

Stage 6 Chemistry - Properties and uses of polymers

Water Recycling Depth Study Program

Sydney
WATER

Depth Study inquiry question - "How does the application of chemistry (properties and uses of polymers) in an industrial setting (Sydney Water) help produce high quality recycled water and protect the environment?"

Duration:
4 – 8 hours

Sydney Water Depth Study program is designed to complement our free excursion program. Our excursion program includes:

- full syllabus links (reference to module content points, working scientifically outcomes and skills, ideas for practical first-hand investigations, secondary sources investigations, sample assessment and data analysis ideas)
- (Optional) Delivery of an excursion by a Sydney Water Education Officer.
- Sydney Water website links to content pages, experiments and resources (PowerPoint presentations, animations and videos).

Suggested Assessment:
1. Fieldwork Report
2. Presentation

Inquiry question: What are the properties and uses of polymers?

- model and compare the structure, properties and uses of addition polymers of ethylene and related monomers – polyacrylamide

Inquiry question: How can hydrocarbons be classified based on their structure and reactivity?

- describe the procedures required to safely handle and dispose of organic substances
- examine the environmental, economic and sociocultural implications of obtaining and using hydrocarbons from the Earth

Inquiry question: How are the ions present in the environment identified and measured?

- analyse the need for monitoring the environment

Sydney Water aim for activity

- Students will learn about the importance of polymers in our treatment of wastewater to produce high quality recycled water
- Students will also investigate the need for monitoring water and the environment and how this knowledge is used to make reliable predictions to treat wastewater and biosolids.
- Our excursion is the starting point for Water Recycling Depth Study; looking at how various chemistry concepts are applied in an industrial/real-life setting to protect the environment.

Syllabus knowledge and understanding outcomes

Module 7: Organic Chemistry and/or Module 8: Applying Chemical Idea

CH12-14 Analyses the structure of, and predicts reactions involving, carbon compounds

CH12-15 Describes and evaluates chemical systems used to design and analyse chemical processes analyse the need for monitoring the environment

Working scientifically outcomes

Planning CH11/12-2 Designs and evaluates investigations in order to obtain primary and secondary data and information

- assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation.

Analysis and problem solving CH11/12-5 Analyses and evaluates primary and secondary data and information

- assess relevance and reliability of the gathered information
- collate useful and relevant information into water filtration process that relates to acid/base and their uses and applications
- evaluate the effect of buffers in natural systems.

Communicating CH11/12-7 Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

- propose ideas in a coherent and logical way and correctly use scientific terminology and principles
- present information on the science and chemistry of acid/base reactions and buffers
- summarise from a range of sources and appropriately acknowledge sources.

Conducting investigations CH11/12-3 (Optional) Conducts investigation to collect valid and reliable primary and secondary data and information

- employ and evaluate safe work practices and manage risks
- use appropriate technologies to ensure and evaluate accuracy
- select and extract information from a wide range of reliable secondary sources and acknowledge them using an accepted referencing style.

Teaching learning and assessment	Resources
Lesson 1 – Introduction This Depth Study program plan applies some content from Module 7/8 relating to organic chemistry (polymers) and apply chemical ideas in (environmental monitoring). The resources for this study are found on our HSC Chemistry webpage. 1. Explain details of the task. Q. Why is a first-hand investigation important? A. Because it allows you to develop the following skills: - fieldwork observations - applying theory to real life - replicating practical activities. 2. Explain Sydney Water's role and responsibility in water management. See our Education webpages for more information. - Who is Sydney Water and what do they do? See our About us webpage for more information. - Where does my water come from, where does it go? See our Water network and Wastewater network webpages for more information. - Why is wastewater treatment and water recycling important? See our Wastewater treatment and Water recycling web pages for more information. 3. Excursion preparation. Q. What will we be doing during the excursion? A. See the High school webpage for more information. Q. Where can I find more information about the excursion site? A. See our Penrith Water Recycling Plant webpage for more information. Q. What are the basic safety and risk assessments on industrial sites? A. This photo shows you how people dress and work in an industrial site. Various personal protective equipment (PPE) is used to minimise risks. Can you come up with what risks this PPE is for? Activity: Students can create a risk assessment table according to the use of PPE. Hints and tips from HSC markers - First-hand investigations involve great opportunities to develop essential numeracy skills through practical measurement and the collection, representation and interpretation of data. - Fieldwork reports and engagement with community experts involve systematic scientific inquiry of real-life application promote students to achieve top marks in the HSC. Further investigations and extension options: • First-hand practical investigations at school	Sydney Water resources High school see HSC Chemistry <i>Make a simple filter experiment</i> <i>Keep wipes out of pipes experiment</i> Education About us Wastewater treatment Wastewater network <i>Wastewater treatment plant webpages</i> <i>EPA pollution data monitoring reports</i> Water recycling Environmental protection Community grants Other resources Water corporation – Water recycling around the world AWA – Water Recycling Fact Sheet



