The Importance of Daily Life Phenomena in Chemical Engineering Education

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***Abstract*—Life is an excellent laboratory to understand, comprehend and master the basic sciences. The theoretical principle underlying the daily life phenomena has a potential to assist education. With this point of view, some examples were offered to use in engineering education, especially for chemical engineering departments, to ease the understanding and mastering of the undergraduate students. In order to check this educational approach, a questionnaire was performed among the students taking the lecture with the notion mentioned in this study and students not taking the course. The evaluation of the questionnaire proved that the daily life examples can enhance learning.**

***Index Terms*—Chemistry, education, engineering, engineering education.**

I. Introduction

Chemical engineering can be broadly defined as the branch of engineering that deals with the application of sciences (e.g., mathematics, chemistry and physics) to the process of converting raw materials or chemicals into more useful or valuable products in an economical and sustainable manner (i.e., simultaneously managing resources, protecting the environment and controlling health and safety procedures).

When one goes back to the historical evolution of chemical engineering, it can be seen that the discipline and the core curriculum have reacted to stimuli both from science and industry. Table I tentatively summarizes what could be considered as the landmarks of the discipline. It can be seen that industry or society needs, such as energy, environment, or nanotechnology, participate together with evolution of the scientific tools, to drive the changes [1].

Chemical engineering education has also evolved with respect to the social and technological requirements in order to keep up with the driving progress since late 19oo's. A variety of studies have conducted to develop a more comprehensive curriculum for chemical engineering education [1]-[4]. Consequently, students have obliged to complete a hard curriculum of both theory and application to achieve an "engineering degree". But, in some cases, the struggle to have the "degree" might cause to miss the link between daily life phenomena and theoretical knowledge. For this very reason, the aim of this study was to give a different perspective to lecturers and also students in accordance with the awareness of their environment and phenomena taking place all around them but never noticed from a scientific point of view.

TABLE I: The Evolution of Chemical Engineering [1]

1880: Society of Chemical Engineers (G. Davis, UK)
1888: First course in Chem. Eng. at MIT (USA)
1906: American Institution of Chemical Engineers
1915: Concept of unit operations (A.D. Little)
1923: "Principles of Chemical Engineering" by Lewis et al.
1950: Chemical thermodynamics
1955: Chemical kinetics
1960: "Transport Phenomena" by Bird, Stewart & Lightfoot
1963: Chemical reaction engineering
1965: System dynamics, process control
1968: Environmental engineering
1970: Safety & risk assessment
1973: Energy
1980: Biotechnology
1985: Computing & simulation (PSE, CFD, MD)
1990: Complex systems
2000: Nanotechnology, bio (life sciences)
A tentative inventory of the historical landmarks of the discipline.

In this study, instead of a perspective where chemical engineers contribute in the advancement of daily life related scientific topics, a perspective of the contribution of daily life phenomena to the chemical engineering education was discussed. The goal was to catch the missing link between real-life and theoretical models.

II. Daily Life Phenomena

A. Decomposition of Chemicals

In a decomposition reaction one substance undergoes a chemical change to produce two or more other substances. Many compounds undergo decomposition reactions when heated [5].

Daily Life Example: Air bag

In order to inflate safety air bags in automobiles, the decomposition of sodium azide, NaN3, is used. Sodium azide is a white to colorless, crystalline powder that is highly water soluble, tasteless, and odorless. Sodium azide, when heated in air to 275°C to 330°C, decomposes to nitrogen and leaves a residue of sodium oxide. This chemical reaction is the basis of its use in airbags.

In airbags, the azide pellet is composed of azide mixed with an oxidizing agent and with burn rate modifiers that produce a given controlled burn rate. This results in an airbag

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inflated with nitrogen gas and a white powder residue of sodium oxide. The decomposition reaction rapidly releases N2(g), which inflates the air bag:

$$2NaN_3\,(s) \rightarrow 2Na(s) + 3N_2\,(g)$$

The system is designed so that an impact causes the ignition of a detonator cap, which in turn causes NaN3 to decompose explosively. Even a small quantity of NaN3 (about 100 g) forms a large quantity of gas enough to full an air bag with an average volume of 50 L [5], [6].

