An Approach to Learning of Chemical Process Technology from Our Daily Life Practice, Experience and Observations

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Abstract:
Engineering relates everything and everybody in everyday life. Life can be understand as an excellent laboratory to comprehend, perceive and master the basic sciences. The experience from the daily life phenomena have a potential to give an assistance in education. A few examples are described from natural processes including the life processes. It is possible to learn some basic ideas about chemical engineering from interesting daily life examples.

Keywords:
Education, Personal development, Transferable skills, Knowledge and skills, Engineering and Technology, Active learning methodologies

1. Introduction

Chemical Technology/Engineering is a programme of engineering education that deals with the manufacture of products and chemical production through chemical processes. Principles of physics, chemistry, mathematics, and economics are used efficiently to transform, use, produce, and transport materials, chemicals, and energy. This branch of engineering also consider as part of designing various equipment, processes and systems for refining raw materials and for mixing, compounding, transforming and processing materials/chemicals to make valuable products. Using the principles of chemistry, biology, physics and mathematics, chemical engineers solve the problems relating to the production of various chemicals, drugs, medicine, food, fuel and many other products in an economical and sustainable manner (i.e., simultaneously managing resources, maintaining energy efficiency, protecting the environment, regulating carbon and controlling health and safety procedures). Chemical engineering education has also moved forward since last century in order to maintain the social needs and technological requirements.

In this article, a perspective of the contribution of daily life practice, experience and observations to the chemical engineering education has been reviewed instead of a viewpoint where chemical engineers make a contribution of their knowledge in the improvement of daily life related scientific topics. This report presents that using the facts such as cooking, human digestion process, cloth drying and tea preparation explain the aspect of chemical process in our life.

2. Background

Everyday life or daily life constitutes the ways of life in which human being observe, think, feel, and act on day by day. It may be expressed as habitual, routine, natural, or normal. Processes of knowing is the principal characteristics of the science of learning. Peoples are considered as goal-targeted agents who actively try to get information. Humans take a formal education with a range of prior knowledge, arts, beliefs, skills, concepts and ideas. This significantly exert guidance on what they perceive about the environment and how they categorize and interpret it. These, in turn, have an impact on their abilities to analyse and solve problems, remember, reason, acquire and interpret new knowledge.

3. Daily life example and pre-existing knowledge

A scientific understanding involves learning environments, understanding about learning processes, teaching methods, and the many other factors that are responsible for learning. Both in laboratories and in the field contributes the primary knowledge base for understanding to learn about any subject. In this section, the following examples are discussed to understand chemical process technology from our interesting daily life observations/information.[1]

3.1 Preparation of tea as leaching

It's always a good time for a cup of tea. In the morning, tea can provide the boost of energy you need to start your day, while in the evening, tea can serve as a relaxing drink before bed.

In chemical engineering terms, leaching is defined as the process of extraction of a solute from a solid using a solvent at a particular temperature. The process of tea preparation, one of the oldest humankind technique, can be used to understand the leaching process. In tea preparation, the mixture of tea leaves and water is warmed under controlled temperature using sugar etc. In this process, molecules/compounds associated with the tea leaves starts to come into the water as heat is supplied. The water temperature varies from room temperature to its boiling point. The temperature of water controls the rate of leaching tea from tea leaves which means the rate of this process is a strong function of temperature. So, one can be known about the idea of leaching process from this tea making process.

3.2 Home cooking/ processing of food as heat transfer

Home cooking has traditionally been a process carried out informally in a home or around in a feast, and can be enjoyed by all members of the family. It is the combination of art, science, technology and craft. Preparing food for consumption is a unique activity to people in their own homes and professional cooks and chefs in restaurants. Techniques, types and ways of cooking depend on the skill of the cook. In the cooking process, heat as energy is providing to food in different ways by using fire, gas ovens, electric stoves etc. So one can observe the different methods of heat transfer. Heat capacity and heat transfer coefficient are the two concept which explain how quickly food is cooked and what type of cooking utensil is used. Cooking is practical example of chemical engineering.[2] Cooking utensils is a batch rector and this can occur through different type of chemical reaction. Idea about different method of heat transfer and mixing characteristic can be known.

