7th International DAAAM Baltic Conference
"INDUSTRIAL ENGINEERING
22-24 April 2010, Tallinn, Estonia

MODERNIZATION MECHANICAL PLANT FOR WITHDRAWAL PROFILES IN HORIZONTAL CONTINUOUS CASTING

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Abstract: *This paper presents a variant of modernization process of withdrawing the profiles in horizontal continuous casting (HCC) of metals. HCC is a modern method of directly obtaining different types of metallic semi-products by casting without using the laminated lines. In present, semi-products withdrawing, in horizontal or vertical continuous casting, uses systems that are composed of parallel rollers forming a pair. The system consists of two rollers ensure the clamping force between the roller and the movement of advance of the profile. This withdrawal method has a number of disadvantages: the electromechanical device drive of the moving roll, has big gauge; the need of hydraulic or pneumatic system to the pressing roll for raising on the profile of the rolls; clamping force required is applied to a small contact area between roller and semi-product, resulting in a high pressure which deforms the semi-product. To eliminate these disadvantages, the authors propose the realization of a withdrawing system which replaces the rollers with adjustable horizontal tanks.*
This new withdrawing system ensures the modernization of withdrawing installation to horizontal continuous casting with the following advantages: - Simplified construction requiring a simple rotating at the entrance of the mechanism; simple electric drive; low gauge; lack of hydraulic or pneumatic system; large contact area between jaws and semi–product ensure preservation of the semi-product dimensional characteristics; easy maintenance; higher reliability, energy savings, by eliminating the hydraulic installation, the clamping force being provided by springs.

Key words: casting, rolls, tanks, mold, motion.

1. INTRODUCTION

Continuous casting process of metal semi-manufactured is a process of great current in metal and steel industry at European and global level. Horizontal and vertical continuous casting of metals is to obtain different profiles of metal semi-manufactured directly from the melt metal without using lines rolling. This method of directly obtaining metal semi-manufactured without casting in ingots followed by rolling, contribute to large energy savings by increasing productivity and simplifying the technological flow for obtaining metal profiles.

2. THEORETICAL CONSIDERATION

Given the importance which represents continuous casting in steel and metallurgic flow, (fig. 1), are made researches to modernize and optimize continuous casting facilities [1].

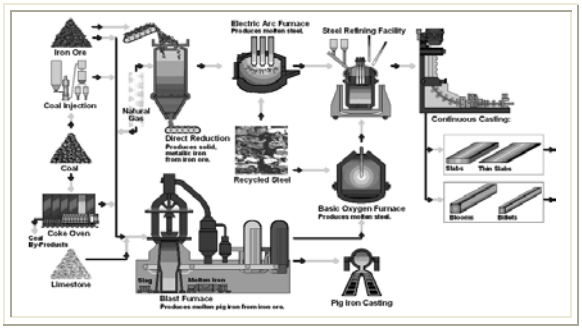

Fig.1. General Flow of making steel

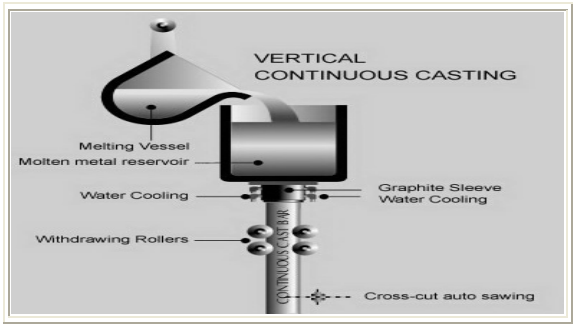

Fig.2. Vertical continuous casting

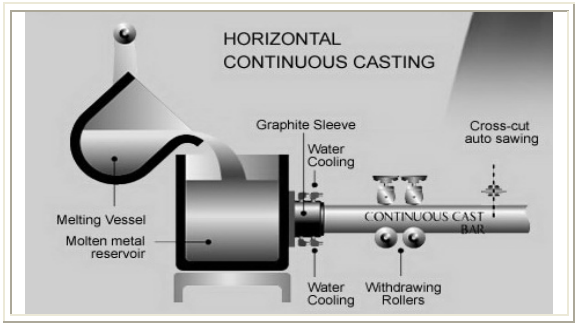

Fig.4. Horizontal continuous casting

2.1 Vertical continuous casting

At continuous vertical casting, molten wire has a vertical route (fig.2) in primary phase of secondary cooling, and then the thread becomes curvilinear and finally reaches the horizontal as in the case of horizontal continuous casting (fig. 3).

