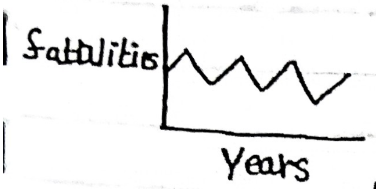
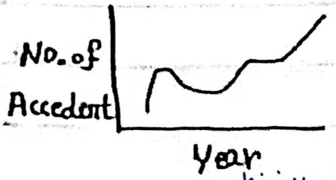
*Safty and loss Prevention :-

بالرغم من تطور ← الثورات هناك زيادة في عدد ← الحوادث.

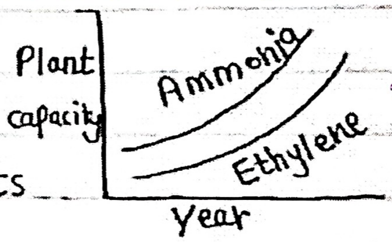




*Development of loss Prevention :-

ظروف التشغيل مثل حرارة والضغط

1) Process operating condition (temp, Pressure, concentration)
2) energy stored in the Process has increased and represents hazards.
3) Materials of construction → شو المعادن تاعت المعدات ؟!
4) Plants (grown in size)
5) storage
   - Raw materials
   - Finished Products
6) Interlinking with other Plants
7) Pollution (air, water, soil)
8) Transport



كيف زيادة في الانتاج خلال السنوات

تكامل عدة صناعات او مصانع مع بعضها (مثال: مصنع بنتج مادة تعتبر هاي المادة مادة اساسية في صناعة اخرى بمصنع اخر)

زيادة الصناعة بسبب زيادة بالتلوث

عمليات النقل

*Loss Prevention :- شو مهم ؟!

1) concern with depth of technology → يدرك تعرف شو العملية الصناعية وكيف تتعامل معها
2) Emphasis on Management → تركيز على الإدارة
3) A system rather than a trial and eror approach → يكون عندك نظام تشتغل عليه مش على نظام بتربة والغلاء
4) A concern to avoid fire explosion or toxic release.

من أكثر الامور المقلقة للموظفين "تاخذ بعين الاعتبار الحوادث الي ممكن تصير"

*Characterstics of loss Prevention :-

1) Identification of hazards. → حدد المخاطر
2) Quantification of hazards. → هل الاخطار كبير ام صغير
3) Planning of emergencies. → تخطط للحالات الطارئة
4) Critique of existing codes and Practices. → اطور ال codes واحسنها والتدرب عليها

نقد

Causes of accidents ⇒

	Kellog experince	ICI experince
Design	10 %	10 %
Erection	20 %	16 %
Equipment	40 %	61 %
Operating	30 %	13 %

⇒ من جدول بكتشف انه اكثر سبب حوادث كان بسبب ال equipment

* هذا مثال على شركتين بوضحوا النسب للحوادث الي صارت عندهم على فترة سنوات طويلة

Erection ⇒ تركيب الأجهزة

Equipment ⇒ هون من ناحية ال equipment selection

Operating ⇒ التشغيل مثل Human errors

No

شو الأضرار الي ممكن تسببها ؟!

* Loss control areas / Accidents :-

1) Business Interuption → توقف العمل
2) Injury
3) Property damage → الدمار يلي ٢١ ديسمبر
4) fire → هل الحريق معمور ام لا
5) Health hygiene ↗ تعرض لمواد مترسبة بالمصنع
6) Pollution
7) Insurance → "تأمين" هل في وقاية وحماية ؟! اذا وضع اموره تمام بيتأمن

* Scale of the hazards :-

1) Inventory → كل ما زاد يكون مشكلة اكبر
2) Time factor معامل وقت
3) energy factor معامل طاقة
4) Intensity-distance relations المسافة
5) Exposure factor معامل التعرض

* (AICHE) ⇒ في مصانع هاي بتكون من عدد كبير

- Pump and camperessor 33.9%
- Incomplete knowledge of the Properties of a spacific chemical 11.2% ← عدم المعرفة الكاملة بمادة معينة
- Incomplete Knowledge of the chemical system or Process 3.5% → عدم اكتمال معرفة ال system
- Poor design or layout of equipment 20.5% → كيف بدك تحط unit على ارض الواقع
- maintenance failure 31%
- operator error 6.9%

(total number of accidents 44)

* Toxicity :- تعريف

- is a property of matter) - biological Property ← Bio chemical
- is the ability of material to injure a living organisms by other than mechanical mean. قدرة المادة على إلحاق الضرر للخلايا بطريقة غير ميكانيكية

