Title: The SURVISMETER- a Green Technology in Service

Item Profile- A multipurpose, fast-track glass apparatus to measure various parameters of a liquid. Initially invented for measuring surface tension and viscosity hence the name. Now finds many applications in many fields and extended to determine interfacial tension, wetting coefficient, surface area of a molecule and friccohesity. It has Singapore (no 126089) and Indian patents in year 2008, and calibrated (no. 06070582/1.01/C-0395) with National Physical Laboratory, Delhi.

Concept and innovation by Dr. Man Singh
Chemistry Research Lab., Deshbandhu College, (University of Delhi), Kalkaji, New Delhi-110019, India
e.mail-mansingh50@hotmail.com

Research consultant and presenter: Dr. (Miss) S. Bhanumati
Chemistry Dept. Gargi College (University of Delhi) SiriFort Road New Delhi India
E-mail sbhanumati@gmail.com Pin code-110049

Collaborators: Dr. Shyam. S. Shukla
Dept. of Chemistry and Physics Lamar University Texas, USA 77710
E-mail shyam.shukla@ lamar.edu

Alka Shukla Southeast College, Houston, Texas, USA 77270
E-mail –alka,shukla@hccs.edu

ABSTRACT-

Viscosity is a measure of stickiness and the reverse is fluidity. It is a valuable data for all liquids in the oil, lubricant, paint, polish, food, beverage, cosmetic, biosolvents, drugs and pharma, polymer, nanomaterials, and thousand other industries. Real life fluids- blood, plasma, serum, proteins, electrolytes, emulsions, gel-sols, colloids and several alikes are better understood and assessed using the viscosity data. The viscosity of blood is around $4x10^{-3}$ Pa.s and the flow rate is proportional to 4th power of a radius of the capillary "r" hence a small decrease in "r" can produce a significant change in the blood flow. If "r" = ½ then the blood flow rate decreases by 16 times. Hence the worry about cholesterol affecting the heart efficiency is fully justified. Viscosity data is therefore extremely valuable. Similarly, engine oil is much less viscous at higher temperatures. This correlates to the fuel consumption in the automobiles.

Liquid surface responds in a way similar to a stretched membrane. Larger the surface area, greater is the energy. To minimize the energy smaller surface area is assumed by liquids in the form of drops. The term Surface Tension (force F per unit length L which tends to pull the surface back to minimum energy) is given as ST=F/L. Soaps and detergents lower the ST of water. Substances with low ST tend to form films.

The Survismeter measures ST and V with high accuracies and precisions. With one time loading, multiple parameters are determined. Sucking of the liquid is avoided because a piston does the job-averting any health hazard being a cost, energy and health protecting device. The survismeter is best suited for academic, research and development laboratories, pharmaceutics, medical, engineering, hydrodynamic studies, automobile, aviation, environmental, municipal wastewater treatment and endless management fields. Survismeter allows minimal discharge of polluting effluents in experiments for Surface Tension, Interfacial Tension, wetting coefficient and Viscosity.

Superior over conventional devices:

Since it is a single unit so saves washing reagents chromic acid and acetone by 90% unlike tensiometers Stalagmometer and viscometers when in use for B.Tech, B. Pharm, B.Sc., M. Sc, M Tech, research etc. Also for quality of syrups, sol-gels, medicinal tablets, useful mixtures like coolants, dry-cleaning, atomizing mixtures like pesticides, spraying agents, disinfectants, cosmetics. Surface tension controls atomization of pesticides Aldrine etc for agricultural use. Insecticides and pesticides do require minimum surface tension for successful and economic process to save large amount that goes wastes. It is simple and fascinating science.

Operation:

The Survismeter works with pressure gradients created with rotation of shaft of piston. There are two operations upwards and down for lifting up sample to functional bulb and releasing to reservoir bulb at the bottom. The pendent drop counts and

viscous flow times are measured within fiducial marks. For interfacial tension a lighter liquid (like benzene) taken in reservoir bulb and denser (like water) in capillary fitted bulb and the capillary remains dipped in lighter liquid. The 4-7 drops min^{-1} in benzene out of water within fiducial marks are counted.

Gibbs adsorption equation: The surface excess concentration (Ґ) is derived with $\gamma = -2.303\ RT\ (Ґ) \log (c)$. The R is 8.314 J $mol^{-1}K^{-1}$, K temperature in Kelvin. The Ґ enables CMC study.

Applications:

Ink Industry

Ink is a semi liquid material used for writing, printing or drawing, as a colloid of fine pigment particles dispersed in a solvent. Dispersion must not settle into clumps.

