Hello students. In this lecture,

we're going to learn about downstream

processing, that is solvent extraction.

I'm Maxwell Trindade, assistant

professor of Microbiology,

Government college of Arts,

Science and Commerce, Khandola. So the outline

of this lecture is, solvent extraction,

the principle and its types.

The learning outcomes of this lecture is,

the student will be able to understand

the principle of solvent extraction,

describe the different types

of solvent extraction systems.

So what is solvent extraction?

It is a method to separate compounds

based on their relative solubilities

in two different immiscible liquids,

usually water and organic solvent.

This technique is also called

partitioning or liquid-liquid extraction.

It is used for the preparation,

purification, enrichment,

separation, analysis of compound.

Solvent extraction consists of

transferring one or more salute

contained in a feed solution in another

immiscible liquid that is the solvent.

The solvent that is enriched

in salute is called extract,

and the field solution that is depleted

of solute is called reffinate.

When shaken with two immiscible solvents,

the compound will distribute,

itself between the two solvent.

Normally one solvent is water and the

other is water-immiscible organic solvent.

Most organic compounds are more

soluble in organic solvents,

while some organic compounds

are most soluble in water.

The principle of this.

When a solute is added to heterogenous

system of two immiscible liquids;

In both of which solute is soluble,

the solute distributes

the two liquids.

The distribution is governed

by Nernst distribution law.

This states that the

distribution of solute, A,

the immiscible solvent (aqueous and organic),

is an equilibrium process; that is Aqueous to

A organic. At a constant temperature,

the ratio of concentration of a solute

of each solvent is always constant,

provided its molecular state

is the same in both liquid.

The classification of extraction systems.

There are four. Extraction by solvation

extraction by chelate formation,

extraction by ion pair formation

and synergistic extraction.

The first one,

extraction by solvation. Solute molecules

are associated with the solvent molecules,

this is known as solvation.

In extraction by solvation,

solvent molecules are directly involved in

formation of the Ion association complex.

In case of extraction by solvation,

the extracted species is solvated with

a definite number of solvent molecules.

Next one. Solvent extraction by

metal ion by chelation.

Formation of chelate molecule

with an organic agent.

Many of these reagents are weak

acids that ionize in water.

The ionizable proton is displaced by

the metal ion when the chelate is formed,

and the charge in the organic compound

neutralizes the charge in the metal ion.

The example of this is

diphenyl thio carbazone,

known as dithizone,

which forms a chelate with lead ion;

and the next one; Extraction

by ion pair formation.

The extraction will proceed with

formation of neutral uncharged species,

which in turn is extracted

into organic phase.

Most of the high molecular weight

amines or so called liquid ion

exchanger comes under this group.

The mechanism of extraction

by ion pair formation can be

described as follows.

The control of temperature and activity

is most important in accomplishing

quantitative separations.

In ion pair extraction,

the metal may be incorporated

with by coordination in either the

cation or anion of the extractable

Ion pair. The next one is

synergistic extraction.

Synergism is defined as the

combination action of two complexing

reagents which is greater than

the sum of the actions of the

individual regions used alone.

An example of the synergic extraction

of caesium with picrolonic acid

and benzo-15-Crown-5.

The process of extraction is enhanced on

account of the use of two extractants.

Example extraction of uranium with

Tributyl phosphate (TBP).

The phenomenon in which two reagents

when used together extract a metal

ion with enhanced efficiency

compared to their individual

act ion is known as synergism.

The next is liquid-liquid extraction.

This is part of solvent extraction.

The separation of a compound

from a liquid mixture

by treatment with a solvent in

which the desired component is

preferentially soluble is known

as liquid-liquid extraction.

The specific requirement is that

a high percentage extraction

of product must be obtained,

but concentrated in a smaller

volume of solvent. Prior to starting

large scale extraction,

it is important to find out

on a small scale,

the solubility characteristics of the

product using a wide range of solvents.

A simple rule to remember

is that ‘like dissolves like’.

The important ‘likeness’,

as far as solubility relations are concerned, is in the polarities of molecule,

that is polar or nonpolar.

Polar liquids mix

with each other and dissolved

salts and other polar solids.

The solvents for nonpolar compounds

are liquids of low or nil polarity.

The dielectric constant is a

measure of the degree of molar

polarization of a compound.

If the value is known,

it is then possible to predict

whether a compound will be polar

or nonpolar with a high value

indicating a high polar compound.

So the advantages of this liquid

liquid extraction system are;

universal application in action

of solvent component mixture.

Flexibility with physical

properties and various parameters.

Columnar design enhance the

efficiency of the extraction system.

Facility stagewise phase contact.

The disadvantages of liquid-liquid

extraction are; lack of selectivity.

Toxicity of solvents.

Large amounts of solvents may be consumed.

There is a risk of emulsion formation.

The applications of these are; separation

of aromatic from aliphatic hydrocarbons.

Purification of antibiotics.

Purification of aromatics such as benzene,

xylene and toluene.

Protein purification using

aqueous two-phase system.

Purification of natural products.

Purification of dyes and pigments

metallurgical purifications.

So the next part is two phase

aqueous extraction.

Liquid-liquid extraction is a

well established technology in

chemical processing and in certain

sectors of biochemical processing.

However,

the use of organic solvent

has limited application in the

processing of sensitive biologicals.

Aqueous two-phase system,

on the other hand,

have high water content and low

interfacial surface tension and are

regarded as being biocompatible.

Two phase aqueous system have been

known since the late 19th century,

and a large variety of natural

and synthetic hydrophilic polymers

are used today to create two or

more aqueous phases. Phase separation

occurs when hydrophilic polymers

are added to an aqueous solution

and when the concentrations exceed

a certain value two immiscible

aqueous phases are formed. Settling time for

the two phases can be prolonged depending

on the components used and vessel geometry.

Phase separation can be improved

using centrifugal separators or novel

techniques such as magnetic separators.

Many systems are available.

Non-ionic polymer,

Non-ionic polymer and water.

Example polyethylene glycol and

dextran. Poly-electrolyte, non-ionic

polymer and water system.

Example sodium carboxymethyl

cellulose and polyethylene glycol.

Poly-electrolyte,

poly-electrolyte and water system.

Example sodium dextran sulfate

and sodium carboxymethyl cellulose.

The distribution of a solute species

between the phases is characterized

by the partition coefficient and is

influenced by a number of factors

such as temperature, polymer, that is,

type and molecular weight of the polymer,

salt concentration, ionic strength,

pH and properties.

(Example molecular weight) of the

solute. As the goal of any extraction

process is to selectively recover

and concentrate a solute, affinity

techniques such as those applied

in chromatographic processes can

be used to improve selectivity.

Examples of this system include

the use of PEG-NADH derivatives

in the extraction of dehydrogenase,

p-aminobenzamidine

in the extraction of trypsin and

cibacron blue in the extraction

of phosphofructokinase.

It is possible to use different

ligands in the two phases leading

to an increase in selectivity or

the simultaneous recovery and

separation of several species.

The application of two phase equipped systems

are, in the purification of many solutes,

proteins, enzymes,

cells and subcellular particles,

and in extractive bioconversion. Several

aqueous two-phase system for handling

large scale protein separation have emerged.

The majority of which use

PEG as the upper phase forming polymer

with either dextran, concentrated salt

solution or hydroxypropyl starch as

the lower phase forming material.

These are references. Thank you.