COMPARISON OF TECHNICAL PARAMETERS OF FORGING ROLLS AND CROSS WEDGE ROLLING

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It is necessary to improve parameters of forging lines, because it leads to higher productivity and minimization of costs during production process.
This paper deals with parameters of modern preforming processes such as forging rolls and cross wedge rolling. These parameters are compared with respect to maximal forces, moments and total energy consumption necessary for production of identical part.

KEYWORDS

forging rolls, cross wedge rolling, preforming, DEFORM, FEM simulation

1 INTRODUCTION

Rotational forging is one of the most effective forging technologies. Usage of this technology is in real process not so often. It is caused by problems with appropriate quality.
This outage of rotational forging was replaced in forging lines by new technology of forging- cross wedge rolling.

Many of technological operations were successfully substituted be these new technologies. Rotational parts can be produced by cross wedge rolling. On the other hand, forging rolls are able to produce non-rotational parts.

Analysis of technology was performed during our research. This analysis was focused on forging rolls. It shows, that higher productivity and higher production rates leads to more frequent errors. They can be caused by manual handling with products. These problems were mostly during inserting of product in forging rolls. All manipulation is performed in modern forging factories by automatic manipulators or robots. These machines are more reliable and accurate, comparing with experienced human operators.

Forging rolls are used again in real factories. They are used mainly as machines for pre-forged parts production. These parts can be used after this technological operation on forging presses. Reason is in their low maintenance, low energy consumption and also lower price comparing with other machines. Information described above are main reasons for using of cross wedge rolling machines and forging rolls. [Cechura 2012]

Analysis of technical rotational forging possibilities was performed and comparing of selected attributes was done. Both simulations were performed for better understanding of this phenomena. Considered were machines, which are able to produce identical product. [Cechura 2013b]

2 SELECTED MACHINES

For simulation were used forming machines from company SMERAL a.s. portfolio:

- Forging rolls – KV 70 – for maximal diameter of material 70mm.
- Cross wedge rolling – ULS 100 for diameter of material 40-100mm. [Smeral]

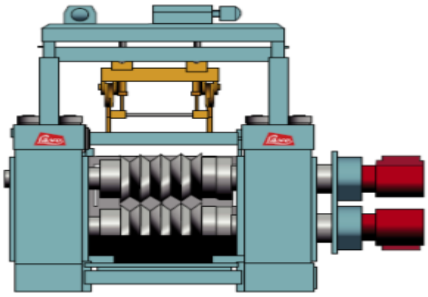

Figure 1. Forging rolls

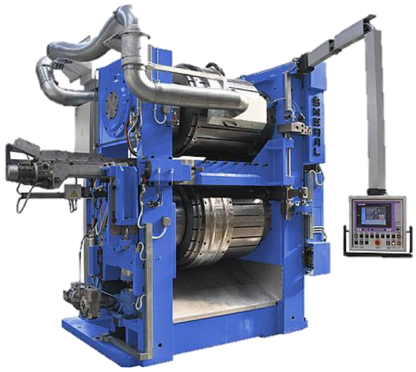

Figure 2. Cross wedge rolling

Tools diameter for forging rolls is 400 mm.

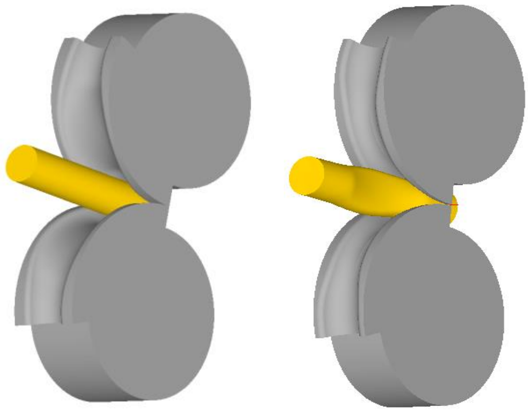

Figure 3. Virtual model of tools for forging rolls with forged part

Tools diameter for cross wedge rolling is 1000 mm, arrow angle β=5°, flank angle α=10° and radial reduction 12 mm.