* Routes of entry :- كيف ممكن توصل للإنسان

1) Ingestion ابتلاع
2) skin absorption
3) Inhalation (lungs) تنفس
4) Eyes

Refinery ⇛ البترول وصافي

pumps & compressors ⇛ 33.9 %

* وين بتصير المشاكل مع الضعف

Furnaces ⇛ 13.6 %

piping ⇛ 10.7 %

Towers & Reactors ⇛ 8.8% ⇛ قليلة لانها مدروسة كويس

Exchangers ⇛ 6.8 %

Utilities ⇛ 22.3 %

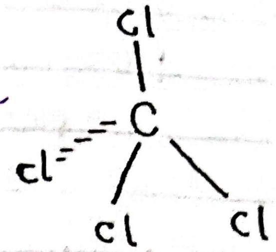
others ⇛ 3.9 %

* Frank P. Less ⇛ safety and loss prevention

مواد على شو ممكن تأثر

No.

- Carbon tetra chloride → liver and Kidneys (كلى)
- Ethyl ether → central nervous system.



* Refrences → sax , Merck ⇒ كتب عن السمية

Oxygen defficiency ⇒ تركيز O_2 في الجو كيف بأثر

20.9%	O_2 in normal air, no effect
15%	No immediate effect → بس لو طولت ١٢ تحس
10%	Dizziness (دوخة), shortness of breath, quicker Pules.
7%	Stupor sets in → دوخة + فقدان للوعي
5%	minimum amount that will support life. → ادنى حد بخليك عايش
2-3%	death within 1 minute

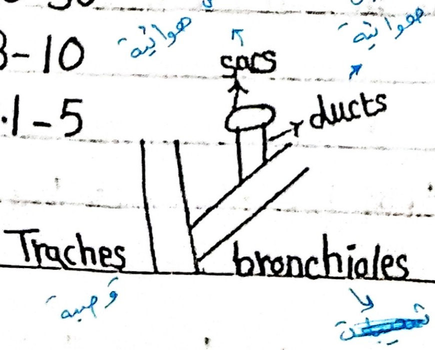
* CO_2 in air ⇒ ليش تركيز CO_2 ممكن يأثر !؟ → بأثر على دماغ

0.04%	normal air, no effect
2%	Deeper breathing → تنفس عميق
4%	Much deeper breathing, discomfort
7-9%	Limit of tolerance → الحدود يلي بقدر اتحملها
10-12%	inability to coordinate → عدم القدرة على تنسيق
15-20%	symptoms increase in severity → زيادة خطورة الاعراض
25-30%	gradual death → موت تدريجي

* Particles :- ⇒ حسب size وين ممكن توصل   * الاردن اغلب صناعاتها مواد صلبة

Size (μm)	Disposition
30	reach trachea → قصبة الهواء
10-30	reach termenal bronchioles → قصيبات طرفية
3-10	reach alveolar ducts
0.1-5	reach alveolar sacs

⇐ حسب ال size وين ممكن توصل بحيث كل ما قلة ال size بتوصل لعمق اكبر



smile...

No.

*: Dust

* Methods of disposition:- ترسيب

• Impact • settling

طاقة وتتم بتسبب ترسيب

* Impact → العينة وهي طاقة حتى تهرب بالجدران وتلتصق بجدران

* Settling → تراكم الحبيبات بشكل ترسبات

- Silica → silicosis

- Asbestos → asbestosis

اذا تفاعل كان مع silica 21 بسبب سرطان اسمه silicosis

عشان هيك لازم تفاعل معها بحذر, تعامل معه خطير

* Hazardous substances (UK):- ترميزها

Group 1 :- Toxic substances : Phosgene, chlorine, hydrogen cyanide, sulpher dioxide.

مواد سامة

مواد بسمية عالية

Group 2 :- Substances of extreme toxicity
Substances likely to be lethal to man in quantities of less than 1 mg

تفاعلية تامة عالية

Group 3 :- Highly reactive substances : Hydrogen, ammonium nitrate, oxide.

مواد قابلة للإشتعال

Group 4 :- other substances : flammable material oil shale..., fertilizer

مواد غير سامة

Indeix for toxic :- 5 Indeixes

1) Threshold limit value (TLV)

تتنفس بدون أي ضرر لمدة 8 ساعات خلال 5 أيام

Difined as the concentration in air which it is belived can be breathed without harmful effect for five consecutive 8 hours working days

$\frac{mg}{m^3}$ → dust , PPm → gass and vapors

(this value is not constant)

دائماً متغيرة

الوحدة حسب طبيعة المادة الي بتعامل معها

2) Total Dose low (TDL)

Lowest known does of a substance that has produced toxic effect.

