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EXPERIMENTAL EQUIPMENT FOR MICROCOOLERS ADDING IN TUNDISH AND CRYSTALLIZER OF CONTINUOUS CASTING INSTALLATION

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Abstract: In this paper is presented installations that are made for adding microcoolers and other adding material like covering powders in distributor and crystallizer of continuous casting installation. This installation are designed started at what type of materials (pulverous or granular) is transported and are preferred two type of transporter helicoidally and vibratory.

1. INTRODUCTION

Continuous casting installation studied is with a tundish and five cast wire, like in figure 1. Tundish have many roles like, to distribute steel for any cast wire with minimum heat loses and due to permit to grosiere impurity to come to the surface of molten steel. Tundish is also a capacity buffer between cast ladle and crystallizers, permit the check of steel flux in crystallizers and are due to offers sufficient stockage capacity for the change of cast ladle in case of sequential cast, [1].

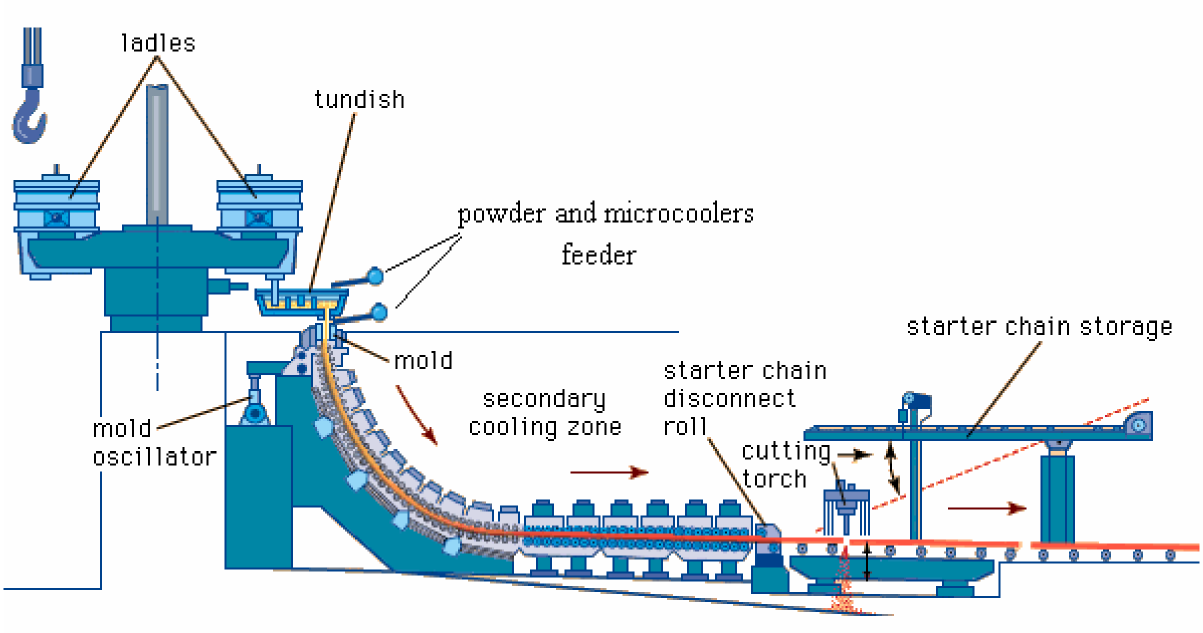

Figure 1 Continuous casting installation

In most cases molten steel comes from steelworks with higher cast temperature and is necessarily to decrease temperature of steel, [2] . This think can be made using the microcoolers (small parts of steel with chemical composition same like casted steel).From calculus, adding of 1 kg/ton microcoolers quantity conduct to steel scales down temperature by 2-3^{O}C. Adding of this microcoolers can be made in tundish and also in crystallizer. If steel temperature is too lower, can be used plasma installation in tundish for increasing temperature of molten steel.

In tundish are used also thermoisolating and covering powders for protection of molten steel from atmospheric gases. These covering powders must be added in proportion of 40-60kg/100ton of molten steel.

In both cases this addition can be made using a specialized transporter like screw transporter, vibratory transporter, pneumatic transporter, and other.

