Current Development in Cold Forging in Brazil

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Abstract

Despite the development of Brazil in general in the recent years, the growth of the cold forging industry didn't follow the speed of development of the country. The amount of hot and cold forged parts and fasteners increased below the national average and below the growth of the automotive industry.

The main reasons for this are:

- The difficulties in importing equipment;
- The costs of raw-material which may be in some cases twice the world marked price even;
- The cost of the state-apparatus.

Regardless of the current difficulties, the cold forging industry in Brazil is starting to use the latest technology in the area and the results show that we can increase a lot in the next years to expand the industry into the national market of automotive vehicles, in order to compete equally with the rest of the world.

This paper shows various processes in cold forging industry. The usual procedures and alternative procedures are emphasized, like Multiple Stages Process and Single Stage Process, detailing the differences between them and the advantages of a Single Stage Processes.

Keywords: Steel, Cold Forging, "closing tool"

1 Introduction

Today Brazil produces:

- 50 % of the steel in Latin America;
- 20 % of the world-wide iron ore;
- 2.9 % of the world-wide steel production.

Brazil is the sixth biggest producer of automotive vehicles and the fourth biggest market for automotive vehicles.

Since the 1990ies, we manufacture pieces with a certain level of difficulty like:

- Universal Joint Crosses;
- Inner Races;
- Gears,
  and others

Today, we work at semi hot temperatures between 400 – 600 °C as well to replace annealing and phosphate.
We also use tools with DLC coating.
In addition the use of “closing tools” is common to reduce operation steps.
Another aspect is to use the relation between strain rate and work hardening in the process design.

2 Single Stage Processes

In Cold Forging there are mainly two philosophies:

1. To use fast and more expensive machines with multi stages;
2. To use simple and inexpensive machines with more complex tools. The development takes into account only the load required in a die, without the complex setup in multi station machines.

Example 1: Shock Absorber Screw

- Multiple Stages Process - These pieces were produced by Multiple Stages Process using multiple tools in the stations.

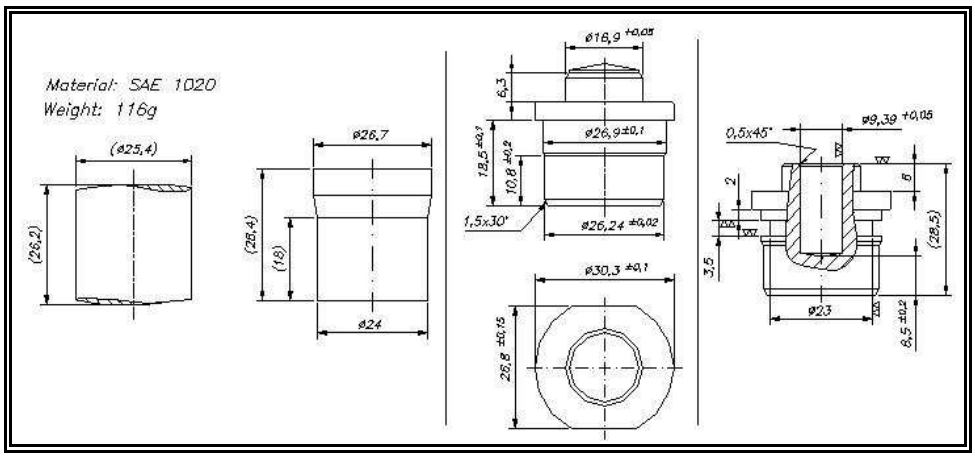

Fig. 1. Multiple Stages Process

- Single Stage Process - The alternative is using Single Stage Process. In this procedure less material is used and the machining is easier, because the collar can be made by forging and not with drills.

