

Aliyev, Eldar; Ismailova, Shebnem

## Article

# Development of a scheme for the distribution of contact areas between the plate and offset cylinders

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## Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics

Düsternbrooker Weg 120

24105 Kiel (Germany)

E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)

<https://www.zbw.eu/>

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Eldar Aliyev,  
Shabnam Ismailova

## DEVELOPMENT OF A SCHEME FOR THE DISTRIBUTION OF CONTACT AREAS BETWEEN THE PLATE AND OFFSET CYLINDERS

*The object of the research is the distribution of contact areas between the plate and offset cylinders. For printing impression in the offset printing process, it is necessary to ensure the transfer of printing ink from the ink unit to the printing plate, from the mold to the rubber-fabric material (deckel) of the offset cylinder and from the deckel to the printed material. At the same time, the quality of the prints is ensured by creating the necessary technological pressure between the plate, offset and printing cylinders, which also contributes to the deformation of the elastic deckel and the transfer of the ink layer in the contact zone. The transfer of illustrative and textual information from the form to the deckel of the offset cylinder occurs due to the actual touch area. Therefore, the study and calculation of the actual contact area is necessary to study the transfer of the paint layer in the contact zones. For this purpose, a review of some studies on contact problems was carried out, their advantages and disadvantages were discussed. Theoretical and experimental relations are given. It has been established that micro protrusions of the surface roughness of the printing plate significantly affect the deformation of the deckel. To study the influence of the surface roughness distribution of the printing plate on the actual deckel contact area in the contact zone, the interaction of micro protrusions of the surface roughness of the printing plate with the deckel surface, leading to additional displacements, was taken into account.*

*A method for calculating the number of roughness protrusions is proposed to further determine the actual deckel contact area and the actual pressure in the contact zone, taking into account the surface roughness of the printing plate. Based on the parameters calculated by the proposed method with known values of the surface roughness of the printing plate in the future it is possible to determine the actual deckel contact area and the actual contact pressure the optimal values of which are necessary to ensure the required ink transfer and print quality during printing. The data obtained also contribute to the determination of the modes of the printing process when printing the entire circulation, which leads to an increase in the circulation stability of printing forms. Increasing the circulation stability of printing plates allows to save the number of consumed printing plates. In the future, according to the results obtained, it is recommended to compile reference data, which are necessary when setting up and operating the printing machine.*

**Keywords:** actual contact area, roughness, deckle, printing plate, contact zone, micro-protrusions surface roughness.

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### 1. Introduction

The printing of prints in the offset printing process occurs by transferring the printing ink from the ink unit to the plate cylinder having the printing form, from the form to the rubber-fabric material (deckel) of the offset cylinder and from the deck to the printed material. The quality of prints in the offset printing process depends on the provision of the necessary technological pressure, which contributes to the transfer of the ink layer and creates deformation of the elastic deckel in the printing contact zone [1]. Therefore, it is necessary to analyze and calculate the real contact area for a better understanding of the transfer of the ink layer from the printing

plate to the deckel and from the deckel to paper [2]. The distortion of the image caused by the deformation of the platen press depends on the load during printing [3–5]. For this purpose, new methods for estimating the real contact area depending on the normal load are presented [2, 6–11]. Mutual contact of parts occurs along the roughness peaks and ledges, on which real contact is made [12, 13].

The amount of ink on the surface of the mold was determined and the separation and transition of the ink layer in the contact zone was studied, taking into account the deepening of micro protrusions of the roughness of the surface of the printing plate into the deckel body [14]. It has been established that the ink layer located in the

free space of the roughness of the surface of the printing plate is also involved in the transfer of ink.

In the studies, ink transfer and separation of the ink layer, as well as the interaction of the elastic deckel and the printing plate, were determined without taking into account the distribution of micro protrusions of the surface roughness of the printing plate.

An analysis of the literature data showed that when studying the printed contact, it is necessary to take into account the distribution of micro protrusions of the surface roughness of the printing plate, on which the real contact of the cylinders is carried out, the determination of which is a very urgent task of the printing process.