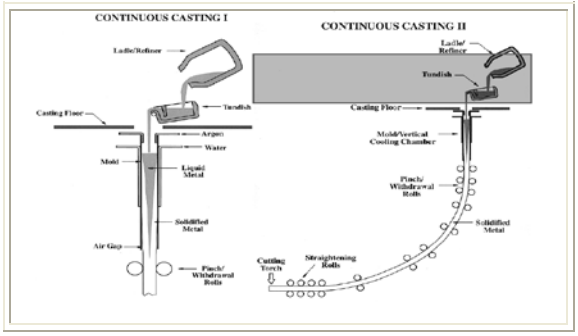

Fig.3. Vertical continuous casting methods

Solidification of molten metal is from outside to middle, slightly asymmetrical, the solidified wall is thicker on the inside. In the same time, the solidification occurs by contraction of the superior wall from the crystallizer surface [2]. The extraction of cast wire, face resistance to friction forces of the cast metal - crystallizer which can be at a time sufficient to generate transverse rupture. Faced with this difficulty, continuous extraction becomes risky and prefers intermittent extraction.

2.2 Horizontal continuous casting

At horizontal continuous casting process, the cast wire has a horizontal route which requires evacuation of molten metal at the bottom and on the lateral sides of the maintenance oven, where is attached the crystallizer (fig.4).

Horizontal position of the crystallizer put the stability problem of wire type liquid lubricant oil. Most convenient solution is self-lubricating. In this purpose resort to electro graphite, which in addition satisfies the imperatives imposed: high thermal conductivity, refractoriness, wear resistance, processing capacity to the desired shape.

In both methods of casting, vertical and horizontal are used generally drawing system equipped with roller (or pair of rolls) perpendicular to either side of the drawn profile. One of the rollers is motor driven by an electric motor through a reducer. The other roll is led through the withdrawn profile (fig.5).

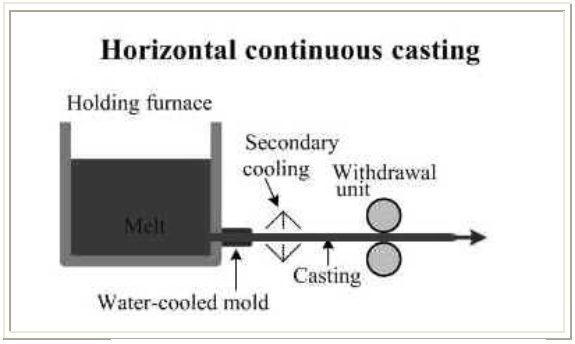

Fig.5. Facility equipped with horizontal pulling rolls

It provides the necessary clamping force to advance the movement of the profile and serves a normal force of contact surface. Clamping force is provided by a hydraulic system. Other methods of withdrawing the semi-manufactured with horizontal continuous casting are those which use instead drawing rollers, steel strip or glass fiber. Another way of withdrawing at

horizontal continuous casting uses withdrawing blocks, fig. 6, 7, 8.

