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Experiment Study on Castex Process of AS Wire

Zhiyuan Shi[1], *Wanjun Wang*[1], *Jinglin Wen*[2], *Xinhua Wang*[1]

1) Metallurgy School, University of Science and Technology Beijing, Beijing 100083, China
2) School of Materials and Metallurgy, Northeastern University, Shenyang 110006, China
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Abstract: In order to optimize the Castex process of AS wire, the systematic experiments have been done for different process parameters with self-made DZJ-II 350 Castex machine. The parameters, such as casting temperature of aluminum, flow of cooling water, extrusion ratio and the gap between the surface of wheel and that of the mould, have been mainly studied. The results show that with the increase of casting temperature or rotating speed of wheel the measured length of liquid metal zone increases too. However, the length of liquid metal zone decreases with the increase of the flow of cooling water. Moreover, the relationship between the extrusion ratio and the extrusion power is studied.

Key words: Castex; AS wire; parameter; length of liquid metal zone

1 Introduction

The conventional extruding technologies mostly utilize the linear movement of chief cylinder in hydraulic pressure crock to push the metal in the extruding container to deform plastically. In order to realize continuous extrusion the technology of ingot after ingot extrusion (extrusion without remaining) was invented but not got widely application because of the unstable production quality for more metals and alloys.

In 1972 Conform was invented by Green [1]. In this technology a periodically rotating wheel with groove was utilized as the driving power instead of linear driving power to force the metal to go forward along the wheel groove and finally through the extrusion die to get product.

As further development of Conform, Castex is a latest technology of high efficiency, energy-saving and high productivity. It was firstly developed by langerweger [2] in 1984 and now it got wide application in the field of processing of non-ferrous metals. From Castex a new bonding technology of AS (aluminum-clad steel) wire has been developed, which is not only an important improvement of Castex but also a great contribution to the bonding technologies of bimetal.

But the insufficient research on Conform or Castex hindered their wider application, especially for the Castex of AS wire, up to now relevant reports were seldom found [3, 5, 6]. In this paper the systematic experiment was carried out with self-made DZJ-II 350 Castex machine to determine the optimal parameters of the process.

2 Experiment

The processing mechanism of AS wire by Castex is illustrated in reference 3.

2.1 Equipment and materials

The main equipment in the experiment is self-made Castex Machine (listed in **table 1**), which not only can produce figured products and wire of Al/Al-alloys, but also can produce bonding products of them. Table 1 is the description of Castex machine.

Table 1 The parameters of Castex machine

Item	Paramters
Type	DZJ-II 350
Wrap angle	90°
Width of groove	10 mm
Depth of groove	10 mm
Rotating speed	5–15 r/min
Driving power	30 kW

The ancillary equipment include: two heating furnaces (60 kW and 20 kW), one speed-control coil (diameter: 400 mm) and accessory kinetic devices (60 kW).

The materials used in this experiment are commercially pure aluminum and annealed steel wire with the diameter of 5.9 mm.

2.2 The Procedure of Experiment

The procedure of experiment is as follows:

(1) Prepare for the experiment, such as the pretreatment of steel wire and the heating of aluminum stock;

(2) Preheat the shoe and mould for the experiment;

(3) Adjust the gap between shoe and mould with leading screw;

(4) Put steel wire pretreated in advance through the mould to the coil;

(5) Measure the temperature of aluminum melt and keep continuous and stable casting;

(6) Control the coiling speed to ensure consistency throughout the whole line.

2.3 Results and analysis

Through systemic experiments the distribution of each parameter to the whole process was got and described as follows respectively:

(1) Casting temperature t_j.

The casting temperature t_j has considerable influence on the process. If t_j is too high, the lack of adequate cooling will make the length of liquid metal zone too long to form the necessary three extruding zones besides the leaking of metal, then the needed extrusion pressure can not be set up for accomplishing Catex process. However, if t_j is too low, the metal will not flow fluently and the driving power increases, which will in turn make insufficient stock feeding and influence the continuity of the process. So the reasonable t_j is very important to the experiment.

The influence of t_j on the length of liquid metal zone is shown in **figure 1** (here the length of liquid metal zone refers to the distance between the filling inlet and the point where the molten metal doesn't solidify completely, the flow of cooling water is Q_w=20 L/min). From figure 1 it can be seen that when the other parameters keep constant, the higher the t_j is, the longer the length is. t_j is recommened in the range of 760–800 ℃.

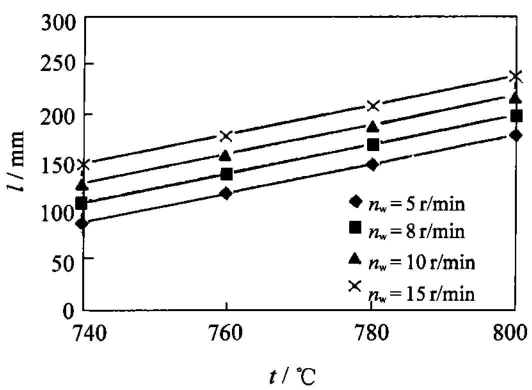

Figure 1 Influence of t_j on the length of liquid metal zone (l).

(2) The rotating speed of wheel n_w.

The faster the speed of wheel, the larger the metal deforms to create more deformation heat and friction heat, making the temperature of machine higher than that of ordinary state. Moreover, the ascending of temperature increases the driving power of the whole system and lengthens the length of liquid metal affecting the stable running of Castex machine. The influence of wheel speed n_w on the process is shown in **figure 2**, from which it can be seen that the applicable rotating speed of wheel is in the range of 8–15 r/min, and the optimal value is about 10–12 r/min.