Soap and Detergent Industry

ST must be reduced so the water can spread and wet surfaces. The surfactants make water "wetter" by lowering of ST.

Paper and Pulp Industry

Cellulose acetate propionate (CAP) and cellulose acetate butyrate (CAB) as additive components of thermoplastic and thermosetting solvents for coating, control viscosity in cosmetics, pharmaceutical and electrophoresis.

Proteins

An ability of protein is to impart favorable characteristics as functionality like viscosity, emulsification etc. Solubility is due to surface active properties of proteins, as well as foaming, emulsification, fat and flavor binding properties. Hydrodynamics influence viscosity and gelation. The protein's surface activities are due to amino acid composition, amino acid distribution that influence pH, ionic strength, temperature, solvent component, and other food components. Viscosity is functional properties of food proteins for stability, emulsions, polymerization, aggregation and hydrolysis.

Foams:

The water has a high surface tension at the surface, when a surfactants absorbs to the surface, the forces are broken down and the surface tension is reduced that foam.

Petroleum and oil industry

Low shear stress or viscosity of oil permits satisfactory flow in engine. Viscosity Index (VI) indicates an effect of temperature change on the viscosity. The high VI infers less change of viscosity with temperature. Viscosity modifier, a lubricant additive usually a high molecular weight polymer reduces the tendency of an oils viscosity to change with temperature.

Drug absorption:

The effect of viscosity and surface tension on an absorption rate of two model drugs ethanol and salicylic acid has been studied. The two drugs were administered simultaneously, dissolved in aqueous solution with 0, 1, 1.5% methylcellulose with viscosities from 1 to 500 cps. Correlation of ethanol and salicylic acid absorption data infer effects of viscosity and surface tension.

Uses in:

Chemical Kinetics, Hydrolysis, Water treatment, Transport, Conductance, Potentiometry, Electro chemistry, Fuel designing, Food and Nutrition, Separation technology, Calendaring, Diffusion, Intermixing, Supramolecular, Molecular radii determination, Purity of materials, Detection of functional groups, Determination of nature of liquid Monitoring of liquids for desired physical properties, Determination of buffer action Complex formation, Intermediate compound formation, Stability coefficient and optimization of molecule, Shear determination of molecule, Newtonian and Non- Newtonian liquid determination, Soil capillary, Chromatography.

Ion Exchange technology

At viscosities greater than 26 cP no mixing occurred as the liquid traveled from one disc to the next. So an influence of surface area is noted but in a packed column the interfacial transfer area is very dependent on the surface properties of the system. Partition coefficient determination, Hydrophobic and hydrophilic interaction, internal pressure in molecule, Degree of hydrogen bonding, Solute-solvent interaction and Phase separation are influenced.

An asset for supercritical mixtures

The surface tension and viscosities of critical and supercritical solvents, inflammable, carcinogenic, VOC can be conducted with the Survismeter because the parameters measuring units are jacketed.

New model for molecular modeling

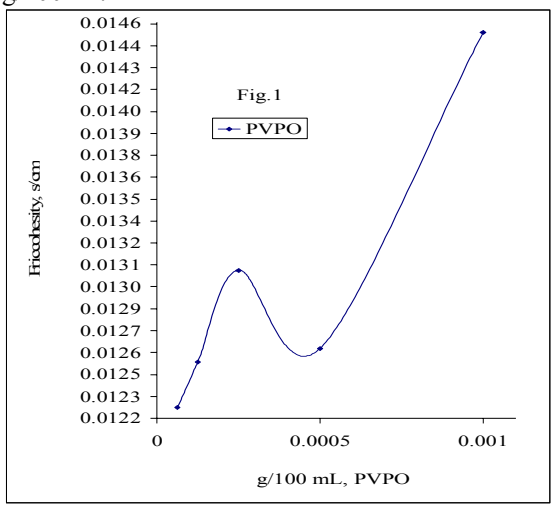
Friccohesity

Science of frictional and cohesive forces plays key role for association, dissociation, linkages, reorientation, and bond optimization of molecules undergoing several changes. Thus an optimization state of these forces is determined with $\sigma \propto tn$ relation. The σ depicts frictional and cohesive forces denoted by t and n symbols. The Friccohesity σ is calculated with ManSingh equation given below.

