

A sticky situation

Context-based learning exercise



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Context-based learning

- Learning and applying chemistry in ‘real world’ situations/contexts
- Challenging students to consider chemistry and the context simultaneously
- Building knowledge, problem solving, communication and team skills



Why are these skills important?

Employability Survey 2012

KKI Associates and the University of Edinburgh asked 6 major employers of STEM graduates what they looked for in their recruits:

- Innovation
- Working in team-based activities
- Problem solving
- Working through formal project/process systems
- Integrating their specialist knowledge with others
- Communication Skills – [Commercial skills for chemists](#)



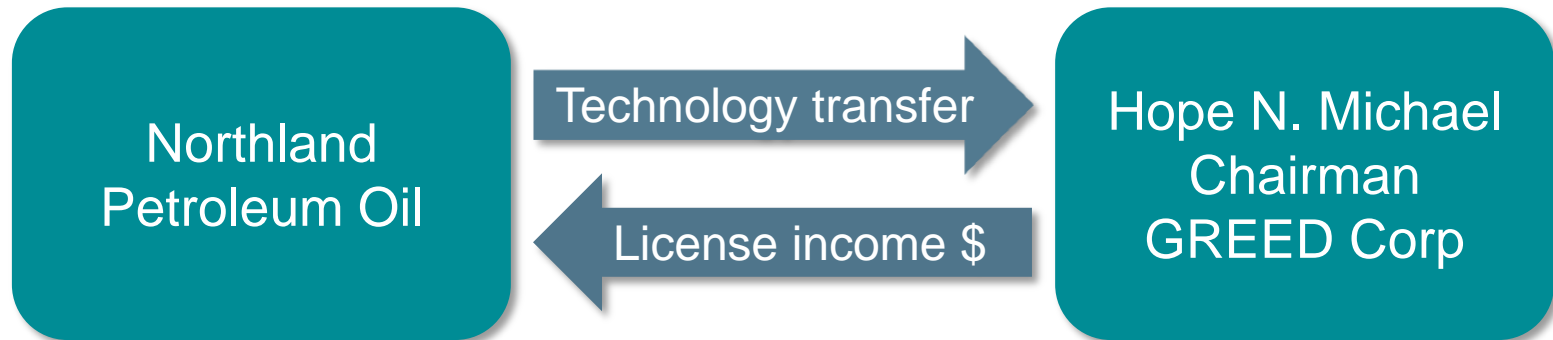
Engine oils are like beer or Coke...

Brand owner/formulator licenses formulations to blenders/distributors around the world



Our Company (Northland Petroleum)

We have licensed our oil formulation to Global Resource Energy Exploitation and Development Co (GREED) in Australia





Australia, September 2014

GREED chairman is opening new ski resort, his car breaks down after the press conference...

...he's not happy

October 2014 (1)

- Northland Petroleum receive lawyers letter claiming damages (physical and reputational).
- ‘poor quality NP oil responsible for engine failure’
- Pictures of oil ‘sludge’ inside engine enclosed





October 2014 (2)

- Northland Petroleum received lawyers letter claiming damages (physical and reputational).
- 'poor quality NP oil responsible for engine failure'
- Pictures of oil 'sludge' inside engine enclosed



That's us



October 2014 (3)

You have a call from the chairman

I need you to pull a team together, have a look at this situation and report back to me. What happened to that car? Do we fight or settle?



Resource structure 1

Setting the Problem

- Billionaire's car breaks down in front of Press
- 'NP Oil' Co are sued
- Task force to investigate and recommend actions



Resource structure 2

Worksheets

- How car engines work
- How lubricants are formulated (2 parts)
- Viscosity Index Improvers (2 parts)
- View from the car makers
- Extending service life
- Testing the oil



Resource structure 3

3 Workshops

- What happened?
- Compare notes and gather information
- Analytical tests
- Integrative exercise – report and recommendations



Your first task

This workshop

- Read the material in the case study briefing
- Make sure you understand the problem
- Clarify anything with facilitators
- Work out how you are going to do the worksheets
- All together or 'divide tasks'



Your next tasks (independently)

Work through 8 worksheets

- Write a short memo for each one
- Answer the questions on them
- Analyse which of these questions bear on the problem of the car
- List and discuss any potentially relevant sources you've found

Worksheet examples 1

- How do engines work?
- Which parts will be physically hard to lubricate?
- Where/how might chemistry be involved?

