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Measurement of Viscosity for Synthetic Polymers

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ABSTRACT: Viscosity is a fundamental characteristic property of all liquids. When a liquid flows, the internal resistance changed. The resistance of the flow or share of fluid is measured by means of viscosity flow of liquid. Viscosity can also be called as a laminar drag force and is a measure of the frictional properties of the fluid. In this paper PIC 18f4553 controller is used for the measurement of viscosity of certain synthetic polymers. Embedded based system is designed for the measurement of viscosity automatically with good accuracy and high resolution. The viscosity of polymers depends on different parameters: inner molecular structure, outside or external force, temperature and pressure.

KEYWORDS: Analyzer, viscosity, Embedded, Polymer, synthetic.

I. INTRODUCTION

Viscosity is an internal property of fluid that offers resistance to flow or it is the measure of the internal friction of a fluid. This friction becomes apparent when a layer of fluid is made to move in relation to another layer. The greater the friction, the greater the amount of force required to cause this movement which is called shear. Hence, viscosity can be deduced to being relationship between shearing stress and rate of shear:

Viscosity μ = shear stress/rate of shear (1)

Shear stress = Force/Area (2)

In other words the shear stress can be increased or decreased by either changing the velocity of the liquid (acceleration), or the pipe size:

Shear rate = Velocity/Film thickness (3)

Kawanishai et al studied the viscosity acetamide and concluded that the chain stiffness in polymer depends on the changes in diluted concentrated media.

Parker and Bikanehave measured densities and viscosities of cellulose acetate solution in connection with the pharmaceutical application of CA.

Planus et al studied the transport properties of conductive blends cellulose acetate/poly aniline (phenyl phosphoric acid).

Kim et alstudied the blends of properties of cellulose acetate with modified poly acrylonitriles in DMF solution through the scanning electron microscopy, Dynamic mechanical properties and Tg measurements. Compatibility studies of CA have been carried out with several synthetic polymers having electron rich pendant groups, such as poly (4-vinyl pyridine).

Vijay Lakshmi Rao et al have reported on the miscibility blend system of cellulose acetate of hydrogen phthalate and poly vinyl pyrrolidone in DMF through the dilute solution viscosity measurements.

Yang et al studied the blend properties of cellulose acetate with copolymers of poly acrylonitrile through different studies like morphology mechanical properties.

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II. THEORY

The coefficient of viscosity or dynamic viscosity 'η' is defined as the force per unit area necessary to maintain a unit velocity gradient between two parallel planes which are at a unit distance apart.

Viscosities of liquid and liquid mixtures can be determined by two methods: (i) absolute method and (ii) relative method. The determination of viscosity by absolute method requires the determination of the constants of the apparatus. Hence, viscosities of liquids and binary solutions were determined by the relative method. In this method, it is easy to measure the viscosity of a liquid by comparison with a reference standard liquid of known viscosity. Different types of viscometers used to determine the viscosity are given below.

(i) Stokes falling Sphere Viscometer
(ii) Oswald's Viscometer
(iii) Ubbelohde suspended level Viscometer

a. Ubbelohde suspended level Viscometer Method(Present Method)

Viscosity measurements were made with the help of Ubbelohde suspended level viscometer (XX) using 10-15 cm^3 of solution. The design of this viscometer eliminates pressure corrections and minimizes surface tension effects. Choice of viscometer dimensions was limited by consideration of two factors.

(i) **Volume of solution required:** purified solvent limited the volume to 10-15 cm^3.

(ii) **Capillary dimensions:** The capillaries are too narrow which are found to be very sensitive to small quantities of impurities or dust, while broad capillaries require a large kinetic energy correction, together with introducing errors due to heating and drainage effects.

