The effect of washes on the offset rubber blanket

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Abstract. The recognition of the spectra of expendable materials for traditional convection offset printing is shown. The theoretical analysis (calculation) of thermodynamic compatibility and assessment of dynamics of interaction of various liquids with polymer that is part of offset blanket is carried out.

1. Introduction
Offset blanket is indirect surface for transferring paint from mold to the paper and is an integral part of offset printing. The paint transfer depends on quality of offset blanket surface, which means the quality and color of printing products [1,2].

The composition of upper rubber-fabric layer has polarity. It is related to the fact that ink that is used for printing, also has polarity. Traditional oil color is nonpolar. Therefore, composition of upper NBR fabric layer (nitrile butadiene rubber, NBR) is polar, because nonpolar: oil and traditional wash-up, and additive in conditioning and water are polar. Opposite polarity is used to avoid swelling. If you use EPDM cloth and traditional paint for printing, the rubber begins to swell quickly. Negative wash-up penetrates the rubber and pulls out the flexible agents and cloth shrinks. Rubber becomes thicker with positive swelling. During the operation of offset blanket, the surface is contaminated with paint, paper, fountain solution and their reaction products. It is also necessary the offset blanket to clear from old image when starting a new print [1-6].

Contacting liquids and their mixtures must be safe for offset blanket, humans and environment. Study of liquids, which contact with offset blanket and assessment of their harm is important issue. In this article, the actual liquids of agents, used in printing plants are determined, and calculation of their sorption on the surface of offset blanket is proposed. Consider the agents of traditional convection offset printing.

The fountain solution includes water > 70%, isopropyl alcohol < 12% and additive in conditioning < 5%. The additive in conditioning for convection printing contains water > 60%, ethylene glycol < 10%, wetting agent < 5% and other additives (colouring agent < 1%, driers < 1%, anticorrosive < 1%, antibacterial < 1%, anti-foam agent < 1%, etc.).

Paints are necessary to create an image on paper. Paints have dry color of 20-22%, resins (rosin-phenolic) 30-35%, oils 10-20%, petroleum solvents 15-20%, additives (pastes, driers) 5-10%

Daily wash-up is designed to quickly clean the offset blanket from old image and should easily clean the surface of offset blanket and quickly evaporate [6-9].

Deep cleaning agents are designed to remove paint, paper and other contaminants from pores. Deep cleaning agents restore the surface of offset blanket and return the ink trapping of paint [8-13].
2. Subjects and methods

The most common expendable materials for traditional convection offset printing presented on Russian market were taken as samples (table 1).

| Name                        | Application                                                                 |
|-----------------------------|-----------------------------------------------------------------------------|
| Böttcherin Gelb new         | Special flushing agent for wash-up the offset cloth. It can also be used for wash-up printed forms. |
| Böttcherin EG-20            | Agent for intensive cleaning of rollers and offset cloths.                  |
| Varn® Jelly Revitol         | Cleaning and restoring gel - from heat and pressure of rollers of inking mechanism, it is liquefied to a certain extent so that it acts as a cleaning liquid. |
| Varn® S.R.R.                | Cleaning agent for deep manual cleaning of rollers, offset blanket.         |
| Boettcher Boettcher BoECLEAN RE | Special cleaning agent for cleaning and caring for paint rollers and offset blanket when changing colors quickly. |
| Alcohol                     | Absolutized (GOST 9805-84) isopropyl                                        |

The research was carried out on the SIMEX FT–801 Fourier-transform infrared spectrophotometer, using the attenuation total reflection method using a prism made of zinc selenide. Spectrum recognition was performed using Zair 1.0, ZAIR 3.5, and characteristic group frequency tables. Thus, by analyzing paints, wash-up, cleaners and process fluids, we can determine the model fluids that affect offset blanket [1-14].

3. Results and discussion

1) Varn® S.R.R. colorless liquid.
   Analysis of first sample showed that it is a two-base ether "dbe". IR spectrum is shown in figure 1. The red curve is spectrum of intact substance, and blue curve is spectrum from the ZAIR 1.0 database.

