THE ACTIONNARY SYSTEM OF THE CONTINNOUS DISCHARGE FURNACE FROM L.T.G -1. MITTAL STEEL

Stefan DRAGOMIR, Beatrice TUDOR, Marian BORDEI

"Dunarea de Jos"University of Galati,
email: doromir@email.ro

ABSTRACT

In this study the authors made a systematically research about the actionnary system at the continuous discharge heating furnace. It take in account the possibility to use a new material, with most good wear resistance, for the knuckles of this system. An anti-friction alloy containing 87% Sn, 15% Sl and Cu is proposed for the inner surface of the knuckle is used.

This material increase about 30% wear resistance while the friction coefficient decreases).

KEYWORDS: knuckle, heating furnace, hydraulic installation.

1. Introduction

The actionnary mechanism has two beams with independence moving, who determine the deplacement of slabs with constant speed.

The constant speed is necessary to realized a good heating treatment of thick iron plates.

The cyclogrames of moving into the heating furnace are realized with hydraulic rotary or linear engines.

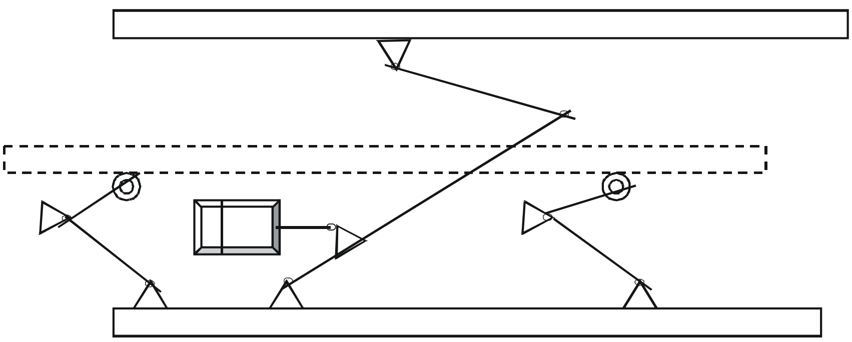

***Fig.1.** The actionnary sistem of continnous discharge heating furnace*

The research of ondulatory phenomena are based wave method who study the transitory processes into the pipes.

We note with:

l – the length of pipe between the pressure source and cylinder;

F- piston force; $p_p(t)$ – the pressure on the piston;

V(l.t) – the flow speed at the pipe end, near cylinder;

The continuity equation in the connection point between cylinder and pipe is :

$$v(l,t) = \Omega v_p(t)$$

The condition for the stationary piston :

$$v(x,0) = 0 \; ; \; v_p(0) = 0$$

$$p(x,0) = p_0 ; p_p(0) = p_0$$

When the weaves are moving into the pipe by similitude we can describe the facts by partials derivations (N.E. Jukovsky) :

$$\frac{\partial p}{\partial x} = -\rho_0 \frac{\partial v}{\partial t}$$

$$E\frac{\partial v}{\partial x} = -\frac{\partial p}{\partial t} \quad (1)$$

The sign "-" is considered in opposed moving direction for piston. After the integration of wave equations result :

$$p(x,t) - p_0 = \omega[\varphi(x-ct) + \psi(x+ct)]$$

$$v(x,t) = \varphi(x,ct) - \psi(x+ct) \quad (2)$$

p_0 is the initially pressure into the pipe.

$$\omega = \sqrt{\rho_0 \cdot E} \quad (3)$$

ω is a proportionally coefficient between the grow up the pressure and the grow up of flow.

$$c = \sqrt{E/\rho_0} \quad (4)$$

c is the proportion speed of elastic wave disturbation
E is Young modules
ρ_0= flow density

$\varphi(x-ct)$- describe the propagation of direct wave process because of perturbatory element
$\psi(x+ct)$- describe the propagation precise of inverse wave.

The values of pressure and flow speed at the end of pipe for x=e are :

$$p(l,t) - p_0 = \omega[\varphi(l=ct) + (l+ct)]$$

$$v(l,t) = \varphi(l-ct) - \psi(l+ct) \quad (5)$$

but:

$$v(l,t) = \Omega \cdot v_p(t)$$

result :

$$\psi(l+ct) = \varphi(l-ct) - \Omega \cdot v_p(t) \quad (6)$$

$$p(l,t) - p_0 = \omega[2\varphi(l-ct) - \Omega \cdot v_p(t)] \quad (7)$$

$$\varphi(l-ct) = \frac{p_d(l,t) - p_0}{\omega} \quad (8)$$

p_d is direct pressure in the piston.
From (7) and (8) result :

$$p(l,t) - p_0 = 2[p_d(l,t) - p_0] - \omega\Omega v_p(t) \quad (9)$$

We consider that the pressure at the end of pipe is equal with cylinder pressure :

$$p(l,t) = p_p(t) \quad (10)$$

We replace that relation in (9) and we obtain the law of changer pressure into the cylinder :

$$p_p(t) - p_0 = 2[p_d(l,t) - p_0] - \omega \cdot \Omega \cdot v_p(t) \quad (11)$$

We can say : that the piston is nearly the direct wave and the grow up of the pressure in the cylinder is equal with double value of grow up for the direct wave pressure.

