Q&A Group 09.07.2020

In this section, all your questions have been categorized to be answered more efficiently.

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- **Shear Viscosity**
- **Capillary Test**
- **Modeling**
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Shear Viscosity

- Where can I find more information about the equations used? to understand them better and the process used to obtain the apparent shear viscosity and stress *Constanza Álvarez López.* *Look for a Book called Transport Phenomena in Chapter 3 you will find a nice explanation and step by step the set up of the differential equations and boundary conditons. And as for the Rabinowitch equation you can go to the following presentation https://slideplayer.com/slide/1517219/ (from minute 10-14 aproxximately)*

- In the slide 5 of the first presentation it is mentioned for the shear rate: It means how fast the velocity changes due to the shearing force imposed to the system change of velocity gives kind of acceleration! Would it be correct that we say how fast the material deforms or how fast the displacement happens? *Javid Azimi Boulali. It is Ok to say how fast the displacement of the layers occur and, even better, how fast the momentum is transported .*

- Do adhesion and cohesion effects of the material take any part in the measurements of viscosity?" *Angel Villalba- Actually , adhesion is very important, the assumption for the mathematical model is that the velocity at the wall is zero (and is a Boundary condition) and implies that the polymer is adhered to the surface.*

- The viscosity can improve the mechanical behavior. SoCan a highly viscosity polymer can be used as a protective material (bullet velvet, helmets, kneepads)? Why there is no such things in the market? *-Diego Ceciliano- Actually, the best thing would be to have a fluid that becomes highly shear thickening but there could be a high risk if leaking happens*

Capillary Test

- why is there a need for correction in the apparent shear viscosity and stress? *Constanza Álvarez López. Because all the mathematical treatment is done by considering that the material is Newtonian and …*

- Capillary Rheometry is useful for measuring the viscosity of just Newtownian fluids, right? not for non-Newtonian fluids!-*Javid Azimi Boulali. NO, actually is the contrary, is used mostly fon Non-Newtonian*

- In a capillary rheometer, where does the computer program obtains the die data (geometry) from? Is it provided by the die manufacturer? *Yes, It is built by the manufacturer, but know you could be able to write the code yourself*

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  How to choose the most suitable fitting models (eg. Carreau model, Yasuda model, etc) and how are they related to the processing of materials? *You will have to try them, but you will see that some are better than others, for example Cross Model for PP and Carrera-Yasuda for HDPE, etc.*

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  I understand that the Bagley correction is needed since the treatment assumes the pressure is solely due to viscosity drag and this correction gives the true shear stress which can help in getting the true viscosity, But, what kind of data does this correction method needs to achieve this? *You need Pressure data and Volumetric flow, as the raw information for making the calculations*

- And what are the necessary requirements (in terms of temperature, barrel, capillary inlet and diameter) to perform this correction? -*Seyedehniousha Mousavi, the geometry of the capillary is needed (besides of pressure and flow)*

- What are the limitations of capillary rheometers? Is needle clogging an issue? How is it solved? I guess cleaning the apparatus is a hassle, are barrels and needles disposable?-*Osamu Katagiri- The barrel needs to be cleaned as wellk as the capillary dies and no, they are not disposable (too expensive since they are really very precise tools)*

Modeling

- How can we know which empirical model is appropiate for the material we want to test?-*Constanza Álvarez López- You will have to try them, but you will see n the lirterature that some are better than others, for example Cross Model for PP and Carrera-Yasuda for HDPE, etc.*

- I really need a review of the math if we are expected to use this. *-Luis Alejandro Garza Soto Yes*

- When we have a momentum balance, we can use directly the equation 8 or we need to do all the integrals from equation 5? - Benjamín Alberto Actually the integration has been already done for you. *The mportant thing is to really understand where the equation is coming from so you can do it for a flat tappered channel like the one form around the extruder*

- Whe we have the flow of the polymer inside barrel, can we have a different form for parabolic shape or it is always parabolic shaped flow? - Benjamín Alberto. *Actually for Non-Newtonian fluids (like polymer melts) it is not parabolic, that case is just for Newtonian fluids*

Modeling

- What model can be used to describe the relationship between the average molecular weight and the zero shear viscosity of polymers in solution? How can we also take into account the solvent properties and polymer concentration? **LET US DISCUSS THAT IN CLASS**

- Are there specific databases for Newtonian and non-Newtonian fluids in order to build mathematical models for share rate and viscosity? I am curious about it because I have interest in application of lipid materials in food industry and pharmaceutical purposes. *Katya Michelle Aguilar . There are data bases but am not familiarized with those for lipids*

- How the rheological measurements and shear viscosity rates can be useful for moulding design ? *Katya Michelle Aguilar Look, you can decompopse a mould in cilinders and flat channel, and calculate the pressure drop for each part, then get the shear rate, and apply the appropriate viscosity data since is shear rate dependent. Ah!!! And besides need to know how the viscosity changes as functon of temperature*

- When we have new materials, MultiMaterials or even composite, what would be our model? *Elnaz Hosseinzadeh You will need to have the viscosity data and the model (as long as is laminar ann under shear) will be the same; if the process is a free wall, tyhen you need Normal Stresses diferences or elongational viscosity for calculations (and obviously the momentum and energy balance)*

Molecular Weight Distribution

What is Mz and PDI when we are talking about the correlation between Mn, Mw and viscosity?