أقل جرعة من مادة تؤدي إلى ضرر أو تأثير سمي

smile...

جرعة => زي كمية مثل كاسة او معلقة

flare or flame ⇛ شعلة تحرق الغازات بشكل صديق للبيئة للتخلص منهم

Flixborough / England ⇛ هاي الحادثة غيرت الكثير من القوانين وال Codes حول العالم

Caprolactum / Nylon

R1 → R2 → R3 → R4 → R5

في 5 reactors وصار عطل ف رقم 3 فقرروا ينقل الى فيه على رقم 5

بس ال pipe بسبب انه ما كان في اشي يدعمه صار اله تقوص ادى
الى حدوث crack وال vapor يلي في تسرب إلى الخارج مع وجود
شعلة خارجية سببت الى حدوث انفجار

Cause of incident ⇛ selection of material

No

3) Toxic concentration low (TCLo) اقل درجة تركيز من مادة أدت الى تأثير سمي

Lowest concentration of asubstance that is reported to have Produced any toxic effect.

4) Lethal Dose low (LDLo) اقل جرعة ~~شي~~ ممكن أن تؤدي الى قتل

Lowest does of a substance reported to have caused death in humans or animals.

5) Lethal Dose fifty (LD50) ~~اقل جرعة~~ متوقع ~~ان تؤدي الى قتل~~

A calculated does that is expected to cause death in 50% of a given experimental animal Population. ~~نسبة~~ كمية ~~تركيز~~ جرعة متوقع ان تقتل 50% من عدد الحيوان الكلي

* Disasters ⇒ كوارث

Death : 2000

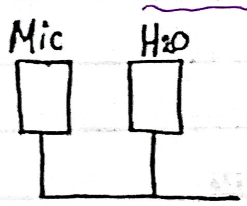
injuries > 2000

- Bhopal / India انفجار

* (methyl isocyanate) Mic

1984 / union carbid اسم الشركة الها فرع بالهند

* Cause of ~~ac~~ incident ⇒ contamination



⇒ two towers :- Mic , H_2O هدول الحاديثين مش لازم يتلامسوا بيناتهم لانه وقتها 21 يتشكل مادة كـ Vapor وهي سامة

بهاي الحادثة كان لازم يردوا ~~اخذ~~ الـ Vapor لل flare بس كانوا عاملين إضراب وماتوا

< *كودات على شكل الوان >

* Color / cylinders من لون بقدر اعرف شو عندي

materials — color

Acid gases → white

Ammonia gases → green

organic gases → black

Raduactive material → PurPle

Carbon monoxide → Blue

Fumes and mists → orange

smile..

* safety engineering ⇒ " هذا موضوع قانوني "

لغاز " chlorine "

شرح حادثة الزرقاء :- حيث صار في تسريب و إسطوانة ال O_2 عبط واحد خلصت

هسا الغاز الي طلع بلش يطلع برى المصنع بس حسب القانون ما بقدروا يخلوا الناس من بيوتهم أكثر من نص كيلو عشان مواضيع ثانية مثل العراقيه

⇐ بعدها صار Dispersion لأنه كمية الغاز كانت قليلة

* Carbon steel من اشهر الإختيارات في بناء ال equipment

* اذا حدا استنشق كلور و انخنقه منه طلعه برى وشلحه ملابسه

* معلومة إضافية لو تعرضت لمادة لفترة قصيرة بس كان تأثيرها طويل الأمد

Acute exposure

Chronic effect

* Entry into closed space
- Preparation of tanks :-
• Draw the gas out → نسحب كل الغاز الموجود
• check / detect gas → نتفقد انه كل الغاز طلع
• Gas Pokets → < surface tension نتيجة الـ < زي بالون من الغاز
• Purging Inert gas ↙ ممكن تكون على ارتفاع للإنسان
• Introduce fresh air → مثل N_2 حتى اتأكد انه كل الـ gas
الي هو قام بدخل inert gas حتى اعمله اذا كان في gas تاني غيره

* Entry
- Two or more Person must Perform the work ← هذا القانون ،
- Two Person connected with a rope to Perform the required maintenance حيث يكون في وسيله ربط بينهم للإحتياط، مثلاً كان في خطرة من ظروف يلي خفقة ما كان مجهول فيها صح و فيها الشخص الثاني يساعد الشخص الأول في حل مشاكله في اشي

