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(54) **STRIPPING SOLUTION AND PROCESS FOR STRIPPING COMPOUNDS OF TITANIUM FROM BASE METALS.**

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Description

The present invention relates to a stripping composition and process utilizing the composition, for stripping compounds of titanium from base metals.

The present invention is a continuation-in-part of U.S. Patent Application Serial No. 599,833 filed October 19, 1990 and relates to an aqueous stripping composition for selectively removing a titanium compound, such as TiN or TiB_2, from a solid base metal without chemically attacking the solid base metal and to an accompanying process for stripping compounds of titanium from base metals.

High performance components in aircraft engine turbomachines such as compressor blades, bearings and gears are typically coated with a titanium metal compound such as TiN to improve their wear characteristics and to provide erosion protection. The engine parts are cast or otherwise molded or machined from superalloys, stainless steels or alloy steels and represent very expensive precision components. Removal of the coating from the underlying base metal is necessary if a defect is discovered in the coating and/or for restoring worn components. It is essential to strip the protective coating from the base metal without suffering any detrimental attack to the underlying base metal.

To selectively strip a titanium compound such as TiN from a solid base metal composed of a superalloy, stainless steel or alloy steel without chemically attacking the base metal is particularly difficult when both the base metal and coating have a high corrosion resistance characteristic. Stripping is even more difficult when the corrosion resistance of the coating is equal to or greater than the corrosion resistance of the substrate.

Although, stripping solutions containing hydrogen peroxide are known there is no known aqueous based stripping solution using hydrogen peroxide which will permit the removal of a coating of a titanium compound from a solid base metal composed of a superalloy, stainless steel or alloy steel without causing detrimental attack to the underlying base metal. A chemical stripping solution comprising hydrogen peroxide is described in U.S. Patent Nos. 4,554,049, 4,410,396 and 4,545,918 respectively. The stripping solutions disclosed in these patents are either unable to strip compounds of titanium from base metals composed of superalloys stainless steels and alloy steels or will actively attack both the titanium compound coating and the base metal.

According to the present invention there is provided a metal stripping composition for stripping a coating of titanium compound from a base metal composed of a superalloy, stainless steel or alloy steel comprising an aqueous solution of an alkali source of hydroxyl ions; hydrogen peroxide or a compound which dissociates into hydrogen peroxide in water at atmospheric pressure and an acid with each of the components in a minimum concentration of 0.29 mole/L, 0.29 mole/L and 0.026 mole/L, respectively, and in a ratio such that the pH of the solution is above 8.

The stripping composition of the present invention comprises an aqueous solution including an alkali source of hydroxyl ions, a source of hydrogen peroxide and an acid with the constituents of the solution in a concentration such that the pH of the solution is above 8.

The present invention will now be further described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a plot of stripping efficiency versus the content of the preferred acid in mole per liter for removing a TiN coating from an Inconel 718 base metal;

Figure 2 is a plot similar to that of Figure 1 showing stripping efficiency as a function of the content of NH_4OH in mole per liter in the stripping solution of the present invention;

Figure 3 is another plot similar to that of Figure 1 of stripping efficiency as a function of the content of hydrogen peroxide in mole per liter in the stripping solution of the present invention;

Figure 4 is a plot of the solution stripping rate for stripping TiN from an Inconel 718 coupon as a function of the solution operating temperature; and

Figure 5 is a plot of the solution active life of a preferred solution composition for removing TiN from Inconel 718 base metal substrates and the stripping efficiency as a function of temperature.

Detailed Description of the Invention

Essentially any coating composition of a titanium compound can be removed from any base metal substrate by the process of the present invention without detrimentally attacking the base metal. The invention is particularly suited to the removal of TiN or TiB_2 from a base metal composed of stainless steels, superalloys or alloy steels.

The stripping solution of the present invention comprises the following three components: a source of hydrogen peroxide, an alkaline source of hydroxyl ions and a suitable acid in various proportions to cause

the pH of the solution to be above 8 without corroding the substrate. The stripping solution is prepared by first combining the source of hydrogen peroxide with water. The source of hydrogen peroxide should be present in a minimum concentration of 0.29 mole per liter and in a preferred concentration range of between 0.29 to about 4.71 mole per liter (mole/L). Any source of hydrogen peroxide such as a perborate, as is well known to those skilled in the art, may be used. Other compounds which readily dissociate into hydrogen peroxide upon contact with water are also suitable. The alkali source of hydroxyl ions (OH) is then added to the solution. The hydroxyl ion is preferably added in combination with ammonium ions through the addition of ammonium hydroxide (NH_4OH). The source of hydroxyl ions should be present in the stripping solution in a concentration of at least 0.29 mole/L and preferably between 0.29 mole/L and 3.23 mole/L. An acid must also be present in the solution at a minimum concentration of 0.026 mole/L and preferably between 0.026 mole/L and 0.76 mole/L. Any acid which will not corrode the base metal may be used, preferably an organic carboxyl or carboxyl-hydroxyl group acid such as lactic acid, oxalic acid, tartaric acid, formic acid, propionic acid or citric acid. Alternatively, a diluted inorganic acid such as, for example, acetic acid, nitric acid, hydrochloric acid and sulfuric acid may also be used provided it will not chemically attack the base metal and is low enough in concentration to maintain the solution pH above 8.

The pH of the stripping solution is critical to the present invention and must be above pH 8 to be effective. The preferred pH range is between pH 9-14 with a pH range of 10-12 being optimum. The pH of the solution may be controlled by adjusting the concentration of alkali, peroxide and organic acid relative to one another provided each is held to a concentration within the preferred range. Additionally, other alkali ions such as sodium or potassium ions may be added to the stripping solution by the addition of NaOH and/or KOH to establish the desired mole concentration and/or to adjust the pH of the solution.