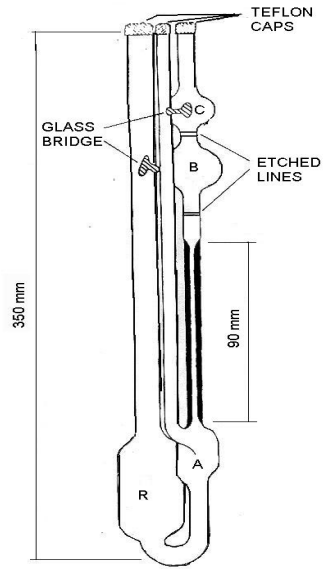

Figure 1: Ubbelohde viscometer

For absolute viscosities the viscometer is calibrated with water at temperature over the range of 288.15–318.15 K and with 30% aqueous sucrose solution, using an equation of the form (4)

$$\eta = \rho (at - b/t) \qquad (4)$$

which may be derived for a capillary viscometer and where 'η' is the dynamic viscosity, 'ρ' is the density of the liquid,'t' is the efflux time and 'a' and 'b' are the viscometer constants. Majority of the work is concerned solely with relative viscosities, $\eta/\eta_o$and it is found sufficiently precise to take

$$\eta/\eta_o = \frac{\rho t}{\rho_o t_o} \qquad (5)$$

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Where 'η', 't' and 'ρ' refer to the solution and 'η_o', 't_o' and 'ρ_o' to the solvent. 't_o' and 'ρ_o' are predetermined for every batch of solvent used.

b. Raspberry Pi microcomputer:

The Raspberry Pi is a series of credit card–sized single-board computers developed inEngland, United Kingdom by the Raspberry Pi Foundation with the intent to promotethe teaching of basic computer science in schools and developing countries.

All Raspberry Pi's include the same Video Core IV graphics processingunit (GPU), and either a single-core ARMv6-compatible CPU or a newerARMv7-compatible quad-core one (in Pi 2); and 1 GB of RAM (in Pi 2), 512 MB (in Pi 1models B and B+), or 256 MB (in models A and A+, and in the older model B). Theyhave a Secure Digital (SDHC) slot (models A and B) or a Micro SDHC one (modelsA+, B+, and Pi 2) for boot media and persistent storage. In 2014,

The Raspberry pi can be used as, a mini Web browser, gaming console, Windows 3.0on a Pi, Robotics, RISC OS for Pi, RPi cloud server and RPi Weather Station.

c. Working of the circuit:

The individual blocks of the embedded based system for the measurement of viscosity of polymer is designed and constructed. The block diagram of the measurement system is shown in Figure 2. The measurement system consists of opto-coupler sensors, its signal processing circuit, analog to digital converter and Raspberry Pi minicomputer. The schematic of the system is shown in Figure3. The processed results are send to PC for display and storage. The necessary MATLAB software is developed which runs in PC. The controller used in the present work is PIC 18F4553, which consists of 12 bit, 10 channel ADC which gives good accuracy and precision. The software for analog to digital conversion and serial communication is written in C language, which is flashed into the PIC microcontroller kit. The algorithm of measurement is shown in the form of flow chart in Figure 4.

