Wire Shaving Improves the Efficiency in the Manufacturing of Copper and Copper Alloys

By Jens Kieselstein *

High quality products require a high quality semi-finished material. The surface of a wire has a significant influence on the quality and the improvement of the surface is working as a lever arm on the price of wire. Besides the continuous improvement of the raw material and the process of production of copper rod, the technology of shaving ensures a higher quality of the copper rod surface. Even the worst wire rod quality can be improved by this production step, before drawing, essentially. A casted copper alloy surface can be treated and the result is a wire with proper conditions for drawing.

In addition to these facts, the main reasons for wire breakage during the drawing process are surface defects. Shaving is a way to remove them. This results in further potential for raising the workability and for increasing cross-section reduction. That allows for a more efficient drawing operation with less drawing and annealing steps.

This article explains it further by using the example of processing copper and copper alloy wire as well as showing equipment solutions developed and installed by KIESELSTEIN International from Germany in the wire world.

Due to the industrial application of copper and copper alloys there is a progress in the wire production business. The focus is on the improvement of technologies and processes for the production and processing of wire. One main issue is the continuous improvement of the characteristics of the workability while increasing wire quality at the same time. Shaving used for increasing the surface quality even today is an integral part of the production of high quality wire.

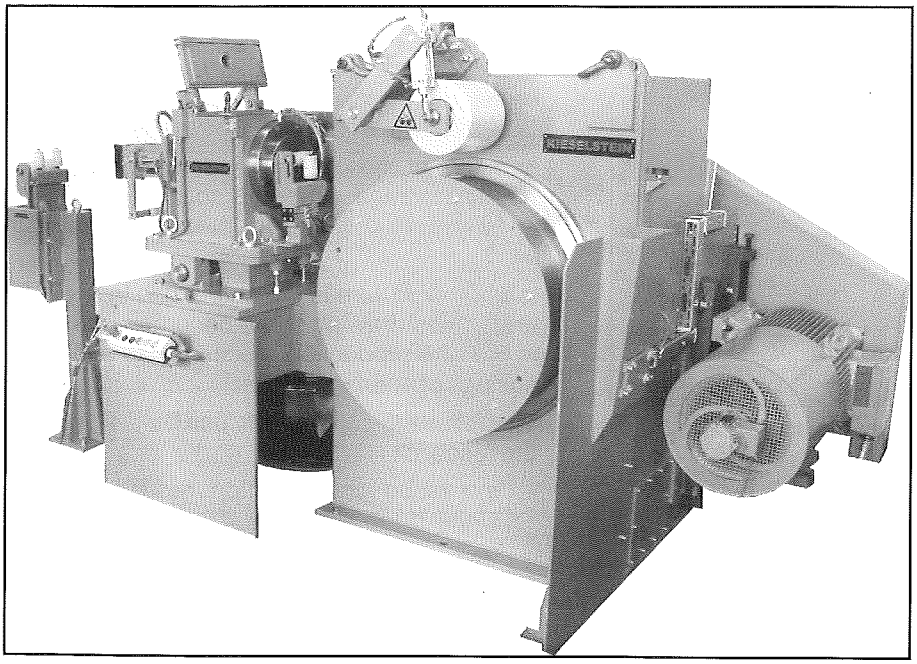

Fig. 1: KIESELSTEIN "shaving machine" for non-ferrous wires.

Besides the manufacture of these kind of wire in steel wire industry especially for spring wire more operations for copper wire and in particular for copper alloys require a surface treatment before and in some cases after drawing to prepare or provide proper surface conditions to fulfil customers' requirements.

In addition, the demand for the application in the processing of non-ferrous metals has increased in recent years. Another reason is that the rod wire production technologies such as casting, create surfaces that complicate the working of the wire. A chipping processing of the defective surfaces therefore also has positive influence on the following wire drawing.

