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Conductivity study of Bulk and Nano $CuSO_4$ with organochalcogenic ligand (H_4L_{Chal})

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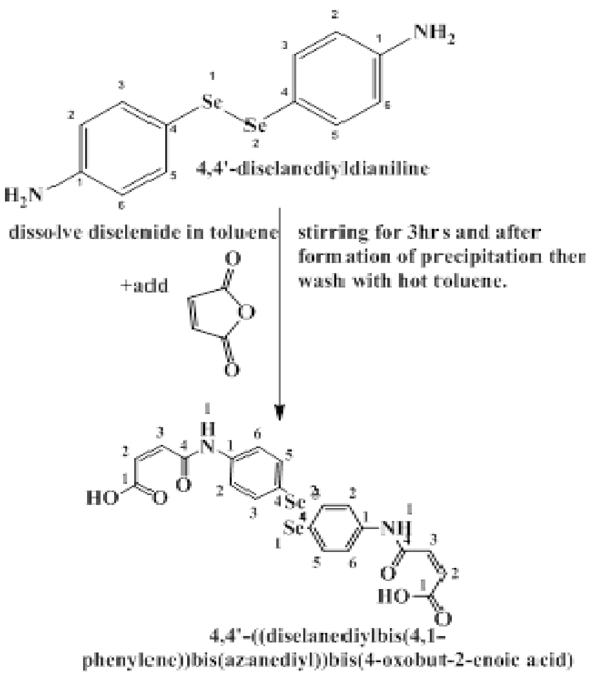
Abstract: The conductivity of bulk and nano copper sulfate salt, $CuSO_4$, in presence and absence of chalcogen ligand **(**H_4L_{Chal}) were studied. Some parameters were calculated (association constant (K_A), dissociation constant (K_D) triple ion (K_3), and association free energy (ΔG_A). explained the data for bulk and nano copper sulfate has done.

keywords:chalcogen–bulk-nano-conductivity.

1.Introduction

Electrical conductivity of materials in water as can be evaluated which depends on ions nature, temperature, and concentration of ions. Conductivity defined as the measurement of ions in solution [1-4]. Conductivity method routinely used because of fast, cheap (61). Conductometric measurements are largely used in industry. For example, treating water or raw water because it comes from a lake, river is rarely suitable for industrial use as it is, fast and reliable method of measuring the ionic content in solutions [5-10].



Structure (1) Preparation of chalcogen ligand H_4L_{Chal}

2. Materials and methods

1. Copper sulfate pentahydrate (bulk and nano).

2.H_4L_{Chal}(ligand) as shown in

3. The solutions' electrical conductivity were estimated by (JENCO, Vision Plus EC3175).

3. Results and Discussion

The conductivity of different bulk $CuSO_4$ and nano $CuSO_4$ additions were measured in different percentage of ethanol (10%, 30%, and 50%). Straight lines were obtained for different ethanol percentages having small slope directions. The Λ_o molar conductances are read by drawing the relation between molar conductances Λ_m and $C^{1/2}$ [10-12].

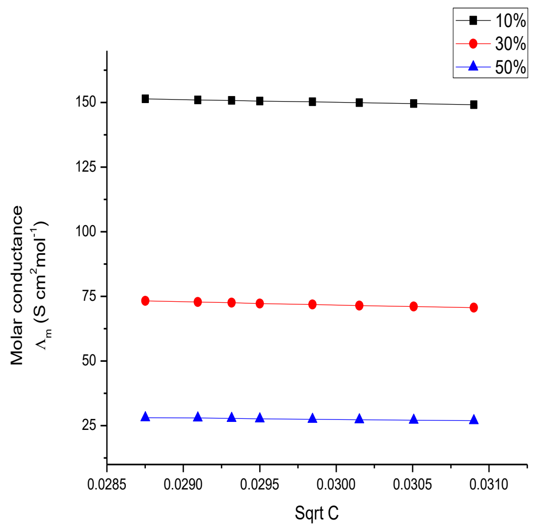


Fig.1. The relation between molar conductance (Λ_m) and $C^{1/2}$ of bulk $CuSO_4$in EtOH-H_2O mixture at 298.15K

