ISBN-978-989-9121-25-6
MILAN 24th International Conference on "Innovations in Science & Technology" (MIST-23)
June 14-16, 2023 Milan (Italy)

Flexible Thermal Convective Emitter - Unsteady Irreversibility Analysis

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Abstract: *The intensity of convective electric heating of the fluid is mainly determined by its volumetric flow, the installed power of the heater and the geometric characteristics of the channel through which it flows. The temperature of the surface of the heating source, and its power is limited by the maximum allowed value. The constant convective surface of the electric heating source, with the above limitations, results in a wide range of electric convective heaters. The thermal efficiency of these heaters depends on a case-by-case basis, while the temperature of the fluid varies in some intervals in relation to the required temperature that needs to be achieved. During fast transient fluid heating processes, convective electric heaters are thermally inert, low efficiency, while in some cases their application is unjustified. Therefore, the thermally generated entropy of the described convective heaters and fluids increases, from case to case, while their energy efficiency is minimized.*

Keywords: *Flexible Heater, Airflow, Entropy Generation, Entransy Dissipation, Modification Irreversibility Ratio.*

1. Introduction

The efficiency of convective electric heating of different fluids depends on several processes and geometric parameters of the analyzed heating source. Basically, forced convective heating is determined by its flow, the installed power of the heater, and the geometric characteristics of the channel through which the fluid flows. The flow of fluid inside a channel can be laminar or turbulent, which depends on the flow speed of that fluid and the geometric parameters of the channel through which the fluid flows. The surface temperature of the heating source and its output heat flux is limited by the maximum allowed value. For various technical applications, different fluids, and their process characteristics, the output heat flux of the heater varied. The reason for the above is that the fluid must promptly take over the obtained heat otherwise the heater will be either overheated or under-cooled. The constant convective surface of the electric heater with the mentioned limitations, results in a wide range of electric convective heaters. The thermal efficiency of these heaters depends on a case-by-case basis, while the temperature of the fluid varies in some intervals in relation to the required temperature that needs to be achieved, from [1] to [7]. During fast transient fluid heating processes, convective electric heaters are thermally inert, i.e. low efficiency, while in some cases their application is not justified.

Therefore, the thermally generated entropy of the described convective heaters and fluids increases, while their energy efficiency is minimized. It is precisely for the above reasons that the idea of flexible thermal convective emitters was arrived at, which enables minimizing the limitations and shortcomings of existing convective heating sources. The solution analyzed in this paper, the flexible thermal convective emitter, enables

https://doi.org/10.17758/HEAIG13.H0623204

the instantaneous change of the convective surface and the input power of the heater. Thermal irreversibility during convective heating of fluids, i.e. generated entropy and entransy dissipation ratio analyzed in this paper.

2. Methodology

2.1. Materials and Procedures

In order to minimize the thermal irreversibility of the analyzed heating system, Fig.1, an analytical model of thermally generated entropy was established. By minimizing thermal irreversibility, the possibility of maximizing the energy efficiency of the analyzed flexible convective emitter is established.

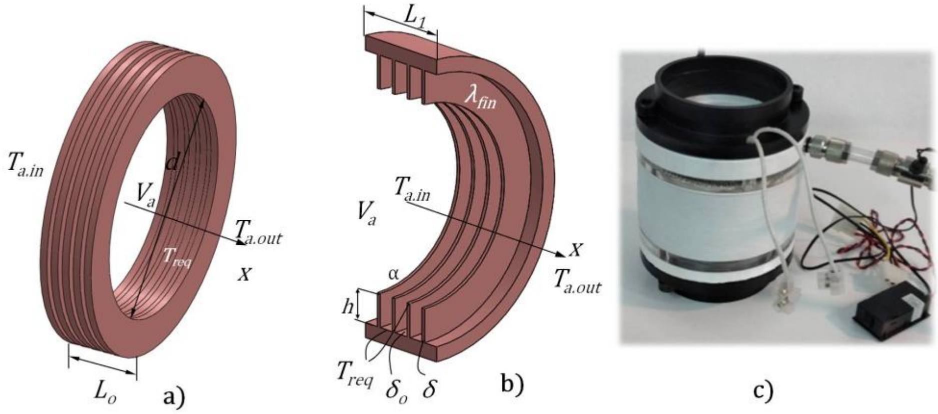

Fig. 1: Synchronized change of the convective surface and input power of the flexible electric heater enables optimal convective heating of the fluid at its constant flow.

