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Application of Control by Flattening the Welded Tubes by HF Induction

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Abstract: In this study, we have tried to describe the flattening test tubes welded HF induction and its experimental application. The test is carried out at the ENTTPP Tébessa (National transformations tubes and flat products). Usually the final products (tubes) undergo a series of Non-Destructive inspection (NDA) online and offline welding and obviously destructive mechanical testing (CD) (traction, hardness, impact strength, bending, flattening, flaring, etc.) and metal (chemical analysis of the material, macro and microfilming, etc.). The quality and reliability of any final product is highly recommended by customers on the one hand, as well as continuing competition in the market and technology design of a second, not to mention the mechanical and metallurgical properties of the material used as a parameter that governs the weldability of the tubes. For this and for the purpose of implementing the flattening test, which applies to the processing of round tubes in other forms, it took four sections of welded tubes draft (before stretching hot) and welded tubes finished (after drawing hot and annealing), it was also noted the report 'health' flattened tubes must not show or crack or tear. The test is considered poor if it reveals a lack of ductility of the metal.

Key words: Flattening, destructive testing, tube drafts, finished tube, Castem 2001

INTRODUCTION

Many steels for general purposes, including plates and profiles are implemented by welding. Today, an estimated 60-80% of the world's steel is used for making welded products. The welding is used in the manufacture and assembly of metal from microelectronics to the manufacture of large hydraulic press corps. We can now weld elements thickness of 0.1-1000 mm or more, soda on almost all metals and alloys used in modern technology. The welding processes and reloading are widely used for the rehabilitation of parts and assemblies worn or damaged.

The definition of the weldability, of these steels is complex because it is a qualitative property assessed by using different criteria depending on the achievements contemplated; It involves many parameters, the steel being only one of them. It is therefore, not subject to specific safeguards, but producers make available to users the information necessary for the successful completion of welding, assembly integrity, integrity essential to avoid any risk of ruin by cracking and breaking from defects (Colombe, 2000).

The current development of welding processes is focused towards perfecting the techniques of use (procedures, metallurgy and equipment), to the introduction of industrial robots and programming, to the application of new energy sources (Laser) (Benissad, 1995).

One of the main applications of welding is the manufacture of pipes and other products closed steel, aluminum or copper by a process fully meeting requirements industrial welding tubes induction High Frequency (HF) (Pender, 1977).

In addition, the familiarity of the material used is essential for the achievement of a satisfactory structure, which gives a guarantee, design-sizing.

The adaptability and reliability of the mechanical properties of the steel used (E24-2) goes through a series of quality control, developing a series of tests to Control Destructive nature (CD) which apply mainly to test pieces and sections of the tubes comprising mainly: traction, hardness, impact strength, bending, flattening, flaring and so on. executed in the draft (not laminate welded tube) and finished product (tube hot rolled and reclaimed by annealing for Standardization).

The experimental study of the test flattening is made to the ENTTPP of Tébessa, the results are stored in tables.

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Table 1: Chemical composition of the steel E24

Nuance	Qualities	Deoxidation mode	C_{max} On casting	C_{max} On product	P_{max} On casting	P_{max} On product	S_{max} On casting	S_{max} On product	N_{max} On casting	N_{max} On product	Alloying elements On casting
E24	2	E (Effervescent)	0.17	0.21	0.045	0.055	0.045	0.055	0.007	0.008	
		NE (Non Effervescent.)	0.17	0.19	0.045	0.050	0.045	0.050	0.008	0.009	
	3	NE	0.16	0.18	0.040	0.045	0.040	0.045	---	---	
	4	CS (killing special)	0.16	0.18	0.035	0.040	0.035	0.040	---	---	Al≥ 0.02

Table 2: Equivalence standards (Beranger *et al*., 1994)

Qualities according to the new European standards Norme EN 10025	Qualities equivalent under the old national standards: Désignation symboliques	Désignation numériques	France NF A 35-501	Germany DIN 17100	Italy UNI 7070	Kingdom U.BS 4360	Spain UNE 36080	USA ASTM	USA ASTM	Japan JIS 3101
	S235JR	1.0037	E24-2	St37-2	Fe360B	40A	AE235B	A283C	A570Gr33	
	S235JRGI	1.0036	E24-2NE	Ust37-2	40B					
	S235JRG2	1.0038		Rst37-2						

