

Tundish Mixing Model

Question

Our order book has shown a great deal of variability lately. We like to run our billet caster tundish for 24 hours or longer before changing. Due to the constantly changing grade situation we are suffering from a great deal of scrap due to intermixed chemistries in the tundish. Is there some way we can predict and reduce the amount of intermixed scrap? R.H., USA

Answer

Over the years there have been numerous studies into the intermix phenomena. The studies have involved the use of water models, computer models, tracer studies in the continuous caster tundish and various forms of chemical analysis. Various studies have found that once started, the mixing in the tundish tends to cause an exponential decrease or increase in the elemental concentration, α . As an example, Figure 1 shows a decrease in elemental concentration, from α_1 to α_2 . During the period, t_1 to t_2 the liquid steel in the tundish is between the lower specification limit (α_{LSL}) and the upper specification limit (α_{USL}) so this is the time when intermixed scrap is produced.

An analytical mathematical model based on ideal mixing is the place to start but some factors will need to be added to the to account for non-ideal flow patterns. In an excellent study, M.L. Lowry and Y. Sahai found out that the temperature difference between the metal coming in from the newly opened ladle and the metal in the tundish can lead to a segregated flow pattern.¹ This will delay the start of mixing at the strand(s).

You can create a first order differential equation mixing model on a PC using a spreadsheet program. Based on data obtained from the caster and chemistry tests, factors could be added to the program to account for non-ideal mixing behavior. In dummy runs, the computer model will tell you to reduce the tundish level as far as possible prior to opening the new ladle to reduce the amount of intermixing. Makes sense but on the other hand, some slag entrainment may occur due to vortexing.

The differential mixing model can be used by the operators to predict the weight and location of the intermix scrap. Ideally, the intermixed scrap would be contained in one billet or slab on each operating strand.

Reference:

1. M.L. Lowry and Y. Sahai, "Thermal Effects on the Flow of Liquid Steel in Continuous Caster Tundishes," *ISS Transactions*, ISS, Vol. 19, No. 3, 1992, pp. 81-86.

QUESTION 5.

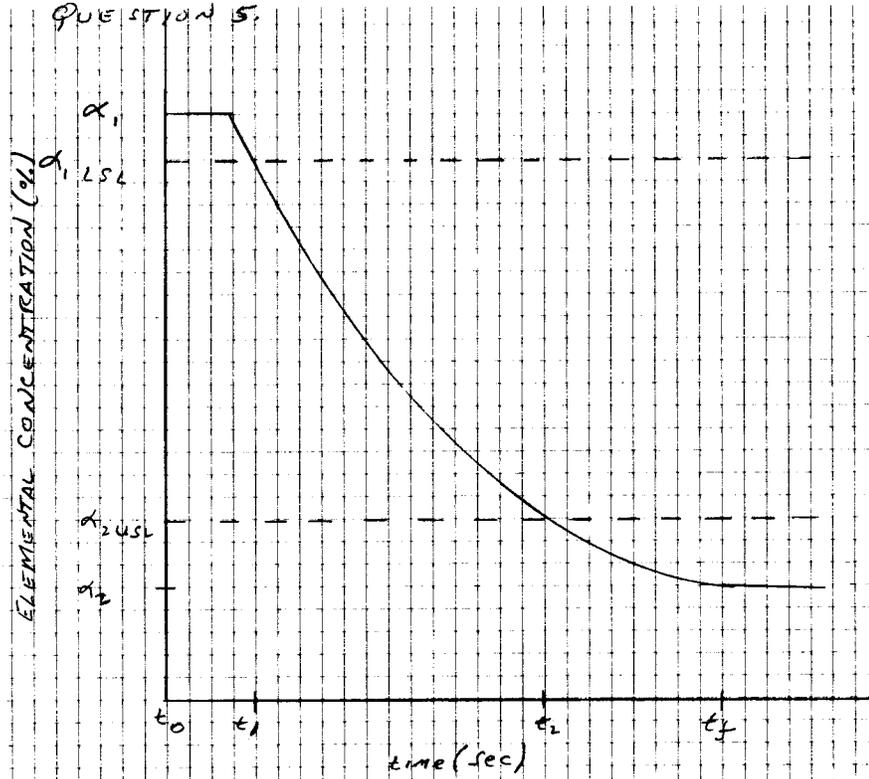


FIGURE 1. TUNDISH MIXING MODEL