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MODEL OF DEBACTERICIDAL ULTRA-VIOLET RADIATOR WITH DISCHARGE PLASMA RADIATED BODY

Keywords: ultra-violet radiator, radiated body sterilizational (debactericidal) devices, working zone

Is offered a mathematical model and modelling algorithm of ultra-violet radiators attached to designing sterilization al and debactericidal devices with cylindrical discharge-plasma radiated bodies, that provides is thrashed a level and evenness of working zone irradiation

INTRODUCTION

Biological action of ultra-violet radiation is conditioned by matters molecules property going into cells storage of living organisms to take up the radiation quanta and hereupon to pull into different photochemical reactions changing their structure and functions. [1]

Action Specificity of short-wave domain of ultra-violet radiation of diapason waves length 200...300 nm determines by absorption of his quanta by molecules of nucleic acids, proteins, lipides and row others of biochemical cells components

Most strongly take up the ray the nitrous bases nucleic acids, into connection with than they strike by most considerable photochemical transformations. Ультрафіолетове of radiation disturbs a primary structure of nucleic acids, that set to physiological changes, mutations and even cells death.

Very popular in last time stood desinfectional (debactericidal) devices [2]. By basic purpose of such devices there is decontaminating, illnesses exciters annihilation in different biomedical objects. However, unlike sterilizers by basic aim there is annihilation of pathogenic (and not at all) microorganisms. Mechanism of debactericidal action of optical radiation is conditioned by UV influence of radiation on cell proteine. Attached to irradiation at first takes place excitation of bacterial cells , their activation. A further irradiation causes oppression of cell vital functions by reason of cell denaturant ion. Attached to sufficiently big doses comes proteins coagulation and bacterium death.

Disinfection reaches for counting of ultra-violet radiation from mercurial radiated sources (RS) of new generation from high debactericidal effectivity. One of creation problems and UV optimization of radiators for sterilization al and debactericidal devices is irradiation evenness providing in zone of treatment. It is one of conditions of identical destruct influence on all bacterium, that are found on thrashed treatment zone plane for hours together. Determination of geometry of optical part of emitter is by solus ion precondition of this task.

MATHEMATICAL MODEL AND ALGORITHM

Structurally an radiator consists from discharge plasma RS, that forms a radiated body in appearance of positive plasma column of cylindrical form and cylindrical reflector, that has a profile of surface gene matrix, necessary for creation of debactericidal irradiation zone (working zone).

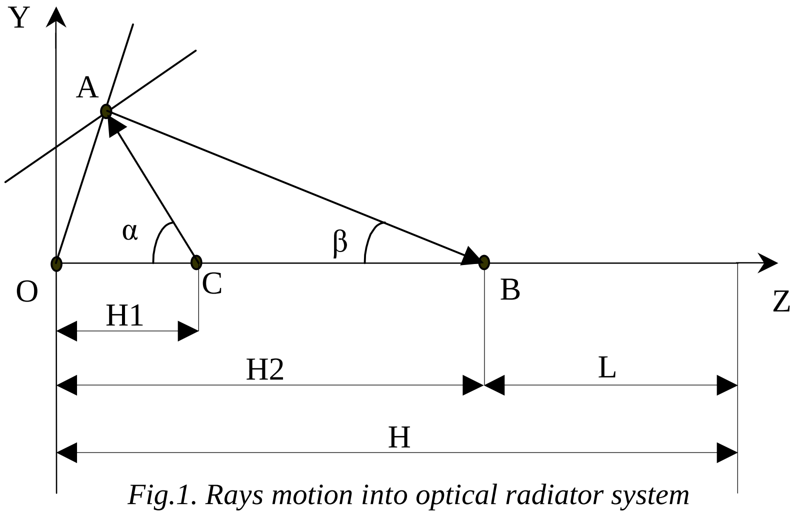


Fig.1. Rays motion into optical radiator system

Guaranteeing of irradiation evenness of thrashed working zone attached to necessary geometrical dimensions is prettily complicated problem. For solution of this task superiority lend to geometrical working zone dimensions.

So be it length of optical system H (Fig. 1). working zone length L,. H1, H2 accordingly radiant finding places and working zone beginning from counting beginning of optical system (point O).

Break up radiation stream and treatment zone on n of identical parts. From point C is going a ray with angle α, which reflect from reflector surface in point A and get in point B with angle β, under this is must be fulfilled an reflected law . Motion of incident ray describes a vector CA, and incident - AB.