Daily Life Example: Baking powder

Baking powder is a dry chemical leavening agent, a mixture of a weak alkali and a weak acid, and is used for increasing the volume and lightening the texture of baked goods. Baking powder works by releasing carbon dioxide gas into a batter or dough through an acid-base reaction, causing bubbles in the wet mixture to expand and thus leavening the mixture. It is known as a double-acting leavening because it begins to release carbon dioxide as soon as it is moistened, and again when heated in the oven. The resulting decomposition reaction can be represented as [7]-[9]:

$$NaHCO_3 + KHC_4H_4O_6 \rightarrow KNaC_4H_4O_6 + H_2O + CO_2$$

B. Hypoxia and Asphyxia Due to Poisoning

Poisoning is an act of causing disturbances to organisms when subjected to a sufficient amount of poison as lead, mercury, carbon monoxide, cyanide, and so on. When inhaled, poisoning effects are catastrophic due to their disruption the physiologic function of heme proteins which are essential for oxidative metabolism with their role of maintaining a supply of oxygen [10].

Daily Life Example: Carbon Monoxide (CO) poisoning

Carbon monoxide (CO) is a colorless, odorless, toxic gas that is a product of incomplete combustion. Motor vehicles, heaters, appliances that use carbon based fuels, and household fires are the main sources of this poison. Carbon monoxide (CO) intoxication is one of the leading causes of death due to poisoning [11]. CO poisoning is also the most common cause of death in combustion related inhalation injury, especially for poor families burning coal in stoves or using natural gas heaters, but closing their fresh air ventilation windows due to energy saving purpose.

Possible mechanisms of toxicity include a decrease in the oxygen carrying capacity of blood due to CO binding to heme proteins. CO combines preferentially with hemoglobin to produce carboxyhemoglobin (COHb), displacing oxygen and reducing systemic arterial oxygen (O2) content. CO binds reversibly to hemoglobin with an affinity 200–230 times that of oxygen. Consequently, relatively minute concentrations of the gas in the environment can result in toxic concentrations in human blood. The net result is a hemoglobin molecule that is poorly equipped to release oxygen at the tissue level. The decreased oxygen delivery is then sensed centrally, stimulating ventilatory efforts and increasing minute ventilation. The latter will increase uptake of CO and raise COHb levels, and will result in a respiratory alkalosis and hypoxia and asphyxia eventually [11]-[14].

Daily Life Example: Cyanide (CN-) poisoning

Cyanide has been widely used as an essential raw material in several industries including textile, plastics, paints, photography, electroplating, agriculture, food, medicine and mining/metallurgy. Because of its high affinity for gold and silver, cyanide is able to selectively leach these metals from ores. Especially, in gold mining processes, cyanide use has potentially poisonous consequences due to its high volatility at low pH values. At an optimal gold extraction pH of 10.5 or greater, most of the free cyanide in the solution is in the form of the cyanide anion (CN-), where cyanide loss by volatilization is limited. In natural aqueous systems that have pH values between 5 and 8.5, the majority of free cyanide can be found in the form of HCN and can be lost by volatilization. When cyanide vapor is inhaled up to critical levels, it causes intracellular hypoxia by reversibly binding to heme proteins with the same mechanism CO does [10], [15], [16].

C. Latent Heat of Vaporization

When a pure substance is liquefied from the solid state or vaporized from the liquid at constant pressure, no change in temperature occurs; however, the process requires the transfer of a finite amount of heat to the substance. These heat effects are called the latent heat of fusion and the latent heat of vaporization [17].

1) Daily Life Example: LPG tank

When the LPG is consumed in a cylinder with a fast flow, dew formation takes place at the upper parts of the cylinder and the valve exit. This formation is observed due to the heat transfer from cylinder exit to the environment in which case the heat required is supplied from the evaporation of LPG.

2) Daily Life Example: Psychrometers

Psychrometer is a laboratory device which is used to calculate relative humidity of the ambient air by measuring the dry-bulb and wet-bulb temperatures [18]. The temperature difference between dry-bulb and wet-bulb thermometers is due to the evaporation of water on the wet-bulb until it reaches to equilibrium with the ambient humidity. By psychrometric charts it is possible to calculate the air humidity according to these temperature values.

