Rocznik Ochrona Środowiska

Volume 23 Year 2021 ISSN 1506-218X pp. 420-433

https://doi.org/10.54740/ros.2021.028 open access

Received: 12 January 2021 Accepted: 22 July 2021 Published: 06 December 2021

The Influence of Atmospheric and Subsoil Impact on the Evaporation Process During Firefighter's Events

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Abstract: The influence of sun rays, wind speed, and different type of subsoil on the evaporation process was analyzed. A dedicated experimental set-up for investigation of evaporation process of three liquids (ethanol, petrol and tap water) deposited on glass and sand was created. Results indicated that for porous surfaces wind decreased the amount of evaporated liquids. After substitution of wind with sun rays for porous surface evaporation process increased for ethanol and petrol, respectively. Finally, the influence of both wind and sun rays indicated a 1% and 5% decrease of evaporation intensity for tap water and petrol, respectively. While, a 2% increase of evaporated liquid was observed for ethanol. It was noticed that application of porous surface caused the highest improvement of evaporation process for petrol and tap water, while the lowest for ethanol. Moreover, application of wind together with porous surface increased the intensity of evaporation for all analyzed liquids.

Keywords: basis, evaporating liquids, atmospheric factors

1. Introduction

Rapid elimination of the effects of uncontrolled spill is important for firefighters to quickly handle a hazard (Polanczyk 2018, Kahn et al. 2019). Leakage of hazardous liquids may aggravate or inhibit natural environmental factors (Li et al. 2019, Polanczyk et al. 2019, Polanczyk et al. 2020). The most important think for firefighters taking part in the event is to secure the area of action and immediately provide help to people, life stock and surrounding area (Polanczyk & Salamonowicz 2018, Colburn et al. 2019, Majder-Lopatka et al. 2020). Safety operations critically reliant on the practices and expertise of firefighters (Maslen 2014, Polanczyk 2018, Salamonowicz et al. 2021). A variety of factors such as natural disaster, corrosion, third party damage, mechanical failure, may cause pipeline leakage and rupture, thereby leading to personal injury, facility damage, and environmental pollution (Batzias et al. 2011, Czapczuk et al. 2017, Zhang et al. 2018). Depending on the size of the pool and the type of liquid, it is possible to estimate the level of hazard and to establish a dangerous zone (Piecuch et al. 2015, Stefana et al. 2016). These actions require the knowledge of soil permeability and liquid evaporation rate (Moon et al. 2018, Polanczyk et al. 2018, Yu et al. 2019, Singh et al. 2020). The intensity of evaporation process depends on the type of liquid. Fingas observed that light crude oils can be reduced by up to 75% of their initial volume and medium crudes by up to 40% of their volume (Fingas 1997). Moreover, drying with evaporation in the soil is associated with coupled heat and mass transfer and depends on the the requirement of evaporation in the atmosphere and the exchange of steam and heat between the surface of the earth and the atmosphere (Polanczyk & Salamonowicz 2018, Qubaja et al. 2020). The rate of evaporation of liquid deposited in soil is also influenced by atmospheric factors such as humidity, temperature and velocity of the surrounding air, as well as by the pore space and transport properties of the soil including thermal and hydraulic conductivity and the diffusivity of steam (Teng et al. 2019). This complexity leads to very dynamic interactions between media properties and transport processes and initiate a broad spectrum of evaporation behaviors (Wawrzyniak et al. 2012, Wawrzyniak et al. 2012, Polanczyk et al. 2013, Zieminska-Stolarska et al. 2015, Chen et al. 2020, Polanczyk et al. 2020). At the critical surface water content or the depth of the pre-drying the first stage ends suddenly, followed by a lower degree, controlled mainly by diffusion mass transfer (Abdel-Aziz 2013). Therefore, in this work, the impact of different types of subsoils, spilled liquids as well as sun rays and wind speed on the evaporation process was investigated.