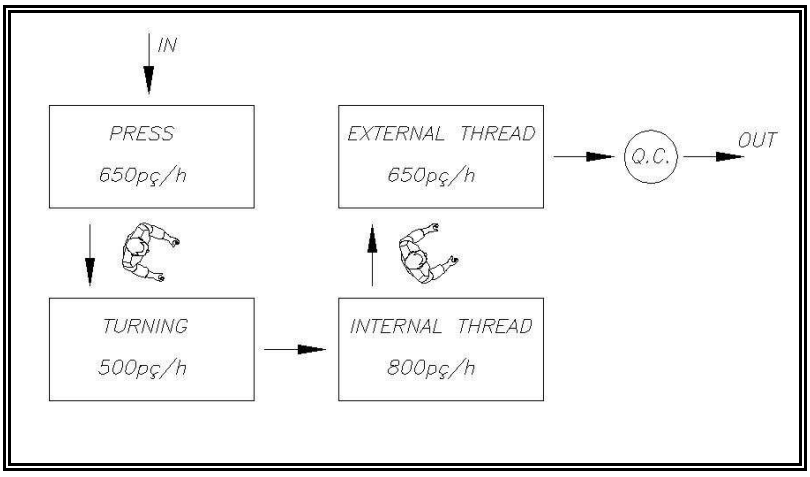

Fig. 2. Production with Single Stage Process

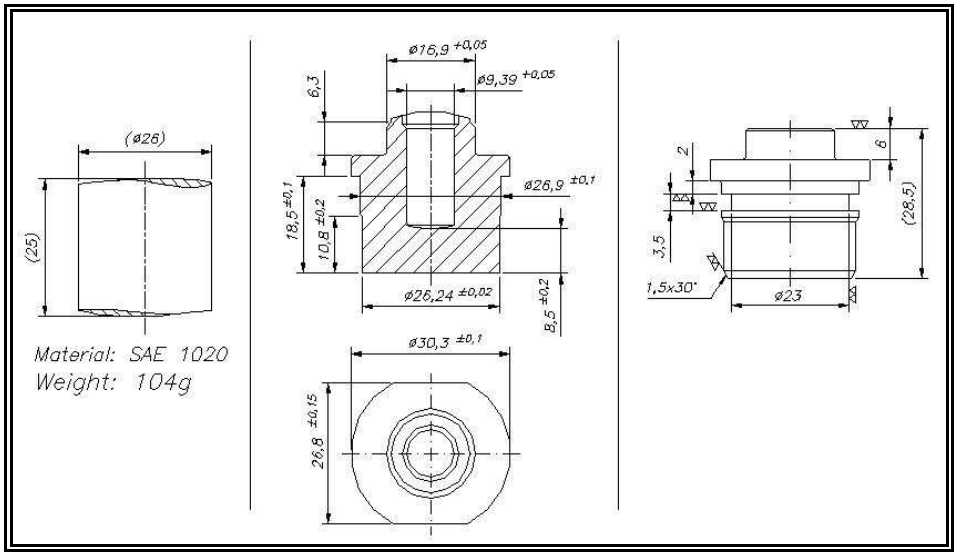

Fig. 3. Single Stage Process design

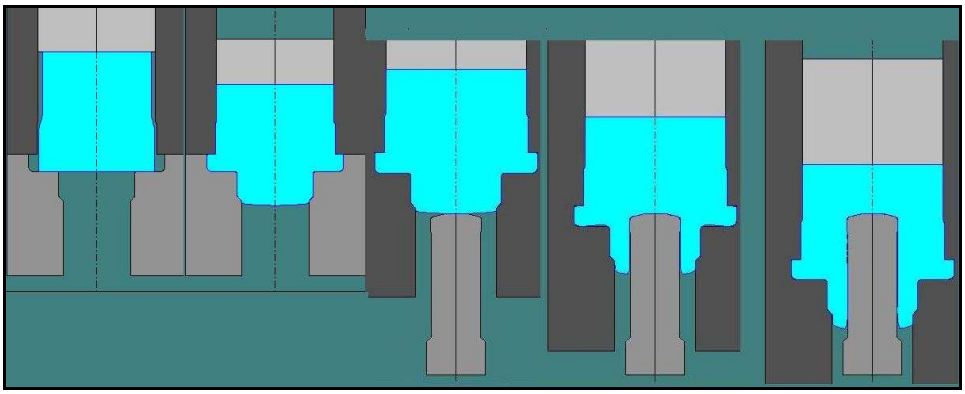

Fig. 4. Simulation shows the tool in operation [6]

Example 2: Brake Piston

- Multiple Stages Process - These pieces are usually produced in backward extrusion.

