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Impact wetting and contact angle on quality offset press

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Abstract
In this paper the most attention on the influence of surface tension. From the results it can be concluded that reducing the surface tension of wetting solution achieves higher print quality. At the same time reducing the amount of solution, which is transferred to the printing surface speeds up the drying process prints, and prevents the dimensional instability of paper. From the above it can be concluded that there is no solution for wetting the sole function of the refusal of oil paint free surfaces, although it is most important. It its quality composition affects: the printing form which prolongs the life of the rubber rollers that press during regeneration, the color with which it forms a stable emulsion and enables printing without difficulty. The solution wetting its irregular composition, can cause major problems in the press. Changing the pH to acidic or alkaline influences the physical and chemical stability of printed elements and free areas by destroying them, great hardness of water causes the formation of poorly soluble compounds that are deposited on the rollers and offset plates, excessive amount of emulsifying solution causes a color that causes toning printed etc. forms. These are just some of the reasons that require a great deal of attention in preparation for the damping solution.
The results showed that the temperature and saturation developer significantly affect the degree of wetting the free surface of the wetting solution. The lowest contact angle, ie the highest degree of wetting is achieved at a temperature of developer than 20°C.

Keywords: Graphic technology, the printing form, physico-chemical processes, offset printing

1. Introduction

The theme wetting plays an important role in many industrial processes, as well as lubricating oil, liquid coating, printing, and spray fire extinguishing. In recent years, there has been increased interest in the study of superhidrophobic surface, due to their potential applications, for example, self-cleaning, nanofluidics, and electrovetting. The importance of the study typically involves measuring the contact angles as the primary data, which indicates the degree of wetting when the solid and liquid interactions. Small contact angles correspond to high humidity, while a large contact angles correspond to low humidity.
Most of the techniques can be classified into two main groups: direct optical methods and methods of indirect force. Calculations based on the measured contact angle values obtained important parameter-solid surface tension, which quantifies the wetting properties of solid materials. The criteria for calculating the solid surface tension will be discussed on the basis of experimental contact angle values.
One of the most common techniques in modern printing press is a technique of offset printing. The basis for all art printing is a printing form which includes printed (accepted color) and free surfaces (not accepted color). On most printing form is achieved by selectively accepting colored geometric difference, but in offset printing to print and free surfaces differ in their physical and chemical properties, ie hydrophilicity and oleofilnost as surface phenomena. Printed surfaces must be highly oleophilic (hydrophobic), while the free surface must be highly hydrophilic (oleophobic) properties. The printing process is first applied to the wetting solution (water with additives) and accepts only the free surface. The next step is to apply paint with oil solvents and she accepts only on surfaces that are not covered by wetting solution (printed surface). Aluminum sheet, most often produces a printing form, must be surface treated by mechanical, chemical and electrochemical processes in order to get her thin, porous coating of aluminum oxide (free surface) which is at the end of oslojava photoactive layer (printed surface). Creating such a printing form consists of illumination and development, thus the free surfaces removes photoactive layer.
The aim of this paper is to present the chemical processes of making offset printing forms, and application of various methods which monitor and optimize these processes:

measurement of contact angle measurements, roughness parameters and electrochemical impedance spectroscopy. Furthermore, as the printing process is of great importance for the wetting solution interaction which is used for printing forms, it is necessary to determine its optimal chemical composition following the pH value, conductivity and surface tension.

2. Solvent Effects Time and Development

Developing a physical-chemical process of dissolving lit / unlit fotoaktivnog layer in an appropriate solvent. In the process of developing in both procedures (conventional and CtP) affect the functions of solvent, the time to develop and mechanical factors. The process of developing today is maximally automated with predefined time passing through the plate device for developing and rollers that perform mechanical pressure on the board when developing, but it is still necessary to control this process with respect to other parameters that influence the process of developing (temperature, saturation developer,).

