

Erin Brockovich

Films about science or even pseudo-science can be powerful tools in the classroom. **Jenna Stevens** from the CISCI project provides a toolkit for using the film *Erin Brockovich* in chemistry and ecology lessons.

Description of the film

Erin Brockovich is struggling to make ends meet as a single mother with three children when she meets attorney Ed Masry and convinces him to give her a job in his firm. When filing the paperwork for a real-estate case, she decides to investigate further because the owners of the property have some unusual health issues. After much research, she discovers that these health problems are due

to the presence of chromium in the area's groundwater and that this is affecting the health of the whole community. She finds herself with a massive case against the large corporation that is causing the chromium pollution and works tirelessly to unite the community in an effort to stop the corporation and get the people the compensation they deserve.

Description of scene

When Erin visits a professor at a nearby college to learn more about chromium, she finds out that there are actually several kinds of chromium, the most harmful of which can cause a wide variety of very serious health problems after prolonged exposure. The professor also tells Erin that chromium(VI) is in the water used to cool piston engines at factories to prevent corrosion.

Basic level

Hexavalent chromium, also referred to as chromium(VI), Cr(VI), chromium-6 or Cr⁶⁺, is a very dangerous form of chromium, as described by the professor in this scene. In this movie, Cr(VI) is ingested by the residents in the area due to its presence in their water. Among the health problems caused by ingesting Cr(VI) are various forms of cancer, respiratory diseases, kidney failure, gastrointestinal conditions, reproductive problems, as well as nosebleeds, headaches, benign (non-cancerous) tumours and hair loss. The workers in plants where Cr(VI) is used also experience health problems when it comes into contact with their skin or when they inhale it.

Throughout the movie, different medical cases of residents are brought

Table 1: *Erin Brockovich* details

<i>Title</i>	<i>Erin Brockovich</i>
<i>Year</i>	2000
<i>Film producer</i>	Jersey Films
<i>Director</i>	Steven Soderbergh
<i>Cast</i>	Julia Roberts, David Brisbin, Dawn Didawick, Albert Finney
<i>Scientific subject and topic</i>	Chemistry and ecology
<i>Website</i>	Filmography links and data courtesy of The Internet Movie Database www.imdb.com/title/tt0195685/

Table 2: Erin Brockovich details

<i>Time interval</i>	31:32-33:00 in Chapter 13
<i>Scientific keywords</i>	Chromium, piston engines, corrosion
<i>Title of scene</i>	What kind of chromium is it?

up and many of these side effects are present. One character in particular, Donna Jensen, has had multiple benign tumours as well as cancer.

Advanced level

Chromium(VI)

Chromium is a transition metal that can have different oxidation states resulting in different properties and reactions with other chemicals. Two common forms of chromium are trivalent chromium (Cr(III)) and hexavalent chromium. Trivalent chromium is more common in natural settings and commonly found in soil, whereas Cr(VI) can be found in industrial settings and is not as safe as Cr(III). When ingested, Cr(VI) can cause problems in various systems of the body, including but not limited to the liver and kidneys, the reproductive system and the respiratory system. It is believed to cause cancer in these systems, but there is controversy over this due to evidence that Cr(VI) becomes Cr(III) when it enters the stomach.

Industrial use of chromium(VI)

Cr(VI) is used in the industrial setting to make dyes and pigments as well as bricks for furnaces, and also to tan leather and preserve wood. The Pacific Gas & Electric Company (PG&E) used it in their piston engines to prevent corrosion. As suggested by the professor in the film, Cr(VI) is added to the water that is used to cool the engines. This is what caused the contamination of the groundwater

in the areas surrounding the PG&E plant.

Corrosion

Corrosion is a result of reactions between a material, typically a metal, and its environment, resulting in an oxide (e.g. MgO) or salt (e.g. MgCl₂) of the metal. This causes the metal to become weak. In an industrial setting, this must be protected against to preserve machines made of metal.

Scientific level

Chromium is primarily found in the Cr(III) form as sediments and is insoluble in water. However, dissolved chromium is typically in the Cr(VI) form. Drinking-water levels of Cr(VI) are usually less than 2 parts per billion. Tests of the area on which the movie was based have revealed 6 to 8 parts per billion of Cr(VI) in the drinking water, confirming there was an excess amount present. In water, Cr(VI) typically exists in the monomeric or bimeric state, such as in HCrO₄⁻ and Cr₂O₇²⁻. These can cause discolouration of the water to a yellow or orange tint, however, at such small concentrations the colour change would be expected to be unnoticeable. The World Health Organization has recommended that the maximum allowable concentration limit for drinking water should be set at 0.05mg/L.

PG&E had large cooling towers to remove excess heat produced from their generators. The cooling towers would accumulate corrosion or min-

eral deposits over time. However, adding sodium dichromate (Cr(VI)) greatly reduces mineral build-up and corrosion. Eventually, the Cr(VI) degrades and is reduced to Cr(III), which is inefficient at inhibiting corrosion. PG&E put their waste coolant into shallow dredge ponds.

The sandy soil allowed the waste coolant to leach into the groundwater and wells of the town of Hinkley, where the plant was based. The town's residents used this water as drinking and bathing water. In the industrial setting, the presence of Cr(VI) in the air is of increasing concern for workers. Recently, the standard for a safe level set by the Occupational Safety & Health Administration of Cr(VI) in the air was changed from 52 µg/m³ of air to 5 µg/m³ of air. This should be a step towards safer working environments for plant workers.

Cr(VI) is so dangerous in the body because it can easily cross cell membranes (whereas Cr(III) has a difficult time crossing cell membranes), causing multiple problems inside cells. Cr(VI) can cause mutations in DNA and selectively targets a small subsection of genes. Within cells, Cr(VI) is reduced to Cr(III), where it is necessary for regulating glucose levels. Inside cells, Cr(III) is not as harmless as it is outside cells. Once inside the cell, Cr(III) accumulates in organ tissue, causing health problems and potential organ failure.

Resources

CISCI

For more information about the CISCI project, visit the CISCI website: www.cisci.net

Alternatively, see *Launch event of Cinema and Science (CISCI)* on page 9.

Link to Trailer Site:

Trailers courtesy of The Internet Movie Database:
<http://us.imdb.com/title/tt0195685/trailers>

Buy DVD

DVD – Erin Brockovich (UK):
www.amazon.co.uk/exec/obidos/ASIN/B00004W4GT/026-6092405-9376435

DVD – Erin Brockovich (USA):
www.amazon.com/gp/product/B00003CXFV/qid=1141187035/sr=8-1/ref=pd_bbs_1/104-7855840-6710367?%5Fencoding=UTF8&v=glance&n=130

Website about film:

http://en.wikipedia.org/wiki/Erin_Brockovich_%28film%29

Websites about the person Erin Brockovich

http://en.wikipedia.org/wiki/Erin_Brockovich
www.quackwatch.org/01QuackeryRelatedTopics/brockovich.html

Websites about chromium

<http://en.wikipedia.org/wiki/Chromium>
www.dartmouth.edu/~toxmetal/TXSHcr.shtml

Websites about hexavalent chromium

http://en.wikipedia.org/wiki/Hexavalent_chromium
<http://searchwarp.com/swa14619.htm>
www.etc.org/technologicalandenvironmentalissues/chemicalsofconcern/chromium_6/
<http://wcaslab.com/tech/hexchrom.htm>
www.clu-in.org/contaminantfocus/default.focus/sec/chromium_VI/cat/Overview/

Website about corrosion

<http://en.wikipedia.org/wiki/Corrosion>

Website about piston engines

http://en.wikipedia.org/wiki/Piston_engines