2. EXPERIMENTAL RESERCH AND INSTALATION DESIGN

In both cases, is possible to use a transporter for addition of material in tundish and in crystallizer, the places where are positioning the transporters is market in figure 2 and 3.

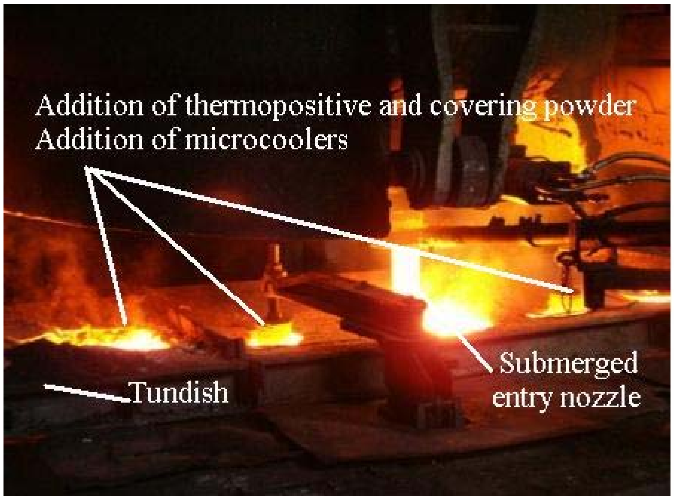

Figure 2 Places for addition thermoisolating and covering powders and of microccoolers in tundish

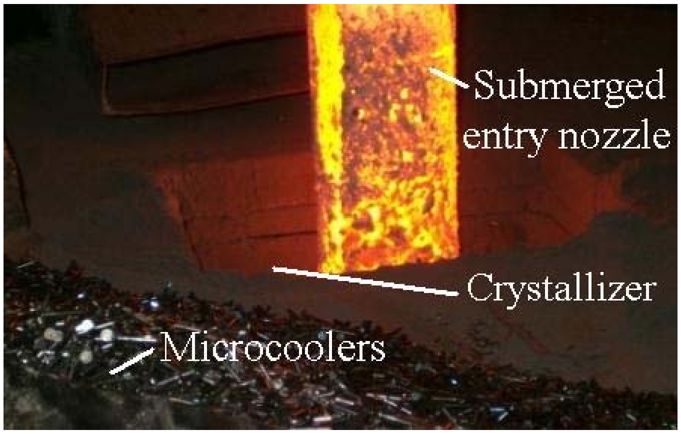

Figure 3 Places for addition of microccoolers in crystallizer

To base design of addition installation of thermoisolating and covering powder are take into account many criteria:

- simple from constructive viewpoint, can be adjusted to other subsequent needs of steelwork;

- capacity has is not too big, because the necessary material are max. 60kg/100 tone of liquid steel and are installation recharging possibility;

- durability in exploitation and higher productivity.

Thus, they were studied three possible variants:

- utilization of dusts airlift transports from the bunkers to distributors. The installation requires a supplementary bunker and cyclone for the separation of dust from air, in aim to avoiding introductions of the air of the in of the distributor (also is better to use an inert gas as transportation agent). Analyzing this variant, he arrived at the conclusion as is not viable for this experimental installation;
- utilization of conveyer with buried auger-nose shells, carry is only that relative complicated from constructive viewpoints;
- utilization of screw conveyer, which are adopted variant by reason of constructive simplicity, of the fact as the can to transport as much pulverous material how much the granular material.

