Mould lead (mould oscillation)

Question

I have seen the term "Mold Lead" used in several technical articles about billet casting recently. Would you please provide a concise definition of "Mold Lead". How can steelmaking technologists calculate this factor and what are the optimum values in the production of oil-cast and powder-cast billets ?

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Answer

In the sinusoidal mode of oscillation with “negative strip”, which is the most widely applied today, the average speed of the mould, during its downwards movement, is larger than the casting speed. The mould therefore travels a little longer in the casting direction compared to the strand. The difference between the distances covered by the mould and by the strand is called “mould lead”.

The name “mould lead” can actually refer to two slightly distinct concepts:

1. The distance that the mould travels past the strand during the negative strip time. This definition focuses on the most important part of the oscillation, where the mould can actually exert a compression force on the billet shell. This distance corresponds to the difference between the y-values of the points A and B in the chart. Calculating it is rather complicated:

The distance covered by the mould during t_N is $Y = H \sin [\pi f (T - t_N)]$, where $T = 1/f$ is the oscillation period (f is measured in 1/s here).

The mould lead is then

$$ML = H \sin [\pi f (T - t_N)] - t_N \times V_c,$$

where $t_N = (1/ \pi f) \arccos [V_c/(\pi fH)]$ is the negative strip time

for the curve shown in the figure, the value of ML is 3.5 mm

2. The distance that the mould travels past the billet during the entire downwards movement (the duration of the downwards

movement is clearly longer than t_N, but the average speed of the mould is lower than in the previous case). In this case the lead is:

$$ML = H - Vc / (2 f)$$

For the same curve mentioned, the lead calculated in this way is 2.3 mm. This factor is clearly much simpler to calculate and is used in the practice, even if it does not give exactly the same information.

The mould lead is clearly a measure of the "healing" effect of mould oscillation, and as the same time it gives an indication of the friction between mould and billet. Higher friction corresponds to large mould lead. Therefore, the mould lead should be more than zero, but "not too long".

Various attempts have been done in the past to correlate the value mould lead (either one or the other expression of it) with "good" oscillation and even with the depth of the oscillation marks. These attempts do not seem to have brought a better understanding of oscillation.

Most likely, this is due to the fact that the mould lead does not really tell us more than the more widely used parameter "negative strip percent":

$$NS\ \% = 1 - Vm / Vc$$

Where Vm = 2 x H x f is the average velocity of the mould during oscillation. It is clear that the same basic parameters contribute to determine both NS% and the mould lead.

In practice then, for a sinusoidal oscillation, I would not worry much about the value of the mould lead and concentrate on the traditional recommendations (which always constitute a good starting point):

NS % = -30 / -35 % ,   NST = 0.08 - 0.12 s

The diffusion of hydraulic oscillators that are able to operate with various non-sinusoidal modes could eventually change our present understanding of the most important oscillation parameters, and some "forgotten" definitions maybe will come to new life.

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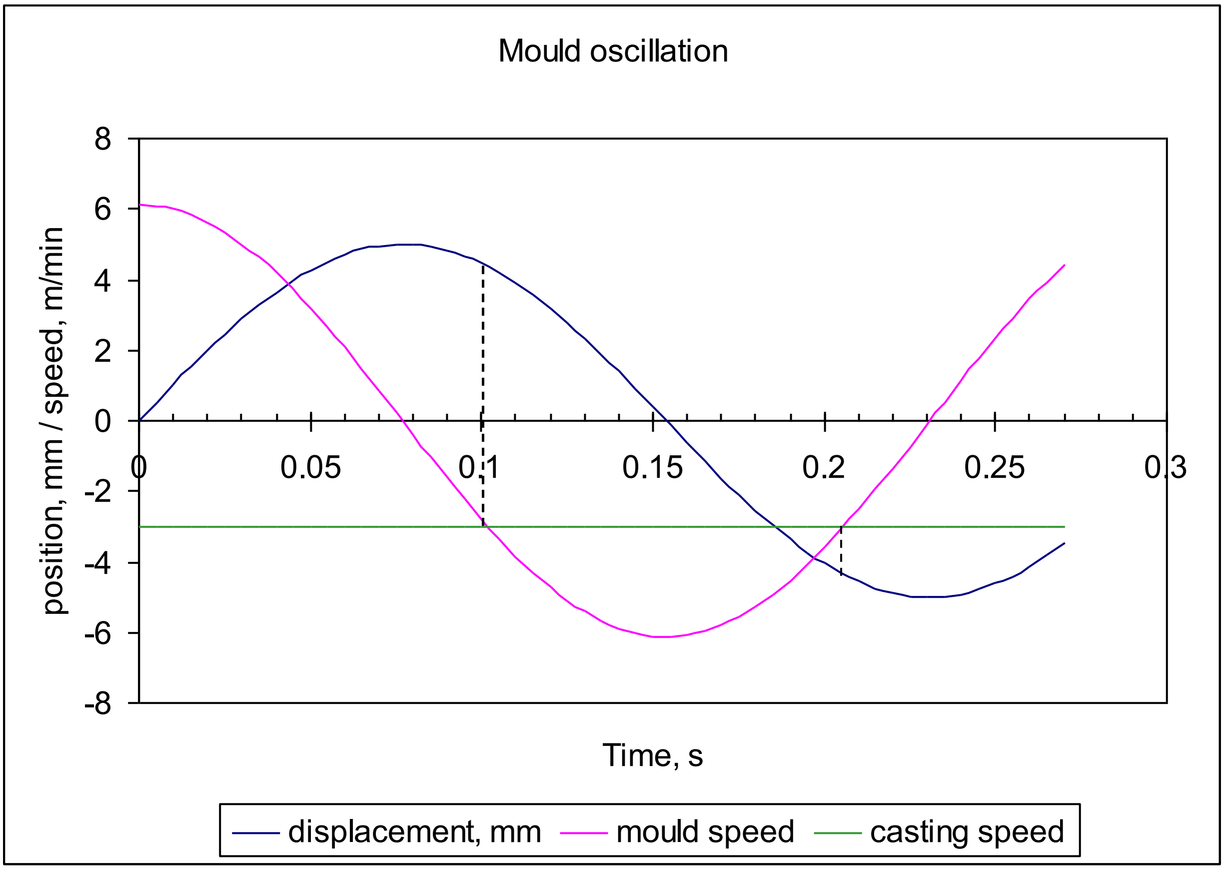
Figure

The chart represents the position of the mould, the instantaneous speed of the mould and casting speed for an example of sinusoidal oscillation with:

Stroke = 10 mm
Casting speed = 3 m/min
Negative strip time = 0.104 s

(This is only a typical representation of high frequency oscillation, the relevant parameters should not be taken as a suggestion for any particular caster)



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