Air enters inside the flexible convective emitter with mean velocity w_a and temperature $T_{a.in}$. The temperature of the inner surface of the convective emitter is limited by the maximum value T_{req}, which is considered constant in this analysis. The forced convective heat balance between the internal heating surface of the flexible heating emitter and the air can be represented by equation (1),

$$\rho_a w_a \frac{d^2\pi}{4} c_a dT_a = q_{req} d\pi dx \tag{1}$$

from which, after integration, the temperature of the air at the exit from the flexible thermal convective emitter is obtained

$$T_{a.out} = T_{a.in} + d\pi \frac{q_{req}}{\rho_a c_a V_a} x \tag{2}$$

The where α is the convective heat transfer coefficient, w_a is the mean velocity of airflow across the channel section, T_{req} is the required maximum temperature of the inner wall of the channel with diameter d. In the case that it is necessary to immediately heat the air to a higher temperature without the temperature of the inner surface of the channel not exceeding the required T_{req}, the flexible thermal emitter increases its surface many times over. The increase of the convective surface can be automatically regulated, so that the total exchanged heat inside the flexible connective emitter is represented by equation (3).

$$Q_{fins} = n_{fin} Q_{fin} + (n_{fin}-1) Q_{bfins} = n_{fin}(T_{req} - T_{a.in}) \left(\alpha P_{fin} \lambda_{fin} A_{fin}\right)^{0.5} tanh\left[\left(\frac{\alpha P_{fin}}{\lambda_{fin} A_{fin}}\right)^{0.5} h\right] + (n_{fin}-1) d\pi \delta_o \alpha (T_{req} - T_a) = q_{ref}\left\{n_{fin} \left(\frac{P_{fin}\lambda_{fin}A_{fin}}{\alpha}\right)^{0.5} tanh\left[\left(\frac{\alpha P_{fin}}{\lambda_{fin} A_{fin}}\right)^{0.5} h\right] + (n_{fin}-1) d\pi \delta_o\right\} \tag{3}$$

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where the end of the fin is thermally insulated, Fig.1, i.e. $\left(dT_{fin}/dx\right)_{x=h} = 0$. According to equation (3), the convective surface of the flexible emitter consists of the total surface of the fins and the unfinned surface. The fins obtain various temperatures on their surface, so the heat exchanged with the airflow is corrected by the thermal fin efficiency, under the adopted conditions. Outlet air temperature in the case of a developed flexible finned surface, inside a circular channel of diameter *d*, Fig.1, can be determined using equation (4).

$$T_{a.out} = T_{a.in} + \frac{1}{\rho_a c_a V_a} q_{ref} \left\{ n_{fin} \left(\frac{P_{fin}\lambda_{fin}A_{fin}}{\alpha}\right)^{0.5} \cdot tanh\left[\left(\frac{\alpha P_{fin}}{\lambda_{fin}A_{fin}}\right)^{0.5} h\right] + \quad + \left(n_{fin} - 1\right) d\pi\delta_o \right\} \tag{4}$$

should In this analysis, the attention is focused on the thermal irreversibility of the air, that is, the thermally generated entropy of the air due to its forced heating. The expression for the thermal entropy of air is represented by equation 5,

$$S_{air.\Delta T} = \rho_a \dot{V}_a c_a \int_{T_{a.in}}^{T_{a.out}} \frac{dT_a}{T_a} = \rho_a \dot{V}_a c_a ln\left(\frac{T_{a.out}}{T_{a.in}}\right) = \rho_a \frac{d^2\pi}{4} w_a c_a ln(\psi) \tag{5}$$

where $T_{a.in}$ and $T_{a.out}$ are the inlet and outlet air temperatures inside the flexible convective emitter, respectively. The entransy flow dissipation rate during the heating of air can be represented by the following expression.

$$E_{ent.in-out} = \rho_a \dot{V}_a c_a \int_{T_{a.in}}^{T_{a.out}} T_a dT_a = \rho_a \dot{V}_a c_a \left(T_{a.out}^2 - T_{a.in}^2\right) = \rho_a w_a c_a \frac{d^2\pi}{4} T_{a.in}^2 (\psi^2 - 1) \tag{6}$$

where the ratio of air temperature increase due to heating inside the flexible convective channel is denoted by $\psi = T_{a.out} / T_{a.in}$. Furthermore, the new irreversibility dimension ratio χ represents the ratio of the entransy flow dissipation rate and the thermal entropy of the air, [7] and [8], which is shown by equation 7.

