σ of rubber

OBJECT: To determine the Poisson's ratio for rubber.

Apparatus used: Rubber tube with metal sleeve and rubber stopper, meter scale, small pointer, slotted weights of 250gm, hanger, Burette and rubber stopper

Formula: The following formula is used for the determination of Poisson's ratio for rubber,

$$\sigma = \frac{1}{2}\left(1 - \frac{1}{A}\frac{dV}{dL}\right)$$

Where *A:* area of cross-section of rubber tube

$A = \pi r^2 = \pi D^2 / 4$

D: diameter of rubber tube

dV = Small increase in the volume of the tube when stretched by a small weight

dL = corresponding increase in the length of the tube.

Figure:

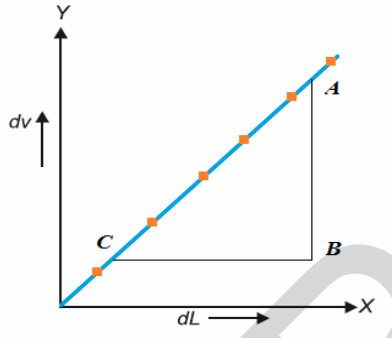

Fig. 2: Graph between dV and dL

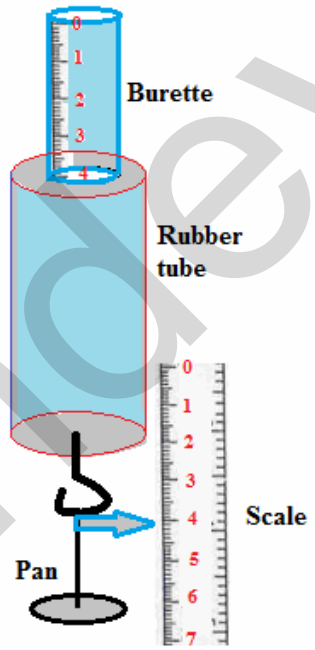

Fig.1: Apparatus

Procedure:

1. First of all, suspend the apparatus through a clamp fixed at a convenient height and pour water in the rubber tube until the water meniscus appears nearly at the top of the burette.
2. Measure the diameter of the rubber tube using Vernier calipers in absence of no load.
3. In absence of load, note down the position of the pointer on the scale and the reading of water meniscus in burette. This gives you zero mass reading *L* and V.
4. Now hang the hanger (mass=250gm) at lower portion of rubber tube and note down the position of the pointer on the scale and the reading of water meniscus in burette. This gives you reading of *l* and V for mass 250gm.
5. Increase the load in steps of 250gm up to 1250gm and note down the readings of pointer and the meniscus of water. This gives you reading *L* and V for corresponding masses.
6. Repeat the above procedure for weights decreasing. In case of load decreasing, the values of *l* and V for last load will be same as for the case of load increasing.
7. Take the mean of the two readings of the burette for the same load on the hanger obtained with increasing and decreasing load. Do the similar for scale reading.
8. Now subtract the mean readings for zero load on the hanger from the mean reading for any load to obtain the change in volume *dV* of the rubber tube for various loads on the hanger. (i.e. To find out dV, determine the difference of each mean V reading with zero burette reading)
9. Similarly, do step 8 for the case of scale reading to find d*L*. (i.e. To find out the value of d*L*, determine the difference of each *L* reading with zero scale reading)
10. Calculate the value of *dV/dL* for each set of observations separately and find its mean value.
11. Plot a graph taking *dL* along the *X*-axis and the corresponding value of *dV* along the *Y*-axis. This will come out to be a straight line (Fig.2). Its slope will give the average value of *dV/dL*.
12. Calculate s using both values of *dV/dL* separately and take their mean.

Observations:

(1) Least count of Vernier calipers = $\frac{value\ of\ one\ division\ on\ main\ scale}{Number\ of\ divisions\ on\ vernier\ scale}$ =……..cm

(2) Zero error in Vernier calipers =……..cm

(3) ***Table for diameter of rubber tube when it is unloaded.***

Sr. no.	M.S. (cm)	V.S. (div)	un-corrected diameter (d= MS + CS x LC) (cm)	Mean un-corrected diameter (d: cm)	corrected diameter (D=d± zero error) (cm)
1.					
2.					
3.					
4.					
5.					
6.					

(4) *Radius of rubber tube (r)=D/2=…..…..cm*

(5) Table for dV and dl:

S .N.	*Load on hanger*	*Reading of burette*			*Change in volume dV*	*Reading of pointer on scale*			*Change in length dL*	$\frac{dV}{dL}$	*Mean* $\frac{dV}{dL}$
		Load increasing X	*Load decreasing Y*	*Mean* $\left(\frac{X+Y}{2}\right)$		*Load increasing X′*	*Load decreasing Y′*	*Mean* $\left(\frac{X'+Y'}{2}\right)$			
1	*0*			*A*	*A-A*			*A′*	*A′-A′*	----	----
2	*250*			*B*	*A-B*			*B′*	*A′-B′*		
3	*500*			*C*	*A-C*			*C′*	*A′-C′*		
4	*750*			*D*	*A-D*			*D′*	*A′-D′*		
5	*1000*			*E*	*A-E*			*E′*	*A′-E′*		
6	*1250*			*F*	*A-F*			*F′*	*A′-F′*		

Calculation: $\frac{dV}{dL}$ = ... *(from Table);* $\frac{dV}{dL} = \frac{AB}{BC}$ = ... *(from graph)*

$A = \pi r^2 = \pi D^2/4$ =…..…..

(Calculate the value of σ using following formula and using both values of dV/dL. Take mean of both σ values.)

$$\sigma = \frac{1}{2}\left(1 - \frac{1}{A}\frac{dV}{dL}\right)$$

Results: *The Poission ratio of rubber (σ)= ……*

Standard value of σ for rubber=…..……..

% error in σ=……

Precautions:

1. Hanger should be stationary at the time of taking down the observations.
2. There should be no air bubble inside the rubber tube or the burette.
3. Weights should be placed or removed gently and in equal steps.
4. After each addition or removal of load wait for about 5 minutes before taking observations in order to allow the apparatus to settle down to new conditions of stress and strain.
5. The load suspended at the lower end of the rubber tube should not exceed the maximum load permissible within elastic limit.