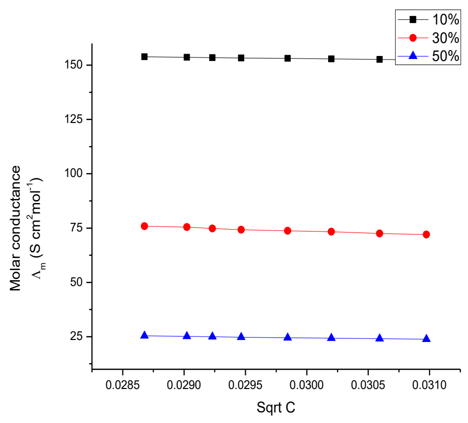


Fig.2. The relation between molar conductance (Λ_m) and $C^{1/2}$ of bulk $CuSO_4$in EtOH-H_2O mixture at 308.15K.

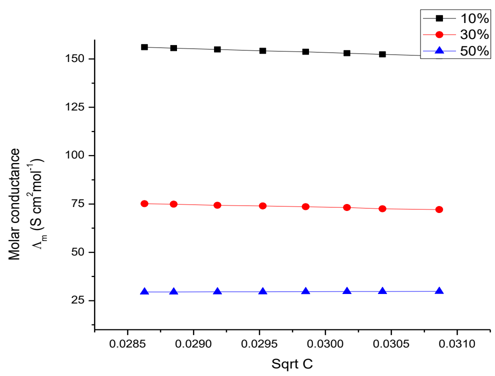


Fig.3. The relation between molar conductance (Λ_m) and $C^{1/2}$ of bulk $CuSO_4$in EtOH-H_2O mixture at 303.15K

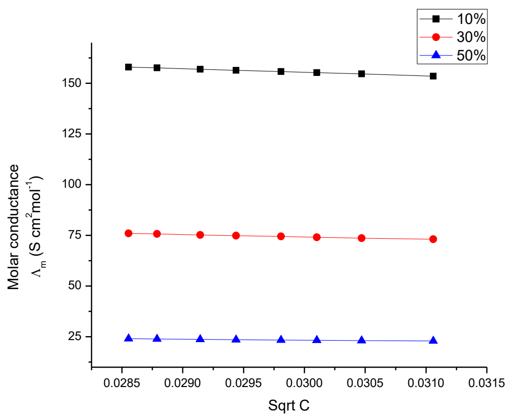


Fig.4. The relation between molar conductance (Λ_m) and $C^{1/2}$ of bulk $CuSO_4$in EtOH-H_2O mixture at 313.15K

The molar conductances are decreased by more adding ethanol indicating decrease of the mobility of free ions due to association and aggregation of ions.

The association constant K_A increased by increase of EtOH percentage.

The dissociation degree α for $CuSO_4$. The dissociation constant K_D decreased by the increase of EtOH percentage. Triple ion association constant K_3 is very small. The Gibbs free energies of association ΔG_A and Gibbs free energies of transfer are increased by increase in percentage of EtOH favoring rise in ions-solvent interaction. All conduct metric data for bulk CuSO4 calculated use Fuoss-Shedlovsky method [4-12] at 303.15K are greater than that at 298.15K due to the increase in the kinetic energy.

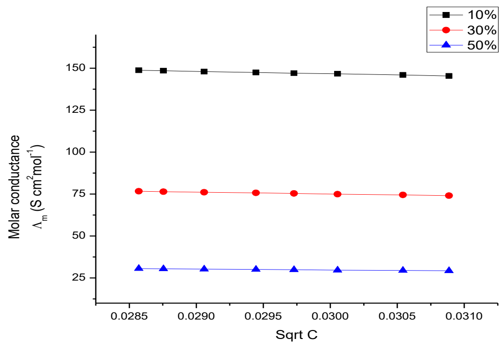


Fig.5. The relation between molar conductance (Λ_m) and $C^{1/2}$ of nano $CuSO_4$in EtOH-H_2O mixture at 298.15K

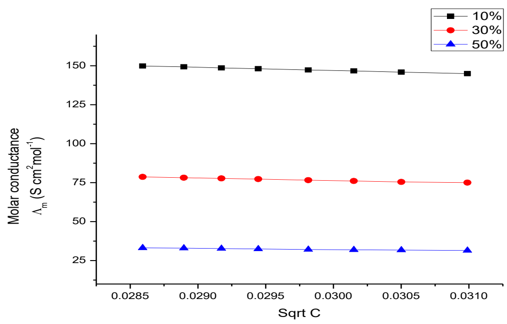


Fig.6. The relation between molar conductance (Λ_m) and $C^{1/2}$ of nano $CuSO_4$in EtOH-H_2O mixture at 303.15K