$$\chi = \frac{E_{ent.in-out}}{S_{air.\Delta T}} = \frac{\left(T_{a.out}^2 - T_{a.in}^2\right)}{ln\left(\frac{T_{a.out}}{T_{a.in}}\right)} = T_{a.in}^2 \frac{(\psi - 1)}{ln(\psi)} \tag{7}$$

Maximizing the irreversibility ratio χ implies minimizing the thermal entropy and maximizing the entransy dissipation ratio. However, obtaining minimum values of thermal entropy does not mean that these are at the same time optimal values of the process or geometric parameters of this heated system. The reason for the above is that entransy dissipation ratio and thermal entropy are not of a similar order of magnitude, so the maximum value of χ does not mean at the same time that its optimum has been obtained. Therefore, it is necessary to reduce both the entransy dissipation ratio and the thermal irreversibility ratio to a similar order of magnitude.

2.2. Novelty of Flexible Thermal Convective Emitter

This convective emitter is intended to forcedly but efficiently heat various fluids circulating thru a flexibly distensible conduit, consisting of an external and internal flexible housing.

A fluid flow is enabled by a pump, compressor, or fan. This device is mostly used by hydraulic and pneumatic plants. Because the internal heating housing is flexible and extensible, the control de/compressed air allows its length change according to the optimal process requirements for fluid heating. The conduit’s length shall automatically be adapted, in the function of working parameters, temperature, and fluid flow rate. The primary advantage of this device represents the possibility of multiple changes in the optimal power of the electric heater and its convective surface. Thanks to this invention, a number of diverse devices with diverse dimensions and forms can be produced. Its installation and dissembling can be simply and quickly done, given that the electric current is used for fluid heating.

3. Results

In order to implement mathematical modeling, geometric and process parameters were established, which concretely define a flexible thermal convective emitter. The volumetric flow rate of air and the required heat flux from the inner surface of the flexible emitter to airflow were varied. The air flow through the convective emitter varied from $0.2 m^3 s^{-1}$ to $0.6 m^3 s^{-1}$, at its constant inlet temperature of 20 ^{o}C. The flexible convective emitter is connected to an external electrical power of 220V. If the flexible convective emitter is in the zero position, then its length is a minimal value of 20cm. With an increase in input power, and in order to maintain a constant heat flux, its total convective surface instantly increases. With an increase in input power, while maintaining a constant heat flux, its total convective surface instantly increases. The increase in the convective surface is ensured by annular convective heat fins. As the input heat flux increases, the output air temperature also increases as expected, Fig.2a.

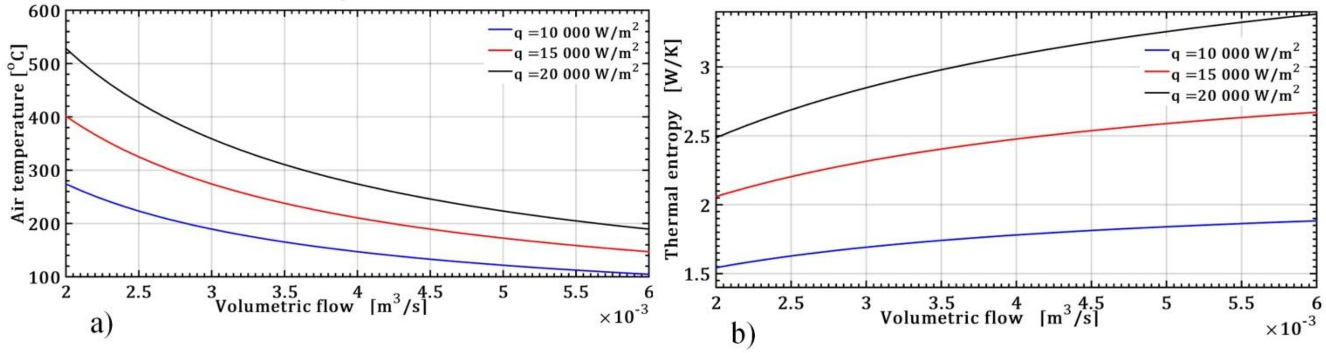

Fig. 2: a) Air temperature at the exit from the flexible emitter. b) Thermal entropy - during the convective transfer.

Smaller air flows have higher exit temperatures since it stays longer in the flexible duct. In this analysis, hydraulic irreversibilities are not included, but only thermal irreversibilities, through the mathematical model of thermal entropy, Fig. 2b.