The effectiveness of the stripping solution of the present invention is determined by the efficiency in which the titanium compound coating is removed from the substrate without suffering any deleterious effect on the base metal. A minimum stripping efficiency of $1 \times 10^{-2} g/cm^2/L$ and preferably above $2 \times 10^{-2} g/cm^2/L$ is necessary for the stripping solution to be acceptable for commercial practice. The stripping efficiency is determined based on total weight loss of the coating per unit coating surface area for a given volume of stripping solution over a time period until the solution is considered inactive.

Experiments were conducted using numerous aqueous compositions all containing various proportions of hydrogen peroxide, an acid and an alkali source of hydroxyl ions. The following tables I, II, III and IV identify the different solution compositions all of which had no deleterious effect on the base metal. All of the tests shown in the Tables I, II, III and IV were carried out by immersing a TiN coated Inconel 718* coupon (1.5 x 25 x 50 mm) into the test stripping solution at between 60 and 85 ° C.

Table I

Effect of Citric Acid Content ($H_3C_6H_5O_7$) on Stripping Efficiency						
Solution	Composition Mole/L				pH	Stripping Efficiency (10^{-2} g/cm^2/L)
	H_2O	H_2O_2	NH_4OH	$H_3C_6H_5O_7$		
1	bal.	1.32	1.09	0	10	0.38
2	bal.	1.32	1.09	0.05	10	3.1
3	bal.	1.32	1.09	0.10	10	3.4
4	bal.	1.32	1.09	0.16	10	3.8
5	bal.	1.32	1.09	0.21	10	4.0
6	bal.	1.32	1.09	0.26	10	4.1
7	bal.	1.32	1.09	0.42	9	5.7
8	bal.	1.32	1.09	0.59	9	4.4
9	bal.	1.32	1.09	0.73	8.5	2.0

Table I should be read in conjunction with Figure 1, which is based on the data of Table I, showing the effect of citric acid on the stripping efficiency of the solution. Citric acid is the preferred acid component although any of the other acids, as heretofore described, may be substituted for citric acid at equivalent concentration or equivalent pH levels to produce substantially equivalent results. The stripping efficiency increases monotonically with increasing concentration of citric acid provided the pH level is above 8.5. The

* Inconel 718 is a registered trademark of the International Nickel Corporation.

concentration of hydrogen peroxide and the alkali component were held constant. It was determined from experimentation that the presence of a minimum concentration of acid was necessary to stabilize the solution and to permit the stripping efficiency to exceed the minimum level. The concentration of citric acid should be above at least about 0.026 mole/L and preferably above 0.052 mole/L. The maximum concentration of citric acid is approximately 0.76 mole/L. Upon exceeding the maximum concentration the pH of the solution drops to below 8.5 which reduces the stripping efficiency below the effective minimum level.

Table II

Effect of NH_4OH Content on Stripping Efficiency						
Solution	Composition Mole/L				pH	Stripping Efficiency (10^{-2} g/cm^2/L)
	H_2O	H_2O_2	NH_4OH	$H_3C_6H_5O_7$		
10	bal.	1.32	0	0.16	2	0.39
11	bal.	1.32	0.37	0.16	10	3.0
4	bal.	1.32	1.09	0.16	10	3.8
12	bal.	1.32	1.46	0.16	10	4.2
13	bal.	1.32	1.80	0.16	10	4.0
14	bal.	1.32	2.51	0.16	11	5.3
15	bal.	1.32	3.23	0.16	11	5.1

Table II should be read in conjunction with Figure 2 which is based on the data of Table II and shows the effect of varying the concentration of ammonium hydroxide (NH_4OH) in the stripping solution. Ammonium hydroxide is the preferred alkali source. The concentration level of citric acid and peroxide were held constant while adjusting the concentration of NH_4OH. From Table II and Figure 2 it is apparent that the stripping solution does not function effectively until the concentration of NH_4OH is raised to a minimum level of about 0.29 mole/L at a pH of 8 or higher. The latter was confirmed by the data shown in Table IV as will be discussed in greater detail later in the specification.

Table III

Effect of H_2O_2 Content on Stripping Efficiency						
Solution	Composition Mole/L				pH	Stripping Efficiency (10^{-2} g/cm^2/L)
	H_2O	H_2O_2	NH_4OH	$H_3C_6H_5O_7$		
16	bal.	0.44	1.09	0.16	9	1.9
17	bal.	0.88	1.09	0.16	9	3.6
4	bal.	1.32	1.09	0.16	10	3.8
18	bal.	2.65	1.09	0.16	10	6.3
19	bal.	4.41	1.09	0.16	10	6.9
20	bal.	2.65	2.17	0.16	11	6.2

Table III should be read in conjunction with Figure 3 from which it is apparent that the stripping efficiency directly increases with increasing concentrations of hydrogen peroxide up to about 2.94 mole/L at which concentration the stripping efficiency of the solution levels off. Accordingly, although the hydrogen peroxide concentration may be further increased the maximum level should be about 4.71 mole/L above which, for practical considerations, there is a negative incentive to further raise the hydrogen peroxide concentration. The minimum concentration of hydrogen peroxide is about 0.29 mole/L and preferably above 0.59 mole/L.

Typically the temperature of the solution has an influence on the stripping rate and efficiency. The reactivity of the solution increases with increasing operating temperature and the solution life decreases with increasing operation temperature. Accordingly, to determine the optimum solution temperature two test solutions were prepared using a different peroxide to alkali molar ratio at a constant acid concentration. The stripping rate was evaluated as a function of the operating temperature as shown in Figure 4. The

composition of the two test solutions were as follows:

Solution 12. 1.32 mole/L H_2O_2 + 1.46 mole/L NH_4OH + 0.16 mole/L $H_3C_6H_5O_7$ balance water (marked "O" in Figure 4).

Solution 4. 1.32 mole/L H_2O_2 + 1.09 mole/L NH_4OH + 0.16 mole/L $H_3C_6H_5O_7$ balance water (marked "Δ" in Figure 4).

The stripping rate is expressed in terms of the total weight loss (in grams) of the coating per unit area (in cm^2) per unit volume (in liters) per unit time (in minutes). As shown in Figure 4 the optimum stripping rate is realized at a solution temperature exceeding 50 °C and preferably between 60 °C and 85 °C.

