

Sulphuric Acid Burn: Evaluation and Decontamination



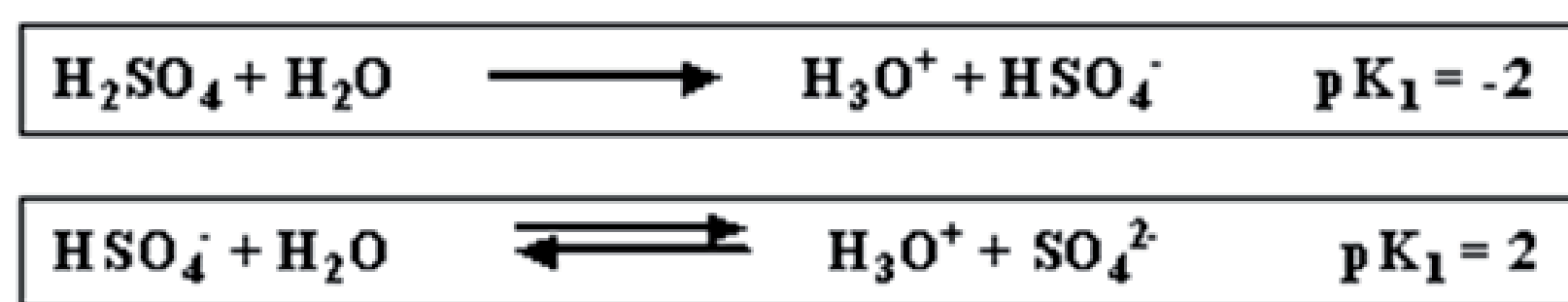
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43rd BBA Annual meeting, Uckfield, April 2010

Sulphuric acid can release 2 H⁺ ions successively in an aqueous solution:



Methods:

Experiment 1: This *ex vivo* study aims to show the extent and nature of epidermal and dermal lesions over 48 hours (burn group) as well as the spontaneous healing process over 11 days (healing group) on 39 human skin explants obtained with consent from plastic surgery patients. The burn was made with filter paper soaked with 30 µL of 95% sulphuric acid.

Time of exposure (burn group) = Observation time / healing group ⇔ 25 seconds.

Histological analysis was performed to evaluate the burn based on an intensity scale.

Results:

Damage induced by concentrated sulphuric acid appears within the first minute. Full skin lesions are observed after approximately 4 hours. No spontaneous healing of the H₂SO₄ burn was observed after 2, 6 and 11 days.

Group	Time of observation	Control	Burn	Burn	Burn	Burn	Burn	Burn	Burn	Burn	Burn	Burn	Burn	Burn	Control	Burn	Control	Burn	Healing	Control	Healing	Control	Healing
		0s	25s	40s	1min	2min	3min	4h	5h	6h	7h	8h	9h	10h	24h	24h	48h	48h	48h	6days	6days	11days	11days
Epidermis	Cellular structures	-	++	+++	+++	+++	++++	++++	++++	++++	++++	++++	++++	++++	-	++++	-	++++	+++	-	+++	-	+++
	Hyalinized collagen	-	-	-	-	+	+++	+++	+++	+++	+++	+++	+++	+++	-	+++	-	+++	-	-	-	-	-
Papillary dermis	Cellular structures	-	+	++	++	+++	+++	+++	+++	+++	+++	+++	+++	+++	-	+++	-	+++	++	-	++	-	+
	Hyalinized collagen	-	-	-	-	-	+++	+++	+++	+++	+	++	++	+	-	+++	-	++	-	-	-	-	-
Superior reticular dermis	Cellular structures	-	-	-	-	-	+++	+++	+++	+++	++	++	+++	+++	-	+++	-	+	-	-	-	-	-
	Hyalinized collagen	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-
Inferior reticular dermis	Cellular structures	-	-	-	-	-	++	++	++	++	+	+	++	++	-	+	-	+	-	-	-	-	-
	Hyalinized collagen	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 1: *ex vivo* results of experiment 1