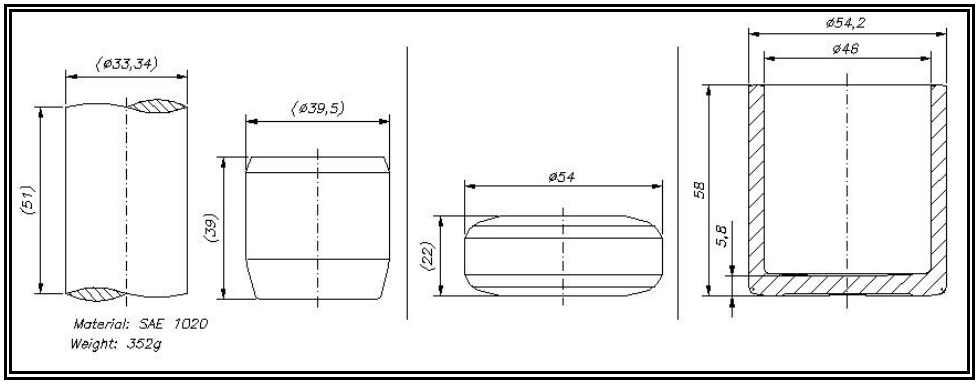

Fig. 5. Multiple Stages Process

- Single Stage Process

- The "OSEN" process, developed and patented at Stuttgart University "IFU" Institut für Umformtechnik [4].

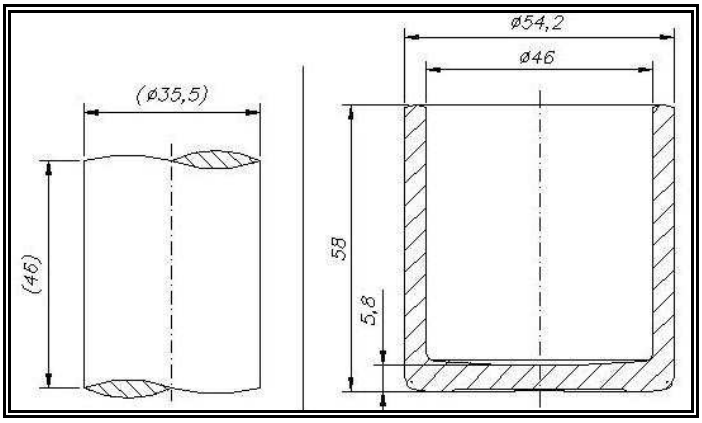

Fig. 6. "OSEN" Process design

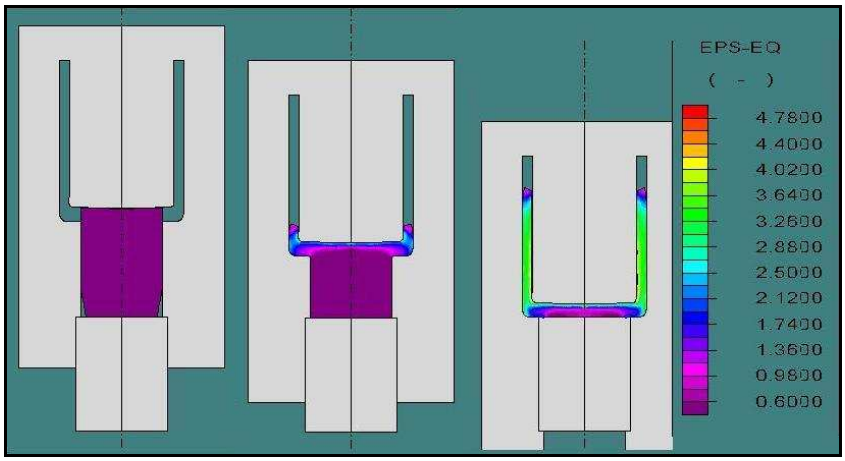

Fig. 7. "OSEN" Process simulation [6]

- Upsetting and extrusion in the same operation.

In the usual process upsetting and extrusion are made in two stages, but now they can be made in a Single Stage Process.