The aim of this research is to study the distribution of contact areas in the printed zone. To achieve the goal, the objectives were set:

- to develop a scheme for the distribution of contact areas in the printed area during the interaction of an elastic deckel and a printing plate;
- to determine the method for calculating the number of roughness protrusions, to further determine the actual deckel contact area and the actual pressure in the contact zone.

## 2. Materials and Methods

For research, a Rapida KBA 105 (Germany) offset printing machine was chosen, in which monometallic printing plates of the PRO-V brand, Fujifilm (Japan) were used. Determination of the parameters of the surface roughness of the printing plates was carried out according to the profilogram taken by the profilometer mod 130.

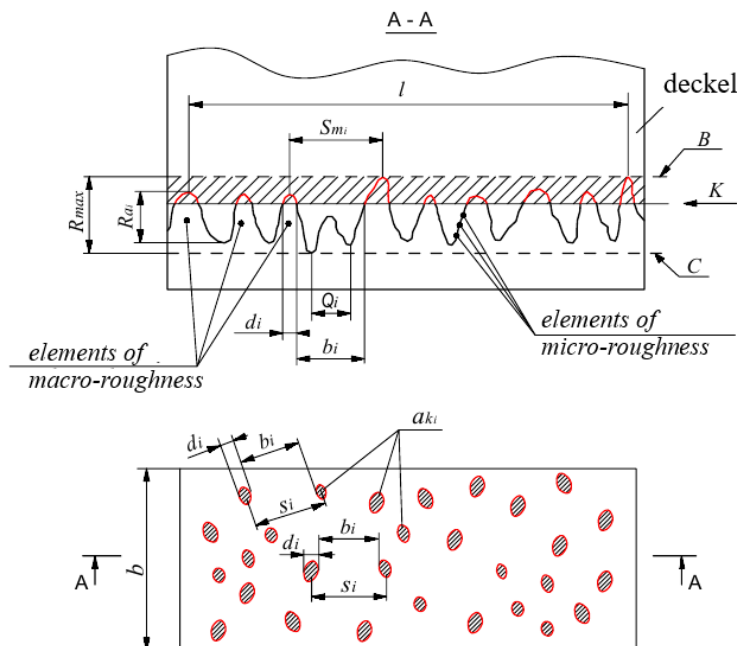
To study the influence of the number of protrusions of the surface roughness of the printing plate on the distribution of contact areas in the printed area in the offset printing method, a scheme is proposed for deepening the microprotrusions of the surface roughness of the printing plate into the deckel body (Fig. 1).

It is known that, the factors that really affect tribological engineering from the parameters of the existing GOST 2789-73 are the average pitch of irregularities and the average pitch of local protrusions of the profile [15, 16]. The authors of the article consider the roughness of the surface of the printing plate as a set of irregularities relative to the base plane of the form at the level of contact between the deckel and the surface of the printing plate.

The parameters used to assess the degree of roughness, based on the requirements of GOST 2789-73, with some specific additions, are presented in the diagram shown in Fig. 1.

It has been established that the formation of the actual deckel-rubber contact area depends on the  $n_m$  – the number of protrusion bases per unit nominal contact area and  $n_0$  – the number of protrusions crossed by the average level of mold surface roughness [15]. If to take into account the fact that the number of protrusions crossed by the middle level on the area corresponding to the base length  $n'_0 = l^2 / S_m^2$ , then  $n_0$  – the number of protrusions, on an area of 1 mm<sup>2</sup>, crossed by the middle level is equal to  $n_0 = 1 / S_m^2$ , where  $l$  is the base roughness length,

$S_m$  is the average roughness step. Accordingly,  $n_m = 1 / S_i^2$ , where  $S_i$  is the average step between adjacent roughness ridges. With known values of  $n_0$  and  $n_m$ , it is possible to determine the coefficient of convergence of surfaces  $-\alpha = n_0 / n_m = S_i^2 / S_m^2$ , which is necessary when determining the actual contact area.