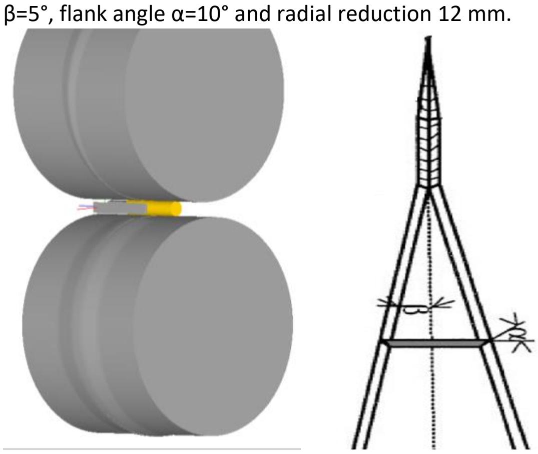

Figure 4. Virtual model of tools for cross wedge rolling

3 FORGED PART

Same material was selected for both compared technologies. Initial diameter is 70mm with 310mm length. Forged part has maximal diameter 70mm with total length 410mm. Material for simulation is CSN 12 060 (AISI 1055). [Cechura 2013a]

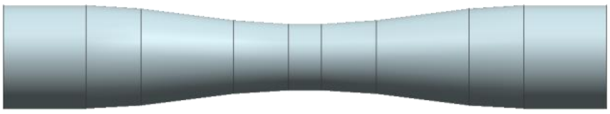

Figure 5. Virtual model of forged part

4 MONITORED PARAMETERS

As monitored parameters are described:

- Maximal achieved force
- Maximal achieved moment
- Total energy

All parameters are monitored with respect to speed of rolling in first case or with respect to friction in second case.

5 RESULTS

5.1 Forging rolls

Influence of speed on other parameters (force, moment and energy) is monitored in these simulation. Coefficient of friction is 0,8 in all cases. [Hasek 1965]

Table 1. Parameters of forging rolls with respect to speed change

Revolutions [1/min]	Force [kN]	Moment [kNm]	Energy [kJ]
90	590	22	41
60	560	20	38
30	530	19	37

