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EXPERIMENTAL RESEARCH CONCERNING THE WELDING RECONDITIONING OF IMPELLERS OF HYDRO ENERGETIC AGGREGATES

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Abstract: *Studies and researches regarding the degradation phenomena and tearing of the hydro-energetic assembly impellers have been effectuated. There has been elaborated a technology for reconditioning through the welding of the surfaces that have been used through abradant erosion and pitting effect. The reconditioning through manual welding of the materials, with electric arrow T09 Cu MoMnNiCu 185-TI and T08 Cu MnNiCu 165 – Mb with added material type FOX Cm 13/4 and E410 completely fulfill the hydraulic impellers` exploitation conditions.*

1. DEPRECIATION AND WEARING PHENOMENA

The impellers of hydraulic turbines in exploitation are subject to complex actions, which lead to pronounced wear and implicitly to their reconditioning. The reconditioning technology is specific to the wear degree, nature of default and steel mark. The reconditioning can be carried out through mechanical procedures and welding.

During the operation, the turbine impeller is subject to mechanical stress, abrasive erosion, cavity erosion and corrosion.

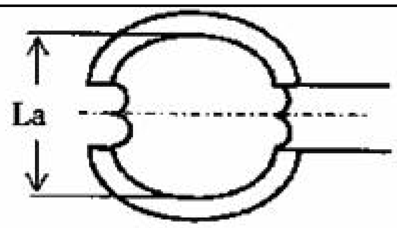
The forces stressing the turbine buckets are tangential and centrifugal forces.

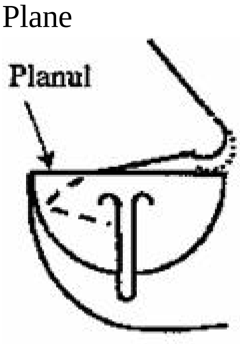
Tangential forces, due to fluid jet, periodically act on the buckets, with a frequency equal to the number of impacts on second.

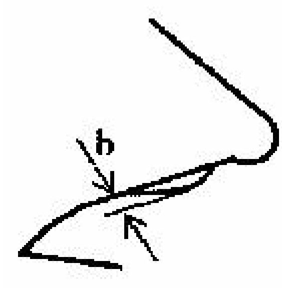
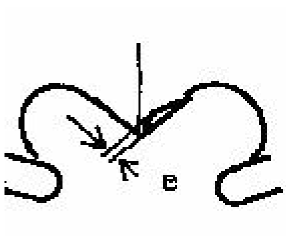
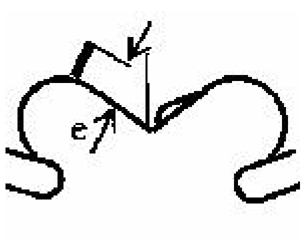
Centrifugal forces provide, at synchronism speed, a constant effort.

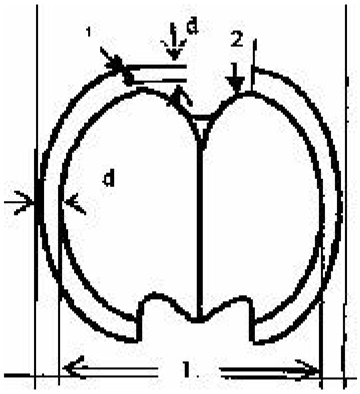
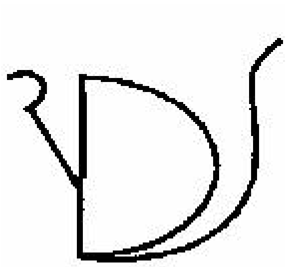
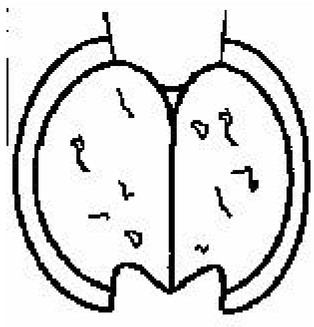
Table 1 displays the main degradations of the hydraulic turbine impellers.

Table 1



	Area	Diagram	Troubleshooting	Remediation	Limit of intervention
1.	Connection of median edge with the hub	Plane 	Cracks or holes (air holes or sand)	Deepening with grindstone	To keep the sharp edge observing the plan, but the connection can be lowered to quite big limits (up to the level of section I, plan

					of the bucket)
2.	Middle edge		Reduced edge cracks or holes	Progressive local deepening with the grindstone and reduction to primitive shape in transversal direction	b = 2,5% La
3.	Middle edge		Long cracks	Stoppage through an ø 6 or 8 mm hole, obstructed by a copper rivet, in case of hard welded steels. Repair by welding in case of easily welded steels.	b = 2,5% La
4.	Gaps		Short cracks or holes	Progressive local deepening with pile and reduction to the primitive shape in longitudinal direction	e = 2,5% La
5.	Gaps		Long cracks	Stoppage through an ø 6 or 8 mm hole, obstructed by a copper rivet, in case of hard welded steels. Repair by welding in case of easily welded steels.	e = 2,5% La

6.	Connecting torques to the hub		Cracks or holes	Trouble 1 – local machining at least up to d-d[1], welding when d< d[1] Trouble 2 – local machining within quite big limits. Is got at welding in the area, generally, difficult to reach.	
7.	Connection to the hub of longitudinal rib		Cracks or holes	Local machining allowed within quite big limits following the rib height. Repair by welding when the rib seems to be too ragged.	
8.	Buckets interior Extrados		Cracks and holes	Cracks repair by welding. Repair by welding of holes that are at distance from vulnerable parts. In case of difficult welded steels there is no intervention on the holes that do not perturb the liquid flow and that are close to vulnerable parts.	