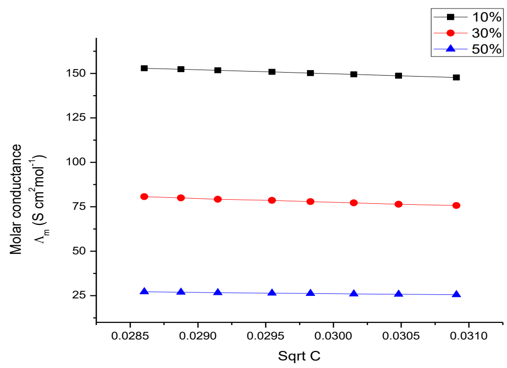


Fig.7. The relation between molar conductance (Λ_m) and $C^{1/2}$ of nano $CuSO_4$in EtOH-H_2O mixture at 328.15K

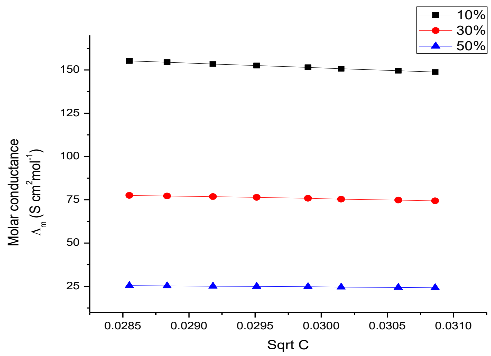


Fig.8. The relation between molar conductance (Λ_m) and $C^{1/2}$ of nano$CuSO_4$in EtOH-H_2O mixture at 313.15K

Table(1) Degree of dissociation (α), dissociation constant (K_D), triple ion association constant (K_3), and Gibbs free energy of association (ΔG_A) for bulk $CuSO_4$in mixture of (EtOH-H_2O) at different temperatures

	Vol.%of EtOH	**10^3 K_D**	**α**	**10^5K_3**	**Δ G_A**
	10	0.0032	0.8393	-.0053	-4.2605
298.15K	30	0.0011	.6864	-.0091	-6.8827
	50	0.0009	.6607	0.0095	17.3096
	10	0.0013	0.7190	3.0004	16.6461
303.15K	30	0.0009	0.6530	5.0000	-7.6652
	50	0.0606	0.9890	2.0002	-7.0669
	10	.0052	0.8919	8.0003	-3.4659
308.15K	30	0.0006	0.5952	6.0001	-8.8448
	50	0.0005	0.5672	8.0003	-9.3474
	10	0.0016	0.7447	2.0001	-6.8085
313.15K	30	0.0009	0.6648	4.0008	-8.1551
	50	0.0008	0.6518	6.0000	-8.5287

Table (2): Degree of dissociation (α), dissociation constant (K_D), triple ion association constant (K_3) and Gibbs free energy of association (ΔG_A) for nano $CuSO_4$ in mixture of (EtOH-H_2O) at different temperatures

	Vol.% Of EtOH	**10^3 K_D**	**α**	**10^5K_3**	**Δ G_A**
	10	0.0022	0.7947	-0064	15.1363
298.15K	30	0.0011	0.6907	-.0089	-.8018
	50	0.0008	0.6382	-.0101	7.5589
	10	0.0012	0.6996	3.0008	-.9581
303.15K	30	0.0007	0.6098	6.0002	-.2681
	50	0.0007	0.6110	6.0008	-.2511
	10	0.0011	0.6881	4.0000	7.4222
308.15K	30	0.0004	0.5403	8.0005	19.5812
	50	0.0006	0.5747	8.0000	19.0833
	0.0008	0.6424	5.0001	18.4081	0.0008
313.15K	0.0009	0.6465	5.0003	-.3485	0.0009
	0.0008	0.6202	7.0001	8.7364	0.0008

ΔG_A for nano $CuSO_4$ in mixed EtOH-H_2O is greater than bulk $CuSO_4$ in same solvents and temperature. Higher values of ΔG_A for nano $CuSO_4$ solutions than bulk $CuSO_4$ at same EtOH-H_2O composition and temperature.

