RHEOLOGY MADE SIMPLE

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- Rheology plays an essential role in the formulation of many products and metals that we come into contact with every day.

- From cosmetics, health products, foods stuffs, petrochemicals etc

- But what is Rheology ?

- And how is it relevant to our industry?

Introduction

- Try and define Rheology
- Understand the essential elements of how materials flow and deform.
- Look at the differences of various materials and get to grips with the 3 pillars of rheology and the terminology .
- Define the rheological characteristics of the perfect filler.
- Finally determine what are the important parameters that can be manipulated to create that perfect product.

Definition of Rheology

- The word is derived from the Greek words, Rheos meaning Flow, and logia meaning the study of.

- So Rheology is defined as the branch of Applied Physics that deals with the deformation and flow of matter primarily in the liquid and soft solid states.

Essential Element of Flow and Deformation

- Material inner structure-its molecular makeup
- Morphology eg short chains, long chains, straight chains etc
- Outside forces that stress a material. These can be compression, traction or shear.
- Ambient conditions eg temp.

Rheological differences between materials and the 3 pillars

- Simplistically we can divide materials into liquids and solids

- Liquids flow and solids don’t.

- But in reality most materials are more complex

- Rheologically speaking most materials are Viscoelastic. Nearly every material has a viscous portion and an elastic portion.

Viscoelasticity-1st pillar

- If a material is more viscous then its a liquid.
- If a material is more elastic then its a solid.
- So we can grade products according to their viscoelastic properties.
- Viscous liquids
- Viscoelastic liquids
- Viscoelastic solids
- Elastic solids
- G prime is a mathematical formula that takes the viscous and plastic properties into account to create a figure that most of would understand as the firmness or hardness of a material.

Viscosity-2nd pillar

- Viscosity is a measure of a fluids resistance to flow by an applied form. Its a measure of the internal friction.

- But from our perspective whats more important is how viscosity behaves when outside forces are applied.

- Lets look as some flow profiles

- We can define flow profiles into 2 categories

- Newtonian

- Non Newtonian

Newtonian Flow profile

- Viscosity remains unchanged when a force is applied eg water

Non-Newtonian

- Viscosity changes when a force is applied
- This can be defined as
- Pseudo-plastic-sheer thinning
- Dilatant-sheer thickening
- Thixotropic-sheer thinning that is time dependent
- Demonstration

Cohesivity-3rd Pillar

- Capacity of a product to stick together and is a measure of the intermolecular forces

- Demo of cohesiveness.

Hyaluronic Acid

- HA is a a naturally occurring substance
- Made of repeated disaccharide units
- More that 50% found in skin
- Levels are determined by processing that create and those that degrade

HA Dermal Fillers

- Cross linked generally with BDDE
- Depending on the manufacturing processes created as homogeneous gel or a suspension of particles in a gel carrier.
- Can be further classified as monophasic or biphasic.
- Monophasic can be subdivided in monodensified or polydensified

Application of Rheology to HA Fillers

- Face is complex and highly mobile
- Any implant will be subject to a variety of compressive and sheer forces both intrinsically and extrinsically.
- Modern HA fillers need to be specifically tailored with different rheological properties to cope with the demands of modern filler treatments.

What do we want from a Volumising filler

- Volumising product-project and maintain shape, flow well and not migrate
- High Elasticity
- Low Viscosity
- High Cohesivity

What do we want from fine lines and lip filler

- Fine lines and lips- some lift and projection, capacity to spread and be mouldable and ease of flow
- Low to medium elasticity
- Low viscosity
- Low cohesivity

What parameters can impact on the rheological profile of a gel

- Cross linking-type and degree
- Length of HA chains
- HA concentration
- % of free HA present

Cross Linking

- Cross linking has a direct effect on viscoelastic nature, viscosity and cohesiveness

- Higher the degree of cross linking the higher the gel firmness, durability is increased and product diffusion is decreased

- On the negative side this can result in a perceptible firmness, difficultly with injection and possibility of increased inflammatory response .

Length of HA chains

- The longer the chains the higher the molecular weight will be.

- The longer the chains the more elastic and cohesive the gel will be. This results in a firmer and more projecting gel with less risk of migration.

- The shorter the chains the less elastic the gel will be

- The shorter the chains the viscosity will be lower and the more mouldable and easier to inject the gel will be.

HA Concentration

- The higher the concentration,
- The higher the elasticity and cohesivity.
- Higher the viscosity.
- As a result the gel is firmer, more durable.
- But may be more difficult to inject and induce more inflammation.

HA Concentration

- The lower the concentration,
- The lower the elasticity and cohesivity.
- The lower the viscosity.
- As a result the gel is less firm and less durable.
- But will be easier to inject and possibly induce less inflammation.

% of free HA

- This can be an artefact of the cross linking process
- Or voluntarily added by the lab to adjust the gel texture.
- The higher the % of free HA the lower the cohesivity.
- The lower is the viscosity.
- As a result the gel is easier to inject and exhibits greater mouldability.