Preventing cracking of OCR8W ledeburitic tool steel during hot deformation

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Abstract

Hot rolling can achieve much higher productivity compared to hot forging and therefore hot rolling of tool steels is also considered the preferred hot bulk forming process. However, special attention should be paid to the occurrence of cracks in this hot forming process, which can be a limitation for industrial use. In this paper, an approach to prevent the occurrence of internal and surface cracks during the hot forming of OCR8W ledeburitic tool steel from ingot to hot rolled profile was developed. The first step to improve hot workability during deformation is to avoid cracks in the centre of the ingot during radial hot forging of the ingot, which was achieved by establishing suitable casting and forging conditions. The second step was to improve the intrinsic hot workability of the tool steel used, which was achieved by determining a suitable soaking temperature for as-cast and semi-wrouht states. For this purpose, a specially developed hot compression test procedure on the Gleeble 1500D thermomechanical simulator was used to determine the optimum soaking conditions. This extended the temperature range for safe hot working, i.e. at both the lower (850°C) and upper (1150°C) limits of the temperature range, and improved the intrinsic hot workability of the tool steel under investigation. This was confirmed by additional hot compression tests carried out in the temperature range of 850 - 1150°C and in the strain rate range of 0.001-10s-1, obtaining flow curves that were mathematically described by an appropriate model. These results were used in the FEM simulation of hot rolling, which was the third step in preventing cracking. This step referred to increasing the compressive stress state in the workpiece during hot rolling, which resulted in complete elimination of billet cracks. Thus, FEM was used to determine the optimal shape of the calibres, which made it possible to achieve sufficiently high compressive stresses at critical points of the rolled workpiece, resulting in the elimination of surface cracks.