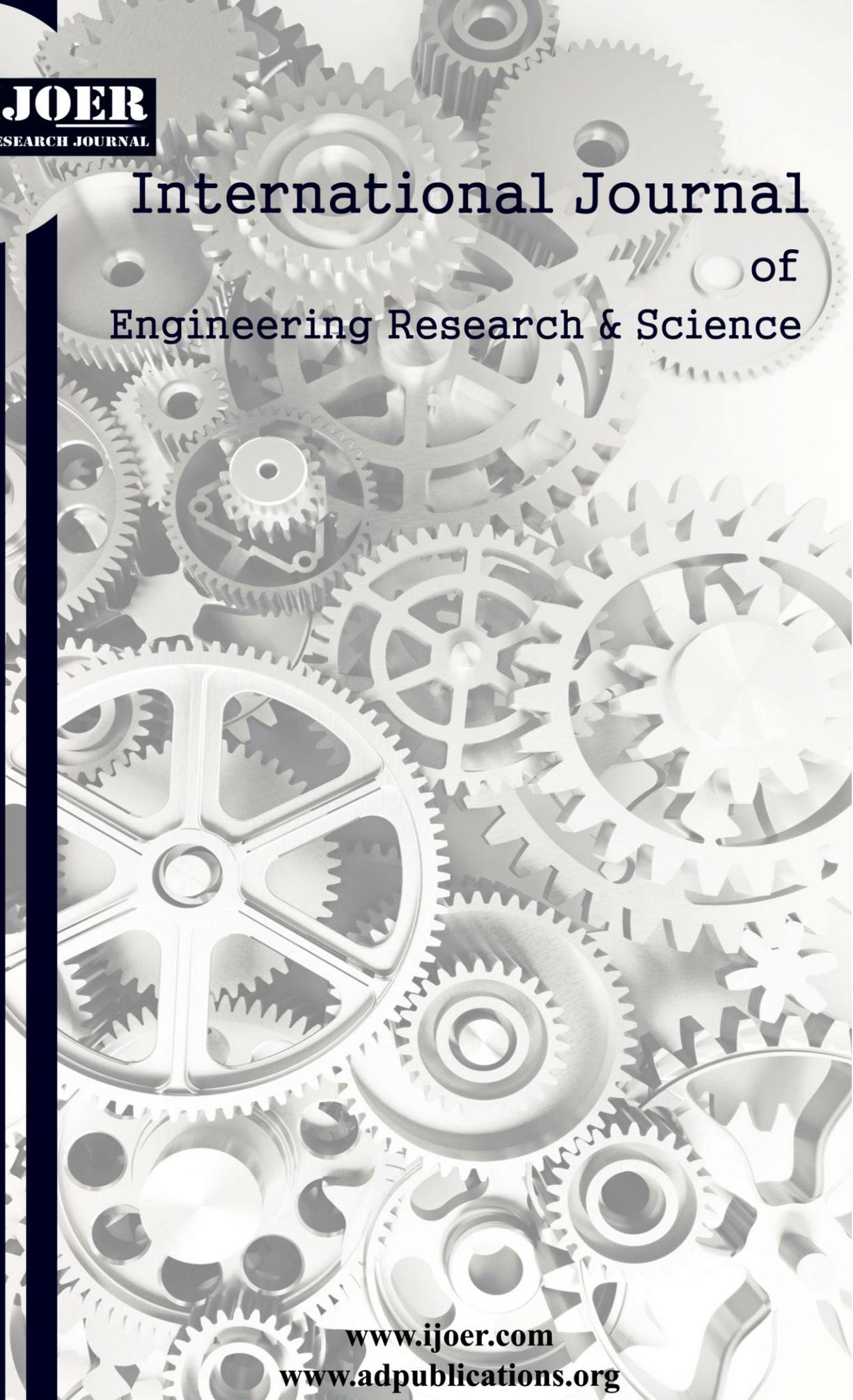




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Preface

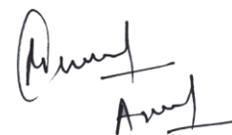
We would like to present, with great pleasure, the inaugural volume-5, Issue-12, December 2019, of a scholarly journal, *International Journal of Engineering Research & Science*. This journal is part of the AD Publications series *in the field of Engineering, Mathematics, Physics, Chemistry and science Research Development*, and is devoted to the gamut of Engineering and Science issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Engineering and Science as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Engineering and Science community, addressing researchers and practitioners in below areas

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Algorithm and Computational Complexity	Artificial Intelligence
Electronics & Communication Engineering	Image Processing
Information Retrieval	Low Power VLSI Design
Neural Networks	Plastic Engineering

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with IJOER. We are certain that this issue will be followed by many others, reporting new developments in the Engineering and Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOER* readers and will stimulate further research into the vibrant area of Engineering and Science Research.



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The Use of *Cyperus canus* J. Presl as Raw Material for Handicrafts in Tabasco

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Abstract— This paper explores the use of Cañita by artisans of Nacajuca, Tabasco, Mexico to elaborate commercial crafts. This plant occurs naturally, but its demand by artisans has increased, which could lead to the gradual extinction of wild populations. The aim of this study is to provide introductory information on Cañita (*C. canus*): botanical description, agricultural production and artisanal use. The conclusion is that despite the economic and agronomic advantages of this plant, the system of artisanal production and the socio cultural environment of the families that work with it do not contribute to the sustainability of the production of Cañita, which is the limiting factor for the production processes related to commercial tourism and the capacity of artisans to make long-term decisions.

Keywords— artisans, extinction, agricultural production, socio cultural.