- Conduct experiments comparing separation techniques – particle filtration, distillation and membrane filtration such as syringe or straw filter. See our make a simple water filter resource for more information. - Investigate how fats and oils are related to soaps and detergents. Look at differences in their structure and properties, such as their interaction with water and impact on the environment. - Identify polymers and organic molecules in everyday life, how they are derived and how to safely dispose of them to reduce impacts on wastewater and waterways. - Test the properties of polymers such as the water holding capacity or degradability. For example, materials such as diapers, water crystals, water beads, plastics and cellulose. • Secondary sourced investigations - Comparative study of the different wastewater treatment techniques at different plants and the water quality requirements of each. See our Wastewater treatment plants webpage for more information. - Comparative study of water treatment and recycling in another country. See Water corporation – Water recycling around the world webpage for more information. • Communication surveys – What do people think about their wastewater and recycled water? - Do a wastewater audit in your home to identify your contribution. See our Wastewater audit webpage for more information. - Investigate the perceptions and environmental impact of using recycled water and biosolid on the community. See the Australian Water Association (AWA) Water Recycling Fact Sheet for more information.	
Lesson 2 – Secondary research Q. Have you thought about where your water comes from and where it goes? A. Probably not! Here in Sydney, we have some of the best drinking water in the world, it's clean, safe, reliable and affordable. But where does it come from and where does it go? Activity: Students can investigate our network using the Urban water cycle diagram on our Urban water management webpage. Q. How do you use your water? A. The average breakdown in Sydneysider is ~200L per day. See our Water use and conservation for more information. Q. Have you ever wondered what happens to water after you've used it? A. The water you used becomes wastewater which is 99% water. The remaining one per cent is made up of things you've added to water as you've used it. We take this wastewater and treat it to re-use as recycled water or discharge into the environment. See our Wastewater treatment webpage for more information. Did you know: We call it wastewater, but your syllabus uses sewage. See our Glossary for more information about the terms and definitions we use in the water industry. Activity: Look at the wastewater network map and see which plant your wastewater goes to. Q. What is in that one percent? How do you think we treat a mixture like wastewater to make recycled water? A. The remaining 1% is made up of things you've added to water as you've used it, such as toilet paper and human waste. To protect public health and environment, treated wastewater has been treated to separate and remove	Sydney Water Resources High school see HSC Chemistry Module 7 Make a membrane model Urban water management Urban water cycle diagram Water use & conservation Water recycling Glossary Wastewater network Wastewater network map Wastewater treatment Penrith Water Recycling Plant St Marys Advanced Water Recycling Plant Solids recycling

pollutants before being released into the environment or reused (recycled water). See our Wastewater Treatment webpage for more information. Q. How can we use our understanding of organic chemistry to help remove the waste from the wastewater? A. Based on physical and chemical properties of matter (heterogeneous mixture), we can apply various techniques to analyse and separate substances. For example, using polymers to help remove small particles, as well as identify and monitor inorganic and organic substances in wastewater. Q. Do you think polymers can be used to protect the environment? Or are they detrimental. A. Both, polymers when incorrectly disposed like plastics and wipes can harm our wastewater network and the environment. They can also be used for protecting the environment, such as the use of polymers in water and waste recycling. See our HSC Chemistry webpage to find factsheets on polymers in water and solids recycling and in reverse osmosis membranes. Also see our St Marys Advanced Water Recycling Plant webpage for more information on membrane technology. Activity: Students can use the flow diagram, webpage and animation for St Marys Water Recycling Plant, to do an annotated flow diagram of the processes of the plant. Key points: 1. Students will identify which and where polymers used according to their properties. 2. Students will recognise polymer use is part of a bigger picture, even if chemistry is not involved in all processes it is an important part of the whole. Q. After the water has been treated, how do we use the recycled water? A. Recycled water is an alternate source of water saving drinking water from being used. We can use it for purposes like irrigation, flushing toilets, washing cars and in manufacturing processes. Some other places use it for drinking water purposes such as Singapore and San Diego. See Water recycling to find out about the uses. Q. What do you think happens to all the waste removed from the wastewater? A. We recycle waste from wastewater to minimise the impact on the environment. Waste, minus litter such as plastics, can make a great fertiliser and even energy. See our Solids recycling webpage for more information. Did you know? Another use of recycled water is for environmental flows, to keep creeks and rivers running as we extracted water from the dam which stores water in the catchment. Using high-quality recycled water, we can make a positive influence on the availability and water quality of the Hawkesbury Nepean-River downstream of Warragamba Dam. Optional activity – Complete the <i>Module 7 Make a membrane model</i> lesson. See our HSC Chemistry webpage for more information.	Other Resources PUB - Singapore's National Water Agency San Diego – Recycled Water
Lesson 3 – Field trip Students will visit a working water recycling plant to explore how we treat and manage wastewater for re-use to protect public health and the environment. Refer to our program outline on our Excursion request webpage for more information.	Sydney Water resources Excursion request High school see HSC Earth & Environmental Science