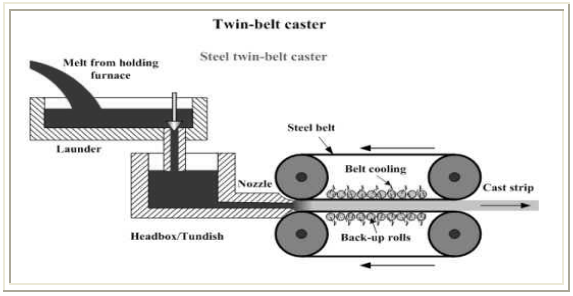

Fig.6. Horizontal withdrawing Installation equipped with steel strips

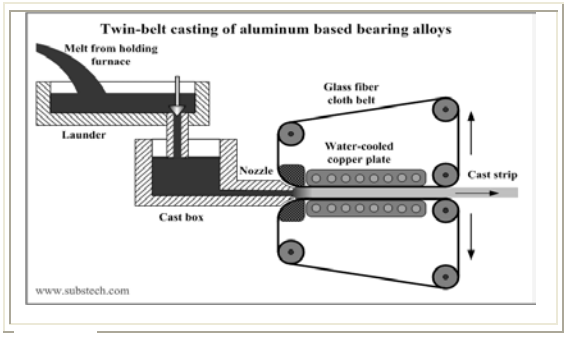

Fig.7. Horizontal withdrawing installation with fiberglass

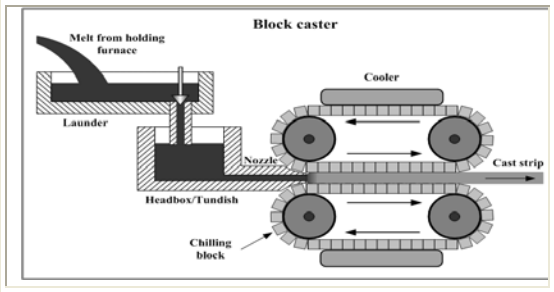

Fig.8. Horizontal withdrawing installation with withdrawing blocks

3. MODERNIZATION OF WITHDRAWAL AT CONTINUOUS CASTING

3.1. Modern solution for withdrawing of profiles

Withdrawing methods described above, present some disadvantages, such as:

- Oversize of the ensemble motor-reducer;
- The need for a pneumatic or hydraulic system to ensure the clamping force on the profile.
- In case of withdrawing with metal strip or strips of fiberglass appear a rapid wear of these because of the high dynamic applications faced by and due to large thermal applications;
- Large size withdrawing system, with blocks and the need for additional facilities for cooling the blocks;
- The need for rigorous controls of pneumatic or hydraulic system to avoid deformation withdrawing profile;
- The use in case of large sizes semi-manufactured of more pairs of rollers which need to be synchronized, resulting in a greater complexity of the drawing installation;
- Withdrawing rolls are grooved, which lead to visible traces on semi-manufactured affecting quality.

To remove these disadvantages of withdrawing methods developed so far, the authors proposethe upgrading of horizontal continuous casting.This modernization refers to optimize withdrawing installation by replacing the classic roller withdrawing with tanks withdrawing, fig.9.

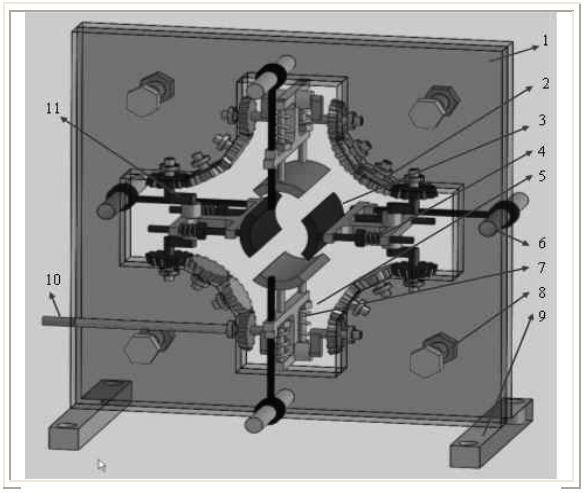

Fig.9. Horizontal withdrawing installation with withdrawing tanks

Legend:

1 are semi-dies

2 - Gears with conical gear

3 -tanks
4 -compression helix spring
5 -gathering nuts for the pre-spring
6 -slide bars
7 -guiding elements of tanks
8 -screw and nut for joining semi-dies
9 -fixing elements
10-input shaft
11-crankshaft.

The projected system of withdrawing was made using 3D CAD program Solid Works 2009 [3], [4]. After designing the system, was made the study of motion elements which validated the run of the simulation program.

