The International Students Olympiad in Hot Bulk Forging Technologies 2017

1. Starting situation

* Designing of an optimized forging process for a given component
* The component is shown in Fig.1

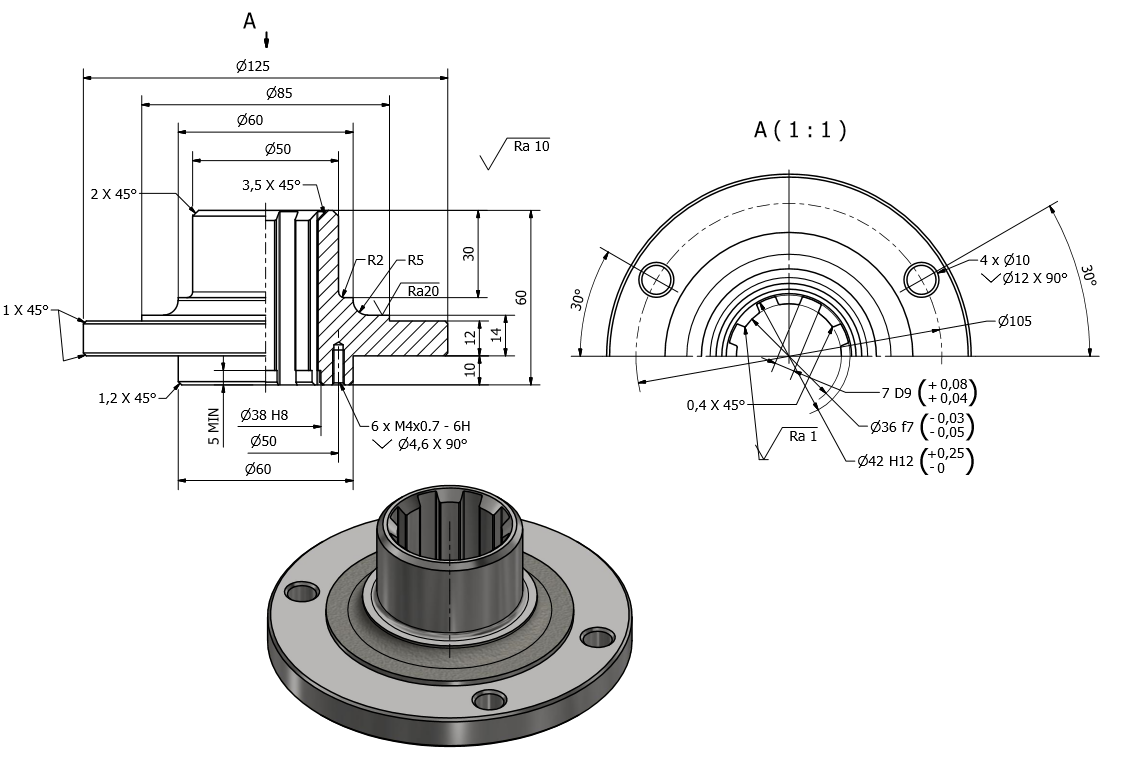


Fig. 1 Component

1. Design of the forging

- An offset is necessary for the final milling process, with attention of clamping surfaces

▪ Offset all round = 2 mm

- For an accurate forging process the draughts have to be big enough

o Outer draught is needed to get the forging out of the dies

▪ Outer draught = 3°

o Inner draught needed to prevent that the forging shrinks on the cone

▪ Inner draught = 6°

- calculation of the thickness of the flash gap

o Mass of needed material and filling process of the dies are influenced by thickness of flash gap

▪ Thickness of flash gap was calculated after VIEREGGE = 2 mm

o Filling process is also influenced by relation between thickness and width of the flash

▪ Calculation of width after VIEREGGE = 5 mm

o Perfect relation leads to a decrease of the press force and less needed material, this leads to a longer lifetime of the dies

- Position of flash generates an influence on the filling process and grain flow (fibers), in this way mechanical properties of the forging increase

- Fig. 2 shows the finish part and the forging

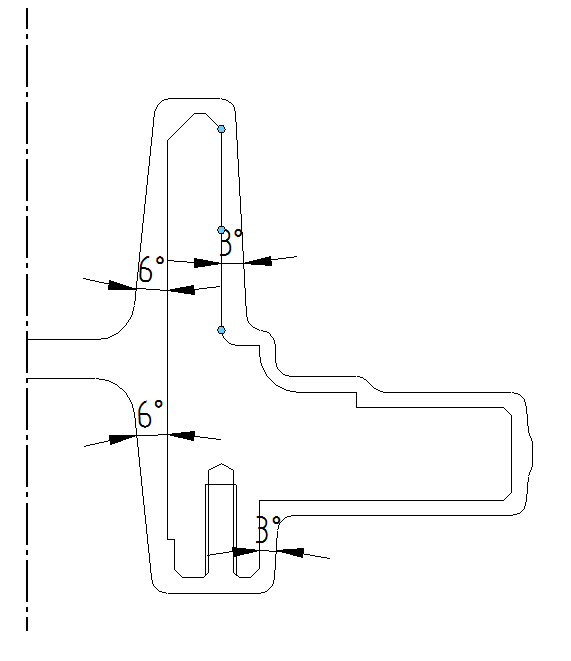


Fig. 2 Finish part and forging

1. Calculation of needed material and single forming steps

- needed material = mass of finished product + offset + flash grap

▪ Needed material = 2,5 kg

▪ Billet 70 x 83 mm (common diameter, so good available)