2. Materials and methods

A dedicated experimental set-up composed of an aerodynamic tunnel made of polycarbonate with a square cross-section (equal to 0.09 m^2) with a hole in the lower part (cross-section equal to 0.00785 m^2) where a 10 cm diameter Petrie dish with investigated liquid was localized. Additionally, the Petrie dish was situated on a scale (Radwag WPS 720/C) to analyze weight changes. Moreover, the liquid temperature was measured with the use of thermocouple pt100 placed in the liquid on the Petrie dish. The temperature in the laboratory was equal to 25 ±1°C and humidity was equal to 55%. For the reconstruction of air flow, a fan, allowing set of constant air velocity value equal to 1.5 m/s (measured with anemometer CFM AZ 8901), was localized at the inlet to the tunnel. A halogen bulb (100W) was placed over the Petrie dish to simulate sun influence.

Evaporation process was analyzed for 100 ml of three different liquids (98% alcohol (ethanol), petrol (95 octanes), and tap water as a reference). Moreover, to reconstruct the real environmental conditions that meets firefighters during events, we analyzed different surfaces (impermeable surface (an empty Petrie dish) and 25 g evenly distributed of sand) as well as different atmospheric conditions. The following cases were analyzed: (1) liquid poured on the surface without additional factors, (2) poured liquid with wind, (3) poured liquid with sun ray, (4) poured liquid with simultaneous wind and sun ray. Each time the evaporation process was monitored for 600 seconds with time intervals equal to 10 seconds.

The measurements were repeated three times to receive an average value. Data are presented as mean ±standard error (SD). Comparison between groups was performed using one-way ANOVA after verification of normality and Person's correlation coefficient (rho) and was calculated with Statistica 12.0 software. Data were considered statistically different when $p < 0.05$ (Polanczyk et al. 2018).

3. Results and discussion

Evaporation is a very important process for most hazardous substances (Abdel-Aziz 2013). Most of the events where firefighters are directed have in general impact on surrounding environment. The methodological framework presented herein considers both evaluation of received results and description with polynomials functions. Evaporation models can be divided into the one which use the basis of air-boundary-regulation or the other that use diffusion-regulated evaporation physics (Moon et al. 2018).

3.1. Impermeable surface

Distribution of mass and temperature for three liquids on an impermeable surface without additional interrupting factors was treated as a reference point. A decrease of density value caused an increase in evaporated liquid which amount 0.17 ±0.02 g, 0.93 ±0.14 g and 4.82 ±0.49 g for tap water, ethanol, and petrol, respectively (Fig. 1a). Approximately 5.37-fold increase of ethanol evaporation intensity compare to tap water was observed ($p < 0.01$).

The comparison of tap water and petrol indicated about 27.84-fold increase of petrol evaporation intensity ($p < 0.001$). Furthermore, comparability of ethanol and petrol indicated about 5.18-fold rise of petrol evaporation intensity ($p < 0.001$). This observation can be associated with the fact that ethanol is a polar molecule with a strong dipole, which undergoes hydrogen bonding to the extent that its boiling point is higher than would be expected based on its molecular weight (Aulich et al. 1994). Moreover, for each of analyzed liquid the following decrease of temperature was observed: 0.55 ±0.18°C, 1.38 ±0.45°C and 3.09 ±0.21°C for tap water, ethanol, and petrol, respectively. Further comparison of a degree of temperature decreases for all liquids indicated that about 2.49-fold higher reduction of ethanol temperature compare to tap water ($p < 0.001$). While comparison of tap water and petrol indicated 5.58-fold higher decrease of petrol temperature ($p < 0.001$). When comparing ethanol and petrol we noticed a 2.24-fold decrease of petrol evaporation ($p < 0.001$). Additionally, there was a strong positive correlation between changes in temperature and mass of tap water (rho = 0.998), ethanol (rho = 0.966) and petrol (rho = 0.983) for the case without additional factors.

