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SOME POLYALKYLARYLAMINES AS A COAGULANT AID IN WATER TREATMENT

By

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خلاصـــة

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فى هذا البحث تم إستخدام هيدروكلوريدات عديد (إيثيلين - شبيه - بارا - فينيلين ثنائى الامين وعديد (امينو ميثين - شبيه - ٤ ، ٤ - ثنائى الامين ثنائى الفينيل) وعديد (إثيلين - شبيه - ٤ ، ٤ - ثنائى الامين - ثنائى الفينيل) لإزالة عكارة الماء وأوضحت الدراسة إمكانية إزالة العكارة بإستخدام هذه المركبات منفردة أو مع الشبه (كبريتات الالومنيوم) . وقد قورنت النتائج مع بعض مزيلات العكاره المصرية والشبه وكانت النتائج لهذه المركبات مقبولة فى حالة الماء الحامضى (رقم الاس الهيدروجينى = ٣) أما فى الوسط المتعادل فكان المركب الاخير فى وجود الشبه يقلل العكارة حتى وحدة واحدة من وحدات العكارة (NTU) اما المركبين الاول والثانى فكان النقص من ١٥ وحدة إلى ١٠ وحدات و ٥ر٦ وحدة على الترتيب .

ABSTRACT

Poly (ethylene-co-p-phenylene diamine) hydrochloride, poly (aminomethine-co-4, 4'-diaminodiphenyl) hydrochloride and poly (ethylene-co-4, 4'-diaminodiphenyl) hydrochloride were used to remove turbidity from synthetic turbid water, prepared as fine clay suspension in tap water. These compounds displayed typical polyelectrolyte behaviour either alone or in combination with alum. They were put *neutral (pH 7) and basic (pH 10) mediums. Laboratory studies have shown that these compouds give good performance individually in acidic medium, where in neutral medium they give good performance, only, in combination with alum.*

INTRODUCTION:

Synthetic polyelectrolytes are being extensively used in treatment of water and wastewater in technically advanced countries of the world. Their use has revolutionised the treatment processes to a level which could not be dreamt in the past, reducing the cost of chemicals, producing comparatively smaller quantities of compact sludge that can be drained and disposed of easily and simplifying handling and dosing of the chemicals (Singh 1985).

Polyelectrolytes are water-soluble polymers with many adsorption sites which are available for adsorption onto the colloid particles. One polymer molecule can therefore become adsorbed on to several colloid particles thus forming a bridge between particles and producing a stable floc, (Walters and Wint 1981). Polyelectrolytes may be anionic or cationic or even nonionic. Many proprietory brands are available such as polyethyleneoxide, polyacrylamide, polystyrene sulphonate, polyacrylic acid, quaternary polyamide and polydiallyldimethylammonium, (Walters and Wint, 1981). Acetamide derivatives of polydiallylamine displayed a typical polyelectrolyte behaviour caused by residual amino units, (Mathias et al, 1987). Vaidya and Bulusu (1981) used CA-14, which is a synthetic organic polyelectrolyte based on polyacrylamide. It has a weak anionic properties and gives good performance in the improvement of coagulation process for turbidity removal in water treatment. Polyethyleneimine, which is a cationic polyelectrolyte was applied as a flocculant for Escherichia coli suspension (Treweek and Morgan 1979), as well as it was used as a flocculant for the purification of industrial effluents containing pertroleum impurities, (Gudasheva and Verkhotina, 1975). Pilipenko et al (1984), reported the optimal conditions for the use of poly-N, N-diallylammonium chloride for flocculation process.

Polyelectrolytes are used either alone or in combination with inorganic coagulant, like alum or ferric chloride. The aim of the undertaken work is to apply three new polyalkylarylamines, which were prepared and characterized by Shaaban et al (1988), as polyelectrolytes in water treatment for turbidity removal.