3.3 Human digestive system as chemical reactor

The human digestive system is one of the fundamental unit of our different organ system such as the blood circulatory system, the nervous system, the respiratory system etc. This digestive system is also known as gastrointestinal (GI) tract. It contains a long muscular tube which integrates oesophagus, stomach, small intestine and large intestine including several organs like the salivary glands, liver, pancreas, and gall bladder. This system is responsible for food ingestion and the production of absorbable chemicals/molecule through digestion process of consuming food materials which is an important part in the living of all human beings. It is also responsible for the absorption of digested products with the elimination of undigested materials. Large number of enzymes and related hormones controls the digestive process for the conversion of food to provide nutrients and energy to the body.[3, 4]

The digestive process integrates the chemical, bio-chemical and mechanical processing starting from mouth, transport in the gut and finally absorption of degraded products. Then, undigested ingredients move through small intestine to large intestine where some amount of it produce gas by bacterial fermentation. Other remaining waste materials get prepared for discharging from the digestive system. In this process, the large molecules i.e., carbohydrates, proteins and fats are disintegrated to absorbable smaller molecules and then absorbed in the gut boundary and transported through bloodstream to liver for metabolism. Mechanical breakdown of food is in the mouth by chewing and chemical transformation of broken food starts by the introduction of saliva juices/enzymes. The rate of this biochemical reaction depends on several factors such as pH, temperature and surface area. These factors influences the digestion process

of large food molecules. Hydrochloric acid in the stomach starts to break down the structural form in foods. These food molecules passes into the small intestine where further decomposition occurs by enzimes. Reabsorption of additional nutrients, water and associated liquid also occur in the large intestine before the elimination of waste materials.

Whereas, in the context of chemical engineering, a chemical reactor is identified as container where various chemical reacts itself and produces products. This process uses in industrial chemical processing plant. Mass transfer including absorption, kinetics, input and output material balance, rate of absorption etc. all these parameters involve in the Chemical reactor theory. This theory had been used to design industrial chemical process plant for decades. It can be found that digestion process of food involves both mechanical and continuous chemical processes.[5] This is similar to an industrial chemical processing plant. In the context of chemical engineering, digestive processes may be understand by chemical reactor in a context of regulatory physiology.[6] In the digestive process, food i.e., nutrients and other elements (Chemical reactants) are fed into the digestive system where reactions occur. The products are used to carry out all of the activities required, including growth, reproduction, energy as well as maintenance. Moxon et. al., shows the mass transfer process and absorption by the absorption of nutrients through our gut.[7] D. L. Penry and P. A. Jumars applied the chemical reactor analysis ideas to digestion processes to formulate a mathematical model of our digestive process.[3, 4]

3.4 Heat and moisture transfer through clothing

The human body transforms/converts the food (carbohydrate, protein and fat energy) into work by metabolism, chemical energy and thermal energy, depending upon the level of their activity. This chemical energy is stored in body fat tissue. It has been known that average temperature of human body as $37^{O}C$ is accepted. Heat produced due to metabolism releases to the environment to maintain the constant body temperature. Balancing in heat generation and heat exchange is controlled by biological signals. The thermoreceptors of the skin transmits this signal to the hypothalamus of the brain.[8] Maximum amount of heat transports through the skin via sweating whereas small percentage of heat releases by respiration. There are mainly two type of heat loss via skin i.e. dry heat loss which is known as sensible heat loss and latent heat loss (evaporation). But heat exchange is strongly affected by clothing as most part of the skin is covered by clothing. In the context of chemical engineering, here the heat release process is the heat and moisture transfer through clothing.

Evaporative heat exchange is a process where evaporation of sweat coming out from glands of the skin release latent heat to the environment. It starts effective cooling of the body. This process depends on ambient air quality i.e. humidity and the permeation efficiency of the cloth. If the surrounding air contains more moisture i.e. high humidity, evaporation of sweat is low which results discomfort. Evaporated sweat i.e. water vapour diffuses through cloth. If the ratio of the produced sweat and evaporation is high, in this situation moisture accumulates in the clothing layers. Hence, clothing strongly influences the evaporation process, cooling including the control of body temperature.[9]

Woollen Sweater/Jacket are used in winter season for cold weather to warm our body. The dry heat loss from the skin is protected by the insulation of the clothing. Insulation which restricts

the passage of sensible heat, includes the insulation of the clothing itself, air between different cloth layers and the air layer between clothing and skin. In the context of chemical engineering, there are three types of sensible heat loss such as convection, conduction, and the radiative exchange with the surrounding surfaces.[9] It may be understand the heat transfer process from the above discussion.

