Quantifying Water Required to Cool Artificial Turf

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Abstract

Artificial turf containing black colored infill material has gained widespread use on athletic fields starting in the early 2000s.One of the main arguments made in the desert southwestern part of the United States for replacing natural playing fields with these types of artificial surfaces is that water is not needed for irrigation. However, it has been shown that in arid and semiarid zones the surface temperature of these synthetic fields can range from 60 to 82.2 ºC (140 to 180°F) during the summer, requiring irrigation and drainage systems to keep them cool enough for use. What is still unknown is the amount of water needed to maintain surface temperatures of these infill fields at levels similar to natural turf grass areas. An experiment was conducted at New Mexico State University (USDA Plant Hardiness Zone 8) to investigate the effect of varying amounts of irrigation water on surface temperatures of artificial turf. A mathematical model was developed based on the heat balance equation to evaluate the heat dissipation from infill fields and to compare the predicted values to experimental data. First results indicated that the amount of water required for cooling artificial grass is an exponential function of the temperature decrease.

Problem

- Water is needed to cool artificial turf during the summer, but it is unknown how these amounts compare to irrigation amounts required to maintain warm-season turf.

Objectives

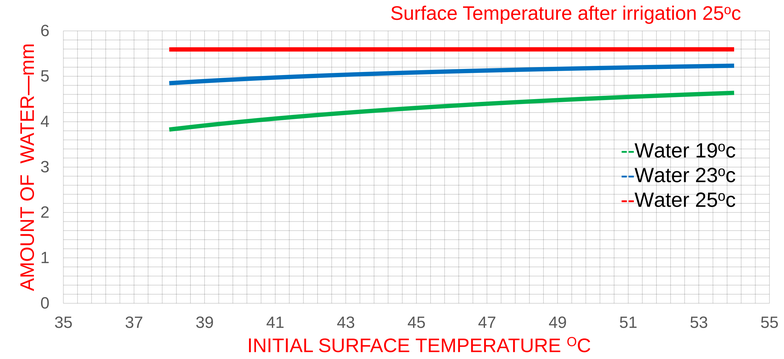
- The aim of this study is to investigate the effects of varying amounts of irrigation water on surface temperatures of artificial turf.

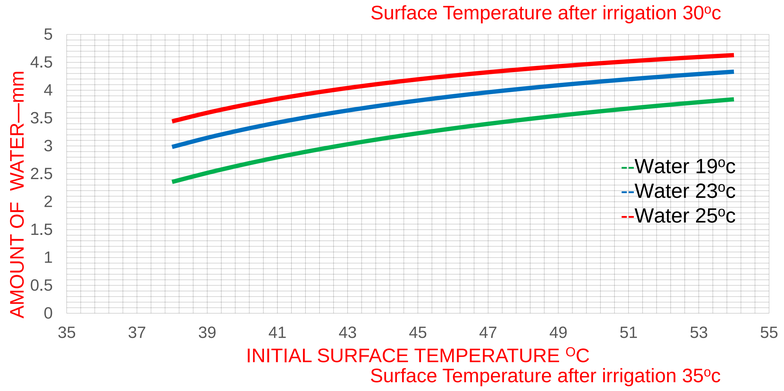
Materials and Methods

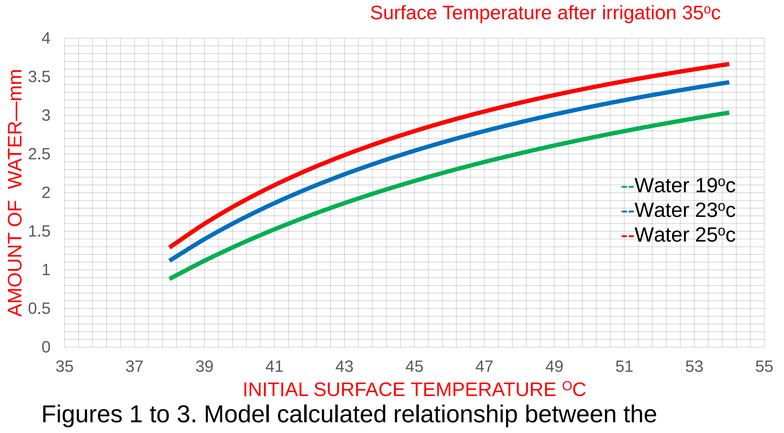
- A mathematical model was developed based on the heat balance equation to evaluate the heat dissipation from infill fields and to compare the predicted values to experimental data.
- The amount of water required to cool an artificial turf field can be calculated using the heat balance equation:

$$m_w = \frac{m_{art} Cp_{art}(T_{ist} - T_{st}) + \epsilon\sigma A_{art} (T_{ist}^4 - T_w^4) - hA_{art} (T_{ist} - T_a)}{Cp_w (T_{ist} - T_w)}$$