Then equation of incident ray

$$Y_1 = - k_1 X + b_1,$$

where $k_1 = tg(\pi - \alpha_n) = - tg\,\alpha_n$

$b_1 = -tg\,\alpha_n \cdot X = - tg\,\alpha_n H1$

and

$$Y_1 = tg\alpha_n \cdot X - tg\alpha_n \cdot H1 \qquad (1)$$

where α_n – angle between axis of optical system and incident ray.

An index n changes from 1 to n.

Equation of reflected ray can be represented in following appearance

$$Y_2 = - k_2 X + b_2$$

where $k_2 = tg(\pi - \beta_n) = - tg\beta_n$
$b_2 = k_2 H2 = - tg\beta_n H2$
and then

$$Y_2 = tg\beta_n X - tg\beta_n H2 \qquad (2)$$

where β_n – angle between axis of optical system and reflected ray.

Equating right parts of (1) and (2), find a point A (X n; Yn):

$$tg\alpha_n \cdot Xn \quad tg\alpha_n \cdot H1 = tg\beta_n \cdot Xn \quad tg\beta_n \cdot H2$$

$$X n = \frac{tg\alpha_i \cdot H1 - tg\beta_i \cdot H2}{tg\alpha_i - tg\beta_i} \qquad (3)$$

$$Yn = - tg\alpha_n \cdot Xn + tg\alpha_n \cdot H1$$

$$Yn = - tg\alpha_n \cdot (Xn - H1) \qquad (4)$$

For X n determination, Yn pick up such β value attached to which a following condition is fulfilled