I. INTRODUCTION

Handicrafts are decorative and utilitarian objects which integrate economic, social and cultural aspects that reflect the worldview of indigenous peoples^[24]. These decorative objects play multiple roles: some indigenous groups elaborate handicrafts for the needs of the "uses and customs" of their ethnic group, while others elaborate handicrafts to fulfill domestic needs and those of a tourist market. Within the uses and customs of different ethnic groups, handicrafts may have ceremonial use, they can be used as symbols, as art objects for everyday use, for ritual or sumptuary use. Commercial handicrafts compete with industrial products made in production lines with sophisticated processes. A common raw material for handicrafts is the plant called Cañita (*Cyperus canus* J. Presl and C. Presl). This plant material is known in other places as "tule negro" or "tule de petate"; the core of the stem is extracted, and is called "metate" or heart^[8]. Cañita is used for making handicrafts such as "petates", mainly, but also baskets, bags, tablecloths, tortilla warmers, mats, hats and various figures of birds and characters depicting everyday images taken from the immediate and common environment of the artisans^[1]. In the municipality of Nacajuca, in the state of Tabasco, artisans use Cañita as raw material for making commercial handicrafts^[16]. The intensive use of this plant, and the lack of knowledge about how to manage its agricultural production, could cause the gradual extinction of wild populations^[21]. This study aimed to contribute to the understanding of family workshops in which tourism serves as a driving force for cooperation between groups without business and agricultural experience, in order to establish community intervention guidelines for the creation of jobs and local development models^[8]. Given the importance of Cañita, artisans of the municipality of Nacajuca, Tabasco try to cultivate it using empirical methods, without any technical support^[5]. The aim of this study is to provide introductory information on Cañita (*C. canus*): its botanical description, importance, agricultural production and artisanal use.

II. HANDICRAFTS

Handicrafts are objects that are representative of a country, a region, a culture and an identity. The more artisans stick to the original techniques in terms of raw materials, labor and traditional tools, the more their products will be imbued by the feelings, skill and cultural significance that makes them works of art^[24]. The Maya-Chontal produce utilitarian, ceremonial and tourist handicrafts. Traditionally, the most important artisanal activity was the construction of dugout canoes, of which there were two styles, one built with mahogany and one with cedar. This custom was lost with the passage of time, and with it the interest in forest conservation. The communities continue to make drums, "tunkules" and flutes for the music played in dances, ceremonies and cultural celebrations. Maya-Chontal artisans also make "júcaras" (gourd bowls) of different types, as wooden figures and spoons for the tourist market. They also make tiny ceramic objects used as offerings to the supernatural beings of the forest, and as toys^[19, 11]. One of the factors that forces artisans to sell their products at low prices is that many indigenous communities produce the same product, resulting in market saturation and benefiting intermediaries, who buy handicrafts at very low prices and resell them elsewhere at a higher price^[19]. The area of Nacajuca produces "cinta" for

chontaleño hats and other palm products that are sold in the Southeast of the country^[2]. According, this cinta is used mainly for weaving baskets and mats^[14]. All the parts of this plant are used, including the stem core and the bark; the latter is used to make various products such as hats, mats, fans, bags, etc. The artisans who make handicrafts with this plant are chontales located in the municipality of Nacajuca, Tabasco.

III. CAÑITA

Cañita (*C. canus*) is obtained by extracting the heart of the plant, which is called "mecate" or "corazón de cañita"^[13]. Initially it was used to make only "petates" or bedrolls, whose use is still common among indigenous communities in Nacajuca and surrounding places, but now it is also used to make baskets, bags, tablecloths, tortilla warmers, mats, hats and various figures of birds and characters^[1].

Cañita is a round rush that grows in damp areas (Figure 1). The name "cañita" is used by the residents of Nacajuca. This plant belongs to the genus Cyperus, kingdom Plantae, division Magnoliophyta, class Liliopsida, order Cyperales, family of Cyperaceae. This genus is composed of about 600 species distributed across all continents in both tropical and temperate regions^[13]. These plants are annual or perennial, growing in low lying areas. The species vary in size from only 5 cm high up to 5 m high^[13]. Includes several species of Cyperaceae under the term tule: C. tenerrimus J. Presl & C. Presl., C. canus J. Presl & C. Presl, C. articulatus, L. Schoenoplectus (Scirpus), S. validus (Vahl) A. (Scirpus lacustris L.), y S. validus (Vahl) A. (Scirpus), (Eleocharis palustris) Volkart ex Schinz, and S. validus (Vahl) A^[22].



FIGURE 1. The plant cañita (Cyperus canus J. Presl and C. Presl) in Nacajuca, Tabasco

The roots of this plant are adventitious, growing from a rhizome, which gives rise to new plants^[7]. Stems can have circular or triangular cross-sections, usually without leaves along the entire length of the stem; there are whole leaves in the basal area of the plant and spiral leaves at the apex of the flower stems. Leaves are almost reduced to pods; the flowers are greenish and grow clustered between the apical leaves^[20]. The flowers are regularly arranged in opposite rows; they consist of one spikelet, hairy, ovate to linear-oblong, flattened, 20 mm long and 2.5 mm wide, of clear red-brown color, with rachilla persistent; scale broadly ovate 1.6 to 2 mm long and 1 to 2 mm wide, nerved almost to the margins, deciduous; stamens with anthers 0.7 to 1 mm long. Comments that the flowers are greenish and grow clustered between the apical leaves^[18]. The fruit is roundly trigonous, ellipsoid, 0.4-0.6 mm long and 0.2-0.3 mm wide, dotted, brown. The seed is a small grain that is spread by the wind for pollination^[9]. The habitat are tropical zones; it grows in lowlands, mainly in those with weeds, occasionally in swamps and creeks and other undisturbed areas.