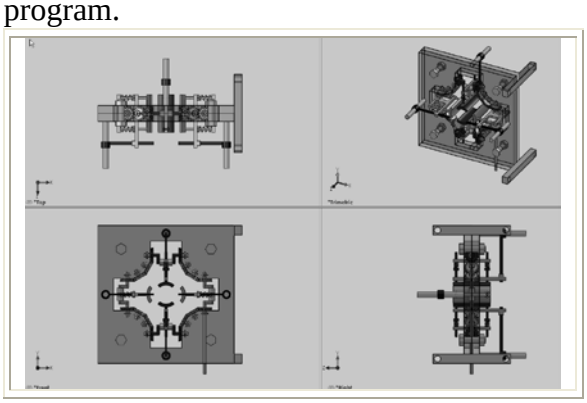

Fig.9. Top, lateral and isometric view

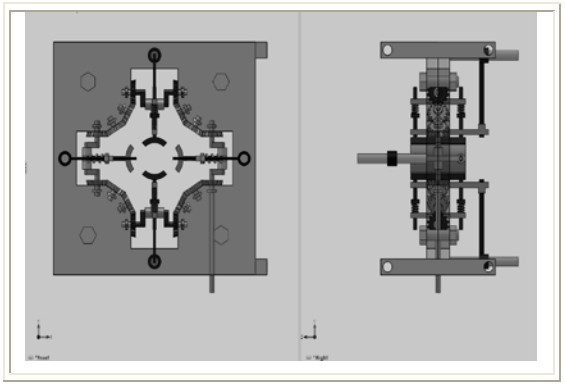

Fig.10. Top and lateral view of system

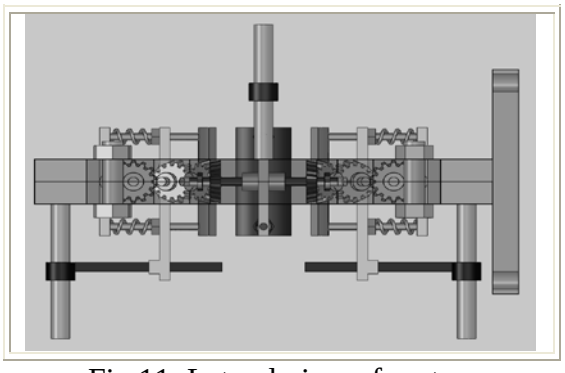

Fig.11. Lateral view of system

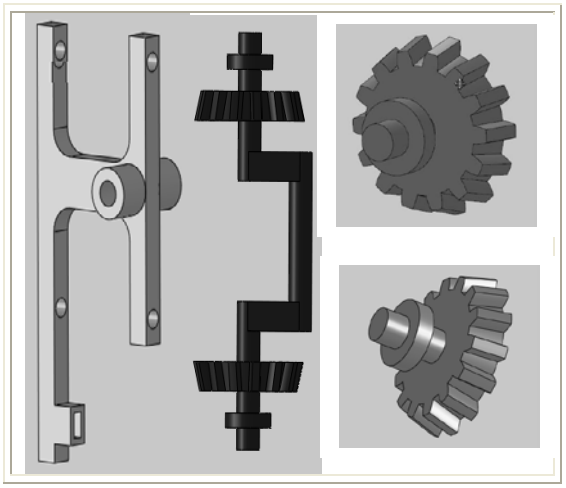

Fig.12. Elements of withdrawing system

The disadvantage of the proposed method for the modernization of the drawing system is that you can not use this to the continuous casting which is not intermittent (constant withdrawing rate)

Although the method uses two pairs of tanks out of time (push-pull), there are dead times when the tanks are not in contact with the profile.

3.2 Determination of dynamic solicitation by pressure of the tank on the bar under tensile and compressive.

Although the mechanical strength ferrous alloys reached the filament (~ 700 ° C) decreases ten times over the mechanical strength at room temperature, very small amount of pressure distributed evenly on the semi-manufactured surface will not affect the profile through mechanical deformation.

The main advantages that bring the withdrawing system with tanks are:

- Increasing the contact area between tanks and semi-manufactured reducing the risk of deformation of the tank profile.
- Elimination of the hydraulic or pneumatic system necessary to create the clamping force.
- Eliminating gearbox which has oversize.
- Possible intermittent drawing of the profile
- Action the entire system with a single rotating motion inlet.

- Modern power of induction motor drive through field orientation method (vector control).
- Energy saving.

This determination was made by calculation using the finite element application Cosmos Works 2009 [5]. Finite element method was applied to calculate the mechanical solicitation of the semi-manufactured pulled and the calculation of displacement of tank rods during mechanical action on the profile [6] (see fig. 13 a, b, c, d).