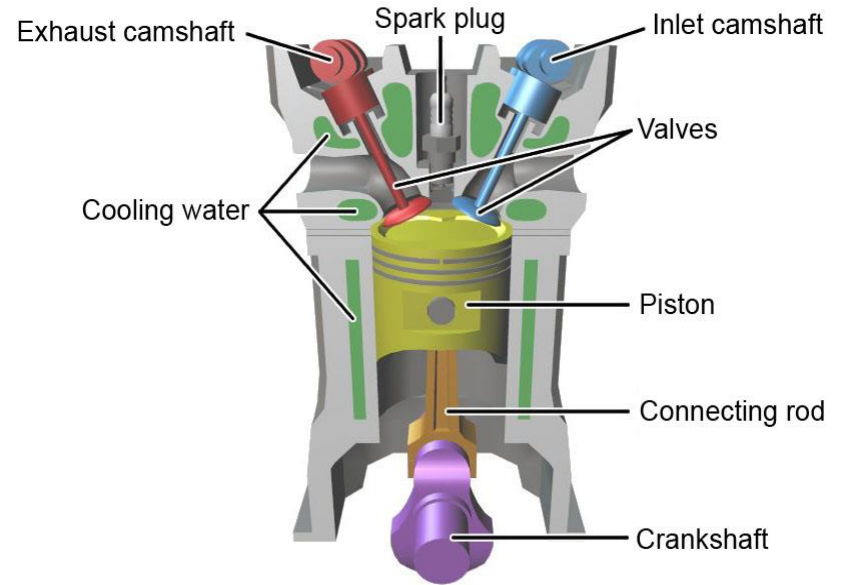


Image credit: Wikicommons

Worksheet examples 2

The properties and composition of lubricating oil

- What's in the oil?
- What properties do we measure?
- What happens when it gets hot?
- What happens in use?

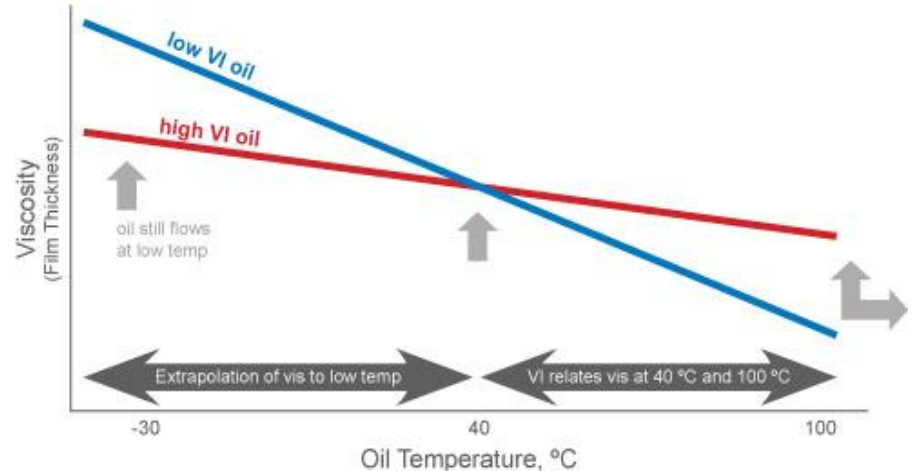


Image credit: Courtesy of Chevron Oronite, LLC

Worksheet examples 3

Viscosity Index Improver

- What's in a VII?
- What determines polymer properties?
- What causes storage problems?
- What could we do to resolve this?