Ideally, all the parameters of solvents should be constant, ie within set boundaries. Saturation of solvents is constantly changing. In the development, the solvent must be recovered, as by dissolving fotoaktivnog layer creates an increasing saturation, which reduces the effect of solvents or even completely prevented. Too long or too short exposure to solvent results in too small or too large dot values, so you can always regulate the time to develop, and the solvent is held off until the moment when the developer so saturated that it cannot be regenerated. Developing and solubility depend on the temperature of the solvent. The optimum temperature is 20-22ºC develop. With increasing temperature the particles move faster, so that increases the rate of reaction, the solvent is rapidly saturates, and, if that does not watch out, the process can become rather aggressive and lose small details, so it is necessary to reduce the time of dissolution. Likewise, if the temperature is too low, the process is slowed down and up to 2 to 3 times.

2.1. The solution for wetting

Addition to the basic role, preventing the application of paint on the free surface, the wetting solution to the printing process must:

- maintain the hydrophilic character of the free surfaces,
- enable quick cleaning paint with free surfaces,
- enable the rapid expansion of water on the surface of the printing form,
- enable uniform flow of water through the rollers wetting,
- greased plates, rollers and offset cylinder,
- control emulsification of water and paint and
- controlled cooling.

If wetting during the printing process is not good, there may be negative consequences. One of them is flush printed surface as a result of the excessive amount of solution for wetting the surface of the printing form. Or toning, which occurs in case of insufficient quantities for the damping solution on the surface of the printing form, and color acceptance on free surfaces. To wetting solution could meet all the demands that are placed on it, in addition to the basic ingredient, water is added to the solution of a number of supplements, each of which has its role during the printing process.

2.2. Water

Chemistry untreated water is composed of a lot of dissolved minerals in the printing process can create problems. Depending on the amount of dissolved minerals have hard and soft water. Hard water contains a lot of different dissolved inorganic salts. One dissolution in water dissociates into ions (Ca_2^+, Mg_2^+, Na^+, CO_3^{2-}, Cl^-). If the concentration of calcium ions (Ca_2^+), and carbonate (CO_3^{2-}) is large, it may cause precipitation of calcium carbonate ($CaCO_3$), which is in the process of printing is deposited on the rollers. Glue and reduces their ability to transfer solution for wetting. If precipitation occurs on the surface of the printing form to reduce its free surface energy and thus has a negative impact on the power of adsorption of the wetting solution. It may also cause an increase in the pH value of the solution affects the electrical conductivity of the solution wetting. All these bad effects as a consequence may have the toning process printing. Therefore, it is necessary for the preparation of solutions for moistening pay attention to the hardness of the water, and if it is too big implemented demineralization, ie. for the preparation of solutions for moistening use demineralized water.

3. Contact Angle Measurement

The measurement of contact angle on freshly prepared samples of printing forms is measured contact angle of wetting. Samples should be first dried dry cloth, and set the goniometer. Goniometer over the video system projects the image on the splash screen of your computer, and determine the position of the droplets with an accuracy of ±1mm. The accuracy of the video system is also under the specifications of ±1 mm. The angle of wetting can be determined by computer, using Vhilhelmi sessio drop method or methods, and may vary 0-180º, including video oscillation system of ±1mm. Sessile drop method or the hanging drop method - when a drop of liquid comes in contact with a solid flat surface, droplets form a specific shape. The contact angle is measured between the basic level (touch the surface of the liquid and solids) and tangent droplets on the border of three phases (solid, liquid and gas).

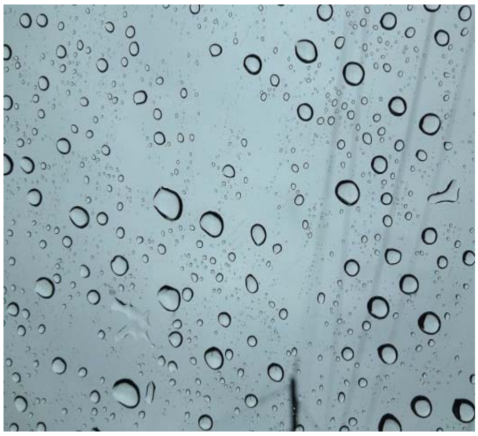

Fig 1: Water droplets on glass

When taking liquid interface and the solid, the angle between the liquid surface within the contact area is described as the contact angle θ (small letter theta). Contact angle (wetting angle) is a measure of moisture solids from liquids.

