Analytical Investigation of Crown Fire in Bulgaria

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Abstract: In the presented paper an analytical methods of studying the development of forest fires and, in particular, the rate of velocity of the fire and its temperature are considered. It is shown what is the influence of the environment on the development of the fire. The researches were done at different initial powers of the fire. All the results obtained can help the interested parties in fighting fires.

Keywords: analytical method, crown fire, results.

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1. Introduction

Crown forest fires are occur based on the ground fire and represent a further stage in his development. Crown fire is a fire which burns crowns and trunks of trees. Their initiation almost always is associated with the presence of ground (string) fire. The last one is spreading in layers of ambient noise, branches and small shrubs. The presence of baggy, most - often dry twigs of trees, wind and slope of the terrain is contribute to convert ground fire to crown fire. At the crown fire trees in the forest are completely destroyed. The development of the crown fire expect the wind also depends of tree density, structure of the burning material (coniferous or deciduous), humidity of the timber, weather conditions (temperature and humidity), etc. Very often the movement of the front of the fire is been called hopping movement coinciding with preheating of the underlying land garbage and shrubs. It is depends of the velocity of the fire of gas fire and from a rebound of the spark and hubs.

After the effect of preheating there will be a jump ahead of the crown fire and then a period of lull and it is prepare a new jump. According to [2,3] the development of the combustion of ground fire is with velocity at 3 ÷ 5 m / s. The aim of work is to make an investigation according [1] of distribution at temperature and velocity of crown fire.

2. Abramovich Approach

Crown fires are accompanied by a large release of heat. They have a strong impact on the atmosphere. Heated air and combustion products lead to the formation of a convective column above the fire (Fig. 4.6). This convective column, whose diameter can exceed 100 m, rises to a very high height. The flame in its middle can reach a height of 120m. In addition to the product of combustion, it carries out burning branches and main ones, which, carried by the wind, can spread a long distance in front of the fire front (up to 700 m) and cause new fire outbreaks. The powerful convective column draws air to the hearth of the fire, intensifying the combustion, creating wind around the fire. According to observations, in the absence of wind, the convective column passes along the front of the fire or shortly after it.

To determine the temperature along the length of the fire, according to [1], the expression can be

$$T_{\max} - T_{am} = \frac{5{,}38\left(Q_c / r\right)^{2/3}}{H} \tag{1}$$

Where $T_{\max}$ - the maximum temperature of the fire, K, T_{am} - ambient temperature, K, Q_c - power of the fire, kW, r - the distance at which the fire is spread in length, m, H- the height at which the fire reaches, m.

To determine the maximum speed along the length of the fire, the following formula is used

$$V = 0{,}197\left(\frac{Q_c{}^{1/3}}{r^{5/6}}\right)^{1/2} \tag{2}$$

3. Numerical Investigation

In fig. 1-6 the temperature distribution is given in relation to the distance at which the crown fire can reach. The conditions under which the studies were carried out are as follows, $T_{am} = 298K$, $Q_c = 50,100,300,500,1000,2000,3000,4000,5000kW$, $r = 50,100,200,300,400,500,700m$, $H = 10,15,20,30,40,50m$ The selected initial conditions are based on the fact that, according to literature, crown fires reach a distance of up to 700 m and the height of the tallest conifers in our country reaches up to 40 m.

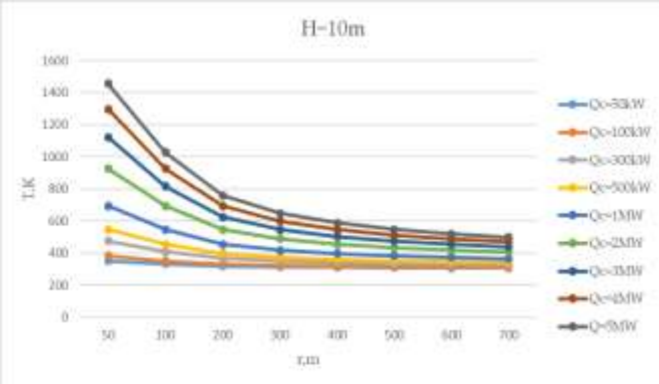

Figure 1 Temperature distribution along the length of the crown fire at a tree height of 10m