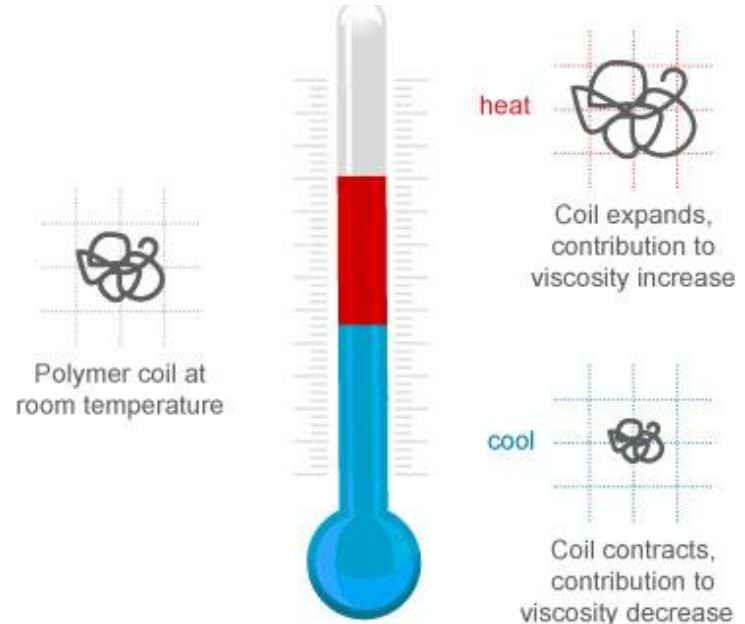


Image credit: Courtesy of Chevron Oronite, LLC

Worksheet examples 4

VI Improver part 2

- What are crystalline and amorphous polymers?
- What is 'Differential Scanning Calorimetry' (DSC)?
- How do polymers interact with solvents?
- What is the solubility parameter?

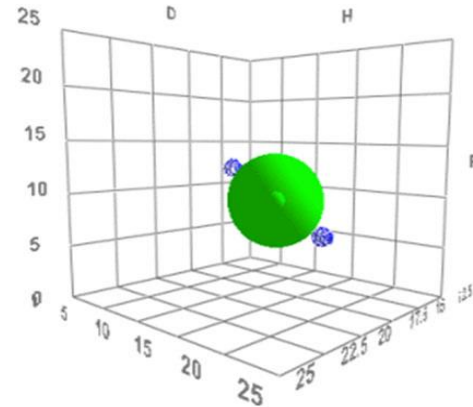


Image credit: Copyright © Steven Abbott, Charles Hansen & Hiroshi Yamamoto

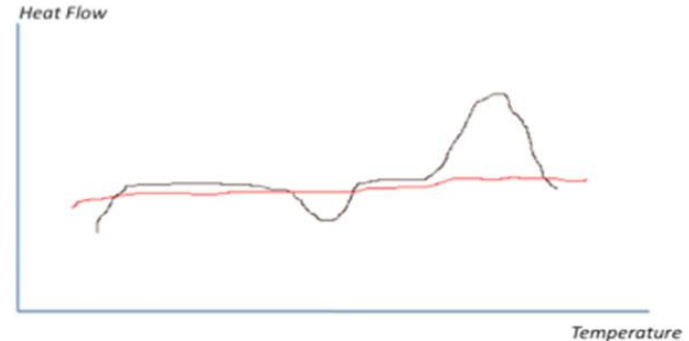


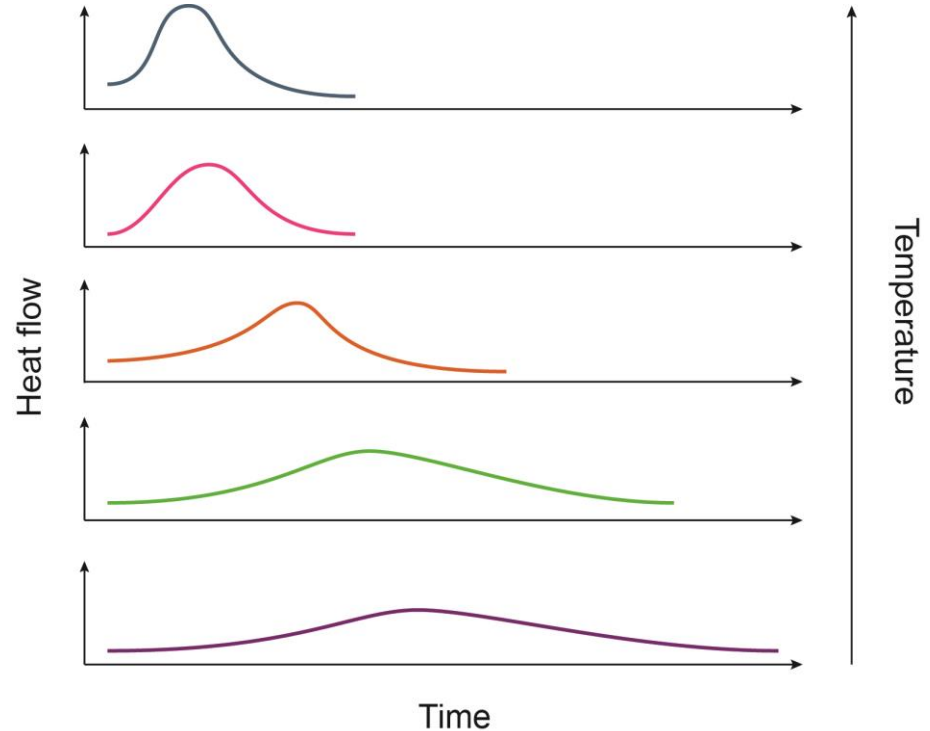
Image credit: KKI Associates, created from data and examples from University Southern Mississippi

