properties this increase is not equivalent to the energy consumption needed to increase the temperature.

Table 3: Effect of Adsorption conditions on the Degree of extraction (R %), and Adsorption Capacity (SC, mg/g)of Metal Ions with Nylon-6 Nonwoven Fabrics Treated with DMABAC and Grafted with PGMA

[(a)] Adsorption Time (min.)	Metal Ions							
	Cu^{+2}		Pb^{+2}		Cr^{+6}		Ag^{+}	
	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g
10	64.6	4.10	59.5	10.9	55.3	5.94	5.61	1.10
20	68.1	4.32	61.3	11.2	58.2	6.25	5.91	1.14
30	73.0	4.63	63.5	11.6	61.8	6.60	7.57	1.40
60	73.0	4.63	63.5	11.6	61.8	6.64	7.60	1.46
120	73.7	4.68	63.6	11.6	61.9	6.65	7.63	1.47
[(b)] Adsorption pH	Cu^{+2}		Pb^{+2}		Cr^{+6}		Ag^{+}	
	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g
3	16.9	1.07	7.10	1.30	9.13	0.89	5.70	1.10
4	19.7	1.26	11.8	2.16	13.2	1.42	5.95	1.15
5	36.9	2.34	28.9	5.30	30.5	3.28	5.95	1.15
6	73.0	4.63	63.5	11.63	61.5	6.64	7.60	1.46
[(c)] Adsorption Temperature (°C)	Cu^{+2}		Pb^{+2}		Cr^{+6}		Ag^{+}	
	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g
25	72.9	4.63	63.5	11.63	61.8	6.64	7.56	1.46
40	78.0	4.95	65.7	12.03	68.0	7.31	7.90	1.52
60	83.5	5.30	70.7	12.90	70.2	7.54	8.55	1.65
80	87.1	5.53	72.3	13.24	73.0	7.84	9.20	1.77
[(d)] Initial Concentration (ppm)	Cu^{+2}		Pb^{+2}		Cr^{+6}		Ag^{+}	
	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g
20	29.5	1.87	23.8	4.35	22.4	2.41	2.02	0.39
40	49.0	3.11	54.5	9.98	43.8	4.71	2.75	0.53
100	73.0	4.63	63.6	11.63	61.8	6.64	7.60	1.46
200	73.6	4.76	63.7	11.70	62.2	6.68	7.73	1.49
[(e)] Graft Yield %	Cu^{+2}		Pb^{+2}		Cr^{+6}		Ag^{+}	
	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g	R%	SC, mg/g
21	36.2	2.29	38.9	7.12	42.8	4.60	3.90	0.76
42	56.5	3.58	46.5	8.51	49.3	5.30	5.70	1.10
66	64.5	4.10	55.2	10.10	57.3	6.20	6.70	1.30
80	70.0	4.41	60.0	11.20	59.9	6.46	7.20	1.39
90	73.0	4.63	63.5	11.63	61.8	6.64	7.60	1.46

Adsorption Conditions:

[(a)] Initial Concentration of Salts, 100 ppm; Adsorption pH, 6; Adsorption Temperature, 25°C, Graft Yield, 90 %; [DMABAC], 4.79×10^{-4} mol/100 gr Nonwoven Fabric.

[(b)] Initial Concentration of Salts, 100 ppm; Adsorption Time, 60 min.; Adsorption Temperature, 25°C; Graft Yield, 90 %; [DMABAC], 4.79×10^{-4} mol/100gr Nonwoven Fabric.

[(c)] Initial Concentration of Salts, 100ppm; Adsorption pH, 6; Adsorption Time, 60 min.; Graft Yield, 90 %; [DMABAC], 4.79×10^{-4} mol/100 gr Nonwoven Fabric.

[(d)] Adsorption pH, 6; Adsorption Time, 60 min.; Adsorption Temperature, 25°C; Graft Yield, 90 %; [DMABAC], 4.79×10^{-4} mol/100 gr Nonwoven Fabric.