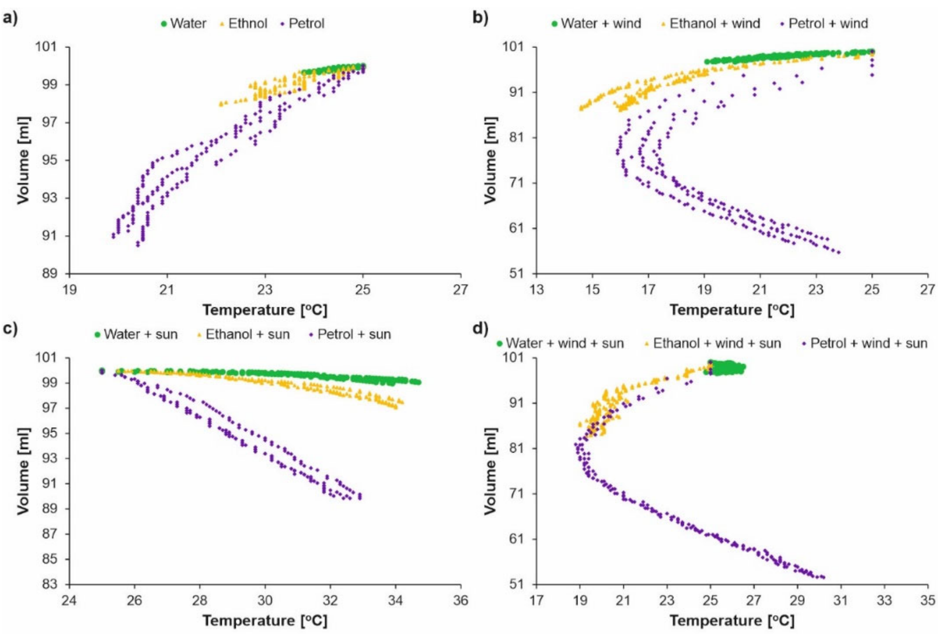

Fig. 1. Scatterplot graphic presentation of liquid evaporation for: a) case without external factors, b) with wind impact, c) with sun impact, d) with wind and sun impact, in contact with impermeable surface

Addition of wind factor increased evaporation intensity for all liquids which amount 1.19 ±0.09 g, 7.13 ±0.12 g and 27.47 ±1.42 g for tap water, ethanol and petrol, respectively (Fig. 1b). The highest increase was observed for the ethanol (7.67 times, $p < 0.001$), while the lowest for the tap water (5.70 times, $p < 0.001$). A 5.98-fold increase of ethanol evaporation intensity compare to tap water was recorded ($p < 0.001$). While comparison of tap water and petrol showed 23.04-fold increase of petrol evaporation intensity ($p < 0.001$). Contrarily, comparison of ethanol and petrol indicated 3.85-fold increase ($p < 0.001$).

Moreover, for each liquid different decrease of temperature was observed and amount 3.40 ±0.03°C, 7.01 ±0.60°C and 5.67 ±0.81°C for tap water, ethanol and petrol, respectively. A 2.06-fold higher decrease of ethanol temperature compare to tap water was observed ($p < 0.001$). While, in the case of tap water vs petrol we noticed a 1.66-fold higher decrease of petrol temperature ($p < 0.001$). Comparison of ethanol and petrol indicated approximately 0.81-times higher decrease of petrol evaporation ($p < 0.01$). Additionally, there was a strong positive correlation between changes in temperature and mass of tap water (rho = 0.981), ethanol (rho = 0.934) and a weak negative correlation for petrol (rho = -0.238).

After substitution of wind with sun rays it was observed that the evaporation process was not so intensive like for wind factor, however it was higher comparing to the reference one without additional interrupting factors such as wind or sun rays (Mehrizi & Wang 2017). The highest increase was observed for the tap water (2.57 times, $p < 0.001$), while the lowest increase for the petrol (1.06 times, $p < 0.001$). A comparison with wind factor indicated that the highest increase was observed for the tap water (approximately 0.37 times, $p < 0.001$), while the lowest for the ethanol (approximately 0.17 times, $p < 0.001$). Adding of sun rays factor showed that evaporated volume of liquid was equal to 0.44 ±0.05 g, 1.18 ±0.12 g and 5.10 ±0.04 g for tap water, ethanol and petrol, respectively (Fig. 1c). A 2.67-fold increase of ethanol evaporation intensity comparing to tap water was noticed ($p < 0.001$). While comparison of tap water and petrol indicated approximately 5.10-times increase of petrol evaporation ($p < 0.001$). Comparison of ethanol and petrol indicated approximately 1.18-fold increase of petrol evaporation intensity ($p < 0.001$).

