**Safety in Process Industries course**


## Lesson 1

1) Accidental events in process industry can be more frequently ascribed to:

- Unexplained equipment damages
- Basic errors in the process layout
- Lack of proper operator training unavoidably leading to human errors

2) Secondary reactions occurring in chemical plants:

- Generate the desired products, generally in the reactor
- Occur in internal part of the plant
- Often lead to the development of explosive phenomena

3) In the case of mechanical explosions:

- Chemical reactions take place
- No chemical reaction takes place and no expansion of gases occurs
- A gas expansion inside the vessel generates the explosive phenomenon

4) Offline measures are:

- Protective safety measures
- Preventive safety measures acting on devices and control systems
- Preventive safety measures including investigation on the potential hazard of chemical species and processes

5) Thermal explosions include:

- The presence in the system of a proper source of ignition
- The occurrence of a runaway phenomenon coupled with a pressure increase

- The occurrence of a runaway phenomenon

6) Thermal explosions are due to:

- Only a primary reaction
- Only a secondary reaction
- Both primary and/or secondary reactions

7) By taking into account the reaction rate expression used for evaluating the thermal power generated by an exothermic reaction (A→P), it follows that:

- The reaction rate decreases by enhancing the temperature
- The reaction rate increases by enhancing the temperature
- The reaction increases as the A reagent is consumed throughout the reaction

8) CHETAH gives:

- A preliminary evaluation of the hazard connected with the manipulation of a chemical species
- An estimation of decomposition kinetics
- An estimation of the toxicity of the species

9) The **CHETAH** method is based on

- Five criteria
- Four criteria to be used together with the aim of providing a proper hazard assessment.
- Four criteria to be independently used. The four criteria should not necessarily subject to a total evaluation as each single criterium provides a reliable safety assessment.

## Lesson 2

1) Scanning calorimeters work:

- At a fixed temperature
- At varying temperature
- At ambient temperature

2) Information that can be obtained from a DSC:

- Only onset temperature
- Onset temperature, heat of reaction and reaction kinetics
- Onset temperature and heat of reaction

3) No-return temperature depends upon:

- Chemical system and vessel
- Only chemical system
- Only the vessel

4) No-return temperature and SADT differ for more than:

- 100 K
- 500 K
- 10-12 K

5) No-return temperature is a value:

- Beyond which the reaction proceeds safely up to a complete conversion
- Beyond which an explosion occurs
- At which the process is safe

6) The logarithm of time to maximum rate:

- Depends approximately linearly upon 1/T
- Depends linearly upon T
- Does not depend upon temperature

7) Semenov's explosion theory was developed under the assumption of negligeable consumption of reagent. This assumption is:

- Conservative (calculated Time to Maximum Rate is lower than the real one)

- Unconservative
- Irrelevant, the same results could be obtained removing this assumption

8) Semenov's explosion theory is valid for:

- Stirred systems at low viscosity
- Stirred systems at high viscosity
- Unstirred system at high viscosity

## Lesson 3

1) Homogeneous explosion can be recognized by the occurrence in a confined system of:

- A luminous zone involving all the volume of the mixture
- A flame propagating in the volume of the mixture
- A pressure increase without the formation of any luminous zone

2) Homogeneous explosions occur:

- Only when a liquid is present
- When a gaseous mixture containing oxidant, fuel and an ignition source are present
- When a gaseous mixture containing oxidant, fuel is taken to high temperature

3) $T_{Ai}$ is for mixtures of a fuel and an oxidant:

- The lowest temperature at fixed pressure to observe a homogeneous explosion
- The highest temperature at fixed pressure to observe a homogeneous explosion
- The temperature at fixed pressure at which no explosion occurs

4) Experimental determination of $T_{Ai}$:

- Requires to wait a maximum time of 300 seconds after injecting the gaseous mixture in the test apparatus
- Requires no waiting time
- Requires a waiting time of 10 seconds after injecting the gaseous mixture in the experimental apparatus

5) The delay to ignition is:

- The time elapsed between preparation of gaseous mixture and injection in the test apparatus
- The time elapsed between the injection of the gaseous mixture in the test apparatus and the appearance of a luminous zone inside it
- The time elapsed between the appearance of luminous zone and its disappearance

6) For the most part of chemicals the occurrence of homogeneous explosion depends upon pressure and temperature so that the plane P-T is:

- Devided in two zones
- Devided in three zones
- Devided in four zones

7) Semenov's theory can:

- Explain the behavior of all chemical systems with respect to homogeneous explosion
- Explain the behavior of the most part of chemical systems with respect to homogeneous explosion
- Not explain the behavior of chemical systems with respect to homogeneous explosion

8) Heterogeneous explosions happen when:

- Oxidant and fuel are present without an ignition source
- Fuel is present along with an ignition source
- Oxidant, fuel and ignition source are present

## Lesson 4

1) Quenching diameter is:

- The minimal diameter of a test tube below which flame propagation is not possible
- The minimal diameter of a test tube above which flame propagation is not possible
- The length of a test tube for observing flame propagation

2) Flash point of a chemical species may be estimated. What kind of information is necessary?

- Vapour pressure dependence upon temperature for the species
- Vapour pressure and flammability limits dependence upon temperature for the species
- Only flammability limits dependence upon the temperature

3) The value of MOC for a ternary mixture fuel/oxidant/nitrogen can be estimated as $MOC=LFL_{air}*Z$, where Z are the stoichiometric moles of oxygen for mole of fuel in the total combustion reaction. Is this formula valid only with nitrogen inert?

- Yes
- No, the same value is used also for other inerts
- A proper value of LFL is used for other inerts

4) MOC for a certain couple inert/fuel is 10.0%. What are the consequences for safety if continuous measurements of oxygen concentration are collected in a real system?

- Oxygen concentration has to be fixed at 9.0%
- Oxygen concentration has to be fixed at a concentration lower than 8.0%
- Oxygen concentration has to be fixed at 10.0%

5) Minimum Oxygen Content is:

- The concentration of oxygen at which a flame propagation in an oxidant/fuel/inert mixture is still possible
- The concentration of oxygen above which propagation in an oxidant/fuel/inert mixture is not possible

- The concentration of oxygen in a working place at which life is still possible

6) Many types of energy source may trigger a deflagration. What is the order of magnitude of the energy required?

- Joule
- Tenths of joule
- Tenths of mjoule

7) What is the difference between ''flame propagation speed'' and ''combustion speed''?

- No difference at all: they are just two different ways of indicating the same concept
- Flame propagation speed is the velocity of the flame front seen by an external observer, combustion speed being a relative velocity of the flame front with respect to a point in the fresh gases
- No relation at all: flame propagation speed refers to the movement of the flame front in the space and combustion speed to the velocity of combustion of the fuel

8) Millijoules or tenths of millijoules are typical minimum ignition energies for deflagration. What are typical values for detonation?

- Of the same order of magnitude
- $10^5$ times higher
- 10 times higher

## Lesson 5

1) A correct approach for estimating the real energy released after a mechanical explosion considers:

- The energy amount evaluated under adiabatic and reversible (isentropic) conditions
- The energy amount estimated in the case of isothermal conditions
- An average value of the energy calculated by performing calculations under both isentropic and isothermal conditions

2) The estimation of damages due to an explosion is done by means of the TNT-equivalency method in which the concept of TNT equivalent mass is adopted. This mass is calculated through:

- An energy balance
- A mass balance
- A momentum balance

3) The estimation of damages due to a deflagration is done by means of the TNT-equivalency method in which an efficiency factor is used. What is the origin of this factor?

- To take into account that TNT explosion is a detonation
- To take into account that any explosion is not reversible
-To take into account that at ambient temperature TNT is a solid

4) Deflagration phenomena are examples of heterogeneous explosion. What is the order of magnitude of the flame propagation speed in this case?

- 10-100 cm/s
- 5-20 m/s
- 1-2 Km/s

5) The TNT-Equivalency Method can be applied to:

- Confined vapour cloud explosions
- Unconfined vapour cloud explosions

- Unconfined dust explosions

6) The “Point source model” is employed for evaluating:

- The thermal flux reaching a receptor at a fixed distance from the radiation source ideally concentrated in a single point
- The thermal power reaching a receptor at a fixed distance from the radiation source ideally concentrated in a single point
- The thermal flux reaching a receptor at a fixed distance from the radiation source ideally represented by a cylinder

7) In evaluating the effective radiated energy received by the receptor according to the “Point source model”:

- The radiation absorption in the infrared wavelength range of diatomic molecules in atmosphere should be taken into account
- The radiation absorption in the infrared wavelength range of triatomic molecules in atmosphere should be considered
- The radiation absorption in the infrared wavelength range of diatomic and triatomic molecules in atmosphere can be neglected in real applications for a rough safety assessment

8) BLEVE is an explosive typology involving:

- Only a storage vessel in which a flammable chemical species is stored at ambient pressure
- Only a storage vessel in which a flammable chemical species is stored under pressure
- Only a storage vessel in which a flammable or a not flammable chemical species is stored under pressure

9) May liquid oxygen in a pressurized storage vessel undergo a BLEVE phenomenon?