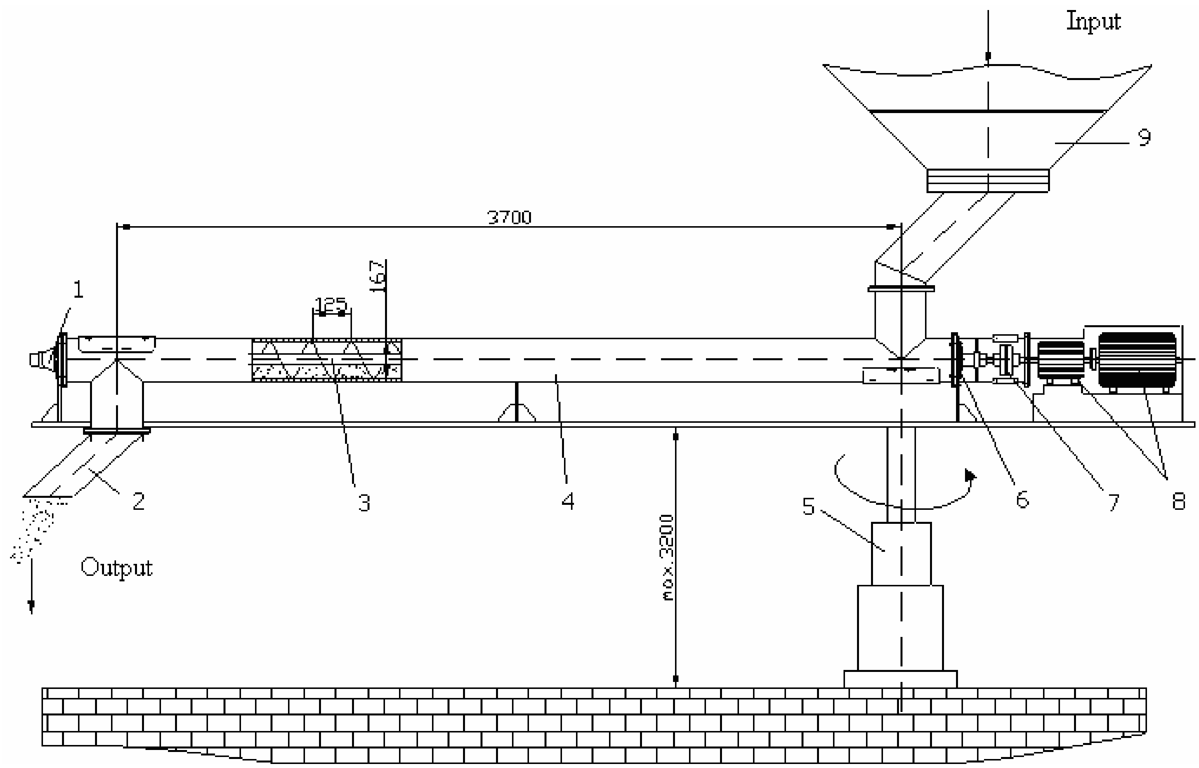

Figure 4 Screw conveyer
1- end bearing box (radially axial); 2- evacuation trough; 3-endless screw; 4-sheet-iron lining; 5-swingable adjustable axes; 6- crossing bearing box (radially); 7- connecting sleeve; 8- reduction gear box; 9- storage bin

The schematic is presented in figure 4 and the most important parameters are presented in next paragraph.

Transportor productivity:

$$Q = 60 \cdot \frac{\pi \cdot D^2}{4} \cdot t \cdot n \cdot \gamma \cdot \beta \cdot \psi \text{, [t/h]} \quad (1)$$

$$Q = 60 \cdot \frac{3{,}14 \cdot 0{,}16^2}{4} \cdot 0{,}125 \cdot 40 \cdot 0{,}9 \cdot 1 \cdot 0{,}35 = 1{,}89\, t/h = 31{,}65\, kg/\min \quad (2)$$

The admissible revolution:

The screw revolution is as a rule contained between 10-150 rot/min, in order to prevent the material fling toward frame by reason of centrifugal force. Thus the admissible rev is calculated with the relation:

$$n_{\max} = \frac{A_1}{\sqrt{D}} \text{ , [rot/min]} \tag{3}$$

$$n_{\max} = \frac{45}{\sqrt{160}} = 127{,}27 \text{ rot/min,} \quad n<n_{max}.$$

Power necessary to the screw axes, for the material transport shall be:

$$P_1 = M \cdot \omega = \frac{k_o \cdot k_1 \cdot g \cdot Q}{3{,}6 \cdot \eta_S} \cdot (\mu \cdot L + H) \text{, [N·m/s]} \tag{4}$$

or

$$P = \frac{P_1}{1000} = \frac{k_o \cdot k_1 \cdot Q}{367 \cdot \eta_S} \cdot (\mu \cdot L + H) \text{ , [kW]} \tag{5}$$