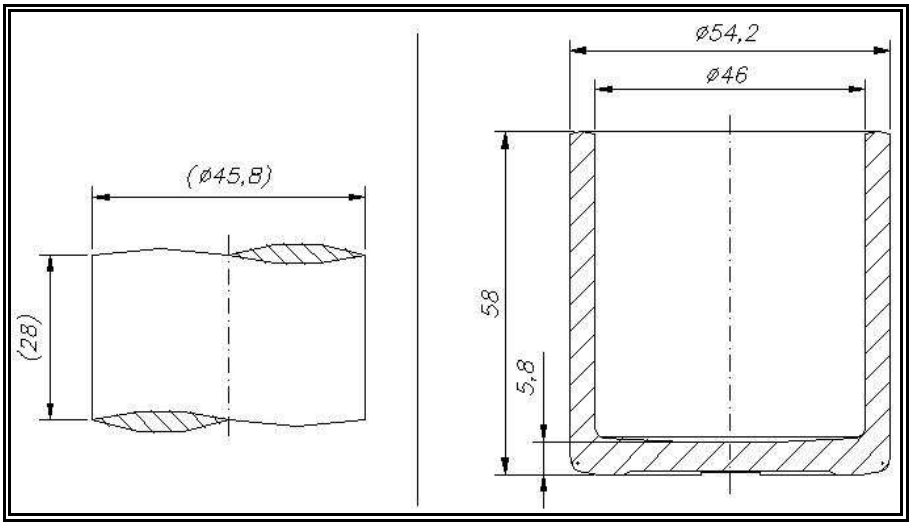

Fig. 8. Backward Extrusion Process design

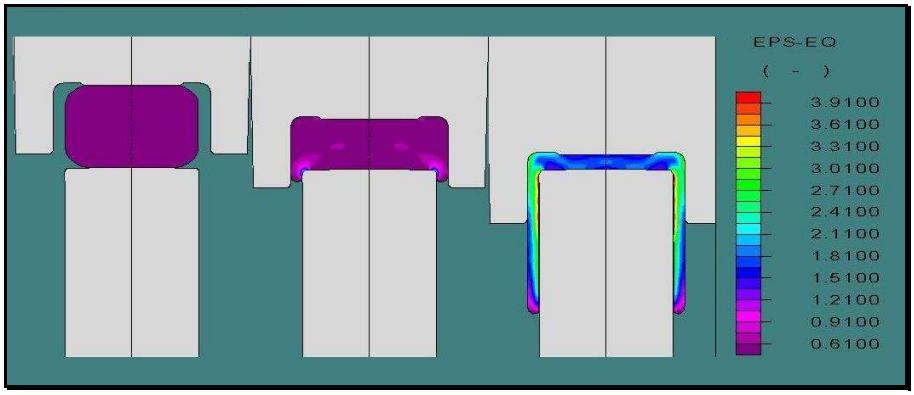

Fig. 9. Backward Extrusion Process simulation third blow [6]

Since both processes besides some minor differences in friction require the same work to form the piece there is a significant advantage of the “Osen” process. It requires fewer loads on the machine.

The work for the processes is about 65 kNm.

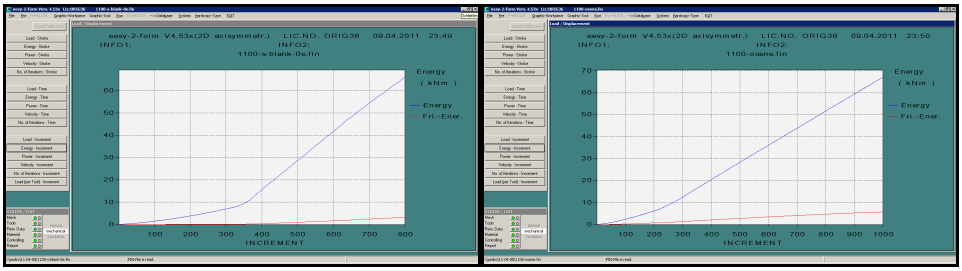

Fig. 10. Energy required for the backward extrusion and for the “Osen” process

Therefore the load needed to form the parts is depending on the cross section of the punches. The “Osen” process needs about 180 tons while the backward extrusion process needs about 450 tons. So the “Osen” Version can be produced on a smaller press if the longer stroke is available.

Example 3: Valve Tappet

- Multiple Stages Process - Traditionally this piece was manufactured in two operations in a MKN 300 machine. Then after annealing and phosphate another two operations were done in an OKN 320 machine.

