$$U = 1.28 \cdot 20000 = 25640 \quad \text{V}$$

And consequently, the rate of voltage rise after connecting the condensers is: 28%.

This constitutes a great risk for the mounted (installed) devices, and the condensers can't be connected in this case where the companies manufacturing condensers do not allow the rise of the voltage over (more than) 20% except for very limited minutes during the day.

Deduction:

1- Non-usage of condensers haphazardly, particularly in the factories with nonlinear loads.

2- Studying the harmonics in the network and defining the harmonic in which the phenomenon of voltage increase is formed on connecting the required condensers for raising the power factor.

3- Designing the percolator, required and suitable, for absorbing the dangerous harmonics which form on connecting these condensers.

4- Protection from momentary currents resulting from the condensers connection.

5- Designing the percolator (filter) required and suitable for absorbing the dangerous harmonics which exist (form) on connecting these condensers.

6- Protection from the momentary currents resulting from connecting condensers.

7- Application of industrial security on (when) installing condensers.

Reference: **1.** As Pabla, Electric power distribution systems, Tata Mc.Graw-Hill. 1992. **2.** Glenn. Stagg, Ahmed El-Abiad, Computer Method in power system analysis, Mc.Graw-Hill 1986. **3.** George. Kusic, Computer aided power systems analysis, New Jersy 1986. **4.** Hermann. Dmmel, EMTP, Vancover, Canada. 1986. **5.** Sz. Kujszczyka. Electroenergetydzne sici rozdzielcze. Warszawa. 1991. **6.** W. Paterson, A.E. Guide, Electrical power systems volume (1), Pergamon press. 1979.

SURFACE ROUGHNESS AT ABRASIVE JET MACHINING

Potârniche Ş., Slătineanu L., Gherman L.A., Grigoraş (Beşliu) I., Nistoroschi G.

(“Gheorghe Asachi” Technical University of Iaşi and University “Ştefan cel Mare” of Suceava, Romania)

One of the characteristics of the surfaces obtained as result of applying a certain machining process is the surface roughness. Even nowadays there are many parameters used to define the surface roughness, on the mechanical drawings especially the surface roughness parameter Ra is inscribed. The size of the surface roughness can be modified by various machining methods; one of these machining methods is the surface abrasive jet machining, which is based on the effects generated at the contact of the abrasive particles transported and directed to the workpiece surface by means of a compressed air jet. The results of the applying the abrasive jet machining can be influenced by the machining conditions; the paper presents some experimental results obtained at the study of the influence exerted by the average dimensions of the abrasive particles, by the distance between the nozzle and the flat surface of the test piece and by the angle of inclination between the abrasive jet and the flat surface of the test piece on the size of the surface roughness parameter Ra. The main conclusion was that for the considered experimental conditions, only the distance between the nozzle and the flat surface of the test piece exerts a significant influence on the surface parameter Ra.

1. Introduction

Conventionally, the surface roughness could be defined as the profile deviation (in comparison with the desired one) which is characterized by a ratio between the pitch and the height lower than 50. There are many parameters that could be used in order to offer information about the surface roughness; in accordance with the actual information, there are parameters of amplitude which take into consideration aspects referring to the prominence and gap (*Rp*, *Ry*, *Rz*, *Rc*, *Rt* etc.), parameters of amplitude which consider the average value of the ordinates (*Ra*, *Rq*, *Rsk*, *Rku* etc.), parameters of pitch (*RSm*), and hybrid parameters ($R\Delta q$) etc. If during the rough machining methods the material removal rate is one of the main technical requests, in the case of the finishing methods, the surface roughness becomes one of the most important output parameters. There are various machining methods used to obtain a certain roughness of the machined surface [2, 4]; one of these machining methods could be the abrasive jet machining. Essentially, such a machining method (abrasive jet machining) is based on the effects developed at the contact of the abrasive particles transported by a gas jet with the workpiece surface layer.