Worksheet examples 5

Extending oil life

Anti-wear additives

- Zinc dithiophosphates – what are they?
- What do they do?
- What happens in high sulfur fuels?

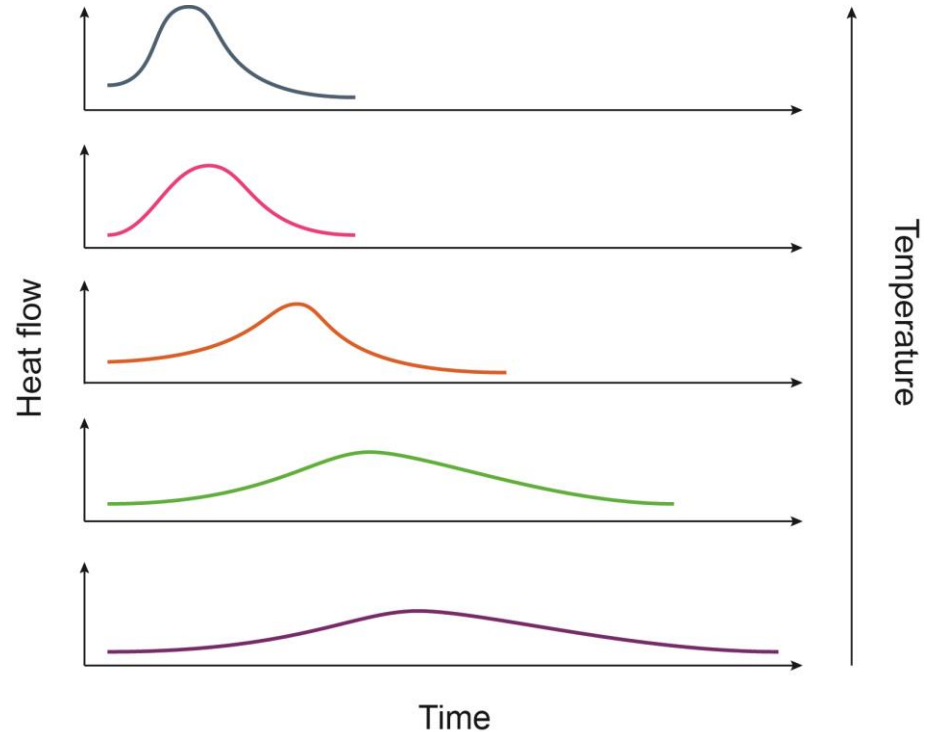


Worksheet examples 6

Extending oil life

Antioxidants

- Mechanism of oxidative degradation?
- Chemistry of antioxidants
- Base oil additive interactions
- DSC tests
- PAO vs XHVI





Discussions at the car makers

Smaller engine

- Higher compression ratio
- Impact of turbo-charging
- Dry sump
- Exhaust catalyst life

Tight engine packaging

- Heat
- Long service intervals

What will these do
to the oil?

OEM performance
standards for
engine oil

Other Information

- Articles
- 'Mysterious list' on desk of missing employee
- Weather Forecast

Australia Daily Times

'Open Mike' defends refinery policy Fuel quality claims 'spurious'

In a hard hitting response to concerns expressed by environmentalists, Hope N. Michael, owner and CEO of GREED refining corporation, refuted criticism of the fuel produced at his, and other Australian refineries.

'This spurious concern for fuel economy and engine performance is just another sneaky trick, aimed at Australia's petroleum industry by the "eco-hippies" he said, at a press conference yesterday.

'I use our fuels in my Konigsberg, which is probably the fastest car in Australia' he said, 'no problems at all.'