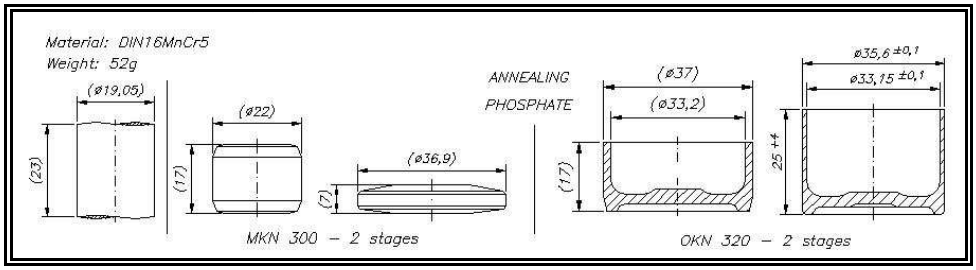

Fig. 11. Usual Process design

- Single Stage Process - The two firsts operations are made in a MKN 300 press still. Thereafter, without annealing and phosphate, a single operation is performed at 600 °C.

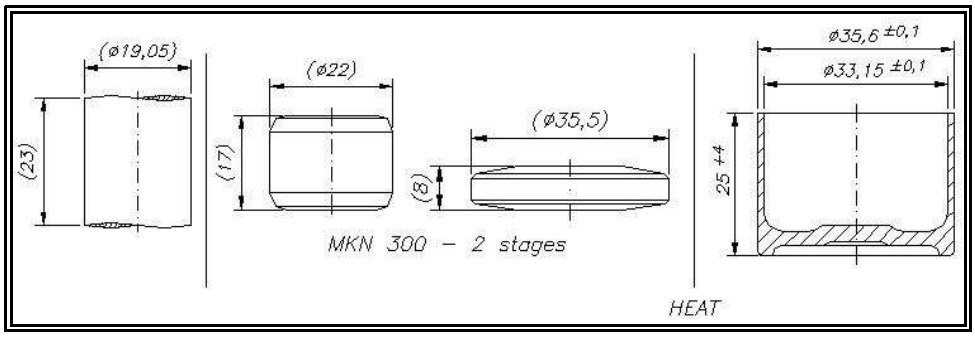

Fig. 12. Single Stage Process design

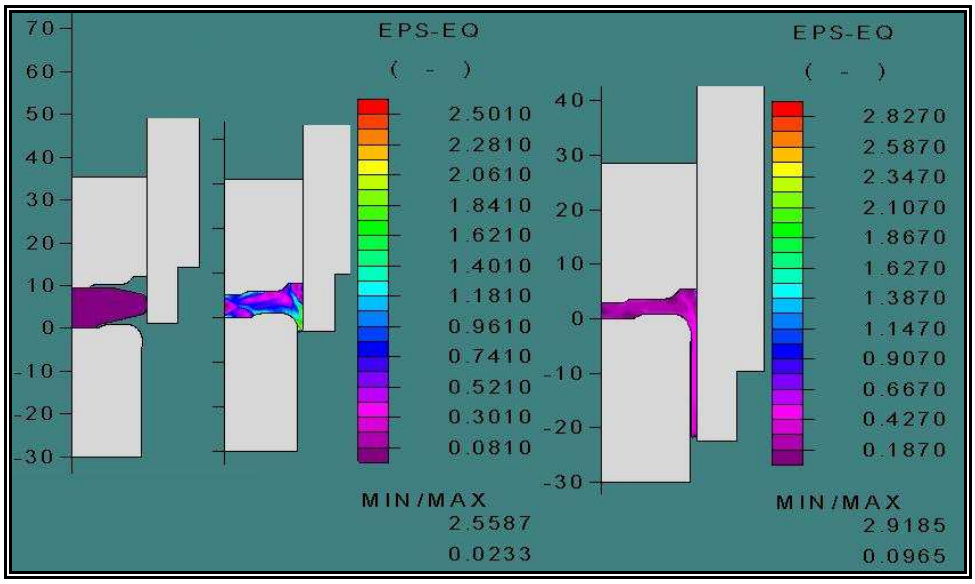

Fig. 13. Single Stage Process simulation [6]

<u>Example 4:</u> Cages

- <u>Multiple Stages Process</u> - Usually these pieces are made from tube, being machined externally, internally and at the ends.