EXPERIMENTAL:

Poly (ethylene-co-p-phenylenediamine) hydrochloride (I), poly (ethylene-co-4, 4′-diaminodiphenyl) hydrochloride (II), and poly (aminomethine-co-4, 4′ - diaminodiphenyl) hydrochloride (III) were prepared and characterized elsewhere (Shaaban et al 1988), their chemical structure and melting points are given in Table (I). For the application of these compounds as a coagulant aid in water treatment, synthetic turbid water was prepared as a fine clay suspension, by slurring fine mud with particle size $< 63\ \mu m$ in tap water. Different concentrations of mud in water were prepared and their respective turbidity were measured. The relation between mud concentration and the turbidity of the suspension are given in Fig. (1). A fine clay suspension of approximately constant turbidity was prepared by slurrying 125 mg/Lit mud in tap water, which gave a turbidity of about 25 NTU (Nephelometric Turbidity Unit). The stock suspension was continually stirred, with mechanical stirrer, to keep its turbidity constant through operating of the different runs.

To locate the critical dose of the coagulant and how it is affected by pH, laboratory tests over a wide range of coagulant dosage were carried out as follows: A series of samples are set up on a stirrer with variable and adjustable number of revolutions and the applicant coagulants were added. After vigorous stirring for one minute, samples were flocculated by gentle stirring for about 30 minutes, and then allowed to stand for an hour. The clear liquid layer is then checked for turbidity. pH of the solution was adjusted by addition of HCl or by NaOH.

Turbidity was measured using a nephelometer calibrated turbidimeter measures in Nephelometric Turbidity Units (NTU), Hach Model 2100A. pH values were measured using a digital pH meter, SCHOTT GERÄTE, W. G. Model CG 818.

In the case of combination of alum and polyelectrolyte, first the optimum alum dose, using alum as the sole coagulant, was determined. Now to the synthetic turbid water containing the optimum alum dose, different doses of the polyelectrolytes were added to locate the dose giving the minimum turbidity. Trials for obtaining optimum dose were started with a low dose, and gradually increased till the optimum dose was reached or little beyond it.

RESULTS AND DISCUSSION:

The new polymeric compounds were used either alone or in combination with alum as a coagulant aid. A typical graph showing the relationship between the dose of the coagulant (on log scale) and residual turbidity ratio (on linear scale) are used for presenting the results. Results obtained from individual compound at different pH values are shown in Fig. (2). The critical dose and the respective residual turbidity ratio for each compound at different pH values are given in Table (2). From this table it is obvious that in acidic medium, (pH 3), compound (I) gave the same results as polyacrylamide. They gave the least residual turbidity ratio at the same concentrations. Following these two compounds coming: compound (II), compound (III), then alum. Alum gave the highest residual turbidity ratio at a critical dose of 5 mg/Liter.

In neutral medium, (pH 7), alum gave a residual turbidity ratio of about 0.06, which is very low, but with high critical dose of 35 mg/lit, compared with 0.5 mg/lit obtained from compounds (I) and (II) which gave a residual turbidity ratio of 0.31 and 0.33 respectively. It seems that the three presented compounds, in neutral medium, gave better results than polyacrylamide which gave a residual turbidity ratio of 0.48 with a critical dose of 1 mg/lit.

In alkaline medium (pH 10), alum gave a residual turbidity ratio of 0.06 at a critical dose of 120 mg/lit, whereas polyacrylamide and the other three compounds (I, II and III) gave a residual turbidity ratio of 0.7, 0.69, 0.56 and 0.65 at a critical dose of 0.25 mg/lit for each respectively. In alkaline medium the hydrochloride derivatives of the polyalkylarylamine tend to give the free polymer which precipitates in solution (Shaaban et al, 1988), therefore, the efficiency of these polymers, as coagulant aid, significantly decreased in alkaline medium.

Results obtained from alum are concordent with that given in literature (Walter and Wint, 1981). Investigation through Fig.(2) indicate that, the clarification effect of both polyacrylamide and compounds (I), (II) and (III) is lower than alum, specifically in neutral medium. This may be attributed to their lower capacity for charge neutralization, as they are nonionic. Therefore, the use of these compounds alone will not offer a charge neutralization, and it is recommended to be used in combination with inorganic coagulant as alum.