Moreover, for each of analyzed liquid the following decrease of temperature was noticed: 6.15 ±0.32°C, 5.45 ±0.16°C and 4.11 ±0.39°C for tap water, ethanol and petrol, respectively. A 0.89-fold higher decrease of ethanol temperature compare to tap water was observed ($p < 0.01$). While comparison of tap water and petrol indicated a 0.67-fold higher decrease of petrol temperature ($p < 0.001$). Comparison of ethanol and petrol showed 0.75-times higher reduction of petrol evaporation ($p < 0.001$). Additionally, there was a strong negative correlation between changes in temperature and mass of tap water (rho = -0.940), ethanol (rho = -0.971) and petrol (rho = -0.998).

Finally, the influence of both factors (wind and sun rays) was investigated. The highest increase compare to the reference case was observed for the ethanol (9.14 times, $p < 0.001$), while the lowest increase was observed for the petrol (6.22 times, $p < 0.001$). Moreover, comparison with wind factor indicated that the highest increase in evaporation intensity was observed for the ethanol (1.19 times, $p < 0.001$), while the lowest increase was observed for the tap water (1.06 times, $p < 0.001$). Further comparison with sun rays indicated that the highest increase was observed for the ethanol (7.17 times, $p < 0.001$), while the lowest increase was observed for the tap water (2.83 times, $p < 0.001$). Adding of wind and sun rays indicated that evaporated volume of liquid was equal to 1.26 ±0.11 g, 8.50 ±0.16 g and 29.95 ±0.41 g for tap water, ethanol and petrol, respectively (Fig. 1d). A 6.75 increase of ethanol evaporation intensity compare to tap water was recorded ($p < 0.001$). While comparison of tap water and petrol showed 23.80-fold rise of petrol evaporation intensity ($p < 0.001$). Furthermore, comparison of ethanol and petrol indicated 3.52-fold increase of petrol evaporation intensity ($p < 0.001$).

Moreover, for each of analyzed liquid the following decrease of temperature was observed and amount 0.60 ±0.32°C, 3.94 ±0.32°C and 1.45 ±0.21°C for tap water, ethanol and petrol, respectively. A 6.51-fold higher decrease of ethanol temperature compare to tap water was observed ($p < 0.001$). While comparison of tap water and petrol indicated 2.40-fold higher decrease of petrol temperature ($p < 0.001$). Comparison of ethanol and petrol indicated 0.37-fold higher reduction of petrol temperature ($p < 0.001$). Additionally, there was a weak negative correlation between changes in temperature and mass of tap water (rho = -0.127) and strong negative petrol (rho = -0.713) and strong positive correlation for ethanol (rho = 0.889).

3.2. Porous surface

Distribution of mass and temperature for three liquids without additional interrupting factors and on a porous surface (sand) was analyzed. It was accordance with the data of (Volchkov 2006, Nasr et al. 2010). Similarly, to impermeable surface with a decrease of density value an increase in the amount of evaporated liquid was noticed and amount 0.21 ±0.02 g, 0.80 ±0.02 g and 5.53 ±0.37 g for tap water, ethanol and petrol, respectively (Fig. 2a). Additionally, a 3.79-fold increase of ethanol evaporation intensity compare to tap water was observed ($p < 0.001$). The comparison of tap water and petrol indicated a 26.16-times rise of petrol evaporation intensity ($p < 0.001$). While comparison of ethanol and petrol indicated 6.90-times increase of petrol evaporation intensity ($p < 0.001$). Moreover, for each of analyzed liquid the following decrease of temperature was observed (0.67 ±0.11°C, 1.27 ±0.32°C and 3.14 ±0.23°C for tap water, ethanol and petrol, respectively). A 1.91-fold higher decrease of ethanol temperature compare to tap water was observed ($p < 0.001$). While comparison of tap water and petrol indicated 4.71-fold higher decrease of petrol temperature ($p < 0.001$). A comparison of ethanol and petrol indicated approximately 2.46-fold higher reduction of petrol evaporation ($p < 0.001$). Additionally, there was a strong positive correlation between changes in temperature and mass of tap water (rho = 0.998), ethanol (rho = 0.996) and petrol (rho = 0.991) for the case of without additional interrupting factors.

