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CONFIGURATION OF THE MODEL OF SUPERECONOMICAL DRIVE, WORKING ON PROCESS OF POLYMORPHIC TRANSFORMATION OF B-TIN INTO Г-TIN

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Summary. In the article the basic parameters of the analytical computation of drive of reciprocating action, using the effect of the polymorphic transformation of β-tin into γ-tin, is redetermined. The configuration of the model of super-economical drive, working at the polymorphic transformation of β-tin into γ-tin, is developed.

Key words: polymorphic transformation, β-tin, γ-tin, hydraulic cylinder, drive.

INTRODUCTION

White β-tin at polymorphic transformation into **γ**-tin increased in a volume on ≈ 12 % in the process of its heating. As a result of this effect it can be used as a working «high-tough mobile liquid» in the hydraulic cylinders of «pulse-wise-pressing machines» of new generation [Чередниченко 2004]. Nevertheless, the power of polymorphic transformation of β-tin into **γ**-tin and the opportunities of practical application of this phenomenon are not enough investigated.

REVIEW OF LITERATURE

Tin at polymorphic transformations, that relate to the phase transitions of 1-th kind, at which an expulsion or absorption of heat takes place and internal energy and entropy abruptly changes, as well as and physical properties, depending on the location of atoms in a structure, has the following physical characteristics [Куняц 1983], resulted in a table 1.

In connection with that white β-tin is one of the softest metals, with $\sigma_s \approx 12$ MPa, so it can be accepted as a "high-tough mobile liquid". In such state white β-tin can be placed in the closed hydraulic cylinder with a piston, made from highly strength metallic alloys with σ_s more than 1.7 GP. At heating of β-tin it undergoes the transition into γ-tin, as a result, this "high-tough liquid" will be increased in a volume on 12 percents and, in its turn, will move the piston of hydraulic cylinder.

Table 1. **Basic physical properties of β- and γ-tin-modifications**

Polymorphic modification	β-Tin	γ-Tin
Temperature interval of existence, K	286.3-446.1	446.1-505
Density, gm/cm^3	7.295	6.52
Specific heat capacity, J*K/gm	0.2234	0.2234

In works [Чередниченко 2005 – 2006] there are the calculations of ratio of the expulsed energy to expended one at the working stroke of hydraulic cylinder in the process of polymorphic transformation of β-tin into γ-tin.

The calculation of the efficiency of hydraulic cylinder is presented in the work [Чередниченко 2006], the hydraulic cylinder was working on the process of polymorphic transformation of β-tin into γ-tin.

The calculation of the efficiency of drive, working on the process of polymorphic transformation of β-tin into γ-tin, is executed in the work [Чередниченко 2006].

Comparing the total calculation data, carried out in the works [Чередниченко 2006], we receive the values of the efficiency of the drive working on the process of polymorphic transformation of β-tin into γ-tin, which are presented in a table 2.

Table 2. **Calculation data of the drive efficiency at the work on the process of polymorphic transformation of β-tin into γ-tin at different specific pressures**

Specific pressure on a piston, MPa	0,1	100	200	500	1000	1500
Efficiency, %	0,076	56,8	63,9	50,8	32,0	21,1

Dependence of growth and falling of drive efficiency on specific pressures on a piston is shown on fig.1.

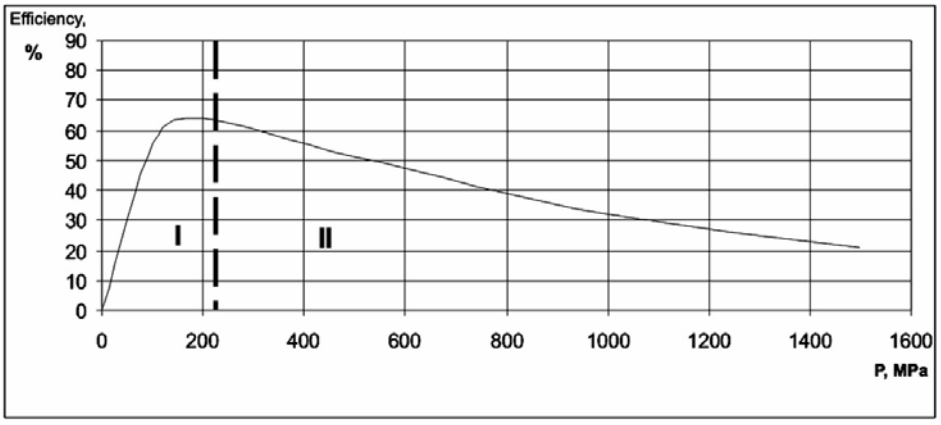

Fig. 1. Change of the drive efficiency at the work of the drive on the process of polymorphic transformation of β-tin into γ-tin depending on specific pressures
I - the studied area of dependence; II- the supposed (calculated) area of dependence

The presented calculation data of drive efficiency show that the most value of relation is observed at P ≈ 200 MPa and arrives at 63,9 % , and at further growth of specific pressures it diminishes and makes 21,1 % at P=1.5 GPa.