By drawing the relation between log K_A and 1/T giving straight line with slope (-ΔH_A/2.303R) as shown in Figures 9, 10

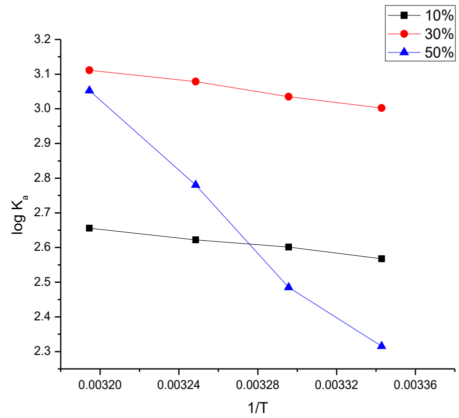


Fig.9. log K_A against 1/T for B-$CuSO_4$ in EtOH-H_2O mixture

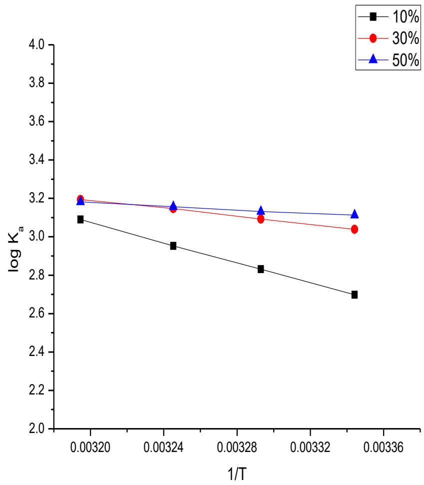


Fig.10.log K_A against 1/T for N-$CuSO_4$ in EtOH-H_2O mixture

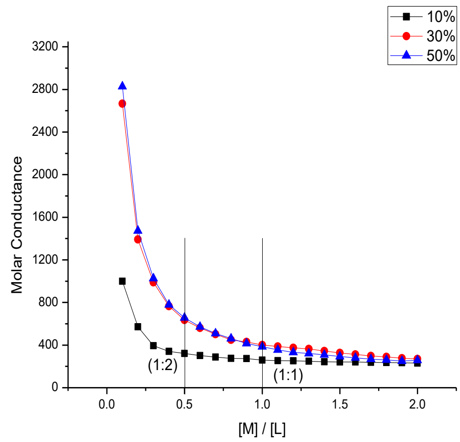


Fig.11. at 298.15K

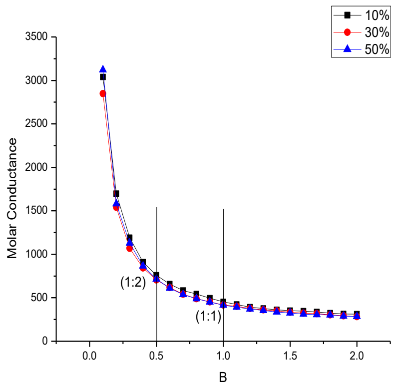


Fig.12. at 303.15K

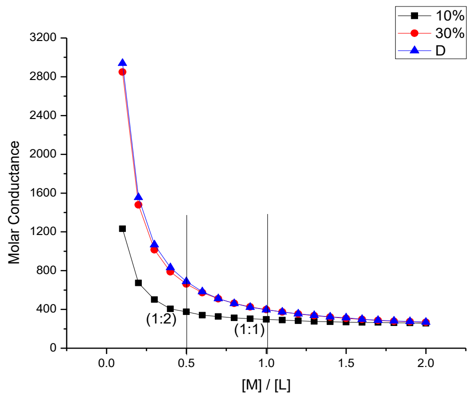


Fig.13.at 308.15K

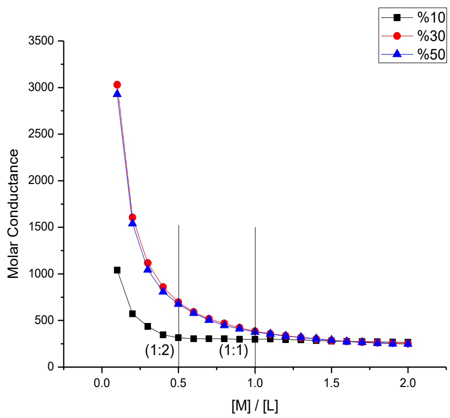


Fig.14. at 313.15K

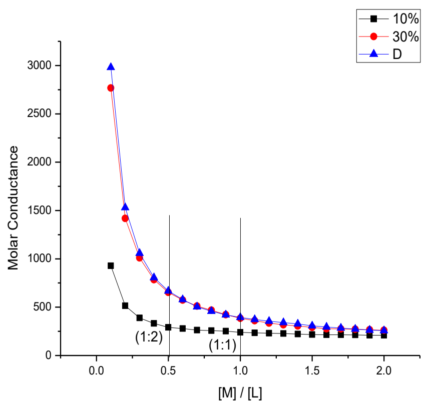


Fig.15. at 298.15K

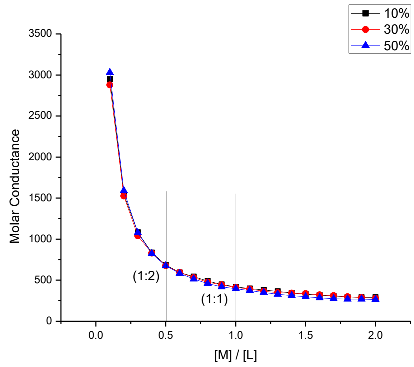


Fig.16.at 303.15K

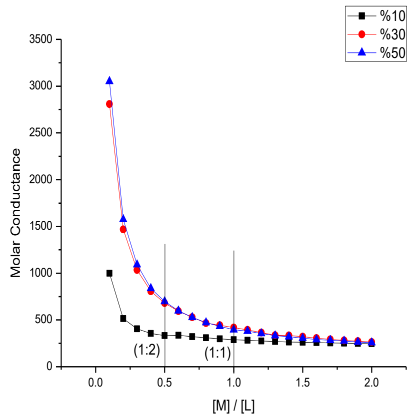


Fig.17.at 308.15K

