Recommendation for pumping viscous liquids with peristaltic pumps

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Peristaltic pumps are widely used for fluid handling and dosing tasks in various industrial and research applications. It is very important to choose the right combination of tube, pump head and peristaltic pump drive to get the perfect result. However, pump capacities are always specified for laminar flow of non-viscous liquids (aqueous solutions). When pumping and dispensing viscous fluids such as honey, resins, and electrolytes, the efficiency of the peristaltic pump decreases. This is because the laminar flow rate depends on the viscosity, the inside diameter of the hose, and the pressure drop at the ends of the hose. The laminar flow velocity is calculated using Poiseuil's formula: -

$$Q = \frac{\pi R^4 \Delta P}{8 \mu L}$$

Q- Usage m^3/s
R-inner radius of tube m
η- Viscosity Pa*s
I - Length of the tube m
Δ – pressure transfer of the tube ends Pa

The formula shows that the flow velocity is directly proportional to the hose's inner radius to the fourth power, directly proportional to the pressure drop and inversely proportional to the viscosity of the pumped medium.

Based on the above, LabVector recommends the following steps when pumping viscous liquids

1. Heat the solution to be pumped The viscosity of a fluid is the ratio of the derivative of the velocity of the fluid flow to the tangential stress. If the viscosity of a fluid is constant, the medium is called Newtonian, i.e. obeying Newton's law of viscous friction, with dependence on temperature and pressure only. The basic form describing the dependence of viscosity on temperature is as follows:

$$\mu = \mu_0 e^{\frac{E_a}{kT}}$$

η - viscosity at a certain temperature

η_0- viscosity constant

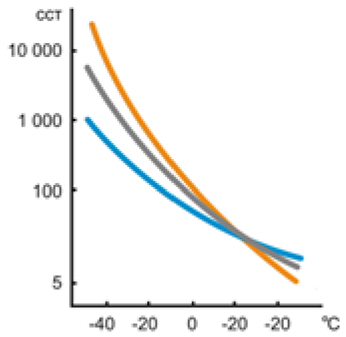
E_a- activation energy of a new bonds in a molecule

k– Boltzmann constant

T- temperature

Thus heating the medium reduces its viscosity and results in a higher flow velocity for the same parameters.

The exponential dependence graph is as follows



2. Reduce the number of revolutions.

The physical properties of the fluid form a kind of 'plateau' of maximum flow rate. Up to this 'plateau' the flow rate will increase with increasing RPM, within the 'plateau' range increasing RPM will not increase the flow rate.

The number of revolutions is adjusted empirically. Try to operate at a minimum RPM within this "plateau" range for maximum equipment efficiency.

3. use higher stiffness or thicker wall material.

According to Poiseuille formula the dependence of the flow rate is directly proportional to the pressure drop across the tube ends. The vacuum (suction force) depends on the compressing-expanding strain caused by the movement of the rollers in the pump head. The stiffer and thicker the wall, the quicker the hose will return to its original shape after deformation, the greater the suction head vacuum, the better the pump will do.

4. use smooth walled tubing

With small inside diameter of hose the effect of the "roughness" of the hose wall (friction forces) on the flow rate increases. Experiment with pumping on silicone tubing that is as smooth as possible.

5. Use a tube with a larger inside diameter.

The larger the inside diameter of the hose, the greater the flow capacity.

Select the recommended hose according to the table, based on the viscosity of your media in centipoise (cps) and the desired flow rate

Tubing size selection table, depending on the required flow rate and viscosity of the pumped medium.

consumption \ viscosity	2	15	35	75	100	150	200	300	500	600	800	1000	1200	1500	3000	4500	9000	15000
4000–4700	#82	#82	#82	#82	#82	#90	#90	#90	#90	#90	#90							
2700–4000	#26	#26	#73	#82	#82	#82	#82	#82	#90	#90	#90	#90	#92					
1300–2700	#35 #36	#35 #36	#26	#73	#86	#82	#82	#82	#82	#82	#90	#90	#90	#92				
800–1300	#17	#17	#15 #24	#35 #36	#26	#73	#73	#86	#82	#82	#82	#90	#90	#90	#92			
500–800	#16 #25	#16 #25	#17	#17	#15 #24	#35 #36	#26	#73	#73	#73	#86	#82 #88	#90	#90	#90	#92		
200–500	#16	#16	#16	#25	#17 #18	#15 #24	#35	#36	#26	#73 #86	#73 #86	#73 #86	#73 #86	#82 #88	#90	#90		
50–200	#14	#16	#16	#16	#25	#25	#24	#24	#35	#36	#26	#26	#73 #86	#73 #86	#82 #88	#92	#92	
0–50	#13	#14	#16	#16	#16	#16	#18	#18	#24	#24	#35	#36	#26	#26	#73 #86	#82 #88	#90	#92

50-600
50-350

viscosity

*The information is for reference only. The data in the table corresponds to Westoprene, Westofluour rigid tubing.

How do I select a hose from the chart?

For example, you need a flow rate of 150 ml/min of fluid with a viscosity of 700cps. Referring to the chart, find the correct size #35/#36 hose at the intersection of flow and viscosity.