- Yes
- No

- It depends upon the season

## Lesson 6

1) Probit variable is used to estimate a probability to have a certain kind of damages during a particular accidental typology: $Y=K_1+K_2 \ln V$ with V being the causative variable. The values of the couple $K_1$ and $K_2$ depend upon:

- V
- The type of damage
- V and the type of damage

2) TLV-TWA, TLV-STEL and TLV-C are threshold limit values for a chemical species. Which of them has to be considered in a working place to avoid overexposition of workers?

- TLV-TWA
- TLV-C
- All

3) If for a certain working place a concentration-time plot for a toxic species is available, how this can be compared to TLV-TWA from MSDS?

- Properly averaging on a shift standard duration (8 hours) the experimental data over the time
- Properly averaging on 24 hours the experimental data over the time
- Properly averaging on 15 minutes the experimental data over the time

4) Where chemico-physical data on a species can be found in MSDS?

- Section 9
- Section 2
- Section 10

5) Dose-response curve is a plot of:

- Probability of occurrence of damages against log of concentration
- Probability of occurrence of damages against time
- Probability of occurrence of damages against log of time

6) The highest peak of blood concentration is observed with the following way of contact:

- Ingestion
- Injection
- Inhalation

7) Once the value of Y (probit variable) is calculated for a certain accidental typology, how the probability of occurrence of a damage may be obtained?

- Y is a probability
- Taking the value from a table in which probability is reported versus Y
- No probability can be calculated from Y

8) How V is assumed to be for calculating the probability of radiation damages?

- V = thermal flux
- V = thermal flux multiplied by time of exposition
- V = radiated power

9) Human body:

- Is capable of distinguishing between toxic species and drugs
- Is capable of distinguishing between different toxic species those which are safe
- Considers all the xenobiotic species as toxic

10) What is the aim of biotrasformation process 1 and 2?

- To increase the solubility of xenobiotic species into urine
- To destroy xenobiotic species
- To favour the accumulation of xenobiotic species into fat tissues

11) What does it mean a high value of logKow (octanol/water partition coefficient) for a certain species:

- The species may accumulate in fat tissues
- The species may not accumulate in fat tissues
- The species is safe for human body

## Lesson 7

1) The adoption of ventilation for a working place represents:

- A preventive safety measure
- A protective safety measure
- Both types of measures

2) Discs and safety valves are:

- Alternative safety devices
- Complementary safety devices
- Complementary safety devices that can be used only in parallel

3)The use of a rupture disc on a plant vessel represents:

- A protective measure of safety
- A preventive measure of safety
- An attempt to protect the quality of the species inside the vessel

4) Sweep-through-purging is:

- An inerting technique that operates at ambient pressure
- An inerting technique that consumes very small amount of inert gases
- An inerting technique that can be used also in places in which men may enter

5) Vacuum purging and pressure purging are two alternative inerting techniques that can be used:

- With all the vessels
- With properly certified vessels
- Only with plastic vessels

6) Vacuum purging and pressure purging are two alternative inerting techniques that:

- Consume the same amount of inert
- Consume different amounts of inert and require different times to reach the results chosen

- Consume different amounts of inert but require the same time to reach the results chosen

7) Ventilation modeling makes possible to estimate the stationary concentration in a working place once a source term for release is fixed along with the air flow rate. The value obtained has to be compared with:

- Flammability range of the species in air
- TLV-TWA of the species
- Flammability range of the species in air and TLV-TWA

8) The stationary concentration of a species in a working place can be estimated with the following equation: C= mass flow rate/k volumetric flow rate, with k being the mixing factor. What are suitable values for this factor in the applications?

- Always 1
- A value between 0.1 and 0.5

-0.8

9) Cubic law is valid:

- Only for Gaseous mixture explosions
- Only for dust explosions
- For both gaseous mixtures and dust explosions

10) What is $K_G$?