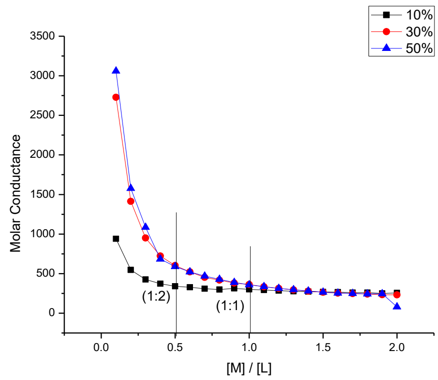


Fig.18 at 313.15K

The relation between (Λ_m) and the [M]/[L] molar ratio of bulk $CuSO_4$-H_4L_{Chal} complexation in (EtOH–H_2O) mixed solvents as shown in figures (11-14).

The relation between (Λ_m) and the [M]/[L] molar ratio of nano $CuSO_4$-H_4L_{Chal} complexation in (EtOH–H_2O) mixed solvents as shown in figures (15-18)

The plot of log $K_f$versus (1/T) at different temperatures for bulk $CuSO_4$-H_4L_{Chal} (1:2) and (1:1) M: L stoichiometric complexes in 10%, 30%, 50% (EtOH–H_2O) mixed solvents as shown in figures (19-21

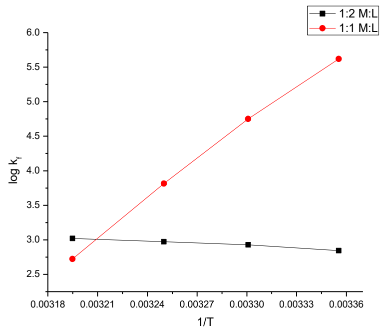


Fig.19.log $K_f$versus (1/T) for B-$CuSO_4$-H_4L_{Chal} (1:2) and (1:1) M:L stoichiometric complexes in 10% (EtOH–H_2O) mixed solvents

