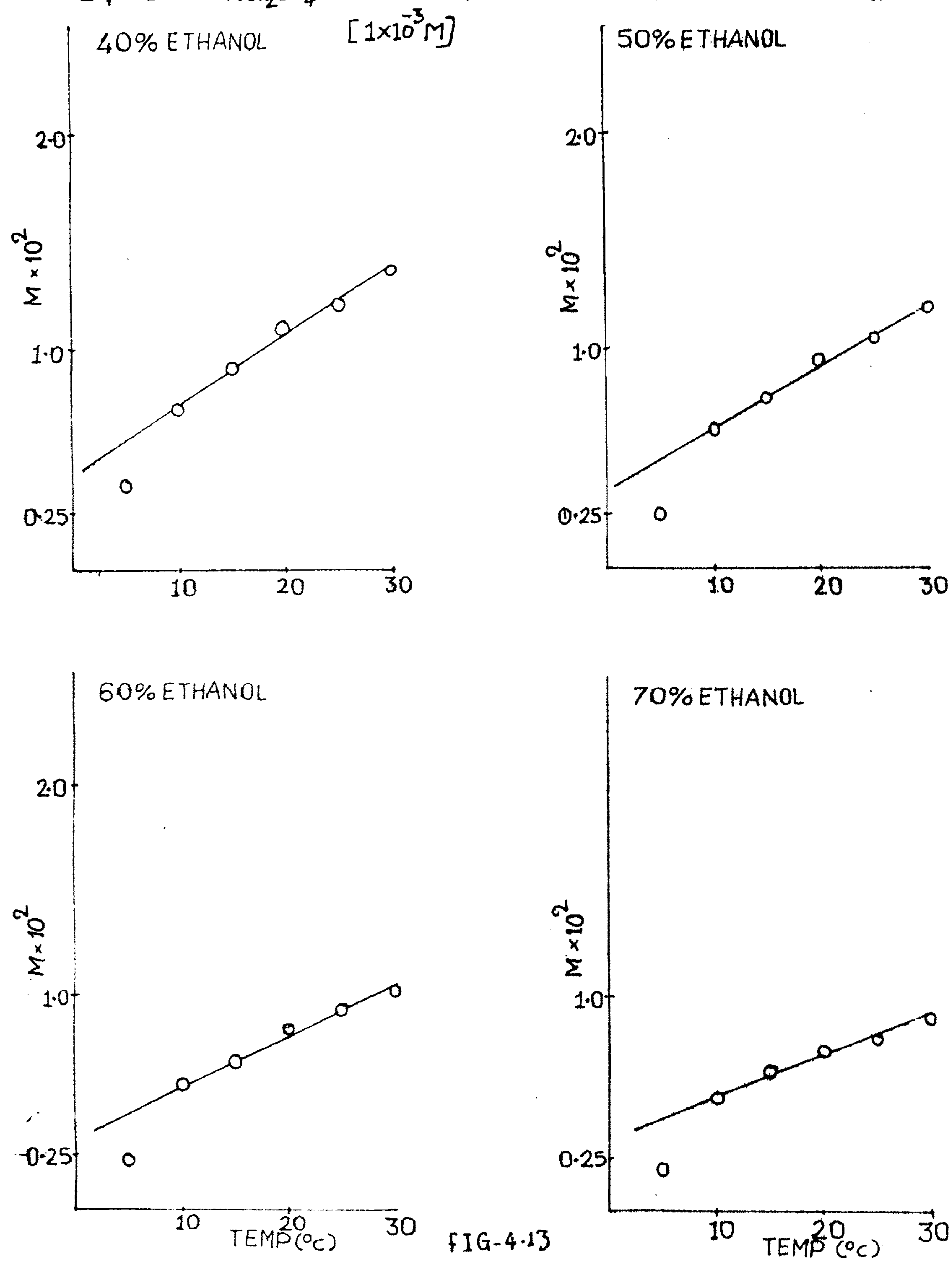


FIG-4.13

SYSTEM : NA_2SO_4 (0·001M), SOLVENT : ETHONOL- WATER.

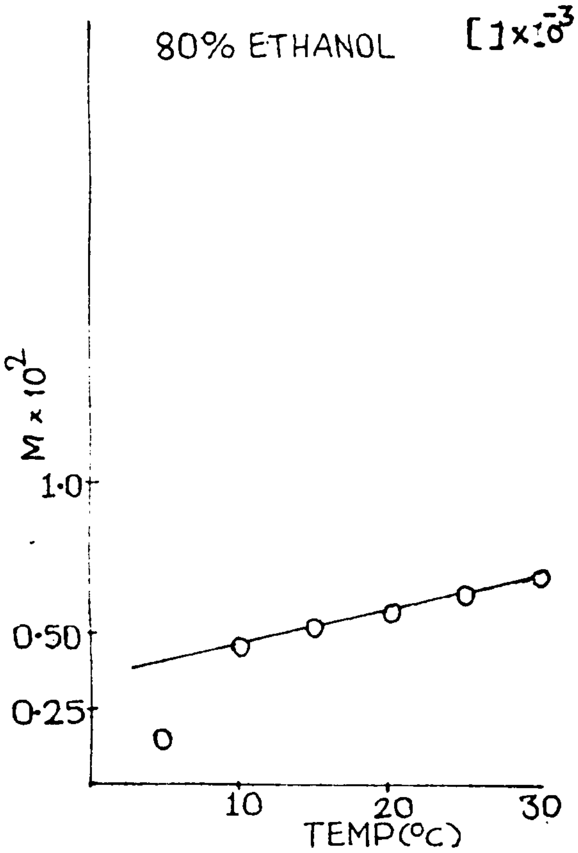


FIG-4·14

SYSTEM : Na_2SO_4 (0·0001M), SOLVENT: ETHANOL WATER.
[1×10^{-4}M]

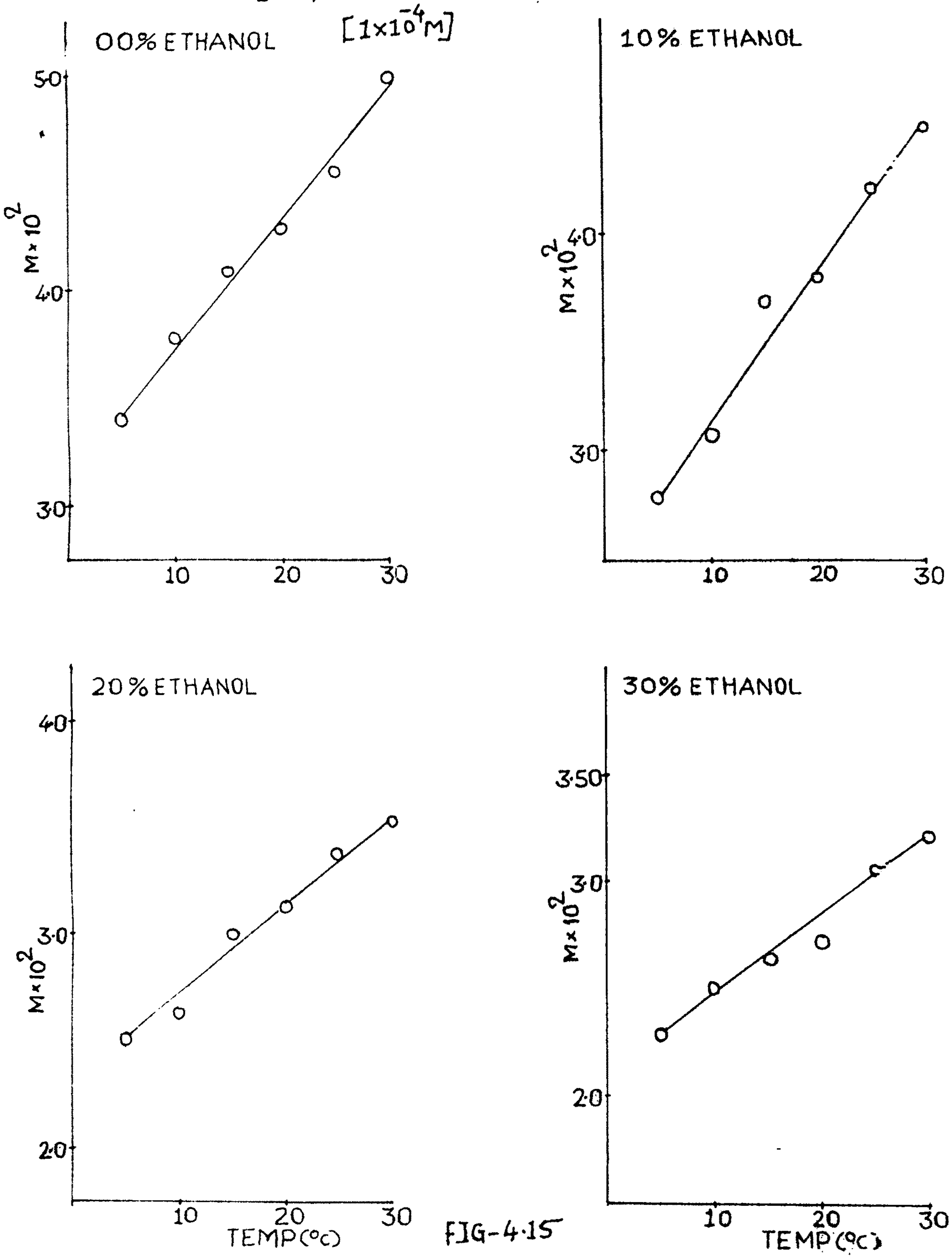


FIG-4.15

SYSTEM : NA_2SO4 (0·0001M), [1×10^{-4}M] SOLVENT: ETHANOL-WATER.

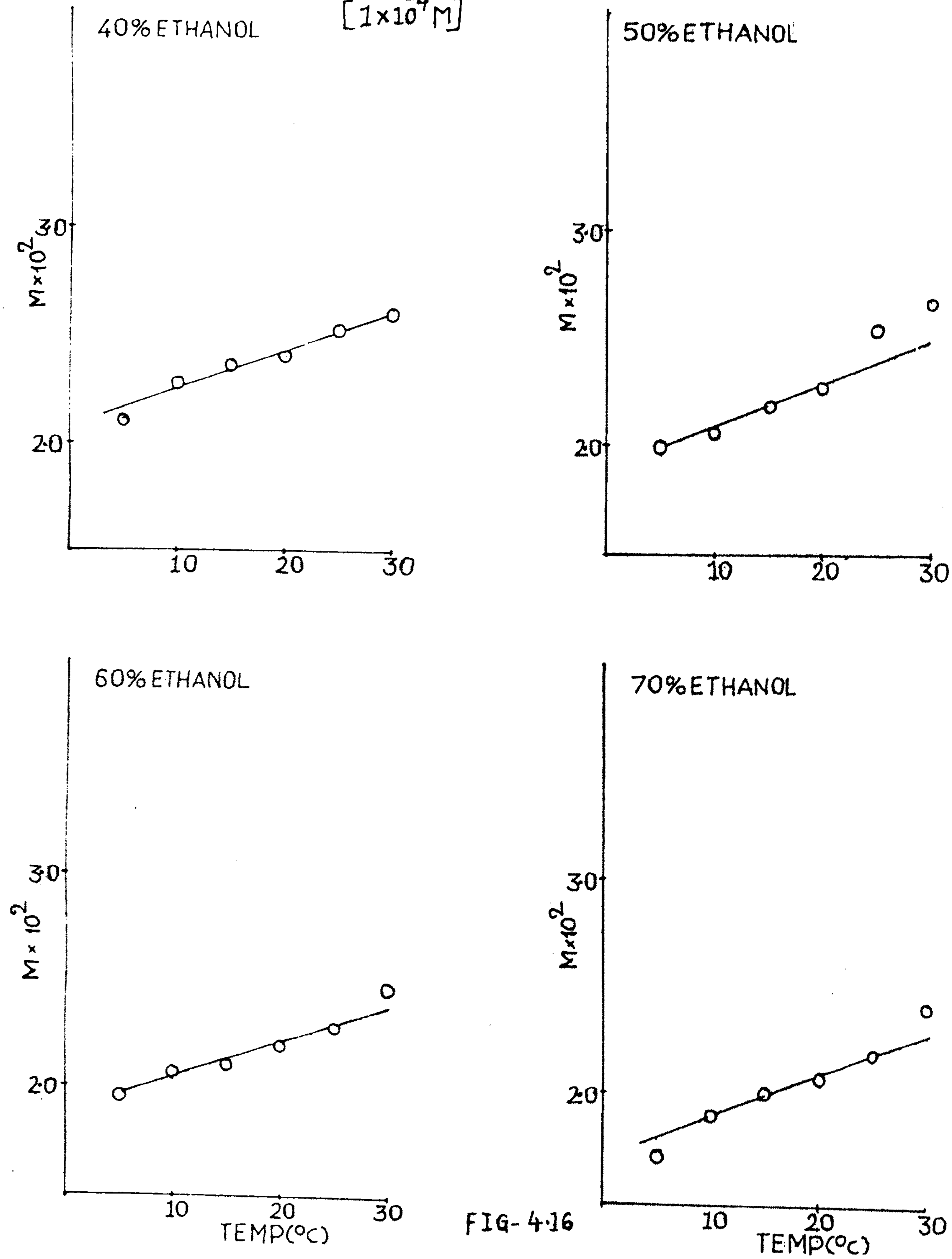


FIG-4·16

SYSTEM : Na_2SO_4 (0·0001M), [1×10^{-4} M]   SOLVENT: ETHANOL - WATER.