Results obtained from polyacrylamide in combination with different alum doses are given in Fig. (3 A), whereas the results obtained from the other three comounds (I), (II) and (III) are given in Fig. (3 B), Fig. (4 C) and Fig. (4 D) respectively. The critical dose and the respective esidual turbidity ratio for each compound with different fixed alum doses are given in table 3). Investigation through these results reveals the role of compounds (I) and (II) with 5 mg/lit ium dose; they could decrease the residual turbidity ratio from 0.6 to 0.34 and 0.39 with critical ose of 2 and o.75 mg/lit respectively. Best clarification effect was obtained from compound II). It could decrease the residual turbidity ratio from 0.06-obtained by the use of 35 mg/lit lum dose-to 0.04 with a critical dose of 0.75 mg/lit. It is worthy of notice that the final turbidity btained by the system 35 mg/lit alum + 0.75 mg/lit compound (III) reaches 1 NTU. The reduction turbidity to such lower values is necessary before chlorination to ensure complete inactivation virus (Singh 1985 b). The typical polyelectrolyte behaviour displayed by compound (III) is caused y the residual amine unit in the structure of this compound. (Mathias and vaidya 1987).

ONCLUSIONS:

Three new polymeric compounds: Poly (ethylene-co-p-phenylene diamine) hydrochloride (I), ly (ethylene-co-4, 4'-diaminodiphenyl) hydrochloride (II) and Poly (aminomethine-co-4, 4'-diaminodi- nyl) hydrochloride (III) were investigated-either alone or in combination with alum-as a coa- nt aid. They were put in comparison with the well known, organic coagulant, polyacrylamide. ese three compounds gave a reasonable results in acidic medium (pH 3). Compound (I) gave ilar results as polyacrylamide. They gave a residual turbidity ratio of 0.34 with a critical of 1 mg/lit. Alum with a critical dose of 5 mg/lit could decrease turbidity to 15 NTU, e the organic coagulant could decrease it to about 8 NTU with critical doses in the order mg/lit.

In neutral or alkaline mediums organic coagulants could not withstand as alum.

Use of compound (III) in combination with alum, in neutral medium, could decrease the turbidity to about 1 NTU with alum dose of 35 mg/lit and 0.75 mg/lit of compound (III). Combination of compound (I), with a critical dose of 2 mg/lit, and 5 mg/lit alum dose could reduce turbidity from 15 NTU to about 10 NTU, where combination of compound (II), (a critical dose of 0.75 mg/lit) with alum (dose 5 mg/lit) could reduce turbidity to about 6.5 NTU.

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Table (I): Chemical Structure of
Prepared Polyelectrolytes.

No.	Compound	Structure	Meltin point (°C)
I	Poly (ethylene-co-p-Phenylenediamine) hydrochloride	$+HN \quad NH-CH_2-CH_2 +_n \; 2nHCl$	315
II	Poly (ethylene-co-4, 4´-diaminodiphenyl) hydrochloride	$+HN \quad NHCH_2 \; CH_2 +_n \; 2nHCl$	250
III	Poly (aminomethine-co-4, 4´-diaminodiphenyl) hydrochloride	$+NH \quad NH-\underset{NH_2}{CH} +_n 2nHCl$	315

Table (2): Critical doses with their respective residual turbidity ratio for individual coagulant

pH	Coagulant									
	Alum		PAA		I		II		III	
	CD	RTR	CD	RTR	CD	RTR	CD	RTR	CD	RTR
3	5	0.58	1.0	0.34	1.0	0.34	1.5	0.38	0.5	0.44
7	35	0.06	1.o	0.48	0.5	0.31	0.5	0.56	0.5	0.33
10	120	0.06	0.25	0.70	0.25	0.69	0.25	0.57	0.25	0.65

CD Critical dose (mg / lit.)

RTR Residual turbidity ratio

Table (3): Critical doses with their respective residual turbidity ratio for polymeric compounds with different doses of alum at pH = 7

Alum dose (mg/lit)	Coagulant								RTR for alum alone
	PAA		I		II		III		
	CD	RTR	CD	RTR	CD	RTR	CD	RTR	
5	0.75	0.58	2	0.34	0.75	0.39	0.25	0.60	0.60
20	0.25	0.17	0.75	0.17	0.50	0.12	0.25	0.10	0.09
35	0.25	0.15	0.75	0.10	0.50	0.11	0.75	0.04	0.06
50	1.00	0.05	0.25	0.04	0.25	0.11	0.75	0,05	0.11
65	0.5	0.04	0.75	0.15	0.50	0.09	2.0	0.06	0.14
80	0.25	0.05	1.25	0.03	0.75	0.16	----	----	0.18

CD Critical dose (mg / lit.)