The analysis show that most economical design will be the drive working on the process of polymorphic transformation of β-tin into γ-tin at specific pressures of 200 MPa and it can be used as a working organ of various equipment and machines.

PURPOSE OF WORK

The purpose of work is re-determination of the power characteristics of the process and the development of the configuration of model of super-economical drive, working on the process of polymorphic transformation of β-tin into γ-tin.

MATERIAL OF RESEARCHES

Taking a hydraulic cylinder as a working part of drive of reciprocating motion, working on the process of polymorphic transformation of β-tin into γ-tin, we will carry out its heating through an induction heater by the currents of high-frequency, necessary for heating of tin, being the working medium of hydraulic cylinder. The cooling of tin, increased in a volume, will be carried out by water through a circulating cycle; water, in its turn, will be cooled due to the difference of ambient temperatures in water-cooling tower. Return of diminishing in a volume the working medium to initial geometrical sizes of tin will be carried out by the preliminary compressed spring at the working stroke of hydraulic cylinders piston on the value of energy, determined in-the work [Чередниченко 2006].

At optimum selected modes of current frequency for heating of tin, the heating efficiency by high-frequency currents arrives at 86 %, the efficiency of the spring – 98%.

RESULTS OF RESEARCHES

On a fig. 2 the design of configuration of model of super-economical drive, working on the process of polymorphic transformation of β-tin into γ-tin, is presented.

The presented drive consists of the hydraulic cylinder 1, in which the working medium –tin is placed. The cylinder is supplied with the piston 2 spring-loaded by the spring 5. The hydraulic cylinders is placed into pressure-tight body supplied with the inlet 7and outlet 8 branch pipes for feed and release of cooling medium. Water is used as a cooling medium. In addition, the hydraulic cylinder is supplied with the induction heater 6 for heating of the working medium – tin.

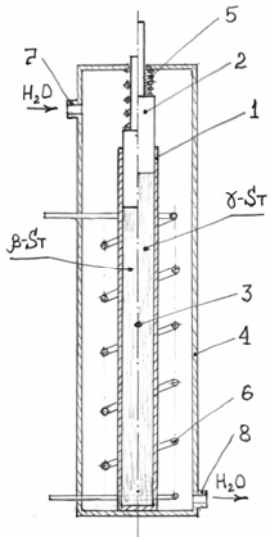

Fig. 2. The configuration of the model of super-economical drive working at the polymorphic transformation of β-tin into γ-tin

The drive, operating on the process of polymorphic transformation of β-tin into γ-tin works as follows:

- the high-frequency current, selected under the mode of heating of tin, is fed on the induction heater 6,
- tin 3 is heated to the transition point of β-tin into γ-tin, there is an increase of its volume on ~12 % and piston 2 moved to the calculated magnitude of working stroke,
- the coolant – water is fed into branch pipe 7, then water is removed through the outlet pipe 8,
- there is cooling of tin before its transition into β-tin and its volume diminishes on ~12 %,
- a spring 5 through a piston 2 deforms diminishing in a volume β-tin to the initial state.

The cycle is repeating many times.

CONCLUSION

The configuration of the model of super-economical drive, working on the process of polymorphic transformation of β-tin into γ-tin, has been developed with the drive efficiency to 63,9 % at specific pressures 200 MPa.

The developed design of drive can be used as a working drive in the «pulse-wise-pressing machines» of new generation, for example, in the broaching machines, which will be super-economical due to the expulsion of the hidden internal energy, expended at previous polymorphic transformation of γ-tin into β-tin as a result of cooling.

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КОМПОНОВКА МОДЕЛИ СВЕРХЭКОНОМИЧНОГО ДВИГАТЕЛЯ, РАБОТАЮЩЕГО НА ПРОЦЕССЕ ПОЛИМОРФНОГО ПРЕВРАЩЕНИЯ β – ОЛОВА ПРИ ПЕРЕХОДЕ В γ – ОЛОВО

Нечаев Г.И., Чередниченко С.П., Шенкман Г.Л.

Аннотация. В данной статье рассмотрена возможность использования процесса полиморфного превращения белого β – олова в γ – олово в модели сверхэкономичного двигателя.

Ключевые слова: полиморфное превращение, высоковязкая подвижная жидкость, импульсно – прессовая машина.