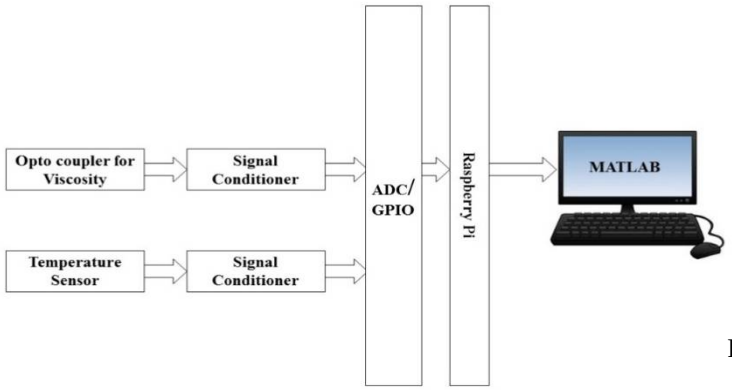

Figure 2: Conductivity Measurement

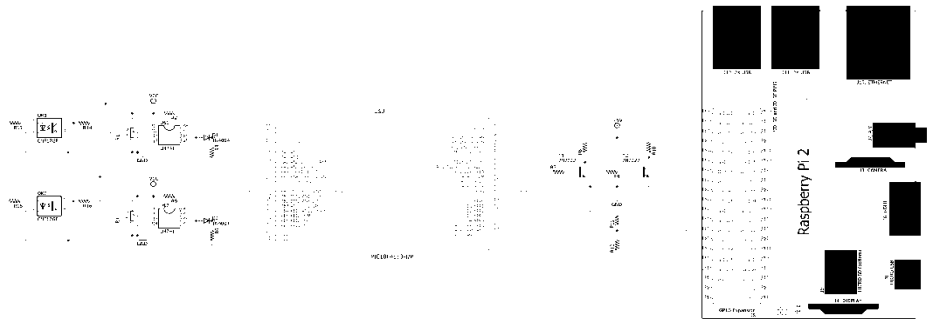

Figure 3: Schematic diagram of Viscosity Measurement

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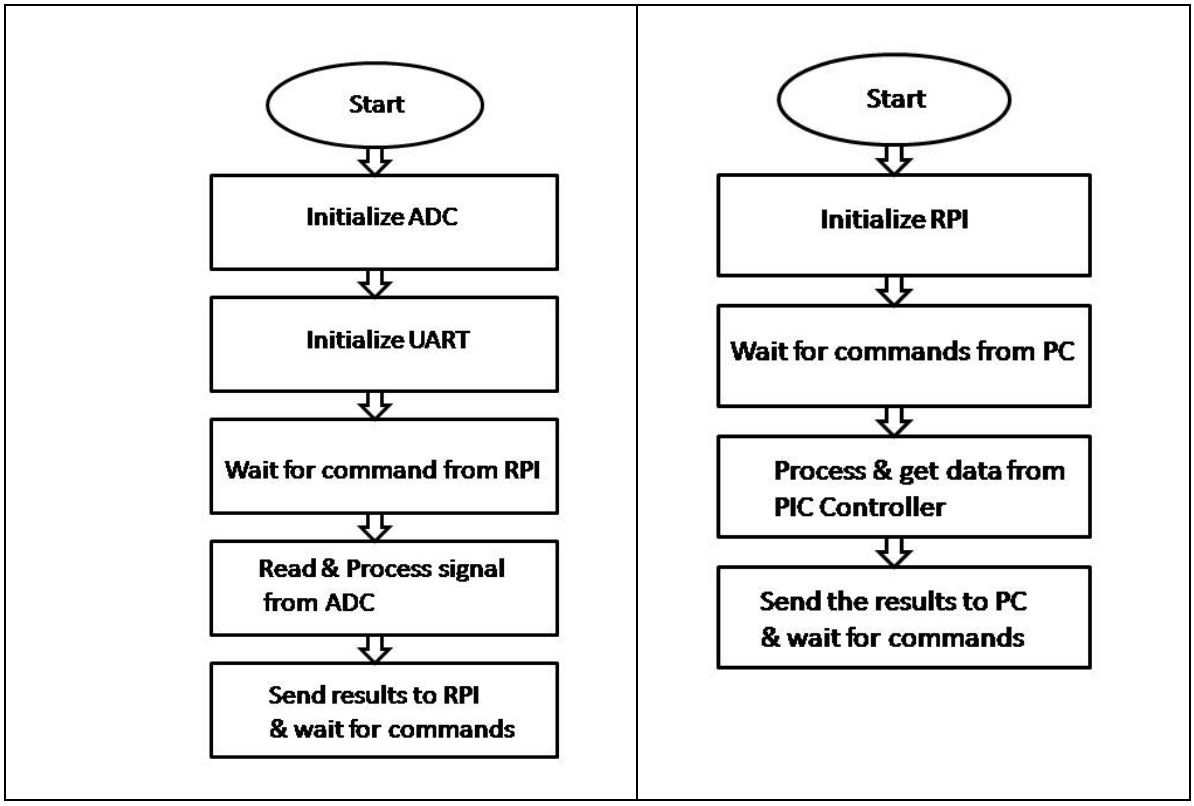

Figure4: Flow chart for the software written in PIC18f4553 and RPI

Calibration & Measurement procedure:

To measure the viscosity of a polymer, the following procedure is adopted.

The viscosity of a solution is highly temperature dependent. Therefore, it is to be temperature compensated, or calibrate the instrument at the same temperature as the solution being measured.

Prepare the polymer solution samples:

Sample preparation can be done as in simple methods, first we take the polymers (PVP and PVA) which are available in powder form. Then it has to be weight as per concentrations such as 1%, 0.9%, 0.8%, and 0.7%. here

1% solution means 1gram polymer will be dissolve into 100ml water.