Considering attrition from bearing boxes through their efficiency η_e and attrition from gearboxes through this efficaciousness η_t, the engine power shall be:

$$P = \frac{k_o \cdot k_1 \cdot Q}{367 \cdot \eta_S \cdot \eta_e \cdot \eta_t} \cdot (\mu \cdot L + H) \text{ , [kW]} \tag{6}$$

Efficiency of bearing boxes can be η_e=0,90-0,93 for slide bearing boxes and respective η_e=0,95-0,96 for rolling bearing boxes. In order to consider the weight of the axe and resistances on no-load running, this power can be increased with 0, 5-1kW. In the case horizontal conveyer (that is one selected for the installation for addition of covering and thermoisolating powder), power of engine is shall calculated with the relation:

$$P_o = \frac{k_o \cdot k_1 \cdot Q \cdot \mu \cdot L}{367 \cdot \eta_S \cdot \eta_e \cdot \eta_t} = \frac{w \cdot Q \cdot L}{367 \cdot \eta_t} \text{ , [kW]} \tag{7}$$

where $w = \frac{k_o \cdot k_1 \cdot \mu}{\eta_S \cdot \eta_e}$ is the coefficient of movement resistances. For constructions material like (dry clay, limestone, cement, sand), this has the value w≈4

$$P_o = \frac{4 \cdot 1{,}89 \cdot 10}{367 \cdot 0{,}95} = 0{,}216 \text{ [kW]} \tag{8}$$

In order to overcome resistances of idle running and the weight of axle, results as power the engine shall be:

$$P_{motor} = P_o + 1 = 1{,}216 \text{ [kW]} \tag{9}$$

On the calculations, the engine with the power of 2kW (the one initially adopted) is sufficient.

In case of addition of microcoolers, the adequate transporter is with vibrating transporter, like in figure 5. Is preferred vibratory conveyer in a detriment of screw conveyer because is a simple robust building, the dosage amount of microcoolers are made from the bin feed. Is possible to adjust the height of conveyer, this thing permits the assembling easily in crystallizer zone (zone which the mounted installation is relative narrow).

The transport installation is composed from trough achieved from sheet metal with the thickness of 3 mm inclined adjustable. For advance of microcoolers material within zone of enters this in the tundish or crystallizer of the continuous casting installation, the trough conveyer vibrates. Due to the material nature (metal) whoa are transported from the bin feed on the inclined trough (metal) isn't necessary a detailed design of the installation.