In the case of complete wetting (spreading), the contact angle is 0°. Between 0° and 90°, and the wettable solid above 90° is not wettable. In the case of the so-called ultrahidrophobic material. lotus effect, the contact angle approaches the theoretical limit of 180°.

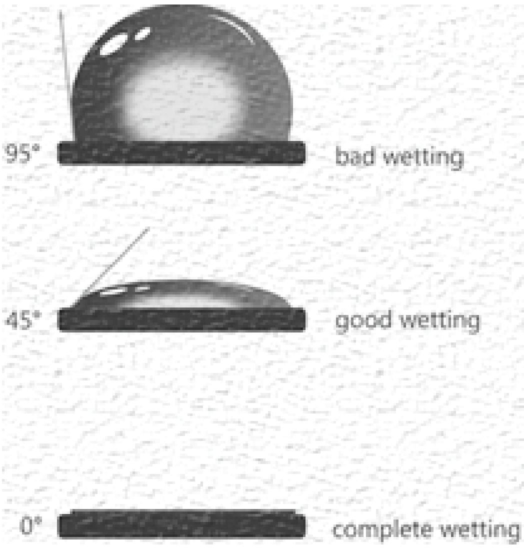

Fig 2: Contact angle on different materials

According to Young's equation, there is a connection between the contact angle θ, the surface tension of the liquid σ_l, interfacial tension between σ_{sl} liquid and solid and surface energy σ_s the good:

$$\sigma_s = \sigma_{sl} + \sigma_l \cdot \cos\theta$$

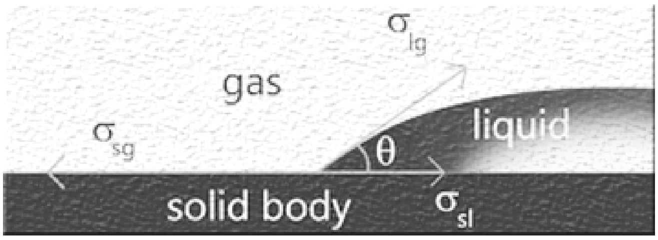

Fig: 3. Schematic diagram of contact angle

The contact angle with one or more liquids can be used to determine the surface free energy of a solid.

3.1. Determining the quality of contact

Moisture determines the quality of contact between the liquid and its limiting surface. The moisture content is also described in terms of hydrophilicity or hydrophobicity. Hydrophilicity characteristics of the materials show an affinity to water and to hydrophobic in the second concept. Hydrophilic materials having the ability to form a hydrogen-connection with water. The hydrophilic character of the surface can be represented by the angle contact between the liquid and the solid substrate when a liquid or a stationary or slow passes over the surface. The figure shows how the angle of contact and droplet shape changes depending on the degree of hydrophobicity.

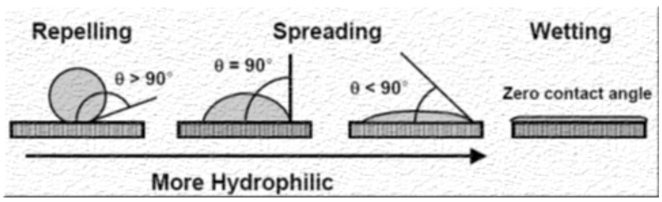

Fig 4: Contact angles and hydrophilicity

3.2. Measurement of contact angle on the goniometer

Contact goniometri a method to determine the moisture on the surface. It can be used to calculate the area and energy. The contact angle is the angle at which the interface liquid/ vapor meets a solid surface. It is specific for any given system that determine the interaction of all three interfaces - solid / liquid, solid and liquid gas/gas.