0.9% solution means 900mill gram polymer is dissolved into 100ml water.

0.8% solution means 800mill gram polymer is dissolved into 100ml water.

0.7% solution means 700mill gram polymer is dissolved into 100ml water.

i. Fill the Glass viscometer up to marked ring with one of the sample as prepared above.
ii. Run/open the concern MATLAB Exe file (visco.exe). it will look like as below.
iii. In opened GUI press the start button to measure the viscosity automatically as shown in fig 5.
iv. Once the viscosity obtained again inhale the air form the meter up to marked ring level.
v. Repeat this process from the points v to vi for 4 reading and take an average of all the 4 readings it will give the precise viscosity.

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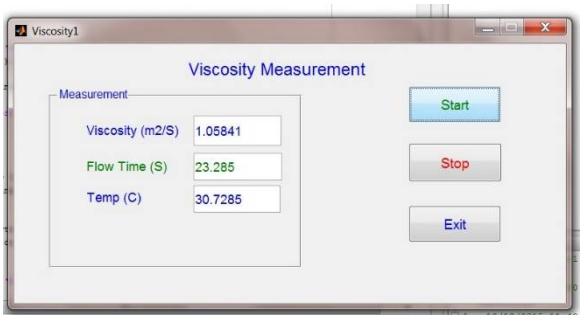

Figure 5: Screen shot of the measurement GUI

III. RESULTS

Viscosity Measurement

S.No	Concentration %	Viscosity(CP)
1	1	0.098
2	0.9	0.086
3	0.8	0.073
4	0.7	0.063

IV. CONCLUSION

Embedded based conductivity measurement system for polymers is designed and tested with known samples and the performance of the system is quite satisfactory. This system can be enhanced as a remote measurement system by writing appropriate software.

REFERENCES

1. H.Kawanishi, Y.Tsunesslima, S.Okada and F.Horri., J.Chemphy, 108, 6014 (1998)
2. K.M.Picker and F.Bekane, I.J.Pharmaceutics, 175, 147 (1998)
3. J.Planes, Y.Cheguettine and E.Banka phys. Rev. B58, 7774 (1998)
4. B.K.Kim, Y.S.Oh, Y.M.Lee, L.K.Yoon and S.Lee, polymer 41, 385 (2000)
5. P.Aptel, I.Cabasso., J.Appl.polm.Sci ., 25, 1969 (1980)
6. I.Cabasso, Coatings plastics chem. Prepr, 5, 359 (1980)
7. VijayaLakshimi Rao, P.V.Ashokan and M.H.Sridhar., J.Appl.Polym.Sci., 76, 859 (2000)
8. Y.Se.Oh, S.Lee, S.K.Min, Y.J.Shin and B.K.Kim., J.Appl.polym.Sci 64, 1937 (1997)
9. A.Varadarajulu, R.Lakshminarayana Reddy, G.Baburao, Jiang He and Jun. Zhang., J.Appl.polym.Sci., 81, 557 (2001)
10. J.W.Qian, Y.M.Miao, L.Zhang and H.L.Chen, J.Membrane Sci. 203, 167 (2002)
11. S.H.Lee, M.Yoshioka and N.Shiraishi, J.Appl.polym.Sci., 77, 2908 (2000)
12. A.A.Bhat and V.G.Pangarkar., J.Membrane Sci., 167, 187 (2000)
13. Q.Xiao, S.Yan, K.D. Rogusch, J.Petermann and Y.Huang, J.Appl.Polym. Sci., 80, 161 (2001)
14. A.P.Marques, R.L.Reis and J.A.Hunt, J.Bio materials., 23, 1471 (2002)
15. N.Ramani and N.P.Robert, Met.Res.Soc.Symp.Proce., 197, 55 (1990)
16. Y.Haiyang, Z.Ping ping, L.Guofeng, W.Peng and R.Peng.,Eur.polym.J. 35, 345, (1999).
17. N.Tewari and A.K.Srivastava, Macromolecules., 25, 103 (1992)
18. Z.Ping ping, Y.Haiyang and Z.Yiming.,Eur.polym.J. 35, 915 (1999)
19. S.M.D.S. Neiro, D.C.Dragunski, A.F.Rubira and V.C.Muniz, Eur.polym.J. 36, 583 (2000)