A note on the dissipation of interfacial waves

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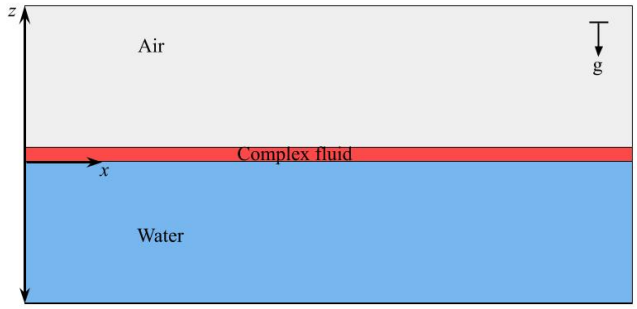
Objective

To accurately model the dissipation rate of swell.

Schematic



What has been done before in this area?

Models have been developed for dissipation rates of waves at the interface of two fluids

Unique feature of the present work

Accounts for a finitely-thick interfacial layer of nonlinear fluid with its own velocity field

Why do we need this model?

- Ocean surface is in general contaminated with slicks resulting from oil spills, biofilms, byproducts of combustion of spilled oil, dead decaying matter from plants and aquatic organisms, algae, etc.
- These substances form complex mixtures that result in an interfacial layer of thicknesses ranging from a few μm to a few mm/cm.

What is a nonlinear fluid?

The relation between shear stress and strain rate is

$$\tau_{zx} = k\left(\frac{du}{dz}\right)^n = k\left|\frac{du}{dz}\right|^{n-1}\frac{du}{dz} = \eta\frac{du}{dz}$$

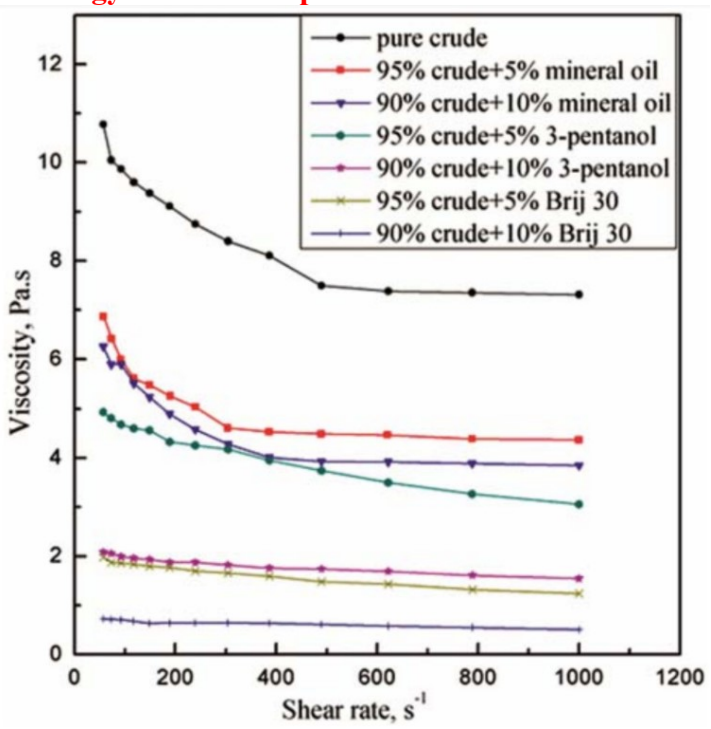
If n = 1, the fluid is linear; else it is nonlinear

Thickness of interfacial layers due to some oil spills

#	Oil Spill Case	Oil Volume	Spread area	Thickness
1	Mauritius (2020)	1035 m^3	3.3 km^2	**0.3137 mm**
2	Chennai (2017)	202 m^3	8.0 km^2	**0.0254 mm**

Ref: 1. *Mauritius Oil Spill: Almost all fuel oil pumped out of MV Wakashio,* BBC News, 12th August 2020. https://www.bbc.com/news/world-africa-53750151
2. Integrated Coastal and Marine Area Management (2017), *Ennore Oil Spill - Chennai Coast, The Ecological Footprint – An Assessment (March, 2017)*, Ministry of Earth Sciences, Government of India.

Rheology of some complex fluids



Ref: Kumar *et al*, Indian Journal of Chemical Technology, 23 (2016)

What will we do in this work?

We will

1. write out the equations governing the motions in the three fluids, and relevant boundary conditions
2. use appropriate forms for the interfacial wave displacement and its frequency
3. derive the dispersion relation and the dissipation rate
4. validate results using field data for swell

Why is it important to predict the dissipation rate accurately?

- Swell influences air-sea exchanges which contribute to major events such as weather and climate changes
- Understanding interfacial processes in the ocean is necessary to model climate change

Acknowledgments

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