The abrasive erosion is due to the presence in the work environment of abrasive particles in suspension, causing the grabbing of metallic particles from the parts surface.

Abrasive particles, during movement, beside the surface damage through chipping, perform also a plastic deformation of the metal, because of repeated crushing of the same portions, which stresses the destructive character of the process.

Cavity erosion is caused by the materials destruction through cavity. Cavitation is a phenomenon characterized by the apparition, development and sudden inrush of certain holes-cavities filled with vapors and gas, in the mass of a liquid, when its temperature is constant, and the pressure is dropping to a certain critical value. The cavitation phenomenon is a dynamic process, being accompanied by vibrations.

2. RECONDITIONING BY WELDING

The welding technology is specific to the type and size of default. The welding is performed after the elimination of a trouble through one of the procedures: slotting, air-arc grinding and grinding. The chemical composition and mechanical features of the base material T09 and T08 are displayed in tables 2 and 3.

The chemical composition of steel T09 CuMoMnNiCr185-Ti

Table 2

Chemical composition %									
C	**Si**	**Mn**	**P**	**S**	**Cu**	**Ni**	**Cr**	**Mo**	**Ti**
max. 0,09	0,25-0,55	2,00-2,50	max. 0,025	max. 0,025	1,80-2,20	3,50-4,50	17,50-19,50	0,10-0,30	0,10-0,30

Table 3

Chemical composition %									
C	**Si**	**Mn**	**P**	**S**	**Cu**	**Ni**	**Cr**	**Mo**	**Ti**
max. 0,07	0,25-0,55	2,00-2,50	max. 0,025	max. 0,025	1,40-1,80	3,50-4,50	15,50-17,50	0,30-0,50	0,20-0,40

The surface destined to welding will be perfectly clean and without irregularities, the pre/heating temperature will not exceed 100°C. The welding is performed with FOX CN 13/4, E 410 electrodes; their diameter is selected depending on the size of the default and on the position of the joining row. The first rows will be welded with 2,5 mm diameter electrodes and the following with the 3,25 and 4 mm diameter. The used electrodes must be perfectly dry; the drying is performed at 350°C for 3 hours. After the deposit of each layer, the scale will be carefully removed, because there is the danger the danger of scale inclusions remaining in the metal, the adherence of the scale increases when the temperature rises. The temperature between two successive rows will not exceed 150°C. The welding parameters are displayed in table 4.

Table 4

Electrode diameter mm	Welding current (A)	Nature of current
2,5	60-90	CC (+)
3,25	90-120	
4	110-160	
5	150-190	

For large thicknesses of metal deposited, it is recommended the penetration liquid inspection between various layers.

After welding repair of parts with important defaults, it is recommended their tempering. Tempering is performed at 600±10°C for 4 hours (figure 1).

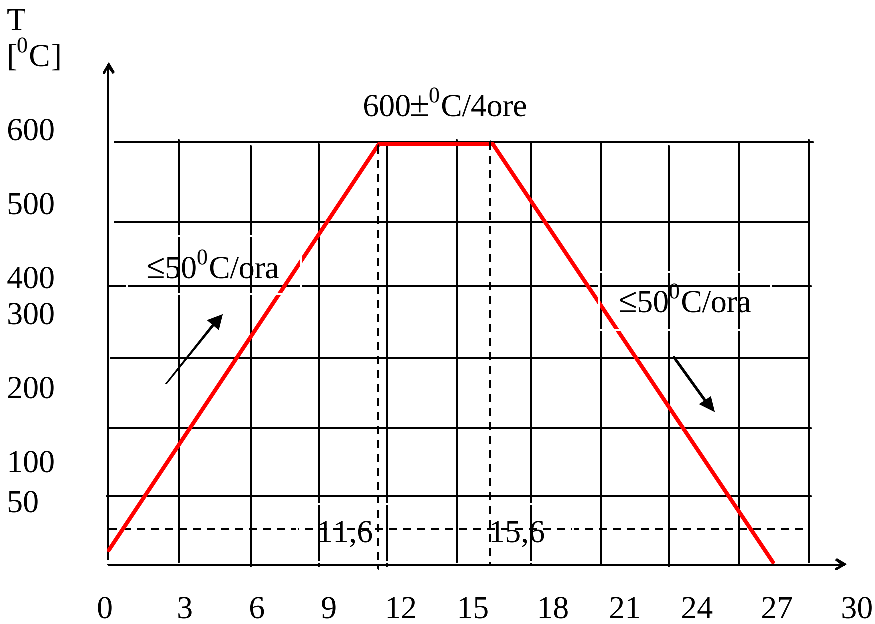


Figure 1 Diagram of heat treatment for tempering

Mechanical features and the reference chemical composition of the metal deposited for FOX CN 13/4, BOHLER and E410 are displayed in tables 5 and 6.

Table 5

Electrode type	Rm (N/mm^2)	$R_{p\ 0,2}$ (N/mm^2)	A5	KCU (J/cm^2)
FOX CN 13/4	1000-1150	830	min. 8	24
E 410	990-1105	820	min. 8	24

Table 6

Electrode type	Average chemical composition %					
	C	Mn	Si	Cr	Ni	Mo
FOX CN 13/4	0,04	0,5	0,3	12,2	4	0,5
E 410	0,09	1,45	0,28	12,5	0,16	0,06

3. CONCLUSIONS

Manual welding with electric arc reconditioning of impellers of hydraulic aggregates manufactured in materials T09CuMoMnNiCr185-TI and T08CuMnMiCr165-Nb with addition material of the type for FOX CN 13/4, BOHLER and E 410 entirely meet the conditions of impellers exploitation, increasing thus their duration of exploitation with low costs.

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