[(e)] Initial Concentration of Salts, 100ppm; Adsorption pH, 6; Adsorption Temperature, 25°C; [DMABAC], 4.79×10^{-4} mol/100 gr Nonwoven Fabric.

2. The adsorption equilibrium for the reactive Nylon-6 nonwoven fabrics in case of the investigated ions takes place after 30 minutes from the beginning of sorption process. In addition, the maximum values of the sorption properties have been attained at pH equal to 6.
3. The sorption properties of Nylon-6 nonwoven fabrics are directly related to the polymer add – on up to 80% PGMA. The increase in the amount of grafted polymer on nonwoven fabrics above 80% did not, practically, affect the sorption values. It is important to mention that creation of a very small amount of DMABAC into Nylon-6 fabrics (4.79×10^{-4} mol/100gr nonwoven fabric) before grafting provides reaching maximum graft yield (130 %). This graft yield is almost double the amount of grafted PGMA needed for obtaining maximum adsorption properties of the fabrics. This, in turn, means that, the maximum graft yield (213 %) **[9]** obtained after creation of 0.5-1.0 % PDADMAC into Nylon-6 nonwoven fabrics followed by its grafting with GMA is not required if these modified fabrics will be applied for extraction of metals from its aqueous solutions.
4. Table (4) illustrates the feasibility of the developed method for grafting GMA onto Nylon-6 nonwoven fabrics. Based on the data listed in this table, one can conclude that, it is more effective for grafting GMA onto Nylon-6 nonwoven fabric using $K_2S_2O_8$ – Cu^{+2} as initiating system to use fabrics containing chemically bonded DMABAC rather than fabrics containing

PDNABAC. This approach provides attaining the optimal PGMA (80-90 %) for achieving maximum sorption capacity for pb^{+2}, Cr^{+6}, and Cu^{+2} within a shorter sorption time, less monomer (GMA), $K_2S_2O_8$, $CuSO_4.5H_2O$ and QAS concentrations.

Table 4: The Feasibility of Creation of DMABAC Instead of PDADMAC into Nylon-6 Nonwoven Fabrics for Grafting GMA

No.	Fabrics	Graft Yield %	Grafting Conditions						
			[GMA] (mol/l)	[$CuSO_4.5H_2O$] (mol/l)	[$K_2S_2O_8$] (mol/l)	QAS mol/100 gr Fabric [DMABAC]	QAS mol/100 gr Fabric [PDADMAC]	Temperature (°C)	Duration (min.)
1	Nylon-6 Nonwoven Containing DMABAC and Grafted with PGMA	80.0	1.05×10^{-1}	1.0×10^{-3}	1.97×10^{-4}	4.79×10^{-4}	-	85	20
2	Nylon-6 Nonwoven Containing PDADMAC and Grafted with PGMA	80.0	3.02×10^{-1}	1.5×10^{-3}	2.96×10^{-4}	-	1.5×10^{-3}	85	40

4. Conclusions

1. An effective and generally applicable method for grafting of glycidyl methacrylate onto Nylon-6 nonwoven fabrics for ion exchange applications has been developed. This method is based on creation of a small amount of dimethylalkylbenzyl ammonium chloride instead of polydiallyldimethyl ammonium chloride into Nylon-6 nonwoven fabrics before grafting followed by grafting GMA using $K_2S_2O_8$ – Cu^{+2} as initiating system. It was found that this approach provides proceeding the grafting reaction with high rate and almost without homopolymer formation. Moreover, this developed method paves the way for attaining the optimal percent of grafted polyglycidyl methacrylate (80 %) for achieving maximum sorption capacity for pb^{+2}, Cr^{+6}, and Cu^{+2}. This occurs within a shorter time, and less monomer (GMA), $K_2S_2O_8$, $CuSO_4.5H_2O$ and quaternary ammonium salt concentrations.
2. The sorption properties and factors affecting sorption of the investigated metal ions (pb^{+2}, Cr^{+6}, Cu^{+2}, and Ag^{+1}) with Nylon-6 nonwoven fabrics containing DMABAC, PGMA and aminated with diethylamine were investigated.

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