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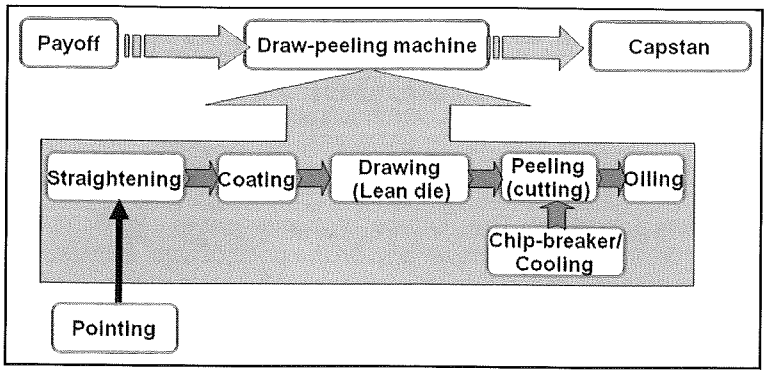

Fig. 2 : Technical process of "shaving".

Fig. 2 shows shaving of the wire is a chipping process. Amongst oxides, casted surface layers and other defects located near the wire surface are removed during the shaving process.

Modern wire shaving plants work in a diameter range from 1.00 mm to 25 mm. The chipping tool – the shaving die – removes between 0.02 mm and 0.5 mm of the wire diameter off the inlet material. This results in a homogenous wire with a defect-free surface with a low roughness of the surface as shown in Fig. 3. Usually this wire is processed further by wire drawing.

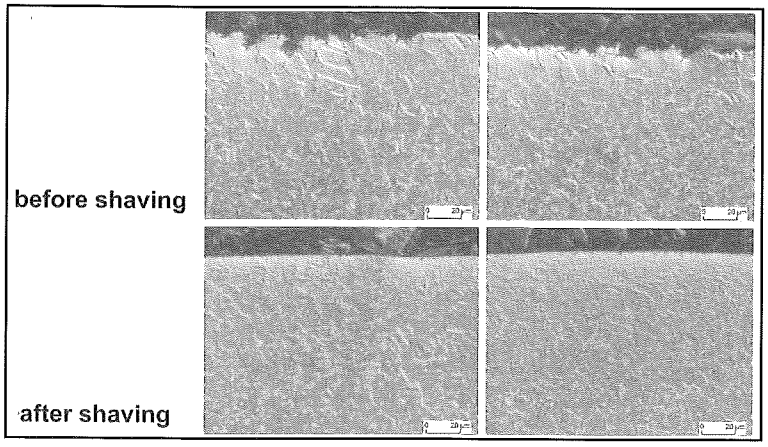

Fig. 3 : Comparison of a wire cross-section before and after shaving.

Drawing Operation With and Without Shaving

KIESELSTEIN International has a high level of experience in the technology and in the manufacturing of machines for wire shaving.

The influence of shaving on the workability of a casted copper alloy (CuZn) wire has been examined. The goal was to reach a specific wire size without any intermediate heat treatment. The wire rod was casted on an up-cast line from Scotland to 8.00 mm in diameter.

Without a shaving treatment, it was not possible to draw the wire to the required size of 2.40 mm. Furthermore, it was a major interest to draw the wire with a minimum number of drawing steps. In reference to that purpose, the maximum achievable cross-section reduction per drawing steps had to be considered and the investigation to improve was part of the research.

The results can be transferred to the processing of other materials as well. The wire produced by casting is processed on the shaving plant. Afterwards it was drawn down to the final diameter. In a test the drawing of the inlet material was compared to the drawing with preliminarily shaved wire.

When drawing the shaved material the degree of workability on a single draft, i.e. the one-time cross-section reduction, could be increased by 15% compared to drawing unshaved material. This means that shaving reduces the number of drafts necessary from the same inlet material to the same finished diameter.

During a second test shaved and unshaved inlet material were compared on a multiple draft. By using shaved material the workability could be increased by 60% compared to unshaved material.

Integrating shaving into the wire production process increases the workability.

Furthermore evidence could be provided that the workability of shaved material compared to unshaved wire is improved also in a single draft. Less drawing steps become necessary in the wire production process. This results in savings of energy and cost.

The following conclusions can be drawn from the research :

- increased cross-section reduction on a single draft
- less drawing steps with multiple step drawing
- improved workability in general
- fewer heat treatment steps required
- higher surface quality
- more efficient production process

One further advantage is that shaving can be integrated into the drawing process of non-ferrous metals, respectively in the existing plants and machinery.