![Figure 1. IR spectrum Varn® S.R.R.](image)

The following bands are well represented on spectrum:
- 1735 cm\(^{-1}\) – limit aliphatic esters – CH\(_2\)-COOR;
- 1435 cm\(^{-1}\) – symmetric bending vibration of CH\(_3\) group in carbomethoxy esters;
- 1158 cm\(^{-1}\) – asymmetric stretch vibrations of C-O-C group in aliphatic ethers.

This product is widely used and sold under the name DBE by company "Neo Chemical", Dzerzhinsk. The product is a mixture of esters: dimethylsuccinate (15-28%); dimethyl glutarate (51-70%) and dimethyladipate (9-25%).

Boettcher BoECLEAN RE yellowish paste
Analysis of the second sample showed that it is hard phase dispersed in oily substance. Dissolution of this sample in heptane and subsequent centrifugation at 6000 rpm within 15 minutes, it allowed to isolate the solid phase and obtain its IR spectrum. It is presented in figure 2.
Analysis of IR spectrum of extracted sediment showed that it is aluminosilicate. This is confirmed by the presence of strong line in the range of 1090-1020 cm\(^{-1}\), which corresponds to Si-O stretching vibrations.

Analysis of liquid phase has shown that it is possible to use Akvol lubricating-cooling fluid. Figure 3 shows the IR spectrum of liquid phase of sample 2.

2) Varn® Jelly Revitol milky appearance of gel.

Analysis of third sample showed that a water-soluble Castrol Sintilo RHS lubricating-cooling fluid is possible. Figure 4 shows the IR spectrum of this sample.

A wide band around 3000-3700 cm\(^{-1}\) shows a large number of O-H groups.

3) Analysis of IPA sample showed that this sample is isopropyl alcohol. IR spectrum is shown in figure 5. Black curve is spectrum of source substance, and red curve is spectrum of isopropyl alcohol from ZAIR database.

Analysis of Gelb-new sample showed that it is a special aviation lubrication oil Castrol Aero GT-85. Figure 6 shows the IR spectrum of this sample. Black curve is spectrum of source substance, and red curve is spectrum from ZAIR database. Analysis of characteristic group frequencies shows that this substance is mixture of aliphatic and aromatic hydrocarbons. This is indicated by presence of following bands:

- 2954 cm\(^{-1}\) – asymmetric stretch vibrations of CH\(_3\) group in saturated hydrocarbons;
- 2921 cm\(^{-1}\) – asymmetric stretch vibrations of CH\(_3\) group of methyl group attached to benzene ring;
- 2869 cm\(^{-1}\) – symmetric stretch vibrations of CH\(_3\) group in saturated hydrocarbons;
- 2855 cm\(^{-1}\) – symmetric stretch vibrations of CH\(_2\) group in saturated hydrocarbons;
- 1455 cm\(^{-1}\) – asymmetric deformation vibrations of CH\(_3\) group in derivatives of alkylbenzenes;
- 1377 cm\(^{-1}\) – symmetric deformation vibrations of CH\(_2\) group in aliphatic hydrocarbons.
Figure 5. IR spectrum of IPA sample.

Figure 6. IR spectrum of Gelb-new sample.

Analysis of Eg-20 sample showed that the IR spectrum of this sample is almost identical to that of Gelb-new sample, except for two lines, namely 1711 cm$^{-1}$ and 1220 cm$^{-1}$. These lines relate to the fluctuations of the group $-\text{H}_2\text{C}=-\text{CO}=-\text{CH}_2-$ and C=O in aliphatic ketones. Figure 7 shows the IR spectra of original sample (black line) and spectrum from the ZAIR database (red line).

Thus, Eg-20 sample is mixture of CASTROL Aero GT 85 aviation lubrication oil and acetone in ratio of 76:24.

Figure 8 shows the IR spectrum of acetone.

Kerosene and all other petroleum products that make up aviation oil and lubricants are aliphatic (saturated) hydrocarbons C7 and more. Table 2 provides a calculation for heptane. For all others, solubility parameter will be almost the same. In this way, we can identify the following model fluids in contact with offset blanket and calculate their dynamic compatibility (table 2).