▪ Dimension of the billet also suitable for induction heating process

- With decreasing the billet mass, the forging process gets more efficient and the lifetime of the dies is increasing

- Attention! Less material can lead to filling faults because exact position of the billet can deviate

- If there is no ejector pin allowed inside the dies, the width of the flash must be big enough for outside ejector pins

- Best combination of single forming steps :

o Bulging to remove cinder (Fig. 3)

o Preform (Fig.4)

o Final form (Fig.5)

- Bulging to remove cinder because it can lead to mistakes on forging surface and it increases wear of the dies

▪ Bulging between two plane plates --> distance 73 mm

- Preform is nearly shaped to final form, so it's possible to reduce flow distance while filling and also decrease press force in final die

▪ Preform was constructed so that the material would be locked inside --> the height of the lower die depends on the stroke length of the injector pins to enable good handling during the process

- Due to the good preform the wear of the final form dies is reduced, so it's possible to produce a high amount of forgings

▪ final form = shape of forging

▪ after piercing, cutting the flash and milling the grain flow is still optimized because of the designed final form

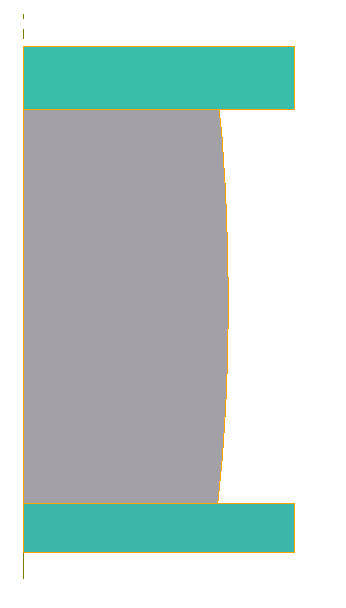


Fig. 3 Bulging

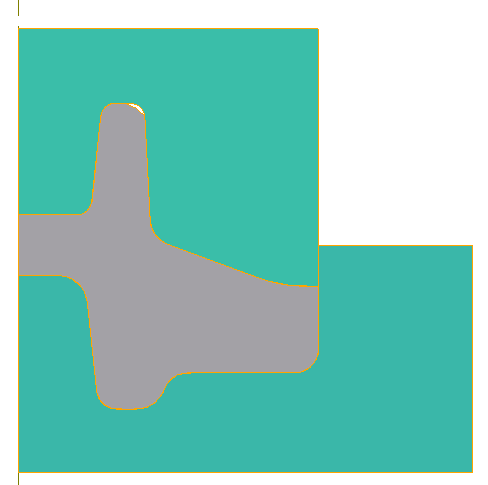


Fig. 4 Preform

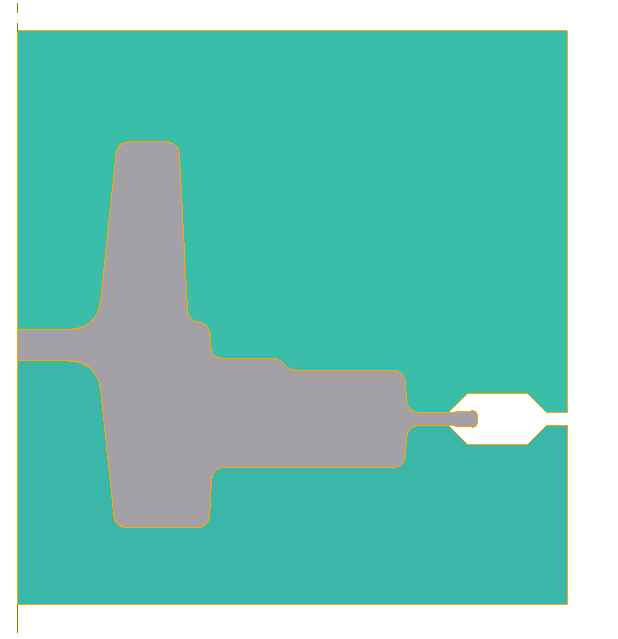


Fig. 5 Final form

4) Choosen process parameters

- Hyd. Press : due to low speed of the press it's not optimal, but in the opposite to the hammer it has injector pins and this leads to better handling