Adding of wind factor increased of evaporation intensity for all liquids (0.97 ±0.10 g, 6.80 ±0.26 g and 26.91 ±0.87 g for tap water, ethanol and petrol, respectively) (Fig. 2b). The highest increase was observed for the ethanol (8.48 times, $p < 0.001$), while the lowest increase was observed for the tap water (4.57 times, $p < 0.001$). Moreover, 7.03 increase of ethanol evaporation intensity compares to tap water was recorded ($p < 0.001$). While comparison of tap water and petrol indicated 27.83-times increase of petrol evaporation intensity ($p < 0.001$). Furthermore, comparison of ethanol and petrol showed a 3.96 increase of petrol evaporation intensity ($p < 0.001$).

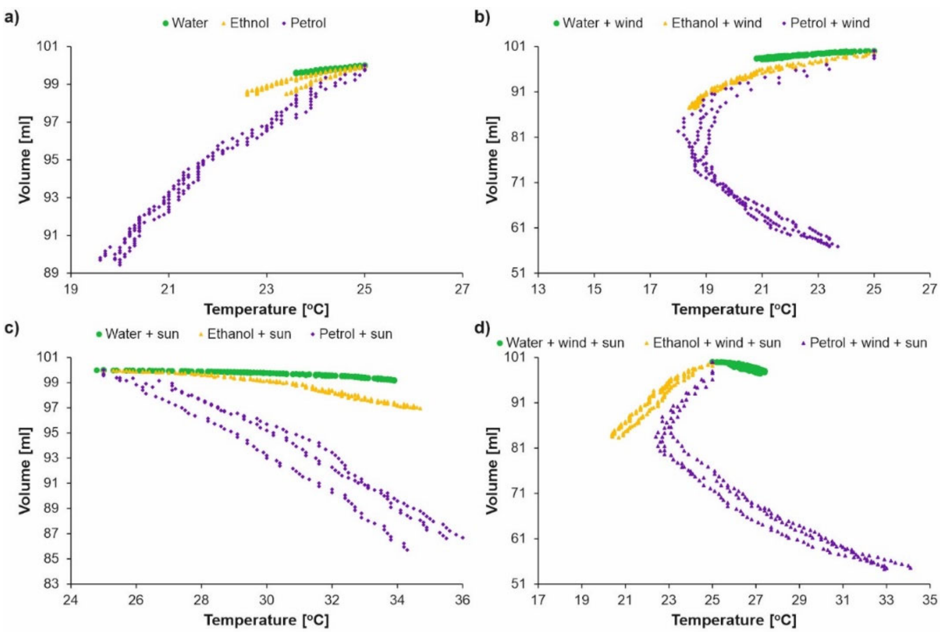

Fig. 2. Scatterplot graphic presentation of liquid evaporation for: a) case without external factors, b) with wind impact, c) with sun impact, d) with wind and sun impact, in contact with porous surface

Moreover, for each of analyzed liquid the following decrease of temperature was observed and amount 2.59 ±0.015°C, 4.55 ±0.10°C and 4.41 ±0.21°C for tap water, ethanol and petrol, respectively. A 1.76-times higher decrease of ethanol temperature compare to tap water was observed ($p < 0.001$). While comparison of tap water and petrol indicated approximately 1.70-fold higher decrease of petrol temperature ($p < 0.001$). A comparison of ethanol and petrol indicated 0.97-fold higher reduction of petrol evaporation ($p < 0.001$). Additionally, there was a strong positive correlation between changes in temperature and mass of tap water (rho = 0.988), ethanol (rho = 0.952) and weak negative correlation for petrol (rho = -0.245) for the case of wind factor.

After substitution of wind with sun rays it was observed that the evaporation process intensity was not so intensive like for wind factor, however it was higher comparing to the reference one (without any external factors). The highest increase compare to the reference case was observed for the tap water (1.72 times, $p < 0.001$), while the lowest increase was observed for the petrol (1.26 times, $p < 0.001$). Moreover, comparison with wind factor indicated that the highest increase was observed for the tap water (0.38 times, $p < 0.001$), while the lowest for the ethanol (approximately 0.20 times, $p < 0.001$). Adding of sun rays factor showed that evaporated volume of liquid was equal to 0.36 ±0.01 g, 1.35 ±0.02 g and 6.98 ±0.18 g for tap water, ethanol and petrol, respectively (Fig. 2c). A 3.71-fold increase of ethanol evaporation compared to tap water was recorded ($p < 0.001$). While comparison of tap water and petrol indicated a 19.23- fold increase of petrol evaporation ($p < 0.001$). On the contrary, only 5.19 increase of petrol evaporation ($p < 0.001$) was noticed when compared ethanol and petrol.