Although the optimum solution temperature is above 50 °C the solution may be operated at a temperature within a wide range extending from about 25 °C to about 95 °C as is evident from Figure 5 which is a plot of the solution active life in minutes as well as stripping efficiency against temperature. A preferred solution of H_2O + 1.32 mole/L H_2O_2 + 1.09 mole/L NH_4OH + 0.16 mole/L citric acid was used to develop the plot. The solution active life was found to decrease exponentially with increasing temperature from about 1000 minutes at 25 °C to about 24 minutes at about 95 °C. The stripping efficiency also decreases rapidly with increasing temperature. At higher operating temperatures of above about 85 °C the solution active life is simply too short for any practical commercial use. Figure 5 should be evaluated in conjunction with Figure 4 which substantiates that the stripping rate is highest above 50 °C. Accordingly from both Figure 4 and 5 a wide operating solution temperature of between 25 °C to 85 °C is practical although the highest stripping rate occurs above between 50 °C and 85 °C with 60 °C - 80 °C being the preferred range for optimum stripping with a reasonable solution active life.

The following Table IV is a compilation of the data obtained using various alkali ammonium compounds and NaOH at different pH levels for comparison with the results of Table II on the effect of stripping efficiency for the various test solutions.

Table IV

Effects of Composition and pH Value on Stripping Efficiency

Solution	Composition Mole/L								Stripping Efficiency	
	H_2O	H_2O_2	NH_4OH	$H_3C_6H_5O_7$	NaOH	NH_4HCO_3*	$(NH_4)_2SO_4$**	$(NH_4)_2C_4H_4O_6$***	pH	(10^{-2}g/cm^2/L)
21	bal.	1.32	—	0.16	1.07	—	—	—	13	0.70
22	bal.	1.32	—	0.16	1.64	—	—	—	14	1.1
23	bal.	1.32	—	0.16	4.11	—	—	—	14	2.1
24	bal.	1.32	0.51	0.10	1.93	—	—	—	14	2.1
25	bal.	1.32	—	0.10	—	1.01	—	—	8	0.70
26	bal.	1.32	—	—	—	1.27	—	—	8	0.65
27	bal.	1.32	—	0.05	—	1.27	—	—	8	0.73
28	bal.	1.32	—	0.10	—	—	0.61	—	2	0.47
29	bal.	1.32	—	0.10	—	—	—	0.43	4	0.52
30	bal.	1.32	—	—	9.11	—	0.43	—	7	0.35
31	bal.	1.32	—	—	6.11	—	—	0.36	8	1.8

* Ammonium Bicarbonate
** Ammonium Sulfate
*** Ammonium Tartrate

From the above Table IV it is apparent that a pH above 8 is necessary for the solution to provide an effective stripping efficiency and that ammonium compounds other than NH_4OH do not produce effective stripping efficiencies unless combined with NH_4OH or another source of hydroxyl ions such as NaOH. However, it is clear from all of the test data that NH_4OH is the preferred alkali source. The effective concentration for the three critical components, viz., a source of hydrogen peroxide, an alkali source of hydroxyl ions and acid is 0.29 mole/L to 4.71 mole/L, 0.29 mole/L to 3.23 mole/L and 0.026 mole/L to 0.76 mole/L, respectively. For the preferred components H_2O_2; NH_4OH and citric acid the preferred concentration is 0.59 mole/L to 4.71 mole/L, 0.37 mole/L to 3.23 mole and 0.05 mole/L to 0.66 mole/L, respectively.

Although the base metal in the test coupons were all of Inconel 718 other coupons including TiN coated stainless steels such as AISI44OC and AISI 17-4 PH and alloy steels such as M50, M50NIL and Pyrowear

53 were tested using the preferred stripping solution. All demonstrated similar behavior to the TiN coated Inconel 718 coupons with no deleterious effect on the base metal.

The hydrogen peroxide component in the stripping solution of the present invention may be generated in situ from any source of peroxide which dissociates in water to form hydrogen peroxide such as a perborate, e.g. sodium perborate tetrahydrate ($NaBO_3 \cdot 4H_2O$) or any other know peroxide compound which will readily dissociate into hydrogen peroxide in the presence of water at atmospheric pressure and within the operating temperatures of the present invention. Ammonium peroxydisulfate ($(NH_4)_2S_2O_8$) is not a suitable source of hydrogen peroxide for the present invention as is evident from the following Table V despite the fact that ammonium peroxydisulfate is used to commercially produce hydrogen peroxide by hydrolysis at reduced pressure and elevated temperature.

In accordance with the following Table V TiN coated Inconel 718 coupons (1.5x25x50 mm) were immersed into separate peroxide containing solutions with a specified pH of above 8 and at temperatures of between 60 °C and 65 °C to evaluate the stripping effectiveness of the solutions with the different sources of peroxide.

TABLE V

Solution	H_2O	H_2O_2	$NaBO_3 \cdot 4H_2O$	$(NH_4)_2S_2O_8$	NH_4OH	NH_4Cl	CH_3OH	$H_3C_6H_5O_7$	pH	Stripping Efficiency (10^{-2} g/cm^2/L)
4	Bal.	1.32	—	—	1.09	—	—	0.16	10	3.8
32	Bal.	—	0.65	—	—	—	—	0.16	8	0.7
33	Bal.	—	0.65	—	1.09	—	—	0.16	11	1.6
34	Bal.	—	—	1.05	2.54	0.66	0.13	—	9-10	0
35	Bal.	—	—	0.66	1.09	—	—	0.16	9-10	0
36	Bal.	1.32	—	—	1.09	0.5	0.13	—	9-10	1.2

As is evident from the above table no stripping action was observed in the solutions 34 and 35 containing ammonium peroxydisulfate and no weight loss was found on the test coupons. The solutions 32 and 33 with sodium perborate tetrahydrate were capable of stripping the TiN coating from an Inconel 718 substrate but at a reduced stripping efficiency. This is in sharp contrast to the effect of an otherwise identical stripping solution composition containing hydrogen peroxide.

