

# Chemical Thermodynamics

**Calendar:** 3rd semester

**Contact Hours:** T: 30,0; TP:22,5; OT:15,0

## **Intended learning outcomes of the curricular unit:**

The curricular unit has the main goal that student acquire knowledge and competences in the thermodynamic area, being these essentials contents for some others curricular units specific for biotechnology area.

It is essential that the students understand and predict physical properties of ideal and real gases, knowing how to apply the three laws of thermodynamics in biochemistry reactions, allowing them to predict and calculate heat changes, entropy variations and spontaneity of the processes.

The student must be able to interpret phase diagram of pure substance, understanding the meaning of triple and critic points, and also to interpret different phase diagrams for mixtures, establishing the basis for several industrial separation process. It is also necessary that student understand the differences between ideal and real liquid mixtures and the importance of the activity coefficients concept, allowing them to control the variables that affect the equilibrium.

## **Syllabus:**

1 Introduction: Fundamental concepts. 2 Properties of gases: Perfect gases. Kinetic theory of gases. Real gases – state equations. 3 1st thermodynamics law: Definitions. Work and heat; Internal energy and enthalpy. 4 Thermochemistry: Transitions enthalpy. Types of enthalpy. Temperature effect. 5 2nd thermodynamics law: Entropy and the 2nd law. Absolute entropy and the 3rd law. Gibbs energy and spontaneity – properties. 6 Physical equilibrium: Transitions thermodynamics. Gibbs energy variation with pressure and temperature. Phase diagrams – interpretations and examples. Liquids molecular structure. 7 Mixtures: Introduction. Ideal solutions. Real solutions and activities. Colligative properties. Mixture phase diagrams – volatile and non-volatile liquids and solid-liquid. 8 Chemical equilibrium: Thermodynamics basis. Standard Gibbs energy. Equilibrium constant and composition. Le Chatelier principle. Van't Hoff equation.

## **Demonstration of the syllabus coherence with the curricular unit's intended learning outcomes.**

The main goal of this curricular unit is to allow the student to acquire thermodynamic basic knowledge that is essential to understand and control biological phenomenon and industrial processes. The 2nd chapter relatively to gases properties, is essential for homogeneous and heterogeneous system control, in which gaseous materials is commonly present, either in ideal or real circumstances.

Chapters 3rd, 4th and 5th referent to thermodynamic laws and thermochemistry, are fundamentals for more advanced curricular units, where energy flow applications, especial y heat flow, are critical. As examples it can be referred curricular units' contents such as combustion processes, heat exchangers, incubators, cooling towers, etc.

In chapters 6th and 7th study of phase diagrams and ideal and real solutions take place. These are very important contents for curricular units with the purpose of processes control that include phase change, such as in distillation towers, vaporizers, etc. or for biological process that are commonly occurring in solution.

Finally, chapter 8th refers to equilibrium which is essential for chemical and biological reactors processes, in which such phenomenon can be used as system control.

## **Teaching methodologies (including evaluation):**

In theoretical classes fundamental concepts are exposed. Illustrative applications of these concepts are solved. In theoretical/practical classes, students solve application exercises individually.

Evaluation: Final examination with a minimum of 9.5 values (0 to 20 values) and 100% weight in the final evaluation In the same semester there is a laboratory associated curricular unit in which the students will perform several experimental works that will exemplify the thermodynamics principles applications.

**Demonstration of the teaching methodologies coherence with the curricular unit's intended learning outcomes.**

The main goal of this curricular unit is to allow the student to acquire thermodynamic basic knowledge that is essential to understand and control biological phenomenon and industrial processes.

For these basic contents to be correctly acquired by the students, it must be teaches in a solid and consistent approach. For that purpose it is necessary that basic concepts and mathematical developments be properly explained. Consequently, it is essential that in theoretical classes' the fundamental concepts are exposed.

The acquired knowledge can be consolidate by solving relevant amount of exercises and practical problems, either by the teacher or by the student, which is a very important reason for the presence of significant number of practical classes. Finally, the concepts consolidation can be made through laboratorial experiments, results analyses and reports. This fundamental part is achieved in the laboratory curricular unit occurring in the same semester.