It is necessary to specify that the abrasive jet machining may be also used to obtain parts by material removal from the workpiece (abrasive jet milling, drilling, cutting etc.). One the other hand, there are machining methods whose objective is to diminish the size of the roughness and machining methods which are applied in order to increase the final surface roughness.

The effect of the impact angle variation on the erosion rate when a powder blasting process is applied to the glass workpieces was studied by Park et al. [6]. They presented some results concerning the micro-grooving of glass. They achieved grooves with a width of 80 μm and characterized by a surface roughness *Ra*=0.6 – 0.8 μm. One of the study conclusions is that the machining depth could be near proportional to the number of scanning time.

Ghobeity et al. applied two methods to machine planar areas with increased sidewall slope by using target oscillation and an inclined direction of the abrasive jet [3]; they showed that the oscillation generates steeper sidewalls and appreciated that this aspect is convenient for application, but a significant mask under-etching could be generated.

Heaton applied that plastic abrasive in order to remove coatings from surfaces in the case of aircraft skins [5]; he appreciated that the cost of blasting used for stripping paint and powder coatings from sensitive aluminium substrates could determine the extending of blasting, inclusive due to some ecological advantages.

2. Theoretical considerations

As above mentioned, the abrasive jet machining uses abrasive particles transported by

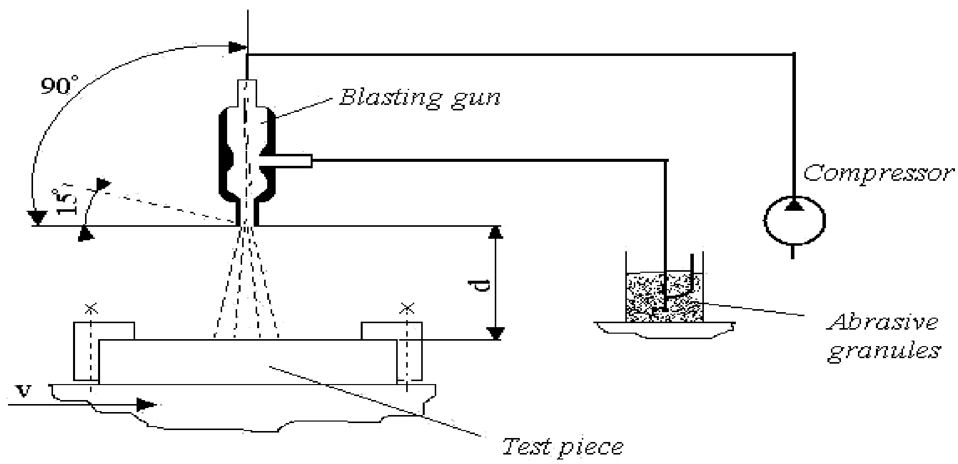

Fig. 1. Equipment for abrasive jet machining

means of a gas; to obtain the abrasive jet, adequate equipment must be used. Essentially, this equipment (fig. 1) includes a filtering subsystem, a compressor, a recipient which contains the abrasive powder and a blasting gun, where the depression generated by the circulation of the compressed air determines the absorption of the abrasive particles; a nozzle is used to generate the abrasive jet [7]. At the contact with the workpiece surface, the distribution of the abrasive particles could be considered as corresponding to the Gauss's law.

The main phenomena which develop at the contact of the abrasive particles with the workpiece surface layer could be the material local micro deformation, micro cracking and micro cutting. It is expected that if the pressure exerted by the abrasive particle on the surface layer material exceeds the compression resistance of the test piece material, initially plastic micro deformations could appear; if the pressure is high enough, micro cracking and micro cutting phenomena could be noticed. Of course, if the pressure is low, only elastic deformation could appear and this fact does not determine the changing of the test piece surface roughness, in the zones affected by the action of the abrasive jet.

One can assume that the phenomena developed as result of the impact are influenced by the mechanical properties of the test piece material; if there is a fragile material, especially micro cracks could develop, while when the test piece material has a high plasticity, especially plastic deformation could appear; of course, the mechanical properties of the workpiece material affect the size of the surface roughness parameters.