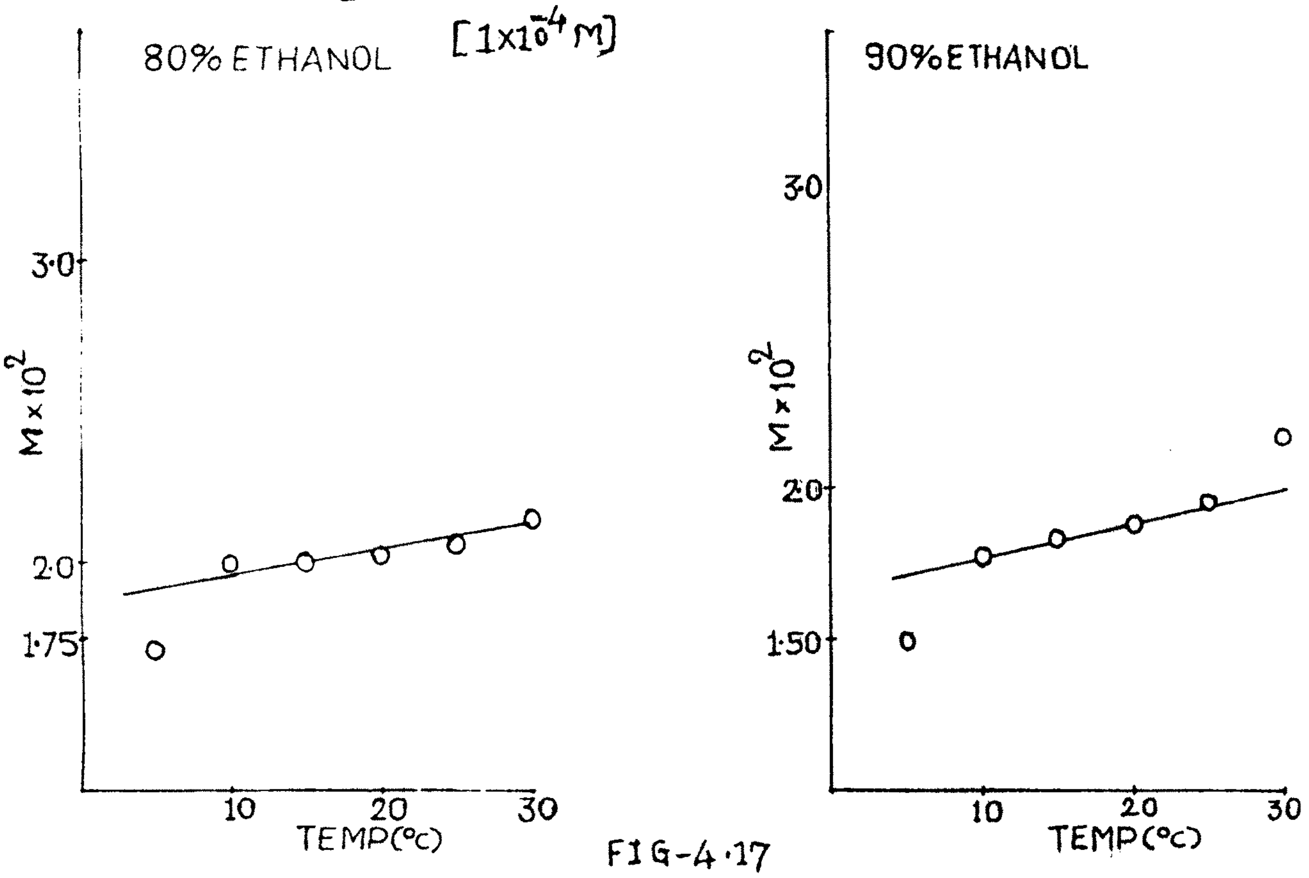


FIG-4·17

SYSTEM: NA_2SO_4 (0·00005M), SOLVENT: ETHANOL-WATER.

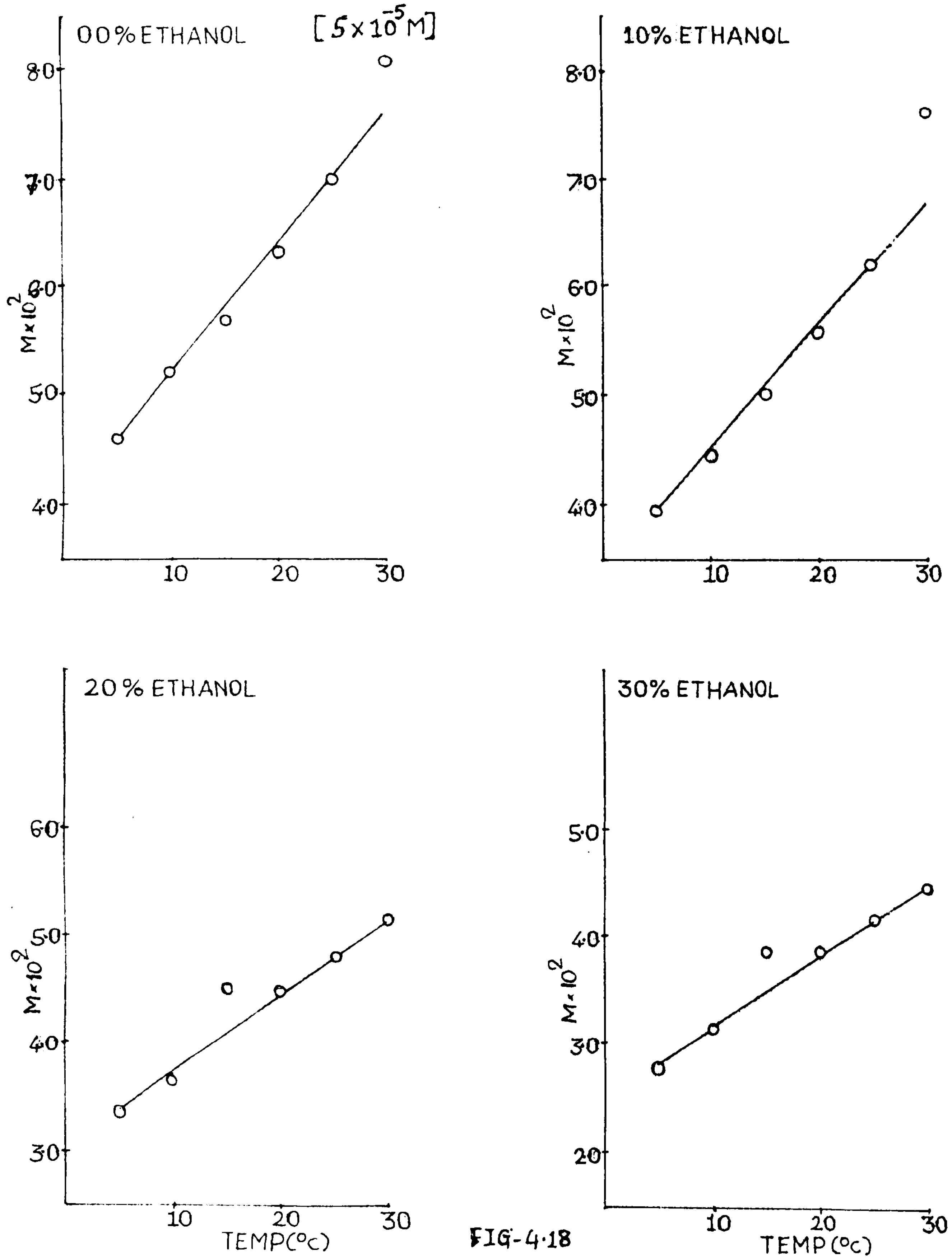


FIG-4·18

SYSTEM: Na_2SO_4 (0·00005M), SOLVENT: ETHANOL-WATER.

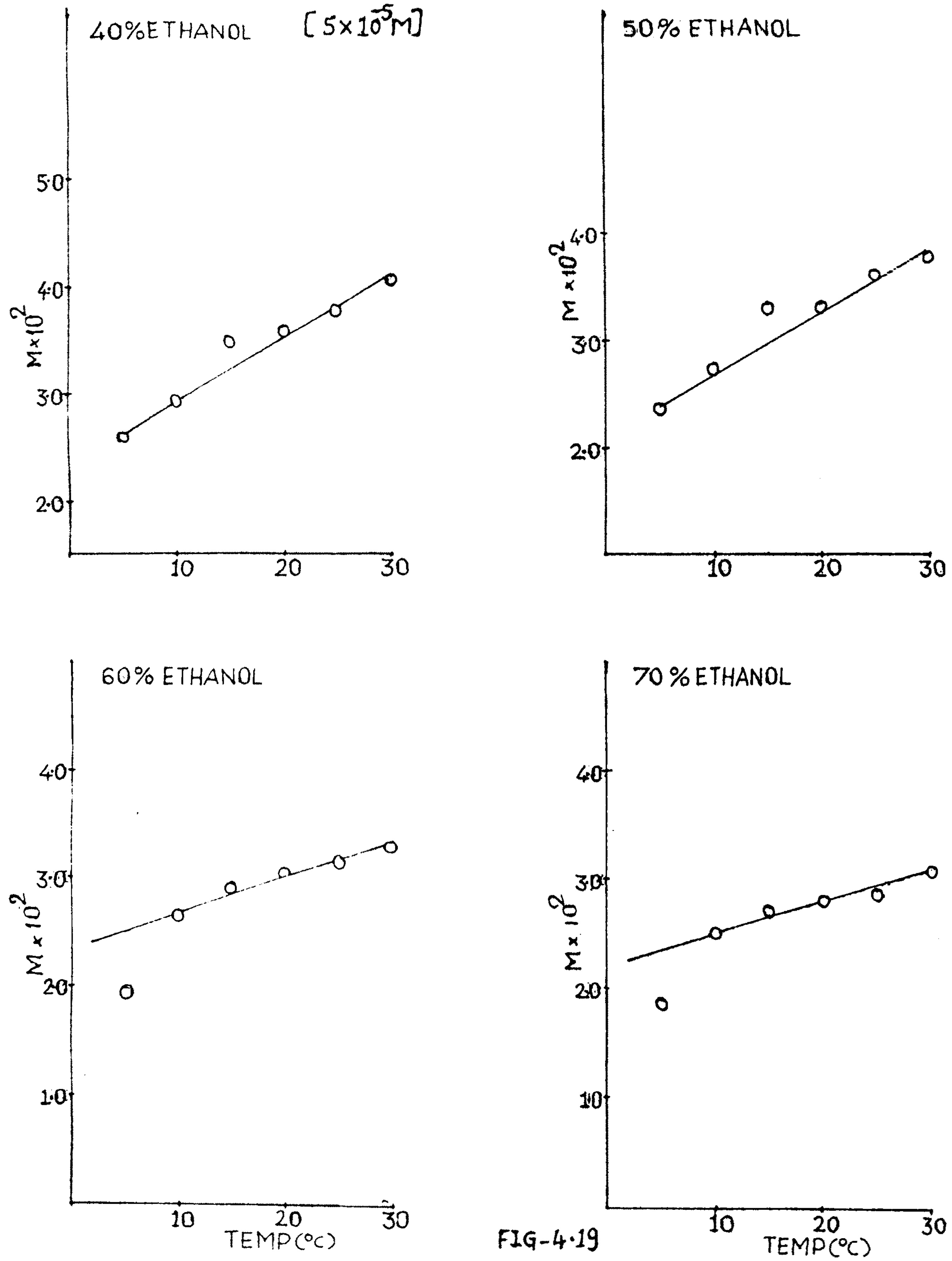


FIG-4·19

SYSTEM: Na_2SO_4 (0·00005M), SOLVENT: ETHANOL-WATER.