IV. PROPAGATION

Cañita propagates vegetatively: A) rhizomes, B) buds, C) underground layering, D) cuttings or shoots and E) direct seeding (Figura 2). A) By rhizomes. Says this is the best propagation method for Cañita. The method involves extracting whole rootstocks from the ground and then separating the rhizomes into three 10 cm long stems^[17]. These stems are planted in bags, burying the rhizomes and part of the stem (Figure 2d)^[3]. This method produces root sprouts eight days after planting. In the nursery, it is advisable to keep the plants under constant humidity, watering every third day in order to avoid water stress,

which could stunt plant growth^[20]. B) By buds, this method consists in collecting buds from the adult plant, removing the leaves with disinfected pruning shears and leaving about 2 cm of the petioles of the leaves and 2 cm of stem. The appropriate size of the bud should be about 6 cm, including a part of the leaves, bud and stem. Afterwards, the buds are planted in bags, burying all the stem and taking care that the bud is covered with little earth, since that is from where the plants will grow. By underground layering. This method consists in bending the stems of adult plants and burying the buds without removing them from the rootstock. Entering into contact with earth causes the bud to grow axillary buds, which can produce up to 10 plants per bud. This method is used to replace plants within the same plantation. D) By cuttings or shoots. This method involves collecting stem cuttings and extracting shoots that grow from it, and E) Direct seeding (underground layering and cuttings and shoots methods) methods are the most recommended and also the most used by artisans to propagate Cañita. This is because these methods yield faster and better plant growth^[4].

V. FIELD TRANSPLANTATION

The plants propagated by rhizomes in a nursery can be transplanted to the field 60 days after planting (Figure 3). The plants obtained from buds are ready to be transplanted to the field after 90 days; the delay is caused by the cutting of leaves and stem from the buds. The number of plants obtained by this method varies from 2 to 3 per bud, and their growth and development is slow^[20].



FIGURE 2. Cañita propagates vegetatively: a) direct seeding, b) cuttings or shoots, c) buds underground layering, and d) rhizomes.

In field, planting is done with 2 x 2 m spacing for a population of 5,000 rootstocks per hectare. Producers say that the planting is done simultaneously so that the plants have a uniform height; sometimes they also plant certain fruit plants such as bananas, cassava and "hoja de toó", which allows for sustainable land use. It is recommended to perform the transplantation in the rainy season, which runs from June to November, although it is possible to plant throughout the year, provided there is enough moisture in the soil. It is not recommended to plant during the heat period, since heated earth affects the plant engraftment^[2].

VI. AGRONOMIC MANAGEMENT

Foliar fertilization was used both in the nursery and in field, using grofoll at 5 g per liter of water, with good experimental results. However, artisans use no fertilization because they establish their plantations on the best soils in their fields or in small plots around their houses. Soil fertilization was used in the nursery of the Academic Division of Agricultural Sciences, with 3, 5 and 10 g of triple 17 per plant; there were no differences with unfertilized plants^[20].

There are no reports of pests affecting Cañita crops. But ants are a common problem during harvest; producers from Nacajuca deal with them by spraying cypermethrin a week before harvest, applying 30 ml per 20 liters of water to remove the nests that ants make in the furrows^[21, 6]. Common diseases of Cañita include some types of leaf rust (*Puccinia recondita* f. sp. Tritici), but these do not affect the production of healthy stems^[16]. Weed control can be done manually using hand tools; it is not necessary to apply herbicides because the incidence of weeds in Cañita plantations is very low. Cañita itself

prevents the incidence of weeds^[5]. The only treatment needed by the fields where Cañita is going to be planted is weeding, because weeds are very invasive and can spoil the transplantation.



FIGURE 3. The plant Cañita propagated by rhizomes.

VII. HARVESTING AND DRYING THE CAÑITA

Cañita is harvested and dried using hand tools when plants are 8 to 12 months of age; this is done during the dry season, in March, April and May, as sunny days are needed to dry the plant material. It is advisable to consider harvesting the plants when the moon is waning, because that is when the stems of the plants contain less water, which prevents the harvested material from decaying or being damaged by fungi and insects. Another harvesting method is to pull the stems off by hand.

The base of the stems has modified leaves or scales that are cut during harvest (this work is called "destute"); apical leaves or umbrellas are also removed during the harvest, and left on the ground to serve as organic fertilizer (this work is called "despunte")^[10]. Cañita is dried by spreading it on the ground and exposing it to the sun; the drying process lasts 4 to 5 days. After the stems are completely dry, they are classified according to their length (Figure 4)^[23].

The stems are considered dry when they turn yellow; at that moment, they are stored in a high place where they are exposed to natural air. Craftswomen stored Cañita in bundles wrapped with nylon to protect them from insects.



FIGURE 4. a) The Cañita and b) Cañita are dried by spreading.

Plantations with a larger supply of water produce a more manageable tule than plantations with less water. Once stored, the material lasts up to one year, as long as it remains in a dry place^[12, 18]. A second crop is obtained from a plantation where tule has been harvested in the dry season. The second crop is called "tule de culebra" (snake tule) because the stems are thinner and can measure up to three meters; from this crop is obtained the fruit called Macoya, which provides tule seeds^[15]. The separation of the bark and medulla is done manually by the artisans dividing with the purpose of having two materials for the production of different crafts^[23].

