# DEGRADATION OF CONTAMINANT ORGANIC COMPOUNDS:

## A possible solution for the environment


Think of a river ...

Source: https://graphics.reuters.com/INDIA-RIVER/010081TW39P/index.html

What do you think that have in mineral water? Is the water pure?

# Mineral water label


DEPT. OF HYGIENE, PREVENTIVE MEDICINE AND PUBLIC HEALTH
AT THE UNIVERSITY OF MESSINA
CHEMICAL AND PHYSICAL ANALYSIS

| | | |
|---|---|---|
| WATER TEMPERATURE AT THE SOURCE | °C | 7,8 |
| HYDROGEN IONS AT THE SOURCE | PH | 7,65 |
| FIXED RESIDUE AT 180°C | mg/l | 105 |
| SPECIFIC ELECTRICAL CONDUCTIVITY AT 20°C | µS/cm | 135 |
| AMMONIACAL NITROGEN ($NH_4^+$) | mg/l | assente |
| NITRITES ($NO_2^-$) | mg/l | assenti |
| CARBON DIOXIDE AT THE SOURCE | mg/l | 2,50 |
| ARSENIC | mg/l | assente |

ELEMENTS CONTAINED IN 1 LITRE OF WATER (mg/l)

| | | | | | |
|---|---|---|---|---|---|
| CALCIUM | $Ca^{++}$ | 16,8 | CHLORIDE | $Cl^-$ | 7,3 |
| SODIUM | $Na^+$ | 6,1 | FLUORIDE | $F^-$ | 0,2 |
| MAGNESIUM | $Mg^{++}$ | 4,9 | SILICON DIOXIDE | $SiO_2$ | 16,0 |
| POTASSIUM | $K^+$ | 1,7 | BICARBONATE | $HCO_3^-$ | 83,6 |
| SULPHATE | $SO_4^{--}$ | 8,2 | NITRATE | $NO_3^-$ | 2,0 |