3. Experimental research

In order to verify some of the above mentioned theoretical considerations, experimental researches were designed and materialized.

Sandblasting equipment was used to ensure the generation of the abrasive jet. Essentially, as above mentioned, such equipment includes [7] a blasting gun connected to a compressor able to ensure the necessary pressure to the transport gas. A second flexible tube connected to the blasting gun ensures the absorption of the abrasive particles from a recipient, by using the effects of the Bernoulli's law.

The abrasive jet could be directed to the workpiece at various values of the angle between the jet axis and the flat surface of the test piece. Other parameter whose values could be changed during the experimental researches is the distance between the blasting gun nozzle and the flat surface of the test piece.

Taking into consideration the highlighting the influence of the test piece material on the results of the superficial abrasive jet machining, four materials were used for the test pieces:

- carbon steel characterized by a ultimate resistance R_m=37 daN/mm^2;
- technical aluminium, characterized by a ultimate tensile strength R_m=80 MPa, relative elongation of 40 %, hardness *HB*= 300 MPa;
- glass ($6SiO_2$•CaO•Na_2O, density 2,5 g/cm^3, strength of compression of about 200 MPa, Young's modulus *E* = 7.1010 Pa;

For each material, a factorial experiment with three variables (average size *g* of the abrasive particles, distance *h* between the nozzle and the flat surface of the test piece, angle *α* between the abrasive jet axis and the flat surface of the test piece) at two levels was considered. Thus, the average sizes of the abrasive particles were g_{min}=0.35 mm and g_{max}=1.6 mm; the sizes of the distances between the nozzle and the flat surface of the test piece were h_{min}=10 mm and h_{max}=40 mm, while the sizes of the angle were α_{min}=15 ^{0} and α_{max}=90 ^{0}. The test pieces were sandblasted for a period of 30 seconds; afterwards, the size of the surface roughness parameter *Ra* was measured by means of a roughness meter Mitutoyo.

The experimental results were processed by means of a software based on the method of the last squares [1]; taking into consideration a possible monotonous variation of the surface roughness parameter *Ra* in the intervals of variation of the input parameters, empirical

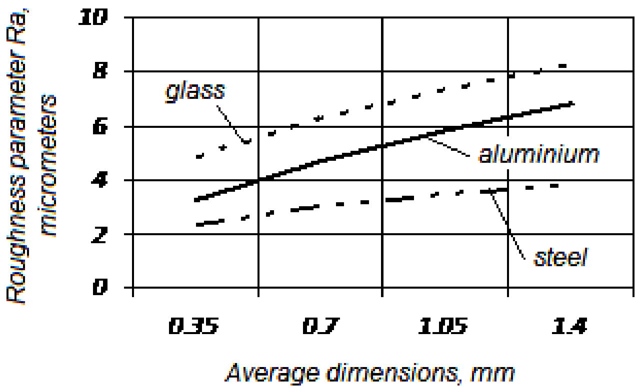

Fig. 2. Influence exerted by the average dimension of the abrasive particles On the size of the surface roughness parameter Ra

functions type power were preferred, due to the fact that such functions offer a direct image about the influence exerted by the considered input factors on the size of the surface roughness parameter *Ra*.

The following empirical relations were thus established:

- In the case of the test pieces made of carbon steel:

$$Ra = 4.471 g^{0.346} h^{-0.061} \alpha^{-0.00867}, \quad (1)$$

(the size of the Gauss's criterion being S_G=1827815);

- In the case of the test pieces made of technical aluminium:

$$Ra = 3.095 g^{0.531} h^{-0.068} \alpha^{0.0922}, \quad (2)$$

(the Gauss's sum being S_G=0.2973505);

- In the case of test pieces made of glass:

$$Ra = 3.66 g^{0.385} h^{0.0246} \alpha^{0.131}, \quad (3)$$

(the Gauss's sum being S_G=0.1772275).