The term wetting describes contact between the liquid and the solid surface. The amount of wetting depends on the energy (or surface tension) on the interface are included in the total energy is minimized. The degree of wetting is the contact angle described. This is the angle at which the interface liquid / vapor meets the solid / liquid. On a flat surface contact angle is measured by a suitable liquid drops lying on the surface. If the liquid is strongly attracted to the solid surface, as for example, water on the hydrophilic solid, droplets will be fully deployed on a solid surface and the contact angle will be close to zero degrees. Less hydrophilic residue will have a contact angle up to 90^0. If the solid surface is hydrophobic, the contact angle will be greater than 90^o. The surfaces with an angle of more than 150^o contact is called superhidrophobic surface. On these surfaces, water droplets simply restu on the surface, without actually wetting to any significant extent. The angle of contact thus directly provides information about the impacts of energy between the surface and the liquid.

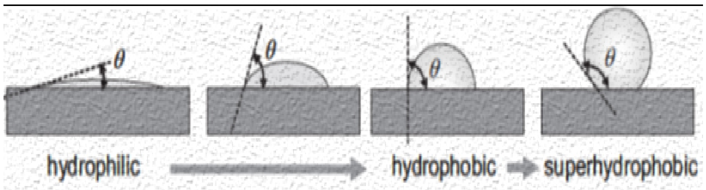

Fig 5: Schematic of different levels of humidity surface

Theoretical description of the contact arises from consideration of thermodynamic equilibrium between three phases: liquid phase droplets (L), the solid phase substrate (S), and gas / vapor phase environment (V). The second will be a mixture of ambient atmosphere and the equilibrium concentration of vapor or liquid could alternatively be another immiscible liquid phases. At thermodynamic equilibrium, the chemical potential of the three phases should be equal. It is generally should consider interstitial energy. Using the simplified equation can be written as:

$$0 = \gamma_{SG} - \gamma_{SL} - \gamma \cos\theta$$

Young equation assumes a perfectly flat surface, and in many cases the surface roughness and impurities cause a deviation in the equilibrium contact angle from the point of contact provided for Jang equation. Even in a perfectly smooth surface will drop to assume a wide range of contact angles between the highest (advancing) contact angle, ha, while the lowest (Receding) contact angle, HR.

There are several methods available for measuring the angle of contact surfaces:

1. The most stable static sessile drop method where the angle between the liquid/solid interface and / vapor interface of the liquid is measured using a microscope or optical system with high resolution cameras and software for recording and analysis of the contact angle.
2. Dynamic sessile drop is similar to the static oak decline but requires that the decline modified. The highest contact angle possible without increasing your firm/liquid interfacial area is measured by adding a dynamic volume. Thismakimumangle the advancing angle, ha. Tom is then removed to produce the smallest possible angle, receding angle, HR. The difference between the advance and retreat angle is the contact angle hysteresis. dynamic contact angle

can be measured for a drop travels down the inclined surface.

4. Experiment

Contact angle is one of the most common ways to measure the moisture on the surface or material. Wetting refers to the study of how fluids deposited on a solid (or liquid) or substrate extends the ability of liquids to form a boundary surface of the solid state. Wetting agents, such as mentioned above is determined by measuring the contact angle, the liquid forms in contact with the solid or a liquid. Wetting fluid is a liquid which forms an angle with a contact solid which is smaller than 90°. The liquid-wetting angle of contact creates between 90 and 180° with the firm.