RTR Residual turbidity ratio

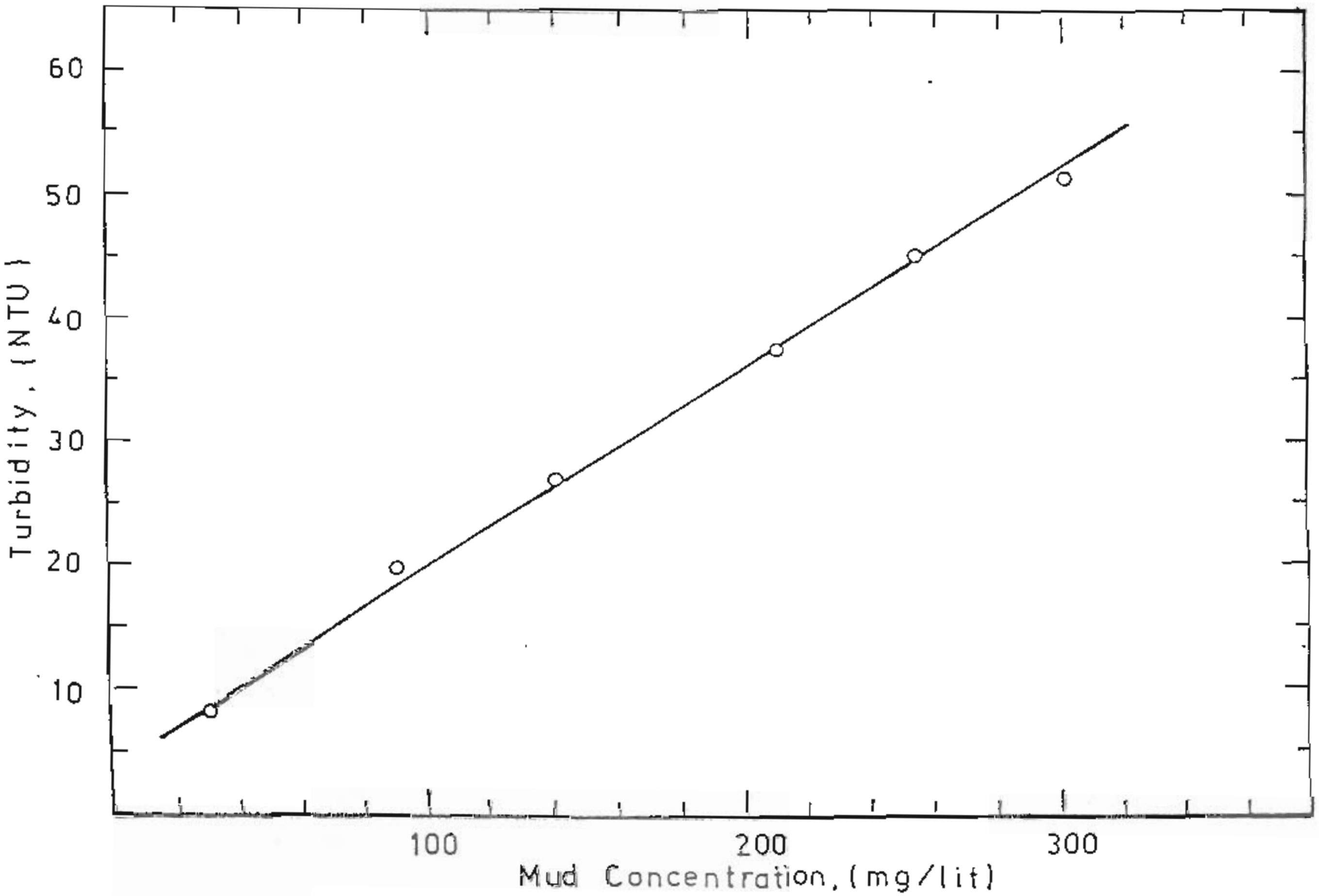

Fig. (1): Relation between mud concentration and turbidity of synthetic turbid water