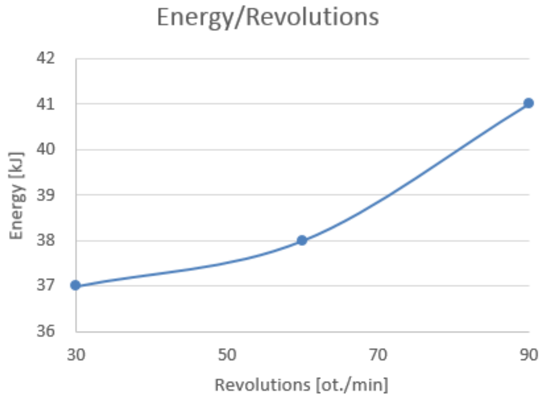

Figure 6. Consumed energy with respect to forging rolls revolutions

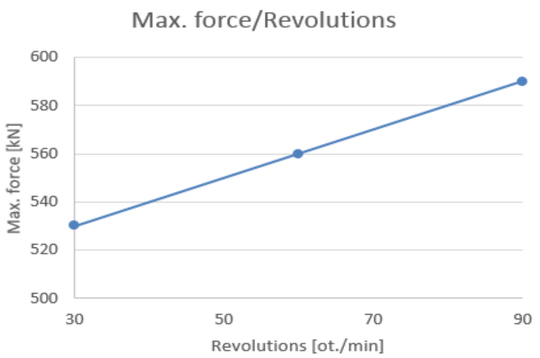

Figure 7. Maximal achieved force with respect to forging rolls revolutions

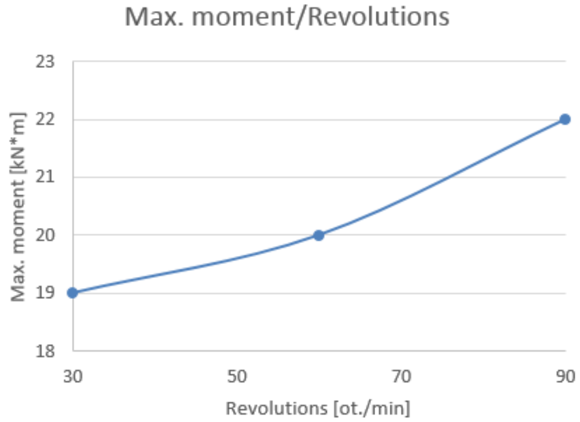

Figure 8. Maximal moment with respect to forging rolls revolutions

Influence of friction on all other parameters (force, moment, energy) is examined in following simulations. Speed of rolling is 60 rev/min in all cases.

Table 2. Parameters of forging rolls with respect to change of friction

Friction [-]	Force [kN]	Moment [kNm]	Energy [kJ]
1,0	590	22	41
0,8	540	19	37
0,6	520	18	32

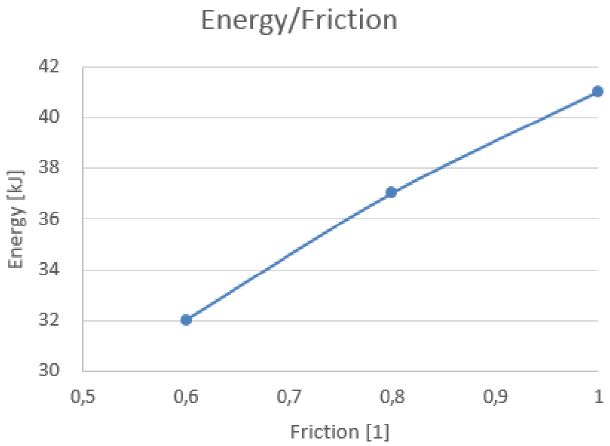

Figure 9. Energy consumption of forging rolls with respect to friction coefficient

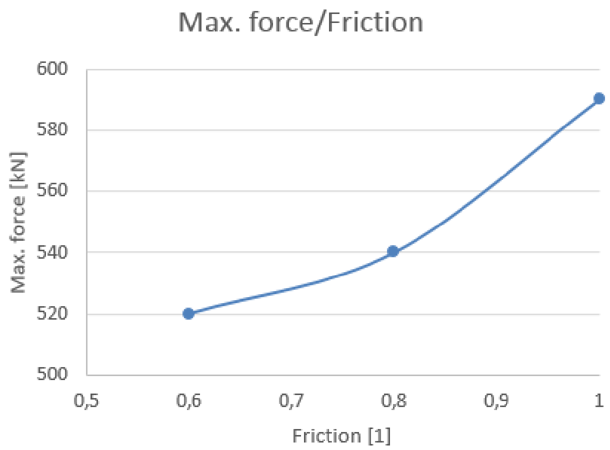

Figure 10. Maximal force achieved by forging rolls with respect to friction coefficient

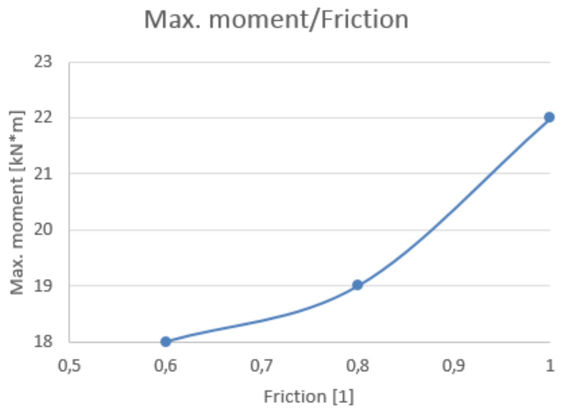

Figure 11. Maximal moment achieved by forging rolls with respect to friction coefficient

5.2 Cross wedge rolling

Influence of speed on other parameters (force, moment and energy) is described in these simulations. Coefficient of friction is 1 in all cases.