Due to the heating of the air, its thermally generated entropy increases. Volumetric airflow, in addition, obtains a significant influence on thermal entropy, so that with its increase, thermal entropy also increases, even though the air temperature decreases. On the other hand, entransy flow dissipation rate decreases with increasing volumetric flow, Fig. 3a. Higher heat flux and air temperature have a higher entransy flow dissipation ratio. Comparing the values in Figs. 2b and 3a, entransy flow dissipation has large values compared to thermal entropy. The case is similar to the modification irreversibility ratio, Fig. 3b.

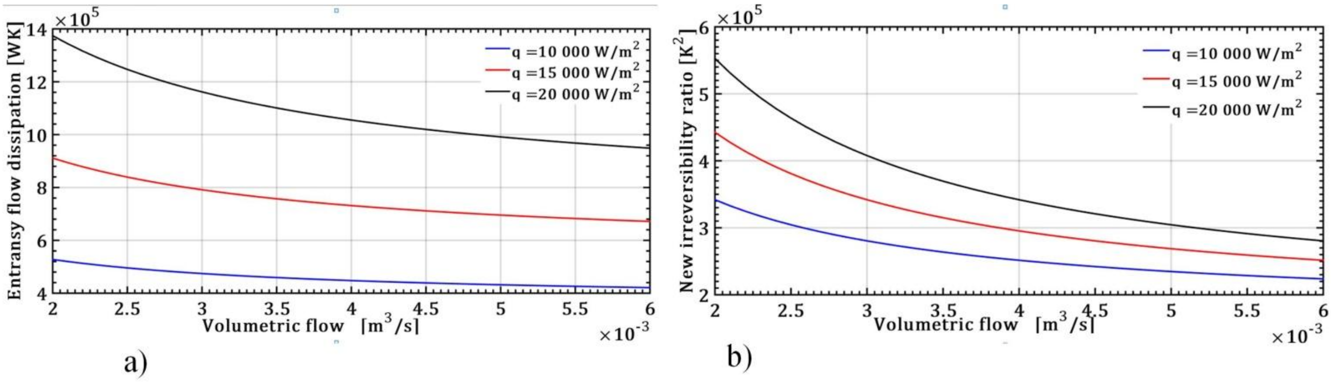

Fig. 3: a) Entransy flow dissipation - during air convective transfer through a flexible emitter.

b) Modification irreversibility dimension ratio.

Modification irreversibility dimension ratio χ represents the ratio of the entransy flow dissipation rate and thermal entropy, shown on Fig.3b. The values of this ratio are of the similar order of magnitude as the entransy dissipation ratio. The functional dependence of χ on the volumetric flow rate and heat flux in form is similar to the change in air temperature, shown in Fig. 2a.

The change in thermal entropy with the combined variation of the number of annular fins and the input heat flux is shown in Fig. 4. Thermal entropy increases with increasing volumetric airflow. The input heat flux obtains a significant role in the increase of thermal entropy, while the increase in the number of fins does not affect the values of thermal entropy. The opposite is the case with the entransy flow dissipation ratio, Fig. 5, where the smallest values are achieved at a minimum heat flux of $0.001 m^3 s^{-1}$. As the input heat flux increases, the entransy flow dissipation ratio increases linearly.