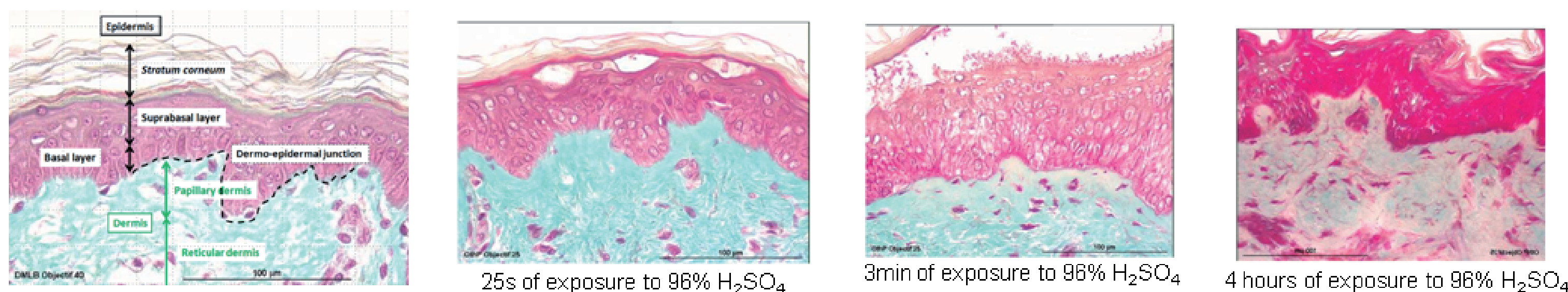


Figure 2: histological results of experiment 1

Methods:

Experiment 2: Simulation of 95% H₂SO₄ diffusion (fig. 3): This type of experiment examines the diffusion of an irritant or corrosive agent through the eye. Sulphuric acid was put on a semi-permeable membrane to imitate eye penetration and diffusion (fig. 4). Diffusion of different concentrations of sulphuric acid was evaluated by pH measurements.