$$(arctg (k_n) + \frac{a+b}{2} - \pi/2) = 0 \ , \qquad (5)$$

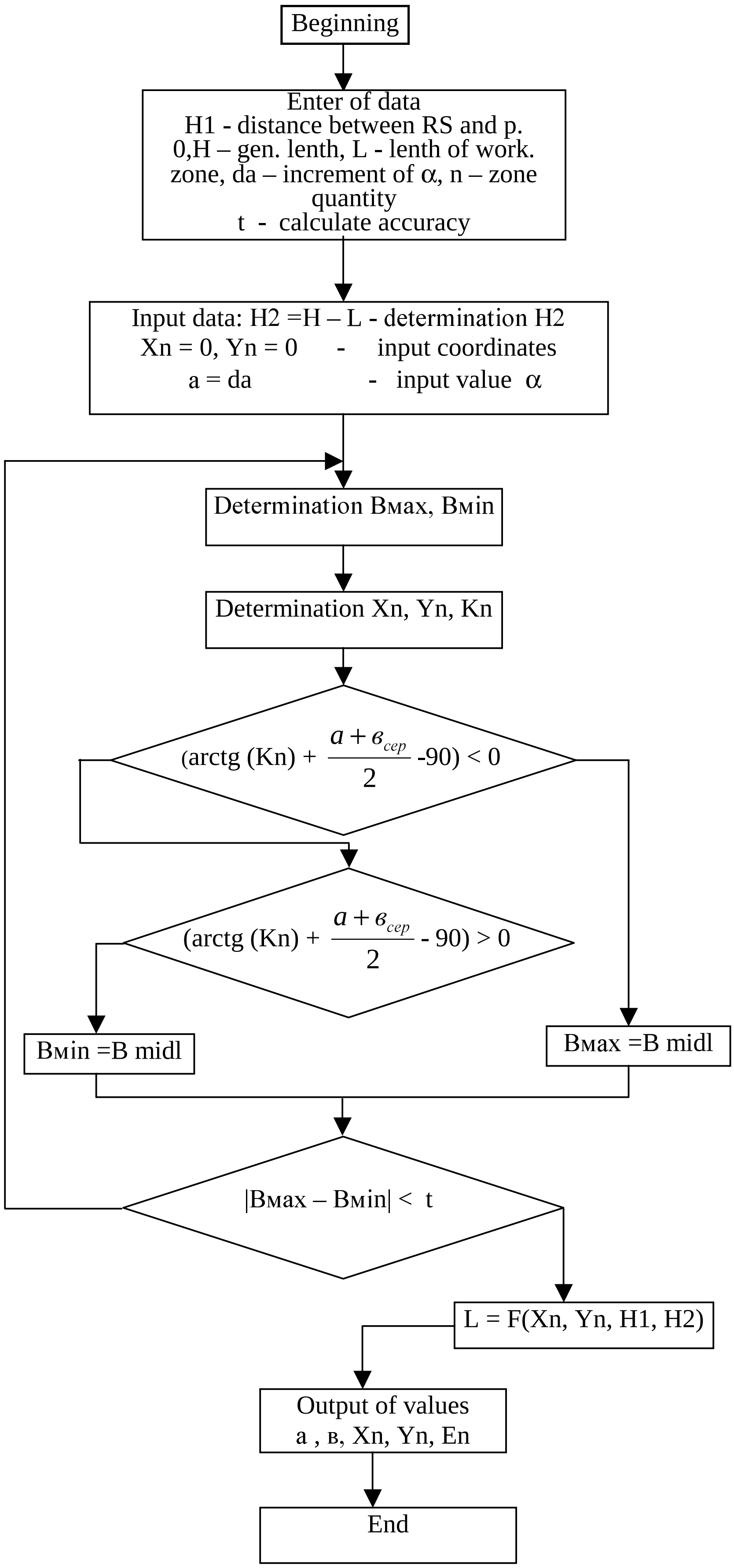
де $k_n = \frac{Yn - Yo}{Xn - Xo}$

For each H2 determine of irradiation for formula

$$En \sim \frac{\cos\beta}{LL^2} \ , \qquad (6)$$

where LL – length of optical ray motion from radiation source into H2.

On got dependence En =f (H2n) valued of irradiation unevenness in working zone. Attached to designing of radiator offers to realize modelling in obedience to algorithm directed beneath (Fig. 2)


Beginning
Enter of data
H1 - distance between RS and p.
0,H – gen. lenth, L - lenth of work.
zone, da – increment of α, n – zone quantity
t - calculate accuracy
Input data: H2 =H – L - determination H2
Xn = 0, Yn = 0 - input coordinates
a = da - input value α
Determination Bмax, Bмin
Determination Xn, Yn, Kn
(arctg (Kn) + $\frac{a+в_{сер}}{2}$ -90) < 0
(arctg (Kn) + $\frac{a+в_{сер}}{2}$ - 90) > 0
Bмin =B midl
Bмax =B midl
|Bмax – Bмin| < t
L = F(Xn, Yn, H1, H2)
Output of values
a , в, Xn, Yn, En
End

DISCUSSIONS

Analysis contemporary sterilization al and methods debactericidal indicates on lack of mathematical emitters model, which provided б is necessary a level and treatment zone irradiation evenness. Offered mathematical model, which permitted to see out a reflector profile curve computation for cylindrical discharge radiated body. For following output data

H1(mm)=30.00   H(mm)=230.00   l(mm)=170.00   da(gr)=10.00 ao(gr)=10.00   n( )= 17
t =0.00001   amax(gr)=170.00

obtained that results

I, gr	I, gr	Xp, mm	Yp, mm	WW, mm	OO, mm	H2, mm	LL, mm	E/$_{I,}$ lx/kd*1E5
10.00	4.98	0.68	5.17	5.14	15.43	60.00	89.32	1.09
20.00	8.53	1.96	10.21	5.16	17.04	70.00	98.64	1.52
30.00	11.23	3.81	15.12	5.23	18.65	80.00	107.92	1.67
40.00	13.39	6.23	19.94	5.36	20.24	90.00	117.13	1.69
50.00	15.23	9.28	24.70	5.57	21.82	100.00	126.27	1.65
60.00	16.87	13.02	29.41	5.87	23.38	110.00	135.31	1.59
70.00	18.42	17.59	34.11	6.27	24.92	120.00	144.24	1.52
80.00	19.95	23.16	38.79	6.81	26.45	130.00	153.05	1.46
90.00	21.55	30.00	43.44	7.51	27.94	140.00	161.71	1.40
100.00	23.29	38.47	48.01	8.42	29.41	150.00	170.18	1.37
110.00	25.27	49.06	52.37	9.63	30.83	160.00	178.41	1.34
120.00	27.63	62.49	56.27	11.23	32.19	170.00	186.32	1.34
130.00	30.55	79.69	59.22	13.36	33.48	180.00	193.79	1.35
140.00	34.38	101.87	60.30	16.21	34.66	190.00	200.60	1.40
150.00	39.70	130.27	57.89	20.01	35.67	200.00	206.41	1.50
160.00	47.76	165.29	49.24	24.88	36.37	210.00	210.48	1.67
170.00	61.84	203.61	30.61	30.46	36.46	220.00	211.01	1.98

A found simplified profil reflector provides sufficiently high evenness irradiating.
Unevenness irradiated composes

$$\eta = (E_{max}\quad E_{min}) / E_{max} + E_{min})\cdot 100\%$$

$$\eta = (1{,}52 - 1{,}34) / (1{,}34 + 1{,}52) \cdot 100\% = 6{,}3\%$$

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