- A universal constant for gases
- A constant factor for physical explosions
- A constant factor present in cubic law

11) $K_G$ is useful for:

- Gaseous mixture explosion classification
- For venting devices sizing
- To predict the explosion of a gaseous mixture

12) Venting size area is proportional to the vessel volume V raised to 0.67 through a coefficient $K_N$ which is taken from proper tables. What information is necessary to select the right value of $K_N$ to be used?

- Only the value of $K_G$ for the mixture of interest
- The value of $K_G$ for the mixture of interest along with set pressure and maximum pressure ($P_M$)
- Only the set pressure

13) Siphon purging is:

- A general purpose technique for inerting
- An inerting technique that can be used in special cases
- An inerting technique that can be coupled with vacuum and pressure purging

## Lesson 8

1) Which are the main sources of contamination in Europe?

- Waste disposal and Industrial activities
- Industrial activities and Storage activities
- Military activities and nuclear operations

2) Which are the main categories of compounds in contaminated sites?

- Heavy metals and mineral oil
- Mineral oil and BTEX
- Phenols and Cyanides

3) What are mitigating measures?

- Interventions aimed at isolating, immobilizing or removing pollutants which are dispersed in the soil or groundwater
- Measures designed to prevent the migration of contaminants to sensitive environmental receptors
- Measures aimed at monitoring the source of contamin ation

4) Draining trenches are:

- Mitigating measures
- Containment measures
- Monitoring measures

5) A site can be defined contaminated if:

- The concentration of contaminats in the site is higher than site specific target levels (SSTL)
- The concentration of contaminats in the site is higher than screening concentrations
- Contaminats are present

6) In the risk assessment procedure, the exposure (E) depends on:

- Exposure rate and concentration at the point of exposure
- Concentration at the point of exposure and hazard index

- Probability of occurrence of the event

7) In the risk assessment procedure, the main components of the conceptual model of the site are:

- Source of contamination, migration pathways and receptors
- Source of contamination, toxicity and receptors
- Exposure, contact factor and hazard factor

8) The secondary sources of contamination are:

- Surface soil, subsurface soil and groundwater
- soil, water and air
- Elements causing pollution (e.g. accumulation of waste)

9) In the case of dermal contact with the source of contamination, the transport factor FT is:

- FT= 1
- FT=PEF (particulate emission factor)
- FT=0

10) Receptors can be differentiated according to:

- Their localization and the use of the site
- Their localization and transport factors
- Transport factors only

## Lesson 9

1) What is Environmental Impact Assessment (EIA)?

- It is a procedure to evaluate the environmental effects of some projects
- It is a study summing up the impacts of projects on the environment
- It is a best practice to ensure the sustainable development

2) Which principles is EIA based on?

- EIA pursues the principles of prevention and precaution
- EIA follow the principle of “polluters pay”
- EIA develops in accordance with the principles of circular economy

3) Which aspects have been claimed as "Determinants of Human Health"

- Individual lifestyle factors, community networks, socio-economic, cultural and environmental conditions
- Exclusively the environmetal conditions
- Both socio-economic and environmental conditions

4) Which is recognized as the main weakness of the Rainbow Model developed by Dahlgren and Whitehead in the early 1990s?

- It failed in defining the contribution of natural environment to human health
- It could not be practically applied
- It did not consider the socio-economic and political context

5) Which is the current state of the art of HIA application within EIA studies?

- It repreents a "best practice" approach in most countries requiring EIA
- It is legally established in most developed countries
- It is legally established together with EIA

6) Which approach can be observed when HIA is applied in the framework of EIA?

- Mandated HIA occurs usually in the context of HIA
- Advocacy HIA occurs usually in the context of HIA
- Community led HIA occurs usually in the context of HIA

7) Which are the main similarities between HIA and EIA?

- The forecast nature and the consideration of both the direct and indirect impacts
- The forecast nature of the evaluation, but not the consideration of the impacts
- There are not similarities between these two procedures

8) Which is the main step of HIA within EIA?

- The main step is the appraisal
- The main step is the screening
- The main step is the monitoring

9) How are human health effects determined within HIA?

- The effects of a project on human health are determined by risk assessment
- The effects of a project on human health are determined by environmental compliance
- The effects of a project on human health are determined qualitatively, depending on the project characteristics

10) Which stage of the HIA procedure foresees the wider participation of stakeholders?

- During the assessment and appraisal steps, when scientific experts meet the stakeholders
- During the scoping step, when both the experts and the stakeholders are involved
- During the monitoring step when the sanitary monitoring plan should be developed