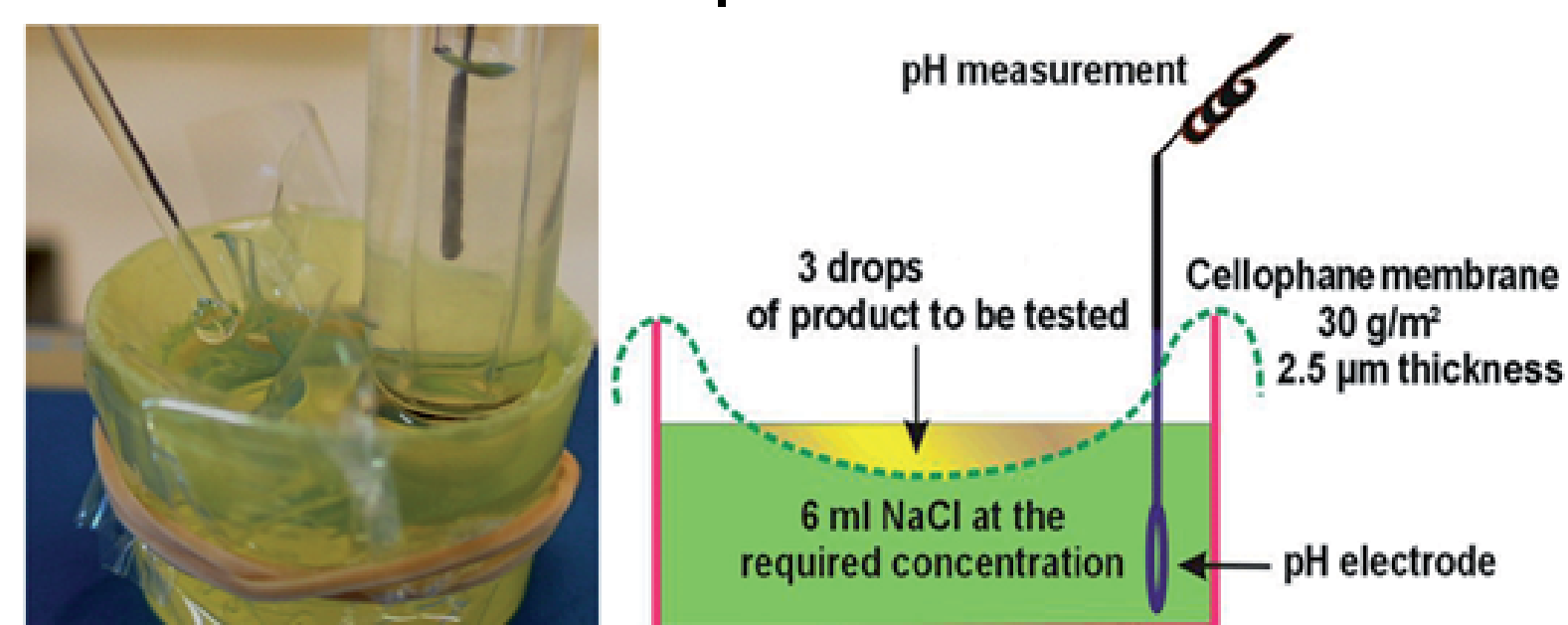


Figure 4: experimental device of experiment 2

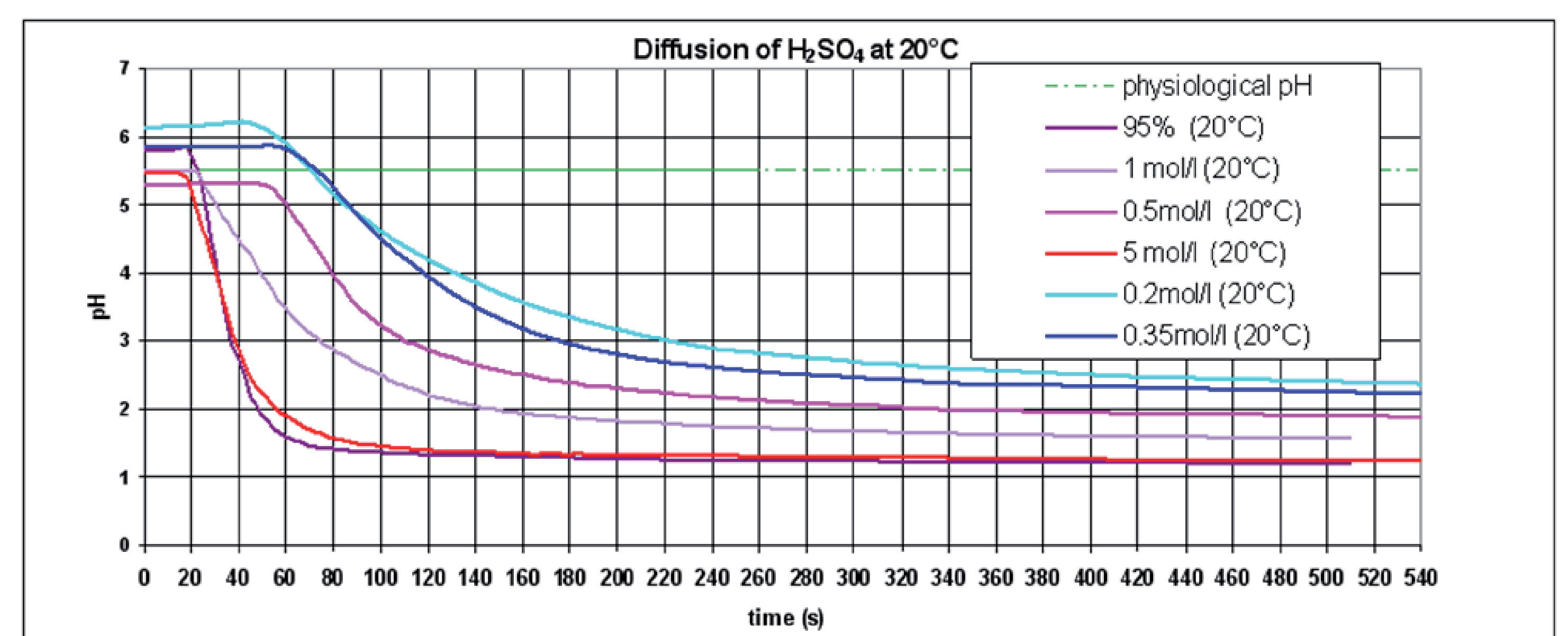


Figure 3: Simulation of 95% H₂SO₄ diffusion

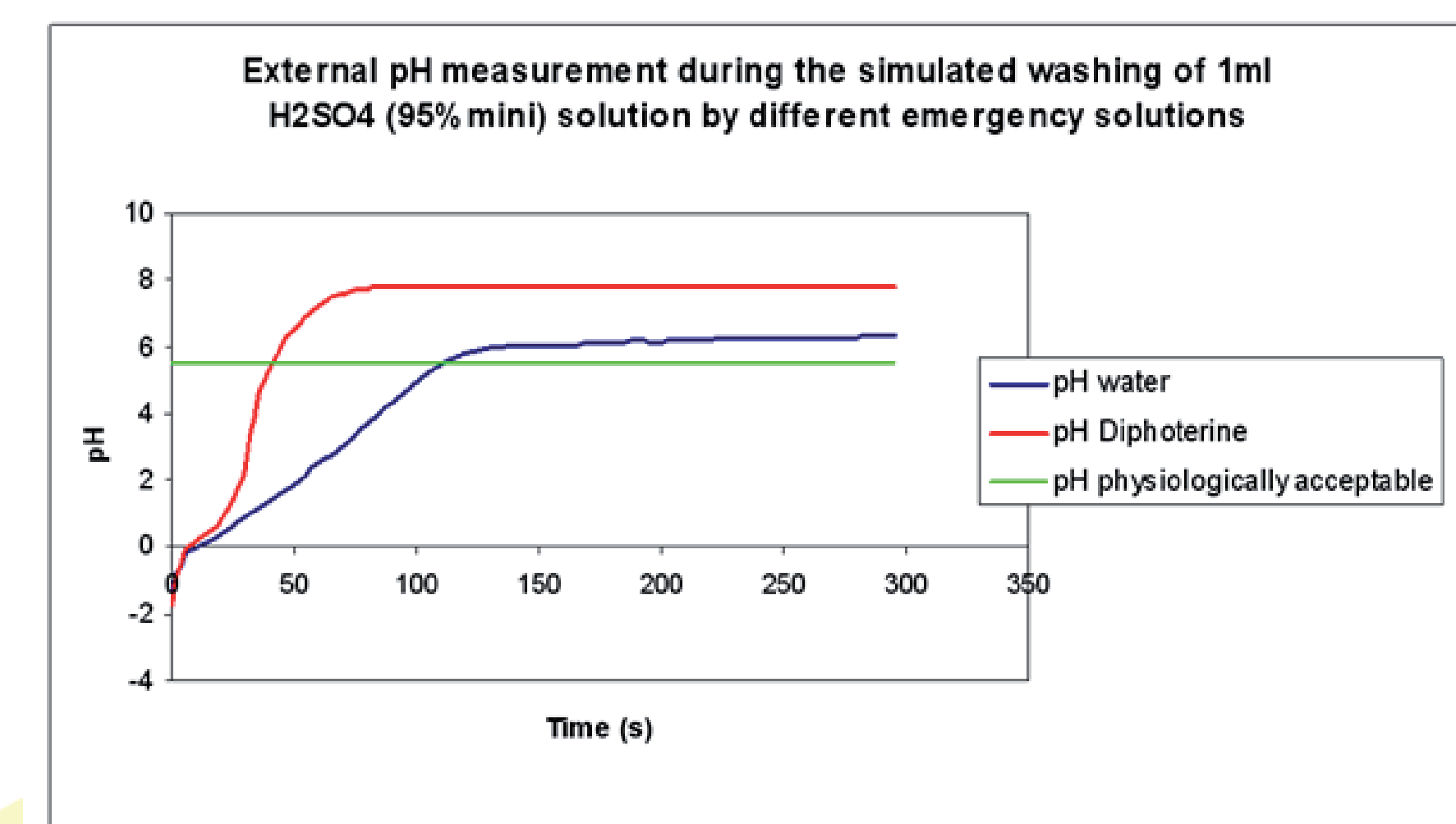


Figure 6: influence of a mechanical effect

Influence of dilution and chemical effect (fig. 5): This experiment is intended to show the effect of dilution and chemical activity of a decontamination solution. It also evaluates heat release during dilution of concentrated sulphuric acid in water. The dilution is evaluated with demineralised water and the chemical effect is evaluated with Diphoterine[®], an amphoteric solution, by pH measurements.

Influence of mechanical effect (fig.6): The simulation of an external rinsing mainly shows the mechanical effect of a washing at the surface of the tissue. 9‰ sodium chloride is put in a beaker where the bottom of the beaker is replaced by a semi-permeable membrane which imitates the cornea. The beaker is then put in contact with 50mL of 95% H₂SO₄. After 10 seconds of contact, the rinsing is started in the 50mL beaker. The pH is measured in the beaker which represents the washing at the surface of the cornea. This experiment compares tap water and Diphoterine[®] as washing solutions with a 150ml/min flow rate.

Conclusion: On *ex vivo* human skin explants, first lesions appear very quickly to appear and full penetration of all the dermis layers occurs in less than 4 hours. The healing group showed that no spontaneous healing happens if nothing is done, which can explain scars and cheloids after such a splash. It confirmed the importance of early washing.

In vitro results presented here showed the need of a mechanical effect as well as as a dilution and chemical effect to perform active and effective skin washing. An *ex vivo* study on human skin explants to evaluate the decontamination impact on both diffusion and from an histological point of view should be performed to confirm these results.