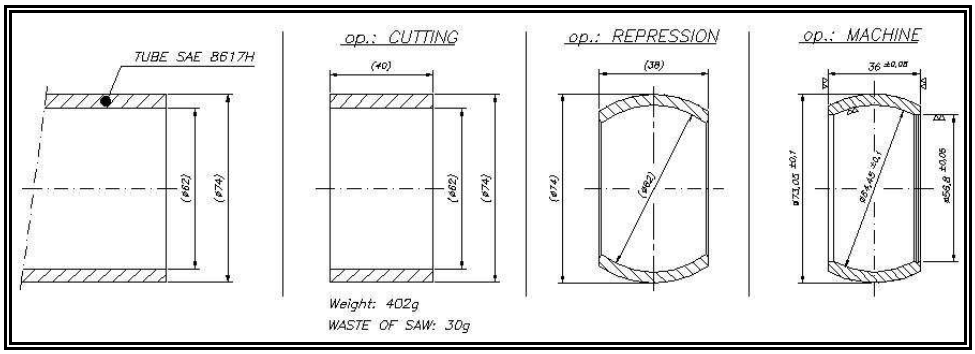

Fig. 14. Usual Process design

- <u>Single Stage Process:</u> Production by using the "OSEN" process [4].

The advantages are:

- machining only inside the piece;
- material saving;
- due to the high degree of cold deformation, the grain size is smaller, increasing the fatigue strength.

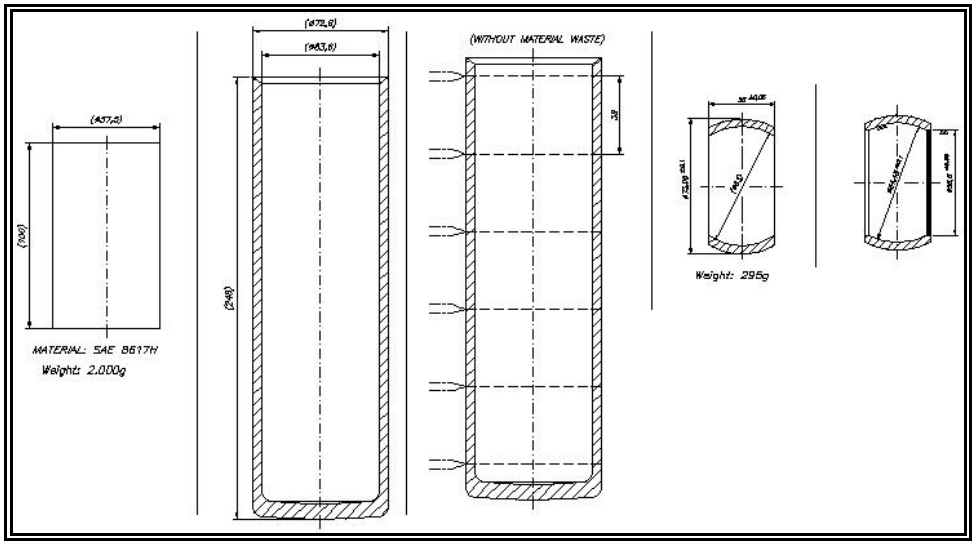

Fig. 15. “OSEN” Process design

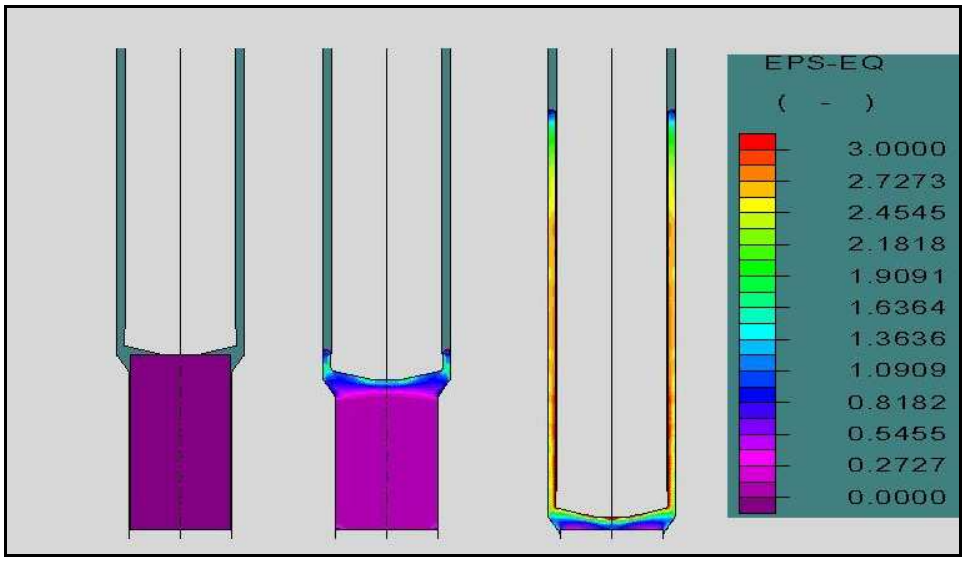

Fig. 16. “OSEN” Process simulation [6]

3 Current Development Projects

3.1 Shock Absorber

This part is a shock absorber for motorcycle made from material SAE 1010. It is a piece with an amount of strain above the limits specified in literature.