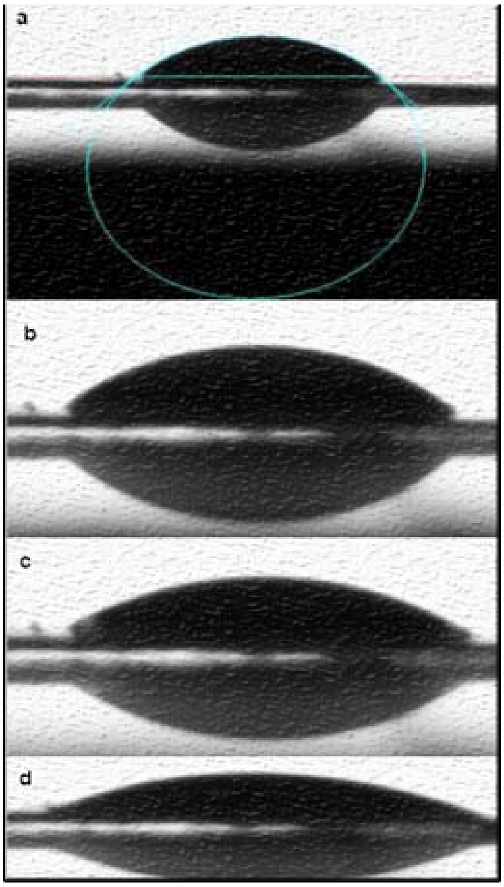

Fig 6: a) Determination of the contact angle measurements on the goniometer, **b)** at the time of droplet contact with a surface, **c)** droplets after 3 seconds, **d)** after the droplet 7 seconds

4.1. Results of contact angle for solutions

Figure shows the results of the mean values of the measured contact angles depending on the temperature changes of standard solutions (diiodomethane, formamide and double-distilled water).

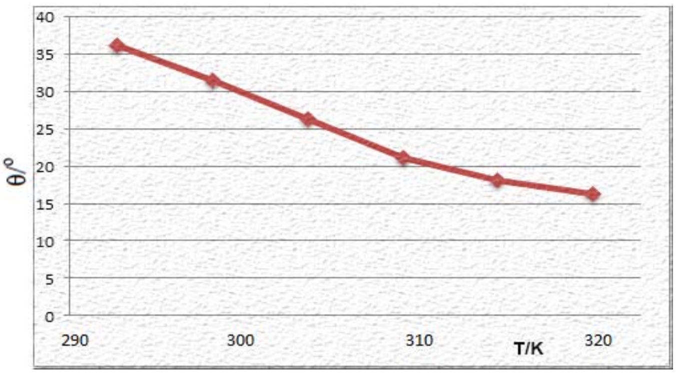

Fig 7: Redestilovana water - The dependence of contact angle and standard temperature drops

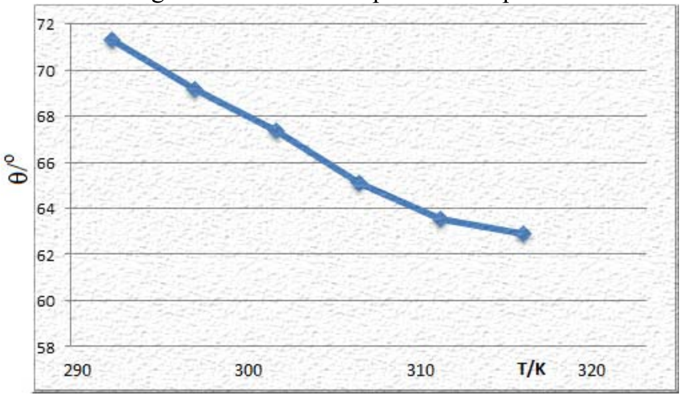

Fig 8: Diiodomethane - The dependence of contact angle and standard temperature drops

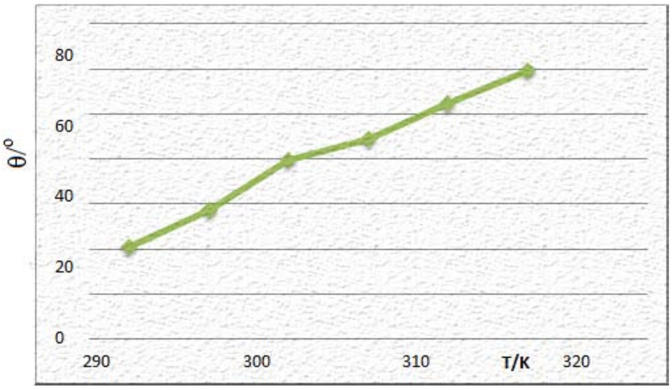

Fig 9: Formamide - The dependence of contact angle and standard temperature drops

From the graphic is evident that the values of contact angle decreases linearly with increasing temperature. It may be noted that the formamide and diiodomethane have higher values of contact angles of double-distilled water, and that their smaller changes depending on the temperature rise.