VIII. CONCLUSION

The cultivation of Cañita among Chontal populations of Nacajuca, Tabasco, has changed rapidly in recent years; it has been affected by livestock grazing and the geographical proximity of the main Chontal settlements to the state capital and oil production oil areas, all of which has accelerated the loss of population of this plant. This study found that the producers of Cañita in Nacajuca are not organized and do not employ adequate agronomic management methods for the production of their raw material and the marketing of their products. This research was an agronomic study of the use and production of Cañita. This study contributes to increase the knowledge of this plant species, which can be used at different educational levels by artisans of the region studied.



FIGURE 5. a) The manually by the artisans for the production of different crafts, b) medulla is done manually c) the artisans dividing with the purpose of having y d) two materials for the production of tapete

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The influence of the environment factors and the surface treatment on Stress Corrosion Cracking of Type 304 Austenitic Stainless Steel

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Abstract— The aim of this work is to understand the combined effects of stress, temperature, humidity and chloride ion on the susceptibility of stress corrosion cracking (SCC) of type 304 austenitic stainless steel. The occurrence of SCC was investigated using the as received (cold work), sensitized samples those are exposed to the environmental test chamber at 40°C and 70°C, respectively. The humidity from 40% to 70% RH with gradient of 10% was applied during the corrosion test lasted 720h. The results showed the environmental conditions where SCC crack can be occurred and where it can be avoided. The initiation and the propagating of SCC crack on the flat and U-bend specimens were grown up to correspond to the increasing of test temperature. Very high stress corrosion cracking can be observed in the period of low relative humidity (40%) and temperature (40°C).

Keywords— SCC, austenitic, cold work, sensitized, chloride ion.

I. INTRODUCTION

Stress Corrosion Cracking (SCC) is a common, often dramatic failure mode for many austenitic stainless steel systems. SCC occurs via a combination of three critical factors: a tensile stress (which can be applied and/or residual), a specific corrosive environment and a susceptible material [1,2]. During the past decade, a consensus had been reached about stress corrosion cracking starting from pits on the smooth samples [3,4]. The general assumption was that SCC, including Atmospheric Induced Stress Corrosion Cracking (AISCC), of austenitic stainless steels does not occur at temperature below the critical temperature, for example 50°C for type 304 stainless steel [5]. So far, it has been proven incorrect. The studies of H.E. Hannien et al. in 1979 [6], which performed SCC test using stainless steel U-bend specimens fabricated according to ASTM standard G30-97, showed that the SCC initiation was observed on the specimens deposited with simulated sea salt and exposed to the environmental test chamber at the temperatures between 35 and 52°C. The amount of salt deposited on the specimen surfaces were between 0.1 and 10 g/m². In 2008, Tani et al. showed that there was measurable Trans-Granular Stress Corrosion Cracking (TGSCC) at the temperature of 298K but it was not clear whether this was a true threshold or whether cracking could have been seen at low temperature in longer experiments [7]. Recent published work by Phan and Cook et al. has observed AISCC at temperatures as low as 40°C of the U-bend specimens of parent material from the surface deposited with salt particles exposed to a humid atmosphere [8,9]. This work described a series of test to evaluate systematically the effect of relative humidity (RH) and concentration of chloride ion deposited on the surface of 304 and 316 austenitic stainless steel samples on SCC initiation at low temperature. It was suggested that the SCC susceptibility of the stainless steel samples was both relating to the process of deliquescence and the increasing of RH. SCC cracks propagate most often by inter-granular path which is more common rather than trans-granular path in austenitic stainless steels.

This work described a series of test in order to systematically evaluate the effect of tensile stress, relative humidity and chloride ion of which SUS 304 with suffering on SCC initiation at 40°C and 70°C. The distribution of cracks and the tree branch cracks were well presented.

II. MATERIAL AND METHOD

2.1 Material and specimens

Type 304 austenitic stainless steels (0.065C, 0.58Si, 1.9Mn, 0.014P, 0.022S, 8.789Ni, 18.56Cr, %mass, Fe: bal) with thickness of 0.8mm was cut into 15mm x150mm as the samples. The tests were carried out using the flat and U-bend specimens fabricated from the above steel (Fig.1).

The testing samples were kept in the condition of “as - received (cold-worked)” and “sensitized”. For the sensitized condition, the samples were treated at 700°C for 2 hours, after that, they were cooled down slowly in the air. The U-bend specimens were prepared according to ASTM G30-97 [10].

