eoss-conf.com

ISSUE
№30

EUROPEAN OPEN
SCIENCE SPACE

COLLECTION OF SCIENTIFIC PAPERS

1ST INTERNATIONAL
SCIENTIFIC
AND PRACTICAL
CONFERENCE

ACHIEVEMENTS OF SCIENCE AND APPLIED RESEARCH

APRIL 7-9, 2025. DUBLIN, IRELAND

EUROPEAN OPEN SCIENCE SPACE

Proceedings of the 1st International Scientific and Practical Conference

"Achievements of Science and Applied Research"

April 7-9, 2025

Dublin, Ireland

Collection of Scientific Papers

Ireland, 2025

UDC 01.1

Collection of Scientific Papers with the Proceedings of the 1st International Scientific and Practical Conference «Achievements of Science and Applied Research» (April 7-9, 2025. Dublin, Ireland). European Open Science Space, 2025. 165 p.

ISBN 979-8-89704-961-5 (series)
DOI 10.70286/EOSS-07.04.2025

The conference is included in the Academic Research Index ReserchBib International catalog of scientific conferences.

The conference is registered in the database of scientific and technical events of UkrISTEI to be held on the territory of Ukraine (Certificate №37 dated 6.01.2025).

The materials of the collection are presented in the author's edition and printed in the original language. The authors of the published materials bear full responsibility for the authenticity of the given facts, proper names, geographical names, quotations, economic and statistical data, industry terminology, and other information.

ISBN 979-8-89704-961-5 (series)

Section: Mechanics and Electrical Engineering

KINEMATIC ANALYSIS OF WORKPIECE ROTATION EFFECTS ON PIPE NECK FORMATION VIA FRICTION-BASED SPINNING

Kulik Tetiana
Ph.D.
Technical University “Metinvest Polytechnic” LLC, Ukraine

Abstract. This paper examines the influence of the workpiece rotation direction on the efficiency of the rotary spinning process. It is demonstrated that this parameter plays a significant role when the friction tool has active calibration, while its effect will be minimal when using flat rotary profiling. In cases of active calibration and counter-rotation shortens the neck length, whereas co-rotation enhances neck elongation due to a more favourable stress distribution pattern.

Keywords: rotary spinning, pipe workpiece, narrow pipe neck, process mechanics, rotation direction, integral force, deformation zone.

Introduction. Belt conveyors fitted with rollers that are linerless rollers are extensively utilized in both metallurgical and mining industries. The operational reliability of such systems largely depends on the durability of the rollers, as they are considered non-repairable under standard production conditions. These rollers are manufactured from tubular workpieces featuring small-diameter necks produced using rotary spinning with a friction tool. These rollers are commonly used under medium to heavy and even extreme operating conditions. Reliability analysis indicates that the average service life of these rollers reaches 4.6 years under normal conditions and exceeds 3 years under severe conditions.

Another significant application of narrow-neck tubular workpieces is in producing high-strength cylinders. Hydraulic pressure failure tests have shown that using rotary spinning to form the necks increases the strength of the cylinders by at least 1.5 times. Consequently, optimizing the production of small-diameter necks through rotary spinning with friction tools is a matter of practical importance.

The primary goal of this study is to analyze the effect of the workpiece rotation direction on the integral deformation force and, by extension, on the productivity and efficiency of producing sealed-bottom tubular parts with narrow necks.

In the process of rotation spinning for forming narrow necks using friction tools, a tubular workpiece is clamped in the spindle of a spinning machine and rotated. The workpiece is preheated to forging temperature and deformed by a set of friction tools. These tools move tangentially, forming a sealed bottom (in the form of a truncated cone with an angle of the generatrix φ_0 and an apex diameter close to the required neck size). The cone is then gradually formed into the final neck. The spinning is completed in one heating cycle and in one working pass of the set of tools.

For analytical purposes, the process can be divided into two main stages (Fig. 1): the formation of a conical bottom and the subsequent formation of the neck. These stages occur continuously, without interruption, since the set of friction tools that perform the deformation are successively mounted on a support (Fig. 1). Such an installation implies that the direction of rotation of the workpiece must remain constant in both stages.

