The methods and the theory of computing the thicknesses of neutral light filters are explained in [1-7]. In specific cases, however, depending on the goals in the application of light filters, an original approach is required in the establishment of the thicknesses of neutral glasses in order to obtain light filters having a given light transmission. In the design of light filters it is necessary to take into account the spectral sensitivity of the light receiver, the spectral composition of the radiation attenuated by the light filter, and the index of absorption. It is necessary to compute the thickness of light filters as a function of a specific glass melt.

Computation of the Thickness of Neutral Glasses in Order to Obtain a Light Filter Having a Given Transmission Coefficient \( t_k \) for a Given Wavelength \( \lambda \). For computation of the required thickness it is necessary to measure the spectral index of absorption \( d_\lambda \) of a specimen of the same glass of the melt from which the light filter is being made. The required thickness is computed from the formula

\[
t = \frac{D_\lambda - D_\rho}{d_\lambda},
\]

where \( D_\lambda = -\lg t_\lambda \); \( D_\rho \) is the correction for reflection.

The correction \( D_\rho \) for glasses of different marks is given in GOST 9411-66 "Glass, colored, optical." For more accurate determinations it is required to take into account the change of the reflection coefficient \( D_\rho \) with wavelength

\[
D_\rho = -2 \lg \left( 1 - \frac{R_\lambda - 1)^2}{R_\lambda + 1)^2} \right),
\]

where \( R_\lambda \) is the index of refraction of the glass for a given wavelength.

Example. Determine the thickness of NS3 glass in order to obtain a light filter having a transmission coefficient \( t_{580} = 10.7\% \) \( (D_{580} = 0.039) \). For NS3 glass the correction for reflection is \( D = 0.039 \). For the design we had a specimen 2 mm thick from an NS3 glass melt. From measurements on a spectrophotometer it was found that for the melt specimen \( t_{580} = 0.166 \). This corresponds to \( D_{580} = 0.78 \).

Using (1) we find the absorption index \( d_\lambda \) of the given glass melt (the optical density of the glass for a thickness of 1 mm):

\[
d_\lambda = \frac{0.78 - 0.039}{2} = 0.37,
\]

\[
t = \frac{0.97 - 0.039}{0.37} = 2.51 \text{ mm}.
\]

Computation of the Thickness \( t \) of Neutral Light Filters Used in Visual Photometry. The optical density of neutral glasses in the visible region of the spectrum (with the exception of NS1, NS2, and NS3 glasses) is linearly dependent on thickness. Therefore in the computation of the thickness of the glass we use (1). The difference is only
that the absorption index of a glass of a specific melt needed for the computation is computed from data from a
visual measurement of the transmission coefficient of the specimen of a glass melt.

Example. Determine the thickness of NS8 glass needed for obtaining a light filter having a light transmission
coefficient $\tau_{\text{vis}} = 10\%$ ($D_{\text{vis}} = 1$), with the light temperature of the source being $T_{\text{lt}} = 2854$ K. The thickness of the
glass specimen is $t = 2.04$ mm, and the reflection coefficient is $D_\rho = 0.036$. The measured value of the transmission
coefficient $\tau_{\text{vis}}^0$ of this glass specimen on a visual photometer was $\tau_{\text{vis}}^0 = 0.255$ ($D_0 = 0.593$).

The absorption index of the glass of the given melt is found from (1):

$$d_{\text{vis}} = \frac{0.593 - 0.036}{2.04} = 0.273.$$

The sought thickness of this glass for the given light transmission is also found from (1):

$$t = \frac{1 - 0.036}{0.273} = 3.16 \text{ mm}.$$

Computation of the Thickness $t$ of Neutral Glasses for Obtaining a Light Filter Having a Given Light Trans-
mission $\tau$ for an Objective Receiver and a Radiation Source Having a Complex Spectral Composition. Since over a
wide region of the specimen neutral glass is selective, the computation of the integral light transmission $\tau_{\text{tot}}$ in this
case is carried out with the formula

$$\tau_{\text{tot}} = \frac{\int E_\lambda v_\lambda \tau_\lambda d_\lambda}{\int E_\lambda v_\lambda d_\lambda} = \frac{\int E_\lambda v_\lambda 10^{-(d + D_\rho)} \tau_\lambda d_\lambda}{\int E_\lambda v_\lambda d_\lambda},$$

(2)

where $E_\lambda$ is the relative distribution of the energy of the radiation of the source over the spectrum; $v_\lambda$ is the relative
spectral sensitivity of the receiver; $\tau_\lambda$ is the spectral transmission coefficient of the glass of a given melt; and $d_\lambda$
is the spectral absorption index of a given glass melt.

The determined glass thickness enters into the exponent of the subintegral function. The solution can be found
by graphical means. For this it is necessary to consider the light transmission of glass of a given melt with respect to (2) for several values of thickness. In this instance the integration is replaced by summation. Then we construct a graph of the dependence of the transmission coefficient $\tau_{\text{tot}}$ of a given glass melt on the thickness $t$, with respect to which we determine a thickness corresponding to a given value of $\tau_{\text{tot}}$.

Example. Determine the thickness of neutral glass for obtaining a light filter having a transmission coefficient
in the light of a source having $T_{\text{lt}} = 2854$ K for an objective receiver having a known spectral sensitivity.

First we measure, through an interval of 10 mm, the spectral transmission coefficient $\tau_\lambda$ of a specimen of a
given melt of neutral glass on a spectrometer, and we compute for each wavelength the absorption index $d_\lambda$. We
determine the average absorption index

$$d_\lambda^{av} = \frac{\sum d_\lambda}{n},$$

where $n$ is the number of values of $d_\lambda$. With the average absorption index $d_\lambda^{av}$ we determine the approximate thick-
ness $t_0$ using (1) for a given light transmission.

Example. The approximate thickness in a specific case was $t_0 = 3.90$ mm. Using (2) for the series of thicknesses
3.60; 3.70; 3.80; 4.00; 4.10; 4.20; 4.30 mm we compute $\tau_{\text{tot}}$ equal, respectively, to 12.85; 11.90; 11.00; 10.25; 9.55; 8.90; 8.30; 7.75%. For $\tau_{\text{tot}} = 10\%$ the thickness of the melt is equal to 3.94 mm.

If together with the light source we use a light filter, the computation is carried out taking into account the spectral transmission coefficient $\tau_\lambda^{C}$ of the light filter, separating out radiation of a given light composition:

$$\tau = \frac{\int E_\lambda v_\lambda \tau_\lambda d_\lambda}{\int E_\lambda v_\lambda \tau_\lambda^{C} d_\lambda}.$$