Table 3. Parameters of cross wedge rolling with respect to speed change

Revolutions [1/min]	Force [kN]	Moment [kNm]	Energy [kJ]
10	250	26	178
7	230	24	163
4	230	23	149

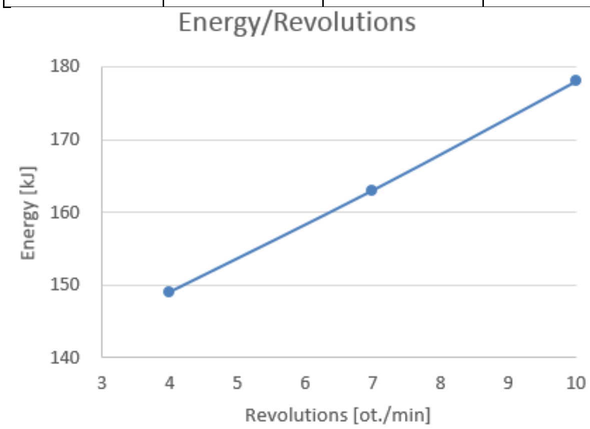

Figure 12. Energy consumption of cross wedge rolling with respect to revolutions

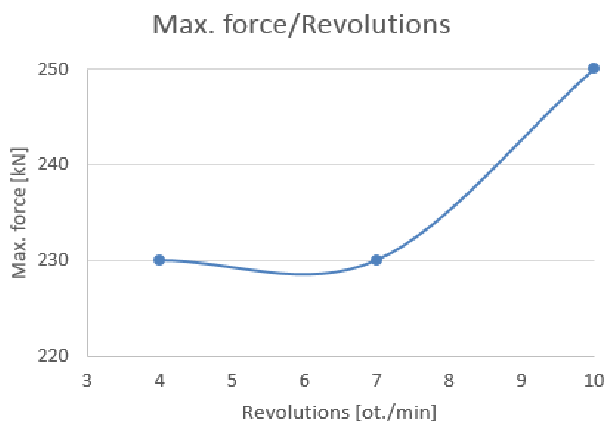

Figure 13. Maximal achieved force of cross wedge rolling with respect to revolutions

Figure 14. Maximal achieved moment of cross wedge rolling with respect to revolutions

Influence of friction on other parameters (force, moment and energy) is examined in all simulations. Speed of rolling is 7 rev/min in all cases.

Table 4. Parameters of cross wedge rolling with respect to friction change

Friction [-]	Force [kN]	Moment [kNm]	Energy [kJ]
1,2	240	24	170
1,0	230	24	163
0,8	190	21	141

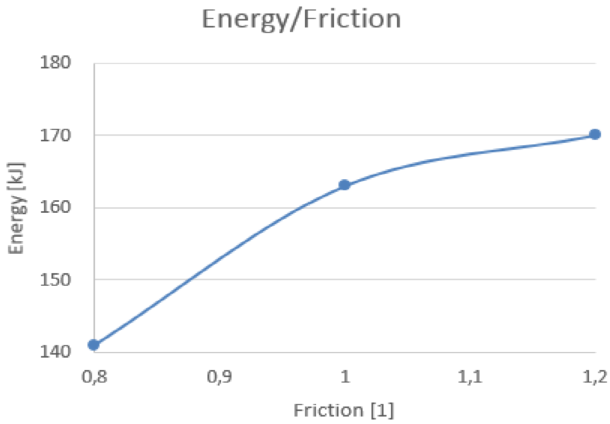

Figure 15. Amount of energy consumption of cross wedge rolling with respect to friction