With the grow up of speed piston upper a precisian value, we see that the really piston pressure ,is less that initially pressure.

If the piston speed is in continuous grow up the pressure into the cylinder can decrease at atmospheric pressure value.

At the grow up of "Ω", the pressure nearly piston decrease very quick.

After the end of displacement effect, the pressure into the cylinder, decrease like a sinusoidal low.

The modification of the pressure and flow speed into the length of the pipe can be simulate with the relation presented in this work.

The increased pressure of contact, superior to limit mentioned above, determines the creation of plastically deformed zone . This zone becomes larger along with the increase of contact. The plastic deformation are integrated in an elastically deformed volume. This state of deformation is called elastoplastic.

The continuous increase of the contact pressure will determine an increase of the plastic zone and advancing toward surface.

The contact with or without sliding foes not significantly alter the above observation in case of single movement of the knuckle body over a contact spot. In the next step of passing , even a first step movement the elasticity is unlimited, the rezidual stress that are generated , will make possible the increase of the contact pressure.

This will lead to elastic deformation as well / a phenomenon called shakedown. The contact pressure should not be surpassed if we expected to continue having elastic deformations.

The elastic deformations in the surface of the contact parts cause modifications of the hertzian distribution of the pressure and provoke, under certain circumstances, among other, fissures that can lead to failure by pitting.

For the knuckles of the sustaining cylinders (chart1)-for which the maximum pressure in the knuckle is about $500x10^5 N/m^2$ = the energy losses caused by friction amount to 40-50% of the total amount of energy consumed. In the case of hydrodynamic knuckles with friction the oil supply is done by an overpressure of 0,1-0,25 MPa correlated with a minimal rotation velocity of the axle which should be higher than the critical rotation velocity which will ensure the oil flux.

The thickness of the oil stratum in the knuckle varies due to the rotation velocity and the charge, determining the thickness of the rolled iron plate.

2.The material used for obtaining the knuckle with a good coefficient of wear

In the knuckles of our system, who is a rotating sliding surface is represented by the outer surface of a spider which is fixed on the conic shaft.

This knuckle is made of a steel alloy which is non-magnetic, wear-resistant, with a low carbon content.

The stratum of anti-friction for the knuckle it is a material who it is was obtained by centrifugal casting, using three combinations of the constituents Sn, Sb, Cu (of which it is made) and then the material samples were tested for wear for three weeks.

The three types of alloys used were:

Table 1

N°	Sn%	Sb%	Cu%	The quantity lost in the wear test at the end of the trial period
1	65÷67	16÷20	15÷17	30%-35%
2	78÷80	7÷8	14-12	18%-20%
3*	85÷88	6÷7	8÷9	11%-12%

The test-pieces of all the three alloys were cast and then tested to find out the wear resistance, while exposed to shock and humid atmosphere containing abrasive particles.

The best results were obtained for the third group of test-pieces : after weighing, a loss of 11-12% of the original weight was registered after a three week trial period.

A contrastive representation of the microstructure of the material in the first and third group of test-pieces is given in fig 2.

Fig.2

3.Conclusions

In the superficial layer from the interior of the knuckle the wear and the fatigue stresses determine damaging in functionary.

The presence in superficial layers of different nature intruders and their concentration in certain dislocation density absence or microcracks than the rest of material surface.

The slide strips produced by the deformation of areas in wear or fatigue processes are also characterised by great dislocation .

These phenomenon are conditioning the energy levels of surfaces and respectively their strength.

The researches showed that the material containing 85-88% Sn, 6-7% Sb, and 8-9% Cu had the best results for the wear, tests in an abrasive atmosphere.

This material was recommended for the knuckle on the basis of the results of the test. By using of this material is improving with 30% the using characteristic of this knuckle an a less friction coefficient inside them :

A sum of .8500$ knuckle/jack was saved by using this material to make the spider/jacks in our country instead of importing the unit.

The knowledge of the maximal values of the pressure can help at the dimensioning of the all actionnary system looking at the resistance of hydraulic shock.

The application of operationally calculus is used research the waving phenomena into the hydraulic installation.

The differentially equation with partial derivations, integrated like wave equation by help of “φ” function (direct wave) and “ψ” function (reflected wave) for different phases of actionnary mechanism.

References

[1].Pitigoi B. *Fenomene tranzitorii in actionarea mecanismelor din metalurgie* –Revista met. 36/1994
[2].Mateescu C. – *Actionari metalurgice* EDP.Buc. 1992
[3].Oprescu, Grosu – *Utilaje metalurgice* EDP.Buc. 1994
[4].Oprescu I. – *Utilajul şi proiectarea sectoarelor metalurgice,* E.D.P.,Bucureşti,1988
[5].Werner W.- *Siguranţa în funcţionare şi întreţinere nr.17,* Neue Hutte,1992
[6].Lindley R., Higggins P.E.-*Maintenance Engineering* Hill Book,Company,N.Y.1997
[7].Cheng P.-*Control of Maintenance Cost Industrial,* Ed.Modern Surrey, U.K.,1998
[8].Miyoshi H. Tsubuku, T, *Instantaneous deformation of subsurface layer in rolling contact,* In proceedings of the Japan International Tribology Conference, Nagoya, 1990.