Messina 17/11/2014 Prof. O. C. Grillo

BACTERIOLOGICALLY PURE AT THE SOURCE

FONTENOCE water complies with L.D. no. 176 of 08/10/11

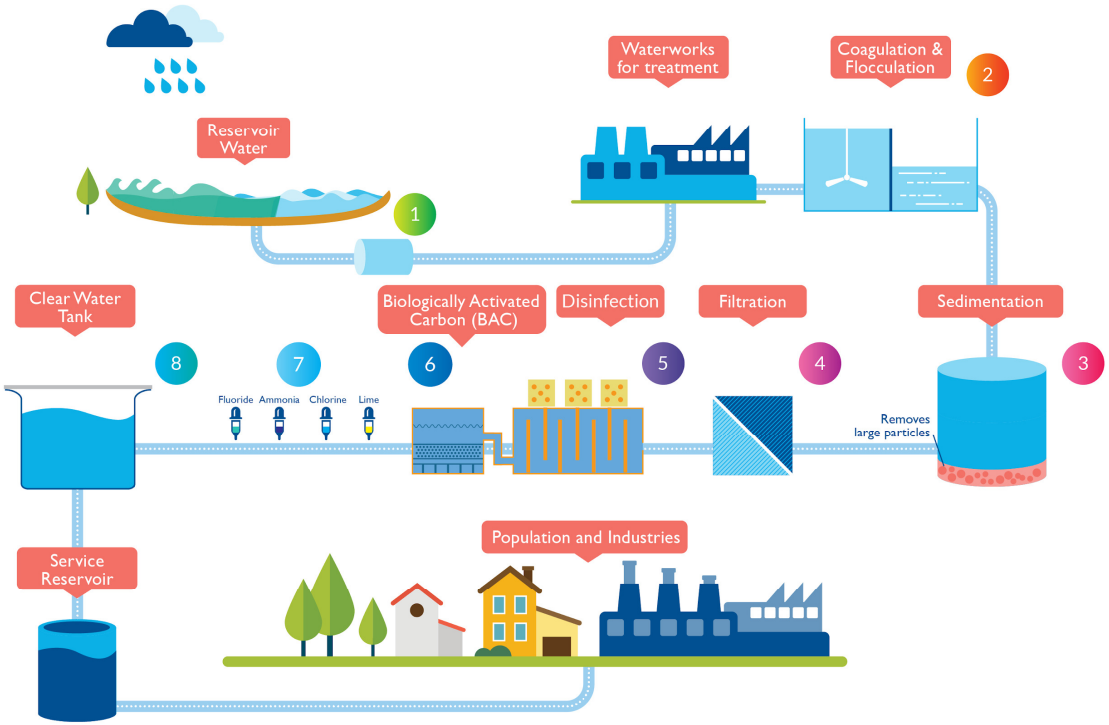
SUITABLE FOR LOW SODIUM DIETS

**Can anyone read what is written here?**

Source: http://www.ibslifestylewater.com/properties-label/

# What substances do you think that have in your tap water?

# Conventional water treatment




Source:https://www.pub.gov.sg/watersupply/watertreatment

## Evaluation

- ✔ Chlorine
- ✔ Fluorine
- ✔ Turbidity
- ✔ Color
- ✔ pH
- ✔ Coliforms

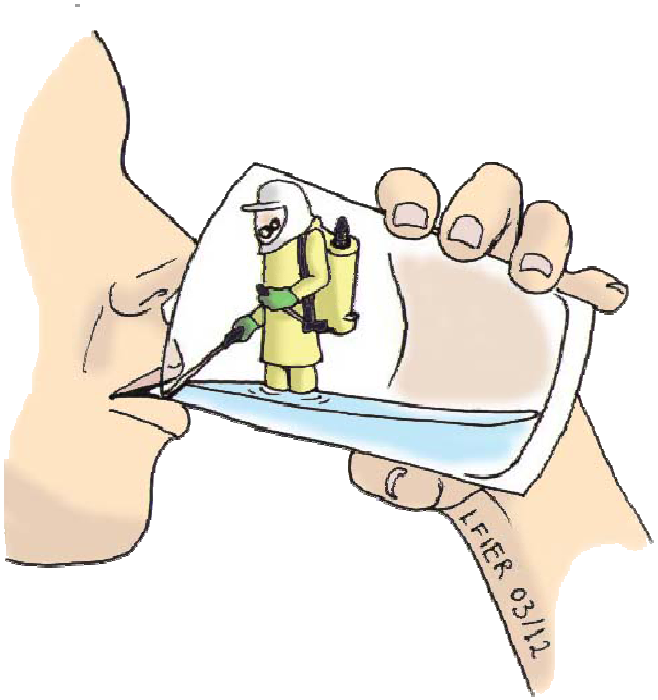
**That's enought?**

# Contaminant limits

| Name of the Contaminant | Permissible Limit as suggested by WHO (mg/L) | Some of the Diseases/Problems Caused (if the actual concentration is more than the permissible limit) |
|---|---|---|
| Cadmium | 0.003 | Kidney dysfunction and lung impairment. |
| Iron | Not Given | Inflammatory problems, kidney problems, hypertension. |
| Arsenic | 0.01 | Black foot disease, arsenicosis. |
| Lead | 0.01 | Lead poisoning. |
| Mercury | 0.006 | Hydrargyria. |
| Chlorine | 5.0 | Possible artery damage, melanoma, and cancers |
| Nitrate (as nitrate ion) | 50.0 | Reduction in the oxygen-carrying capacity of blood, blue-baby syndrome |
| Fluoride | 1.5 | Dental and skeletal fluorosis |
| DDT | 0.001 | Headache, nausea, vomiting, confusion, and tremors. |
| Uranium | 0.03 | Nephritis. |

Source:https://www.researchgate.net/publication/305280524_A_Sustainable_and_Economical_Approach_to_Water_Treatment_A_Review_in_Context_of_India

