Surfactant for Pesticide Formulation.

Supplement Edition,

Concept of I/O Balance, HLB(I/O)

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HLB is one of very useful index which indicate hydrophilic, hydrophobic property of surfactant, it is shown 0 to 20 usually. This concept itself can be apply for all of the surfactant, but actually it is known for only Nonionic surfactant. For Anionic surfactant, we don't know the HLB, but actually we have no need to know HLB of Anionic surfactant because surfactant selection for Pesticide formulation is very complex, and mainly depend on experience. Even so, still HLB is one of index of surfactant because it give us initial idea for surfactant selection.

Limitation of current HLB, are it shows only Balance of Hydrophile Lipophile Balance, but it can't estimate Lipophilic part structure, Functional group, Size of surfactant, especially it can't be apply for Anionic surfactant. In addition, we can't estimate Solvent, Technical such as other ingredient under same estimation method.

In case idea of Inorganic Organic Balance (I/O Balance), we are able to know Inorganic, Organic property separately, and it contains Structure, Functional group, Size factor of surfactant. And ratio of Inorganic, Organic property (I/O × 10) is understood that it is almost similar with conventional, empirical HLB.

The concept of the Inorganic-Organic property (I/O Balance) looks better than empirical HLB, but still we need experience to optimize surfactant for Pesticide formulation. But at least we can say it might be one of very useful idea for Pesticide Formulation.

In following Table, there are (I/O × 10) data for Pesticide Technical, Solvent and Surfactant. In case Surfactant, there is empirical HLB also. Very simply said, Organic Property means Lipophilic (Hydrophobic) property, and Inorganic Property means Hydrophilic property.

In case following Figure, we need pay attention about location of each product. Even data of (I/O × 10) is same, it means HLB is same, if the location is different from origin, it suggest us different of Size of product.

In case Surfactant, we are able to know all surfactant HLB(I/O) under same estimation method.

I/O Balance of Technical Table-1

TC Name	HLB	I/Ox10	TC Name	HLB	I/Ox10
Etofenprox		2.10	Endosulfan		5.67
Fenvalerate		3.63	Phentoate		5.71
Deltamethrin		3.66	Chlorpyrifos		6.89
Prothiofos		4.27	Tetrachlorvinphos		6.90
Cypermethrin		4.61	Fenitrothion		7.03
Mefenacet		4.62	Chlorpyrifos-m		7.73
Fthalide		4.69	Daconil		8.13
Edifenphos		4.74	2.4-D		8.54
Butachlor		4.74	Captan		8.59
Dimepiperate		5.29	Flurprimide		8.73
Pyributicarb		5.51	Propoxur		9.05
Thiobencarb		5.63	Diazinon		9.33
Pendimethalin		5.63	Fenobucarb		9.79
Fenthion		5.65	Pyridaphenthion		9.86

TC-Name	HLB	I/Ox10
Triadimefon		10.30
Isoprocarb		10.68
Dithianon		10.78
Carbaryl		11.67
Topsin-M		12.37
Imidacloprid		13.28
Carbendazim		17.22
Bensulfuron-m		17.92
Maneb		19.23
Oxine-copper		19.44
Simazine		20.00
Benomyl		20.54
Nicosulfuron		21.76
Pyrazosulfuron		28.39

I/O Balance of Solvent. Table-2

Solvent Name	HLB	I/Ox10
Kerosin		0.00
Ethyl benzene		0.75
Xylene		0.94
Toluene		1.07
Benzene		1.25
Methyl naohthalene		2.73
Cyclohexanon		6.25
BDG		8.75
NMP		14.50
PG		40.00
EG		50.00

I/O Balance of Surfactant. Table-3

Surfactant	HLB	I/Ox10	ION	Solubilization	Comment
SK-97DM		2.50	(C)	(M/B)	
SK-5935	4.30	6.08	N	(M/B)	Empirical HLB might be appropriate
SK-12WP	10.82	8.00	N	S	It might be around 9.00
SK-53CA		8.82	A	(M/B)	
SK-355	10.00	10.38	N	S	
SK-94S7	11.80	10.61	N	M	
SK-5218CP	13.00	11.56	N	B	I/O x 10 might be appropriate
SK-33SC	(12.00)	12.07	N-A	B	
SK-22WP	15.32	13.54	N	M	
SK-92FS1	15.00	13.54	N	B	It might be around 14.50
SK-30WP		14.44	N-A	M	
SK-5945	15.00	14.74	N	M/B	
SK-34SC	(15.00)	16.10	N-A	B	
SK-31SX		16.71	A	M	
SK-551		17.62	A	M	
SK-96		19.28	N	M	
SK-10LX		21.67	A	S/M	Easily affect water hardness
SK-62		22.06	B	M	
SK-9702Q		22.50	C	S	Main component of SK-41CN
SK-21K		30.91	A	S	
SK-25CH		34.35	A	S	

HLB : ( ), HLB of raw material Nonionic surfactant,

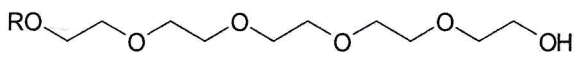
ION : N/ Nonion, A/Anion, N-A/Nonion modified to Anion, B/Betain, C/Cation, (C)/Amine

Solubilization : B/Big, M/B /Medium to Big, M/Medium, S/M /Small to Medium, S/Small

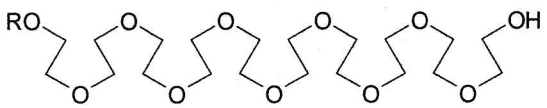
(M/B)/Medium to big in case together with Nonion, single is not water soluble

In case Poly ethoxylated Nonionic Surfactant, it is understood as Hydrophilic part of Nonionic Surfactant, but actually Hydrophilicity is completely different from Anionic Surfactant. We tend to think oxyethylene group is essentially hydrophilic group, and Hydrophilicity manifest only by Hydration of water to Ether Oxygen, but actually structure form change is more important for Hydrophilicity.

We should know oxyethylene group is Hydrophilic group but also it should be understood as a kind of Hydrophobic (Lipophilic) group. In I/O Balance calculation of oxyethylene group, Inorganic property calculated as 60, and Organic property calculated as 30.



Zigzag structure



Meander structure, CH_2 chain covered by ether -O- located in outside

Fig. 1

In case Polyoxymethylene (POM), $-(CH_2\text{-}O\text{-})_n-$ group, it compose more "ether oxygen" compare with Polyoxyethylene (POE), $-(CH_2CH_2\text{-}O\text{-})_n-$ group. So, if Hydration of water to ether oxygen is more important factor of water solubility of surfactant, POM must have more good water solubility, but actually such POM is not water soluble. Such POM, in other word Polyacetal resin is used as Engineering Plastic.