Theoretical limits – based on the literature:

$\varphi_{max.} = 0,9 – 1,4$ $\varepsilon_{max.} = 0,65 – 0,75$

Limits in this application – based on calculations:

$$\varphi_{max.} = \ln\frac{A_0}{A_1} = 1,60 \qquad \varepsilon_{max.} = \frac{A_0 - A_1}{A_0} = 0,80$$

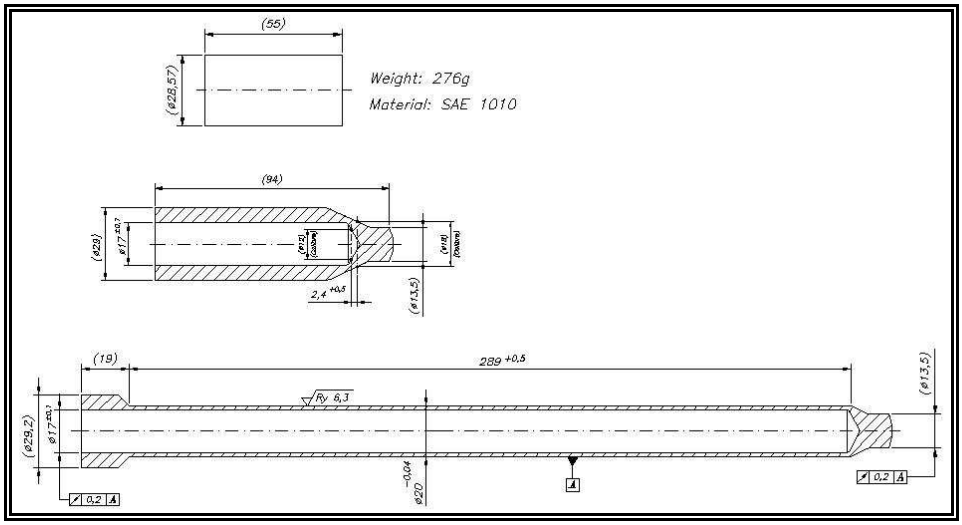

Fig. 17. Project 1 Process design

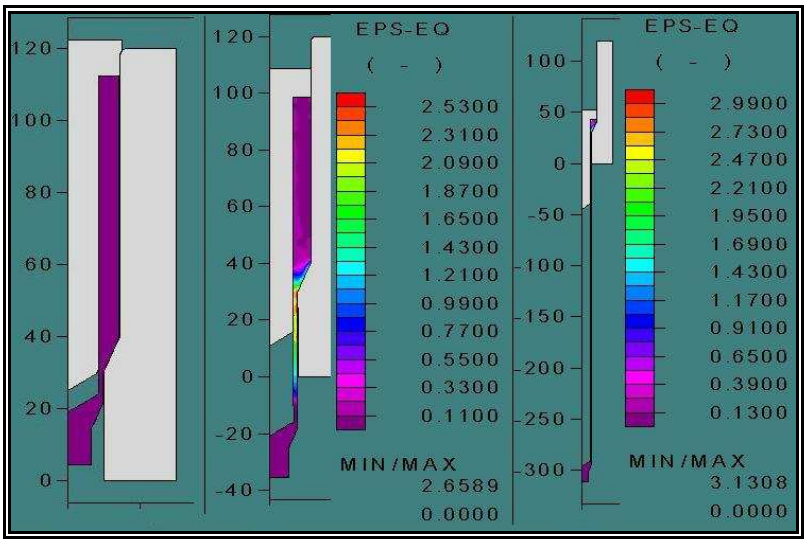

Fig. 18. Project 1 Process simulation [6]

3.2 Outer Race CV Joint

- This piece is usually hot forged;
- We developed the process by forging at around A_1 temperature;
- Piece has a high temperature gradient inside. The body will be formed in closing tools;
- We use DSSD (Double Stroke/Single Die) tooling.