# Contaminants

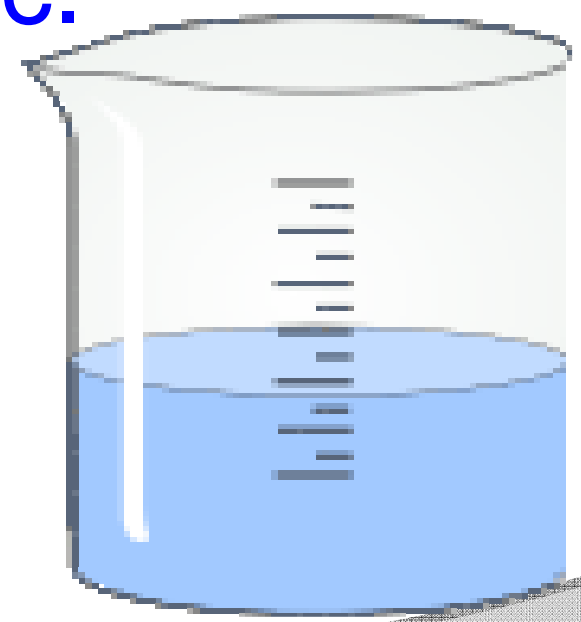




**Do you think there is a procedure that can eliminate these contaminants, for example, dyes, from water?**

# Thinking about a problem situation:

Imagine that you are a chemist and collected a sample of water from a river and it had the following characteristic.



# WE NEED TO ANSWER

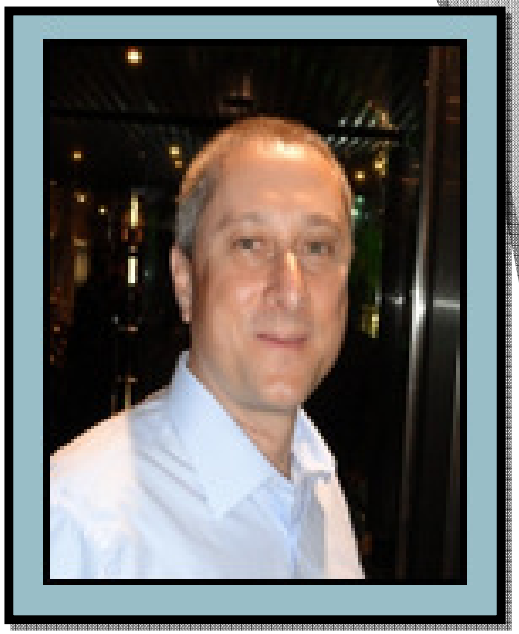
How can we make it “decontaminated” again?

With what treatment?

# CHEMISTRY

Universidade de São Paulo


IQSC

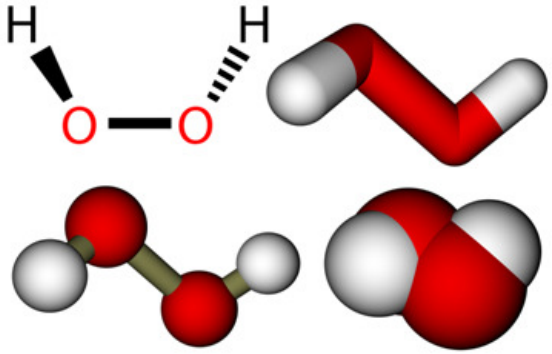


Prof. PhD Marcos Roberto de Vasconcelos Lanza and the Electrochemical and Environmental Processes Group – GPEA

# Oxidative Processes Advanced

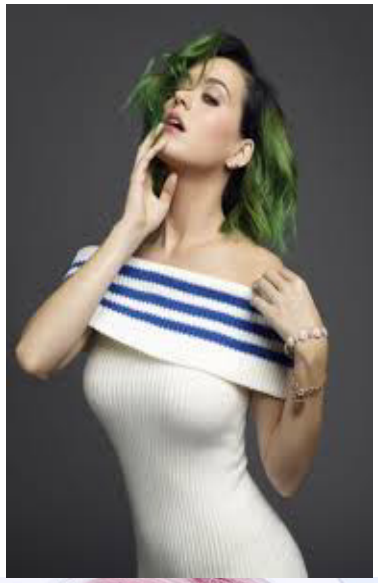
The objective is to degrade pollutants that are not completely removed by conventional water treatment.