Tables V and VI show the results of corrosion on the base metal when the acid component in the stripping solution contains the Cl^- ion. In solution No. 34 and 36, NH_4Cl and CH_3OH were used instead of an organic acid and in solutions No. 37-40 HCl was used. Both TiN coated Inconel 718 and 410 stainless steel coupons (1.5x25x50 mm in size) were immersed into the solution No. 36 and only 410 stainless steel

exhibited corrosion attack due to the presence of the Cl^- ion from the NH_4Cl solution. In the tests in the following Table VI HCl was used as the acid component to strip TiN from different substrate materials at different concentration levels. Accordingly, the chloride concentration levels that cause pitting vary with the substrate material composition. If an acid containing the chloride ion is used in the stripping solution, the concentration of acid should be determined according to the substrate material used.

TABLE VI

Solution	Composition (Mole/L)				Substrate Material	Comments
	H_2O	H_2O_2	NH_4OH	HCl		
37	Bal.	1.32	1.09	0.12	M50 Steel	Pitting corrosion attack
38	Bal.	1.32	1.09	0.35	410 SS	Pitting corrosion attack
39	Bal.	1.32	1.09	0.35	Inconel 718	No corrosion attack
40	Bal.	1.32	1.09	1.16	Inconel 718	Pitting corrosion attack

Claims

1. A metal stripping composition for stripping a coating of titanium compound from a base metal composed of a superalloy, stainless steel or alloy steel comprising an aqueous solution of an alkali source of hydroxyl ions; hydrogen peroxide or a compound which dissociates into hydrogen peroxide in water at atmospheric pressure and an acid with each of the components in a minimum concentration of 0.29 mole/L, 0.29 mole/L and 0.026 mole/L, respectively, and in a ratio such that the pH of the solution is above 8.

2. A metal stripping composition as defined in claim 1, wherein said titanium compound is selected from the group consisting of TiN and TiB_2.

3. A metal stripping composition as defined in claim 2, wherein said acid is an organic acid selected from carboxylic acid or hydroxy carboxylic acid.

4. A metal stripping composition as defined in claim 3, wherein the concentration of said source of peroxide said source of hydroxyl ions and said acid is 0.29 mole/L to 4.71 moles/L, 0.29 mole/L to 3.23 moles/L and 0.026 mole/L to 0.76 mole/L respectively.

5. A metal stripping composition as defined in claim 4, wherein said alkali source comprises ammonium hydroxide.

6. A metal stripping composition as defined in claim 5, wherein said source of hydrogen peroxide is selected from the group consisting of hydrogen peroxide and a perborate.

7. A metal stripping composition as defined in claim 6, wherein said organic acid is citric acid.

8. A metal stripping composition as claimed in claim 7, wherein the concentration range of hydrogen peroxide, ammonium hydroxide and citric acid is 0.59 mole/L to 4.71 mole/L, 0.37 mole/L to 3.23 moles/L, and 0.05 mole/L to 0.66 mole/L, respectively.

9. A process for stripping a coating of a titanium compound from a base metal of a superalloy, stainless steel or alloy steel without suffering chemical attack to the base metal comprising the steps of:

immersing the base metal and coating into a stripping composition as claimed in any one of claims 1 to 8, maintaining the solution temperature between 25 °C and 85 °C and maintaining the pH of the aqueous solution at a pH of above at least 8.

Patentansprüche

1. Metallbeiz-Zusammensetzung zum Abbeizen eines Überzugs aus einer Titanverbindung von einem Grundmetall aus einer Superlegierung, rostfreiem Stahl oder legiertem Stahl, die eine wässrige Lösung einer Alkaliquelle für Hydroxylionen; Wasserstoffperoxid oder eine Verbindung, die zu Wasserstoffperoxid in Wasser bei Atmosphärendruck dissoziiert; und eine Säure aufweist, wobei jede der Komponenten in einer Mindestkonzentration von 0,29 mol/l, bzw. 0,29 mol/l bzw. 0,026 mol/l und in einem solchen Verhältnis vorliegt, daß der pH-Wert der Lösung über 8 liegt.

2. Metallbeiz-Zusammensetzung nach Anspruch 1, wobei die Titanverbindung aus der aus TiN und TiB_2 bestehenden Gruppe ausgewählt ist.

3. Metallbeiz-Zusammensetzung nach Anspruch 2, bei der die Säure eine organische Säure ist, die aus Carbonsäure und Hydroxycarbonsäure ausgewählt ist.

4. Metallbeiz-Zusammensetzung nach Anspruch 3, bei der die Konzentration der Peroxidquelle, der Quelle für Hydroxylionen und der Säure 0,29 mol/l bis 4,71 mol/l bzw. 0,29 mol/l bis 3,23 mol/l bzw. 0,026 mol/l bis 0,76 mol/l beträgt.

5. Metallbeiz-Zusammensetzung nach Anspruch 4, bei der die Alkaliquelle Ammoniumhydroxid enthält.

6. Metallbeiz-Zusammensetzung nach Anspruch 5, bei der die Quelle für Wasserstoffperoxid aus der aus Wasserstoffperoxid und einem Peroxoborat bestehenden Gruppe ausgewählt ist.

7. Metallbeiz-Zusammensetzung nach Anspruch 6, bei der die organische Säure Zitronensäure ist.

8. Metallbeiz-Zusammensetzung nach Anspruch 7, bei der der Konzentrationsbereich von Wasserstoffperoxid, Ammoniumhydroxid und Zitronensäure 0,59 mol/l bis 4,71 mol/l bzw. 0,37 mol/l bis 3,23 mol/l bzw. 0,05 mol/l bis 0,66 mol/l beträgt.

