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ANALYSIS OF OPTICAL-ENERGY CHARACTERISTICS OF SOLAR THERMAL POWER PLANTS WITH MIRROR CONCENTRATION SYSTEM USING NUMERICAL METHODS

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ABSTRACT

In this regard, the purpose of this topic is to develop calculation methods (numerical experiments) and, on this basis, to establish the distribution patterns of the concentrated current in the focal plane and on the surface of the receiver. Also considered are such issues as the development of a methodology for calculating the systems of storage devices with receivers and steam generators, taking into account concentration uncertainties.

Key words: effect, systems, concentrator, optimization, control meter, solar radiation, systems ZU, concentration characteristics, mirror concentration systems (SCS), focal plane, solar radiation point radius, concentrator geometry.

INTRODUCTION

To create an effective concentrator-receiver system, it is necessary to ensure optimal distribution of the embodied flow over the working surface of the receiver. Such optimization can be carried out by calculation in a first approximation and further refined on the basis of experimental studies of the field of concentrated solar radiation.

The complexity of experimental studies is associated, first of all, with the technical complexity of creating and using instrumentation designed to determine their concentration characteristics, as well as the difficulty of such work.

In this regard, the goal of this topic is to develop calculation methods (numerical experiments) and to establish on this basis the patterns of distribution of concentrated current in the focal plane and on the surface of the receiver. Also considered are issues such as the development of a methodology for calculating charge-control systems with receivers and steam generators, taking into account concentration uncertainties.

It is known that the concentration characteristics of mirror concentration systems (MCS) depend on the location, shape and size of the receiver. Therefore, to highlight the internal limiting features of the ZKS, it is customary to determine them in the “focal plane” of the concentrator (see Fig. 1).

The following features are highlighted:

1. Radius of the point of solar radiation in the focal plane - r 0
2. Distribution of concentrated current in the focal plane E (r).
3. Maximum current density at the focus Ef or its dimensionless analogue, concentration
4. The average current density above the image point of the Sun in the focal plane - ZKS or its dimensionless analogue, the concentration level in the Z-U system is further distinguished:
5. Average current density at the input to the receiver - E op. oq or concentration level - Kqq .
6. Radiation distribution on the receiving surface of the receiver - HT(r)

Parameters 1-4 depend on the geometry of the concentrator, its accuracy, as well as the focal length f and opening angle U 0. Parameters 5 and 6 depend on the size and geometry of the receiver, as well as the location of the receiver relative to the concentrator (or relative to the focal plane of the concentrator). It should be noted that the radius of the receiver rp also depends on the operating temperature of the receiver, that is, there is a certain optimal radius of the receiver and, accordingly, a certain concentration C at which maximum efficiency is achieved.

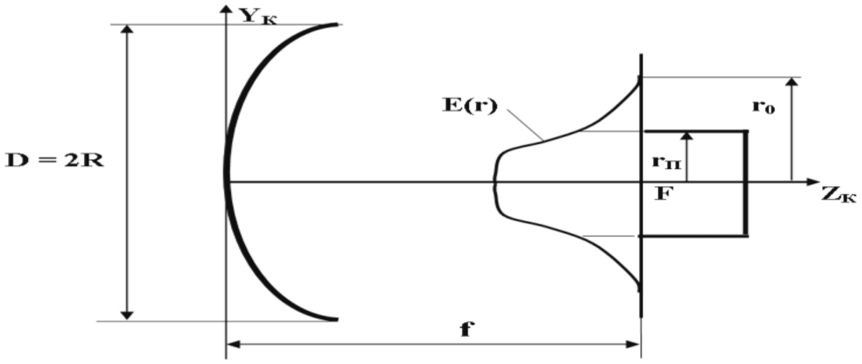

Figure 1. Determination of ZCS concentration characteristics.

Thus, to experimentally determine K , C and Copt, it is necessary to measure the focal plane energy distribution E (x , y , z = f). Therefore, the problem of determining the propagation of radiation becomes a separate, rather complex task, taking into account the important dimensions of the emitting point up to 1.5 m, as well as significant current densities and powers.

$E_r = R_Z E_0 h_1^2 \sin^2 U_0 \exp[- h_1^2 (1+\cos U_0)^2 (r/P)^2]$, (1)

Here Rz is the specular reflection coefficient, E 0 is the density of direct solar radiation on the Earth’s surface, h 1 is a parameter describing the radiation source and the integral uncertainty of the concentrator geometry, P is the paraboloid focusing parameter (P = 2 f , where f is the focal length of the ZKS) .

$h_1 = (E_F / (R_{Z\,E} 0)\ 0.5^{/} \sin U_0$ (2)

In Fig. Figure 2 shows radiation distribution curves obtained on the basis of a numerical solution of the radiation integral for a ZCS with geometry uncertainties distributed according to the normal law, for various given σ(•) and distribution curve

Paraboloid ZKS with U0 = 60 0, normally distributed uncertainty values at different points and the Aparisi model.

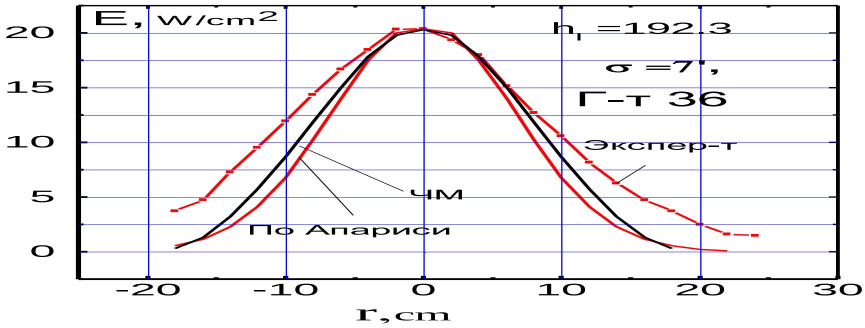

Figure 2. Comparative current distribution from the Heliostat.

In this regard, the relationship between h 1 and is usually found σ, given that we can determine it experimentally. To do this, we will use Zokhidov's obtained by the "cap" function æ, which determines the radiation at the focus. The ZKS paraboloid is universal, as shown from Ef , and the function æ does not depend on the opening angle of the ZKS:

$\ae = ^{\exp(-C\,2}$) , ($_{\sigma}3\ \sigma$)

$$C_{\sigma} = 0.0092\ [(\text{arcmin})^{-2}], \text{ or}$$

$$E_F = \ae E_F^{ID} = \ae E_0 R Z K F \sin^2 U_{0,} (4)$$

Here E_f^{ID} is the illumination in the exact paraboloid focus of the ZKS, and K_f is the maximum achievable concentration in the ideal paraboloid focus of the ZKS with the opening angle $U_0 = 90^0$ (about 46000 for the average brightness of the Sun and about 58000 for the inhomogeneous solar brightness) up to can be achieved in theory.

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