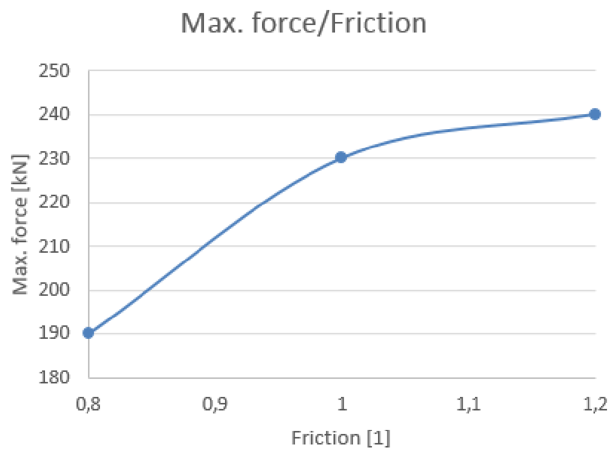

Figure 16. Maximal achieved force of cross wedge rolling with respect to friction

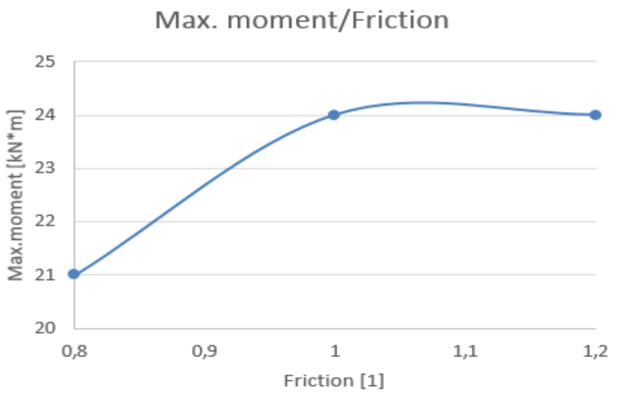

Figure 17. Maximal achieved moment of cross wedge rolling with respect to friction

6 CONCLUSION

Main aim of our research was description of all dependencies and technological possibilities of forging rolls and cross wedge rolling technologies. Selected dependencies were described according virtual simulations.

1. Energy consumption with respect to coefficient of friction

Energy consumption is higher with respect to higher friction. Energy consumption is here increased because of friction by 25% due to change from 0,6 to 1 during technology of forging rolls.
Energy consumption during technology of cross wedge rolling is affected by 17% due to change from 0,8 to 1,2. Increasing of consumed energy is not so significant during usage of roughened rolls (it means with higher friction coefficient f>1). As result can be said, that magnitude of friction affects energy consumption of forging rolls. Resistance is not increased significantly during cross wedge rolling due to rolling of the material.

2. Maximal achieved force with respect to coefficient of friction

Change of forming force with respect to friction is obvious in other pictures.
The increasing of force is by 13,5% during usage of forging rolls. Relation between force and friction in cross wedge rolling technology grows about 26,3%.
Forces and moments values are only an approximation, because they are highly affected by shape of material. Comparison of another shape may have different results. Higher importance has the value of the total energy.

3. Energy consumption with respect to rotational speed

Energy consumption with respect to rotational speed is during forging rolls increased by 10%. This change is in revolutions range 30-90 1/min.
Energy is increased by 18 % when is considered cross wedge rolling in range of revolutions 4- 10 1/min.
Lower change of revolutions is during cross wedge rolling, but energy consumption is increased twice.

4. Maximal achieved moment with respect to rotational speed

Moment is also growing with respect to revolutions. This increasing is by 16% in range of revolutions between 30-90 1/min.
Increasing is by 13% during cross wedge rolling in range of revolutions 4-10 1/min.

It is obvious from performed comparison, that change of friction or rotation speed has great effect on selected parameters in both cases.

The most important change is consumed energy. It is closely connected to energy demands of production. It is also connected with change of torque and force. The value of total energy describes the demands of the operations. This description is better than description by forces and torques, which maximum values may be affected by the specific shape of forged part.

It is possible to say that forging rolls are negatively affected by friction then cross wedge rolling. It is because during forging rolls technology is material not rolling comparable to technology of cross wedge rolling. Cross wedge rolling is more negatively affected by higher rolling speed than forging rolls.

These results were obtained by virtual modelling and can be affected by boundary conditions in simulation model.

Presented results can be used in real forging factories and by producers of forging machines. They can help in setting up production line and they can lead to minimizing of energy consumption. Also loading of machines can be improved by using these results.

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