**Fig. 1.** Scheme of recesses of micro protrusions of the roughness of the surface of the printing plate:  $K$  – plane of contact of the deckel surface with the elements of the macroroughness of the printing plate;  $C$  – the plane of the largest depressions of the macroroughness profile in the deckel contact zone;  $B$  – the plane of the largest microprotrusions of the macroroughness profile in the deckel contact zone;  $l$  – base length, mm;  $b$  and  $L$  – respectively, the width and length of the contact zone between the plate and offset cylinders, mm;  $S_i$  – the pitch of local protrusions,  $\mu\text{m}$ ;  $S_m$  – the step between the protrusions of the deckel contact with the surface of the printing plate within the base length, microns;  $R_{ai}$  – the partial depth of the roughness troughs, which is the vertical distance between the adjacent top and bottom of the roughness element,  $\mu\text{m}$ ;  $d_i$  – the microprotrusion imprint diameter,  $\mu\text{m}$ ;  $b_i$  – the distance between the imprints of microprotrusions,  $\mu\text{m}$ ;  $Q_i$  – the pitch of adjacent roughness microcavities,  $\mu\text{m}$ ;  $a_{ki}$  – spot area

## 3. Results and Discussion

When conducting experiments for the four printing plates used, the surface roughness parameters were determined from the profilogram taken with a profilometer mod. 130:  $R_{max}=0.644; 1.03; 1.85; 2.5 \mu\text{m}$ ,  $R_a=0.0615; 0.127; 0.375; 0.396 \mu\text{m}$ ,  $R_p=0.773; 0.426; 1.21; 1.31 \mu\text{m}$ ,  $l=0.25 \text{ mm}$ ,  $S_m=34.1; 25.7; 41.6; 30.1 \mu\text{m}$ ,  $S_i=4.64; 4.8; 6.37; 7.32 \mu\text{m}$ ;  $b=4 \text{ mm}$ ,  $L=1050 \text{ mm}$ . According to the proposed method, the number of protrusions was calculated:  $n_m=46447, 43402, 24644, 18662$ ;  $n_0=860, 1514, 578, 1104$ , as well as the coefficient of convergence of surfaces  $\alpha=0.136; 0.186; 0.153; 0.243$ . Where,  $R_{max}$  is the maximum roughness height;  $R_a$  is arithmetic mean value of roughness;  $R_p$  is height roughness parameter.

The advantages of this study in comparison with analogues can be considered that, with known values of the surface roughness of the printing plate, it is possible to calculate the actual deckel contact area and the actual contact pressure, which is necessary to ensure the required ink transfer and print quality. According to the data obtained, it is possible to set the printing modes

when printing both the first and subsequent circulation plants, which allows increasing the circulation resistance and saving the number of printed forms consumed. Based on the results obtained, it is also possible to determine and compile reference data for the printing process, which are necessary when setting up the printing machine.

#### 4. Conclusions

The developed scheme of recesses of micro protrusions of the surface roughness of the printing plate into the body of the deckel and the method for determining the number of protrusions of the surface roughness make it possible to determine the actual contact area of the deckel, which is a very important indicator for ensuring the necessary technological pressure and transfer of the ink layer in the printing process. The results of the research allow making the right choice of a set of printing form and deckel, as well as modes of the printing process, which provide the optimal value of the actual pressure and the required thickness of the ink layer, which ensure the quality of the prints. It is known that the production of one set of printing plates, installing them on the printing press and setting up the machine takes about two hours. Application of the proposed method makes it possible to increase the resistance of printing plates and reduce the specified time. At the same time, the predicted increase in the productivity of the printing process can be estimated at about 20 %, which must be confirmed experimentally.

#### Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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#### Data availability

The manuscript has no associated data.

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**Eldar Aliyev**, PhD, Associate Professor, Department of Mechatronics and Machine Design, Azerbaijan Technical University, Baku, Azerbaijan, ORCID: <https://orcid.org/0000-0002-6409-1293>

✉ **Shebnem Ismailova**, Postgraduate Student, Assistant, Department of Mechatronics and Machine Design, Azerbaijan Technical University, Baku, Azerbaijan, e-mail: [shebnem.ismayilova@aztu.edu.az](mailto:shebnem.ismayilova@aztu.edu.az), ORCID: <https://orcid.org/0000-0001-6063-0096>

✉ Corresponding author