Table 3: Correspondence between the nuances E24-2 (S235JR)

Europe IN 10025	France NF A 35-501 (1987)	Germany DIN 17100 (1980)	Belgium NBNA-21101 (1976)	Spain UNE 36080 (1978)	Italy UNI 7070 (1982)	Kingdom U BS 4360 (1986)	USA ASTM Receuil (1987)	USSR	Gost980-71 Gost6713-75 Gost5058-65 Gost19282-73
S235JR	E24-2	St 37-2	AE235 B	A360 B	Fe360 B	40 A	A283 C	St 3 kp .18 kp	

MATERIALS AND METHODS

The material used for welding of steel tubes is E24-2 construction, the chemical composition of which is shown in Table 1. The nuance is indicated by a letter "E" followed by a number corresponding to the minimum yield strength to traction. Possibly the Fig. 2-4 indicating quality (Table 2) (Bautin, 1981).

According to the chemical composition given by the Table 1, steel regarded (E24) belongs to the group of steels with low carbon percentage (mild steel) and dual constituents (ferrite and perlite), with a dominance of ferrite (89%), which is why it is also said ferritic steel.

In addition to the metallurgical properties very necessary to know, the equivalence of standards given in the Table 2 and the correspondences between the nuances recorded in Table 3 represent different designations standard steel for steel used (E24 -2) are recommended to know.

It is imperative that service technicians quality control, specialists design and assembly of metal must be aware of the metallurgical and mechanical properties of the material was welded and checked. In our case the (E24) is a steel construction in frequent use, its mechanical properties are summarized in Table 4.

Table 4: Values standardized calculation of the main characteristics of steel construction (Hirt, 2001)

Modulus of elasticity (to Young)	E	210 KN/mm^2
Module sliding	G = E/2(1 + v)	81 KN/mm^2
Lateral contraction coefficient (Poisson)	ν	0.3
Coefficient of thermal expansion	α	$10^{-5}/°C$
Charge density (density)	γ	78.5KN/m^3

RESULTS AND DISCUSSION

Principle of the test flatting: NF EN 10233 (February 1994, A 49-853). This standard specifies a method for determining the ability to plastically deform by flattening of metal tubes of circular cross section, it may also reveal defects in the tubes.

The standard is applicable to tube outside diameter less than or equal to 600 mm and thickness not exceeding 15% of the outer diameter. The flattening between the trays, a host of a specimen collected at the end of a tube or cut from a tube in the direction perpendicular to the longitudinal axis of the tube until the distance between the shelves, as measured under load in the direction of the flattening, reaches the value specified in the standard product in question (Fig. 1a and b).

If flattening told bloc, the inner surfaces of the specimen must come into contact with each other on at least half the width of the specimen b flat (Fig. 1.c) (AFNOR, 1994).