Lesson 4 – Analysing Data and Information Activity: Students can use secondary sourced data (lessons 1-2) to compare with excursion observations. Students can also investigate the following sources of information and data: • St Marys Water Recycling and St Marys Advanced Water Recycling webpage provide additional details for the excursion site. Students can identify the process that relates to polymers and their uses to protect the environment • What's in wastewater factsheet provide details about the composition of wastewater. See this factsheet for more information • EPA pollution monitoring data reports for all our wastewater systems. These reports measure concentration limits of parameters such as ions, organic matter and other elements after wastewater has been treated. Students can assess the relevance and reliability of the gathered information • Drinking water quality report shows results for up to 70 different characteristics. This is the source water of wastewater. Students may want to compare wastewater, recycled water and drinking water and can assess the relevance and reliability of the gathered information • EPA webpage also provides information on water pollution and quality. After students gathered all the relevant data and information, Students can assess the relevance and reliability of the gathered information and create a scientific report or presentation. Think about: Q. What did we find out about the application of polymers in water recycling to protect the environment? A. The outcomes to water quality and waste recovery would have been significantly reduced without the use application of polymers. Q. Why was it valuable to learn about the greater context of water recycling? A. Water recycling processes show the application Chemistry in real-life (applying polymers and environmental monitoring) and are essential to maintaining public health and protecting the environment. We also get to understand the role of individuals and how we all contribute to sustainable water management.	Penrith Water Recycling Plant High school see HSC Chemistry <i>What's in wastewater factsheet</i> St Marys Advanced Water Recycling Plant Wastewater network <i>Wastewater treatment plant webpages</i> <i>EPA pollution data monitoring reports</i> Water analysis Other resources EPA Water WaterNSW Beachwatch Water Quality Australia Penrith Water Recycling Plant
Lesson 5 Example: Depth Study – Fieldwork Report /Presentation A report may require students to: • describe the context of the site - How does water recycling work, how do we use polymers? - How is wastewater treated at St Marys Advanced Water Recycling Plant and re-used? - How do the chemicals used form predictable outcomes required for recycled water (and waste)? - How did the type and volume of polymers effect their efficiency and function? - Why is it necessary to monitor and manage pollutant(s)? What could be the impact to the environment? • describe and justify methods used during the investigation - What were some of the flaws? - How valid, accurate and reliable were the results? - What needed improvements?	High school see HSC Chemistry Other resources NESA sample work for Chemistry NESA - The scientific research report

• assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation • process and analyse first-hand lab activities, fieldwork and secondary data - How they recorded, conducted and analysed their water samples (excursion)? - How are polymers used to protect the environment? Why are polymers used? - What tables and graphs can you compile? - How could this be information be useful, for example, testing the efficiency of water recycling? Designing a new wastewater treatment system? • communicate the results and conclusions of the fieldwork, lab and research investigations. • See NESA samples for more information.	
Conclusion Evaluation questions • How can chemistry be applied in the sustainable water management? • Why are working scientifically, collaboration and communication skills important? • Why do we have to continuously evaluate our scientific methods? • What could you do to help manage our water for the future? • How has your excursion experience helped you understand chemistry's real-world applications? Reflection activity - students finish these statements: 1. I used to think (at the start of these lessons) 2. but now I think (at the end of these lessons). Practice questions - practice some sample HSC questions using your Water Recycling Depth Study knowledge. See our HSC Chemistry webpage for links to questions. Got students interested in a career with Sydney Water or research and development? See our Sydney Water careers webpage for more information on working here. Find out about the latest research from Sydney Water on our Reports and publications webpage.	Sydney Water resources High school see HSC Chemistry Careers Reports & publications Find out more • sydneywater.com.au/education • facebook.com/SydneyWater  • instagram.com/sydneywater  • twitter.com/SydneyWaterNews 