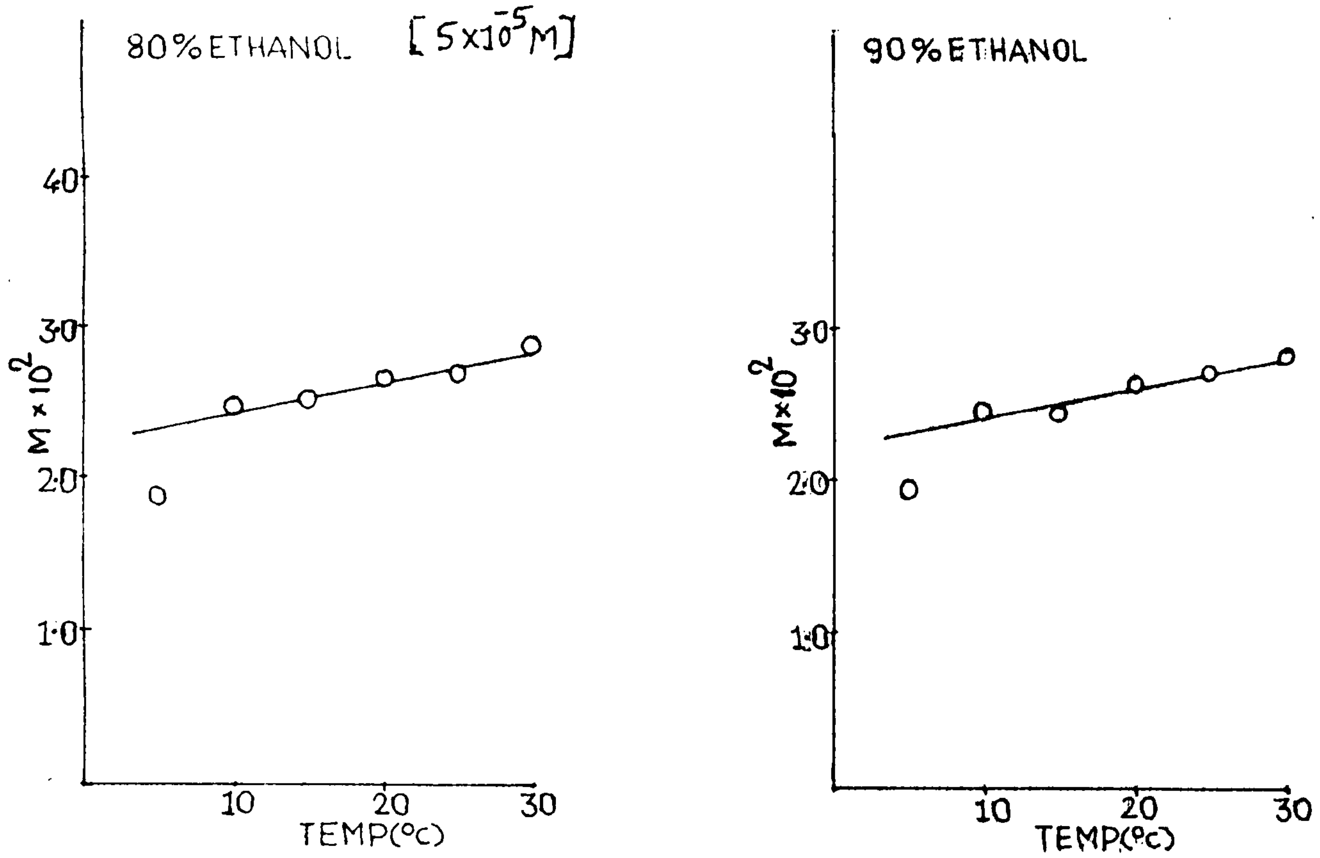


FIG-4.20

SYSTEM: Na_2SO_4 (0.00001M), [1×10^{-5}M] SOLVENT: ETHANOL-WATER

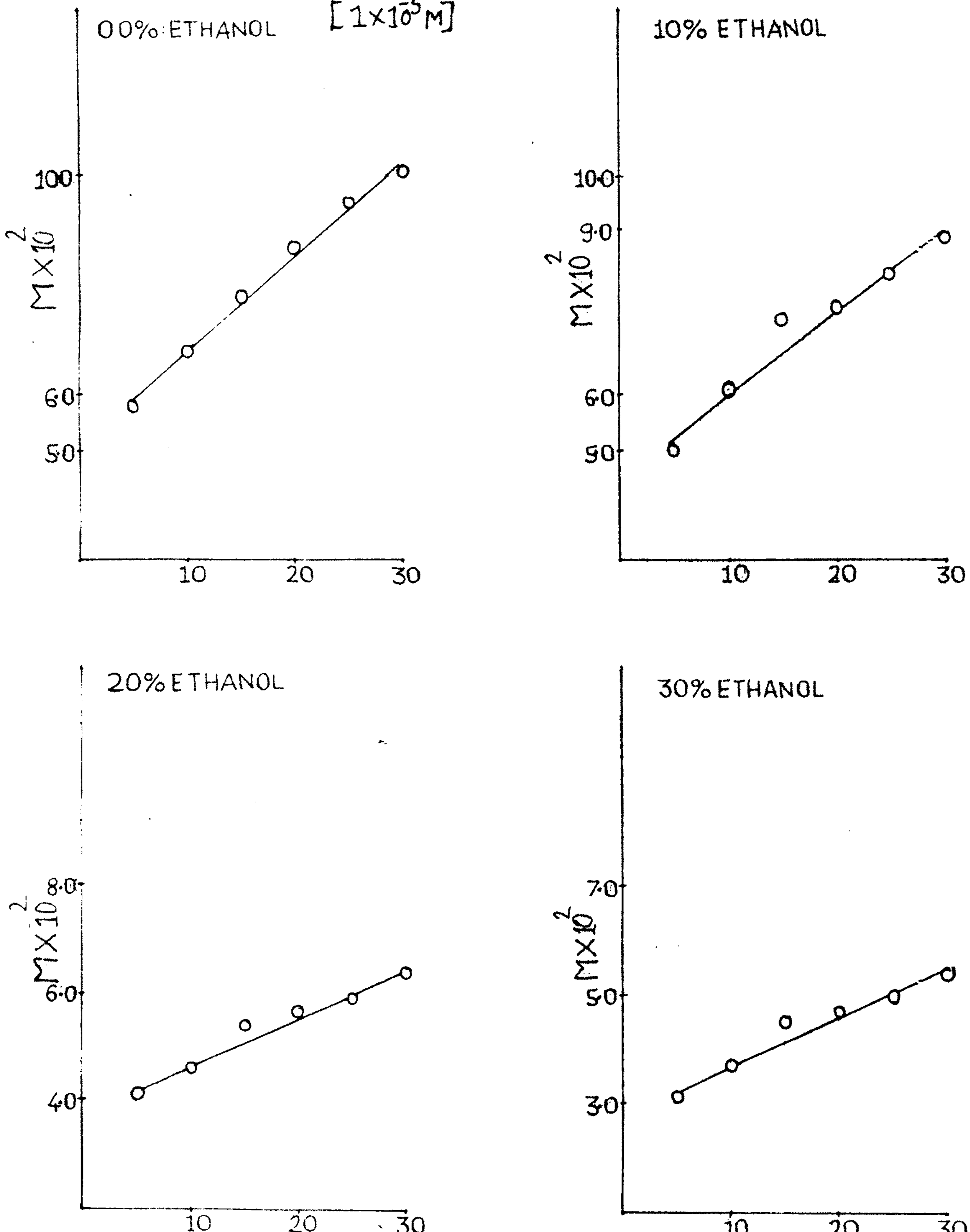


FIG-4.21

SYSTEM: Na_2SO_4 (0·00001M), SOLVENT: ETHANOL- WATER [1×10^{-5}M]

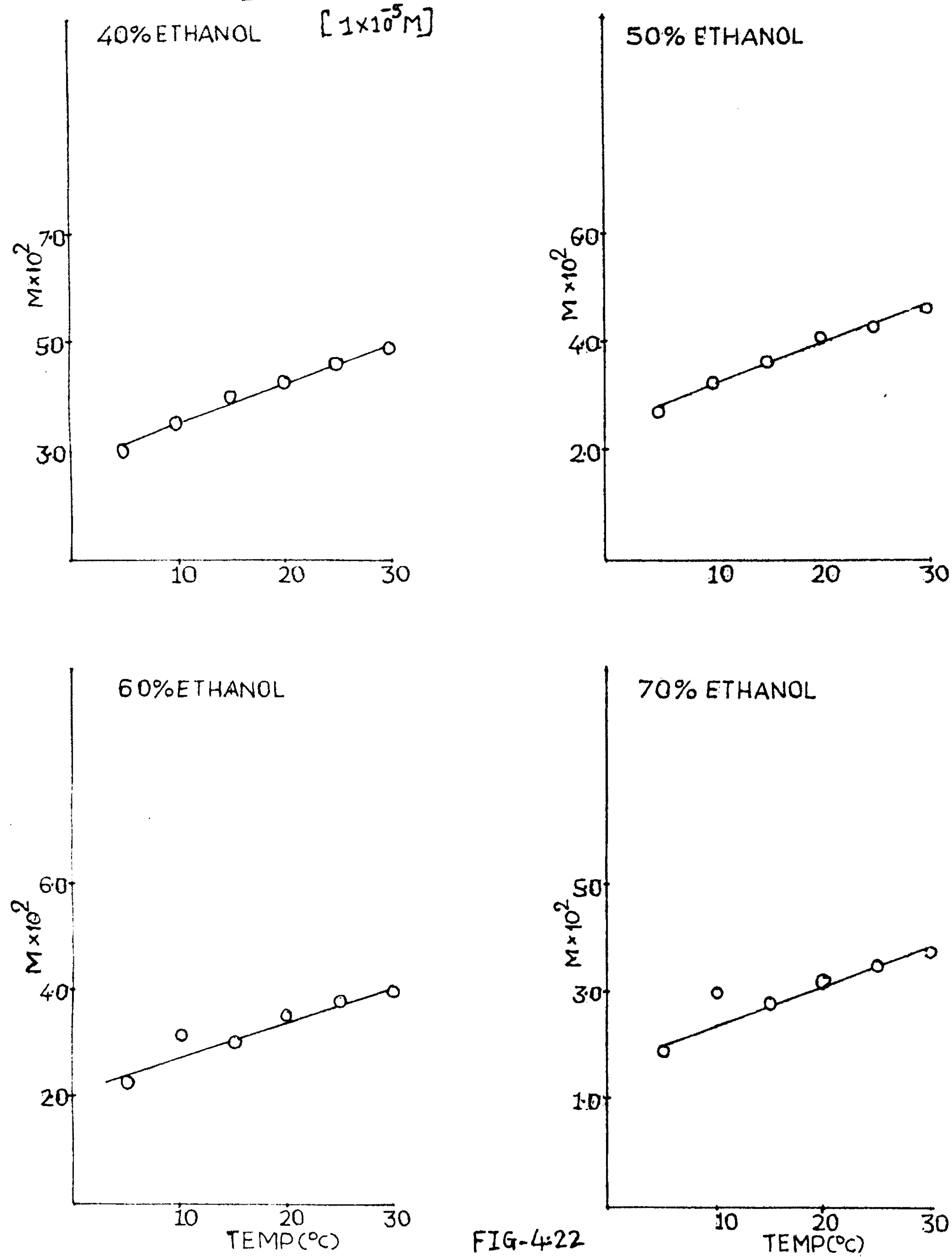


FIG-4·22

SYSTEM : Na_2SO_4 (0.00001M), [1×10^{-5}M] SOLVENT: ETHANOL WATER.

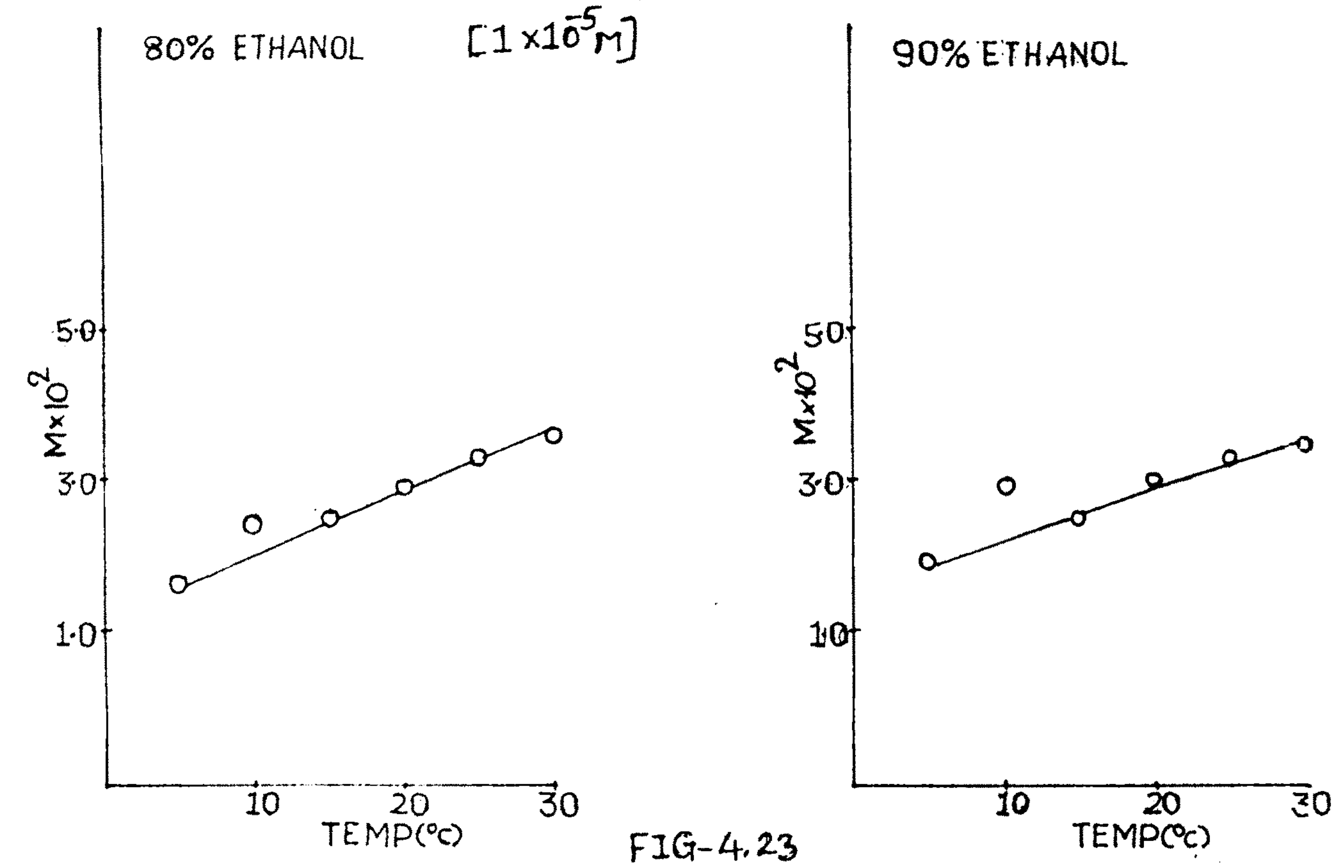


FIG-4.23

SYSTEM: Na_2SO_4 (0.005M) SOLVENT: METHANOL - WATER [5×10^{-3}M]