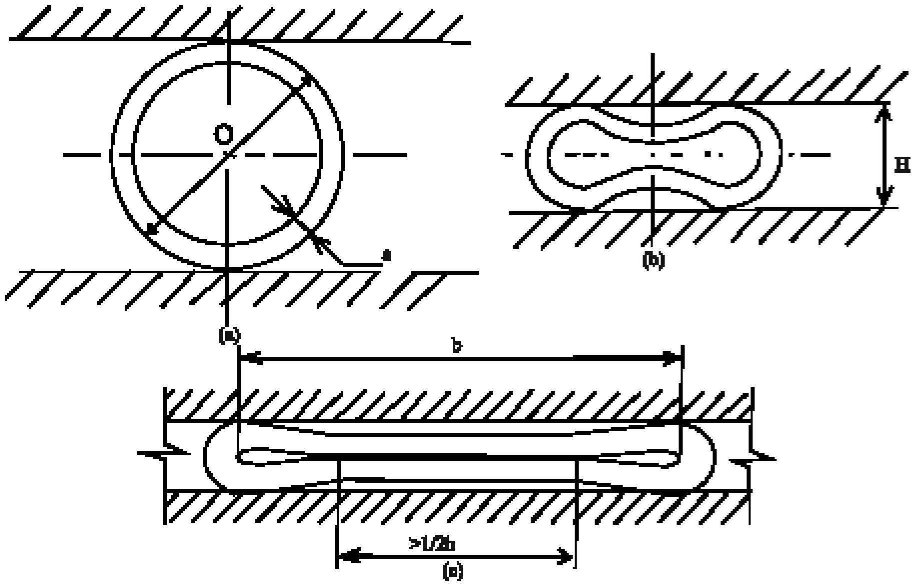

Fig. 1: Flattering test a-c

Table 5: Symbols and designations

Symbols	Description	Unit
D	Outer diameter tube	mm
T	Wall thickness tube	mm
b	Inside width of the specimen flattened	mm
L_c	The length of the specimen	mm
H	Distance between plateaus measured under load	mm

Table 6: Lower limit

Nuance	Value K	Lower limit ($H_{minimal}$)
E24-2	0.09	4.T

Symbols and descriptions: Table 5 illustrates the symbols and descriptions of the various dimensions of the sections of the tubes. The machine used for the test must be able to flatten the tube at the prescribed height H between these two plateaus plans, parallel and rigid (Fig. 1).

The width trays must exceed that of the specimen, that is at least 1.6 D.

The length of the test should not be less than 10 mm and must not exceed 100 mm. The test specimen shall be considered adequate if we are not detect any cracks visible without magnification means. A slight cracking of banks should not be seen as a cause of discarded.

The flattering test is performed in accordance with the standard NF EN 10233, at one end of the tube or on a wall of minimum length of 30 mm levied at one end of the tube. The flattering is conducted until the distance between H plateau, as measured under load, reaches the value set by the formula 1:

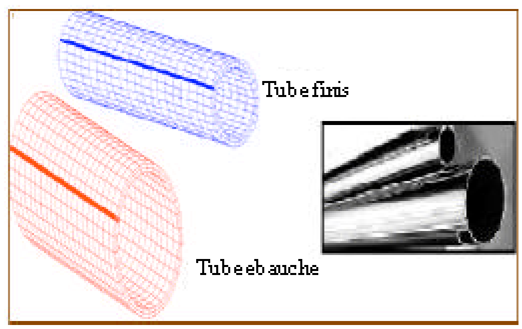

Fig. 2: Tube draft and finished tub

$$H = \left(\frac{1+k}{k + \frac{T}{Dext.}} \right) .T \tag{1}$$

The value of K was 0.09. Value lower limit of H equal to 4. T (T thickness of the tub wall)(SNCF - 00). The flattened specimen shall not crack or tear. The test is considered poor if it reveals a lack of ductility of the metal.

The lower limit of the flattering (Hminimal) is provided by Table 6.

Experimental results: The tubes are banding drafts rolled by the roll forming and welded, while the tubes are tubes finished drafts operation followed by drawing hot for the dressed shape then annealed in the air (Fig. 2).

Table 7: Testing flattening

Test types	N°	Dimensions (mm) D_{ext}	T	Flattening $H_{calculé}$ (mm)	$H_{mesuré}$(mm)	$H_{minimal}$(mm)
Tube Roughing	1	118.5	3.10	29.10	28.70	12.4
	2	94.0	3.10	27.69	26.60	12.4
	3	80.3	3.10	26.39	25.00	12.4
	4	70.7	3.10	25.24	23.50	12.4
Section Du Tube	1	48.3	2.70	20.17	20.00	10.8
	2	48.3	2.20	17.69	20.00	8.8
	3	21.3	2.00	11.85	10.00	8
	4	33.5	2.40	16.35	16.00	9.6