The analysis of these empirical relations shows that among the considered input factors, only the average size *g* of the abrasive particles exerts a real influence on the size of the surface roughness parameter *Ra*, because only for this parameter the sizes of the exponents attached to the variable *g* has a significant value; for the other factors (distance *h* and angle *α*), the sizes of the exponents attached to them are close to zero and this means that for the considered experimental conditions, the distance *h* and the angle *α* practically does not affect the size of the surface roughness parameter *Ra*.

A diagram elaborated by taking into consideration the empirical relations (1), (2) and (3) is presented in figure 2. This graphical representation highlights the increasing of the surface roughness parameter *Ra* when the average dimension *g* of the abrasive particles increases; among the three material used during the experimental researches, the steel proved the possibility to obtain the minimum size of the surface roughness parameter *Ra*, while the applying of the surface abrasive jet machining generates the maximum size of the surface roughness parameter *Ra* in the case of the test pieces made of glass.

4. Conclusions

The superficial abrasive jet machining could be applied in order to modify the surface roughness of the pieces obtained in machine building and the researchers were preoccupied to study the factors able to influence the results of applying abrasive jet machining in cases of various materials. Due to specific aspects of impact between the abrasive particles and the test piece material, it is expected that the mechanical properties of the test piece materials influence the size of the surface roughness obtained by surface abrasive jet machining. Some experimental results of applying surface abrasive jet machining to test pieces made of various materials (glass, steel, aluminium) were presented in the paper. The empirical relations established by mathematical processing of the experimental results showed that for the considered experimental conditions, the main influence on the surface roughness parameter *Ra* is exerted by the average dimensions of the abrasive particles. In the future, there is the intention to extend the study of the influence exerted by the machining conditions and by the mechanical properties of the test piece materials on the surface roughness parameters.

References: **1**. Creţu, G. *Fundamentals of the experimental research. Handbook for the laboratory activities* (in Romanian). - Iaşi: Institutul Politehnic, 1992. **2**. Fan J.M., Wang C.Y., Wang, J., *Modelling the erosion rate in micro-abrasive air jet machining of glass*es. Wear, 266, 968-974, 2009. **3**. Ghobeity A., Papini M., Spelt J.K., *Abrasive jet micro-machining of planar areas and transitional slopes in glass using target oscillation*. Journal of Materials Processing Technology**,** 209, 5123-5132, 2009. **4**. Groover, M.P. *Fundamentos de manufactura moderna (translation of English language)*. - México: Prentice Hall Hispanoamericana, 1997. **5**. Heaton, R. *Improving surface prep through air blasting*, Metal Finishing, Vol. 107, No. 9, 2009, pp. 34-37. **6**. Park D.S., Cho M.W, Lee H., *Effects of the impact angle variations on the erosion rate of glass in powder blasting process*. International Journal of Advanced Manufacturing Technology, 23, 444–450 (2004). **7**. Slătineanu, L., Potârniche, Ş., Gherman, L., Coteaţă, M., Pop, N. *Glass behaviour at abrasive jet engraving*. Buletinul Institutului Politehnic din Iaşi, volume LVII (LXI), 4, Secţia Ştiinţa şi ingineria materialelor, 217-222, 2011.

УПРОЧНЕНИЕ ДЕТАЛЕЙ ИМПУЛЬСНЫХ МАШИН ПОВЕРХОСТНЫМ ПЛАСТИЧЕСКИМ ДЕФОРМИРОВАНИЕМ

Гилета В.П. (*НГТУ, Новосибирск, Россия*)
Тел./Факс: +7(383) 3462889; E-mail: pmx08@mail.ru

Аннотация: *В работе рассмотрены характерные поломки ударника пневмопробойника – импульсной машины для проходки скважин в результате усталостных разрушений, обусловленные конструктивными особенностями ударника. Приведены способы и режимы упрочнения ударника методами поверхностного пластического деформирования. Стендовые испытания показали, что проведенные мероприятия позволили в 2,5 раза повысить долговечность ударника.*

Ключевые слова: *ударник, импульсная машина, усталостное разрушение, поверхностное пластическое деформирование.*

В строительном производстве при возведении и реконструкции сооружений возникает потребность в получении горизонтальных, наклонных и вертикальных