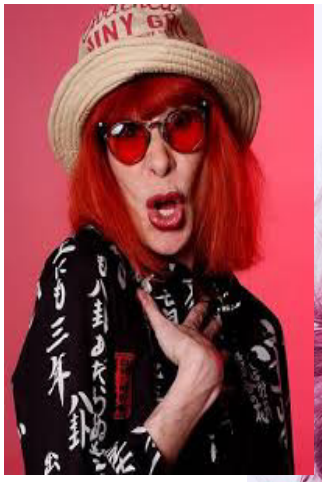
# Oxidative Processes Advanced (POA)





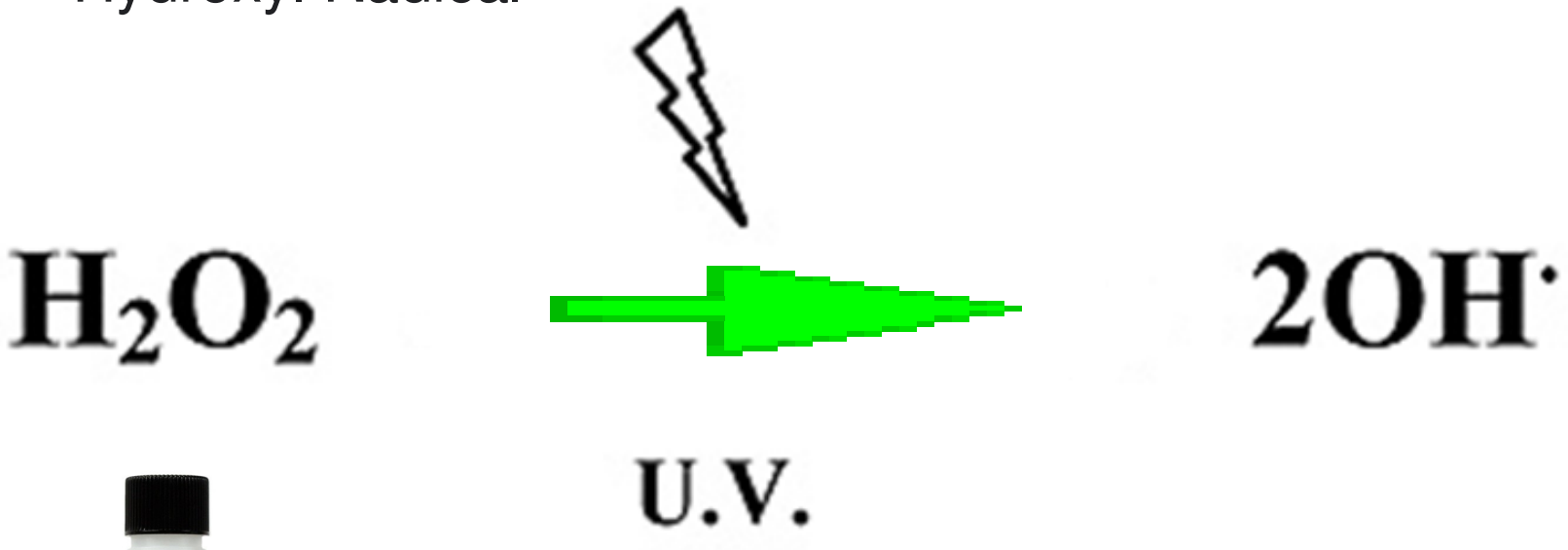
**In your daily life, where do you use hydrogen peroxide?**