9. Verfahren zum Abbeizen eines Überzuges aus einer Titanverbindung von einem Grundmetall aus einer Superlegierung, rostfreiem Stahl oder legiertem Stahl ohne chemisches Angreifen des Grundmetalls, bei dem:
   das Grundmetall und der Überzug in eine Beizzusammensetzung nach einem der Ansprüche 1 bis 8 eingetaucht werden, die Lösungstemperatur zwischen 25 °C und 85 °C gehalten wird und der pH-Wert der wässrigen Lösung bei einem pH-Wert von über mindestens 8 gehalten wird.

Revendications

1. Composition de décapage de métaux, destinée à éliminer un revêtement, formé d'un composé de titane, d'un métal de base constitué d'un super-alliage, d'acier inoxydable ou d'un acier allié, comprenant une solution aqueuse d'une source alcaline d'ions hydroxyle ; du peroxyde d'hydrogène ou un composé qui se dissocie en peroxyde d'hydrogène dans l'eau à la pression atmosphérique et un acide, chacun des composants étant présent à une concentration minimale respective de 0,29 mole/l, 0,29 mole/l et 0,026 mole/l et dans des proportions telles que le pH de la solution soit supérieur à 8.

2. Composition de décapage de métaux suivant la revendication 1, dans laquelle le composé de titane est choisi dans le groupe comprenant TiN et TiB_2.

3. Composition de décapage de métaux suivant la revendication 2, dans laquelle l'acide est un acide organique choisi entre un acide carboxylique et un acide hydroxycarboxylique.

4. Composition de décapage de métaux suivant la revendication 3, dans laquelle la concentration de la source de peroxyde, de la source d'ions hydroxyle et de la source d'acide est respectivement comprise dans la plage de 0,29 mole/l à 4,71 moles/l, dans la plage de 0,29 mole/l à 3,23 moles/l et dans la plage de 0,026 mole/l à 0,76 mole/l.

5. Composition de décapage des métaux suivant la revendication 4, dans laquelle la source alcaline comprend de l'hydroxyde d'ammonium.

6. Composition de décapage des métaux suivant la revendication 5, dans laquelle la source de peroxyde d'hydrogène est choisie entre le peroxyde d'hydrogène et un perborate.

7. Composition de décapage des métaux suivant la revendication 6, dans laquelle l'acide organique est l'acide citrique.

8. Composition de décapage des métaux suivant la revendication 7, dans laquelle les plages respectives de concentration du peroxyde d'hydrogène, de l'hydroxyde d'ammonium et de l'acide citrique sont de 0,59 mole/l à 4,71 moles/l, de 0,37 mole/l à 3,23 moles/l et de 0,05 mole/l à 0,66 mole/l.

9. Procédé pour enlever un revêtement d'un composé de titane d'un métal de base formé d'un superalliage, d'un acier inoxydable ou d'un acier allié sans que le métal de base subisse une attaque chimique, qui comprend les étapes consistant :

à immerger le métal de base et le revêtement dans une composition de décapage suivant l'une quelconque des revendications 1 à 8, à maintenir la température de la solution entre 25 °C et 85 °C et à maintenir le pH de la solution aqueuse à une valeur supérieure à 8 au moins.