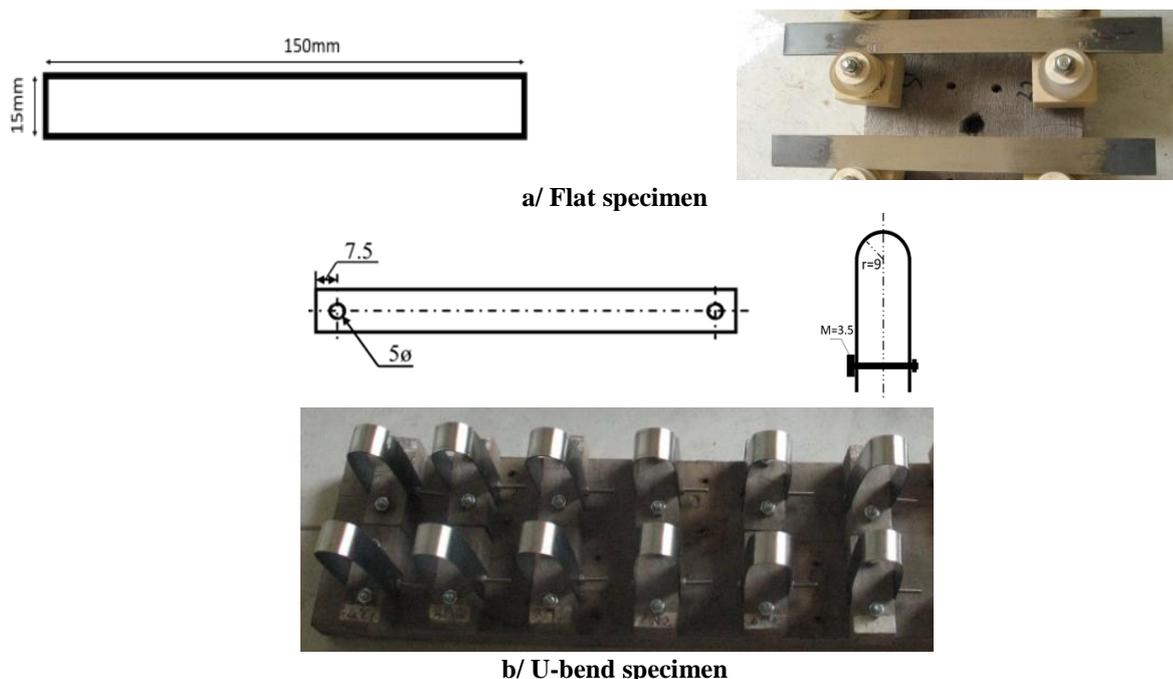


FIGURE 1. Flat (a) and U-bend (b) specimens

Prior to fabrication the metal strips were abraded to 1200 grit with silicon carbide paper and thoroughly cleaned in distilled water to remove the surface contaminations and then dried in acetone. All of the specimens were inspected under a microscope at 40 times magnification to ensure that no crack or fissures were presented before testing.

2.2 Salt deposition and exposure method

Both flat and U-bend samples were dropped with six droplets of chloride solution as shown in Fig.2. For the U-bend samples, two big drops were deposited on the top area and four smaller ones on the side area.



FIGURE 2. U-bend specimen with freshly deposited droplets

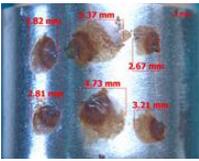
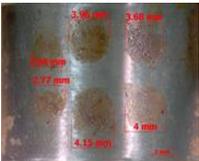
NaCl and MgCl₂ solutions which are saturated and diluted were used to deposit on the samples. The content of chloride ion in gCl/m² were calculated based on the total area of the droplets (Tab. 1 and 2)

**TABLE 1
SURFACE CONTAMINATION WITH DROPLETS OF CHLORIDE SOLUTIONS
(gCl/m²)**

Solution	Saturated	Diluted			
		x3	x10	x30	x100
NaCl	200	67	20	6.7	2
MgCl ₂	344	115	34.4	11.5	3.4

All specimens deposited with salts were exposed in the environmental chamber for one month (~720h) with the relative humidity (RH) steps of 10% to each test (from 40% RH up to 70% RH). The testing temperatures were controlled at 40°C and 70°C.

TABLE 2
DIAMETERS OF CHLORIDE DROPLETS AREA ON THE U-BEND SPECIMENS (mm)

U-bend specimen	Diameter of six droplets (mm)			
	φ1	φ2	φ3	Ave
	2.82	5.37	2.60	3.59
	φ4	φ5	φ6	
	2.81	4.73	3.21	
	2.84	3.96	3.68	3.57
	φ4	φ5	φ6	
	2.77	4.15	4.00	

2.3 Optical and scanning electron microscopy

After exposure, the samples were washed in distilled water to remove the remaining salt and any loosely-attached corrosion products, then cleaned in acetone and dried by hot air. The tested samples were firstly observed under a optical microscope (Axiovert 40MAT- Carl Zeis) and the pit depths were measured. The Scanning Electron Microscopy (JEOL-JSM 6490) was used to identify the SCC cracks and to observe the morphology of the SCC cracks.

III. RESULTS AND DISCUSSION

3.1 The flat samples

All samples deposited with various concentration of chloride ions were exposed in the environmental chamber at 40°C and 70°C which combined with four different levels of 40%, 50%, 60% and 70% RH. The tests were terminated after 30 days exposure. The results for type 304 as-received flat samples are presented in Fig 3.

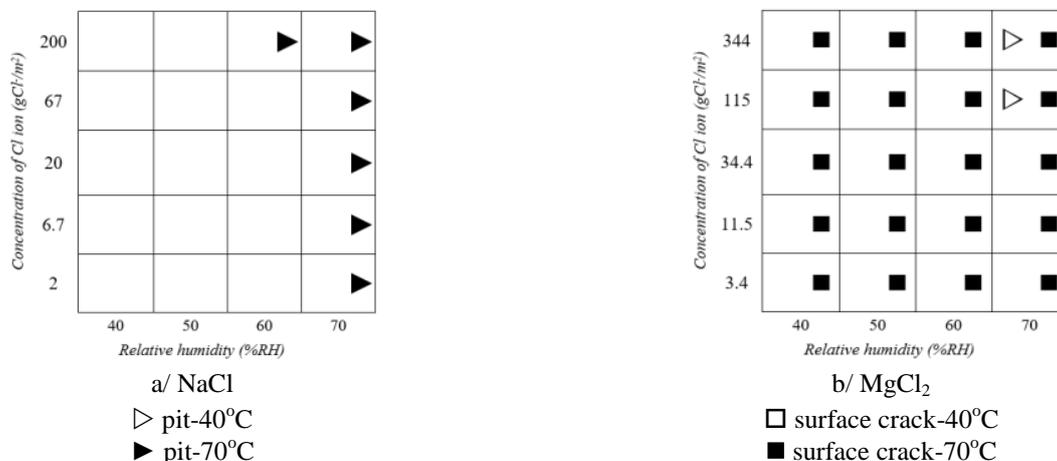


FIGURE 3. The corrosion behavior of the as-received flat samples deposited with saturated NaCl droplets (a) and MgCl₂ droplets (b)

It is recognized that concentrated NaCl solutions were not severe enough for SCC occurred on the type 304 as-received flat samples at 40°C. Even at the high temperature (70°C), only pitting was observed at 70% RH (Fig.3.a).