**Hydrogen peroxide is commonly used to bleach hair.**

Hydrogen peroxide
Hydroxyl Radical

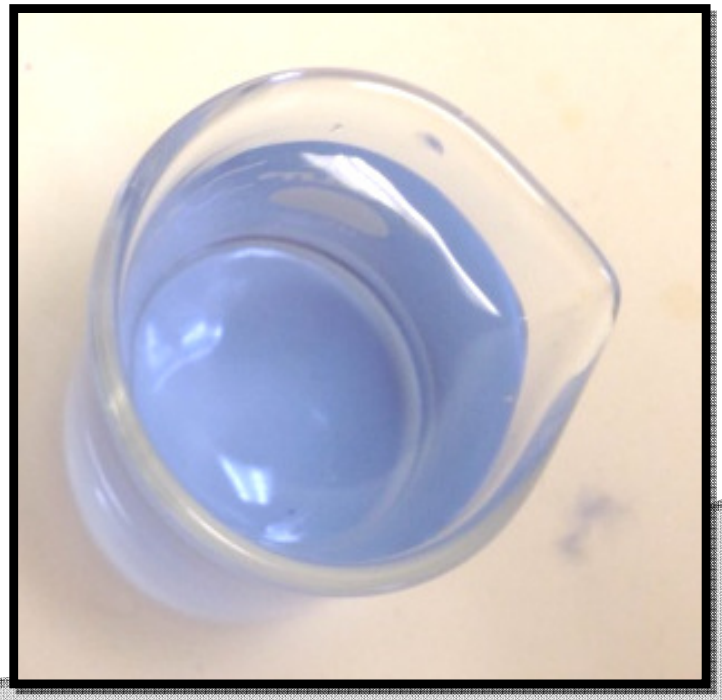



**Before** **After**

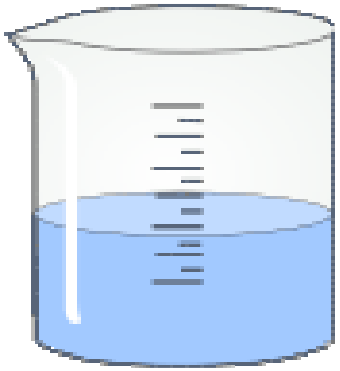
# Example of an oxidized rock in a museum

# Returning to the problematic

**How can we decontaminate water? Let's see how advanced oxidation processes work?**



# THE EXPERIMENT




# Laboratory materials used

Magnetic bar

Balance

Beaker

Pipette

Magnetic shaker

# EXPERIMENT

- ✔ Add to a beaker with 40mL of distilled water and 10mL of dye;
- ✔ Then place a piece of steel wool (~ 0.05g) (releasing the iron in the reaction);
- ✔ Leave under constant agitation;
- ✔ Add 1 ml hydrogen peroxide (3% hydrogen peroxide), and observe.