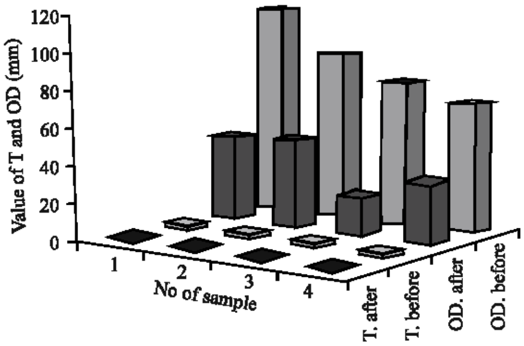

Fig. 3: Comparison of thickness and outside diameter before and after rolling

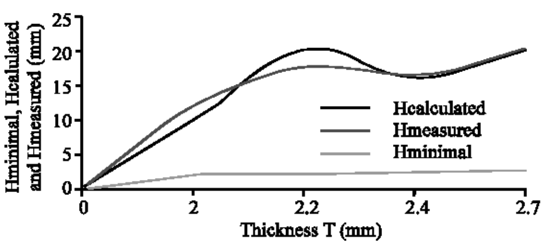

Fig. 4: Comparison of flattening minimum, calculated and measured in office thicknesses after rolling and annealing

The steel pipe is offered to the state stretched and the state annealing, in a variety of lengths, diameters and thicknesses to meet a variety of needs.

Today, the usage of steel pipe are increasingly numerous (Table 7). It is used both for making big varieties in size and quality, Fig. 3 illustrates the practical method to get different thicknesses and diameters is depicted as follows:

Rolled coils ➔ then welded tube induction ➔ obtaining tube Roughing ➔ hot links (Operation drawing) and annealing in the air (relaxation) ➔ finished tube (in shape).

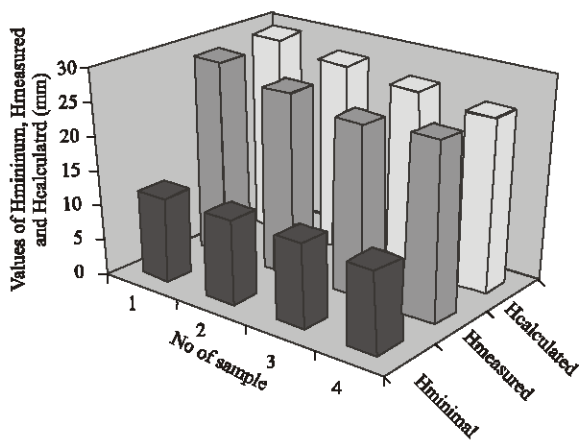

Fig. 5: Flattening minimal measured and calculated before and after rolling

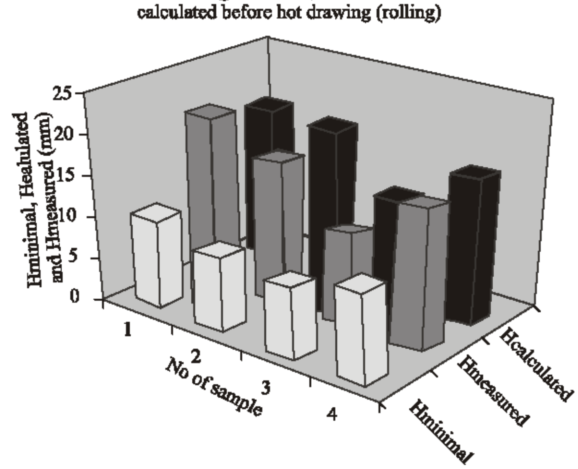

Fig. 6: Flattening minimal, measured and calculated before and after rolling

Hcalcul, Hmesuré and minimum tubes moves clearly based on increases in thickness (Fig. 4) for both types of samples (blanks and finished) and flattening

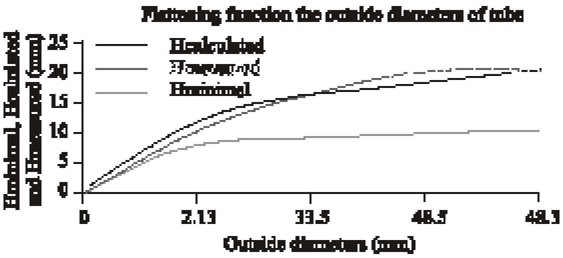

Fig. 7: Comparison of flattening minimum, calculated and measured in office the outside diameter before rolling and annealing