For the MgCl₂ deposited samples, almost no failure occurred at 40°C, but only pitting corrosion appeared at 70%RH on the samples deposited with high chloride levels – saturated and three times diluted. (Fig.3b and 4a). At 70°C, the cracks appeared on all the samples, irrespective of values of relative humidity and concentration of chloride ion, the pit size was larger and the cracks initiated from the pits were observed (Fig. 3b and Fig. 4b). The above results can be explained as follows: The chloride amount in one droplet of MgCl₂ solution is always higher than that in one droplet of NaCl solution, in addition, MgCl₂ solution is acidic (with pH = 5.7), which accelerated the metallic soluble react. Because MgCl₂ deliquesced at lower

Similar to the as-received samples, the NaCl droplets does not cause SCC of the material at 40°C; however, at the higher temperature (70°C), the pits were formed on the surface of all the samples tested at 40% and 50% RH. At 60% RH, the surface crack was observed on the samples deposited with NaCl of at least 20gCl/m². At 70% RH, the SCC cracks appeared on all samples tested at every NaCl concentration. Therefore, NaCl is easier deliquesced at higher RH, which accelerated the metallic soluble react at the crack tip and promoted the cracks appeared. The increase of temperature and Cl⁻ content also showed the similar promotion as the above.

With regard to the sensitized flat samples deposited with MgCl₂, the pits and shallow SCC crack were observed more severely than those dropped with NaCl, which is indicated by the larger SCC cracking size (Fig. 5.b). The pits and the surface cracks were found right at low temperature (40°C) and low RH (40, 50, and 60%) (Fig. 7a); at 70°C, SCC propagation appeared at all samples regardless the values of RH (Fig. 5b and 7b). By means of the increasing temperature and RH, the SCC initiated and the number of crack as well as the crack length becomes greater.

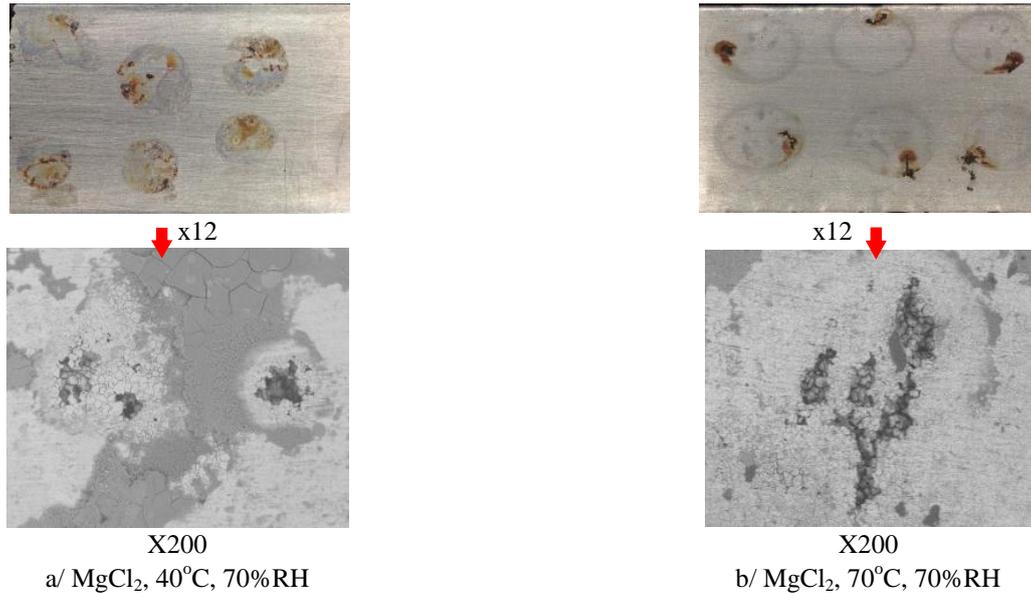


FIGURE 7. The appearance of the sensitized flat samples with saturated solution of MgCl₂ droplets

The main observations: At low temperature, the initiation and the development of SCC in stainless steels was mainly controlled by the concentration chloride ion and the relative humidity. And it's required more than 30 days for the development of SCC from the pitting. Otherwise, at high temperature, corrosion mode transformations were more rapidly.

3.2 The test of the U-bend samples

Following the flat sample trials, the U-bend samples were tested in the same conditions with those applied to the flat samples. The corrosion behaviors of the as-received U-bend samples are expressed in Fig. 8.