# What happened in the experiment?

BEFORE

AFTER

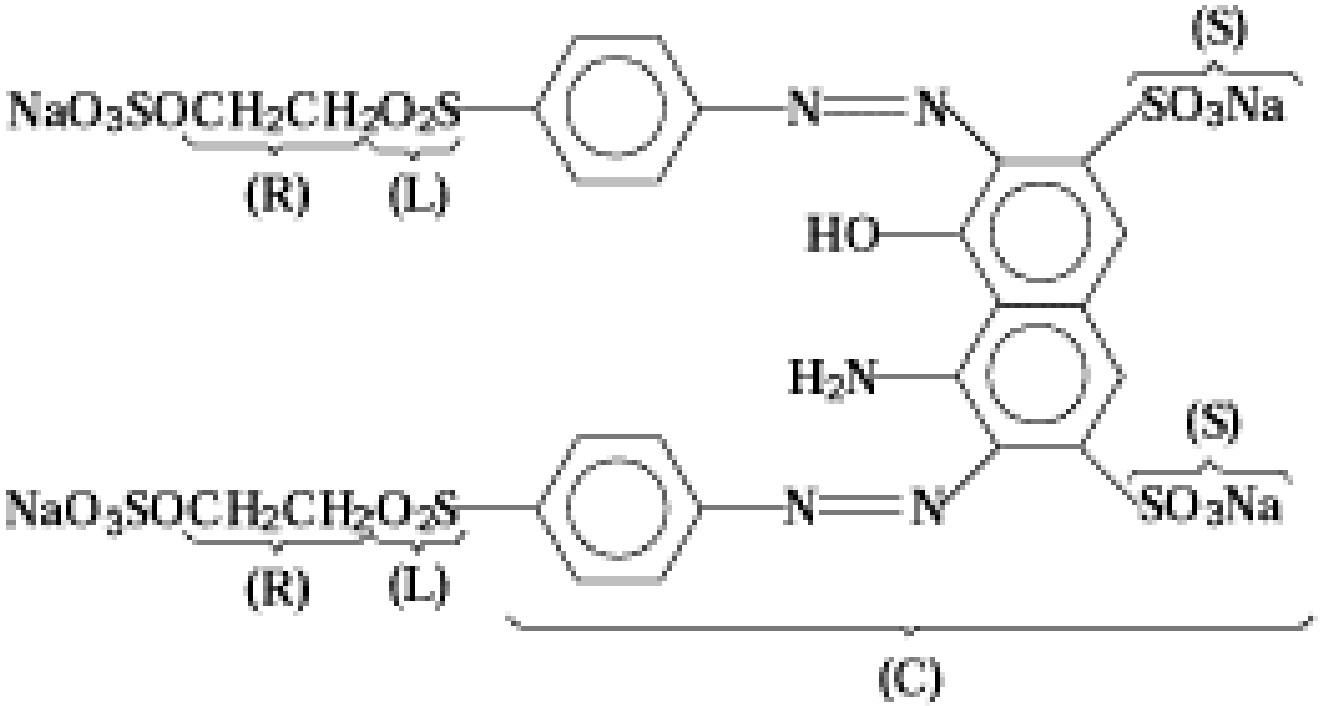
BEFORE

AFTER

# ADVANGES of POA

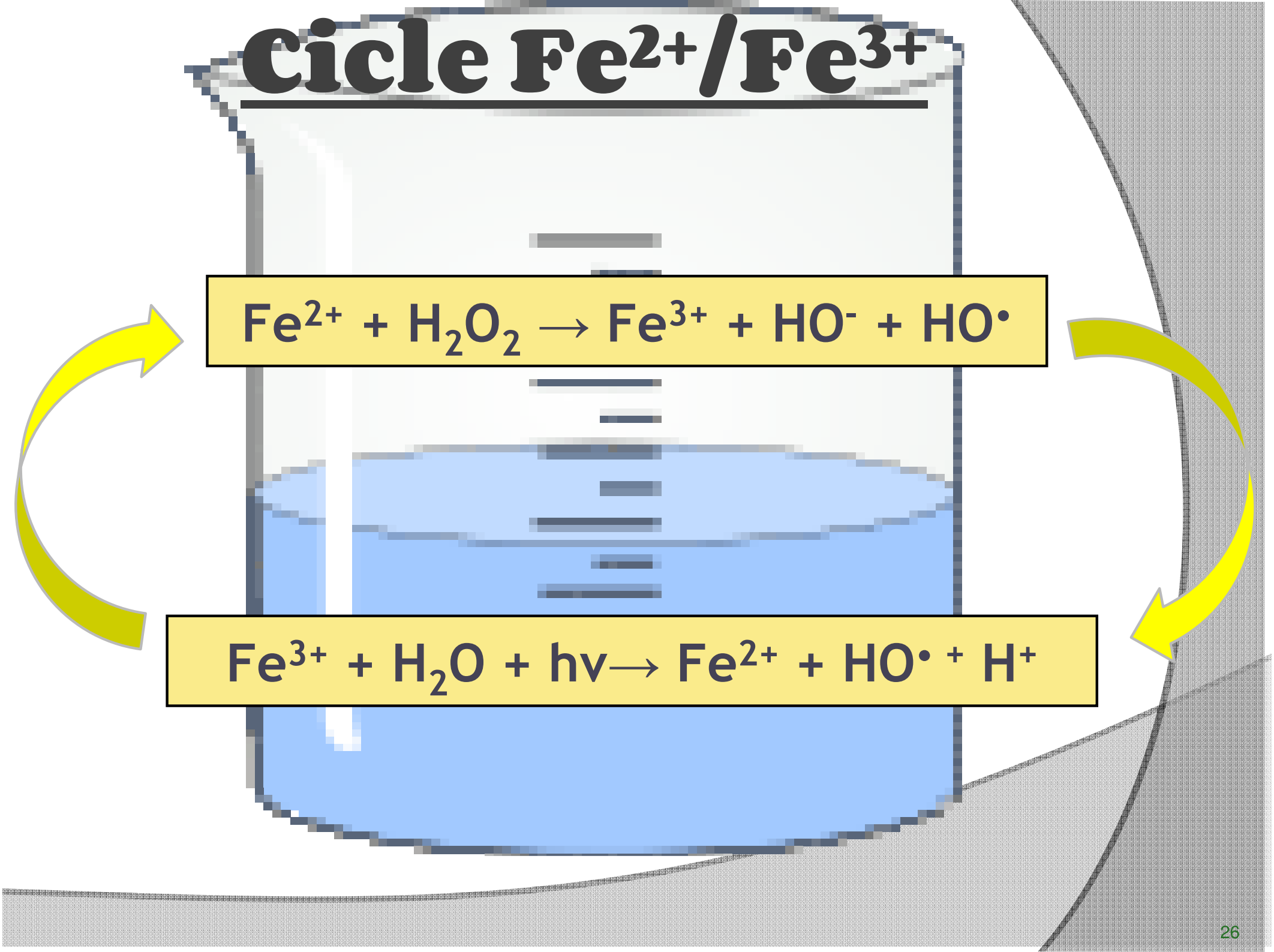
- It has strong oxidizing power.
- It promotes the oxidation of complex compounds until they convert to $CO_2$, $H_2O$ and inorganic compounds, such as gases.
- They don't need post-treatment;
- Consume less energy;
- Enable *in situ* sorting.