D. Joule-Thomson Process

When a fluid flows through a restriction, such as an orifice, a partly closed valve, or a porous plug, without any appreciable change in lunatic or potential energy, the primary result of the process is a pressure drop in the fluid. Such a throttling process produces no shaft work, and in the absence of heat transfer. The process therefore occurs at constant enthalpy. Since the enthalpy of an ideal gas depends on temperature only, a throttling process does not change the temperature of an ideal gas. For most real gases at moderate conditions of temperature and pressure, a reduction in pressure at constant enthalpy generally results in a decrease in temperature [17].

In order to determine whether the temperature is going to increase or decrease, the inversion temperature of the real gas should be considered. The inversion temperature in thermodynamics is the critical temperature below which a non-ideal gas (all gases in reality) that is expanding at constant enthalpy will experience a temperature decrease, and above which will experience a temperature increase. This temperature change is known as the Joule-Thomson effect, and is exploited in the liquefaction of gases [19].

1) Daily Life Example: Natural gas pressure reduction

Natural gas is transferred through high pressure pipelines. But, the pressure is needed to be reduced to supply local chain lines. For the pressure reduction, restriction valves are used. While natural gas passes through the restriction valve, pipelines are covered with a thin layer of ice due to the cooling effect of pressure reduction.

E. Radiative Heat Transfer

Thermal radiation is a form of electromagnetic radiation similar to X rays, light waves, gamma rays, and so on, differing only in wavelength. It is an important mode of heat transfer and is especially important where large temperature differences occur. In other words, radiation is the transfer of energy through space by means of electromagnetic waves in much the same way as electromagnetic light waves transfer light. The same laws that govern the transfer of light govern the radiant transfer of heat. Solids and liquids tend to absorb the radiation being transferred through them, so that radiation is important primarily in transfer through space or gases [20].

1) Daily Life Example: Accidents due to thermal radiation

In 1999, after Istanbul-Kocaeli earthquake disaster, a fire broke out at the biggest petroleum refinery of Turkey. Once a storage tank started to burn and reached extremely high temperatures, one of the nearby tanks also caught fire due to the radiative heat transfer from the hot tank. In order to prevent heat transfer between tanks, the surrounding environment was tried to be cooled by spraying water.

2) Daily Life Example: Firewood in a fireplace

When single firewood is started to burn in a fireplace, the pyrolysis takes place and the produced heat is lost to the environment by the radiation. In this case, pyrolysis cannot continue. But if a stack of firewood is burnt, the radiative heat lost by one firewood is absorbed by the others, and consequently, pyrolysis continues.

3) Daily Life Example: Black ice formation

Black ice or frost, a thin layer of glazed ice formed on the roadways, is one of the leading causes of accidents due to its invisibility in unexpected weather conditions. Even at temperatures above zero, frost formation can cause drivers to have accidents especially mornings of clear nights. On these nights, the sky behaves like a black body and absorbs radiative heat from the roads. For highways, lost heat is gained from the soil via conduction and from air via convection. On the contrary, for bridges or viaducts, lost heat results in a thin layer of frost formation on the surface.

F. Critical Temperature

Critical point is the highest pressure and highest temperature at which a pure chemical species is observed to exist in vapor/liquid equilibrium. Insight into the nature of the critical point is gained from a description of the changes that occur when a pure substance is heated in a sealed upright tube of constant volume [17]. In other words, critical temperature is the highest temperature, a gas can be liquefied by means of applying pressure. At or above critical point, it is impossible to liquefy a pure gas by increasing pressure.

1) Daily Life Example: Household gas distribution

In early 1900s, town gas produced by the pyrolysis of mineral coal, was supplied for household use in Istanbul city. For the distribution of town gas, underground pipelines were constructed throughout the city. Because the critical temperature of the town gas, containing hydrogen, carbon monoxide, and nitrogen, is below the daily temperatures, thus it cannot be liquefied to be sold in tubes. In 1950s, LPG was supplied for household use instead of town gas. But due to high critical temperature of LPG, consisting of propane and butane, it was possible to distribute in tubes instead of pipelines. In 1990s, natural gas supplied for household use. Similar to town gas, primarily methane mixture of natural gas was distributed with pipelines due to its low critical temperature.