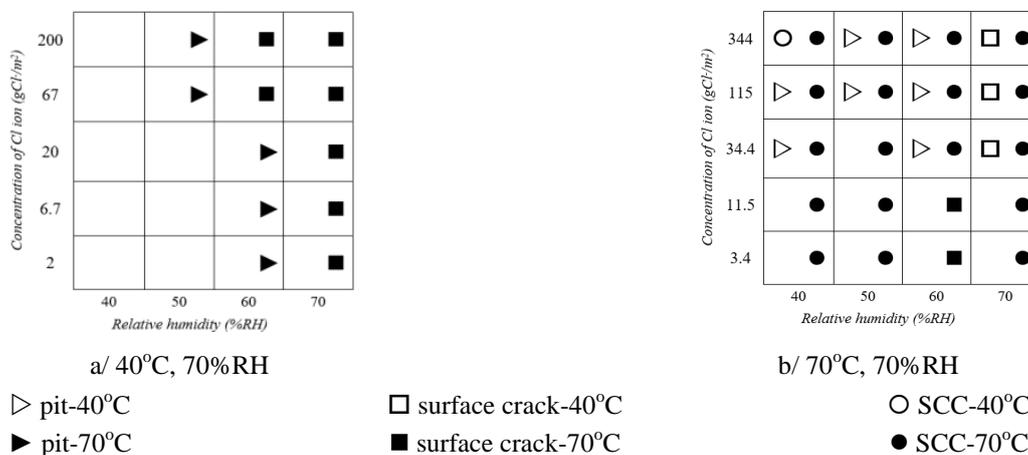


FIGURE 8. The corrosion behavior of the as-received U-bend samples with NaCl droplets (a) and MgCl₂ droplets (b)

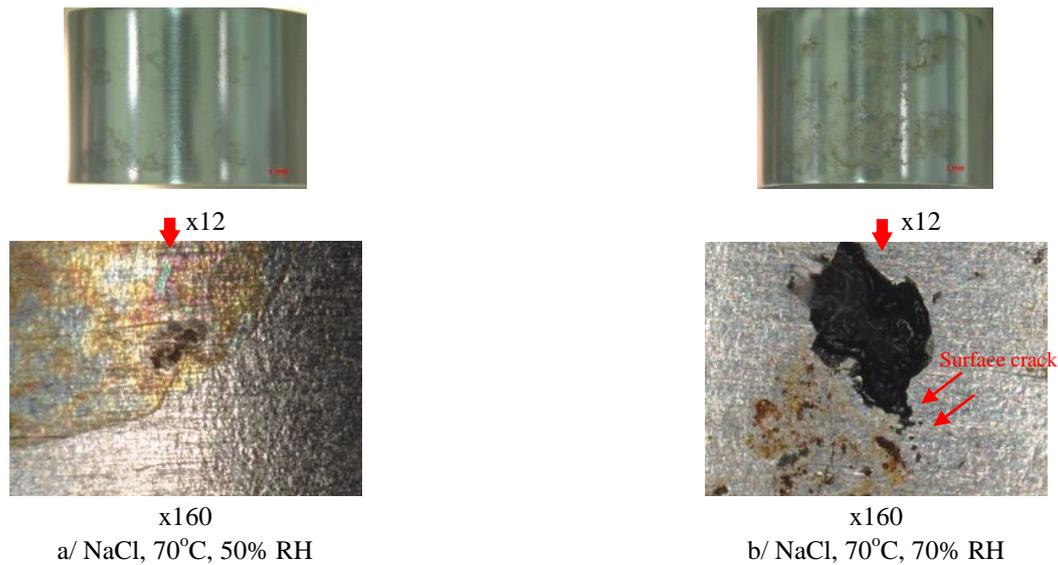


FIGURE 9. The appearance of the as-received U-bend samples with saturated solution of NaCl

Similar to the pattern of the as-received flat samples deposited with NaCl, there was no evidence of corrosion on the as-received U-bend samples at 40°C. The pits and surface cracks appeared only on the samples exposed at 70°C combined with 60 and 70% RH, however, the pits were also observed at 50% RH on the sample deposited with saturated and three times diluted chloride solution (from 67 to 200 gCl/m²), see Fig.8a. and 9b.

With respect to the as-received U-bend samples deposited with MgCl₂ and tested at 40°C, the pits and cracks as well as SCC were observed only at the chloride content ≥ 34.4 gCl-/m² which perhaps are considered as the critical chloride level for the pits occurred at low temperature. Almost samples tested at 70°C showed SCC cracks, regardless of either the chloride content or the value of RH. After testing, the fracture appeared on the surface of all specimens (Fig.10).



FIGURE 10. The appearance of the as-received U-bend samples with saturated solution of MgCl₂ droplets (160x)

For specified combinations of low temperature and low relative humidity (40°C, 40% of RH), the pits and surface SCC cracks were also appeared on the as-received U-bend samples deposited with MgCl₂ saturated solution(Fig. 8b and 11).

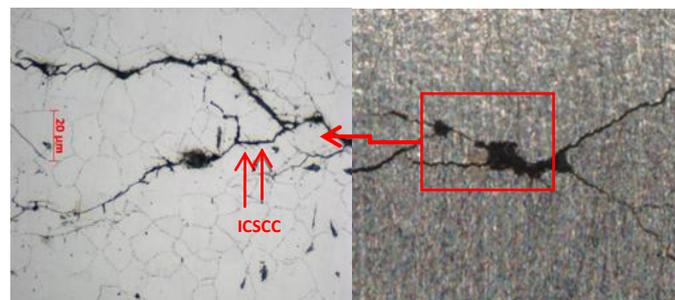


FIGURE 11. Morphology of crack on U-bend sample type 304 (MgCl₂ saturated solution, 40% of RH and 40°C)

This suggested that at the low relative humidity, the layer of droplets solution was thinner than the one's at high relative humidity. The oxygen is easier to attack the surface of material. A combination of ion chloride in the test solution at the high potential on the surface of samples, the SCC initiation was observed. The crack appeared and grew from pit to pit on the specimen surface. The SEM confirmed that the crack most often propagated by inter-granular path.