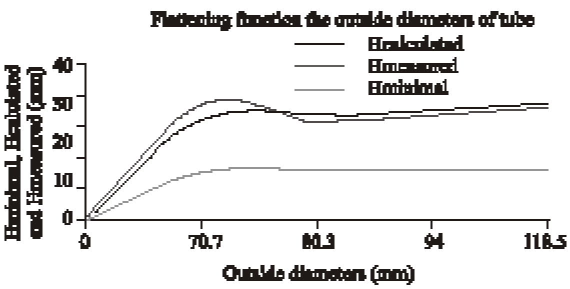

Fig. 8: Comparison of the calculated and measured flattening in office the outside diameter

measured tubes (drafts and finished) important as the flattening calculated in most of the time.

Figure 5 and 6 show the flattening minimum, measured and calculated for two types of samples, respectively (tubes and finished drafts), the differences in values due to the large thickness and outside diameter in the case of tubes drafts and average values for small thickness and outside diameter.

H calculated, Hmeasured and minimum tubes moves clearly based on increases in average outside diameters (Fig. 7) and large outside diameters (Fig. 8) for both types of samples (blanks and finished) and flattening measured tubes (drafts and finished) important as the flattening calculated in most of the time.

SIMULATION NUMÉRIQUE PAR LE CODE CASTEM 2001

During the execution of the load and in a short span of time, the tube begins to deform providing new structures, such as the oval-shaped and elliptical, it continues to achieve its larger deformations where the destruction and damage the structure and arcs of the circle begins to be parallel.

The flattening of an elliptical tube section presents three distinct phases. Firstly the tube ovaled

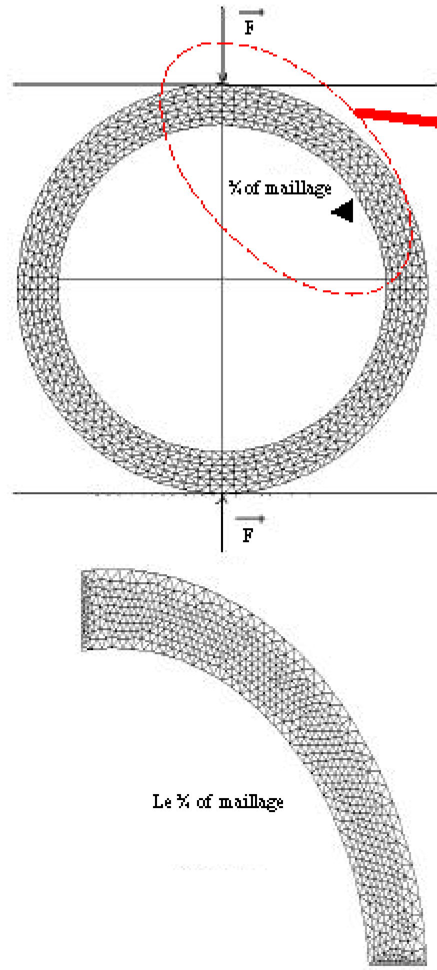

Fig. 9: For reasons of symmetry, only ¼ of the section of pipe is considered

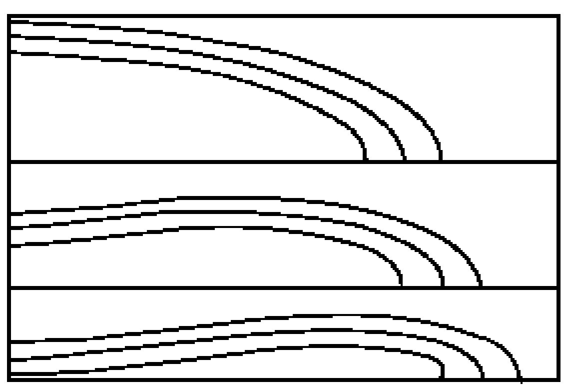

Fig. 10: ¼ tube considered for the simulation

by canceling the curve on the short axis, then after reversing concavity, the opposing walls, which were