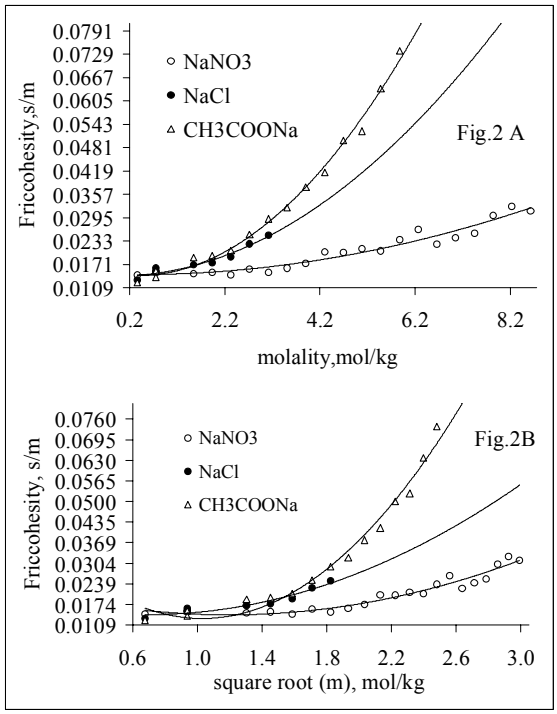
$$\sigma = \sigma_0[(t/t_0 \pm B/t)((n/n_0)+0.0012(1-\rho))]$$

The t and n, t_0 and n_0 denote viscous flow time and drop count for solution and solvent respectively, the B/t is kinetic energy correction, the 0.0012 air density and $(1-\rho)$ is buoyancy correction to drops.

The ρ denote density of the solution. Fig. 1: Friccohesity transition in interaction of polyvinylpyrrolidone oxime (PVPO) at 0.00025 g/100mL.



Figs. 2 A and 2 B illustrate the σ data of the monovalent electrolytes with water. The 2A denotes σ vs m and the 2 B is σ vis $m^{1/2}$. The m is molality. The salts show polynomial relation with m that infer contribution of the frictional and cohesive forces are useful for ion pair interaction with m. Here the figs. 1 and 2 for σ data, clearly visualize behaviour of the organic molecules and ions with water.



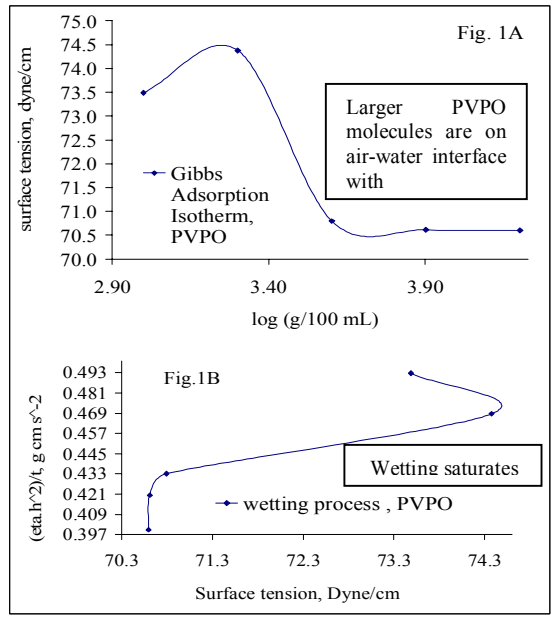


Figure 1 A and B: 1A is for Gibbs Adsorption Isotherm delta γ vs RT Γ ln c, and the 1B is for $(\eta h^2)/t$ vs γ graph wetting process by PVPO molecule with water. Larger PVPO molecules accumulate and saturate on air-water interface with lower surface tension and maximum wetting of the PVPO. The Friccohesities also illustrate a wetting phenomenon because the interfacial tension comes on the way when the individual molecule interact with neighboring dissimilar molecules with different van der Waals forces.

Incentives:

It is available for sale and can be procured from Spectro Equipment Pvt. Ltd. Okhla Delhi. The cost effective and cost intensive models are available. For free training, demo and scientific deliberations one can contact Emails:

crldbc@yahoo.in, mansingh50@hotmail.com. The interested party can visit Chemistry Research Laboratory, Deshbandhu College, University of Delhi, New Delhi-110019, India, on their own expenses with prior appointment at crldbc@yahoo.in. The prospective user has to send short abstract on activities to be pursued.

References

1. Man Singh, J. Instr. Exp. Techn. 48, (2005) 270.
2. M. Singh, J. Biochem. Biyophys. Methods, 67 (2006) 151.
3. M. Singh and A. Kumar, J. Solution Chem. 35 (2006) 567.
4. Man Singh, Surface Review and Letters 14 (2007) 973.
5. Man Singh, Surf. Interf. Analy. 40 (2008) 76.
6. Man Singh, Surf. Interf. Analy. 40 (2008) 15.