Mobile In-Vitro Neurovascular Cast System

Dip Thickness Analytical Analyses I Memo

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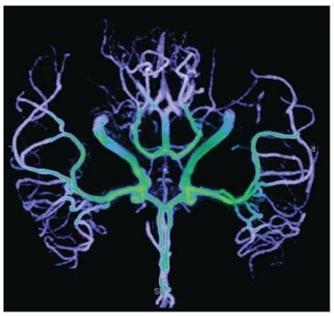

Mobile In-Vitro Neurovascular Cast System

NORTHERN ARIZONA UNIVERSITY

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Introduction

The project is intended to allow for testing of a new treatment for brain aneurysms. Unlike current treatments the new treatment can allow for the vessel wall to heal over the aneurysm reducing the change of a reoccurrence. Our device must mimic brain vessel mechanical properties and geometric properties to allow for proper testing of the treatment. To do this a design has been proposed to create a vessel core that will be coated in our vessel material using the dip coating method. To reach the proper mechanical properties we must be able to determine the correct number of times to dip our core into the molten plastic to get the desired wall thickness. This memo will focus on the analysis of using the melt viscosities of plastics to find the wall thickness.

Materials

For the analysis there were four materials considered, all of which are Star Thermoplastic products. The plastics have varying properties and so yield varying results. The materials and properties are listed below:

StarClear 1035-0000: η = 9.6 Pa sec, ρ = 890 kg/m^2 [2]
StarMed 9030-0000: η = 9.1 Pa sec, ρ = 900 kg/m^2 [2]
StarMed 9040-0000: η = 14 Pa sec, ρ = 890 kg/m^2 [2]
Star TPE 57050: η = 10.5 Pa sec, ρ = 890 kg/m^2 [2].

Analysis

As dip coating is a common manufacturing technique they equation to find the dip thickness is quite simple. The equation is as follows: $h_0 = c_1(\eta U_0/\rho g)^{1/2}$ {1], where h_0 is the dip thickness, c_1 is a fluid constant, η is the fluid viscosity, and U_0 is the velocity at which the core is removed from the fluid. Figure 1 illustrates how the dip coating method creates a thickness, and where the thickness is measured. According to the text where the equation was found, c_1 is usually equals

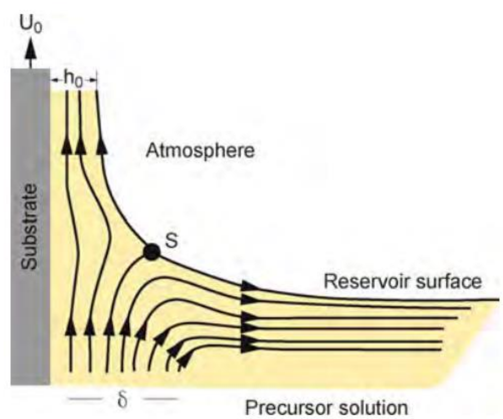

Figure 1: Dip Thickness Illustration [1]

.8 for non-Newtonian fluids [1]. With that in mind data was not provided for the plastic that could be used to find this constant, so the assumption must be made that the plastic will act as a Newtonian fluid to simplify calculations.

Once the assumption is made that the molten plastic will act as a Newtonian fluid the calculation is dependent on the viscosity, the pull velocity, and the density. With the materials chosen the viscosity and density are given values, so the only unknown is the pull velocity. To account for this a spreadsheet was built to allow the pull velocity to be altered to adjust layer thickness. Figure 2 shows the spreadsheet that was built, using a value of 0.1 mm/s for the pull velocity the values below were calculated.

StarClear 1035-0000: h = 0.00026 mm
StarMed 9030-0000: h = 0.000252 mm
StarMed 9040-0000: h = 0.000314 mm
Star TPE 57050: h = 0.000272 mm

			U_o=	0.1	m/s	
T= c_1(ηU_0/ρg)^.5		Thickness Eq	c_1=	0.8	1/m	
			g=	9810	mm/s^2	
StarClear 1035-0000						
η=	9.6	Pa*s	T=	0.00026	mm	Thickness of one dip
ρ=	89000000	kg/mm^3				
StarMed 9040-0000						
η=	14	Pa*s	T=	0.000314	mm	Thickness of one dip
ρ=	89000000	kg/mm^3				
StarMed 9030-0000						
η=	9.1	Pa*s	T=	0.000252	mm	Thickness of one dip
ρ=	90000000	kg/mm^3				
Star TPE 57050						
η=	10.5	Pa*s	T=	0.000272	mm	Thickness of one dip
ρ=	89000000	kg/mm^3				

Figure 2: Spreadsheet Calculations

Conclusions

Due to the assumption of Newtonian fluids, further testing will be required to determine the validity of the results. Biased on the analysis alone, it appears that we may need to dip many times to ensure that we achieve a wall that is thick enough to hold back the pressures. With thinner walls, the harness rating may also become less important allowing our team to use a harder material such as the Star TPE which has a hardness rating of 61A. This benefits the manufacturing process because the harder material will require less dips to produce the needed strength.

Works Cited

[1] Jeffrey Brinker, C. “Chapter 10: Dip Coating.” pp. 233–261.

[2] *Starthermoplastics.com*, Star Thermoplastics, www.starthermoplastics.com/.