Modelling deposit growth in metal spray-forming

Spray-forming is a metal manufacturing process which is capable of producing large bulk deposits of various metal alloys. With careful control, rapidly solidified near-net shape deposits can be produced which have significantly improved microstructural and mechanical properties.

In the billet spray-forming process a molten metal stream is first atomised by high speed gas jets and is then deposited onto a circular collector plate. The collector plate is positioned some distance from the atomiser, it rotates about a vertical axis and is withdrawn slowly downwards at a controlled speed. Usually, the metal spray is directed in towards the rotational axis and oscillates, so as to distribute the metal in a prescribed way. , see Figure 1.

Provided that the oscillatory motion of the spray and the rotation of the billet do not synchronise, and if the process is well controlled, a fairly uniform cylindrically shaped *billet* results, i.e. after a sufficiently long time. Figure 2 shows a steel billet, to be used for tool fabrication.

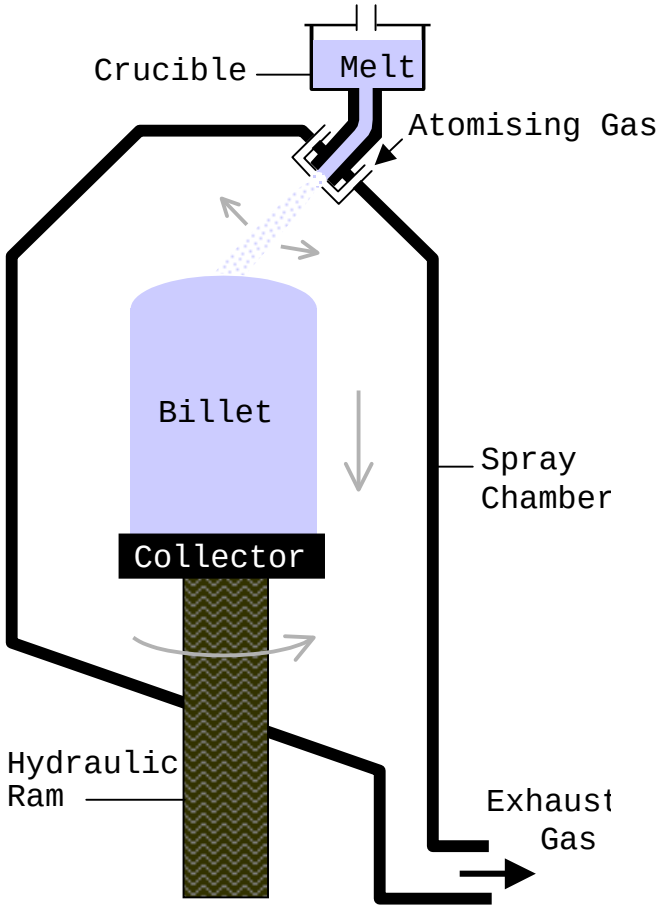

Figure 1: Schematic of a billet spray-forming rig

Figure 2: Tool steel billet, after leaving the chamber.

During the process, it is difficult to visualize the surface of the billet inside the spray chamber, especially at the start of the process, (since clouds of gas and spray can often obscure vision). Sometimes things can go seriously wrong and peculiar shapes arise.

It is not obvious how the billet will grow. The collector plate is flat with no “sides”, unlike a typical metal casting mold. Ideally we would like to control the shape of the billet, for example its radius and perhaps the shape of the billet top.

Figure 3: oops!

Figure 4: At the start of growth

For all the reasons mentioned, it is of interest to have a mathematical model of billet growth, capable of predicting dynamic features.

The main objective for of the modeling week will be to derive such a model.

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I. Frigaard,
UBC Mathematics
frigaard@math.ubc.ca