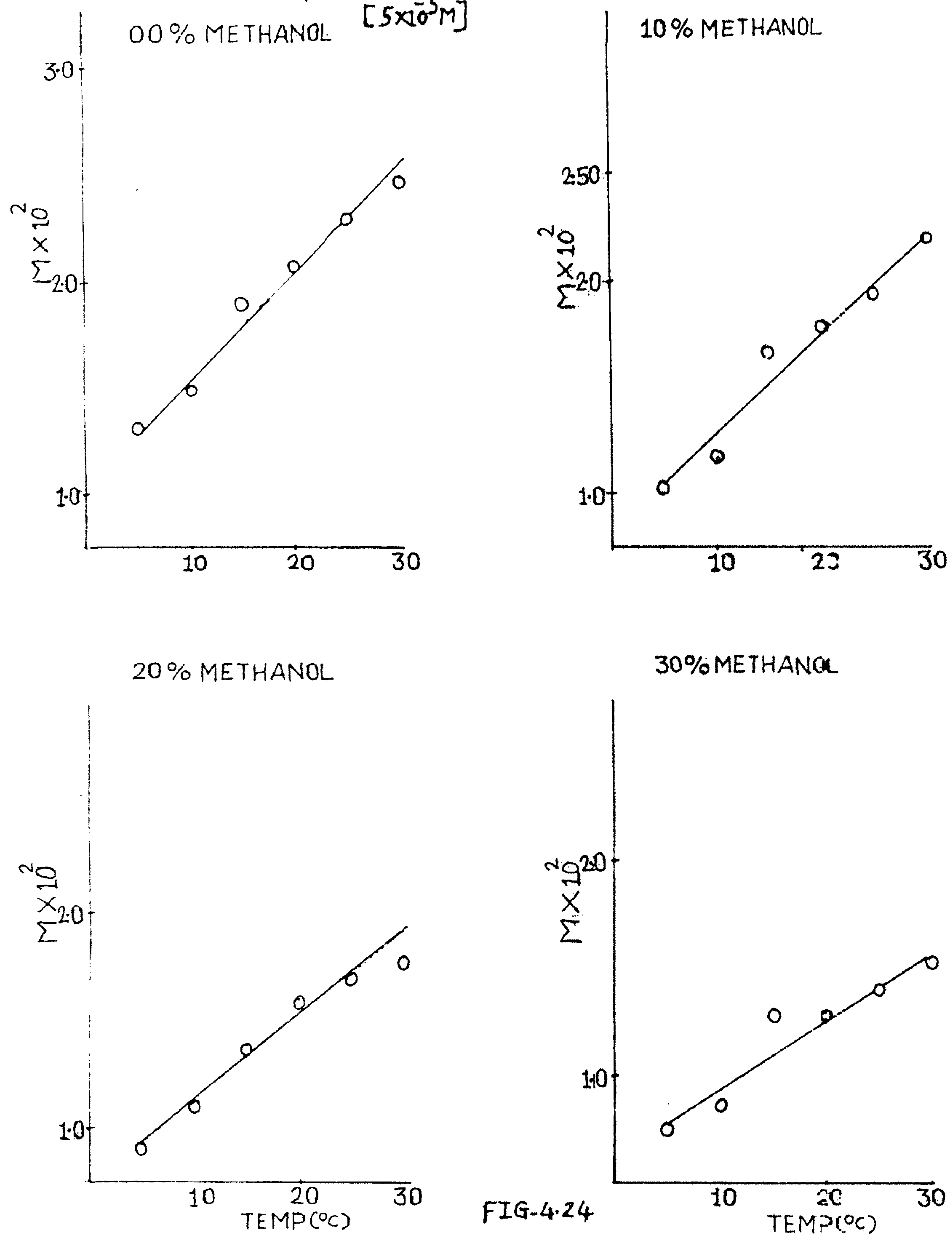


FIG-4.24

SYSTEM: Na_2SO_4 (0·005M) [5×10^{-3}M], SOLVENT: METHANOL- WATER

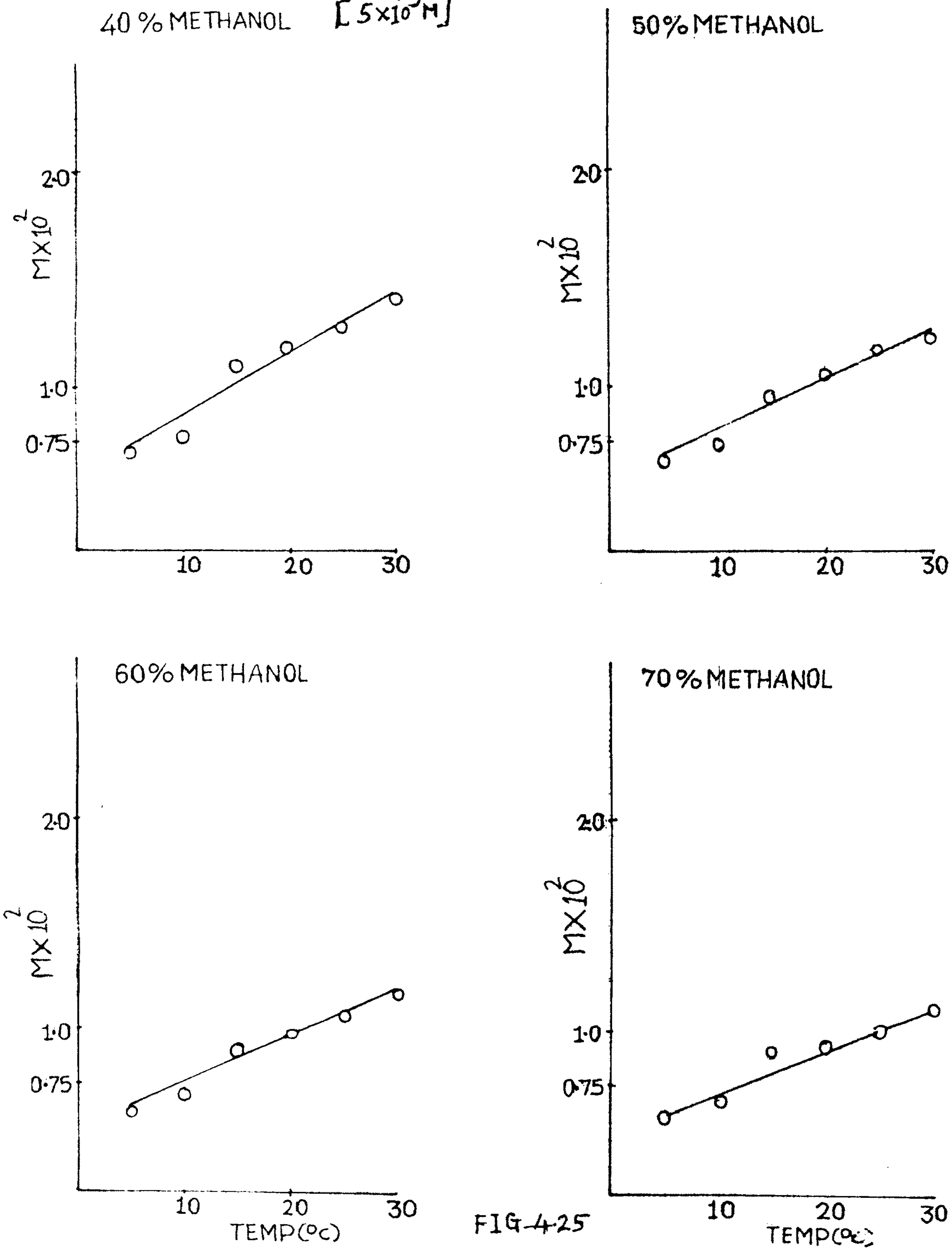


FIG-4·25

SYSTEM: Na_2SO_4 (0·005M), SOLVENT: METHANOL-WATER

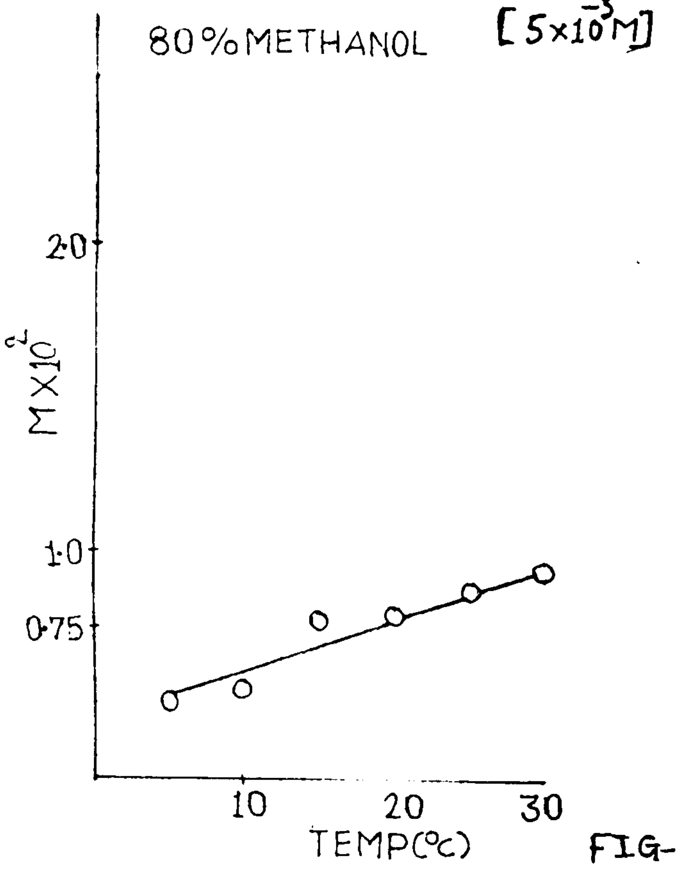


FIG- 4·26

SYSTEM: NA2 SO4 (0·001), SOLVENT: METHANOL-WATER.

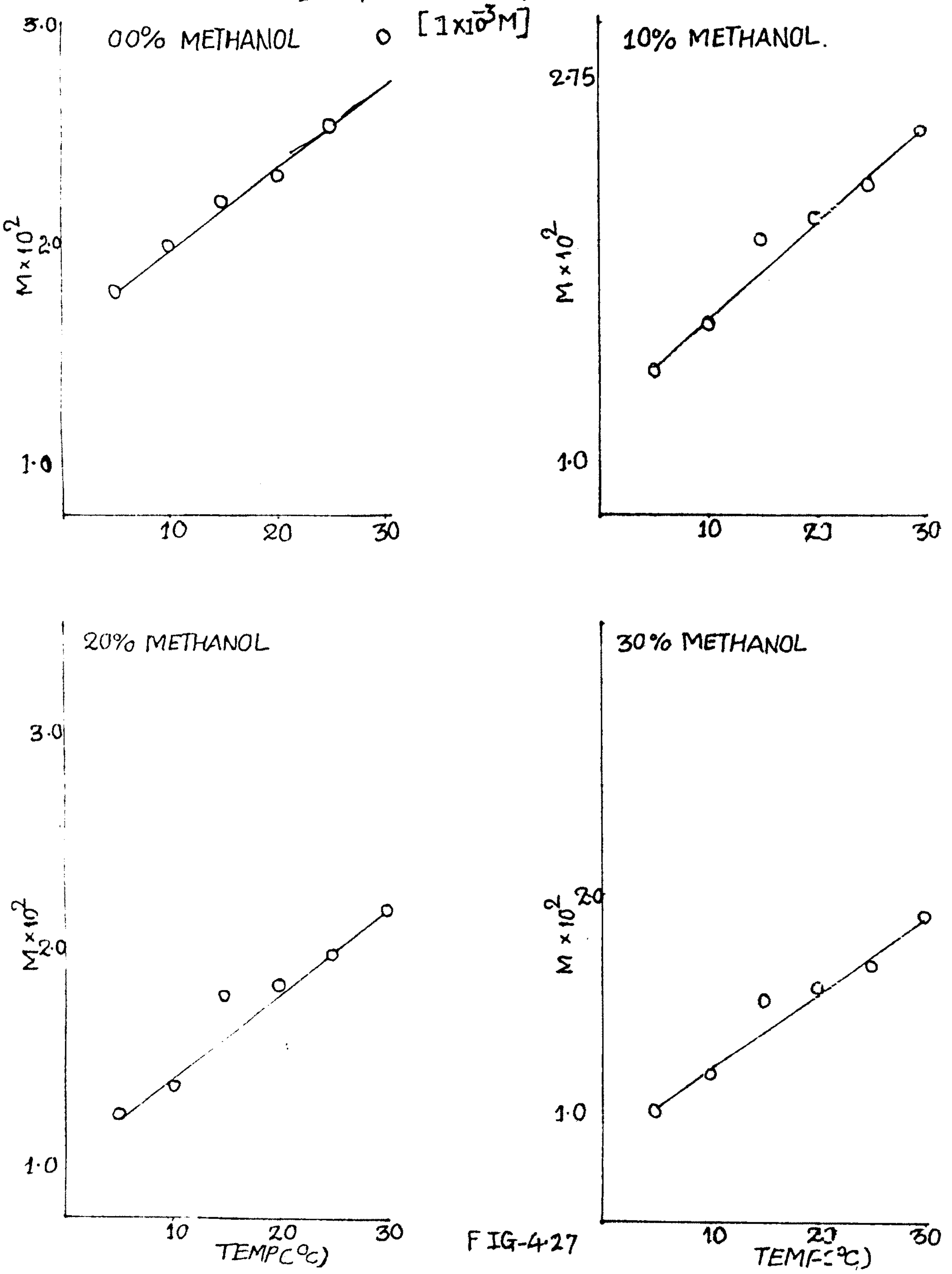


FIG-4·27

SYSTEM: Na_2SO_4 (0·001M), SOLVENT: METHANOL WATER

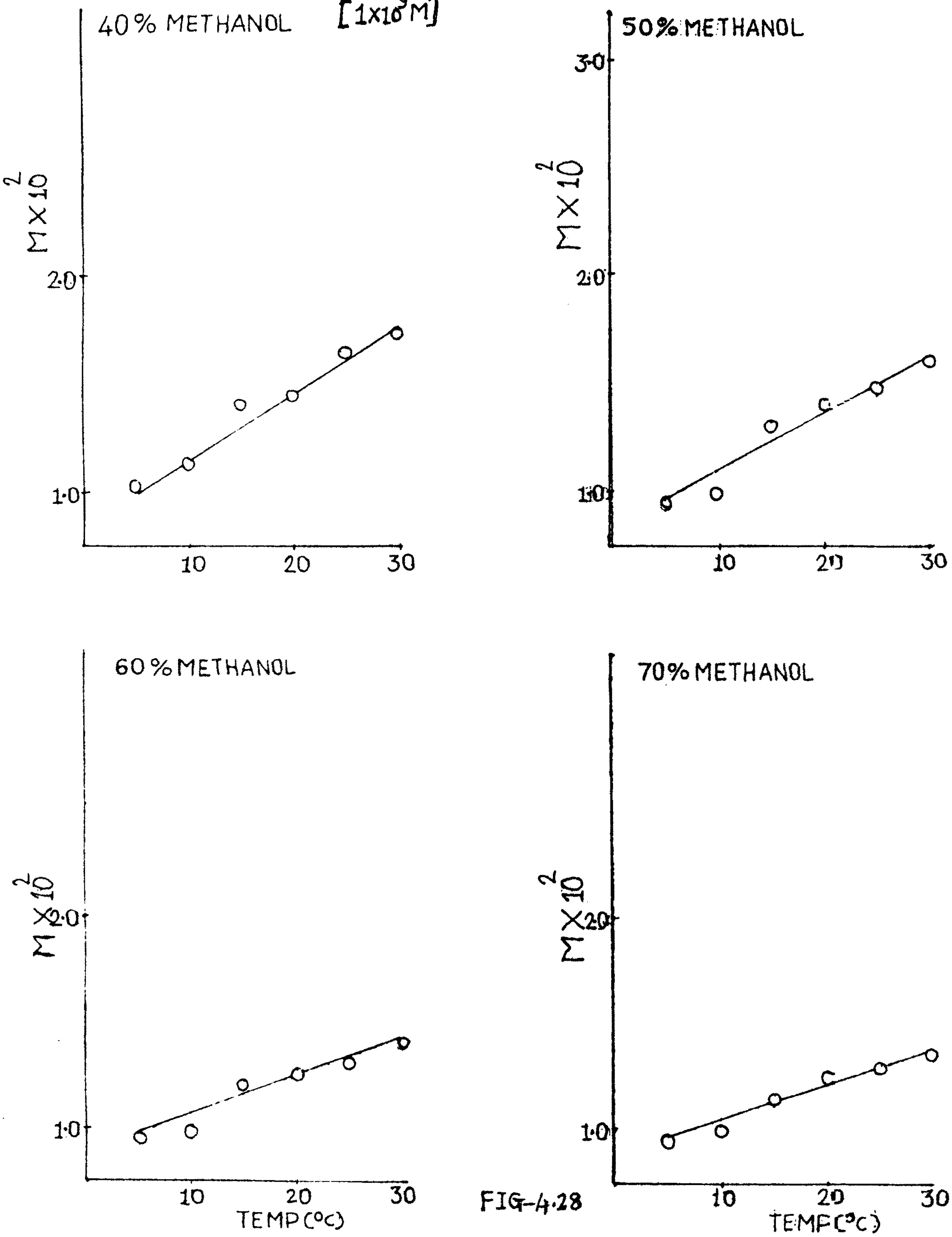


FIG-4.28

SYSTEM: Na_2SO_4 (0·001M), SOLVENT: METHANOL - WATER
[1×10^{-3}M]