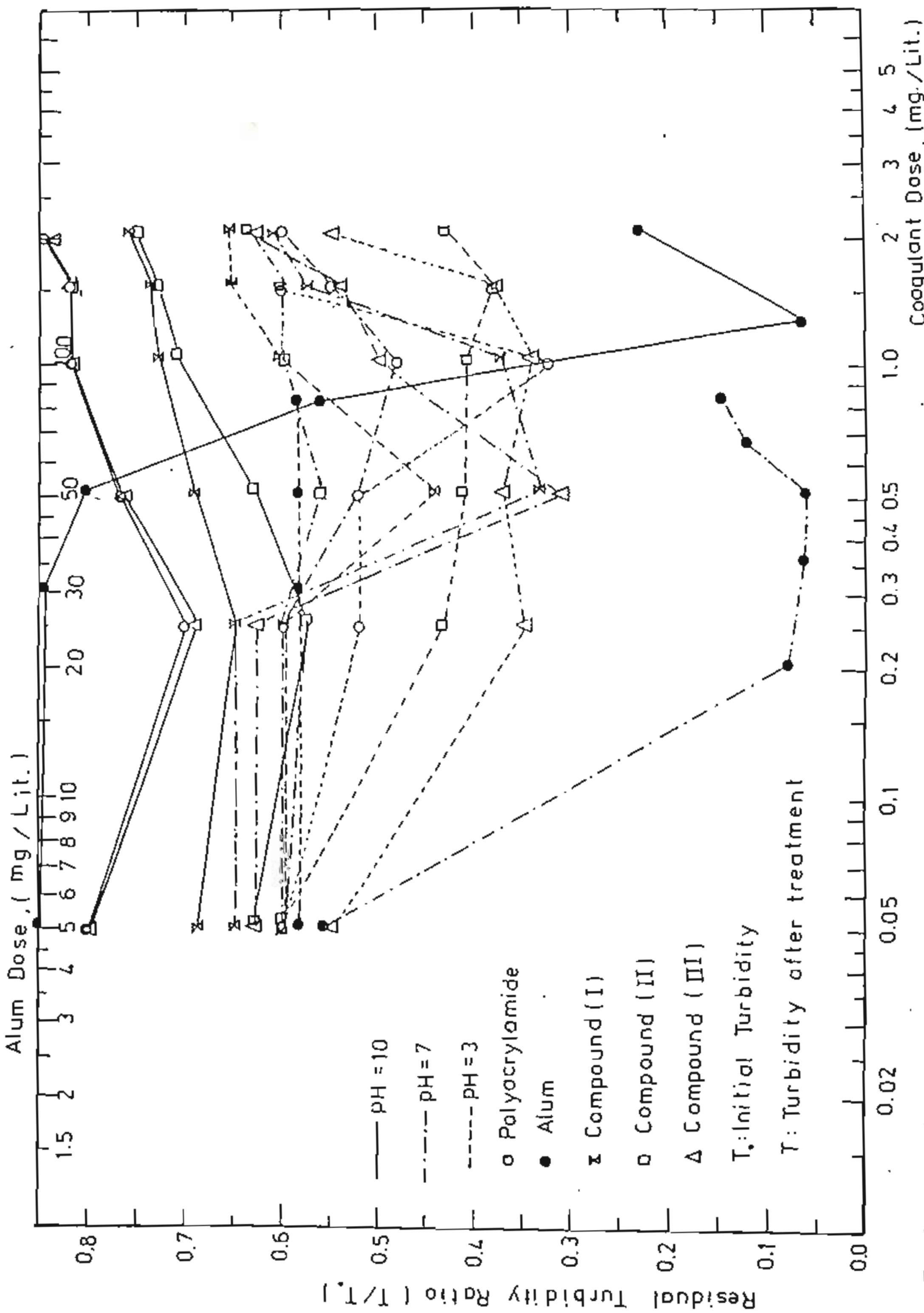

Fig. (2): Residual Turbidity Ratio Vs Dose of Individual Coagulant.