Moreover, for each of analyzed liquid the following decrease of temperature was observed (5.52 ±0.07°C, 5.59 ±0.23°C and 5.93 ±0.83°C for tap water, ethanol and petrol, respectively). A 1.01 higher decrease of ethanol temperature compare to tap water was recorded ($p < 0.001$). While comparison of tap water and petrol indicated approximately 1.07 higher decrease of petrol temperature ($p < 0.001$). Furthermore, comparison of ethanol and petrol indicated a1.06 higher reduction of petrol evaporation ($p < 0.001$). Additionally, there was a strong negative correlation between changes in temperature and mass of tap water (rho = -0.955), ethanol (rho = -0.965) and petrol (rho = -0.992).

Finally, the influence of both factors (wind and sun rays) was investigated. It was observed that the evaporation process was the highest compare to the previous cases. The highest increase compare to the reference case was observed for the ethanol (10.78 times, $p < 0.001$), while the lowest increase for the petrol (5.16 times, $p < 0.001$). Moreover, comparison with wind factor indicated that the highest rise was noticed for the tap water (1.28 times, $p < 0.001$), while the lowest increase was observed for the petrol (1.06 times, $p < 0.001$). Furthermore, comparison with sun rays showed that the highest intensification was observed for the ethanol (6.43 times, $p < 0.001$), while the lowest increase was noticed for the tap water (3.42 times, $p < 0.001$). Adding of wind and sun rays indicated that evaporated volume of liquid was equal to 1.24 ±0.08 g, 8.64 ±0.22 g and 28.55 ±0.11 g for tap water, ethanol and petrol, respectively (Fig. 2d). Also, a 6.96 increase of ethanol evaporation compare to tap water was noticed ($p < 0.001$). While comparison of tap water and petrol showed a 22.98 increase of petrol evaporation ($p < 0.001$). Furthermore, comparison of ethanol and petrol indicated approximately 3.30 increase of petrol evaporation intensity ($p < 0.001$). Moreover, for each of analyzed liquid the following decrease of temperature was observed (1.43 ±0.26°C, 2.69 ±0.22°C and 2.03 ±0.55°C for tap water, ethanol and petrol, respectively). We noticed a 1.89 higher decrease of ethanol temperature compare to tap water ($p < 0.001$). While comparison of tap water and petrol indicated approximately 1.42 higher reduction of petrol temperature ($p < 0.001$). Furthermore, comparison of ethanol and petrol indicated a 0.75 higher decrease of petrol evaporation ($p < 0.001$). Additionally, there was a strong negative correlation between changes in temperature and mass of tap water (rho = -0.977) and petrol (rho = -0.875) and strong positive correlation for ethanol (rho = 0.990) for the case of wind and sun rays factor.

3.3. Comparision of flat and porous surfaces

Application of porous surface involved increase of evaporated liquid for tap water (1.22 times) and petrol (1.15 times). It was accordance with (Zhou et al. 2020). While, for ethanol application of porous surface decrease of evaporated amount of liquid (14%).

Moreover, for porous surfaces adding of wind factor decreased the amount of evaporated liquid by 19%, 5% and 2% for tap water, ethanol and petrol, respectively. After substitution of wind with sun rays it was observed that the evaporation process increased by 1.14 and 1.37 times for ethanol and petrol, respectively. While a 18% decrease of evaporated liquid for tap water was recorded. Finally, the influence of both factors (wind and sun rays) indicated a 1% and 5% decrease of evaporated liquid for tap water and petrol, respectively. While, for ethanol 2% increase of evaporated liquid was observed. Moreover, graphical results of evaporation process for each of analyzed liquids was described with an umbrella shape (Fig. 3).

For tap water and impermeable surface an umbrella had vertical shape. However, substitution of flat surface with porous one indicated aberration from vertical configuration into right side (Fig. 3a and Fig. 3b). While analysis of ethanol instead of tap water indicated aberration of umbrella from vertical configuration into left side for flat surface and porous surface (Fig. 3c and Fig. 3d). Finally, for petrol the shape of umbrella was deformed by collapse into right side for impermeable surface and porous surface (Fig. 3e and Fig. 3f).