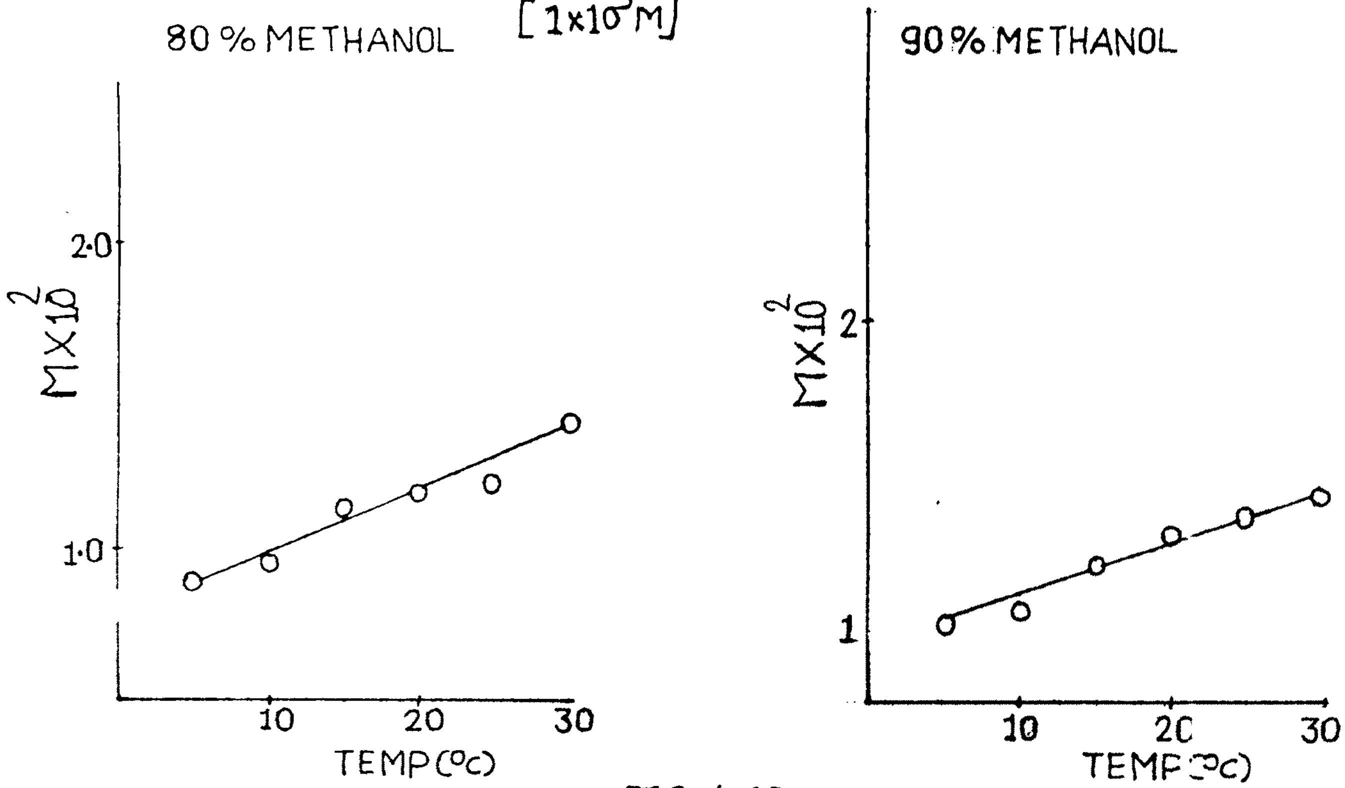


FIG-4.29

SYSTEM : Na_2SO_4 (0·0005M), [5×10^{-4}M] SOLVENT: METHANOL-WATER

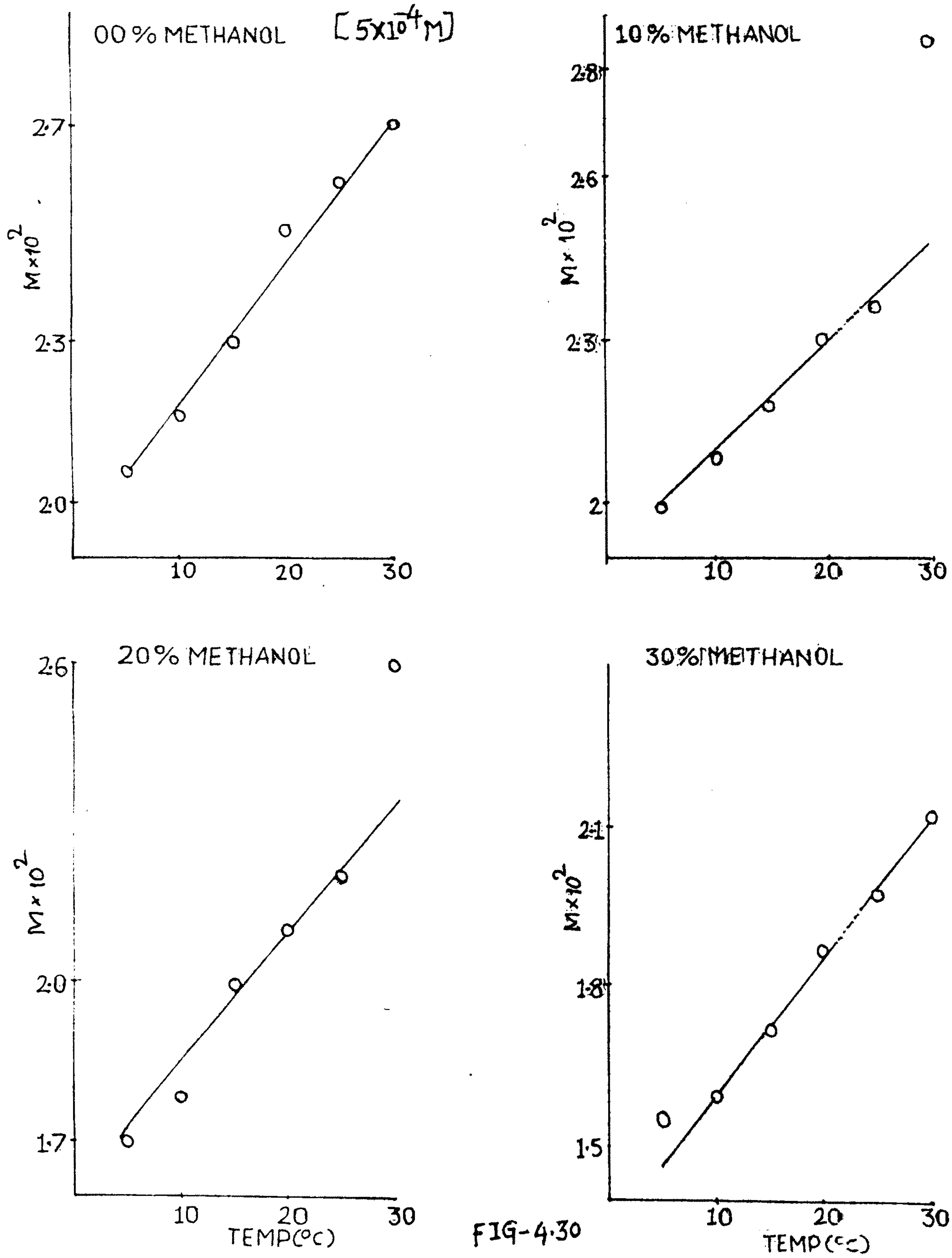


FIG-4·30

SYSTEM : NA_2SO_4 (0·0005 M), SOLVENT : METHANOL- WATER.

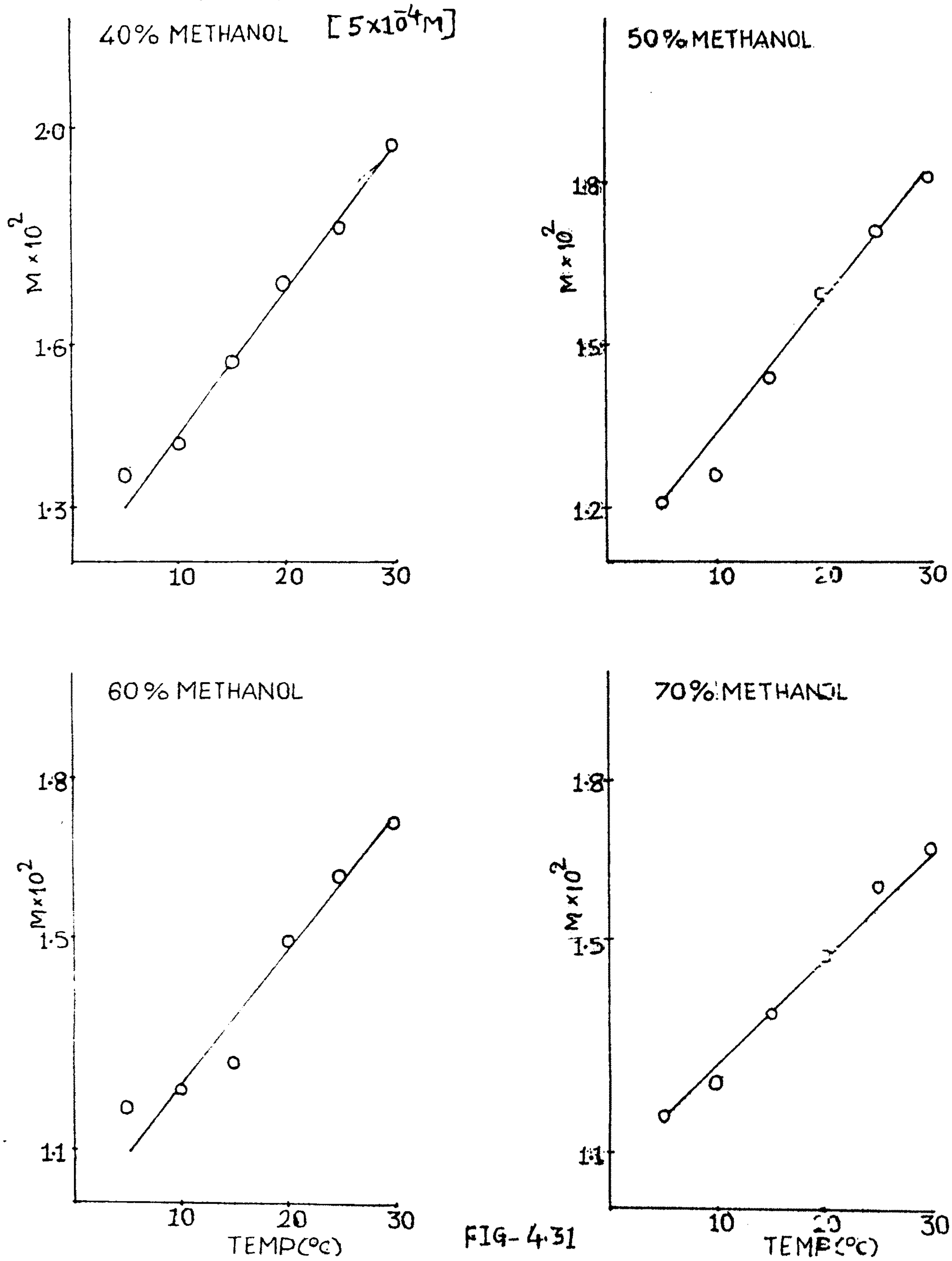


FIG- 4.31

SYSTEM: Na_2SO_4 (0·0005M), SOLVENT: METHANOL - WATER.

[5×10^{-4} M]

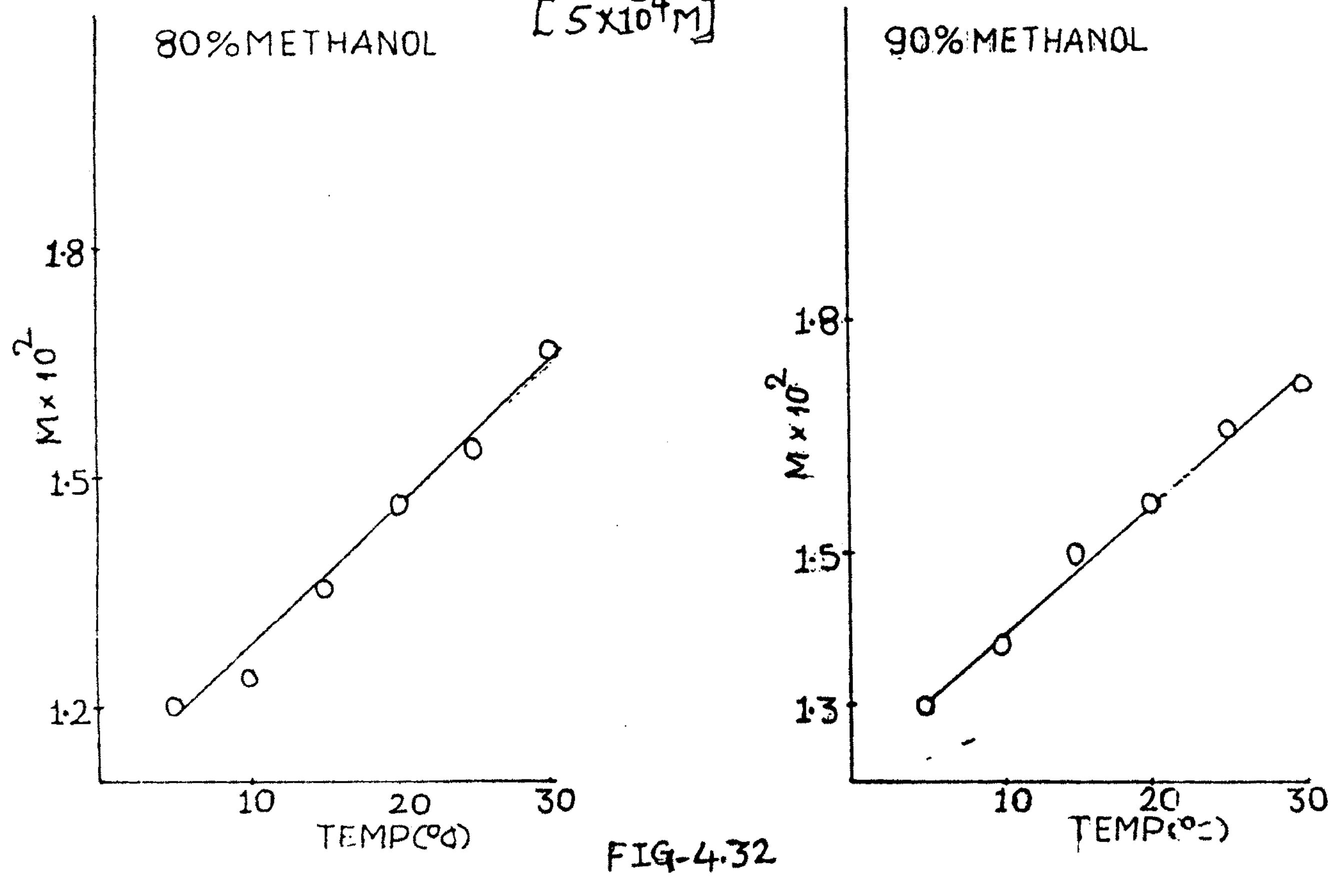


FIG-4.32

SYSTEM : Na_2SO_4 (0·001 M), [1×10^{-3}M]   SOLVENT: ACETONE- WATER.