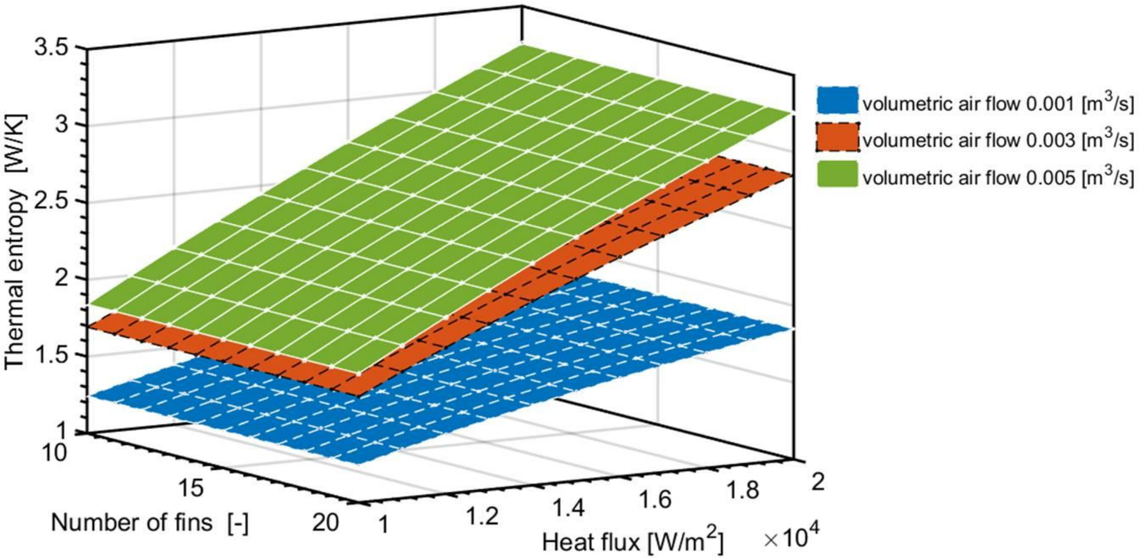

Fig. 4: Thermal entropy - variation heat flux and number of fins.

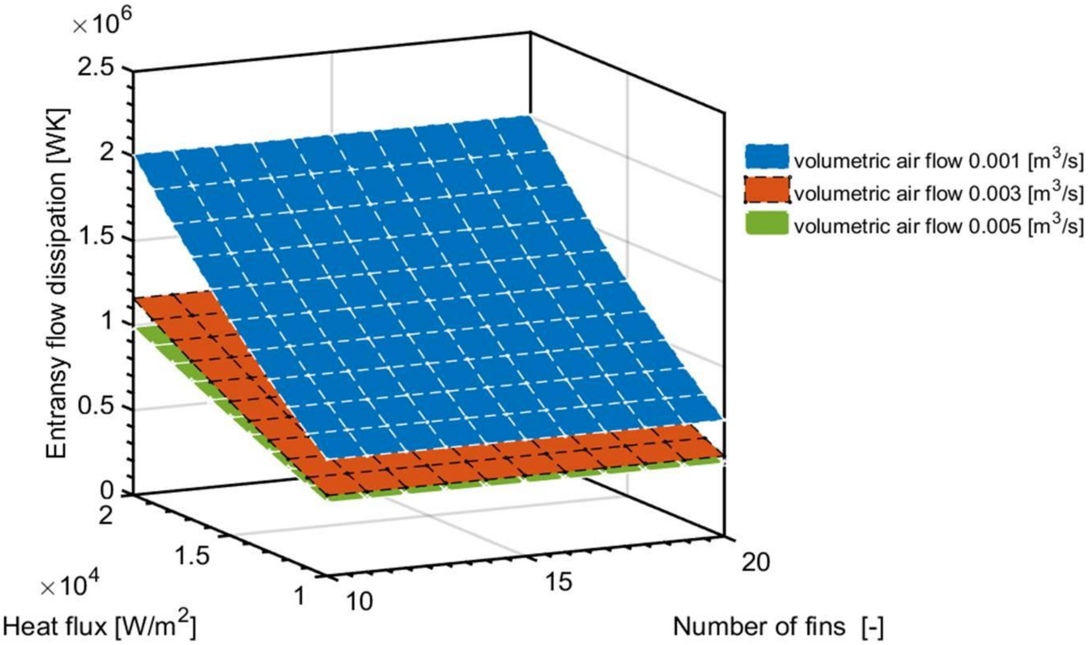

Fig. 5: Entransy flow dissipation – variation heat flux and number of fins.

https://doi.org/10.17758/HEAIG13.H0623204

4. Conclusion and Discussion

The flexible thermal convective emitter provides the possibility of an improved fluid heating solution by increasing the power of the electric heater while maintaining a constant value of the input heat flux. Existing electric heaters of this type contain limitations when increasing the input power of the heater at the same volumetric flow rate. As a consequence of the above, the convective surfaces of existing electric heaters are overheated, which reduces their service life. The adaptability of the synchronous change of the convective surface of the heater ensures that at the same fluid flow, the input power can be increased multiple times, which is not the case with existing convective heaters. A comparative analysis of thermal entropy and entransy dissipation ratio confirms the mutual character of these two physical quantities. While the thermal entropy increases with the air volumetric flow rate, the entransy dissipation ratio decreases. On the other hand, with the increase of the input heat flux, both of the mentioned physical quantities increase. The mentioned facts provide the possibility of maximizing the modified irreversibility distribution ratio, which is aimed at minimum entropy and maximum entransy flow dissipation ratio. The aforementioned limitation of this ratio can be eliminated by reducing the thermal entropy and entransy dissipation ratio to the similar order of magnitude.

5. Acknowledgements

This article is based upon work from the project Flexible Thermal Accumulation Convective Emitter, supported by the Ministry of Civil Affairs of Bosnia and Herzegovina.