In Table 1 mathematical functions for each of analyzed liquids were presented. Each liquid was described with several functions to reflect the shape of umbrella. Each time the range of function was selected that regression coefficient was not lower than 0.769. While the highest regression coefficient was equal to 0.989.

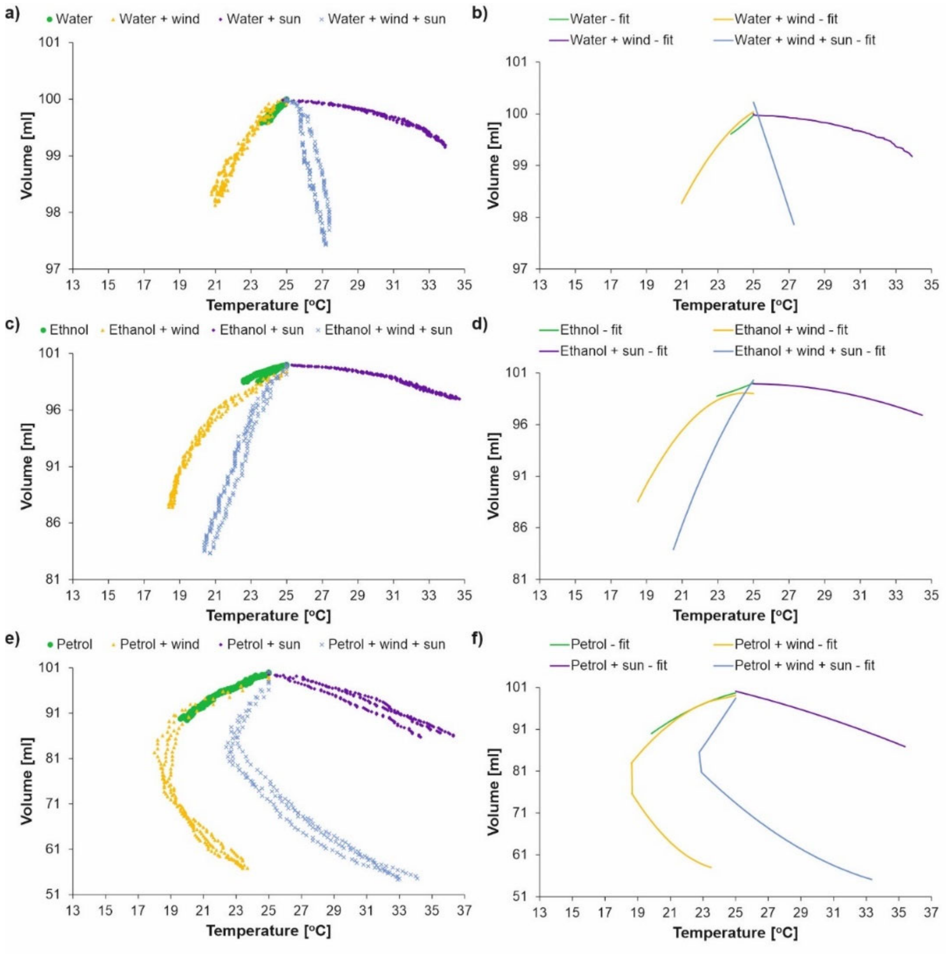

Fig. 3. Scatterplot graphic representation of porous surface for: a) tap water, b) tap water fit function, c) ethanol, d) ethanol fit function, e) petrol, f) petrol fit function

Table 1. Graphical description of analyzed cases. IS – impermeable surface, PS – porous surface, WO – without external conditions, W – wind, S – sun, TW – tap water, E – ethanol, P – petrol