Bibliography:

Flamminger A, Sulfuric acid burns (corrosion and acute irritation) : evidence-based overview to management, COT 25, 2006, 55-61

Milton R, Chemical assault and skin/eye burns: Two representative cases, report from the Acid Survivors Foundation, and literature review, Burns 2010 Jan 18, epubication

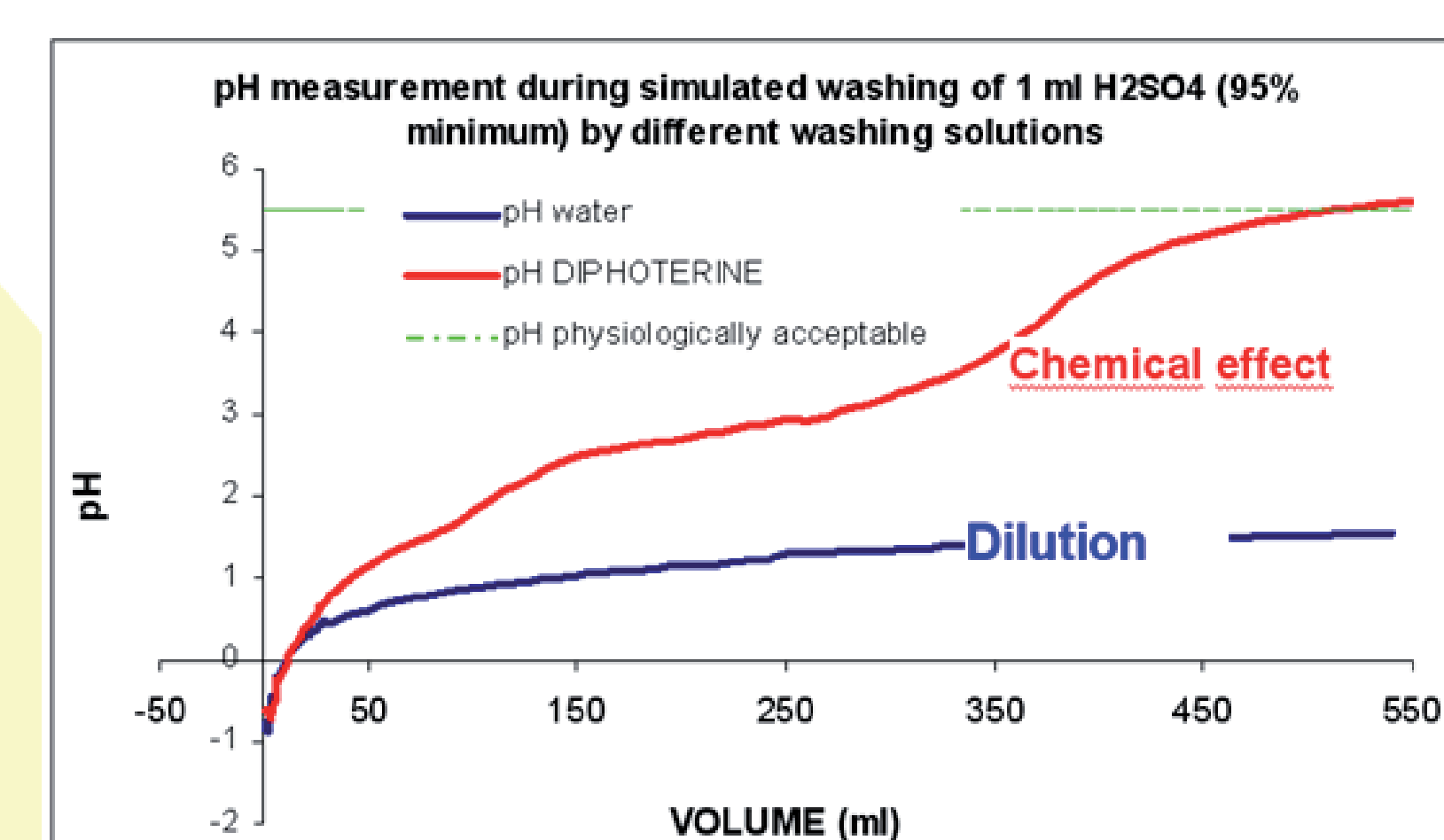


Figure 5: influence of dilution and chemical effect

Results: The dilution effect is a minor effect of washing compared to the major mechanical effect - its efficacy is improved by the chemical effect in order to rapidly reach a physiological state. No additional heat release is observed and a lesser amount of solution is needed when Diphoterine[®] is used for decontamination compared to water.