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Removal of Chloride, Hardness & TDS From water Using Different Adsorbents

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Abstract: Effective removal of Chloride, Hardness, and TDS (Total Dissolved Solids) from water has gained immense importance these days because these are at a high level in the water. Adsorbents i.e. Activated carbon is one of the most effective media for removal of these contaminants from water. Therefore, in our study we have used Adsorbent i.e. Activated carbon; Neem leaves powder, Coconut shell powder, and Charcoal powder which proved the effective removal of Chloride 250 mg/l (59.52%) from 420 mg/l, Hardness 557 mg/l (62.58%) from 890 mg/l, and TDS 1787 mg/l (67.9%) from 2632 mg/l from the water. We have collected the water sample for our study from Bore well near A. B. Road & Gole ka mandir in "Gwalior" city exceed the safe permissible limit for Chloride, Hardness, and TDS in water. The main objective of our study is to find the removal efficiency of all three Adsorbents i.e. Activated carbons with respect to chloride, Hardness, & TDS. The removal efficiency of each adsorbent is conducted over batch study, which includes the effect of various doses, contact time, the effect of initial concentration at normal pH and room temperature.

Keywords: Adsorption, Adsorbent, Activated Carbon, Neem Leaves, Coconut shell, charcoal, Chloride, TDS, Hardness.

I. INTRODUCTION

Adsorption is the mass transfer process through which a substance like liquid or gas solute accumulates on the surface of solid or liquid (adsorbent), forming an atomic film which is known as adsorbate hence adsorbate attached to the adsorbent surface in this process. Adsorption is one of the important processes over the last few decades for the removal of contaminants from water. Activated carbon is the excellent adsorbent, so it is most used adsorbent these days. Therefore, we have used adsorbent i.e. Activated carbon; Neem leaves powder, Coconut shell powder, and Charcoal powder for our study. The main aim of our study is to find the removal efficiency of all three Adsorbents i.e. Activated carbons with respect to chloride, Hardness, and TDS. We have collected the water sample for our study from Bore well near A. B. road & Gole ka mandir in "Gwalior" city exceeding the safe permissible limit for Chloride, Hardness, and TDS in water.

Table 1: Initial parameters of raw water samples are as follows:

Raw water sample source	pH	TDS (mg/l)	Hardness (mg/l) as CaCO ₃	Chloride (mg/l)
A.B. Road bore well water	7.2	821	440	420
Gole Ka Mandir bore well water	8.3	2632	890	1058

II. MATERIALS & METHODS

We have used three different Adsorbents in our study in the form of Activated carbon such as Neem leaves powder, Coconut shell powder, and Charcoal powder. We have prepared Activated carbon: Neem Leaves powder in our institute laboratory. The Activated carbon; Coconut shell powder, and charcoal powder bought from the market.

A. Preparation of Neem Leaves Powder Adsorbent

We have collected Neem leaves nearby area and they were washed several times with clean water and then with deionized water to remove the dirt, and other impurities and then leaves were dried under sunlight for 7 days. After that leaves were crushed fine. About 20 grams of this material treated with 10ml concentrated HNO₃ & the charred material was kept overnight. Then material was washed repeatedly with deionized water & material was heated in an oven for 6 hours at 100°C. Then final adsorbent is ready.

III. EXPERIMENTAL WORK

The experimental work was carried out by subjecting various doses of adsorbents with different concentrations of chloride samples & various contact time at neutral pH (i.e. 7) and room temperature $25 \pm 1^\circ\text{C}$. Initially, we have taken the water sample in 1000ml capacity glass containers and add a particular amount of each adsorbent separately in each container with the dose rate of: Activated Carbon: Neem Leaves Powder; 0.5g, 1g, 1.5g, and 2 grams per litre of water sample, Activated Carbon; Coconut Shell Powder & Charcoal Powder; 2g, 4g, 6g, and 8 grams per litre of water sample. Then the glass container containing mixture agitates in jar test apparatus at 150 rpm for (70 min, 140min, and 180min) as different contact time. After that mixture is then filtered using Whatman filter paper No.41. The filtrate sample was checked for pH, Chloride, Hardness, and TDS for bore well water samples collected from A. B. Road and Gole ka mandir respectively. However the test was done at neutral pH, i.e. 7 which was adjusted by using 0.1N HCl & 0.02NaOH as acid/basic solutions.

