May 2020

Device to Attenuate the Oscillation in a Radar Signal for Measuring Liquid Metal Level in Restricted Openings

Jonathan Quisenberry

John Robert Buster McCallum

Device to Attenuate the Oscillation in a Radar Signal for Measuring Liquid Metal Level in Restricted Openings

The measurement of molten metal levels may prove difficult, particularly in small spaces, such as clad chambers. While lasers are an option for measuring molten metal levels, they may be unreliable. Radar measurement is an alternative, although in confined spaces, proves subject to interference and unreliability due to oscillations. For example, as shown in Figure 1 below, measurements in a 40 mm clad channel proved to deviate from expected control tests. The pink line indicates the signal from the radar overlayed with the true value, indicated in orange. As can be seen, at the measured distances, oscillations can give inaccurate data as to the molten metal level.

Figure 1

Described is an invention to attenuate radar signal for measuring liquid metal levels in restricted openings. The invention may utilize channels or guides, such as fake walls, that allow a radar measurement device to receive an accurate signal. As the channels extend further, such as past 115 mm, the walls may remove the oscillation of the radar signal, providing for an accurate measurement of molten metal levels. Radar measurements can operate at a sweet spot, such as at 115 mm, by the new operational height obtained using the channels or guides. The graph below shows a range of distances that the radar is able to obtain accurate signals before oscillations begin affecting measurements. The experiment of Figure 1 shows a radar measuring water level as a control. The attenuated signal is observed at distances above about 90 mm and as the distance between the water level and the radar becomes shorter, more oscillations are observed.

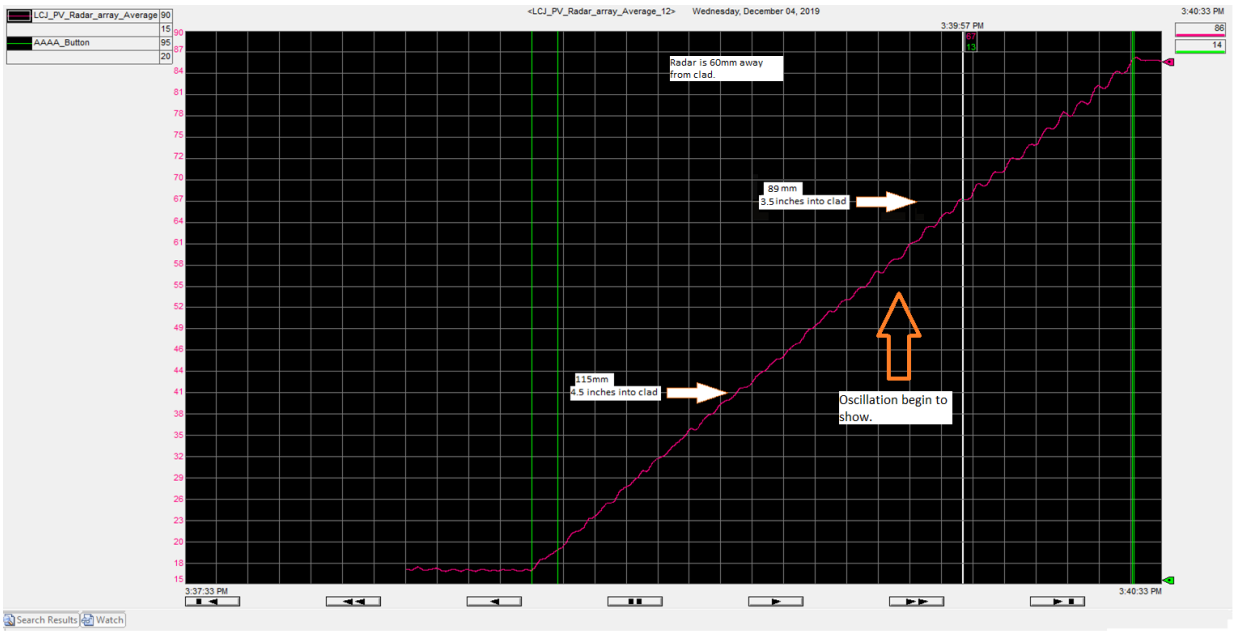
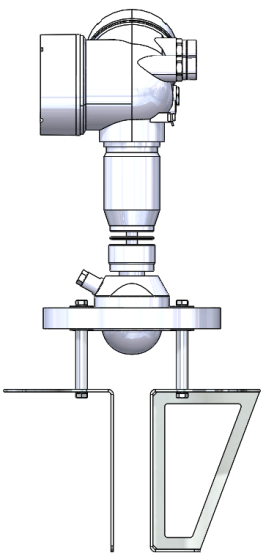
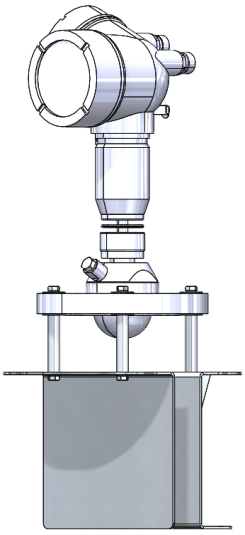