I guess this relationship is only through (true?) for newtonian fluids where zero shear viscosity is applicable and not the non-newtonian fluids. also in the capilllary rheometry, the barrel has sharp circular edges, however in the schematic image in the video it is demonstrated that the polymer would go directly to the die. but in a non- ideal situation some fluids might get stuck in the edges of the barrel or how do we avoid this. I gues this might Jeopardize the trueness of our results from the capillary rheometry device. -*Neda Karami* *LET US DISCUSS THESE POINTS IN CLASS*

Polymer flow

- I dont know if the resin flow, RTM, can affcet or create miss aligments on fibers reinforcements that can affect the mechanical properties. By controlling the flow can you reduce the voids on the composite (RTM)?-*Miguel Alejandro Pérez Salazar* *You have to get rid of the bubbles before processing to avoid voids and make sure that you are in the laminar flow region.*

- From the paper, could you please expalin the differences of rheological behavior of macromolecules and low weighted molecules? So Polymer is considering as Macromolecules, so do we see all the regions of newotonian, non-newotonian behavior? In which area do we have more viscoelasticity? *Zahra Taravatfard* I WILL EXPLAN THIS IN CLASS

- During material processing in order to determine an acceptable constant flow value. Do exist tolerance ???? values for shear thickening factor? Is it possible to add emulsifiers in order to improve the rheological behavior of a polymer? –Katya Aguilar- *In solution you can add additives for that purpose typically solids to cause shear thickening*

- Could a polymer blend affect flow? How would the viscosity in a polymer blend be affected if the polymers are not miscible? Jonathan Núñez It will have consequences in the mixing zone sicen you need to assure the best mixing possible; twin screws might be a good option for blends

- The flow inside barrel is turbulent or laminar? - Benjamín Alberto *Laminar at the the typical velocities used in those instruments*

Viscosity curves

- How the newtonian viscosity is used (the example of the non-returning syringer). *Julio Alberto Cao Romero Gallegos* *Is a good way to characterize the material since is a MATERIAL CONSTANT as is typically related to Mw*

- Can you construct a shear rate or viscosity graph from the molecular weight distribution graph?- *Angel Villalba-* *There are some papers (Mead et al) attempting that*

- With zero shear viscosity can you predict molecular weight of other materials like lipids or proteins? *The Mw plays a role on the viscosity of the material but I am not sure what correlation is the one used for lipids or proteins.*

- Only the capillarity rheometer give you the apparent shear rate or also the cone on plate rheometer?-*José Iván Avilés Castrillo* *Yes only in the capillary rheometer, other mesurements follow a different equation.*

- The empirical function for the viscosity data are related only for the newtonian region. What happen or are there empirical funcion for non-newtonian region? I also found the math difficult and confusing to follow. –*Marino Luna* *Those equations are meant to cover the whole curve*

Viscosity curves

- For non-Newtonian region which we use Empirical function, it is mentioned that we use one of the equations based the polymer we are using. *You will have to try them, but you will see in the literature that some are better than others, for example Cross Model for PP and Carrera-Yasuda for HDPE, etc.*

- How we can have this data? For any specific polymer it is given that which mathematical model can be applied? *Elnaz Hosseinzadeh You will have either, measure it or request it to the supplier*

Others

- All these make me wonder: what about mixed stresses? Like, in the video we saw yesterday, there was the coaxial cilinder rheometer, so the shear rate must be in the polar coordinate system. *Yes inddeed in polar coordinates* But if we are pulling a polymer with a force F and a torque M, will the math be the same as with beams?-*Marco Salazar Meza The deformation phenomenon is the same but the CONSTITYUTIVE equation is different*

- From the videos, in figure 4, we have that the direction of the transfer of momentum is y-axis. But here I think we have transfer of momentum in two dirrections of y and x, so why do we just consider the x axis?-Zahra Taravatfard *(Good question, It is assumed that the lenth in the y direction is to big as compared to the x direction) But it is possible to do both at the same time*

- Is there any way a polymer turn into a Newtonian fluid? *Diego Sebastián Ceciliano Franco Yes, at very, evry low molecular weight or with a lot of additives to make it more non-newtonian*

- I didn't get when we have to apply Newton's law of viscosity that is in the paper, I mean that which if it's valid for all newton fluids or if it is valid for all fluids. *Jonathan Núñez.*

- *?????*

- We should manipulate the standard one based the composition of the polymers? *Elnaz Hosseinzadeh?????*