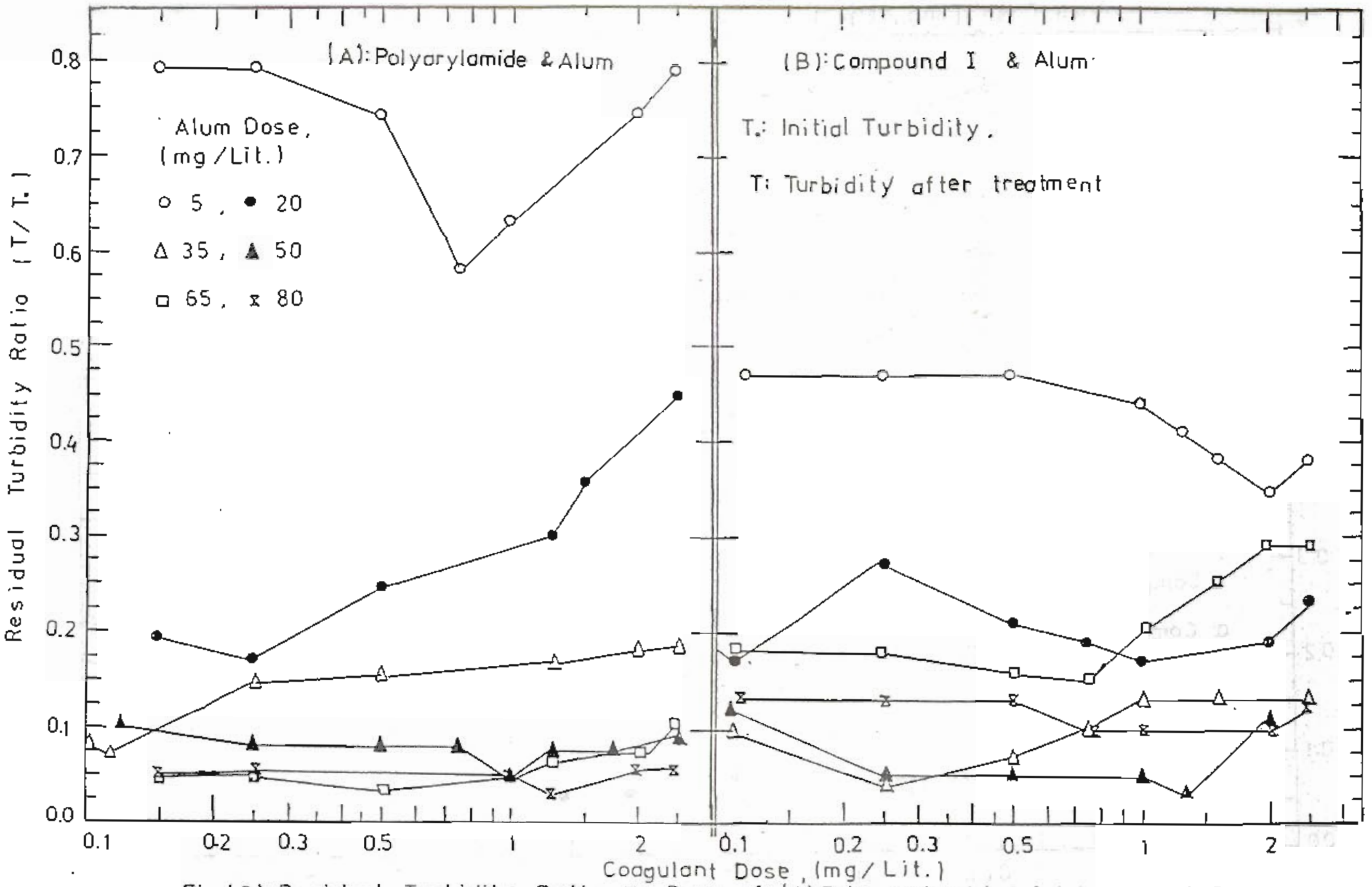

Fig.(3): Residual Turbidity Ratio Vs Dose of: (A) Polyacrylamide & (B) Compound I