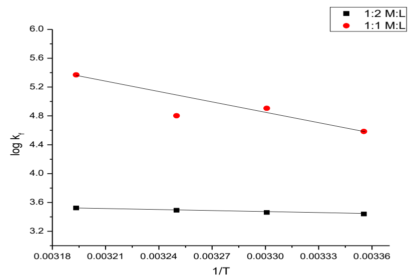


Fig.20.log K_f versus (1/T) for B-$CuSO_4$-H_4L_{Chal} (1:2) and (1:1) M:L stoichiometric complexes in 30% (EtOH–H_2O) mixed solvents

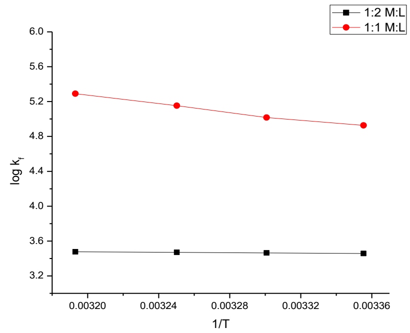


Fig.21.log $K_f$versus (1/T) for B-$CuSO_4$-H_4L_{Chal} (1:2) and (1:1) M:L stoichiometric complexes in 50% (EtOH–H_2O) mixed solvents

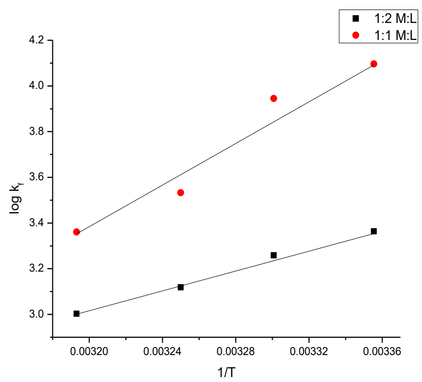


Fig.22.log K_f versus (1/T) for N-$CuSO_4$-H_4L_{Chal} (1:2) and (1:1) M:L stoichiometric complexes in 10% (EtOH–H_2O) mixed solvents

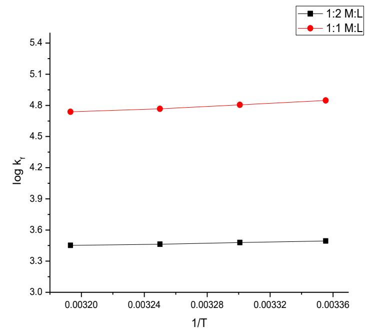


Fig.23. log K_f versus (1/T)for N-$CuSO_4$-H_4L_{Chal} (1:2) and (1:1) M:L stoichiometric complexes in 30% (EtOH–H_2O) mixed solvents

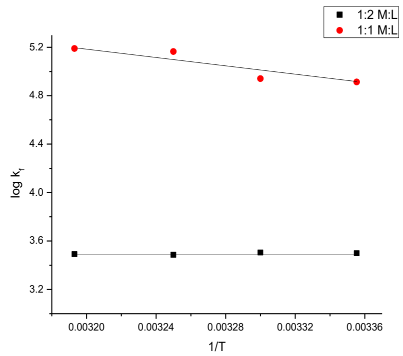


Fig.24.log $K_f$versus (1/T)for N-$CuSO_4$-H_4L_{Chal} (1:2) and (1:1) M:L stoichiometric complexes in 50% (EtOH–H_2O) mixed solvents

The plot of log $K_f$versus (1/T) at different temperatures for nano$CuSO_4$-H_4L_{Chal} (1:2) and (1:1) M:L stoichiometric complexes in 10%, 30%, 50% (EtOH–H_2O) mixed solvents as shown in figures(22-24)

1:1 (M/L) complexes are more stable because they have greater thermodynamic parameters than 1:2 (M/L) complexes. Very high positive entropy of complex formation for nano $CuSO_4$+ H_4L_{Chal} shows easier formation 1:1 and 1:2 complexes.

Conclusions:

1 Gibbs free energies of association, ΔG_A for nano $CuSO_4$ in mixed EtOH-H_2O is greater than bulk $CuSO_4$in same solvents and temperature,

2-.Higher values of ΔG_A for nano $CuSO_4$ solutions than bulk $CuSO_4$ at same EtOH-H_2O composition and temperature.

3-High positive entropy of complex formation for nano $CuSO_4$+ H_4L_{Chal} indicating easier more complexation than bulk salt.

4. References:

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