Fig. 1

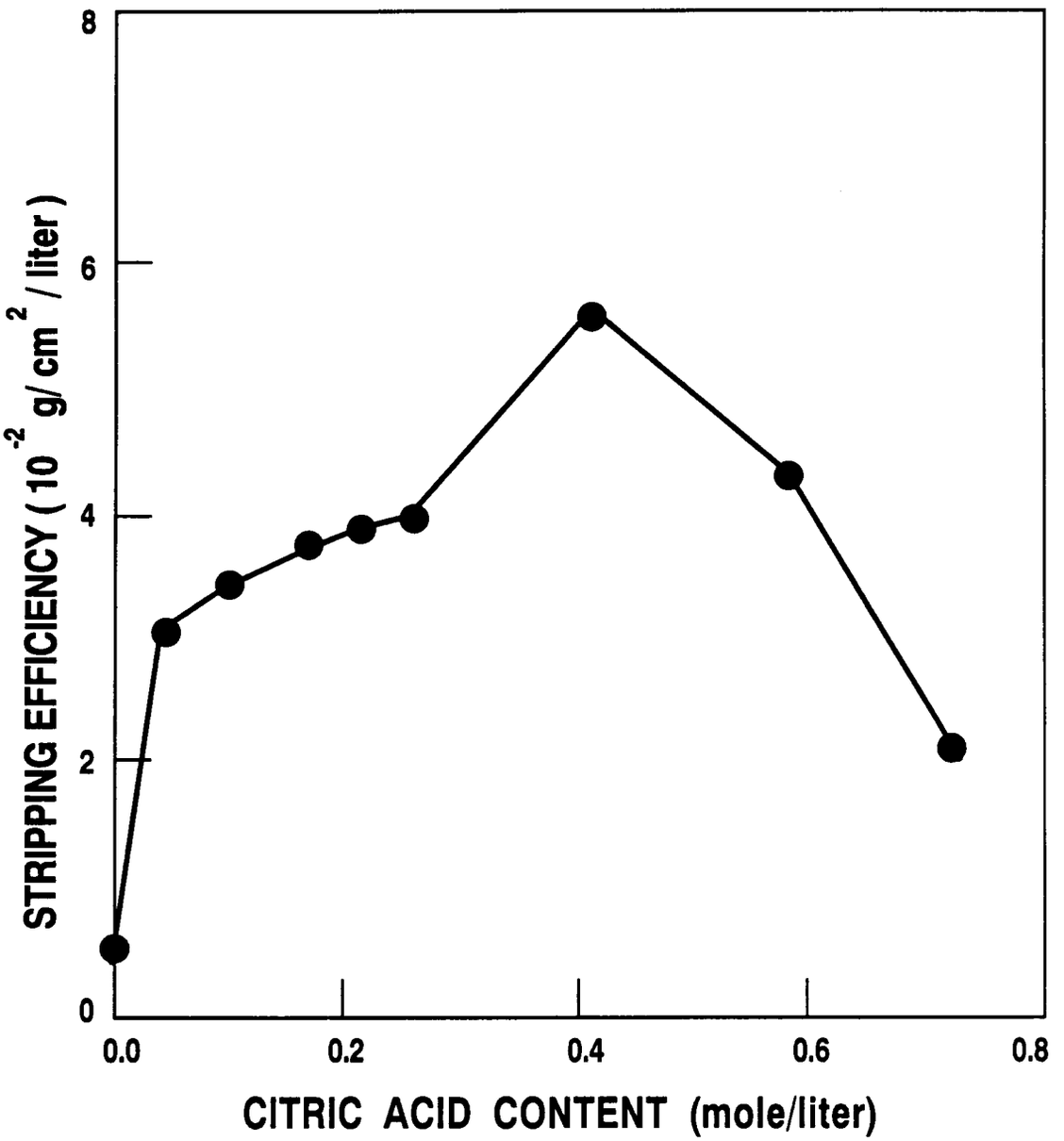

8
6
4
2
0
STRIPPING EFFICIENCY (10 -2 g/ cm 2 / liter)
0.0
0.2
0.4
0.6
0.8
CITRIC ACID CONTENT (mole/liter)

Fig. 2

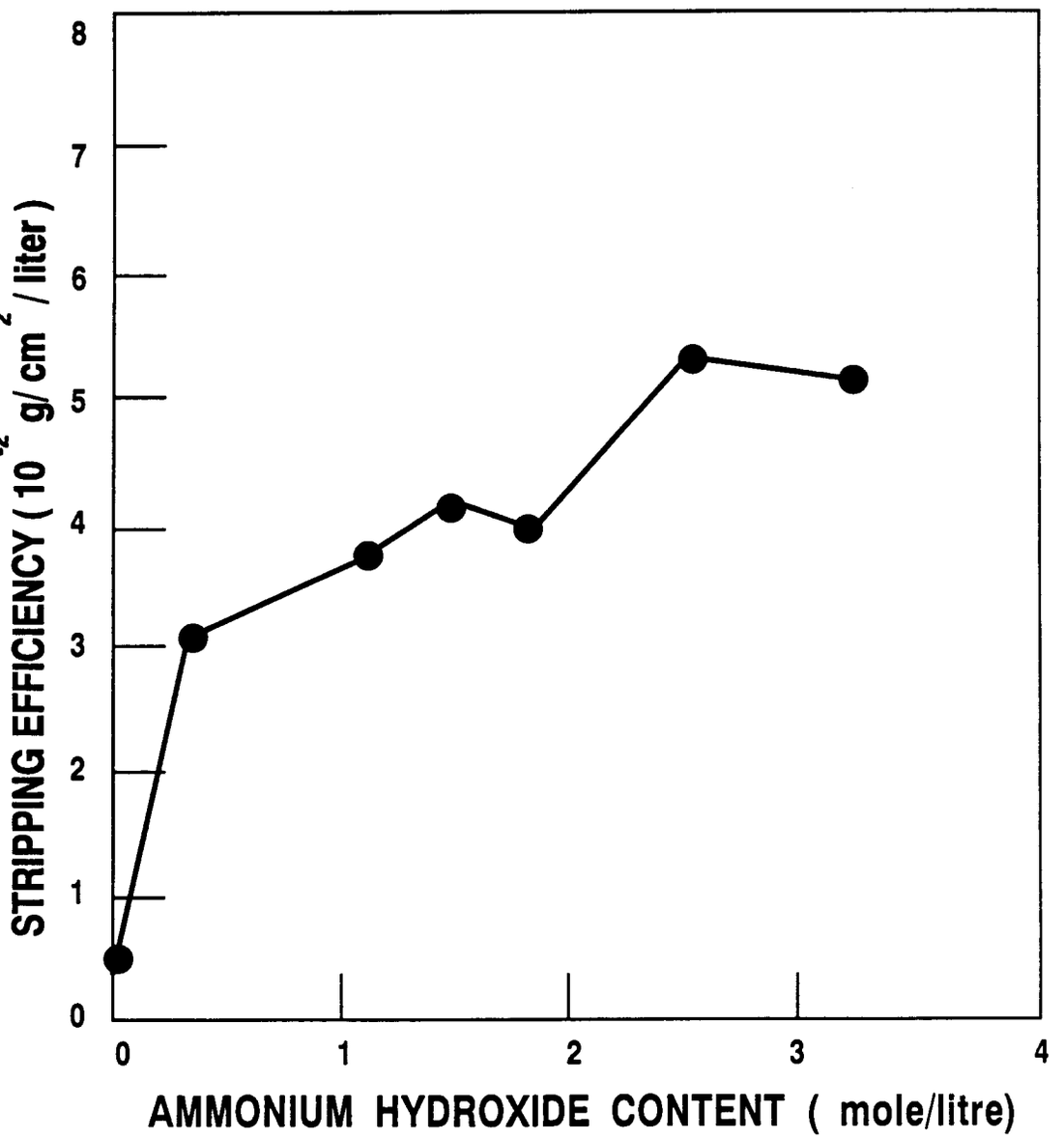

STRIPPING EFFICIENCY (10 -2 g/ cm 2 / liter)
0
1
2
3
4
5
6
7
8
0
1
2
3
4
AMMONIUM HYDROXIDE CONTENT (mole/litre)

