The Study Toughness Ecologicals Metals Materials

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This aim of this is to determine the manner of realizing tubing pipe, which have to comply with suplimentary requirements concerning the notch impact strength at lower temperature (below - 30^{0}C). We realized ∅73 x 5.51 mm and ∅89 x 13 mm pipes applying various final heat treatment variants. For each heat treatment variant were determined the mechanical properties and the impact absorbed energy at temperatures between (-60 ^{0}C and +15 ^{0}C).

Keywords: Characteristics mechanical, treatment heat, toughness

Worldwide more and more severe condition are imposed on oil pipes. These condition are determined by the exploitation of new oil deposits which are located very deep, are associated with acid gas or located in geographical areas with severe climate (arctic regions) [14].

For these reason the internal producers have to know their own ability to comply with supplementary requirements (like notch impact strength values at low temperatures) [3].

Therefore micro alloyed steels are used to obtain high tensile strength combined with good toughness. In addition to achieving an optimum ratio between strength and toughness characteristics by the use of fine grain size can be obtained increasing the weld ability of the steel by lowering the carbon content to achieve the same level of tensile strength [1, 9, 11-13].

Using micro alloyed while simultaneously reducing the carbon content of steel, lead to reduction in weight per meter of pipe used in drilling [2,4, 15].

The current concern for prevention and pollution reduction, an economic and economic alternative ecological, is the production of microalloyed steels using recycled scrap [7, 10, 12].

The main source of vanadium is from the recovery of used catalysts from oil refining operations. This reduces the need to use vanadium extracted from minerals, which reduces energy consumption and pollution generated by mining. These catalysts together with other vanadium *waste* are recycled by several companies that develop the supply of ferrovanadium alloys [8]. The application of vanadium microalloyed steels is now accepted for almost all complex metal structures: containers, bridges, construction equipment, machinery, etc. [23-25]. This is confirmed by the large use of vanadium microalloyed steel [5]. The current concern for preventing and reducing pollution [6, 7, 10, 16, 20, 21]. The steel used in this work is vanadium microalloyed steel.

Experimental part

Materials and methods

Using a steel with the composition swon in table 1, were realized by hot rolling ϕ 73 x 5.51 mm and ϕ 89 x 13 mm casing pipes. After rolling the pipes were quenched at 900 ^{0}C and then tempered by three variants: V_1 = 570 ^{0}C, V_2 = 620^{0}C, V_3 = 690 ^{0}C [5,7].

From each heat treatment variant were sampled specimens to determine the mechanical characteristics (yield strength, tensile strength and elongation) as the absorbed energy at temperature between -60 ^{0}C and +15 ^{0}C.

The absorbed energy of ϕ 73 x 5.51 mm pipes was determined on reduced sample 10 x 5 x 55 mm and the obtained values was change to the full size specimens.

Results and discussions

The chemical compozition of the steel used in experiments is presented in table 1.

The mean values obtained for mechanical properties for both tube sizes are presented in table 2. In figure 1 is shown also their variation function of the tempering temperature. The mean values for the notch impact strength values are shown, in table 3 for each testing temperature and heat treatment variant, besides the fibrosity values determined on the fracture section.

According to the literature [1] the transition temperature (depending of the aspect of the fracture) is the temperature for which 50 % ductile fracture is obtained. According to the literature [1] obtained results that means -40 ÷ -35 ^{0}C [1].

It is obvious as concerning mechanical properties depending on the heat treatment variant, that several grades can be obtained as follows: N80, L 80, C 90, C 95, and T95.

The best performing condition are satisfied for the grade N80.

It is noticed good toughness at -60^{0}C (according to the results obtained for the analyzed steel). Aspects of the

Table 1
THE CHEMICAL COMPOZITION OF THE STEEL USED IN EXPERIMENTS

Nr.crt.	C	Mn	Si	Cr	Ni	V	Nb	Al	Cu	S	P
1	0.24	0.60	0.31	0.24	0.22	0.07	0.028	0.031	0.06	0.008	0.012
2	0.24	0.61	0.30	0.24	0.21	0.07	0.028	0.031	0.06	0.008	0.012

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Table 2
THE OBTAINED MECHANICAL PROPERTIES
(MEANS VALUES)