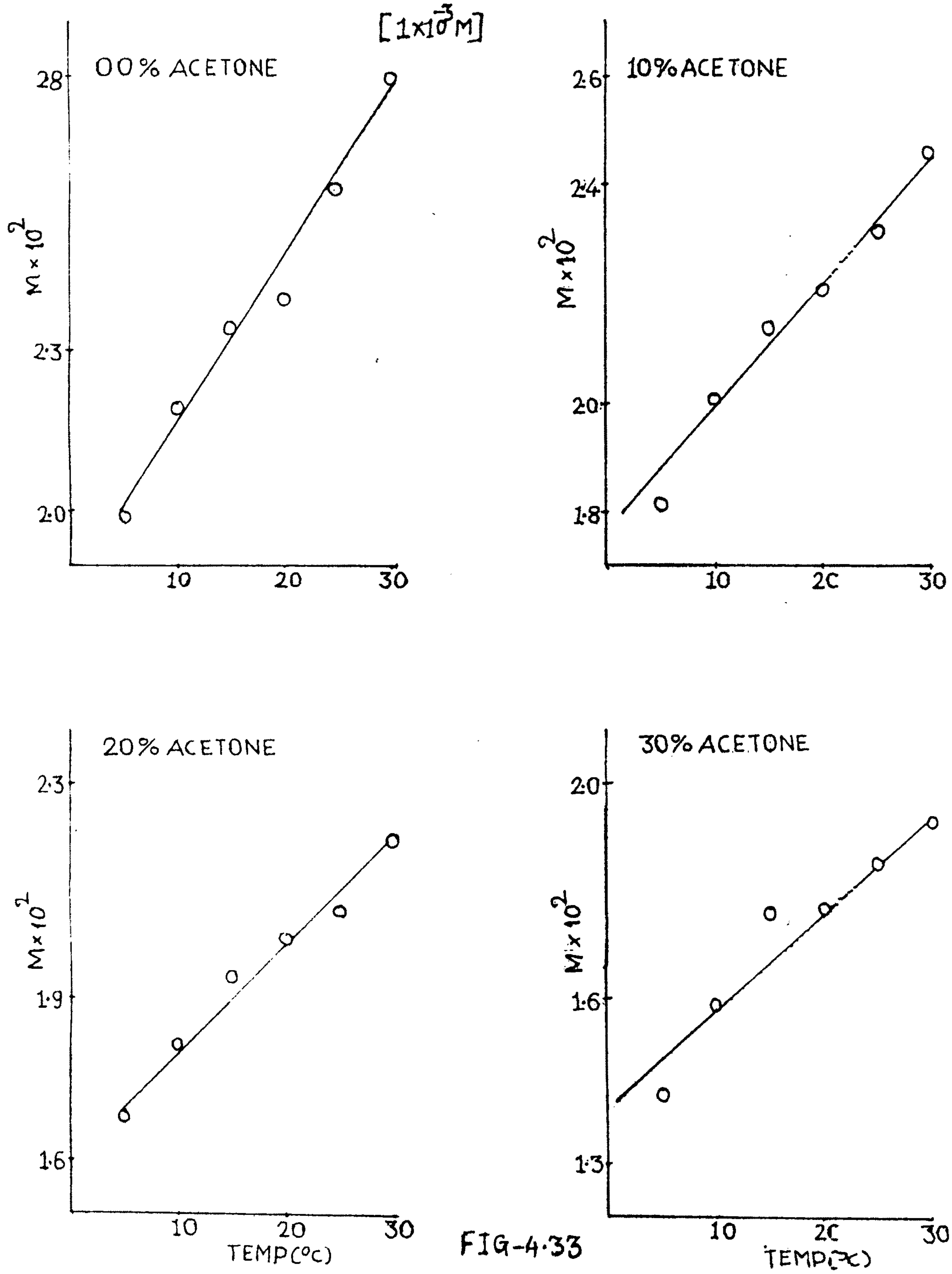


FIG-4·33

SYSTEM: NA_2SO_4 (0·001M), SOLVENT: ACETONE-WATER.

[1×10^{-3} M]

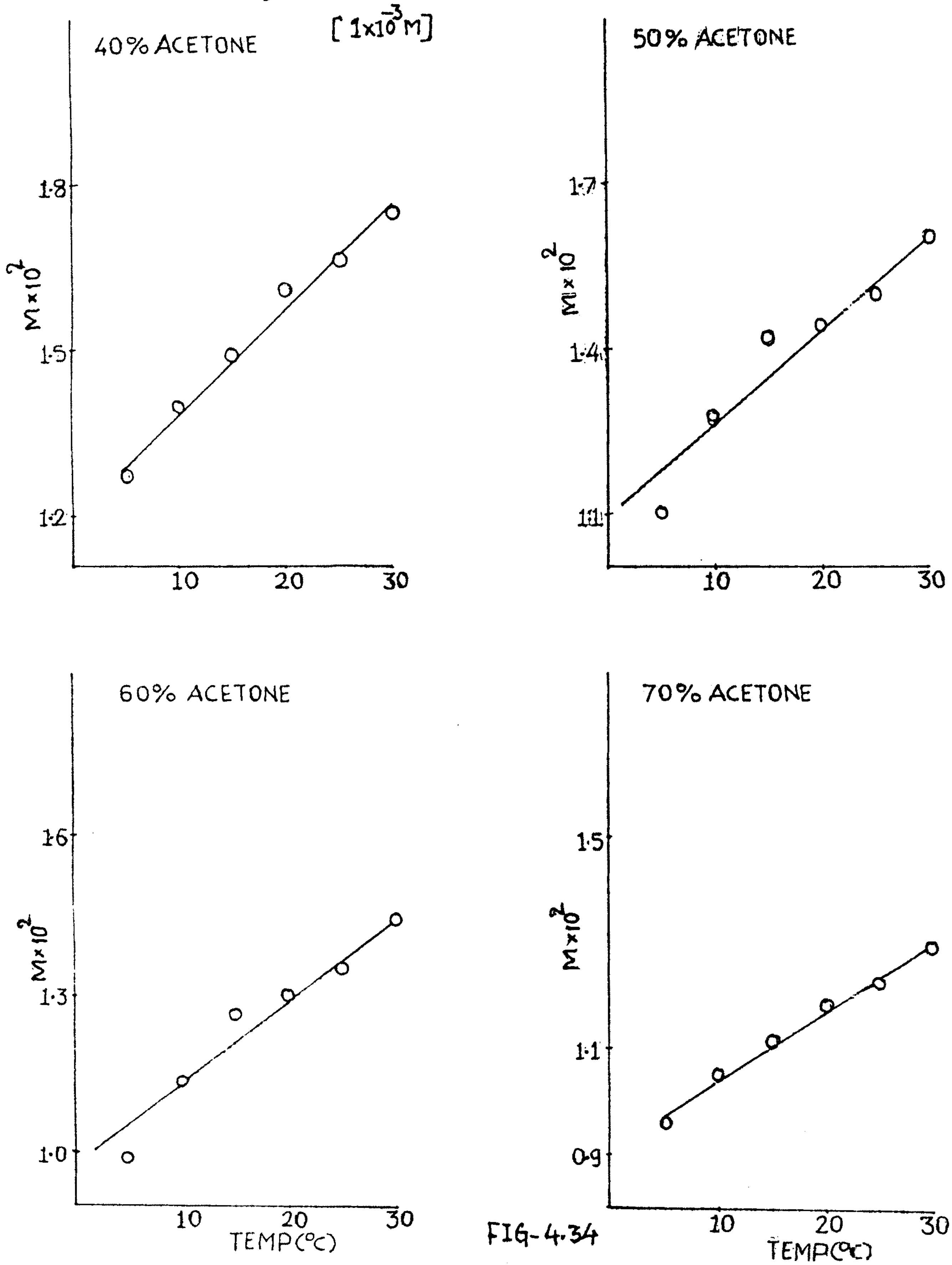


FIG-4.34

SYSTEM : Na_2SO_4 (0·001 M), SOLVENT: ACETONE-WATER.

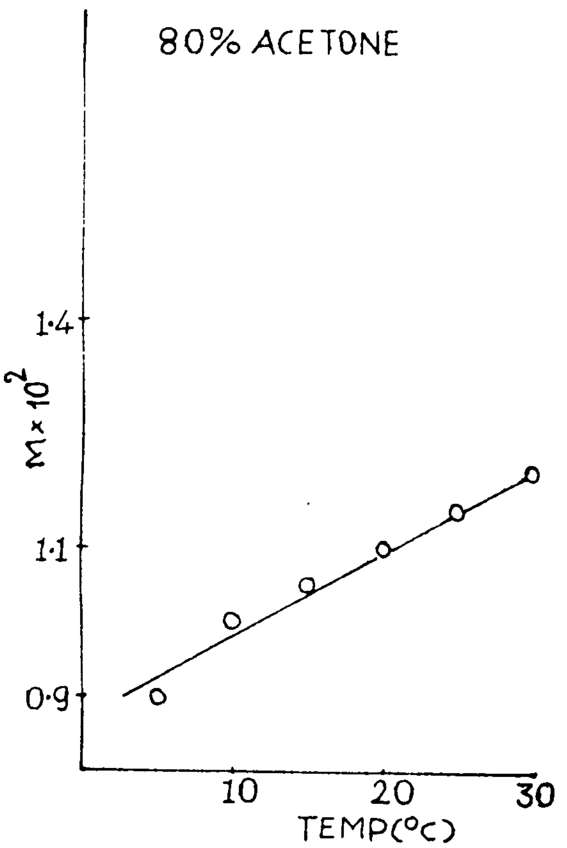


FIG-4.35

SYSTEM: NA_2SO_4 (0.0001M), SOLVENT: ACETONE-WATER.

$[1 \times 10^{-4} M]$

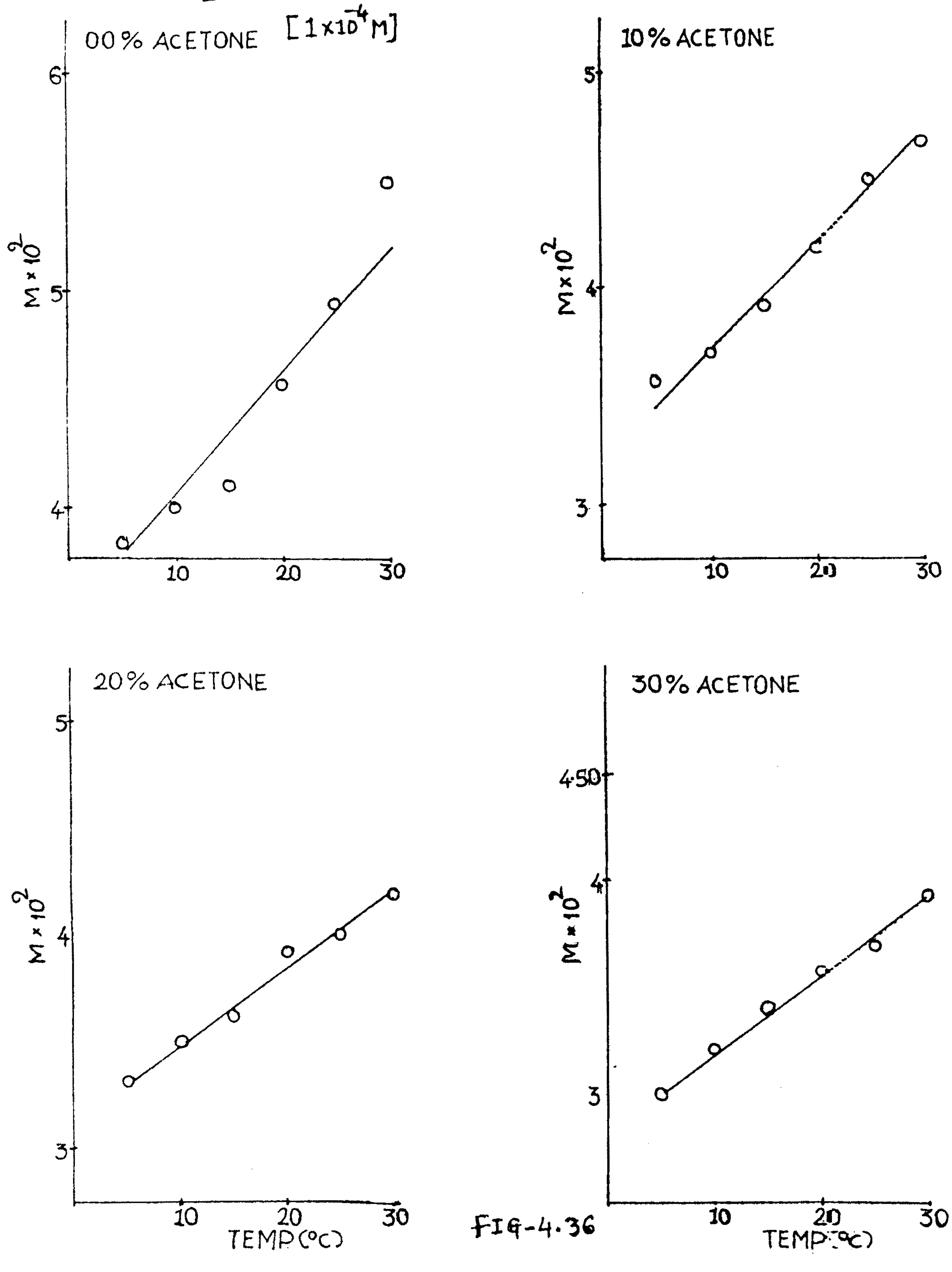


FIG-4.36

SYSTEM: Na_2SO_4 (0·0001 M), SOLVENT: ACETONE- WATER.