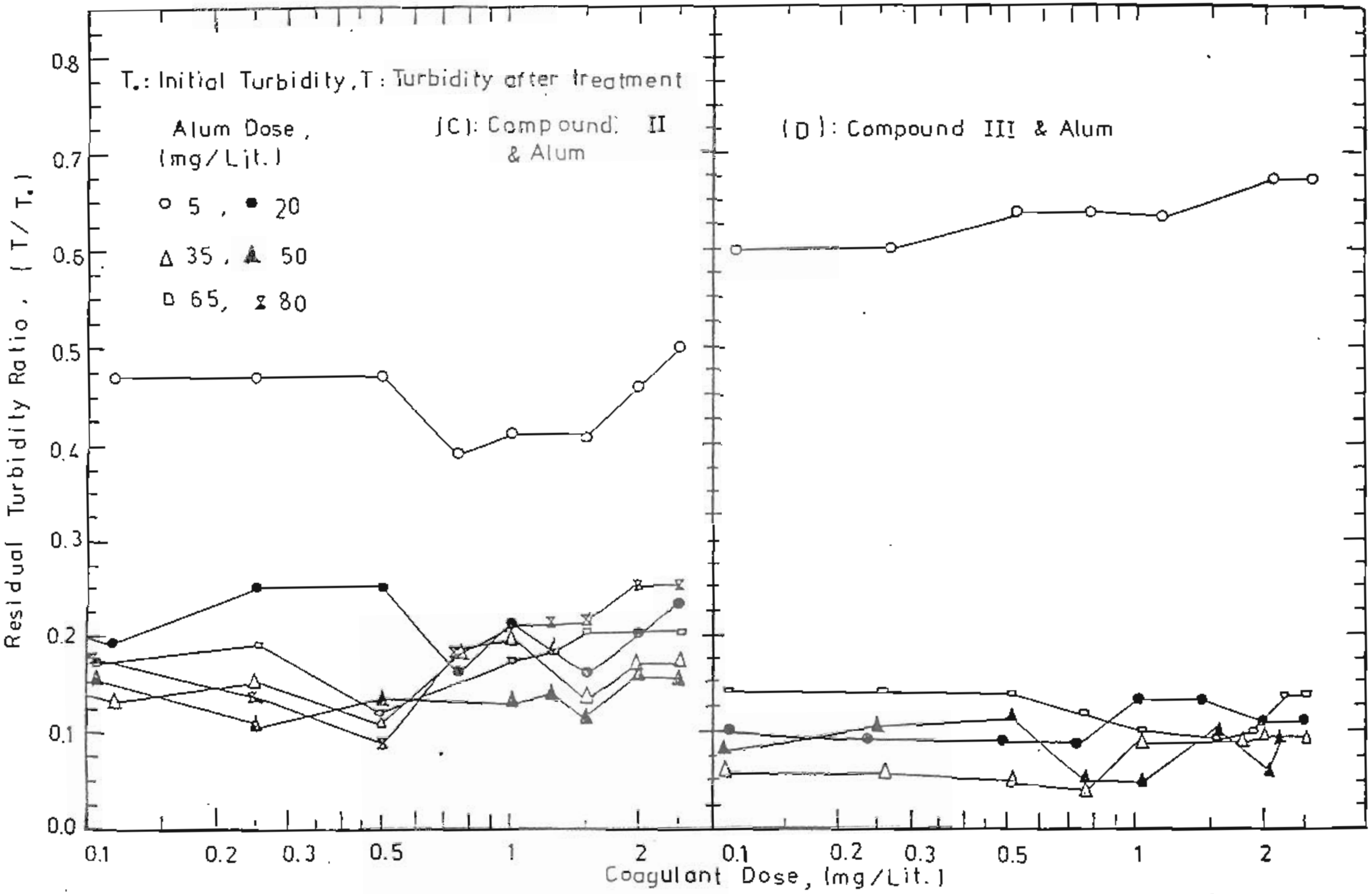

Fig. (4): Residual Turbidity Ratio Vs Dose of : (C) Compound II & (D) Compound III