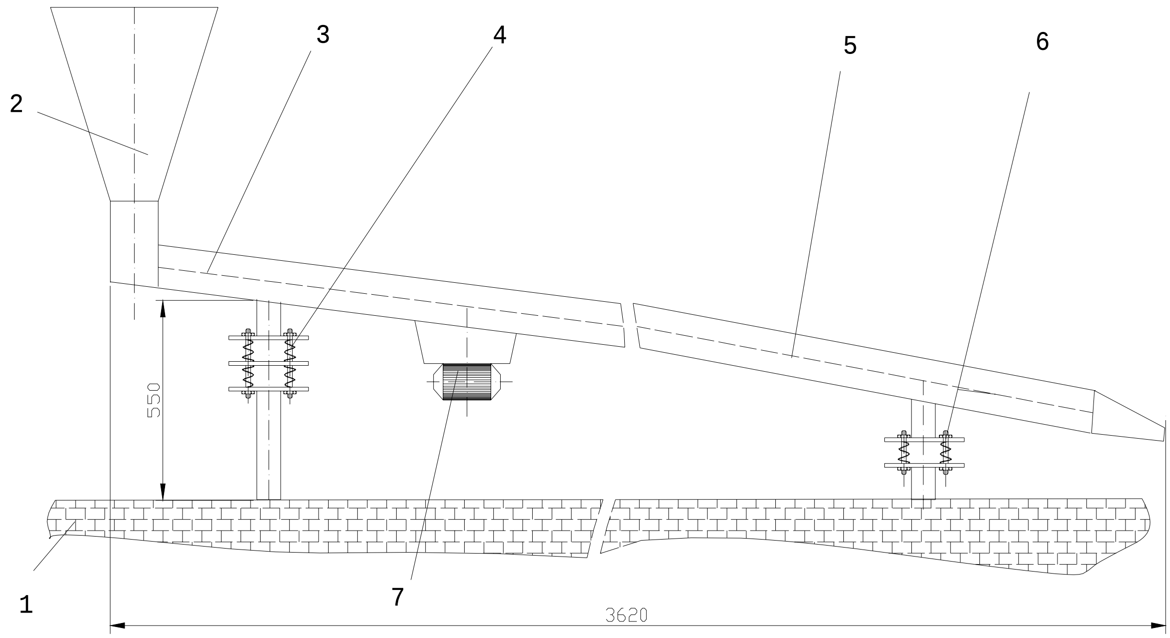

Figure 5 Experimental installation for addition of microcoolers in the tundish and crystallizer of the continuous cast installation
1- foundation, 2- bunker, 3- trough, 4, 6 - system of vibrato with spring, 5 - walls the troughs, 7 - devices of vibrato

The feeding of conveyer with microcoolers is done on at an end of superior with an prismatic pyramidal bunker, and the discharge is done on at an end opposed of discharge trough. Because this trough shall be placed the in zone crystallizer of continuous cast installation the temperature is precinct 1600^0C, and shall be protégée with refractory material. Motion is transmitted from the engine with vibrator (eccentric). In the downside bunker is equipped with a system of microcoolers dosage, having the role entered the in conveyer definite quantities of material.

In the sight optimum correlation of technological factors is required establishment of basic parameters for the casting process with microcoolers: determination of optimum amount of microcoolers and temperature of the steel.

For facilitation of calculus are used simplifier hypotheses: microcoolers is considered as is delivered uniform in mass of liquid steel and are spherical form, respective in the time of this introduction in crystallizer closes down the shift of heat between steel and this.

Duration of microcoolers melt time depends on next factors: casting steel temperature of the $T_{T,}$ liquid's temperature the steel $T_{L,}$ the average microcoolers size r, respectively the specific consumption of microcoolers m, kg/ton.

If are utilized next values for the thermo-physics property ale of the carbon steels: c = 690 J/kg^{o}C, c_{mr} = 836 J/kg^{o}C, L = 267776 J/kg si T_l = 1500^{o}C se are obtained the relation for steel temperature:

$$T = \frac{1000 \cdot T_t - 705 \cdot m}{m + 1000} \qquad (10)$$

where: T_t - casting temperature of steel, in ^{o}C;

m – specific consumption of microcoolers, in kg/t.

In other way, the specific consumption for decreasing the steel temperature from casting temperature to a temperature T, [3]:

$$m = \frac{1000 \cdot (T_t - T)}{T + 705} \quad (11)$$

3. CONCLUSIONS

Based on the problematic presented in this paper, is results the following conclusions:

- the installation that we designed and built-up can be used at any continuous casting machinery, resulting an constantly adding of thermoisolating and cowering powder or microcoolers in tundish or just microocolers in crystallizer;
- for addition of covering powders or microcoolers in tundish is necessary just one of this installation (the covering powders, in contact with the liquid steel is transformed in a liquid slag which covers all surface of the steel and in case of addition of microcoolers is adjust just temperature of the steel in the sense of decreasing of this);
- in the case of the addition of microcoolers in crystallizer, when is obtained a better structure of semifinished continuous cast product, is necessary five conveyer for each casting wire, what conduct to an agglomeration of equipment from platform;
- the investments in construction of this conveyers is retrieved in very short time, what does advantageous these utilization for optimization of the process in steel continuous casting

REFERENCES

[1] Ardelean E., Heputț T, Ardelean M., Socalici A., Abrudean C., Optimizarea proceselor la turnarea continuă a oțelului, Editura CERMI, Iaşi, 200pp, 2007.
[2] Ardelean E., Socalici A., Ardelean M., Cunțan C., Abrudean C., Popa E., Optimizarea regimului termic al otelului pe traseul cuptor-agregat de tratament termic secundar-instalație de turnare continuă, Program Excelență Grant AT 2005, nr.3194/13.10.2005.
[3] Socalici A., Ardelean E., Ardelean M., Pinca-Bretotean C., Abrudean C., Popa E., Cercetări şi experimentări privind îmbunătățirea structurii semifabricatelor turnate continuu, Program Excelență Grant AT 2005, nr.3196/13.10.2005.