# CURRENT STATE AND DEVELOPMENT PROSPECTS OF METHODS TO INCREASE THE STRENGTH AND DURABILITY OF THE CYLINDRICAL THIN-WALLED ELEMENTS

## СОВРЕМЕННОЕ СОСТОЯНИЕ И ПЕРСПЕКТИВЫ РАЗВИТИЯ МЕТОДОВ ПОВЫШЕНИЯ ПРОЧНОСТИ И ДОЛГОВЕЧНОСТИ ТОНКОСТЕННЫХ ЦИЛИНДРИЧЕСКИХ ДЕТАЛЕЙ

Ass. Prof Fayzimatov Shuhrat Numanovich
Department of Mechanical Engineering and Automation, Faculty of Mechanics, Fergana Polytechnic Institute, Uzbekistan
*Email*: shuhrat-fayzimatov@mail.ru

**Abstract:** *The main issues are considered in this topic is the impact of pneumovortex effect on the free ball located inside the cylindrical thin-walled elements. Researches were carried out with various diameters of deforming balls and lengths of cylindrical parts. Obtained results show high precision of roughness inside walls of cylindrical tubes.*
***KEYWORDS**: FINISHING-STRENGTHENING, PNEUMOVORTICAL PROCESSING, DISTORTING BALLS, ROUGHNESS*

### *1 Introduction*

Nowadays the ball rolling is widely used for finishing-strengthening treatment of non-rigid elements parts, which provides to receive high specific pressure to the wall parts with less effort. However, the main condition of reliable operation of such rolling-off is a high precision in production. Increased requirements to accuracy of hole-rolling processing, even in small oscillations of tension, lead to a drastic change of efforts and the angle pressing in of distorting elements, which has an adverse effect on quality of thin-walled elements. Furthermore, the use of roller burnishing tool does not supply high-performance process.

On the other hand there are examples of use of known methods, applied to the cylindrical thin-walled elements (cold cathode substrate) made of viscose steels and alloys in some factories of engineering and electronics industries.

### *2 Solution of the problem*

However, technological losses at processing of the thin-walled cylindrical parts using the method of rolling by distorting ball are more than 10 % [1]. These losses arise at "tough" contact of distorting element with work detail owing to charging surface, change of geometry of the detail and non-uniformity of distribution of processing efforts. Besides small rigidity and vibration resistance of the system results in occurrence of defects as sections with high sizes of the surface roughness having random nature of distribution.

On the basis of our theoretical and experimental research has developed a number of device constructions for pneumovortical processing of cylindrical elements.

At pneumovortical process distorting balls, committing complex motion regarding work surface interact with microasperities of the initial surface in various directions [2].

Rolling microasperities occurs on different sides, whereby the deformation resistance decreases, and the deforming action of the balls increase during this motion. The resulting component flow pushes the ball constantly with a certain force to the surface at an angle of ascent respect to the axis normal of the cylindrical element (Figure 1).

However, factors such as turbulence of the vortex flow, surface roughness, loss of energy flow along the length of the workpiece, the contact friction and weight of the ball prevent the latter to move up on the surface incrementally, which provides required roughness of the finished product. Hence, above mentioned factors do not allow the ball to contact with all microasperities of the initial surface.

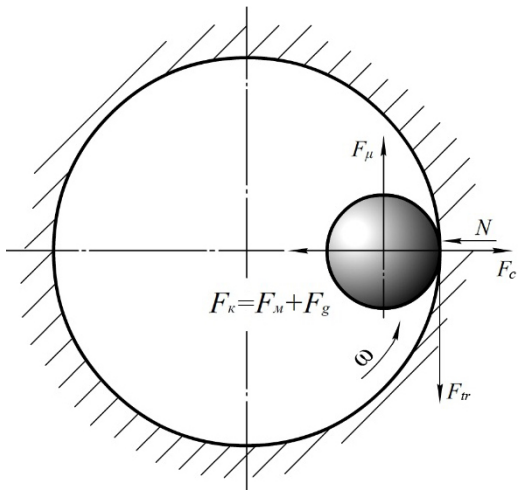



***Figure 1** Forces at the contact point of the ball and cylindrical tube*

The deforming balls contact with the entire work surface can be achieved by increasing their number. It is necessary to find a combination between control parameters ($P_v$, $d_ш$, $N_ш$) that would supply the required quality of the surface along the whole length of workpiece.

### *3 Experiment, Results and Analysis*

As the deformation elements were chosen polished steel balls of material ШХ-15 with diameter range $d_ш$ = 1,6 ÷ 3,5 mm; in an amount of $n$ = 10 ÷ 300. The input pressure was selected within $P_v$ = 0,2 ÷ 0,35 MPa. Output parameters of workpiece and output of devices of pneumovortical processing to a large extent is defined of following parameters: the initial surface roughness, diameter and length of workpiece and control parameters.