The printing form is made of aluminum, which spontaneously oxidized in air, which formed aluminum (III) oxide, which is polar material. Therefore, it was expected that upon contact with such highly porous material non polar diiodomethane show high values of contact angle (from 71.32 to 62.88º). On the other hand, the polar water will be well adsorbed to aluminum (III) oxide, and thus the value of the contact angle of less (36.10º to 16.28º). The biggest drop contact angle shows double-distilled water.

Increasing the temperature of 295.20 K to 314.80 K (20°C - 40°C), the contact angle decreases to 20: 22K, which amounts to a reduction of the contact angle of nearly 1° by 1 K. This difference changes the contact angle measured for fluid can be explained by the viscosity of each liquid. Viscosity formamide at 295.20 K is 3305 mPa•s, diiodomethane viscosity 2.81 mPa•s, and the viscosity of water only 0.1004 mPa•s. The diagram shows that the change in temperature of 20 K, reducing the value of the contact angle of at least najviskozniju liquid (formamide - 0.45%).

Slightly higher decrease of contact angle indicates slightly less viscous liquid (diiodomethane - 11.66%), while reducing the contact angle by far the least viscous liquid (demineralized water - 55.59%) the highest.

4.2. Results of contact angle solution for wetting

Contact angle was measured also 15 times for each sample solution prepared by moistening at temperatures from 295.20 K to 314.80 K with a shift of 6 K. From the results calculated by the mean value of the contact angle for each of these temperatures. The graphical representation of the mean values of the measured contact angles depending on the change in temperature for both samples for the damping solution is shown in fig.

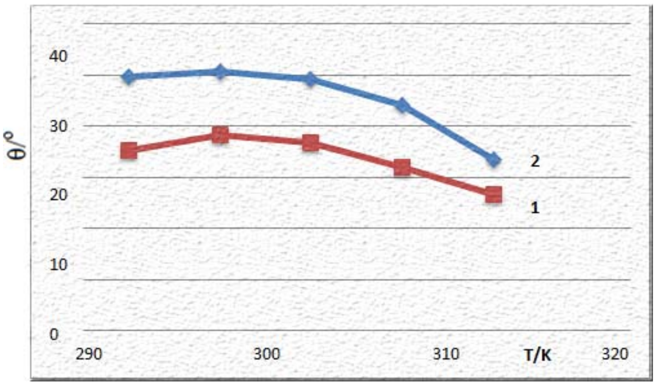

Fig 10: The ratio of contact angle and wetting solution temperature

The dependence of the contact angle of the temperature for both samples for the damping solution. The Figure shows how a change in temperature directly affects the change in contact angle. One can notice how both sample solution wetting show similar dependence on increasing the temperature. It is evident that the heating of the printing form with 296.10 K to 302.25 K contact angle grows slowly, no further increase in temperature the contact angle decreases. In this sample 1 shows lower values than the sample 2. This shows how the value of the contact angle of two different samples for the damping solution for the same change in temperature are almost identical behavior, which indicates very similar physico-chemical properties. Reducing the value of the contact angle by increasing the temperature can be explained by the reduced viscosity solution wetting. As the temperature rises, the kinetic energy of the particle fluids, thus reducing the force of attraction between the molecules, and therefore the viscosity decreases.

5. Conclusion

The tests in this study showed that the impact on the quality of the developer of the free surfaces, although the process of developing a standardized, significant. Presents the results of this research, as well as defined conclusions expand what is currently known about the surface structure and surface phenomena on printing forms.

By increasing the temperature leads to a linear decrease of contact angle. The largest reduction shows demineralized water, since she had it share of the largest polar phase. The smallest change in contact angle indicates formamide. This can be attributed to the large viscosity of the formamide. Reducing the value of the contact angle by increasing the temperature can be explained by the reduced viscosity of the solution wetting. The increase in surface free energy surface causes the improvement of wetting wetting solution.

It may be useful to do additional research and come up with a solution to the dynamic conditions during the printing process to ensure the same print quality throughout the print run.

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