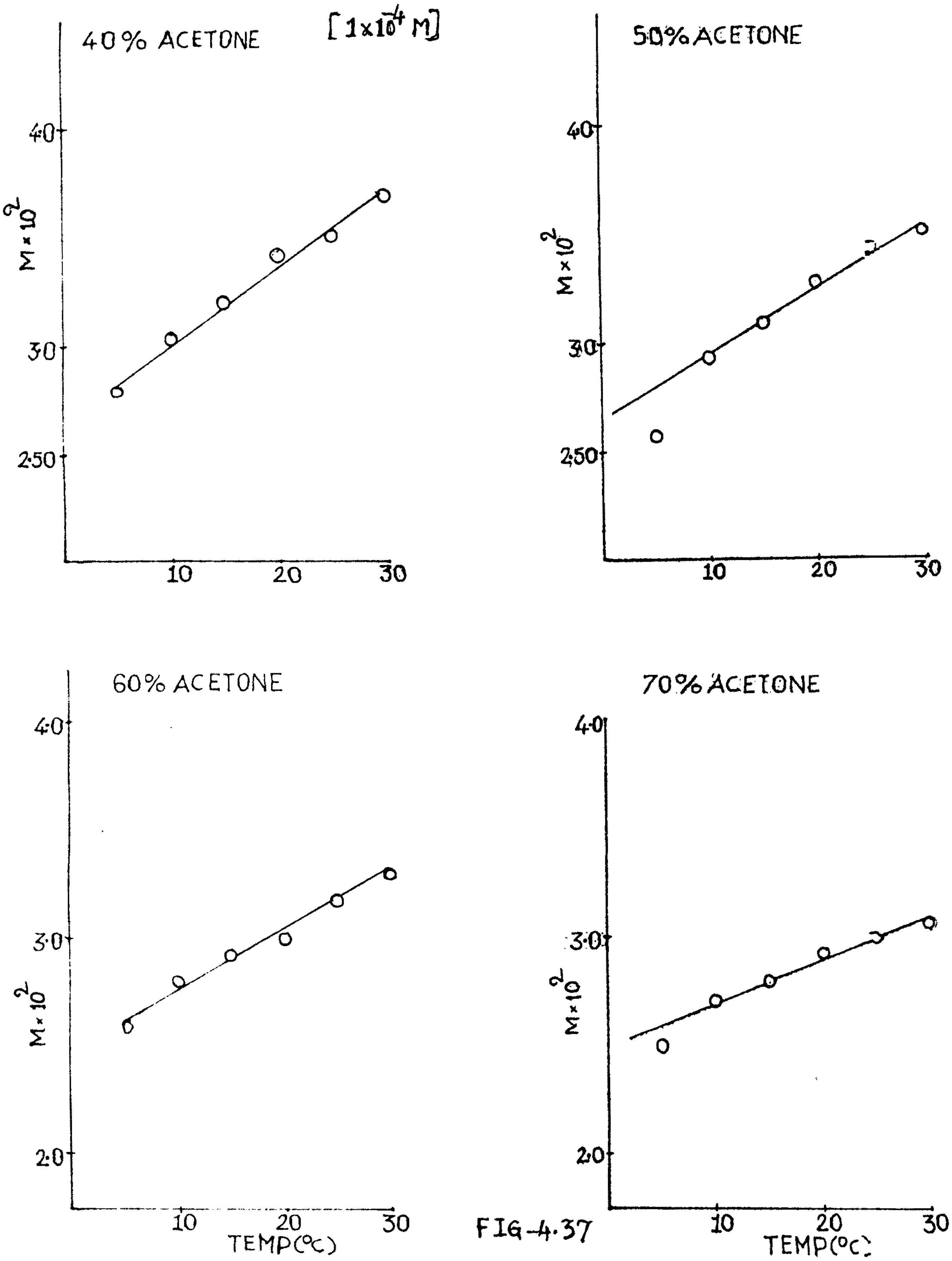


FIG-4.37

SYSTEM : NA_2SO_4 (0·0001M). SOLVENT: ACETONE - WATER.

[1×10^{-4}M]

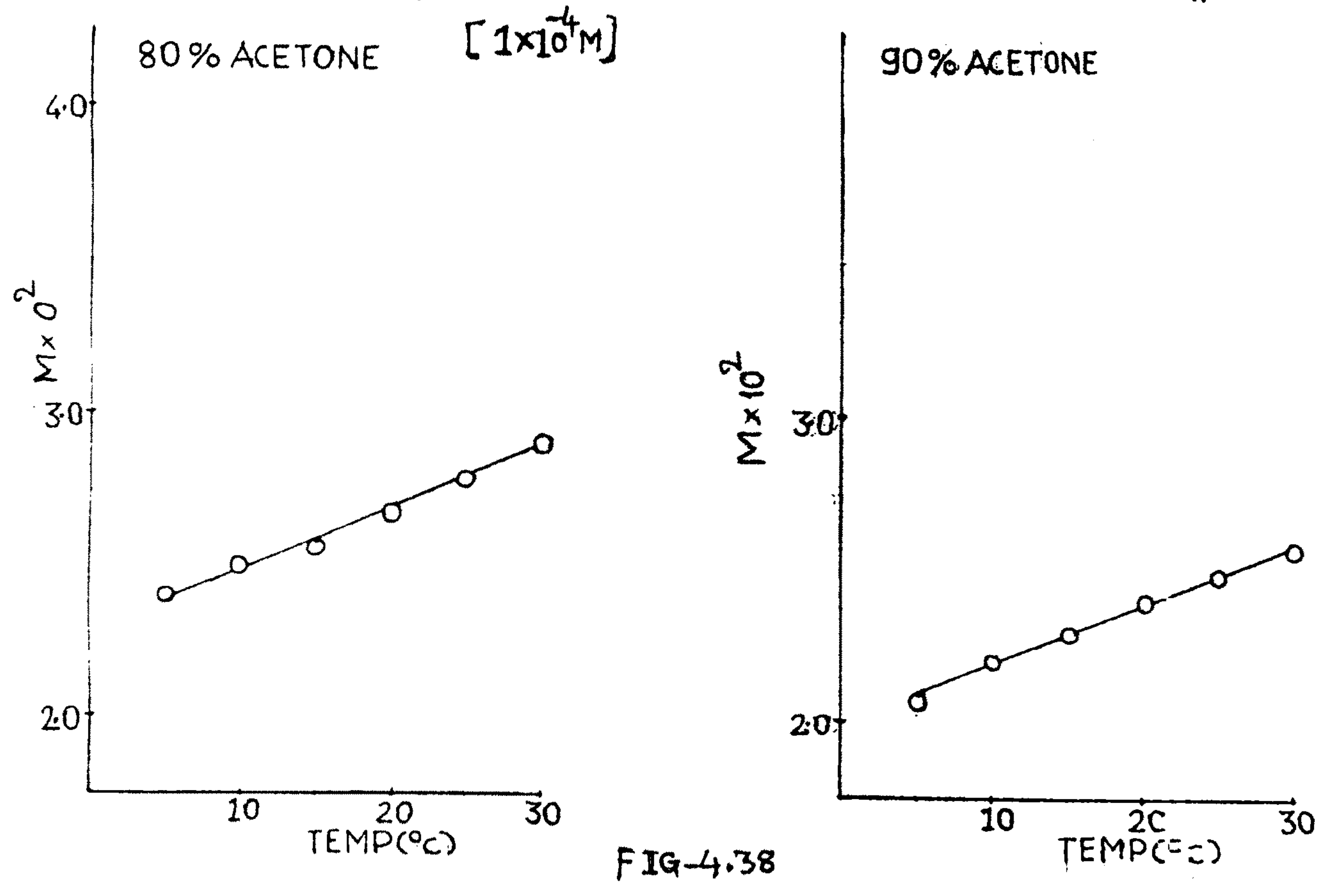


FIG-4.38

SYSTEM : NA_2SO_4 (0·00005M) , SOLVENT: ACETONE-WATER

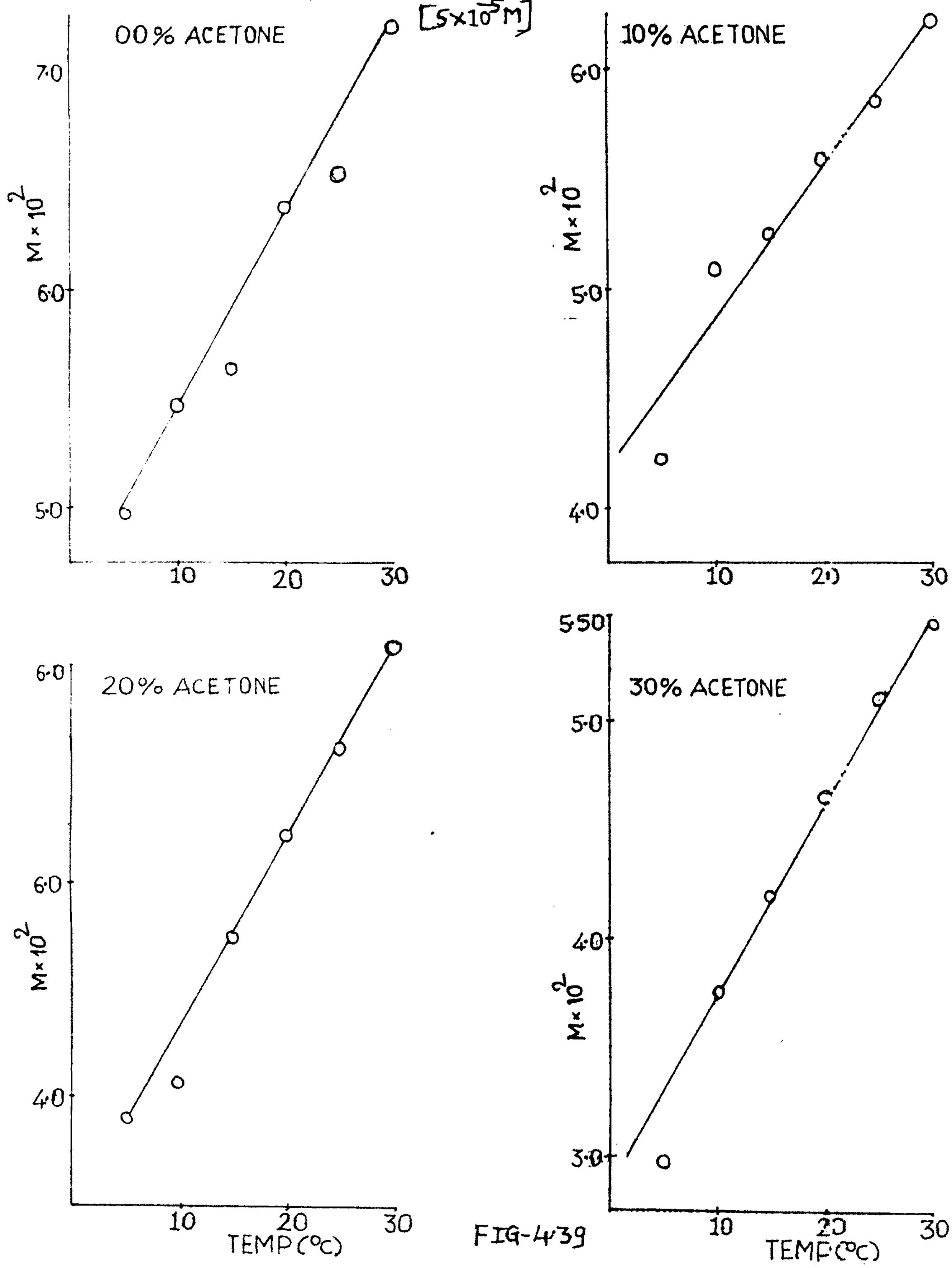


FIG-4·39

SYSTEM: Na_2SO_4 (0·00005M), SOLVENT: ACETONE-WATER.
[5×10⁻⁵M]

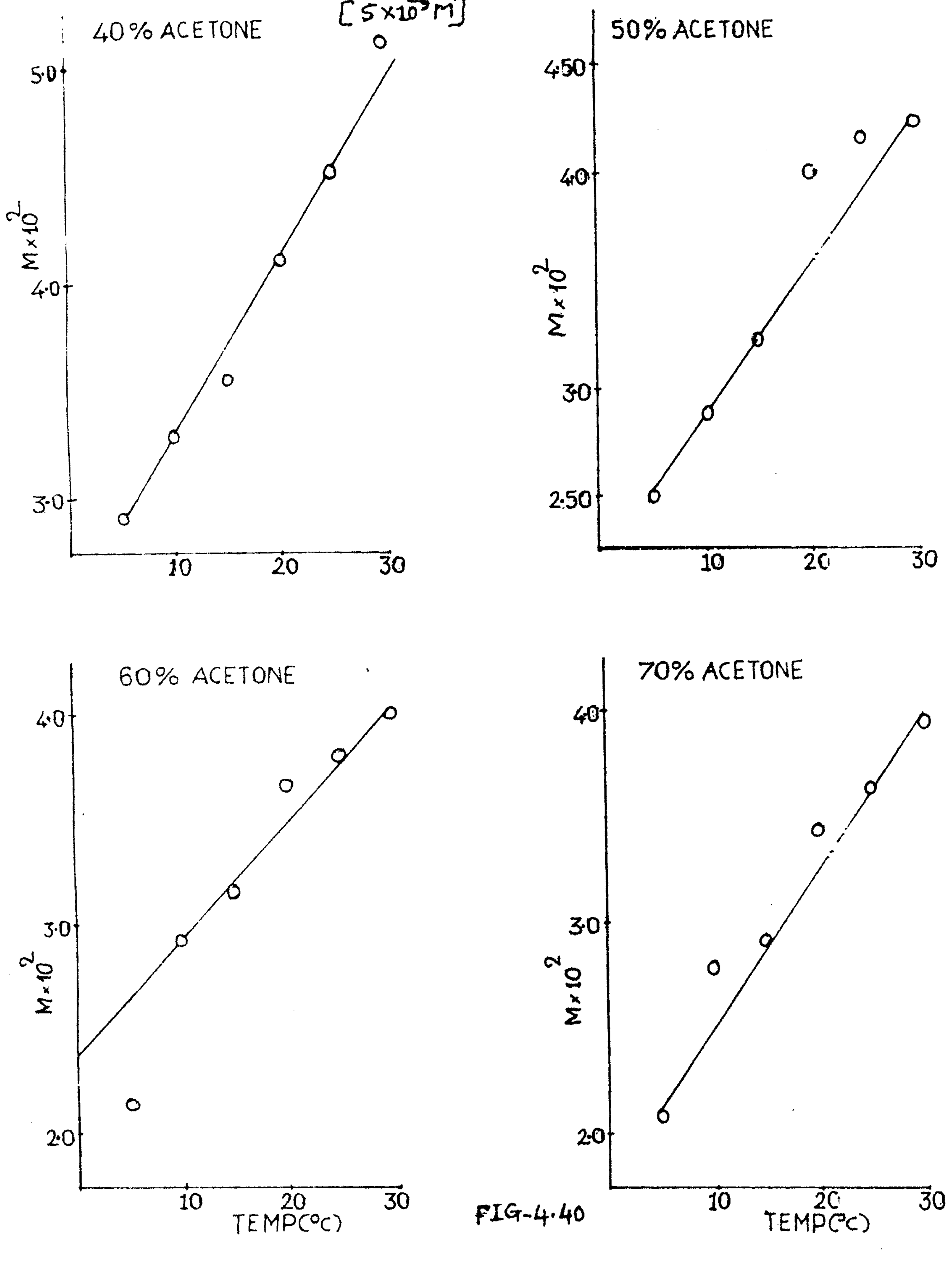


FIG-4·40

SYSTEM: Na_2SO_4 (0·00005M), SOLVENT: ACETONE – WATER.
[5×10^{-5}M]