Fig. 3

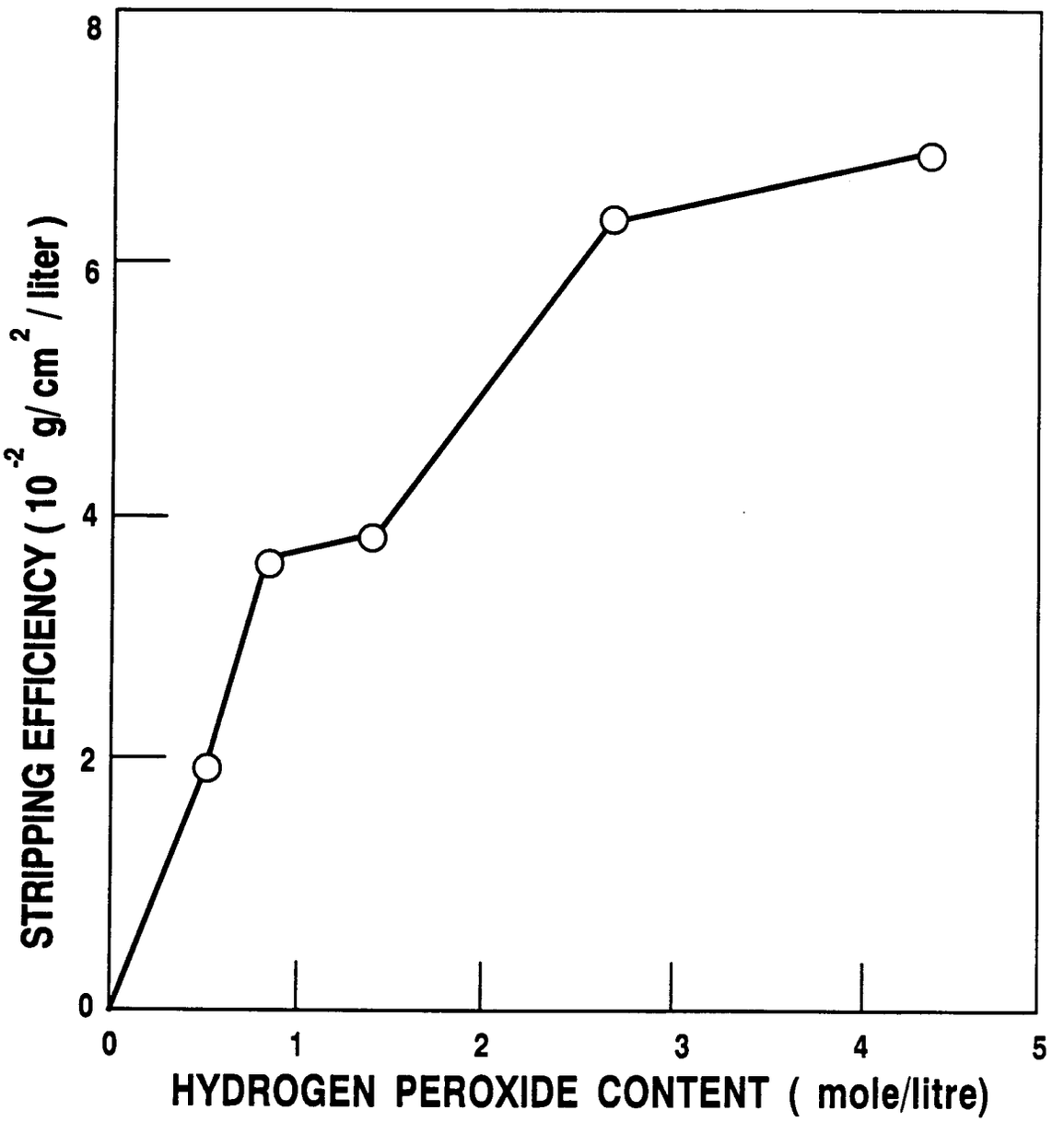

STRIPPING EFFICIENCY (10 -2 g/ cm 2 / liter)
0
2
4
6
8
0
1
2
3
4
5
HYDROGEN PEROXIDE CONTENT (mole/litre)