G. Bernoulli's Principle of Fluid Flow

According to the Bernoulli's principle, an increase in the speed of a fluid results in a decrease in its pressure, or vice versa. In other words, velocity of a fluid flowing can be calculated from the pressure difference [20]. This principle is the basis for many practical applications of daily life and laboratory practice.

1) Daily Life Example: Bunsen burner

The Bunsen burner is a laboratory device which is used to heat, sterilize or combust materials. In order to have a hotter flame than using the ambient air and fuel gas alone, flammable gas is premixed with air before ignition. Gas-air mixture velocity is adjusted with the throat holes. From the holes, high pressure air enters the burner, but the fuel gas does not escape due to its low pressure.

2) Daily Life Example: Pitot tube

Pitot tube is a device measuring fluid flow velocity in order to calculate the fluid pressure; especially for calculating the airspeed of an aircraft. Open end of the device is placed on the wing facing toward the flow and due to the pressure difference the aircraft velocity can be calculated.

III. Methods

In this study, the aim was to determine whether daily life examples can enhance learning basic scientific concepts from an engineering point of view. "Occupational Safety in Chemical Industries", which was held in Turkish as Kimya Sanayiinde İş Güvenliği, lecture was taken into consideration for the evaluation of the claim because this lecture was based on the theoretical knowledge underlying the daily life phenomena.

In order to prove the claim, the following four-part framework was carried out: 1) A 20-question multiple choice questionnaire consisting of daily life examples and asking for their scientific basis was prepared (see Appendix). 2) A group of Marmara University Chemical Engineering undergraduate students was selected as the target group for the above mentioned questionnaire. 3) The target group was divided into two sections; the first section consisted of 43 students who attended the lecture while the second one consisted of 39 students who did not attend the lecture. 4) The questionnaire was applied to the groups with the traditional examination method.

In this study, two groups of students were investigated to determine whether "Occupational Safety in Chemical Industries", which was held in Turkish as Kimya Sanayiinde İş Güvenliği, lecture was helping students to connect the theoretical knowledge with daily life examples.

The above-mentioned two groups sections had taken all the lectures required to have a basic knowledge of the topics covered in the questionnaire. Some of these lectures are can be listed as the physical chemistry, thermodynamics, transport phenomena, fluids mechanics, heat and mass transfer, chemical kinetics, and so on. Therefore, the groups sections differed in only one lecture “Occupational Safety in Chemical Industries” which is was especially mentioning the daily life examples as case studies.

A 397-student-group of not taking the lecture and a 43-student-group of taking the lecture were subjected to a questionnaire including 20 questions given in the Appendix. Their answers were evaluated with χ2 (chi-square) statistical analysis method, with the null hypothesis of no significant difference exists between two groups.

The results of the questionnaire were first scored according to the number of true answers. A success criterion was defined as at least 10 true answers (including 10) out of 20 questions. Then, questionnaire scores was evaluated with chi-square (χ2) test which is a quantitative measure applied to determine whether a relationship exists between two categorical variables. In our case, this statistical method was applied to estimate whether there is a significant difference between two sets as a result of the performed teaching approach. The null hypothesis stated that “There is no significant difference from a success rate point of view between students who attended the course and who did not attend the course”. Consequently, the alternative hypothesis stated “There is a significant difference from a success rate point of view between students who attended the course and who did not attend the course” proving the course enhanced learning.