The results of experimental researches are plotted in fig. 2. It can be seen that the more rough the initial surface before lining-reinforcing processing, the easier to achieve a sharp improvement of the surface roughness in the beginning.

For example, at the initial roughness $R_{init}$=5,0÷6,0 mcm, (the elements' material is Д16Т) for initial time of processing $t$=1,5 minutes $Rz$ decreased on ΔR=4,6 mcm at the initial $R_{init.}$=1,25 mcm, for the time of processing roughness decreased ΔR=1,0 mcm.

Besides at any initial surface of preparation the curve of change $R_a$ of processed detail at increase of the time of processing asymptotical seeks some size.

At the initial roughness $R_{init}$ =5,0÷6,0 mcm value asymptote averages 0,18 mcm, and at the initial roughness $R_{init}$=1,25 mcm value asymptote - 0,12 mcm.

Such nature of processing the balls contact with work surface on the tops of micro roughness, reference area of which is small. Thereof on contact surface significant specific pressure causing plastic deformation of micro roughness develop. However hereinafter contact takes place to big reference area. Besides to quality of processing they begin to influence arising wear hardening of the surface and occurrence of defect layer. All of these results in reduction of power impact increase of strength of the surface and, as investigation, slow change of roughness in time.

Seeking to increase impact of balls to surface at the expense of increases of entrance pressure higher that recommended results in destruction of surface layer, occurrence of scores and hollows.

In such a manner, such initial roughness of preparation is possible that even with infinite the time of processes we will not receive required quality of the surface (surface roughness $R_a$=0,1÷60,08 mcm).

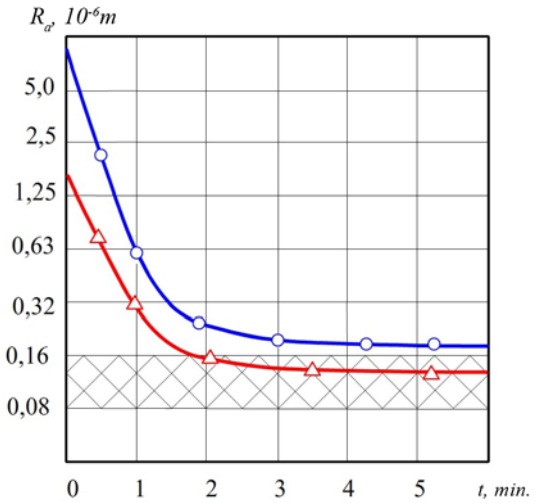



***Figure 2*** *Influence of duration of processing to roughness at various $R_{init}$:*
*○ - $R_{init}$ =5,0 mcm; △ - $R_{init}$ =1,25 mcm*

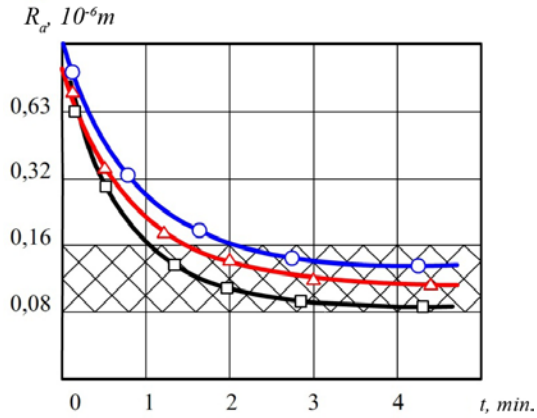



***Figure 3*** *Influence of duration of processing to roughness at different diameters and lengths of workpiece*
○ - $D_n$=40 mm, $L$=200 mm; □ - $D_n$=40 mm, $L$=160 mm;
△ - $D_n$=40 mm, $L$=160 mm

For the above mentioned parameters of the device and the modes of processing at required roughness of vendor part $R_a$=0,16÷0,08 mcm receipt of required quality is possible only in case semi-finished items surface roughness will be less size $R_{ini}$<0,3 *MPa* mcm.