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ISBN-978-989-9121-25-6
34th MILAN International Conference on "Nanotechnology, Materials, Biology & Environmental Sciences" (BNMBE-23)
June 14-16, 2023 Milan (Italy)

Wild Sunflowers: A Promising Habitat for Environments in Europe

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***Abstract*:** *Sunflower (Helianthus annuus L.) origins in the United States and exists in almost all parts of the american continent in different environments from deserts to cold regions. Wild sunflower grows easily in many kinds of soil, from salty marshes to rocky mountains in the US. The Helianthus genus is well adapted successfully in harsh environments containing 51 species and 19 subspecies. Sunflowers were first transferred to Europe by Spanish sailors in 1510. Firstly, it existed as a garden flower in palaces and rich people's garden houses due to giving longer flowering and exhibiting attractive yellow colors. Then it spread across Europe throughout the 1700s and as well into Russia and Ukraine lately and turned into an oil crop of the 19th century. However, wild sunflowers are so attractive plants for insects, especially bees. On the other hand, sunflower has huge ornamental potential because the Compositae family has big heads with full flowers. Furthermore, it uses commonly as a cut flower in the market. However, annual ones use also in the garden. On the other hand, even if it is native to the US, sunflower grows in almost all parts of Europe as being the largest planted industrial crop in Europe. It gives blooming mostly in the end of June to mid-July depending on the planting time and contributes a lot of the wildlife of Europe exhibiting much pollens and nectars. However, especially annual sunflowers could be existed as wild crops in the edges of the roads and in common and non-cultivated areas and like US then it prolongs pollen production for insects. The wild sunflower garden covering almost all Helianthus species is set up in Trakya University in Edirne, which is a European part of Turkey. In the study, the leaves and heads were observed and measured as well as flowering performance in wild sunflower species. Most of the wild sunflower species are branched, prolonging flowering time with longer blooming. Based on study results, wild sunflowers present promising results and exhibited easy adaptation to European conditions and it could be a very good habitat existing all parts of Europe. In conclusion, wild sunflowers should exist in both rural areas and also city-around environments as a friendly habitat because their seeds are excellent feeding sources for wild animals as well as birds, flowers supply pollens and nectars in highly longer periods for bees and other insects.*

Keywords: *Wild Sunflower, Helianthus species, Europe, Animal and bee feeding,*

1. Introduction

The cultivated Sunflower (*Helianthus annuus* L.) consists of 51 species, 17 annuals, 34 perennials, and 67 species together with their subspecies. All of these species are of American origin and are found in wild form in the USA. Sunflower, which is in the *Compositae* family, has a collective flower, and a common species of this family is the Jerusalem artichoke (*Helianthus tuberosus*), which is widely found as an ornamental material in the gardens of in Turkey and many European countries and sold as food in the markets [1]. In addition, some cultivars are grown in the plains of the USA as fodder and silage crops. The species of the *Helianthus* genus were observed in the study in sunflower were given in Table 1.

The basic chromosome number of sunflower is 17 (n=17), and diploid, tetraploid, and hexaploid forms exist in nature. Generally, species belonging to the genus *Helianthus* are perennial, of which only about 12 are annuals [3]. Many interspecies crosses have been made and continue to be made in this genus by plant breeders in order to transfer beneficial characteristics such as high oil percentage, cytoplasmic male sterility (CMS), resistance to diseases and pests, to the culture form (2n=34) and commercial varieties [4]. Because these wild species are extremely useful as a source of a wide variety of genes [5]. On the other hand, sunflower has huge

https://doi.org/10.17758/HEAIG13.H0623204

potential for ornamental purposes both for cut flowers and also in gardening due to giving longer flowering and enlarged green areas and it is a wild adapted plant in all parts of America [6].

TABLE I. The species of the *Helianthus* genus were observed in the study.