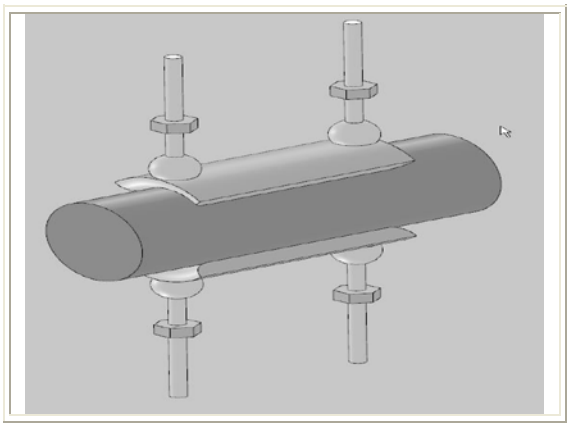

Fig.13.a. Mechanical model of study

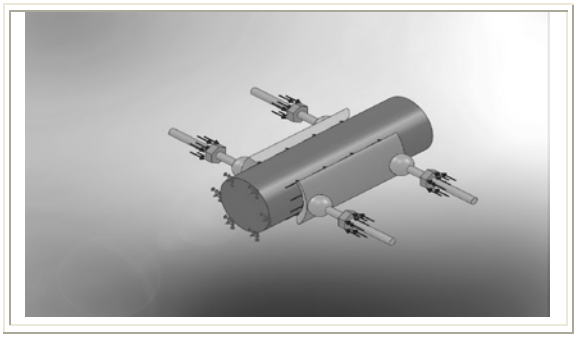

Fig.13.b. Aplication forces of model

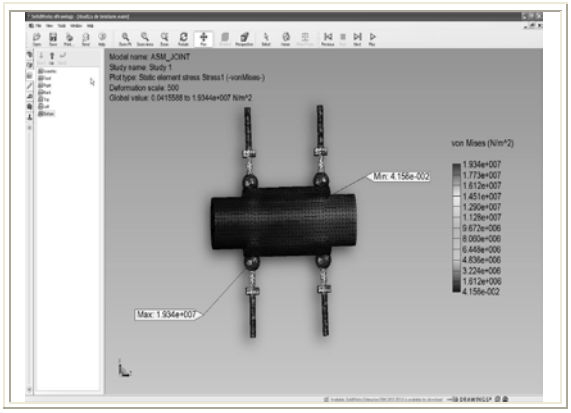

Fig.13.c. Stress determination

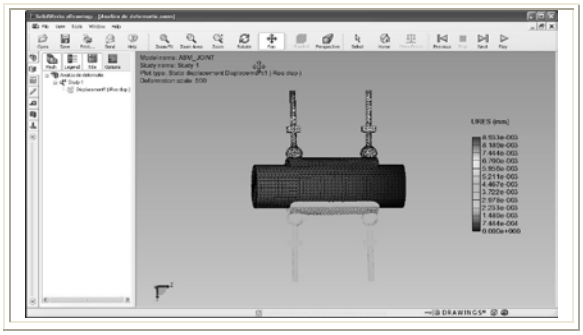

Fig.13.d. Dispacement dermination

4. CONCLUSION

Given the importance of continuous casting of metals in the steel and metallurgical general flow, is required to modernize and optimize existing continuous casting plant to increase product quality and reduce energy consumption.

Withdrawing method of the semi-manufactured proposed by authors, will be practic realised on a smaller scale to validate the principle and then to be implemented in the profile industry.

Shall have regard to future research on the achievement of modernization and improvements to existing facilities and the development of new mechanical systems for drawing horizontal continuous casting.

5. REFERENCES

1. Tufoi, M.; Marta, C.; Vela, I.; Bizau, V.; Suciu, L., *Method for the automation of horizontal continuous casting installation with programmable logical automata,* Annals of Daaam 2009, **20**, 01, 1611-1613.
2. Marta, C., *Numerical methods of simulation of casting and solidification of metal alloys*, Eftimie Murgu Publishing House, Resita, 2005.
3. Radulescu, C.; Vela, I.; Varga, S.; Vela D., *Projection of devices. Robotics,* Didactic and Pedagogic Publisher, RA House, Bucuresti, 2006.
4.*** SolidWorks 2009, User Guide
5.*** CosmosWorks 2009, User Guide
6.***http://www.substech.com/continuous casting, *accesed in 10.01.2010.*