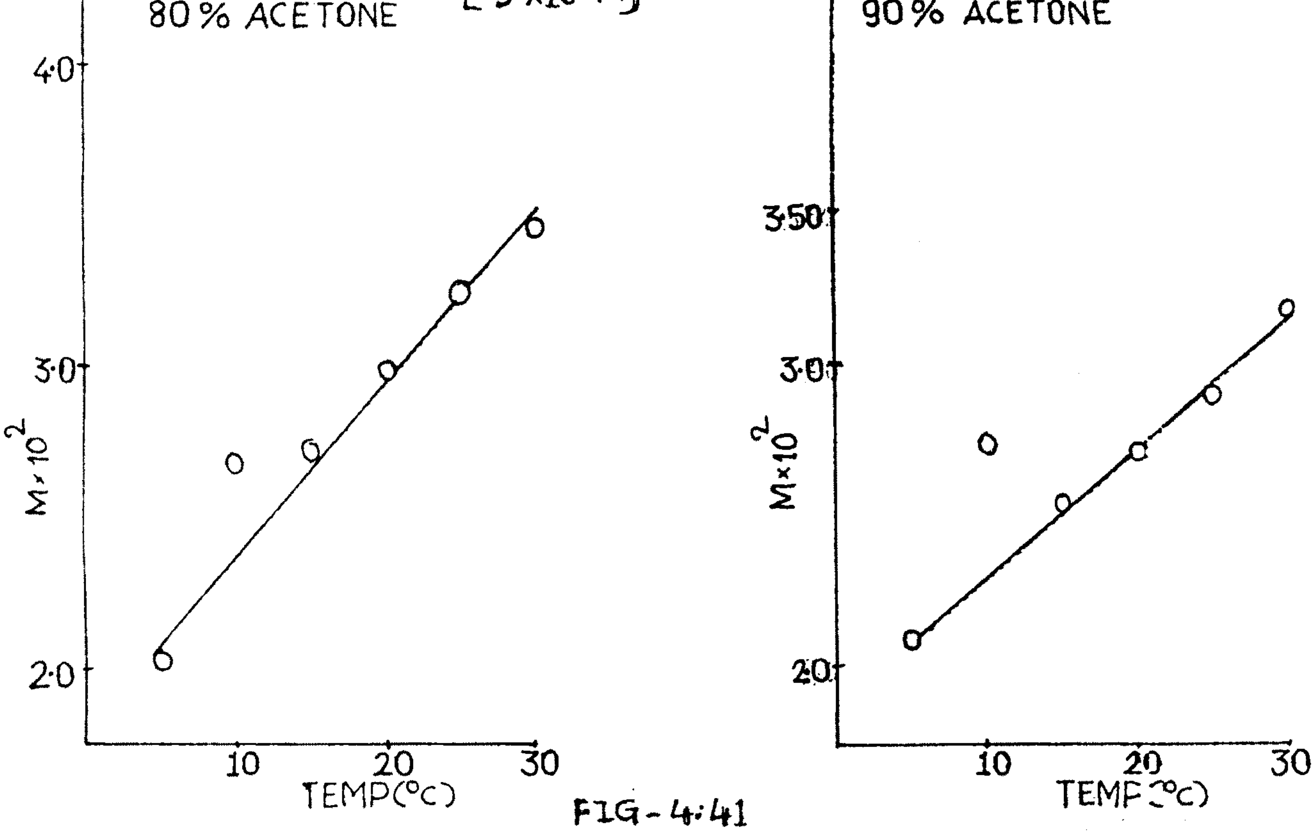


FIG - 4·41

SYSTEM: Na_2SO_4 (0·00001M), SOLVENT: ACETONE-WATER.

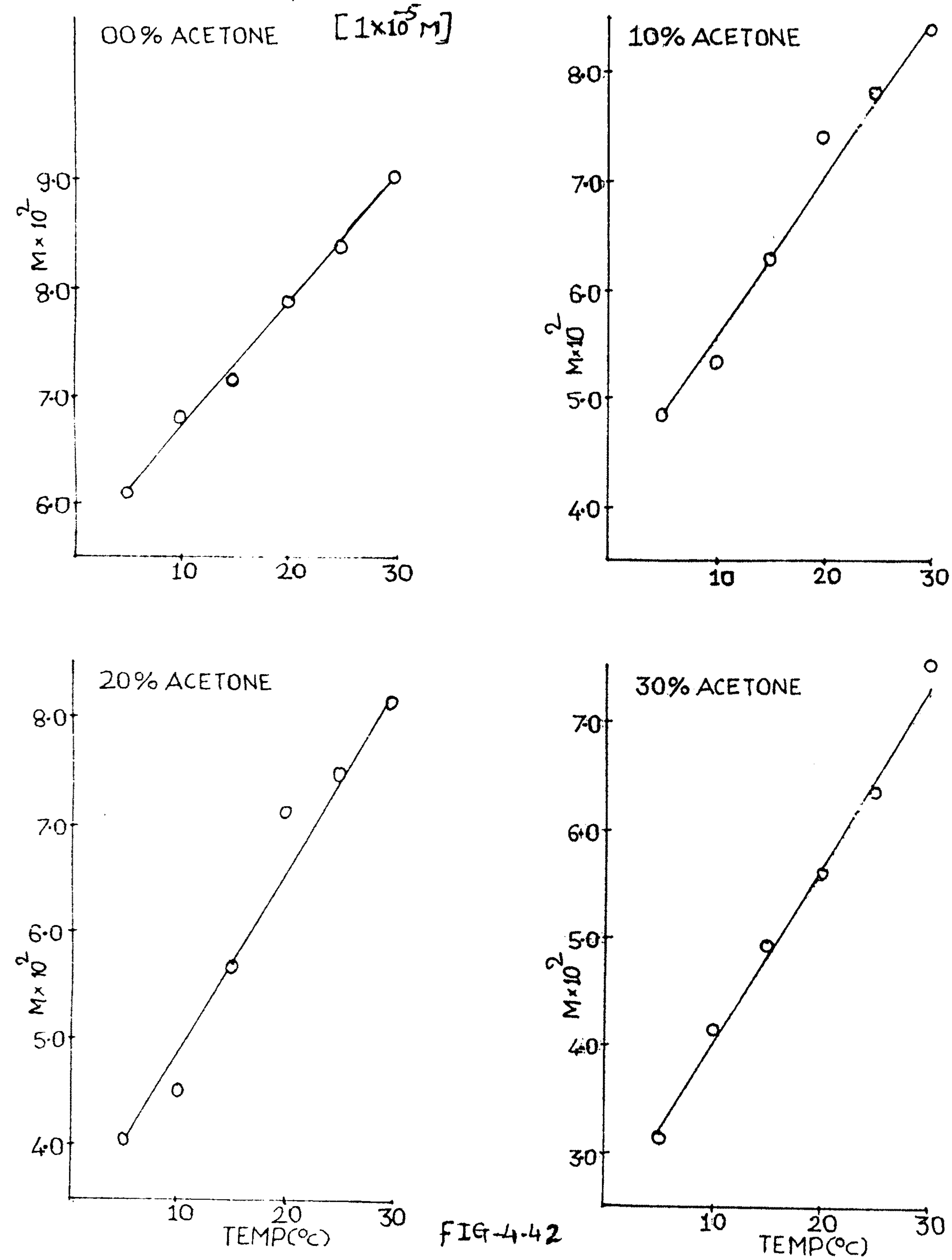


FIG-4.42

SYSTEM : Na_2SO_4 (0.00001M), SOLVENT: ACETONE-WATER.

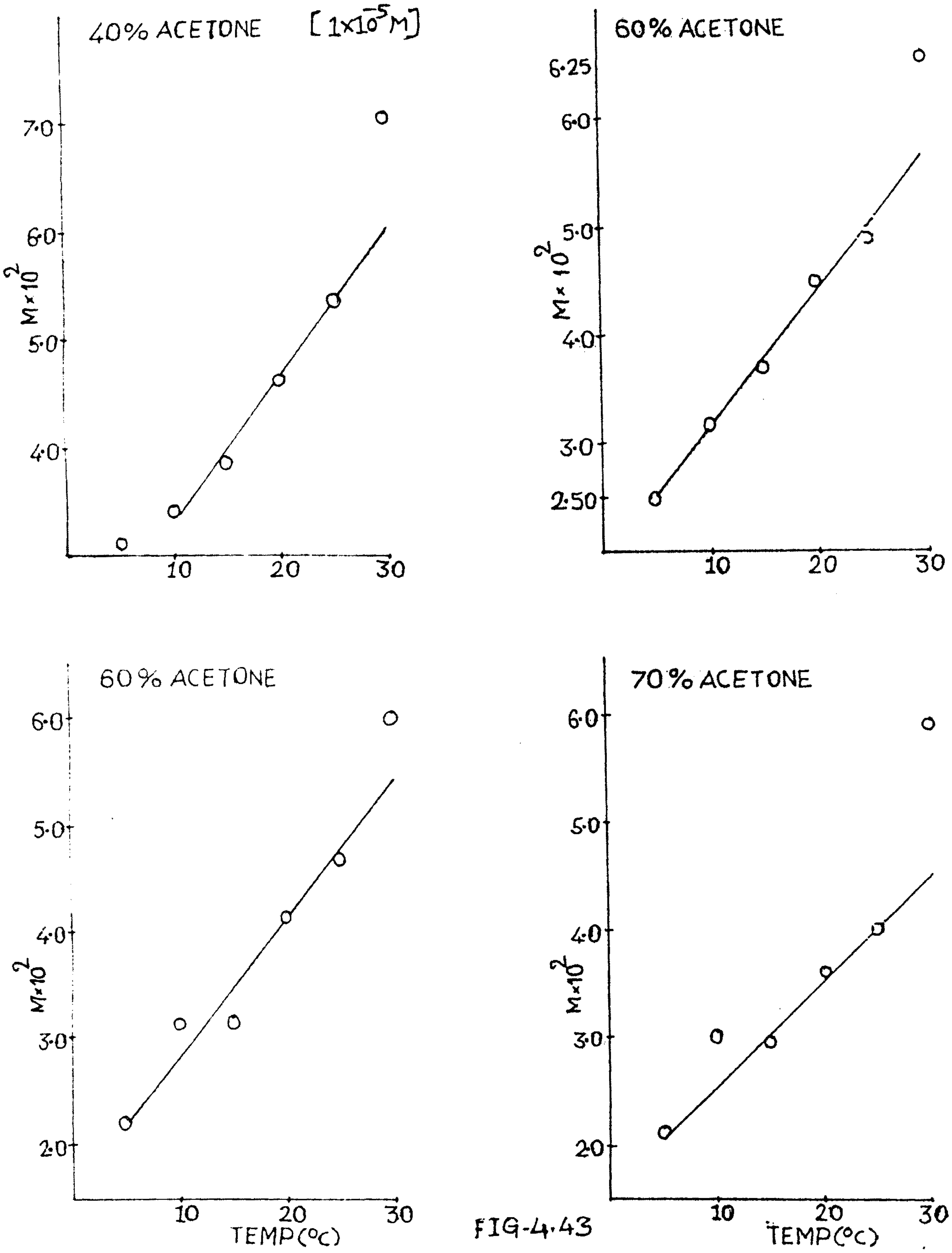


FIG-4.43

SYSTEM: Na_2SO_4 (0.00001 M). [1×10^{-5} M] SOLVENT: ACETONE-WATER.

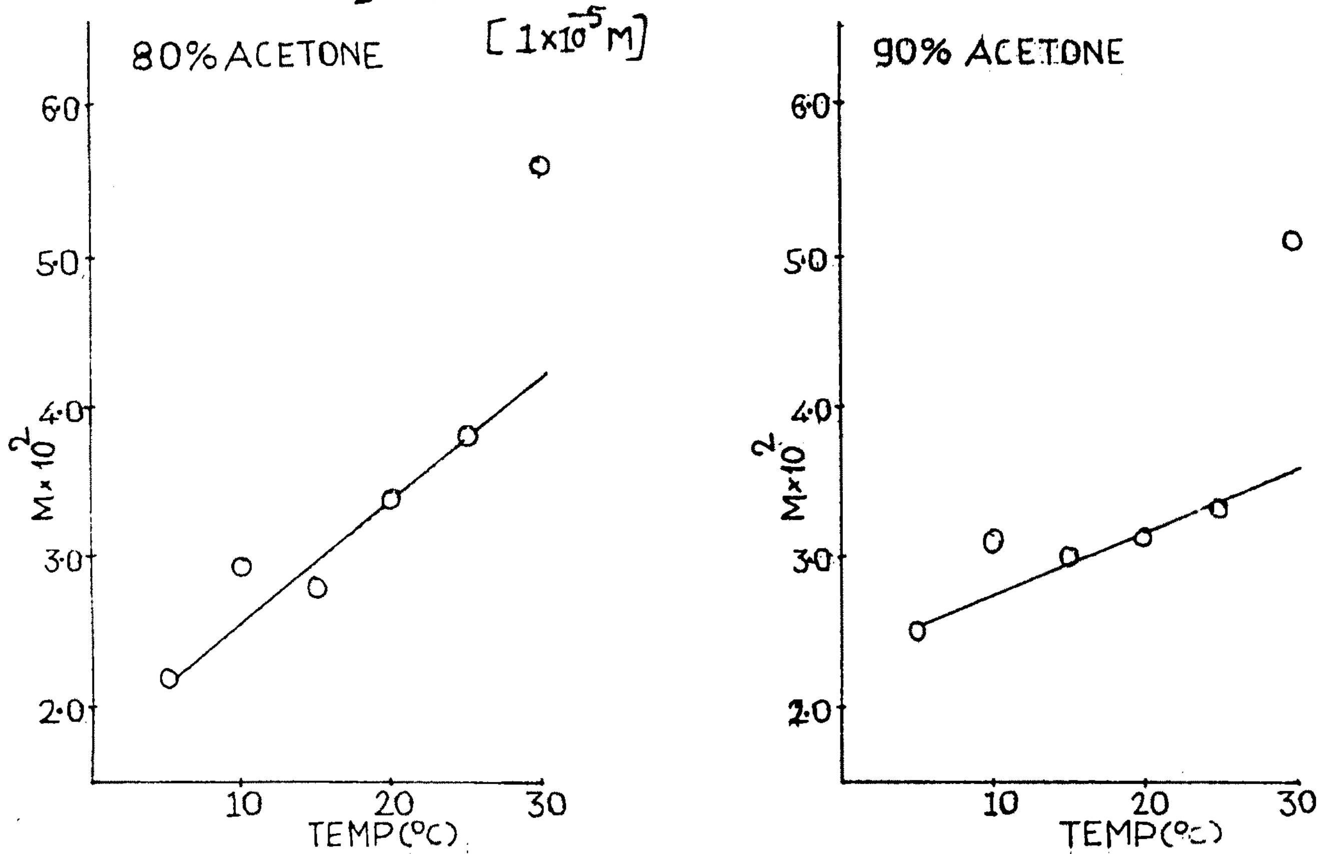


FIG-4.44