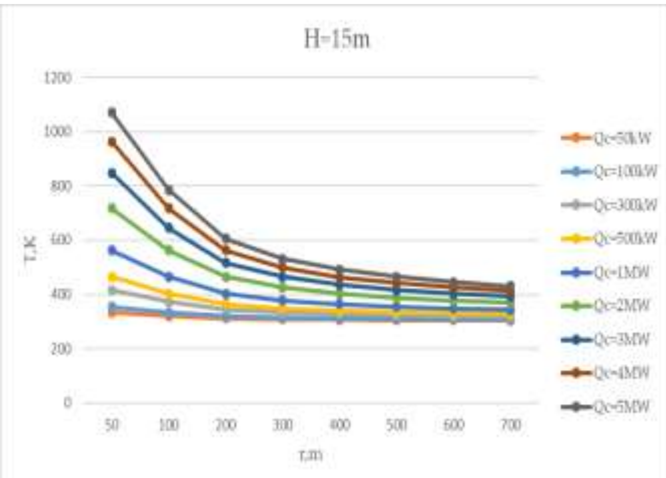

Figure 2 Temperature distribution along the length of the crown fire at a tree height of 15m

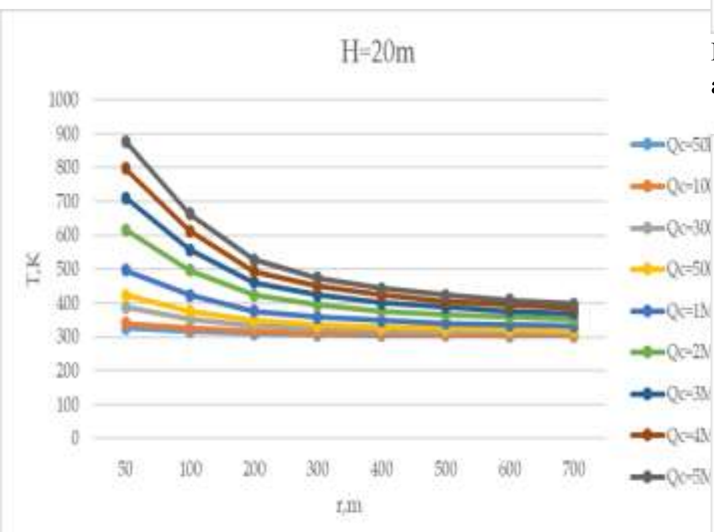

Figure 3 Temperature distribution along the length of the crown at a tree height of 20m

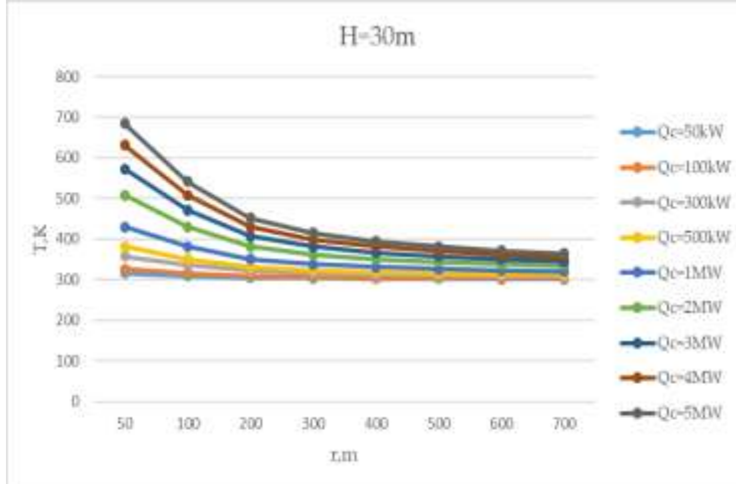

Figure 4 Temperature distribution along the length of the crown fire at a tree height of 30m

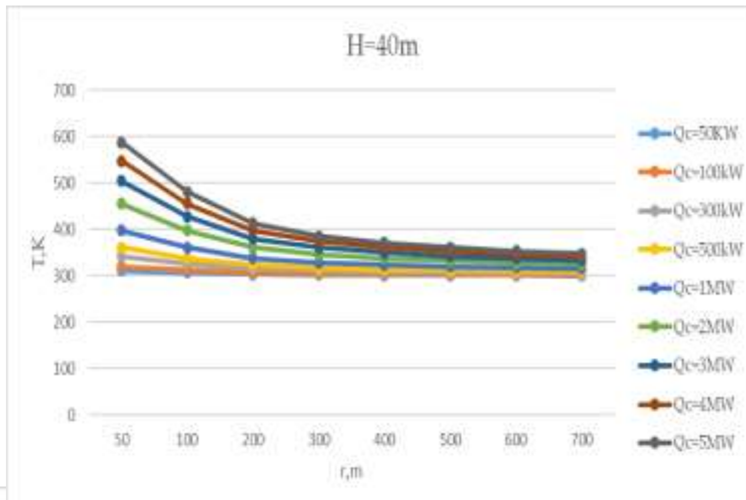

Figure 5 Temperature distribution along the length of the crown fire at a tree height of 40m