How polymers work

<http://bit.ly/1os1ALB>

Solubility parameters: Theory and application

<http://bit.ly/1KFzSVF>

³¹P NMR study of the mechanism and kinetics of the hydrolysis of zinc(II)O,O-diethyl dithiophosphate and some related compounds

<http://rsc.li/1o37zqf>

Tech 101: Zinc in oil and its effects on older engines

<http://bit.ly/1T7zyQS>

¹³C NMR spectra of model hydroaromatic hydrocarbons and solvents

<http://1.usa.gov/1V3SH5o>

Motor oil FAQs

<http://bit.ly/1nYtQoG>

Polymer solutions

<http://bit.ly/1TSrXq9>

Synthesis and characterisation of olefin copolymers as viscosity modifiers for engine oil (copy and paste to browser)

<http://bit.ly/1PCXuHd>

Quenching oils and heat treatment fluids information

<http://bit.ly/20Lw4JO>

Diesel engine lubricants

<http://bit.ly/1o3a3oA>

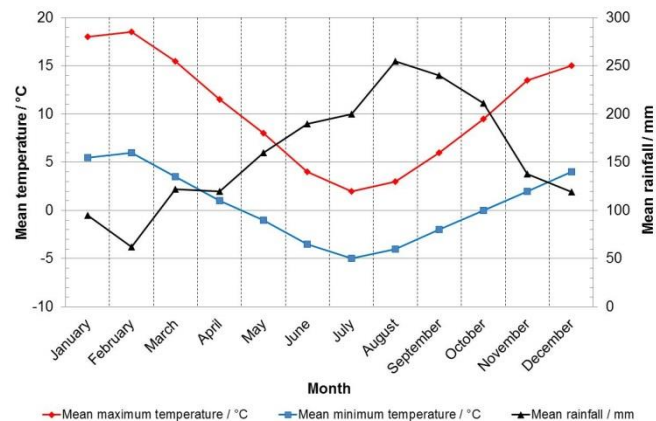
The lubricant's nemesis - Oxidation

<http://bit.ly/1Q926ue>

Insights into organogelation and its kinetics from Hansen solubility parameters.

Toward *a priori* predictions of molecular gelation

<http://bit.ly/1PCYn2q>



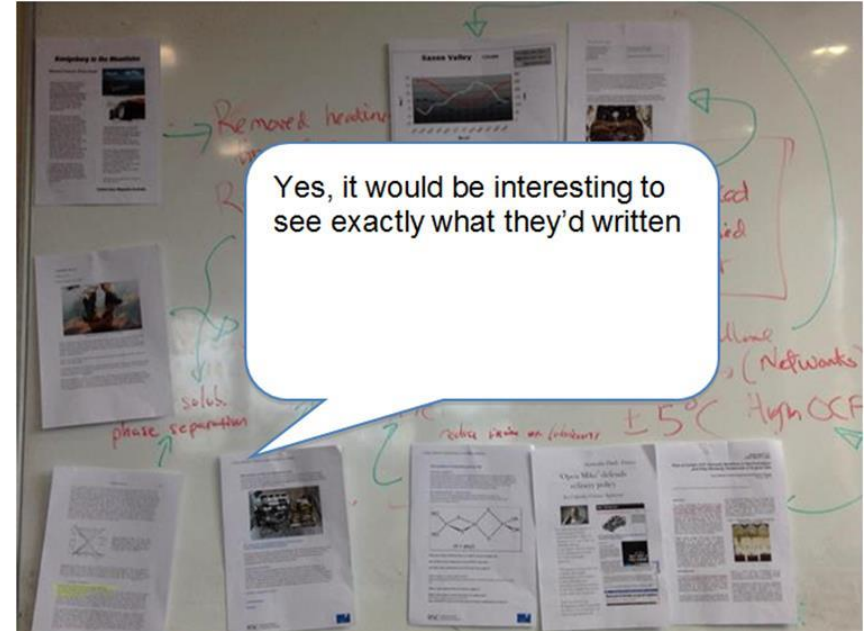


Second workshop

- Should have finished worksheets and sent to facilitator for checking
- Share results with each other (if not yet done so)
- Discuss potential reasons for engine failure
- You'll have a choice of oil samples and analytical techniques 'available'
- Select the ones you want

Third workshop

- 'Analytical Results' back
- Develop narrative about 'what happened'
- Develop 'schematic' of factors
- Write the 'contents page' of your report to Northland management





Report to chairman

- What happened?
- One or multiple factors?
- Whose fault was it?
- Do we settle or fight court case?
- How to stop this happening in future
- Recommendations to reformulate oil
- Recommendations to improve VII



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