3.5 Wet clothes drying as mass transfer

The clothes are a mesh of fibres that capture droplets of water in the mesh. When one hangs the cloth some of the droplets fall from the mesh due to gravity. It has been observed that if wet clothes expose to a heat source it dries faster. However, the heat does not boil the droplets. In drying process, the liquid water associated with the clothes turns into water vapour and spread around the surrounding air. On the molecular scale, wetness of clothe contains a large number of water molecules which are non-statically and loosely bonded to each other in liquid form. These water molecules are also in bonded to clothe. In the drying process, individual water molecules are separated by breaking their bonds to each other and to clothe and then diffuses into the air. In general, this process is influenced by three major factors which are the air flow rate, moisture concentration of the surrounding air i.e. humidity and the temperature. Therefore, the drying rate is estimated by the net evaporation rate water from the clothes.[10] From this observation of clothe drying process, mass transfer process can be realized.[9]

3.6 Alcohol preparation as distillation process

Alcohol has been produced using juice of sugarcane and Gur. Whereas, tribals community uses Mahua flowers (Madhuca indica) and jhola Gur (molasses) for liquor production to consume their needs. This flowers contains high amount of sugar (68-72%) and minerals. One of the most important raw materials for alcohol fermentation are also present. Produced liquor from the flowers is colourless with a characteristic smell of Mahua flowers. This fermented liquor is known as wash which contains 15-20 % ethyl alcohol. This process is identified as fermentation process. During this process, conversion of sugars into ethyl alcohol occurs in presence of the enzyme like zymase and invertase. The produced alcohol in wash is separated from mixture based upon the boiling point of different liquid. This separation process is called fractional distillation. It separates into three fractions such as: 1. Low boiling liquid taken out from the head of the column. It contains mainly of acetaldehyde. 2. Main fraction consists of 95% ethyl alcohol drawn near the top of the column. 3. High boiling fraction removed near the base of the column. From this observation the distillation process and condensation process can be learned.[11]

3.7 Pumping and supply of water as fluid mechanics.

The pumping and supply of water found anywhere is a practical technique. It is true whether the water has been drawn from a fresh source, transported to a needed location, wastewater sewage treatment, purified, or used for washing, irrigation, or for evacuating water from an undesirable location. In a house two main types of plumbing are observed such as drain-waste-vent pipes and water supply pipes. The drain-waste-vent pipes operate under gravity whereas the water supply pipes are working under pressure.

4. Discussions and applications

From the above mentioned observations from our daily life practice, experience/information, it is to be learned the basic and preliminary ideas of chemical engineering including other engineering. Basic concepts of chemical engineering principles are chemical reaction, fluid flow, heat transfer, mass transfer etc. These principles are applied in various industrial process such as distillation, absorption, adsorption, liquid-liquid extraction, evaporation, leaching, drying, crystallization, humidification and water cooling etc. The following two applications of chemical engineering are now discussed based on above processes.

4.1 Cooling and humidification process as Air Conditioning

It is known that the use of air conditioning application for cooling purposes in our daily life is to live comfortable in dry and hot regions. One of the popular application for cooling purposes is the evaporative cooler. It is also known as desert cooler. This is like a big box inside which contains a small water tank, a fan and a pump for flowing of water which is at temperature lower than the air temperature. Pump acts for recirculation and spraying of water inside the box. A strong air current is passed by fan over the water sprays for the addition of moisture to the air i.e. humidifying air. When the strong current of air is passing over the stream of water or spraying water, the water molecules tends to get evaporated by releasing heat which in turn the moisture content in the air increases and water temperature increases. In the context of chemical engineering, humidification process may be understand as the basic principle of heat and mass transfer. At the same time, the temperature of moisture is less than the air temperature, there is reduction in the overall temperature of the air.[12]

4.2 Oil refinery.

Refinery process in petroleum industry is a combination of both chemical and physical processes. There are some unit operations and unit processes. Oil refinery is an industrial processing plant where crude oil is separated, refined and transformed by fractional distillation into more useful products such as diesel fuel, kerosene, gasoline, petroleum naphtha, asphalt base, heating oil, jet fuel, liquefied petroleum gas (LPG) and fuel oils, etc. Crude oil also produces petrochemicals feed stock like ethylene and propylene which are used to make polythene, fibre, rubber, plastic. This industrial complexes are large with extensive piping system. This pipe carry different fluids between various chemical processing units, such as distillation columns.

5. Conclusion

The aim of this article was to give an idea about chemical engineering from our everyday life experience. On this background, this report discussed some areas of our daily observed phenomena and experience. A few examples was described from natural processes including the life processes such as preparation of tea, heat and moisture transfer through air conditioning and clothing, cooking/processing of food, cloth drying, and human digestive process. It was possible to learn the simple idea about chemical engineering from interesting daily life examples.

Declaration of Conflicting Interests

The author expressed no potential conflicts of interest with respect to the authorship, and/or publication of this article.

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