Fig. 4

○ H_2O-1.32 mole/L H_2O_2-1.46 mole/L NH_4OH -0.16 mole/L $H_3C_6H_5O_7$

△ H_2O-1.32 mole/L H_2O_2-1.09 mole/L NH_4OH -0.16 mole/L $H_3C_6H_5O_7$

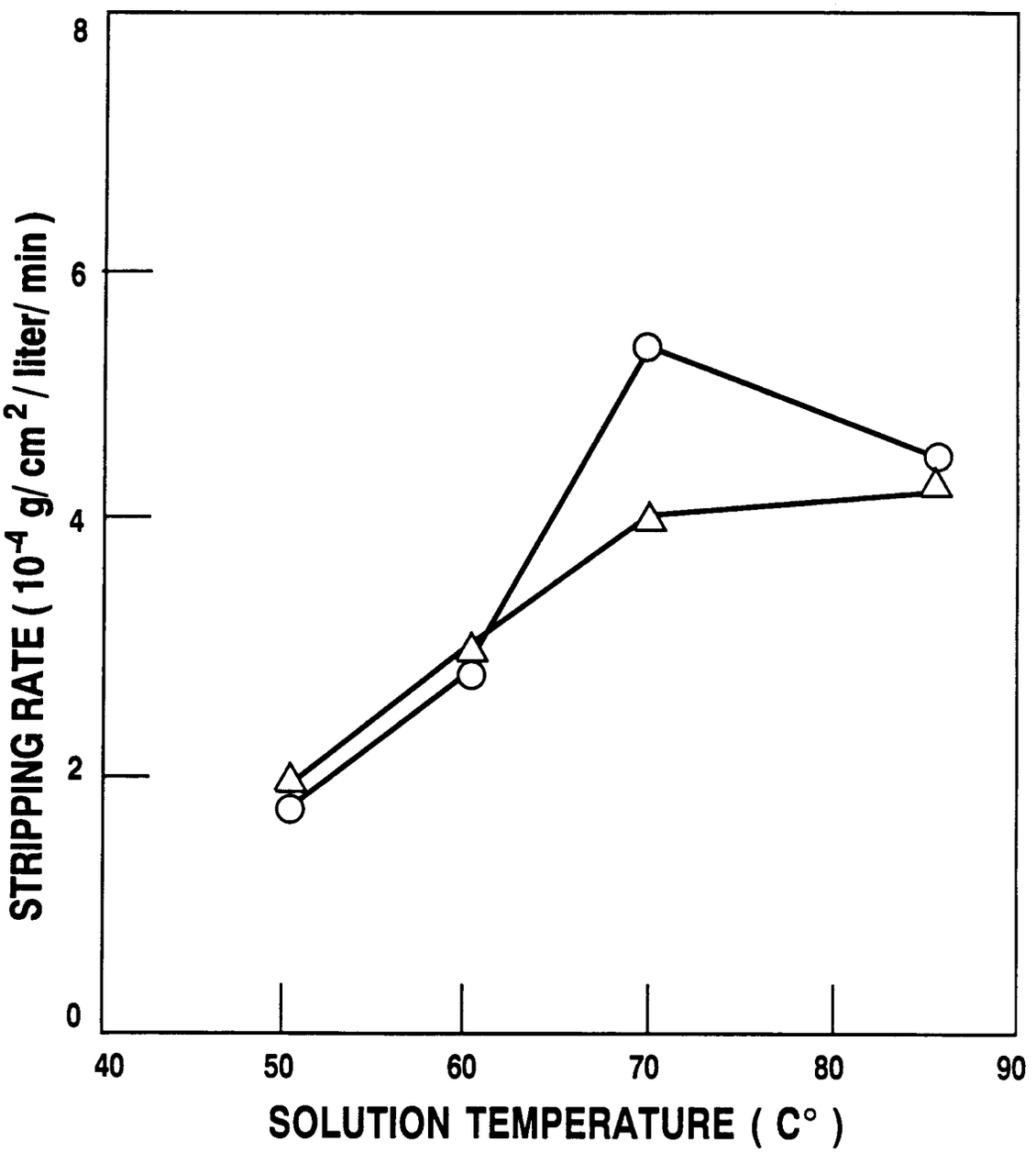
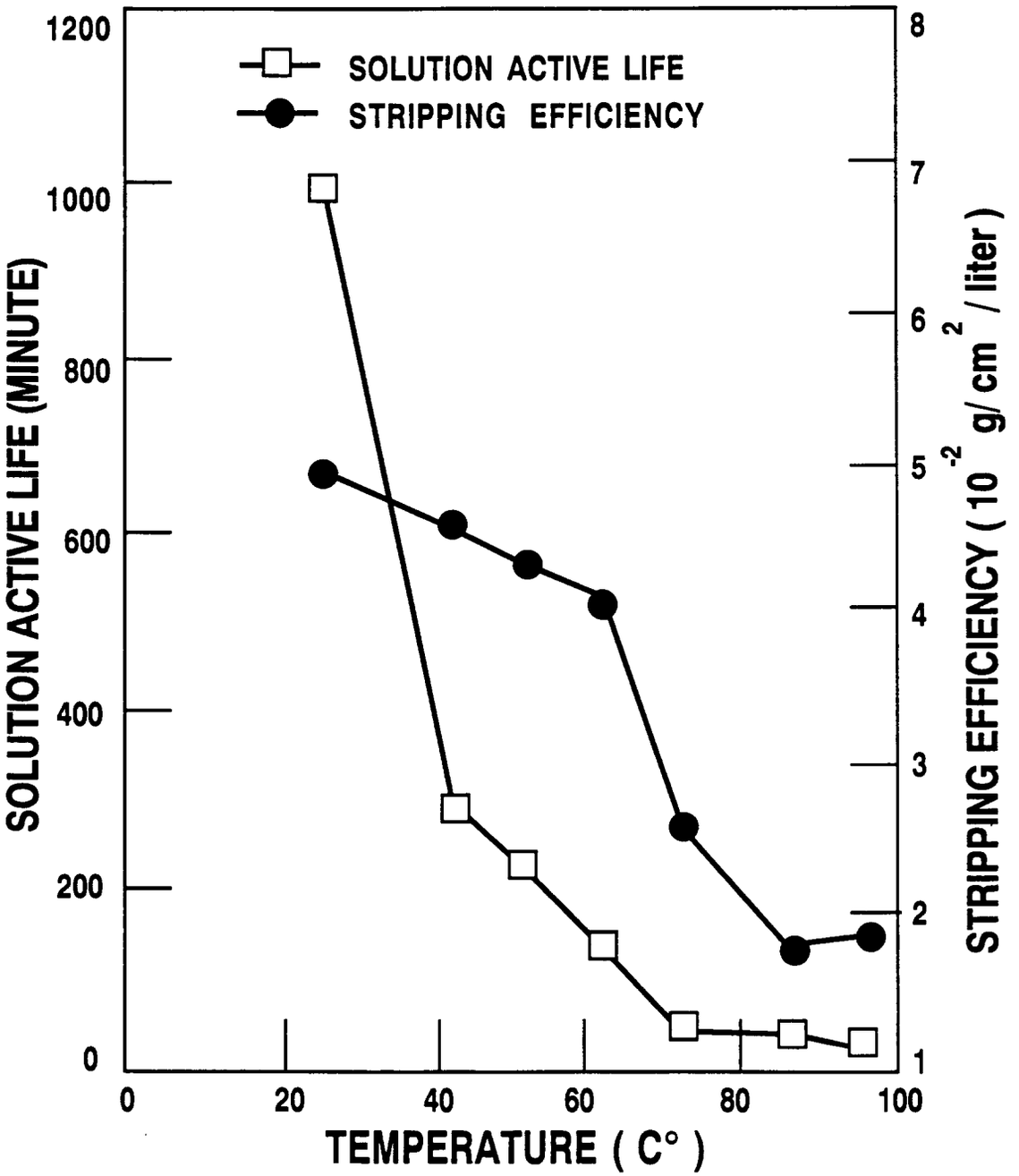


Fig. 5


SOLUTION ACTIVE LIFE
STRIPPING EFFICIENCY
SOLUTION ACTIVE LIFE (MINUTE)
STRIPPING EFFICIENCY (10 -2 g/ cm 2 / liter)
TEMPERATURE (C°)
0
200
400
600
800
1000
1200
1
2
3
4
5
6
7
8
0
20
40
60
80
100