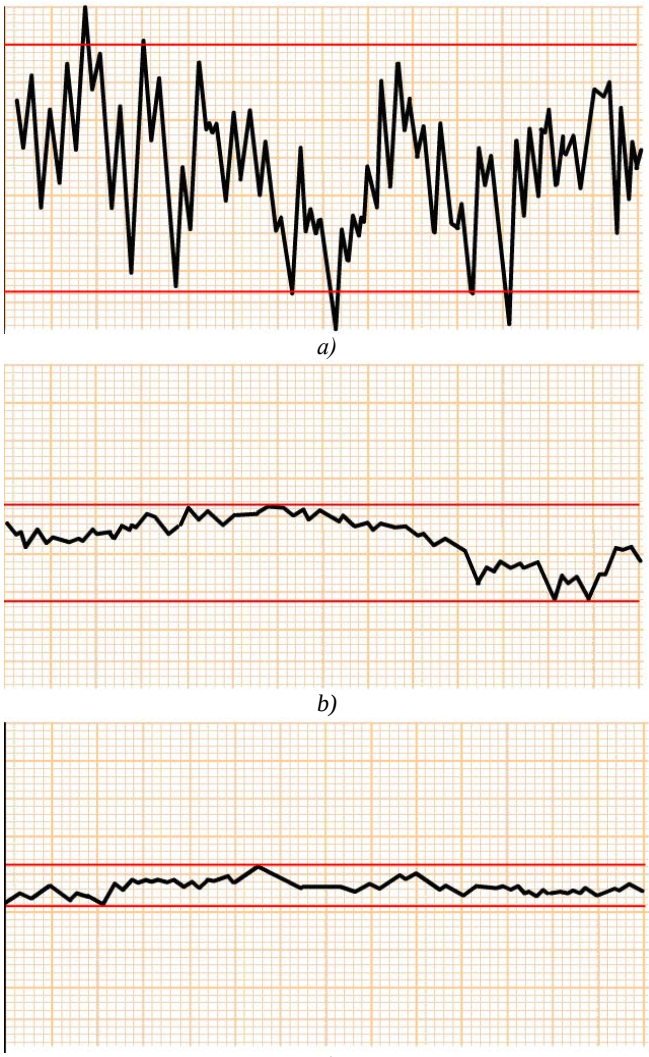
Based on above-stated, it is recommended the initial detail roughness to choose within the range of $R_{ini}$=0,63÷2,5 mcm. At the same time processing will long for 2÷3 minutes.

In fig. 2 the results of research in influence of processing duration to surface roughness are presented at different diameters and lengths of workpiece. For example, increase of length of the cylindrical elements from $L$=160 *mm* to $L$=200 *mm* at diameter of the element $D_n$=40 *mm* results in increase of the time of processing with $t$=2,5 to $t$=3 minutes, and for element with $D_n$=30 *mm* and length $L$=120 *mm* processing time accounts for already $t$=2,0 minutes. It is due to that with increase of length and diameter of workpiece the way passed by the ball during processing is increased, and therefore, duration of processing grows.

Excessive increase of requirements to quality of the semi-finished items surface though results in processing time reduction, but much will increase expenditures to previous operations.

Other advantage of thin-walled cylindrical elements is opportunity of formation of optimum microrelief (uniformity of surface layer) and significant hardening of surface layer of metal without deformation of preparation on her all section.

On fig. 4 they are presented in profilograms, obtained from the surfaces of work piece (elements' material is Д16Т) recorded on profilograph - profilometer 201, at identical vertical and horizontal increases. Profilogram (fig. 4, a) corresponds condition after passage on the machine tool of the model 1И611П (roughness on parameter $R_a$=1,25÷0,63 mcm), and profilograms (fig. 4 b, c) condition after lining-reinforcing processing at duration of processing, respectively $t$=2 and $t$=3 minutes is corresponded (roughness on parameter $R_a$=0,16÷0,08 mcm)



*a)*

*b)*

*c)*

***Figure 4*** *Nature of the surface roughness of work detail after:*
*a) passages on the machine tool of the model 1И611П;*
*b) lining-reinforcing processing of pneumovortical action at duration of processing respectively t=2m and t=3m.*

As exemplified by received profilograms the microrelief of processed detail surface by method of lining-reinforcing processing of pneumovortical has an insignificant amount of shallow grooves, projections smoothed form have, and surface roughness $R_a$ does not exceed 0,16÷0,08 mcm. Such surface supplies an almost ideal

distribution of the current in the class to the area of the cathode and satisfies to all requirements imposed on work detail after operation roller.

## *4 Conclusions*

In such way, the strengthening effect produced by finishing and hardening treatment is not only the value of power impact of the ball on the surface, but also due to load annex ratio to surface and complex relative movement of distorting ball regarding the workpiece.

## *5 References*

1. Бобрецов В.Б., Коржавый А.П., Сигов Д.Н. Современные методы получения и исследования изделий электронной техники, Тез. докл. 5-й Все союзный межвузовская конференция. – М:, 1979, с.33-37.
2. Файзиматов Ш.Н. Применение энергии закрученных воздушных потоков при отделочно-упрочняющей обработке цилиндрических деталей. Вестник естественых и технических наук, М.: Издательство «Перо», №2, 2010. с. 7-10.