#	**Taxonomy**	**Type**	#	**Taxonomy**	**Type**
1	*H. agretis*	Annual	33	*H. eggertii*	Perrenial
2	*H. annuus*	Annual	34	*H. floridanus*	Perrenial
3	*H. anomalus*	Annual	35	*H. giganteus*	Perrenial
4	*H. anomalus*	Annual	36	*H. glaucophyllus*	Perrenial
5	*H. argophyllus*	Annual	37	*H. gracilentus*	Perrenial
6	*H. bolanderi*	Annual	38	*H. grosseserratus*	Perrenial
7	*H. debilis* subsp. *cucumerifolius*	Annual	39	*H. heterophyllus*	Perrenial
8	*H. debilis* subsp. *debilis*	Annual	40	*H. hirsutus*	Perrenial
9	*H. debilis* subsp. *silvestris*	Annual	41	*H. laciniatus*	Perrenial
10	*H. deserticola*	Annual	42	*H. laetiflorus*	Perrenial
11	*H. exilis*	Annual	43	*H. laevigatus*	Perrenial
12	*H. neglectus*	Annual	44	*H. longifolius*	Perrenial
13	*H. niveus* subsp.*canescens*	Annual	45	*H. maximiliani*	Perrenial
14	*H. niveus* subsp.*canescens*	Annual	46	*H. mollis*	Perrenial
15	*H. paradoxus*	Annual	47	*H. nuttallii*	Perrenial
16	*H. petiolaris*	Annual	48	*H. nuttallii* subsp. *nuttallii*	Perrenial
17	*H. petiolaris* subsp. *fallax*	Annual	49	*H. nuttallii* subsp. *rydbergii*	Perrenial
18	*H. petiolaris* subsp.*petiolaris*	Annual	50	*H. occidentalis*	Perrenial
19	*H. porteri*	Annual	51	*H. occidentalis* subsp. *plantagineus*	Perrenial
20	*H. praecox*	Annual	52	*H. pauciflorus*	Perrenial
21	*H. praecox* subsp. *praecox*	Annual	53	*H. pauciflorus* subsp. *pauciflorus*	Perrenial
22	*H. praecox* subsp. *runyonii*	Annual	54	*H. pauciflorus* subsp. *subrhomboideus*	Perrenial
23	*H. praecox* subsp.*hirtus*	Annual	55	*H. pumilus*	Perrenial
24	*H. angustifolius*	Perrenial	56	*H. radula*	Perrenial
25	*H. arizonensis*	Perrenial	57	*H. resinosus*	Perrenial
26	*H. atrorubens*	Perrenial	58	*H. salicifolius*	Perrenial
27	*H. californicus*	Perrenial	59	*H. silphioides*	Perrenial
28	*H. carnosus*	Perrenial	60	*H. simulans*	Perrenial
29	*H. ciliaris*	Perrenial	61	*H. smithii*	Perrenial
30	*H. cusickii*	Perrenial	62	*H. strumosus*	Perrenial
31	*H. decapetalus*	Perrenial	63	*H. tuberosus*	Perrenial
32	*H. divaricatus*	Perrenial	64	*H. winteri*	Perrenial

2. Landscape Enrichment Potential of Sunflower in Europe

As an originated plant in North America, sunflower is still found in many regions in the central part of the USA. The sunflower seeds collected from North America in the 1850s by Spanish travelers were first grown in Spain as an ornamental plant in gardens. Sunflowers were used by North American Indians as both a mixture and flour for making bread and other foods, and they observed that the Indians viewed sunflowers as the ornamental and venerable plant of their land. Prior to the cultivation of corn, American Indians used sunflowers as a food source, also used as a medicine plant, as oil for body painting, as material for pottery and paint, and as a timekeeper to determine the hunting season [1].

Sunflowers are attractive to many people because of their bright yellow color, large size, and cheerful appearance. They are often used as decorations in gardens and homes, and they are a popular choice for bouquets and floral arrangements. Sunflowers are also known for their ability to follow the sun, which is why they are sometimes referred to as "happy flowers" [3].

Adding new sunflowers to new landscapes or city parks is a great way to add a splash of color to any outdoor space. Sunflowers are a great choice for new environments because they are easy to grow and require minimal maintenance. They come in a variety of colors and sizes, so you can find the perfect sunflower to fit the landscape. Sunflowers are also a great choice for attracting pollinators such as bees and butterflies. Planting sunflowers in city parks or nature could help to create a beautiful and vibrant outdoor space in Europe like the US. Sunflowers typically begin to flower in late spring or early summer and continue to flower until the first frost of the season. The flowers will usually last for about two weeks, depending on the variety and the weather. Sunflowers will usually reach their peak bloom in mid-summer [6].

2.1. Sunflower Potential Advantages for New Landscape Designs

Sunflowers have a number of adaptations that help them survive and thrive in their environment. These adaptations include; **Tall Stems:** Sunflowers have tall, sturdy stems that allow them to reach for the sun and maximize their exposure to sunlight. **Large Leaves:** Sunflowers have large, broad leaves that are able to capture more sunlight than smaller leaves. **Heliotropism:** Sunflowers are able to track the sun throughout the day, turning their heads to maximize their exposure to sunlight. **Thick Stems:** Sunflowers have thick, strong stems that are able to support the weight of the large flower heads. **Resilience:** Wild sunflowers are able to withstand a wide range of environmental conditions, including drought, extreme temperatures, and poor soil quality. Sunflowers are also able to adapt to their environment, growing in different directions to maximize their exposure to sunlight to self-regulate their growth, meaning they can adjust their growth rate depending on sunlight to store energy in their seeds, allowing them to survive even in the harshest of conditions [7].