Table: 2 Analysis results of bore well water sample collected near A. B. Road in Gwalior city

Analysis Results						
S. no.	Name of Adsorbents	Different		Removal of		
		dose (g/l)	Time (min)	Chloride (mg/l)	Hardness (mg/l) as CaCO ₃	TDS (mg/l)
1.	Neem leaves powder	0.5	70	180	60	124
		0.5	140	210	190	261
		0.5	180	150	179	411
		1.0	70	240	240	336
		1.0	140	250	200	161
		1.0	180	175	220	522
		1.5	70	220	220	404
		1.5	140	184	150	194
		1.5	180	100	120	495
		2.0	70	210	210	405
		2.0	140	170	130	171
		2.0	180	80	100	456
2.	Coconut shell powder	2.0	70	120	80	116
		2.0	140	106	100	193
		2.0	180	40	150	428
		4.0	70	216	220	203
		4.0	140	131	119	347
		4.0	180	84	103	449
		6.0	70	90	204	166
		6.0	140	210	160	336
		6.0	180	100	139	454
		8.0	70	60	180	128
		8.0	140	150	130	356
		8.0	180	80	105	529
3.	Charcoal powder	2.0	70	140	175	154
		2.0	140	102	198	231
		2.0	180	109	190	333
		4.0	70	163	225	349
		4.0	140	110	150	410
		4.0	180	120	167	397
		6.0	70	100	220	456
		6.0	140	160	250	300
		6.0	180	170	240	333
		8.0	70	90	160	483
		8.0	140	150	230	291
		8.0	180	143	225	331

Table: 3 Analysis results of bore well water sample collected near Gole ka mandir in Gwalior city

Analysis Results						
S. no.	Name of Adsorbents	Different		Removal of		
		dose (g/l)	Time (min)	Chloride (mg/l)	Hardness (mg/l) as CaCO ₃	TDS (mg/l)
1.	Neem leaves powder	0.5	70	336	210	869
		0.5	140	342	280	1111
		0.5	180	338	300	1221
		1.0	70	440	440	1119
		1.0	140	436	500	1311
		1.0	180	423	475	1292
		1.5	70	567	430	1411
		1.5	140	618	470	1513
		1.5	180	544	410	1548
		2.0	70	427	495	1384
		2.0	140	448	458	1708
2.0	180	442	452	1611		
2.	Coconut shell powder	2.0	70	198	450	1311
		2.0	140	348	528	1718
		2.0	180	320	375	1612
		4.0	70	380	540	1511
		4.0	140	358	530	1687
		4.0	180	346	603	1727
		6.0	70	278	520	1724
		6.0	140	444	461	1706
		6.0	180	378	557	1787
		8.0	70	248	500	1479
		8.0	140	275	553	1608
8.0	180	243	470	1769		
3.	Charcoal powder	2.0	70	317	237	1250
		2.0	140	348	230	1469
		2.0	180	380	256	1402
		4.0	70	347	372	1563
		4.0	140	369	390	1595
		4.0	180	409	400	1613
		6.0	70	378	400	1687
		6.0	140	399	452	1587
		6.0	180	418	458	1571
		8.0	70	348	415	866
		8.0	140	338	461	811
8.0	180	354	393	903		

IV. RESULTS AND DISCUSSION

Effect of Contact Time with Doses

To study the effect of contact time with different doses of adsorbents on the maximum removal of Chloride, Hardness, and TDS (Total Dissolved Solids) from water samples collected from different locations were carried out. In the experimental work, the sample results are compared with the original sample of initial chloride, hardness, and TDS of bore well water to know the maximum removal of Chloride, Hardness, and TDS of different Adsorbents.

It is clear from results analysis of different samples that time plays an important role for the removal of chloride, hardness, and TDS from the water with different initial values of Chloride, Hardness, and TDS (Total Dissolved Solids) in the bore well water.