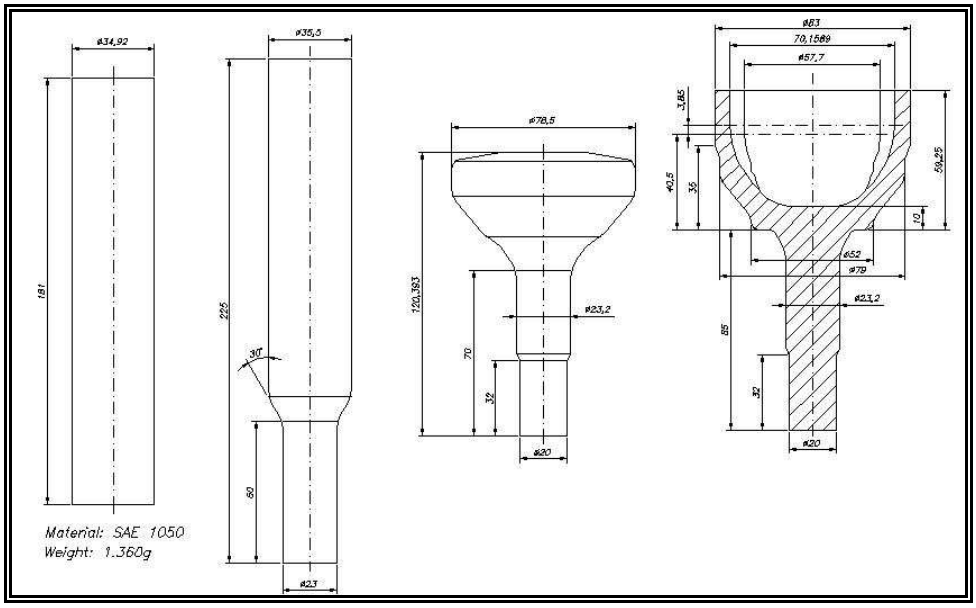

Fig. 19. Project 2 Process design

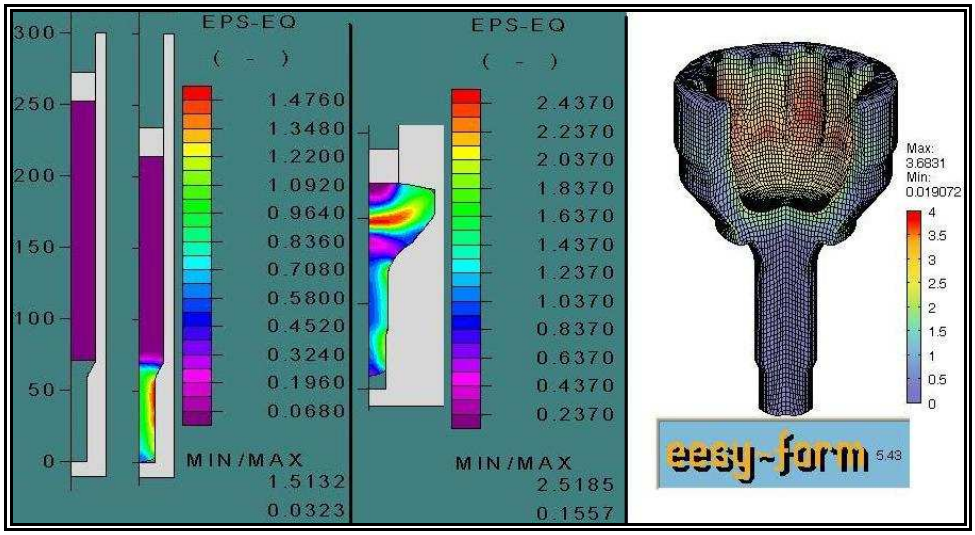

Fig. 20. Project 2 Process Simulation [6]

4 Conclusion

Processes developed for the production of large quantities not always are the most recommended. The option to establish Single Stage Processes in industry for production brings excellent results.

In Brazil, even without the governmental support for technological development, industries search for creative alternatives to continue being competitive at international level.

If the governmental policies for the country encourage a drop in raw-material (steel) price for the internal market, instead of stimulating the iron ore exportation, then Brazil will become more competitive and may even beat Chinese products.

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