Pipe size [mm]	Heat treatment variant	Mechanical properties		
		R_c, [N/mm^2]	R_m, [N/mm^2]	A [%]
ϕ73 x 5.51	V_1 570 ^{0}C	795	907	16.3
	V2 620^{0}C	727	858	16.3
	V3 690 ^{0}C	683	810	17.1
ϕ89 x 13	V_1 570 ^{0}C	634	784	24.6
	V2 620^{0}C	603	756	24.5
	V3 690 ^{0}C	487	707	27.3

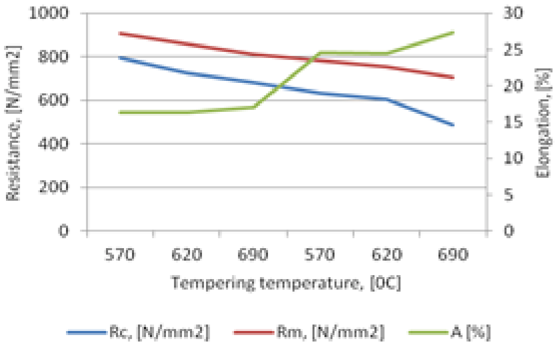
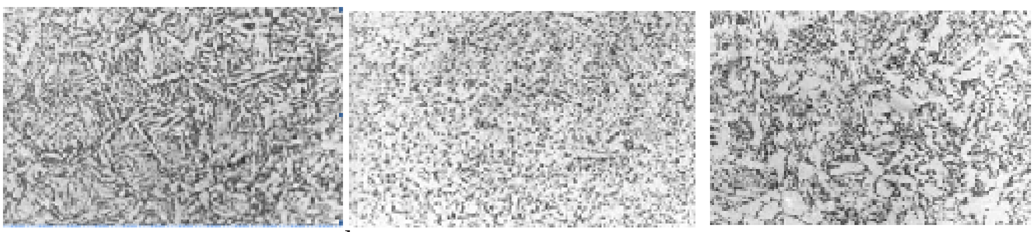


Fig. 1. Variation of mechanical properties function of the applied heat treatment variant (∅73 x5.51 mm pipes) (∅89 x13 mm pipes)

Table 3
THE MEAN OBTAINED VALUES FOR TOUGHNESS AND FIBROZITY

Pipe size [mm]	Alternative treatment	Properties	Testing temperature, [^{0}C]							
			-60	-50	-40	-30	-20	-10	0	+10
(∅73 x5.51 mm	V1 570^0 C	KV	40	42	53	70	96	105	116	118
		Fibrozity	10	15	20	60	70	90	100	100
	V2 620^0 C	KV	41	44	47	75	118	133	140	149
		Fibrozity	10	15	15	40	60	80	90	100
	V3 690^0 C	KV	65	73	84	165	173	180	202	182
		Fibrozity	10	15	20	60	80	90	100	100
∅89 x13 mm	V1 570^0 C	KV	10	15	20	60	80	90	100	100
		Fibrozity	51	64	73	104	106	123	138	144
	V2 620^0 C	KV	10	15	20	60	80	90	100	100
		Fibrozity	55	62	69	96	111	122	134	137
	V3 690^0 C	KV	10	15	20	60	80	90	100	100
		Fibrozity	78	90	98	119	137	161	167	169



a x100 b x100 c x100

Fig. 2 Aspects of the structure obtained after hardening and tempering structure of the material after tempering is shown in figure 2. It is noted that the (hardening at 900^{0}C) due to the austenitic grain size is maintained after the return of the needle aspect hardening constituent [5, 8, 18]. Corresponding structure was obtained in figure 2 b when constituent globular after comeback is fine and evenly distributed. Microstructure with elongated grains in rolling direction has been presented in the papers [12-19, 21].

In figure 2 c, the return of the high temperature (690^{0}C) was started, and recrystallizing the ferrite phase, the structure after annealing is ferrite of sorbitol separation, which explains the decrease of the yield strength.

Conclusions

It is noticed good toughness at -60^{0}C (according to the results obtained for the analyzed steel).

Steel studied heat treated by quenching in water and return, must be heated to austenitising below 900^{0}C to avoid increasing grain by solubilizing particles which reduces graininess and over 850^{0}C for complete conversion and then will apply the return temperature sublime grains in small proportion (recrystallized volume growth mitigates the yield strength).

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Manuscript received: 22.04.2018