To determine the solubility parameter of a low-molecular substance (liquid) and polymer material uses the molecular attraction constants of Resin, which are contained in tables of molecular attraction constants [9-15]. They are used to calculate the solubility parameter using the formula:

$$\delta^2 = \frac{\sum F_i}{V_m},$$  

(1)

where $F_i$ is tabulated value of contribution of structural fragment of a molecule, atom or bond between atoms to value of solubility parameter of a substance, MJ $^{0.5}$/m$^{1.5}$·mol; $V_m$ is molar volume of substance, m$^3$/mol.
To calculate the solubility parameter of a polymer or liquid (solvent), the structural (graphical) formula of substance or repeating polymer link is identified, divided into separate functional groups, and value of its contribution to the value of solubility parameter of a substance ($F_i$) is found.

Table 2. The calculated values of solubility parameters of polymers and solvents.

| Compound                   | Structural (graphical) formula of repeating polymer and liquid link | The values of solubility parameter, $\text{MJ}^{0.5}/\text{m}^{1.5}\text{mol}$ |
|----------------------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------|
| nitrile butadiene rubber   | \( \text{CH}_2-\text{CH}=\text{CH}-\text{CH}_2-\text{CH}(\text{CN})-\text{CH}_3 \) | 9.83, 8.92                                                                       |
| ethyl acetate              | \( \text{CH}_2-\text{CO}-\text{CH}_3 \)                            | 8.92                                                                           |
| ethanol                    | \( \text{CH}_3-\text{CH}_2-\text{OH} \)                             | 12.02                                                                          |
| isopropyl alcohol          | \( \text{CH}_3-\text{CH}-\text{CH}_3 \)                             | 10.58                                                                          |
| n-heptane                  | \( \text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3 \) | 7.48                                                                           |
| toluene                    | \( \text{C}_6\text{H}_5-\text{CH}_3 \)                             | 8.94                                                                           |
| o-Xylene                   | \( \text{CH}_3-\text{C}_6\text{H}_4-\text{CH}_3 \)                  | 9.00                                                                           |
| cyclohexanone              | \( \text{C}_6\text{H}_{11} \)                                       | 8.23                                                                           |
| acetone                    | \( \text{CH}_3-\text{CO}-\text{CH}_3 \)                             | 10.00                                                                          |
| ethylene glycol            | \( \text{HO}-\text{CH}_2-\text{CH}_2-\text{OH} \)                   | 16.30                                                                          |
| dimethyl glutarate         | \( \text{H}_2\text{CO}-(\text{O}-(\text{CH}_2)_3-\text{C}(\text{O})-\text{OCH}_3 \) | 10.04                                                                          |

According to calculated values of solubility parameter, it follows that an offset rubber cloth based on a copolymer of butadiene-nitrile rubber will dissolve in acetone ($\Delta\delta=0.17<1$), as well as in dimethyl glutarate ($\Delta\delta=0.21<1$). In ethyl acetate ($\Delta\delta=0.91<1$), isopropyl alcohol ($\Delta\delta=0.75<1$), toluene ($\Delta\delta=0.89<1$) and o-xylene ($\Delta\delta=0.83<1$), this material will swell. Offset blanket will not be dissolved in ethylene glycol ($\Delta\delta=6.47>1$), n-heptane ($\Delta\delta=2.35>1$), ethanol ($\Delta\delta=2.19>1$) and cyclocexanone ($\Delta\delta=1.60>1$).

4. Conclusion
The results obtained allow us to recommend the use of ethylene glycol and ethanol (aliphatic (saturated, diatomic and monatomic) alcohols), cycloexanone (alicyclic ketones), n-heptane (aliphatic (saturated) hydrocarbons) as agents that prevent the swelling of offset rubber blanket (ORB), since the values of solubility parameters do not coincide. These liquids diffuse into offset blanket at minimum speed and in smaller quantities, do not dissolve the surface layers of polymer and do not have a plasticization effect on it.
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