NEW UV RADIATION SOURCES FOR PHOTOTHERAPY

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Ultraviolet (UV) phototherapy has been effectively used in medical practice for many years. Both the whole spectrum of UV radiation (220-400 nm) and its individual components (UV-A, UV-B, UV-C) can be applied to patients, the individual components having differing biological effects [4].

Deteriorating environment (air pollution, growing rate of allergic diseases, etc.) makes the development and production of UV therapeutic devices important.

The UV therapeutic device should meet spectral and radiation intensity requirements, provide radiation energy distribution over the desired irradiation field, and provide dosimetric control of the actinic radiation. The last factor is of particular concern for both domestic and foreign designers of UV therapeutic equipment.

The optimal spectral characteristic of the actinic radiation depends on the desired biological effects. Therefore, its selection is the starting point for the development of a new radiation source. Close collaboration with physicians and biologists is desirable to attain this goal correctly. In this context, sources of invisible medical radiation differ from medical sources of visible light, because the efficacy of the latter can be assessed by visual perception alone.

The effective spectral range (spectral composition) of actinic radiation, irradiance at a set working distance, irradiation field size, and uniformity of radiant flux are basic characteristics of phototherapeutic devices.

The spectral range and maximum output radiant power required to provide the sought biological effect (e.g., light-induced biosynthesis of vitamins, erythema, etc.) are determined by proper selection of radiation source and optical system.

Commercially available radiation sources often fail to meet the requirements of the a newly designed phototherapeutic device, and an individual radiation source should be designed and produced by a special design bureau. Radiation sources used in phototherapeutic devices must satisfy particularly stringent safety requirements. Generation of ozone and nitrogen oxides [1] and of short-wavelength UV radiation (in prophylactic and phototherapeutic devices) [5] must be excluded. UV lamps with reduced content of liquid mercury are preferable.

Medical UV phototherapeutic devices are routinely equipped with high-pressure or low-pressure gas-discharge lamps. Low-pressure lamps are used in light sources with narrow action spectrum because they emit narrow bands of radiation with high efficiency within the required spectral range. Gas-discharge lamps are designed to operate with special circuit ballast. The circuit ballast should have high efficiency, low size and mass, and induce no radio interference.

The optical system is the most critical element of a phototherapeutic device. In addition to the radiation source, it includes optical elements for spreading radiant power over the specified irradiation field with the specified homogeneity level.

The mirrors of UV radiation sources are usually made of high purity aluminum (not less than A7) because even slight impurities substantially deteriorate UV-radiation reflection [2]. The mirrors are electrochemically polished or anodized to the required surface quality.

The optical system of UV-radiation sources may include special flexible and rigid light guides adapted for phototherapy of various cavities of the human body.

Dosimetric control of actinic radiation is of particular importance for ensuring the safety of patients and medical personnel. New models of phototherapeutic devices are equipped with electronic or mechanical timers. More expensive models contain photoelectric UV dosimeters for controlling energy dose of actinic radiation [3].

Thus, development of new medical phototherapeutic devices includes many biomedical and technological problems which should be solved at different stages of development and production.

Joint-Stock Company VNIIMP-VITA (All-Russian Scientific-Research Institute for Medical Instrument Engineering, Moscow) has been for many years a leading domestic center for developing medical phototherapeutic devices.

Two new broad-band UV phototherapeutic devices (a rack-type and a desk-top) have been recently developed and prepared for serial industrial production.

The OUN 250 model (Fig. 1) has been developed to replace the OKN-11M mercury-quartz phototherapeutic device which has been produced for many years. The OYSh 500 model (Fig. 2) has been developed to replace the ORK-21M mercury-quartz phototherapeutic device. The OKN-11M and ORK-21M phototherapeutic devices were designed for individual local irradiation. Both of them have a number of substantial disadvantages, particularly, ozone formation, significant short-wave spectral component, and lack of control of exposure time. The newly developed phototherapeutic devices are equipped with DRT250-1 250-W lamps specially designed by the Lisma Joint-Stock Company, the lamps generating practically no ozone and having spectral maximum at 280-400 nm. The lamp bulb is coated with a special cover that absorbs the short-wave spectral component (UV-C).

The OUN 250 phototherapeutic device is designed for individual local phototherapy. It consists of a lamp (DRT 250-1), an optical system, and a control unit; all the components are mounted on a cantilever. The optical system contains an aluminum parabolic-cylindrical diffuse reflector. The output UV radiant emittance within a 0.2 x 0.3 m lighted area is not less than 5 W/m² with uniformity of radiant flux of not less than 0.67 and distance of 0.5 m.

The control unit contains a lamp circuit ballast and an electronic timer. When the lamp reaches operating conditions, the timer generates audio and visual signals. It also accurately sets the exposure time over the interval from 15 sec to 15 min 45 sec and automatically switches the device off when the time is over.

The cantilever with the lamp and optical system is capable of sluing through 180° about the control unit. The lamp unit itself is hinged to the cantilever and capable of sluing through ±90° about the vertical position. The degree of freedom allows light source orientation to practically any desirable area, thus providing comfortable conditions for phototherapy. Besides, on