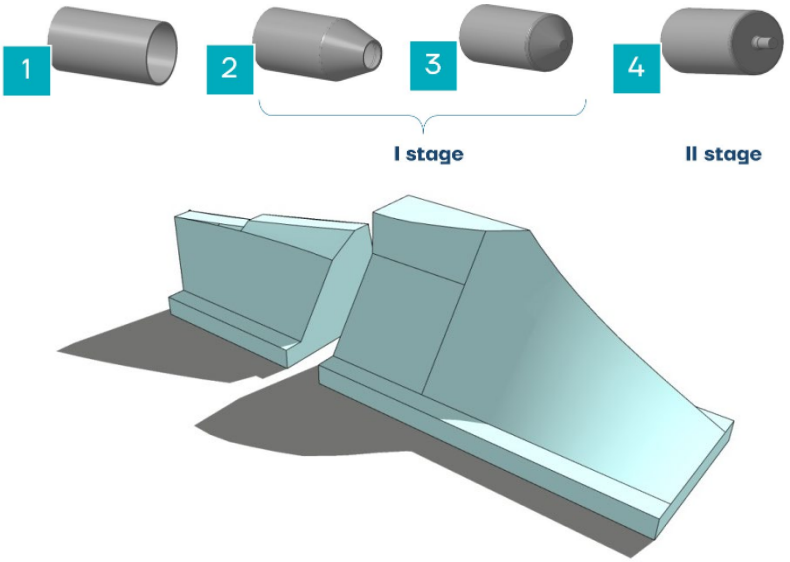


Fig. 1. Stages of neck formation and Two successively located friction tools

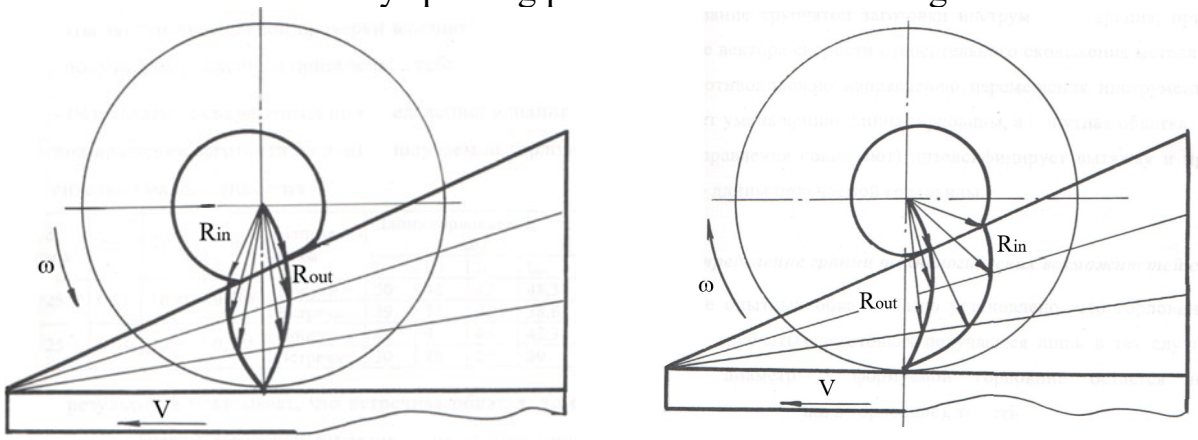
The tool used to form a neck of the required dimensions consists of two functional sections on its working surface. The first section is responsible for neck formation, where the friction surface is aligned at a constant angle. The second section shapes the supporting surface.

An analysis of the mechanics and kinematics of the process indicates that the rotation direction of the tubular workpiece directly influences the components of the integral deformation force. In turn, this affects the spatial orientation of the vector of the integral deformation force. However, if the workpiece is processed using a flat rotary tool—commonly applied when forming spherical bottoms—then a change in rotation direction alters the deformation zone (its geometry, size, and orientation) only symmetrically with respect to the plane of symmetry. As a result, the vector of the deformation force also changes direction symmetrically but does not significantly impact the process itself.

This minimal influence is due to the plane of symmetry, which passes through the axis of rotation of the workpiece and is perpendicular to the working surface of the friction tool. Consequently, the force and deformation characteristics along the tool's normal remain practically unchanged. In such cases, rotation direction only needs to be considered when determining the optimal load distribution on the spinning machine for strength calculations.

In contrast, when using a friction tool with active calibration—meaning the surface profile changes across sections—a reversal in the rotation direction of the

workpiece results in a modification of both the shape and spatial position of the deformation zone. The rotary spinning process is illustrated in Fig. 2.



а) counter-rotation б) co-rotation

Fig. 2. Deformation zone configurations during rotary spinning

From a kinematic standpoint, counter-rotation - is a deformation process where the direction of relative sliding between the metal and the friction tool is opposite to the movement direction of the tool itself. In co-rotation, these directions align.

When processing is performed with identical tools—featuring the same profile variation along the normal—, but the workpiece rotates in opposite directions, the exit radii from the deformation zone and their spatial configuration remain nearly identical in both cases. The entry radii are also similar in size but occupy different spatial positions depending on the rotation direction.

Conclusion. A detailed analysis was conducted to evaluate the influence of the workpiece rotation direction on the resulting neck length during the rotary spinning process. Findings indicate that counter-rotation reduces the neck length, while co-rotation promotes more intensive drawing, resulting in a longer neck. In conclusion, the direction of the workpiece's rotation is critical for enhancing the deformation process—but only when using friction tools with active calibration.

References

1. Kulik, T. (2024). Increasing the operational durability of the friction tool for spinning of necks. In MININGMETALTECH 2024 – The mining and metals sector: integration of business, technology and education: International scientific-technical conference (pp. 166–167). Zaporishia, 28–29 November 2024. Baltija Publishing. https://doi.org/10.30525/978-9934-26-506-8-57