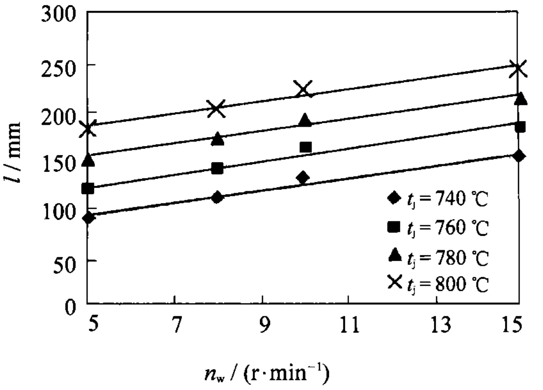

Figure 2 Influence of n_w on the length of liquid metal zone(l).

(3) Flow of cooling water Q_w.

In this experiment the circulating cooling is used with the flow of 10, 20 and 30 L/min respectively. From the experiment results while increasing the flow of cooling water the length of liquid metal zone decreases and the extrusion power goes up. However, contrasted with the casting temperature of aluminum t_j and the rotating speed of wheel n_w, the influence of the flow of cooling water to the length of liquid metal zone is unremarkable. But the temperature of cooling water is not mentioned in the experiment. The influence of the flow of cooling water on the length of liquid metal zone is shown in **figure 3**. The optimal value of Q_w is 20 L/min.

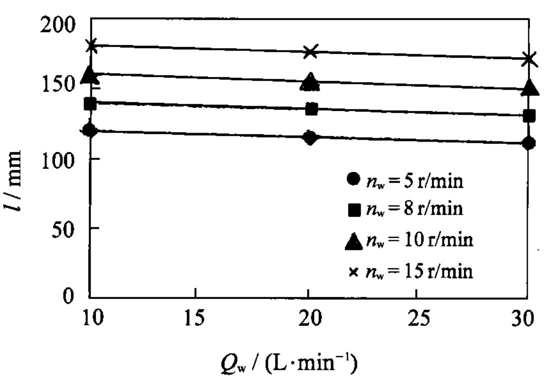

Figure 3 Influence of Q_w on the length of liquid metal zone (l).

(4) Extrusion ratio *f*.

With the constant extrusion speed the larger the extrusion ratio, the more deformation heat metal generates. In this experiment the tried diameters of AS wire is 8, 9, 10 mm, so the extrusion ratio is 1.56, 2.83 and 4.54. With these values the Castex process proceeds fluently. However, when working with larger f the extrusion power of Castex machine goes up remarkably. **Figure 4** is the relationship between the extrusion ratio and the extrusion power. Generally, the extrusion ratio 2.83 is most appreciated.

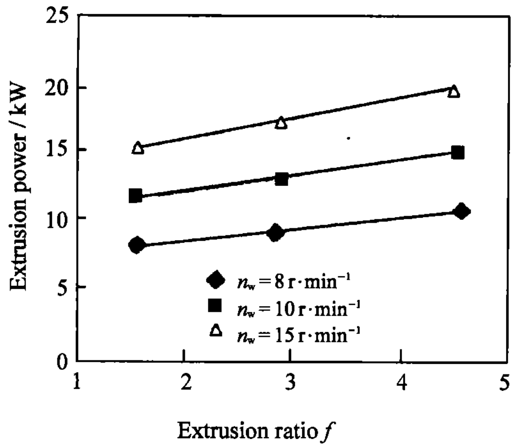

Figure 4 Relationship between the extrusion ratio and the extrusion power.

(5) Fit clearance between the wheel surface and the sealing blocks (or mould).

Through experiments the influence of fit clearance on the running of Castex machine was got (listed in **table 2**).

Table 2 The influence of fit clearance to the Castex process

Fit clearance	Working state
Too large (>0.1 mm)	Frictional force and leaking increase, and the driving power goes up.
Too small (< 0.05 mm)	The mould got badly worn, which results in unstable running of Castex machine.
Process reasonable (0.01–0.1 mm)	There is a thin layer of aluminum-film between the surface of the sealing blocks (or the mould) and that of the wheel, Castex proceeds fluently.

In this experiment the steel wire should be preheated prior to bonding with aluminum to promoting the bonding. To expedite the progress of experiment the recommended preheating temperature value of reference [4] was adopted, the value is about 350 ℃. From the practical use it is found that this value is reasonable.

3 Conclusions

(1) Through enormous experiments a set of optimal process parameters which can be referred to in practical application are got as follows:

Casting temperature t_j: 760–780 ℃;

Rotating speed of wheel n_w: 10 r/min;

Flow of cooling water Q_w: 20 L/min;

Extrusion ratio f: 2.83;

Fit clearance: 0.01–0.05 mm;

Preheating temperature of steel wire: 350 ℃.

(2) Among all parameters the casting temperature contributes most to the length of liquid metal zone. So the casting temperature must be controlled in a proper range to ensure the accomplishment of the process.

(3) The temperature of cooling water not mentioned in the experiment may also be a key affecting factor to the process, which is to be studied in later work.

References

[1] F. Cao, J. Wen, T. Li, X. Meng: *Journal of Northeastern University* (in Chinese), 15 (1994), No. 4, p. 368.

[2] J. Wen, Z. Zhou, T. Li: *Journal of Northeastern University* (in Chinese), 13 (1992), No. 5, p. 438.

[3] Z. Shi, W. Wang, Z. Kan, et al.: *J. of Univ. of Sci. and Tech. Beijing*, 6 (1999), No. 4, p. 262.

[4] L. Xiao: *Wire Industry* (in Chinese), 61 (1994), No. 9, p. 639.

[5] B. awcao: *The Analysis on the Process of Metal Forming*, Translated by X. Wang. Beijing: National defence industrial press, 1988 (3), p. 123.

[6] C Etherington: *Wire Industry*, 44 (1977), No. 2, p. 85.