Figure 2

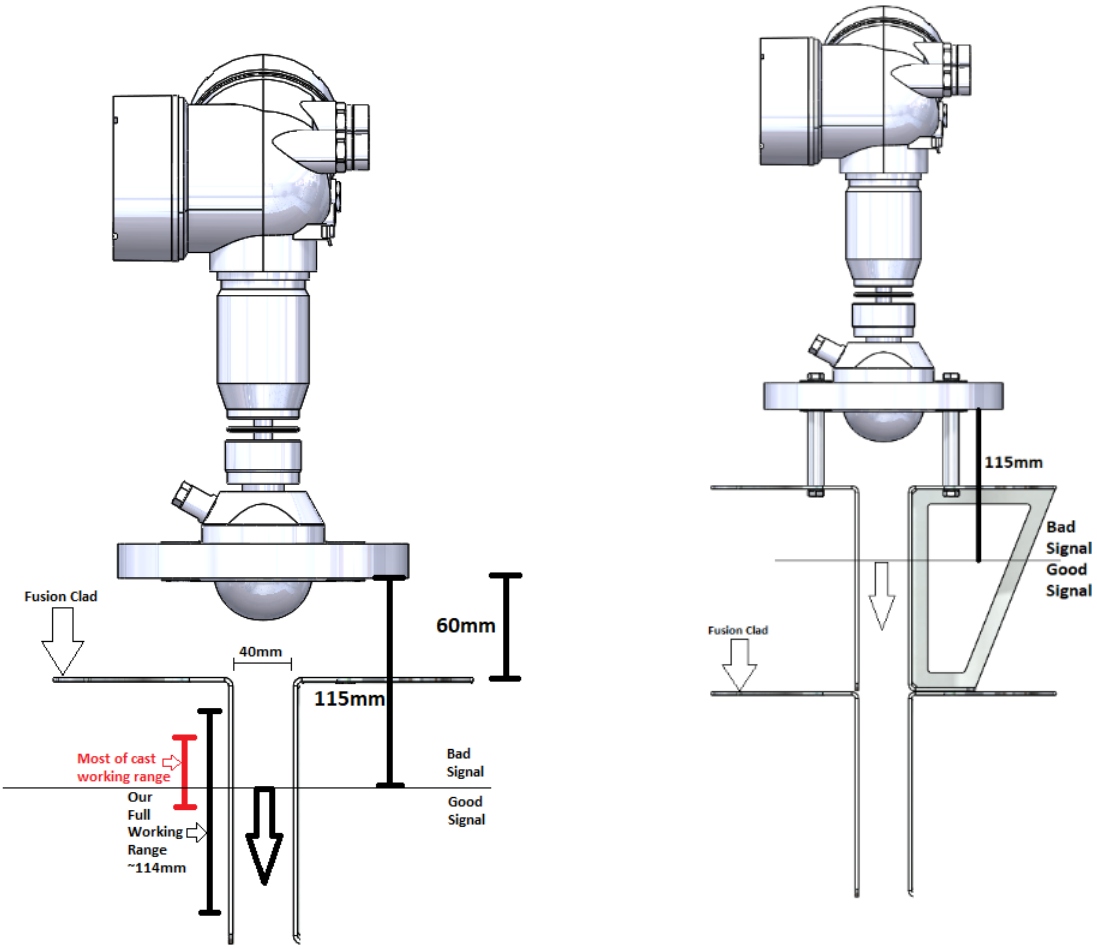
An example of such an apparatus to help attenuate radar signals is shown below. The apparatus may use the shown channels to achieve a sweetspot distance from the clad, allowing the radar to attenuate said oscillations observed as shown in Figure 1. The radar may be perched above said apparatus by a fastening mechanism, such as screws and rods, or nuts or any possible fastener. The apparatus can be mounted atop the clad, extending upwards, or be mounted from the radar and hung down to achieve the operational height desired. In some examples, the supporting apparatus may be suspended above the clad channel, with the radar mounted atop; in such an example, the apparatus would not be in contact with the clad.





As shown, the channel formed by the apparatus can extend a radar distance over the opening for a metal casting chamber, mold, or any receiver for molten metal. Moreover, the

apparatus can increase the operational and measuring height of the radar over the molten metal, such that the radar is at an optimal measuring height to attenuate received signals, while still accommodating for the small opening observed in a clad channel. The apparatus can be used to aid in the measurement of molten metal level in other confined spaces beyond just a clad opening. As shown in the below comparison, the radar cutoff range gets drastically elevated above the clad removing oscillations from later-stage casting.



Providing an accurate measurement system for clad metal levels may mitigate cast abort due to clad level issues. The improved measurements provide reduced material loss. The apparatus, by way of providing a mount for the measurement system, may also progress casting processes, such as a fusion casting process, towards a hands-free process.

Different arrangements of the components described above, as well as components not shown and described, are possible.