Fig. 1 shows a shaving-line which is foreseen for the installation ahead of a rod break-down machine. This machine has a separate capstan to pull the wire and is synchronized with downstream equipment by sensor roll. The principle of this machine is plug-in play solution for the wire industry.

Depending on the tensile strength of the wire it might be a requirement to do the lean die drawing and the shaving in two separate operations. Fig. 2 of this article gives an overview.

Such a machine is shown in Fig. 4. The machine consists of two drawing blocks. The first one is for lean die drawing as the integral step before the chipping by the shaving tool.

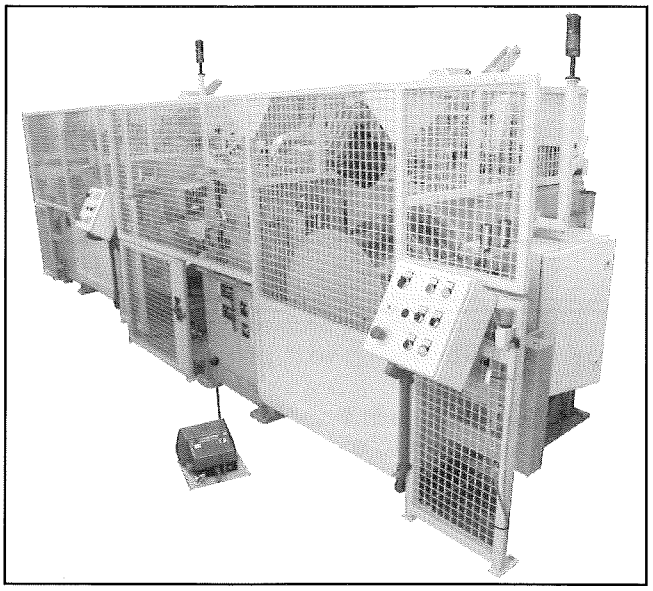

Fig. 4 : KIESELSTEIN "shaving line" for copper wire in magnetic wire manufacturing.

Beside the integration into existing lines, KIESELSTEIN International recommends combined drawing/shaving plants for the treatment of non-ferrous metals including various types of take-ups. Fig. 5 shows such a machine.

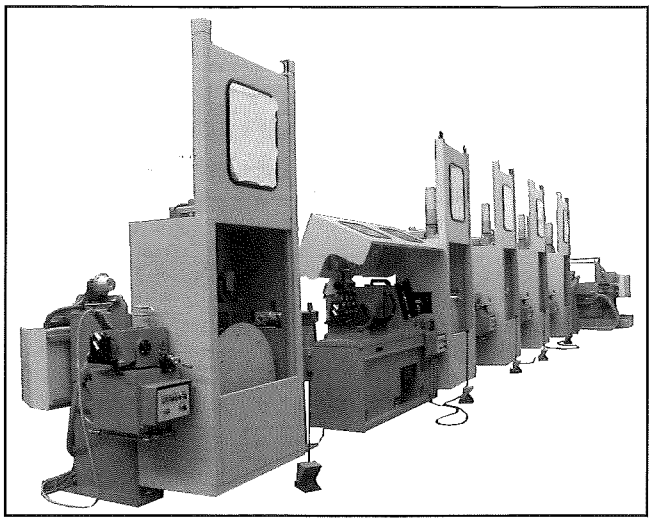

Fig. 5 : Combined drawing/shaving plant for the processing of non-ferrous metals including traversing spool take-up.

Summary and Outlook

The conclusions drawn from the results of the research allow for an economisation of the technological procedure of the production of copper and copper alloys. The savings realised due to unnecessary annealing or the increase of the cross-section reduction in each processing step are considerably higher than the costs the integration of shaving into the drawing process of non-ferrous materials induces. In addition to the improvement of the workability, the defects in the surface are removed and a defined roughness adapted to the following processing can be reached. Even the worst wire rod can be improved and prepared to use for applications with higher demands, which the unshaved wire can never fulfil.

This enables a production considerably more efficient while increasing the product quality significantly at the same time.

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