(A) For Neem Leaves Powder:

(1) for bore well water sample collected near A. B. Road: -

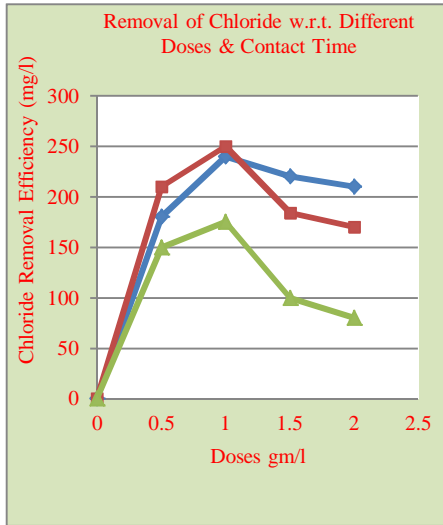


Fig IVA (1) Removal of Chloride w.r.t. Different Doses & Contact Time

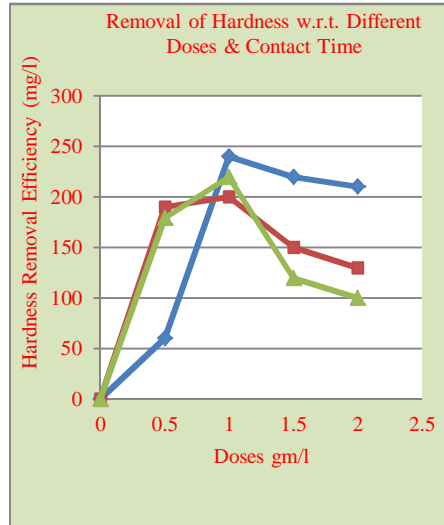


Fig IVA(1) Removal of Hardness w.r.t. Different Doses & Contact Time

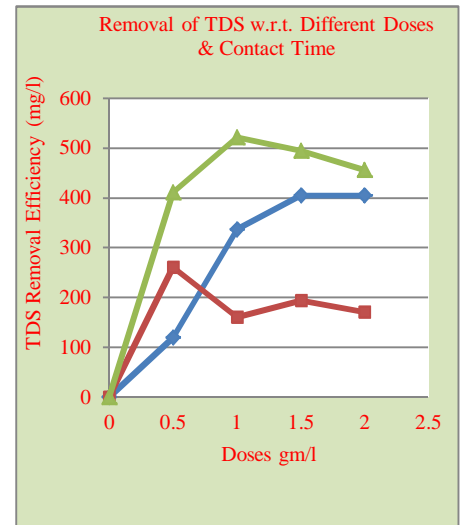


Fig IVA(1) Removal of TDS w.r.t. Different Doses & Contact Time

(2) for bore well water sample collected near Gole ka mandir: -

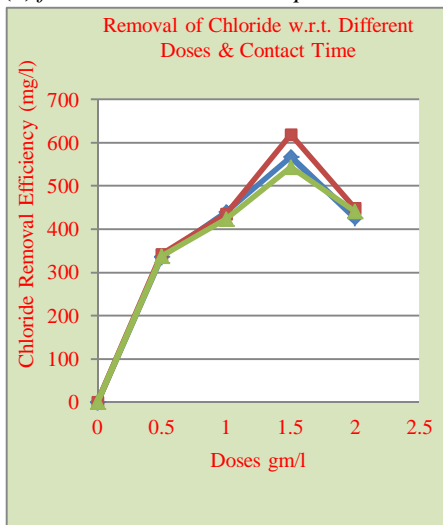


Fig IVA (2) Removal of Chloride w.r.t. Different Doses & Contact Time

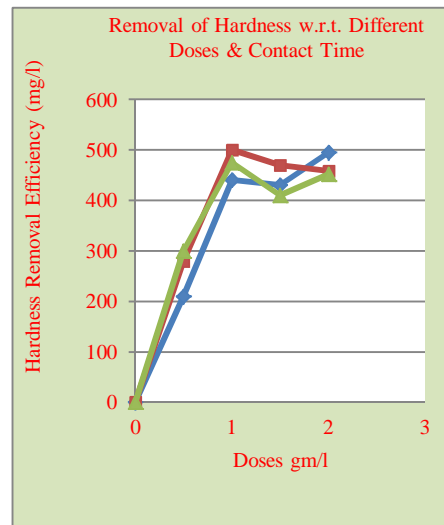


Fig IVA (2) Removal of Hardness w.r.t. Different Doses & Contact Time

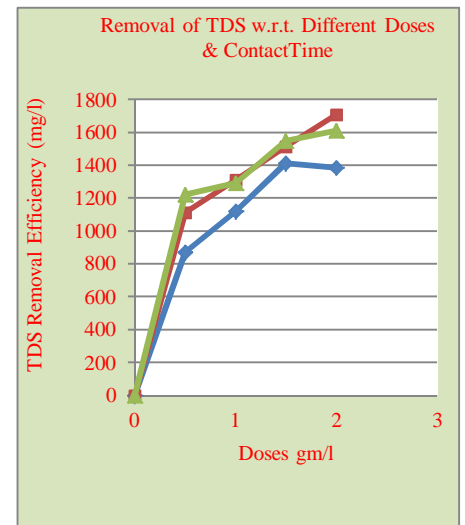


Fig IVA (2) Removal of TDS w.r.t. Different Doses & Contact Time

Contact Time: 70 min ◆
 Contact Time: 140 min ■
 Contact Time: 180 min ▲

(B) For Coconut Shell Powder:

(1) for bore well water sample collected near A. B. Road: -

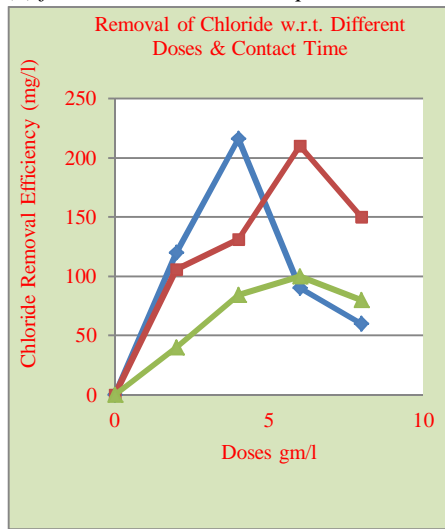


Fig IVB (1) Removal of Chloride w.r.t. Different Doses & Contact Time

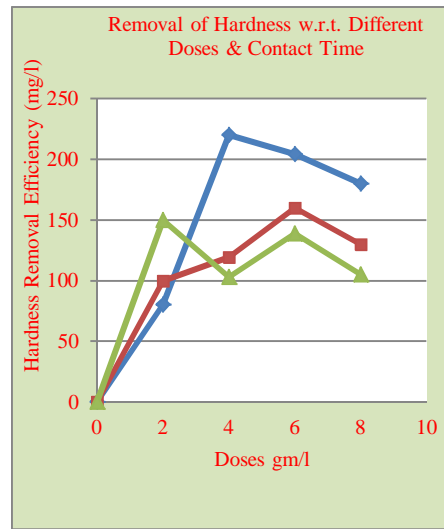


Fig IVB (1) Removal of Hardness w.r.t. Different Doses & Contact Time

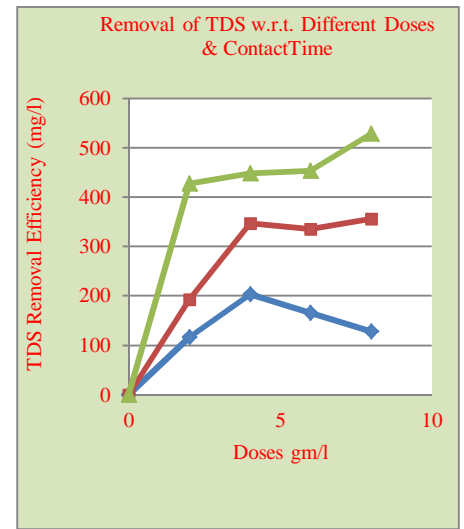


Fig IVB (1) Removal of TDS w.r.t. Different Doses & Contact Time

(2) for bore well water sample collected near Gole ka mandir: -

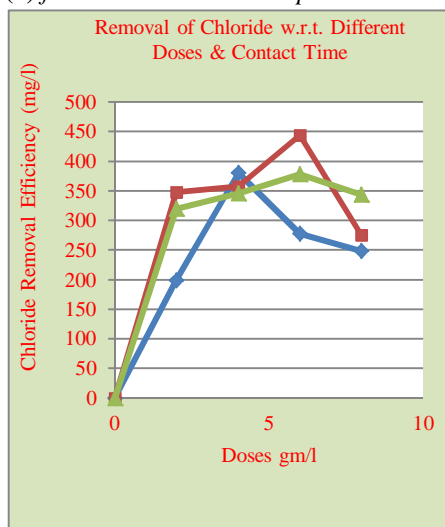


Fig IVB (2) Removal of Chloride w.r.t. Different Doses & Contact Time

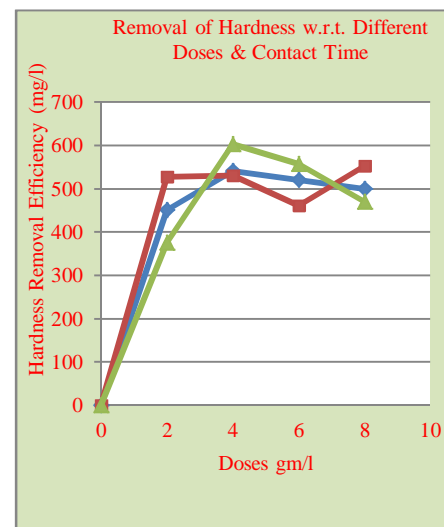


Fig IVB (2) Removal of Hardness w.r.t. Different Doses & Contact Time

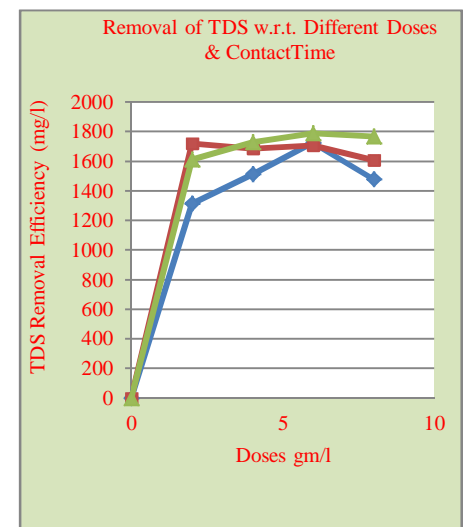


Fig IVB (2) Removal of TDS w.r.t. Different Doses & Contact Time

Contact Time: 70 min ◆
 Contact Time: 140 min ■
 Contact Time: 180 min ▲

(C) For Charcoal Powder:

(1) for bore well water sample collected near A. B. Road: -

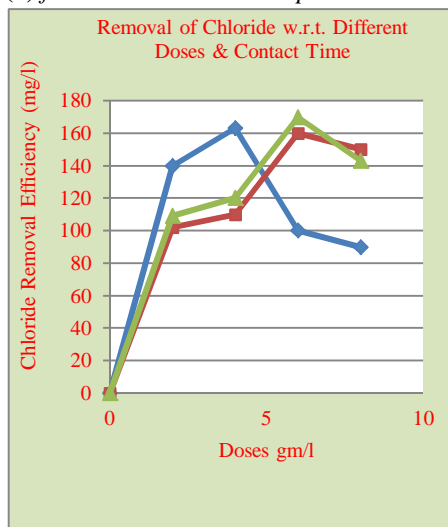


Fig IVC (1) Removal of Chloride w.r.t. Different Doses & Contact Time

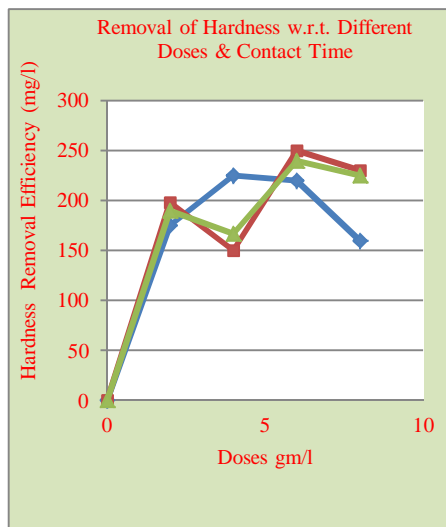


Fig IVC (1) Removal of Hardness w.r.t. Different Doses & Contact Time

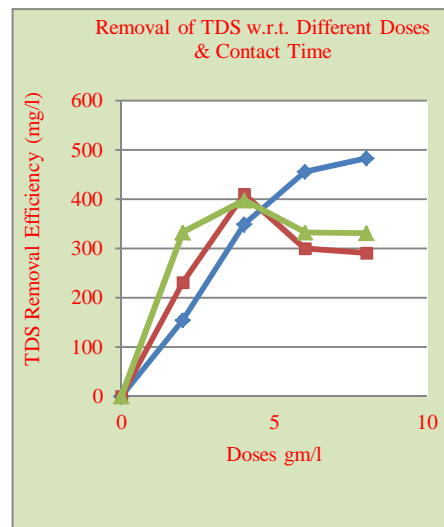


Fig IVC (1) Removal of TDS w.r.t. Different Doses & Contact Time

(2) for bore well water sample collected near Gole ka mandir: -

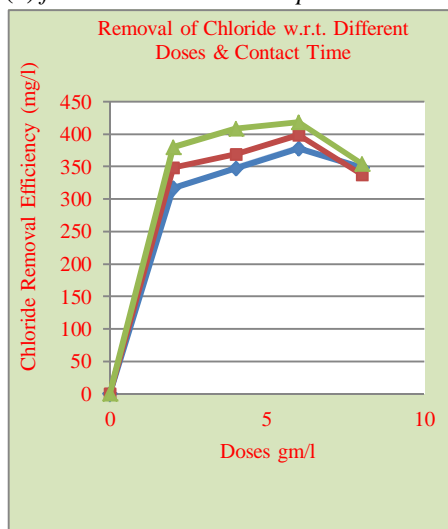


Fig IVC (2) Removal of Chloride w.r.t. Different Doses & Contact Time

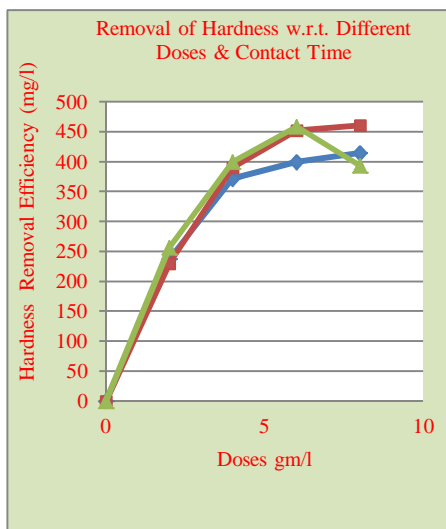


Fig IVC (2) Removal of Hardness w.r.t. Different Doses & Contact Time

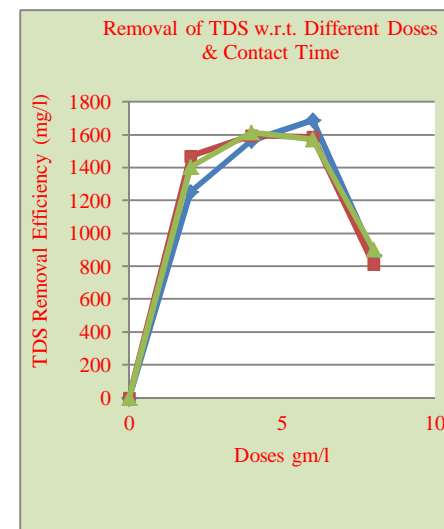


Fig IVC (2) Removal of TDS w.r.t. Different Doses & Contact Time

Contact Time: 70 min ◆
 Contact Time: 140 min ■
 Contact Time: 180 min ▲

V. CONCLUSIONS

As per experimental work carried out in the institute laboratory with Activated carbon; Neem leaves powder, Coconut shell powder, and Charcoal powder at neutral pH and room temperature following conclusions were drawn: -

- A. The maximum Chloride removal is observed as 250mg/l (59.52%) with Neem leaves powder at an optimum dose of 1 g/l and contact time 140 minutes for raw water having 420 mg/l initial chloride content.
- B. The maximum Hardness removal efficiency is observed as 557 mg/l (62.58%) with Coconut shell powder at an optimum dose of 6 g/l and contact time 180 minutes for raw water having 890 mg/l initial Hardness.
- C. The maximum TDS (Total Dissolved Solids) is observed as 1787mg/l (67.9%) from 2632 mg/l respectively with Coconut shell powder at an optimum dose of 6 g/l and contact time 180 minutes for raw water having 2632 mg/l initial TDS.

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