Microorganisms are present everywhere in nature, be it in the air, in water or in the soil, and they play a fundamental role in the permanent recycling of matters there, which constitutes the life of our planet.

The microbial life is subject of interest for many industrial processes. It is used, deliberately, in the agri-food industries, the pharmaceutical industries and some chemical industries, for producing the molecules having resisted, until present, to the attempts of chemical synthesis. It has increasingly been used for the water purification, where it consumes the by-products undesirable for our activity. On the other hand, the microbial life invades the aqueous systems used by the industries; when the conditions for life favorable to one or more species are realized, this invasion is the source of problems, which can be divided into three types:

- fouling of the equipment, which makes the conditions of their operation deteriorate;
- dispersion, through the aerosols generated by cooling towers, of the pathogenic bacteria, Legionella pneumophila;
- corrosion of the elements in contact (exchangers, piping), which shortens their service life.

9.1 Microbiology of the Cooling Towers

It is important to see that, although an isolated cell has no effect whatsoever on the functioning of the cooling towers, the conditions in cooling systems are most often favorable for the development of microorganisms: pH close to neutrality, tropical temperature and the abundance of mineral salts and organic compounds serving as nutrients, while the light being capable to meet needs for the photosynthesis in the towers.

Therefore, even though the water concentration ratio generally does not exceed 6, the microorganism concentration may exceed several million.

The microorganisms found in water cooling circuits belong to three main groups.
9.1.1 Bacteria

These unicellular and microscopic living organisms can not be classed in the plant or animal kingdom, since the differentiation between the two kingdoms requires more advanced state of evolution.

Numerous bacterial species secrete polysaccharide which acts as a binding agent in the deposit formed on the heat exchange surfaces. This is the biofilm. The biofilm serves as the hanging support for suspended solids, the colloids present in the water. It is a place of life for all the bacteria species, including the Legionella pneumophila.

The true weight of the bacteria themselves in these deposits is much lower than 1 % of the total weight.

The presence of a large number of bacteria in a cooling circuit may have no effect on the system. Problems occur when debris agglomerates in the sludge and coverings on the heat exchanging surfaces.

There exists a very large number of bacterial species with very different characteristics:

► Colony formation
Some of them are unicellular, in other words, the bacteria remain isolated. Certain among them form colonies by remaining in more or less close proximity and surrounded by various secretions which prevent their moving apart.

The size of the bacteria may vary from 0.1 to 80 μm.

► Form of bacterial cells
- Spherical cocci;
- Bacilli or rods;
- Spirilla with different degrees of curvature.

► Mode of reproduction
- Spore formation (form of resistance);
- No spore formation (encapsulated).

► Optimum temperature
- Psychrophilic bacteria from 0 to 25 °C;
- Mesophilic bacteria from 25 to 45 °C;
- Thermophilic bacteria from 45 to 70 °C.

► The presence of oxygen
Aerobic bacteria can live only in an aerated medium, as they require air to ensure their metabolism of oxidation-reduction (redox).

Anaerobic bacteria can not live in air and use other chemical processes for their oxidation-reduction metabolism. (indifferent bacteria).

► Carbon source
Bacteria may be autotrophic, that is to say, they do not need organic matter, as they utilize carbon dioxide as carbon source.