# Black 5 Reactive Dye Molecule




$$R\text{-}N{=}N\text{-}R + 4H^{+} + 2Fe^{0} \rightarrow R\text{-}NH_2 + H_2N\text{-}R + 2Fe^{2+}$$

# Cicle $Fe^{2+}/Fe^{3+}$



# As we know what is in the treated solution?

# Chemical analysis

**To find out what is in the treated solution, we can use different types of chemical analysis, such as chromatography.**

# Research Lab

## ⦿ The research lines are:

1) Development and evaluation of processes / materials for the electrosynthesis of hydrogen peroxide in-situ;

2) Development and evaluation of electrode materials for electrochemical synthesis processes and / or for the treatment of effluents;

3) Development and evaluation (POA);

4) Development and evaluation of electrochemical sensors and / or biosensors for online analysis.

# Is this process applied?

# Group of electrochemical and environmental processes:


Scientific research

Master's

PhD

Post doctoral

# Partnerships

The Paulista State University - UNESP
Araraquara

Federal University of São Paulo - UNIFESP

São Carlos School of Engineering - EESC

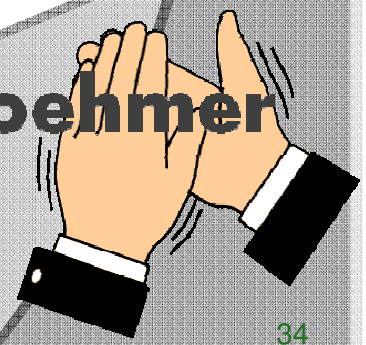
University in Canada

# Thanks!

**Scholarship students involved:**

Ana Carolina Steola
Ariane Carolina da Rocha
Caio Nunes
Daniel Matheus da Silva
Karen Angelotti
Fábio Gullo

Coordenation: Kenia Naara Parra
Supervision: Prof.ª Drª Ana Cláudia Kasseboehmer



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