

A simple theory helps identifying which different rheological properties can result in the same IDDSI syringe flow test performance

Rémi Lecanu, Cassandre Leverrier, Guy Della Valle, Marco Ramaioli

▶ To cite this version:

Rémi Lecanu, Cassandre Leverrier, Guy Della Valle, Marco Ramaioli. A simple theory helps identifying which different rheological properties can result in the same IDDSI syringe flow test performance. 12th Annual Congres of the European Society for Swallowing Disorders - Deglutology: (re)Connecting in Dysphagia, Sep 2022, Leuven, Belgium. hal-03843429

HAL Id: hal-03843429 https://hal.science/hal-03843429v1

Submitted on 8 Nov 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

A simple theory helps identifying which different rheological properties can result in the same IDDSI syringe flow test performance

Rémi LECANU^A, Cassandre LEVERRIER^A, Guy DELLA VALLE^B, Marco RAMAIOLI^A

Abstract

^AUniversité Paris-Saclay, INRAE, AgroParisTech, UMR 782 SayFood, 91300 Massy & Thiverval-Grignon, France. ^BINRAE UR 1268, Biopolymers, Interactions & Assemblies (BIA), 44316 Nantes, France.

IDDSI tests¹ are easy to use, inexpensive and widely available thanks to the use of syringes, forks and spoons.

The aim of this study is to propose a model to predict the **transient flow** during the **IDDSI syringe flow test**. Unlike previous approaches, the simple theory developed in this study does not require the use of any simulation software³ and predicts IDDSI flow test considering the complete flow curve of the fluid, rather than considering arbitrarily the viscosity at a single shear rate⁴.

This study considers : distilled water and **glycerol** (**N** - **Newtonian**) ; Vittel water thickened with xanthan gum (XG - Shear thinning) ; Vittel water thickened with a starch-based commercial thickener, Resource Thicken Up (TU - Shear thinning).

Theoretical Model



 $\frac{d\left(m_{n}v_{n}\right)}{d\left(m_{s}v_{s}\right)} = \frac{\Delta P\pi R_{n}^{2}}{\Delta 2\pi R_{n}L}$

Biopolymères Interactions

The surface forces acting on the system, the fluid in the syringe : 1. The pressure forces – driving 2. The viscous forces – **dissipating**



IDDSI Flow Test and Rheological Characterisation



The IDDSI Flow Test is performed in a syringe recommended by IDDSI², and recorded with a camera at 25fps

 $\eta = K \dot{\gamma}^{n-1}$

universite INRAO AgroParisTech SayFood S

The study considers shear thinning Power-Law fluids :

- K is the consistency index [Pa.sⁿ]
- n is the flow index

The fluids are selected to display a large panel of behaviours :

The main components are :

1. Hydrostatic pressure, driving the flow under its own weight **2.** Laplace pressure, effect of the surface tension at the outlet

- 3. Pressure loss due to the contraction between the syringe barrel
- 4. Shear stress at the wall of the syringe, friction dissipating energy

5. Inertia term, coming from variation of mass in the syringe

Transient flow model compared to experience for



1.00% 6.32% 99% 99% **a** 10³ 10³ sity 10 ້ 10¹⊧ 0.10° **10**¹ **10¹ 10¹** 10^{2} 10^{2} Shear Rate [1/s] Shear Rate [1/s] Flow curves of the glycerol (N) and Flow curves of the glycerol (N) and **TU** solutions the XG solutions

Glycerol – Newtonian

0.04 Pa.s ≤ **η** ≤ 1.31 Pa.s

- Xanthan Gum Range of K and n 0.14 $Pa.s^n \le K \le 13.1 Pa.s^n$ 0.15 $\le n \le 0.48$
- $0.06 \text{ Pa.s}^n \le \mathbf{K} \le 15.8 \text{ Pa.s}^n | 0.38 \le \mathbf{n} \le 0.75$ Thicken-Up – Range of K and n

Final residue after 10s

Park en on	PAK 91 01 01 01 01 01 01 01 01 01 01 01 01 01	huduuduudu	10 mL - 33



Conclusions

Thickened liquids with very different rheological properties result in the same IDDSI level, using the IDDSI syringe test. The simple theory presented in this study gives a good prediction of the IDDSI Syringe Flow Tests results for Newtonian liquids.



Thickened liquids with very different shear rheology result in the same IDDSI level

References

¹IDDSI Framework : www.iddsi.org , © The International Dysphagia Diet Standardisation Initiative 2019 @ https://iddsi.org/framework. Licensed under the CreativeCommons Attribution Sharealike 4.0 License https://creativecommons.org/licenses/bysa/4.0/legalcode. Derivative works extending beyond language translation are NOT PERMITTED. ²BDs syringe for IDDSI Flow Test : <u>BD-Syringes-for-IDDSI-Flow-Test-International-Codes.pdf</u>, ³Hanson et al.(2019). *ABE*, 47, 2296-2307. ⁴Matsuyama et al. (2020). *IJFST 2020*, 55, 2962-2969

Perspectives

An extension of this model to more complex rheological properties, can help us identify which different rheological properties can result in the same IDDSI syringe flow test performance and orient future clinical trials to confirm the clinical relevance of this IDDSI "equivalence".

Contact

Rémi Lecanu, <u>remi.lecanu@agroparistech.fr</u>

Marco Ramaioli, <u>marco.ramaioli@inrae.fr</u>