The chi-square test was applied in 5 steps: 1) evaluation of the numbers of successful and unsuccessful students with respect to their attendance (see Table III), 2) construction of the 2x2 contingency table (see Table II), 3) calculation of the χ2 score (3.1), 4) calculation of the degree of freedom (3.2) and determination of the probability of error level, 5) evaluation of the null hypothesis.

$$\chi^2 = \frac{(ad-bc)^2 n}{ABCD} \tag{3.1}$$

"Degree of freedom=(Number of columns-1)×(Number of rows-1)" (3.2)

TABLE II: A TYPICAL CONTINGENCY TABLE

	Attended	*Not attended*	*Total*
Successful	f_{11}=a	f_{11}=b	n1.=A
Unsuccessful	f_{21}=c	f_{21}=d	n2.=B
Total	$n_{.1}$=C	$n_{.2}$=D	n

IV. RESULTS AND DISCUSSION

The first step to evaluate the questionnaire results was the determination of the success rate values according to the gender with respect to their attendance to class. The success rate defined as the number of students having 10 and/or more true answers out of the total student number of the same gender. As clearly seen in Table II, attended students –both female and male – had a considerably high percentage of success. However, the difference between the success rates of the attended female students (72 %) and the not attended ones (27 %) was worth mentioning.

TABLE III: THE SUCCESS RATE OF THE STUDENTS ACCORDING TO THE GENDER WITH RESPECT TO THEIR ATTENDANCE

	Attended	**Not attended**
Female	72 %	27 %
Male	55 %	31 %
Total	67 %	28 %

As the second step, the 2×2 contingency tables for both female and male students were constructed separately (Table IV and V). The columns were determined as the attendance parameters while the rows were stating successful and unsuccessful students. A total number of 58 female students’ (Table IV) and a total number of 24 male students’ results were examined (Table V).

TABLE IV: THE CONTINGENCY TABLE FOR FEMALE STUDENTS

	Attended	*Not Attended*	*Total*
Successful	23	7	30
Unsuccessful	9	19	28
Total	32	26	58

TABLE V: THE CONTINGENCY TABLE FOR MALE STUDENTS

	Attended	*Not Attended*	*Total*
Successful	6	4	10
Unsuccessful	5	9	14
Total	11	13	24

Then, χ2 values for the two separate sections were to be calculated according to the contingency tables. Since the number of the not attended successful male students was below 5, the χ2 method could not be applied for male students’ section due to the nature of this method. Therefore, two sections are gathered to construct a combined contingency table for the evaluation (see Table VI). Additionally, the contingency table showed that the female students’ results were appropriate for the application of χ2 method. So the χ2 method also employed for the female students’ section.

The calculated χ2 values were 11.6 and 12.6 for the female students (Table V) and combined sections (Table VI), respectively. Since the contingency table was a 2×2 matrix, degree of freedom was calculated as 1. Both χ2 values exceeded the probability table value of 10.8 at 1 degree of freedom and on alpha level of 0.001. This resulting χ2 value is dramatically smaller than alpha level 0.001 probability table value while the generally accepted alpha level of 0.05 and below is considered to prove a significant difference. Thus, we reject the null hypothesis in favor of the alternative hypothesis stating there is a significant difference between groups from a success rate point of view between students who attended the course and who did not attend the course.

TABLE VI: THE COMBINED CONTINGENCY TABLE FOR FEMALE AND MALE STUDENTS

	Attended	*Not Attended*	*Total*
Successful	29	11	40
Unsuccessful	14	28	42
Total	43	39	82

The difference between two sections was proved to be significant via not only the contingency tables but also $\chi2$ statistical method. The results also confirmed our claim about the importance of daily life phenomena in chemical engineering education to ease the understanding and mastering the scientific concepts. Thus, it is possible to improve the quality of teaching by enriching the chemical engineering curriculum with daily life examples.

V. Conclusions

The aim of this study was to give a different perspective to lecturers and also students in accordance with the awareness of their environment and phenomena taking place all around them but never noticed from a scientific point of view. To be a successful engineer in the long term, the students should be equipped with theoretical knowledge but they should also have skills to handle, analyze, and offer solutions to the problems they encounter in daily life. With this standpoint, we state that for many courses held in the curriculum, it is possible to find interesting daily life examples in order to create the notion in students' minds that theoretical knowledge can be converted to a numerous of useful applications in real life.