Based on this aspect, sunflowers as drought-tolerant plants are easy to grow and require minimal maintenance, and can help conserve water in the landscape adding vibrant color and texture to any landscape design. Sunflowers attract beneficial insects such as bees, butterflies, and other pollinators as well as providing a food source for birds and other wildlife. Sunflowers can be used to create a natural privacy screen or windbreak and could be used to create a beautiful focal point in the landscape in Europe [8].

Sunflowers could distribute to nature around cities as well as in city parks because they supply pollens in longer periods to wild insects as well energetic seeds to birds and other wild animals. Sunflowers could grow in different types of soils and environments as highly resilient plants. Then the landscape design incorporates different strategies to ensure that some wild sunflower species that adapted to harsh environments could thrive and improve the poor soils as well. These strategies include selecting sunflower varieties that are adapted to the local climate, providing adequate drainage, and using mulch to protect the soil from extreme temperatures. Additionally, sunflower resilience landscapes may include companion plantings, such as planting other flowers and vegetables that can help protect sunflowers from pests and diseases. Wild sunflowers may also incorporate water conservation strategies, such as using drought-tolerant plants and rainwater harvesting in European areas which have a similar climate to the US [9].

To determine these characteristics, a wild sunflower garden was set up at Trakya University in Edirne which is in European part of Turkey, and some observations such as plant height, stem, leaf traits as well as flowering period were performed. Among wild species, *Helianthus maximilani, H. radula* and *H. salicifolius* were higher potential for landscape design and adaptation for the traits mentioned above (Figure 1, 2 and 3).

Fig. 1: *Helianthus maximiliani* has attractive flowers for bees and insects

Fig. 2: *Helianthus radula* gives longer flowering

Fig. 3: A promising species: *Helianthus saliciflius*

Some morphological characteristics of wild *Helianthus* species such as plant height, leaf length, leaf width, table diameter and stem diameter were measured, and it was determined that there were great differences between species in the study (Table 2). It was observed that the tallest species among the species was *H. grossesserratus* with 310 cm. In terms of plant height, the species showed a variation between 12-310 cm. There is a variation between 1.5 - 41.5 cm in leaf length, 0.1 - 37.5 cm in leaf width, 0.5 - 34 cm in plate diameter and 0.04 - 15 cm in stem diameter among wild *Helianthus* species given Table 1.

TABLE II. Some morphological characteristics of wild *Helianthus* species

	Plant height	Leaf length	Leaf width	Table diameter	Stem diameter
Average	135,63	11,64	5,33	2,51	4,36
Maximum	310,00	41,50	37,50	34,00	15,00
Minimum	12,00	1,50	0,10	0,50	0,04
Standard Deviation	56,12	7,81	5,67	3,21	2,58
Medyan	133,50	10,50	3,50	1,80	3,50
Mode	200,00	10,00	3,00	1,00	2,00

3. Conclusions

In conclusion, wild sunflowers could be a promising habitat for environments in Europe as a great source of food and shelter for a variety of species, and they can help to improve soil quality, reduce erosion, and provide a habitat for pollinators. Wild sunflowers are also a great way to add color and beauty to any landscape. They are easy to grow and require little maintenance, making them a great choice for any garden. In addition, wild sunflowers are a great way to attract beneficial insects, such as bees and butterflies, which can help to pollinate other plants in the garden. Wild sunflowers can also help to reduce the spread of invasive species, as they can help to provide a barrier to the spread of these species. Finally, wild sunflowers can help to reduce the amount of carbon dioxide in the atmosphere, as they absorb carbon dioxide from the air and store it in their leaves and stems.

4. Acknowledgements

The study was supported by the Scientific and Technological Research Council of Turkey (TUBITAK) under the Project “The Determination of DNA Contents and Ploidy Levels of Wild Species and Interspecific Hybrids utilizing Flow Cytometry and Evaluation of some Yield Traits” numbered 119O218 and Trakya University Project Office project “The Phylogenetic Analysis of Wild Sunflower Species (*Helianthus spp*) with Molecular and Classical Methods” numbered 2020-62.

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