- another positive aspect is a good ability to semi and full automation

- Lubricant: graphit + water

- Temperature: 1250 °C (lower temperatures lead to high press forces)

- Tools : 5140 HRC39

- Billet : C45

5) Results

* A complete and accurate filling process is given through the calculated forming steps
* temperature profile shows the problem of slow press speed --> the flash gap shows relative low temperatures

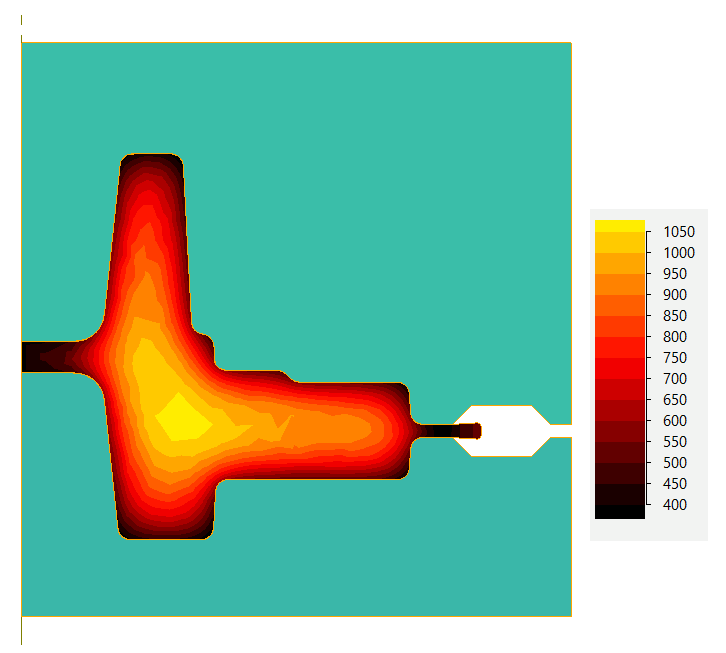
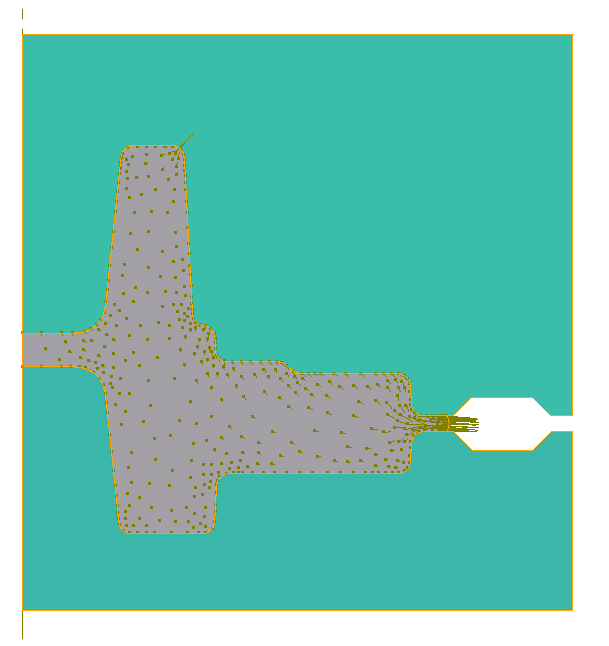
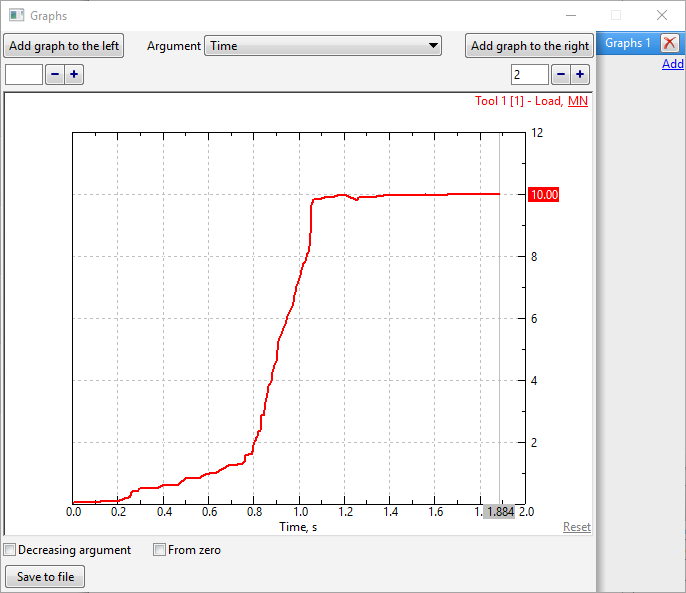


Fig. 6 temperature profile of the forging

- detailed observation of filling process shows no critical spots --> as critical count spots where the material flow from to sites and this can lead to folds



*Fig. 7 Flow vectors*



*Fig 8 Press force in final form*