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APPENDIX

A. Questionnaire

1) When Al and Fe2O3 mixture was put into two pieces of steel, Fe is formed and Al2O3 dust remains in the environment while railroad tracks are being welded. With which of the following concepts or laws, do you explain these phenomena?
- With density difference between Al2O3 and Fe2O3
- With electrode potentials of Al and Fe and accordingly their electropositivity
- With Hess Law showing that energy gained or lost between two different state points are not related to path but first and last conditions
- Solubility of metallic Al and Fe within each other

2) If a LPG tube is consumed rapidly, water drops exist at the evacuation area of the tube. Why?
- Leaking of the humidity present in the LPG tube
- Joule–Thomson effect
- Obtaining required latent heat from liquid LPG while evaporation
- Dropping of internal pressure with fast flow from the tube

3) A natural gas flame heats the top of flame, not the side parts. However, you feel the heat near the diesel oil or wood flame. Why?
- Energy released is not enough to heat side parts because natural gas molecules are small. Others reject more heat.
- Natural gas flame burns rapidly and goes upwards.
- Combustion of natural gas is a complete homogeneous combustion, for this reason it has no solid particles which radiate energy in every wave length. However, other flames have particles.
- Since natural gas flame, which burns faster than other flames, absorbs air, warm air cannot reach side parts.

4) On the basis of which principle does Linde instrument, used for obtaining liquid nitrogen and oxygen, work?
- Thermodynamic principles
- Bernoulli's law
- Joule–Thomson effect
- Utilization of latent heat of evaporation

5) Tubes which are used to weld or cut with oxygen acetylene flame and to store oxygen in gaseous state under pressure get cold on a rapid operation. Why?
- Leaking of the humidity present in the LPG tube
- Joule–Thomson effect
- Obtaining required latent heat from liquid oxygen while evaporation
- Dropping of internal pressure with fast flow from the tube

6) In 1920s, air gas, which is formed via pyrolysis of coal and includes H2, CO and N2, was distributed with pipe line in Istanbul, not sold in tubes. For LPG (propane, butane), which was started to be sold in 1960s, pipe lines were not used, sales were carried with various sizes of tubes. For natural gas (methane), which was started to be distributed in 1990s, distribution lines were installed, not sold in tubes. What is the reason for the difference between these city planning applications?
- Technological progress of these days
- Low heating values of mentioned gases
- Critical temperatures of mentioned gases
- Toxic or explosive properties of mentioned gases
- This is a trick question. No technical reason exists for these cases. This behavior is due to economic reasons.

7) Pressure of natural gas in the entrance station of Istanbul drops from 70 atm to 20 atm. In these pressure reducing stations the expansion area is covered with ice. Why?
- Natural gas is cooled to reduce its pressure and cooling operation is supported with ice.
- Cooled natural gas makes the humidity in air freeze with Joule–Thomson effect
- Reverse Joule–Thomson effect causes ice formation
- Pressure drops according to Bernoulli's law

8) A pressurized hydrogen tube which kept outside a building for safety reasons, works with high flow rate on a hot day in August, but after a while required flow rate cannot be obtained. Why?
- Heated tube prevents obtaining required flow rate because of Reverse Joule–Thomson effect and hot summer day
- Starting of spontaneous combustion of hydrogen due to heat
- Absence of the latent heat to give hydrogen
- Heat increases the rate of combustion

9) While in old Turkish movies people commit a suicide with air gas, after 1980 we do not see this kind of suicides. Why?
- This is a trick question. No technical reason exists for this case. Type of movies has changed.
- CO, which forms a complex with haemoglobin and prevents oxygen transfer of blood, is present in air gas, for this reason air gas is poisonous but other gases are not.

- Air gas requires more air for burning than tube gas. For this reason, air in the room is used up quickly while air gas is burning.
- Air gas combusts spontaneously, uses up oxygen.

10) While flame is burning on the top of a Bunsen burner or herd, primer air input is supplied with a hole below the flame. Why does not fuel leak from the hole?

- While air is passing rapidly, absorption occurs and pressure drops.
- Because the molecules in the flame are lighter than the ones present in natural gas and air, they draw the air to the top.
- In fact gas leaks from the hole but leaked gas burns with the flame passing through the edges.
- A semi-permeable diaphragm in the air input point allows the air in, but prevents the fuel with big molecules out.

11) How do we explain the poisoning from central heating boiler in winter time?