Case	Liquid	Factors	Form of mathematical function	Range	R^2
IS	TW	WO	$y = -0.0439x^2 + 2.4238x + 66.831$	$x \in \langle 23.80 - 25.00 \rangle$	0.868
		W	$y = -0.0313x^2 + 1.767x + 75.312$	$x \in \langle 19.10 - 25.00 \rangle$	0.926
		S	$y = -0.0116x^2 + 0.599x + 92.255$	$x \in \langle 25.00 - 34.70 \rangle$	0.911
		W+S	$x = 25.6$	$y \in \langle 97.68 - 100.00 \rangle$	–
PS	TW	WO	$y = 0.0428x^2 - 1.8003x + 118.23$	$x \in \langle 23.60 - 25.00 \rangle$	0.914
		W	$y = -0.0558x^2 + 3.0036x + 59.823$	$x \in \langle 20.80 - 25.00 \rangle$	0.956
		S	$y = -0.0108x^2 + 0.5546x + 92.84$	$x \in \langle 24.79 - 33.90 \rangle$	0.988
		W+S	$y = -0.0116x^2 - 0.4362x + 118.38$	$x \in \langle 25.00 - 27.40 \rangle$	0.769
IS	E	WO	$y = -0.0177x^2 + 1.472x + 74.066$	$x \in \langle 22.10 - 25.00 \rangle$	0.810
		W	$y = -0.0979x^2 + 5.0704x + 33.986$	$x \in \langle 14.60 - 25.00 \rangle$	0.882
		S	$y = -0.029x^2 + 1.4281x + 82.394$	$x \in \langle 25.00 - 34.20 \rangle$	0.966
		W+S	$y = -0.4304x^2 + 21.325x - 165.45$	$x \in \langle 19.00 - 25.00 \rangle$	0.823
PS	E	WO	$y = 0.0664x^2 - 2.5753x + 122.9$	$x \in \langle 22.60 - 25.00 \rangle$	0.806
		W	$y = -0.2904x^2 + 14.246x + 75.648$	$x \in \langle 18.40 - 25.00 \rangle$	0.977
		S	$y = -0.0325x^2 + 1.6125x + 79.942$	$x \in \langle 25.00 - 34.70 \rangle$	0.989
		W+S	$y = -0.2715x^2 + 16.002x - 130.06$	$x \in \langle 20.40 - 25.00 \rangle$	0.954
IS	P	WO	$y = -0.1575x^2 + 8.7402x - 20.323$	$x \in \langle 19.90 - 25.00 \rangle$	0.929
		W	$y = 0.094x^2 + 5.9751x + 7.7743$	$x \in \langle 15.90 - 25.00 \rangle$	0.796
		W	$y = 0.1303x^2 + 7.6915x + 166$	$x \in \langle 16.10 - 23.80 \rangle$	0.918
		S	$y = -0.0229x^2 - 0.038x + 115.56$	$x \in \langle 25.00 - 32.90 \rangle$	0.973
		W+S	$y = -0.2826 + 15.127x - 103.04$	$x \in \langle 18.80 - 25.00 \rangle$	0.973
		W+S	$y = -0.0911x^2 - 6.6428x + 170.78$	$x \in \langle 18.90 - 30.20 \rangle$	0.988
PS	P	WO	$y = -0.1744x^2 + 9.704x - 33.915$	$x \in \langle 19.60 - 25.00 \rangle$	0.985
		W	$y = -0.3533x^2 + 17.942x - 128.66$	$x \in \langle 18.00 - 25.00 \rangle$	0.811
		W	$y = -0.5239x^2 - 25.721x + 373.11$	$x \in \langle 18.50 - 23.70 \rangle$	0.966
		S	$y = -0.0286x^2 + 0.4499x + 106.72$	$x \in \langle 25.00 - 36.30 \rangle$	0.931
		W+S	$y = 0.0938x^2 + 1.3273x + 6.64$	$x \in \langle 22.40 - 36.30 \rangle$	0.909
		W+S	$y = 0.127x^2 - 9.5973x + 233.93$	$x \in \langle 22.50 - 36.10 \rangle$	0.967

4. Conclusions

The impact of external factors on the evaporation process in the laboratory scale, which simulated a hazard that firefighters may meet in their work, was analyzed. Application of porous surface caused the highest improvement of evaporation process for petrol and tap water, while the lowest was observed for ethanol. Moreover, application of wind together with porous surface increased the intensity of evaporation for all analyzed liquids compare to the case without additional interrupting factors such as wind or sun rays. However, application of sun rays instead of wind caused the highest improvement of evaporation process for ethanol and petrol and the lowest for tap water. Finally, application of both external factors provided similar intensity of evaporation.

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