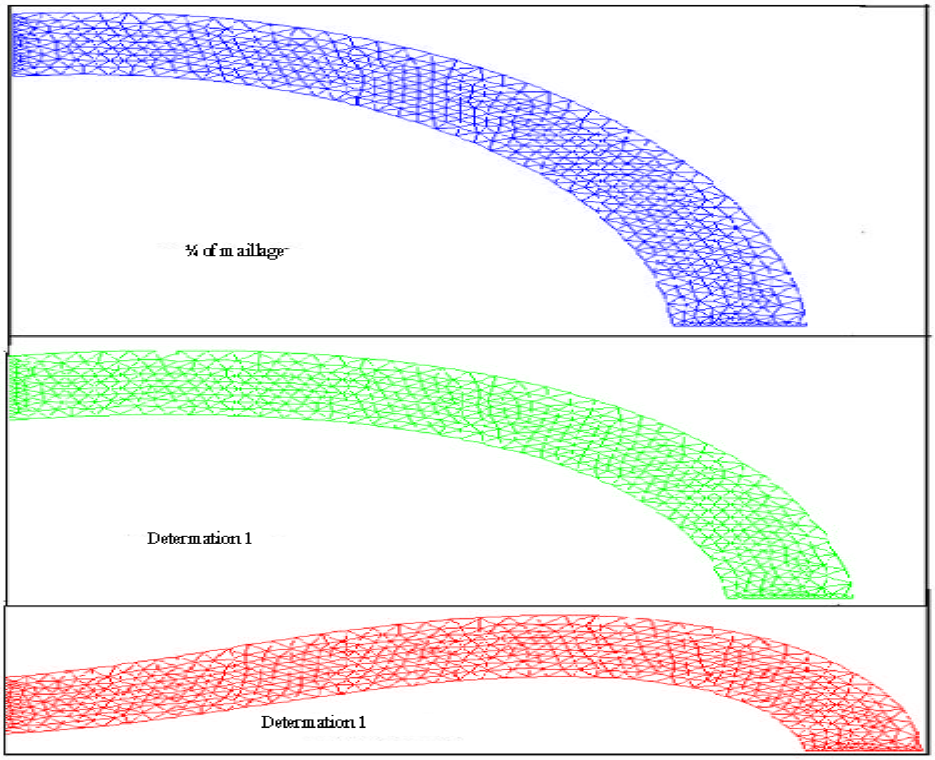

Fig. 11: numerical simulation of tube ¼ 2D and registration deformations

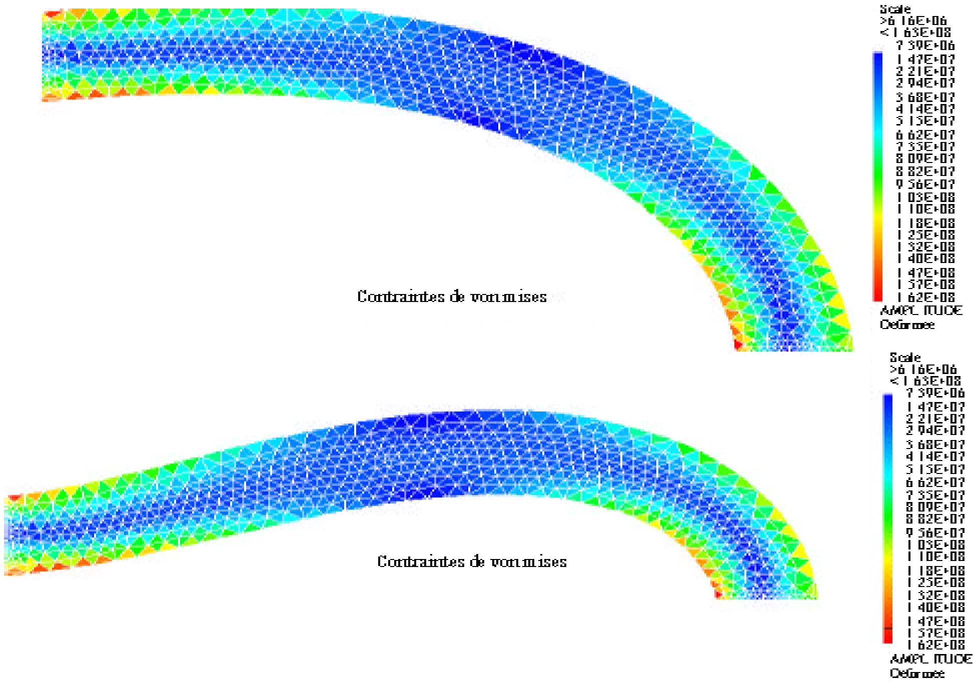

Fig. 12: Visualization of the constraints of Von Mises distorted

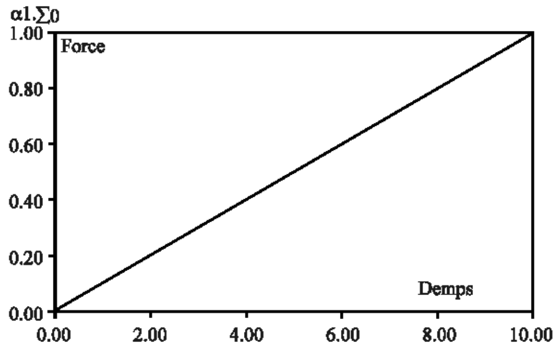

Fig. 13: Evolution of the load as a function of time

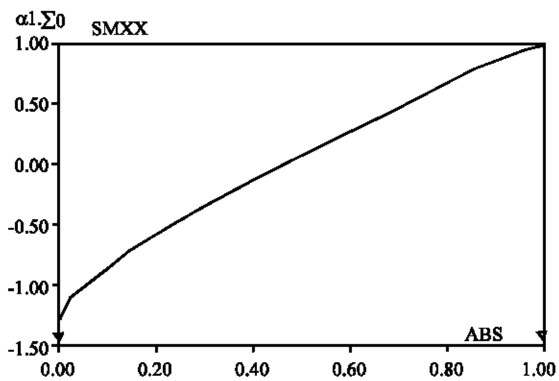

Fig. 14: Variation of the main (stress) MXX

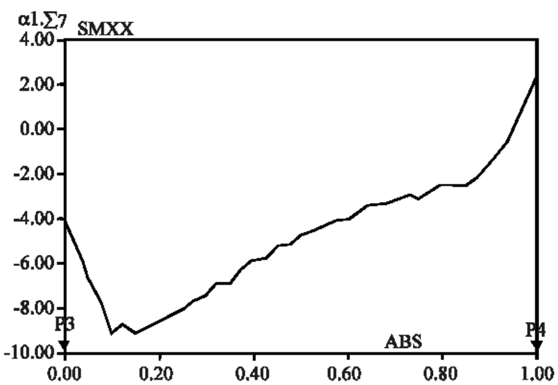

Fig. 15: Variation of the main (stress) MYY

substantially parallel move closer to finally touch in the center and mark the start of the second phase. During this new phase, the curvature at the point of contact (center O) gradually becomes zero, a segment of contact can be developed in the last phase (Fig. 9-15).

CONCLUSION

In the area of production tubing research is regularly conducted to gain knowledge innovative, this need arising from the strong competition and rapidly changing technology in order to respond to market demands and provide satisfactorily and continuing a guarantee the product quality and design.

The flattening test is a method to flatten a sample tube between parallel plates (compression) with the weld at 90° from the direction of the applied force, until the opposite walls of the tube are touching. It applies to the processing of round tubes in other forms. The experiment done at the ENTTPP of Tébessa given to satisfactory results without disclosing defects on the four tube samples (blanks and finished). The digital followed by finite element (EF), we are allowed to see the deformation near samples at different amplitudes.

As recorded in the flattening graphics changes based on external diameters and thicknesses and the flattening calculated tubes (drafts and finished) are important as the flattening measured.

For quality control testing is considered a procedure to determine the relative ductility of metals to form (usually pipes), without cracking (tear) or default (crack) The test is considered poor if it reveals a lack of ductility of the metal.

In conclusion test flattening is essential and highly recommended for the control of quality of welded tubes in order to ensure a saint.

Destructive testing is a valuable tool when used in support of defect prevention.

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