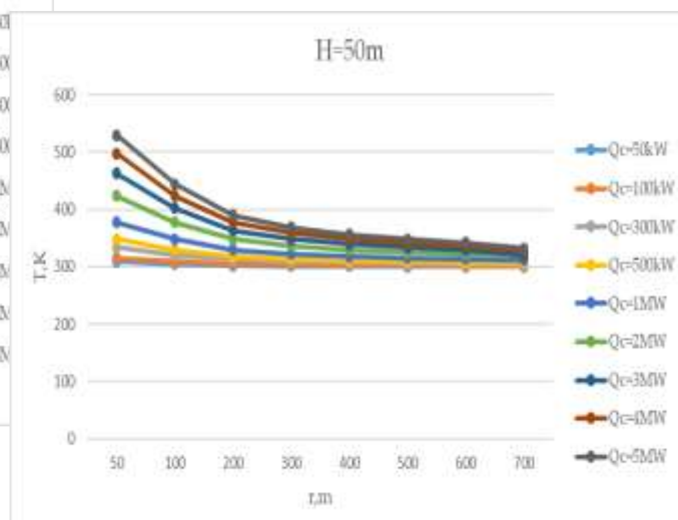

Figure 6 Temperature distribution along the length of the crown fire at a tree height of 50m

In fig. 7-12 shows the variation of the maximum speed relative to the distance at which the crown fire can reach. The conditions under which the research was done are as follows $T_{am} = 298K$,

$Q_c = 50,100,300,500,1000,2000,3000,4000,5000kW$,

$r = 50,100,200,300,400,500,700\,m$,

$H = 10,15,20,30,40,50m$.

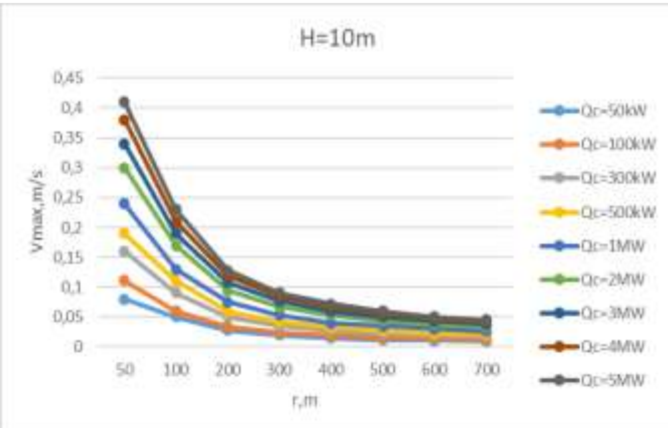

Figure 7 Distribution of the maximum velocity along the length of the crown fire at a tree height of 10m.

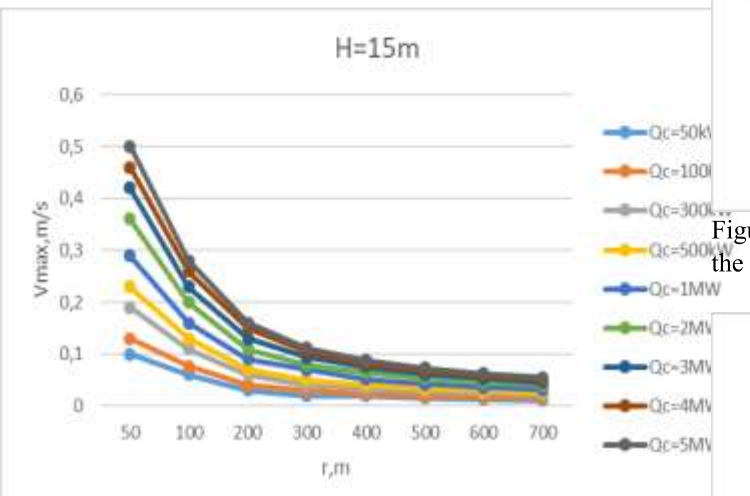

Figure 8 Distribution of the maximum velocity along the length of crown fire at a tree height of 15m.

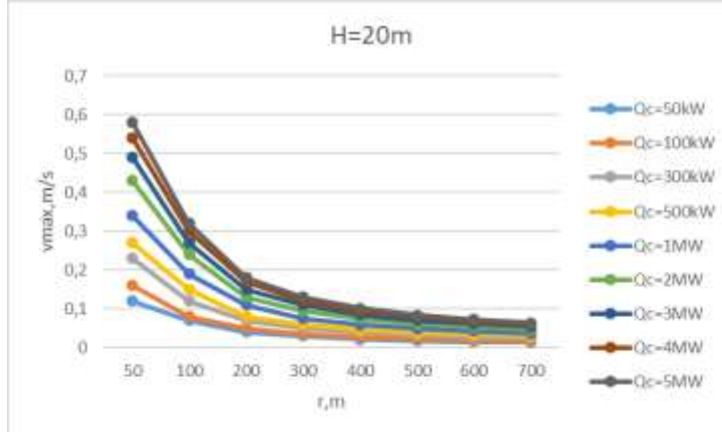

Figure 9 Distribution of the maximum velocity along the length of the crown fire at a tree height of 20m.