The results of testing the sensitized U-bend samples are shown on Fig. 12. For the specimens dropped with NaCl and tested at 40°C, the surface cracks were found at 40% and 70% RH when the minimum of chloride ion level is ≥ 20 gCl⁻/m²(Fig. 12a and 13a).

Under the condition of higher temperature (70°C), the surface crack was observed on all the specimens tested at 40, 50 and 60% RH without distinction of concentration of chloride ions. Furthermore, when the RH increased, the SCC crack was found to propagate and the secondary crack was very easily detected (Fig.12a and 13b).

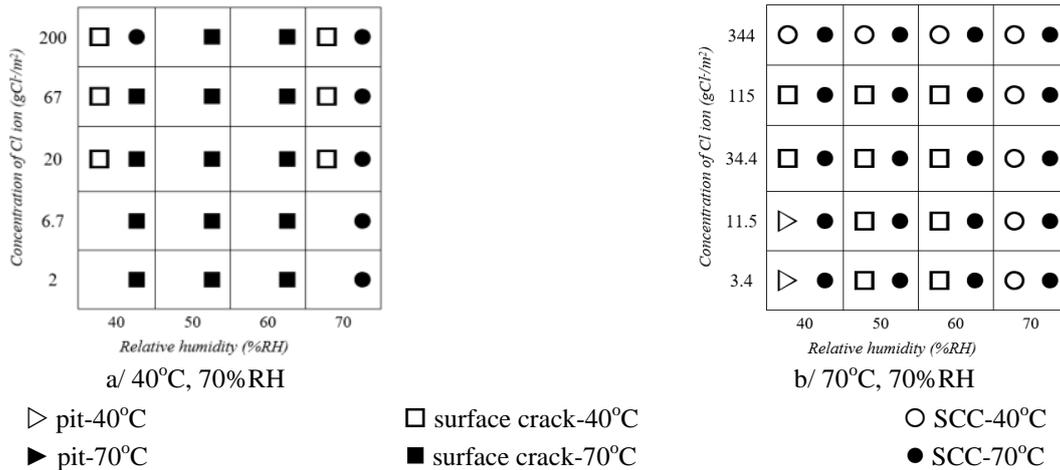


FIGURE 12. The corrosion behavior of the sensitized U-bend samples with NaCl droplets (a) and MgCl₂ droplets (b)



FIGURE 13. The appearance of the sensitized U-bend samples with saturated solution of NaCl droplets (12x)

In the experiments of U-bend specimens with MgCl₂ droplets, the SCC-accelerated was not controlled by the humidity of environment. The main factors which influence SCC were the temperature and concentration of chloride ions (Fig. 12.b).

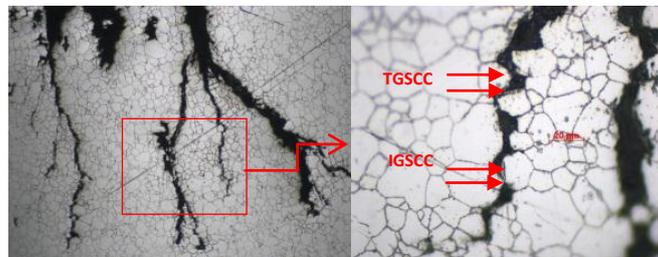


FIGURE 14. Morphology of the crack on U-bend sample type 304 (MgCl₂ saturated solution, 40% of RH and 40°C)

At low temperature (40°C), the severity of SCC is controlled by the increase of RH and chloride ion content. Under the saturated MgCl₂ droplets SCC cracks were found on all samples, irrespective of the RH values, and at 70%RH, the SCC cracks appeared regardless of the chloride ion content. In addition, the SCC cracks were also found to develop from the pits

on the sensitized specimens exposed to MgCl_2 at low RH (40% and 50% of RH). The crack often propagated by the inter-granular and trans-granular path (Fig. 14.).

Finally, at 70°C , the SCC cracks were observed on all of specimens, irrespective of RH values or ion chloride concentration (Fig. 12b). Especially the samples with saturated MgCl_2 solution, which were tested at 70°C and 70%RH, were broken completely. The high humidity and high temperature as well as high chloride concentration may accelerate the metal soluble react at the crack tip, which speeds the crack propagation (Fig.15 b).



FIGURE 15. The appearance of the sensitized U-bend samples with saturated solution of MgCl_2 droplets (12x)

Similar to the case of flat samples, the MgCl_2 showed the more severe SCC to type 304 stainless steel than NaCl did; The severity of SCC is increased with the increase of RH and Cl^- concentration; And the temperature accelerated the SCC stronger occurred. All the explanations are the same those given above.

IV. CONCLUSION

The sensitized samples are more susceptible with SCC in comparison with the as-received samples (cold work). The U-bend samples are more susceptible with SCC than the flat samples.

With 30 day-exposure at low temperature (40°C), NaCl did not result in SCC on the as-received samples; however, the saturated NaCl caused the surface crack on the sensitized U bend sample at the condition of 40°C and 40%RH. MgCl_2 is more active; it caused the pitting corrosion, the surface cracks or SCC propagation on almost samples. At the high temperature (70°C), both NaCl and MgCl_2 caused pitting corrosion, surface crack, or SCC initiation.

The increase of temperature, RH as well as chloride concentration promoted the pitting corrosion as well as accelerated the metal soluble react at the crack tip and foster SCC propagation.

The exposure test should be extended for further understand the impact of NaCl on SCC susceptibility of type 304 stainless steel.

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