- Poisonous gases burned in the central heating boiler leaks with the aging boiler or fittings.
- When the rooms are closed tightly, central heating boiler uses up all the air in the room and people die from the insufficient oxygen presence.
- If there is not sufficient air for central heating boiler, CO is released instead of CO2 after combustion. CO forms a complex with hemoglobin and prevents oxygen transfer of blood.
- Lead (Pb) which is used in the raw material of old central heating boilers evaporates and causes heavy metal poisoning.

12) Panel heaters working with electricity or gas, warms directly its opposite direction not the top or the air. What is the reason for that?

- In fact, it warms the air but we cannot recognize that because heater warms a part of the room and this part mixes with the cold air rapidly.
- Air is warmed but the warmed air goes up via natural convection.
- Mentioned heaters transfer heat via radiation. N2 and O2 present in the air, have low radiation absorption and emission. Radiation passes through the air and is absorbed by the material or the body just opposite.
- Main energy is gained with the ionization of air with these heaters besides conduction.

13) At a ship fire on TV, sea firemen were trying to extinguish an oil tanker which was burst into flames by pressurized stream water with a fire hose. Comment this video news.

- Firemen were applying wrong extinguish method. Oil and derivatives cannot be extinguished with water.
- Reducing the combustibility of oil via soaking with water is a true application.
- The steam formed by sprayed water was thought to remove the combustion air from the medium.
- With the cooling of tanker's body, the transfer of evaporated oil, which was reheated and reboiled by steel via conduction from the combustion of oil, was aimed to be prevented to reach the upper fire area.

14) For spark ignition engines, petrol vapor in the pistons is ignited with spark plug. For diesel engines, no ignition occurs. With which mechanism does the mixture of air and fuel vapor in the piston react?

- Sparkles supply the ignition with the rapid friction between piston and cylinder.
- Rapid compression of air-vapor mixture heats the cylinder (Joule–Thomson effect)
- According to the Bernoulli's Law, internal pressure of a mixture moving in a cylinder declines rapidly, its temperature increases proportionally.
- Static electricity, formed by the movement of piston, is the reason of this continuous reaction and this may be the most important application of static electricity.

15) At winter nights, when the sky is clear and the temperature is above zero for example 5- 6 ℃, paved roads over the bridges are covered with a thin layer of ice. Without frost, which of the following statements are correct for this phenomenon (there may be multiple correct answers as well no correct answer)?

- Over the bridge, wind is very strong and vacuum caused by the flowing air forms a regional cold area.
- There is something wrong in this question. According to the thermodynamic principles, if the air temperature is above zero, the air cannot cause a frost. I think the temperature measurement was wrong.
- Paved roads conduct heat to the sky via radiation and while cooling gain heat from air via convection and from the bottom via conduction. Paved roads radiate heat in considerable amounts because of their dark color. Since no soil exists below, heat transfer from the earth via conduction cannot occur and this eases the freezing of roads over bridges.
- We do not observe this situation below trees. Because the trees are warmer than the sky, heat transfer from paved roads via radiation is less.
- This phenomena is more distinct on windy days, wind also cools the bridge.
- This phenomena exists more difficultly on windy days, wind warms the bridge.
- The reason for such a phenomenon over zero degree is the increase in heat transfer via conduction with the electrical conductivity supplied by static electricity.

16) When wood starts to burn, firstly flames moves all around it. Then, internal combustion continues in the wood. Which of the following statements are correct for this phenomenon (there may be multiple correct answers as well no correct answer)?

- At the beginning, flames are the combustible gases released with pyrolysis. Combustion energy of these molecules continues burning by heating the surface of the firewood.
- Firstly burnt flames are spontaneous combustion ignited by the oxygen present in the formula of wood.
- Only one wood may not continue to burn, but combustion of a grouped wood tile is easier.
- Radiated energy from a grouped wood tile serves to keep the tile warm and to continue the pyrolysis.
- In a fireplace or oven, pyrolysis cannot continue if air suction or draft is too strong.
- The release of flue gas from a fireplace or oven, shows that the gases from pyrolysis have not reached to the lower combustion limit.
- The release of flue gas from a fireplace or oven, shows that

the proportion of the gases from pyrolysis to the air is higher than the stoichiometric ratio.

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