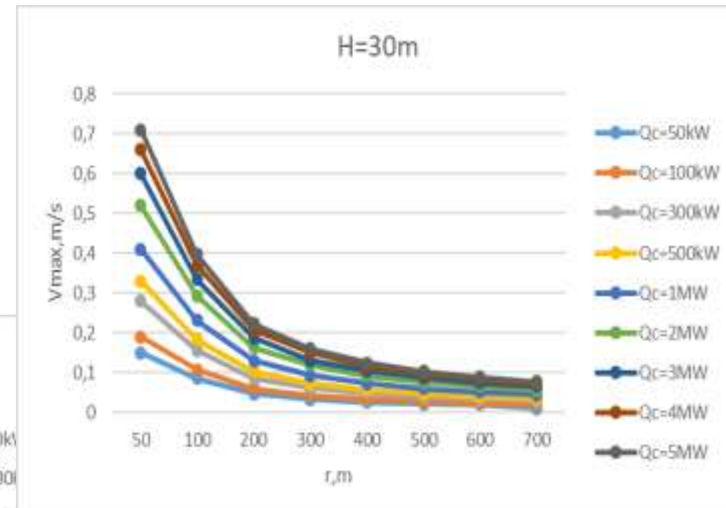

Figure 10 Distribution of the maximum velocity along the length of the crown fire at a tree height of 30m.

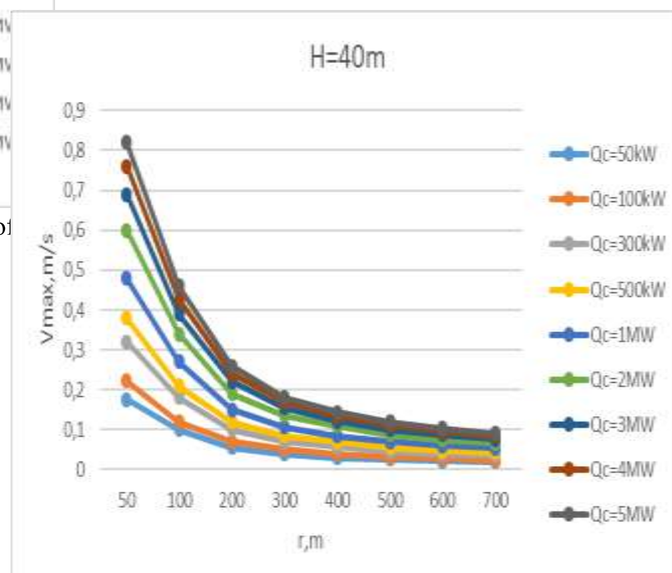

Figure 11 Distribution of the maximum velocity along the length of the crown fire at a tree height of 40m.

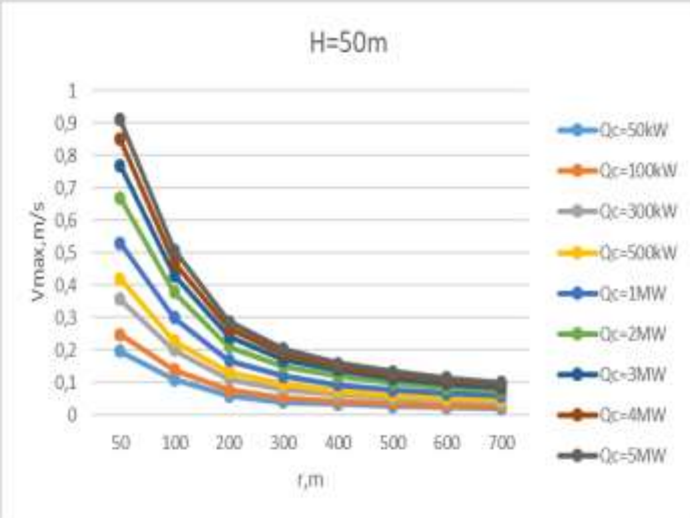

Figure 12 Distribution of the maximum velocity along the length of the crown fire at a tree height of 50m.

4. Conclusion

The obtained results show that as the length of the fire increases, its temperature decreases. At greater heights and powers of the fire, the temperature increases along the length of the fire. These studies can serve to forecast and support the services that fight this type of natural disasters in the territory of the Republic of Bulgaria.

Acknowledgment

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