- m_w: mass of the water used for cooling
- m_{art}: mass of the artificial turf to be cooled.
- Cp_{art} ;C_{pw} : specific heat capacities of artificial turf and water, respectively.
- ϵ ; σ : Emissivity and Boltzmann constant for artificial turf.
- h: Heat Transfer coefficient.
- A_{art} : Area of artificial turf to be cooled
- T_{ist} ; T_{st} : initial surface temperature and surface temperature after irrigation
- T_w: water temperature
- T_a: air temperature
- Irrigation to the artificial turf was applied from four sprinklers (Hunter I-20)
- Distribution Uniformities (DU) were determined for each run and resulted in values between 0.75 to 0.80
- Temperatures were recorded with standard thermocouples E-type at the surface and at height of 100 cm above the artificial turf and above irrigated bermudagrass turf.







Figures 1 to 3. Model calculated relationship between the temperature of the artificial turf after irrigation and the amount of water needed to reach the desired temperature at varying initial surface temperatures.

Results

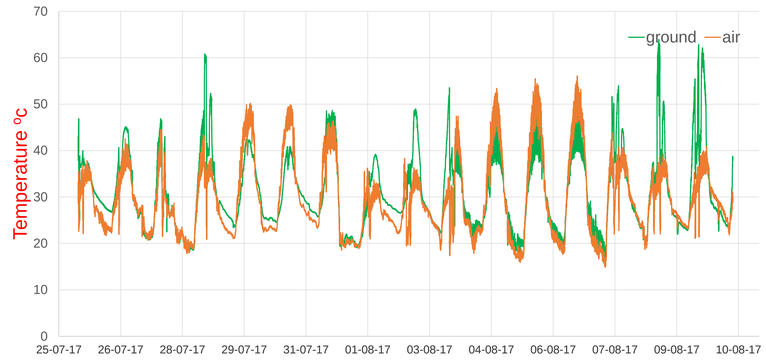
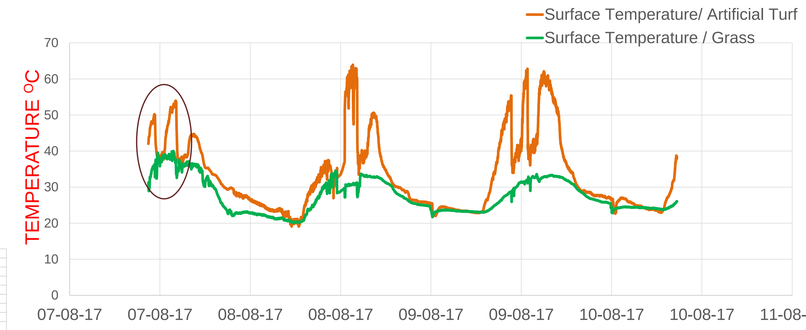
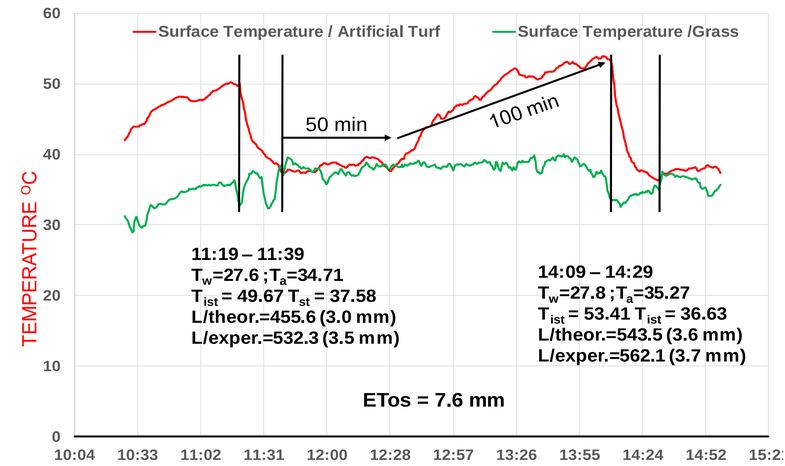


Figure 4. Temperature changes above artificial turf: surface (green) and at 100 cm height (red)





Figures 5, 6. Change in temperature above bermudagrass (green line) and artificial turf (red line). Irrigation was applied for 20 minutes and water usage is listed for both the theoretical model estimation and actual experimental application.

Conclusions

- Preliminary findings indicate that water requirements to cool artificial turf can be calculated with reasonable accuracy using the heat balance equation.
- If water is applied on artificial turf to lower the temperature to levels similar to natural turf, the cooling effect lasts only for approx. 50 minutes.
- In order to provide a cool, playable surface, irrigation amounts for artificial turf are greater than for natural warm-season turf.

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