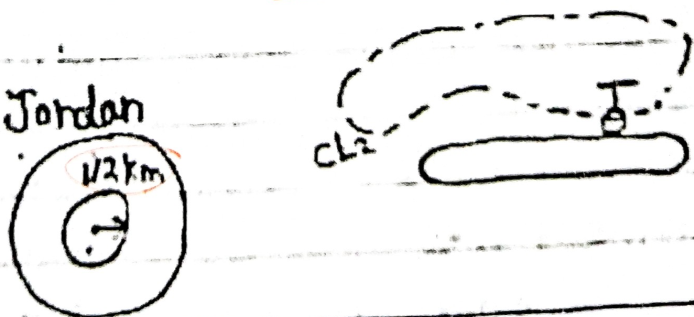
* Toxicity
من ناحية السمية
• Acute : single exposure ⇒ تأثيرها لفترة صغيرة ← تعرض لفترة بسيطة
• chronic : exposure repeated for long time. ⇒ تعرض لفترات طويلة ← تأثيرها بطول

* Grading ⇒ one of the codes ,

0	None	No harm	صار فيه تأثير
1	slight	cause reversible change	بس تعود فترة
2	Moderate	reversible and irreversible changes	وراح
3	High	Death or Permanent Injury	ممكن يكون وممكن لا
U	unknown مش معروف	Effect unknown	الموت او إصابة في الرئتين

كل ما زاد الرقم يزيد التأثير

* Chlorine Incident / Jordan
* Immediate step :
1- empty the tank
2- Less Inventory



(Displaced People)

smile..

Carbon monoxide → مادة قاتلة بشكل
صامت

Information given to employees →

1-
- Name of material < identification >
-
- purity
- uses

2- Hazards identification
- Local dengers
- General

3-
prepaution → (تحضير)

4-
- Immediate 1st Aid

5-
- Eye Injuries

قائمة تفقد لأي مادة بدي اتعامل معها ←

CHECKLIST—TOXIC MATERIALS

1. Is any material used which in small amounts could be harmful to a person if it is inhaled or swallowed, or absorbed through or chemically reacts with the skin?
2. Can the material affect the nervous system, act as an anesthetic, or cause cancer? Have all materials been checked to determine if they are carcinogenic or have any other adverse characteristics? Are the sources of the information reliable and up-to-date?
3. Can any two or more materials available in the plant react to create a toxic material? Are such materials separated? Are the containers of such materials marked with warnings against mixing it with any other material which could generate the dangerous substance?
4. If workers who might be affected or be involved in such a situation cannot read English, are the warnings in a language they can read, or are easily understandable logos used?
5. Can deterioration or combustion of any material result in a product (or products) which could be toxic?
6. Will any process being used in the plant generate carbon monoxide? Is it possible the monoxide can leak into an enclosed, occupied space? هل ال
7. If a gas which is toxic is being used in the plant, does it have a warning odor? Are persons in the plant knowledgeable as to what that odor is and what it signifies? أقة ؟!
8. Has reliable information been obtained to determine if any new substance to be used is toxic, how toxic it is, what the effects might be, the precautionary measures to be taken, and any antidotes or treatments?
9. If a toxic material is a gas, has a Threshold Limit Value (TLV) or other rating been established? Have controls been instituted to ensure that no person is exposed to excessive amounts of the toxicant?
10. If a material is hazardous in an enclosed space either by itself or in combination with any other common material, have the potential users been warned and instructed in the conditions under which it is safe to use? Have janitorial personnel been warned against mixing cleaners?
11. Are persons who must or may have to wear respiratory protective equipment familiar with its use and with its limitations?
12. When a person must work in a closed space where there might be a respiratory hazard, such as in a tank, is the buddy system used? Does the man outside the tank know his duties and has he been informed he is to perform no other task than to safeguard the person in the tank?
13. Is the plant medical staff familiar with the types of materials used in the plant which might be injurious? Are they familiar with the characteristics of each such material, the symptoms which would indicate exposure to the material, and measures to be used for treatment?

Safety data sheet معلومات الرئيسية لـ

=>

1- Identification => من خلالها اعرف المادة

2- Hazards identification => شو الأضرار الي ممكن تنتج منها
والمادة هاي هل هي سامة او
قابلة للإشتعال الخ

3- Handling and storage => كيف اتعامل معها واخزنها

4- exposure Controls / Personal protection =>

ACGIH , OSHA بحيث انه يتبع كودات

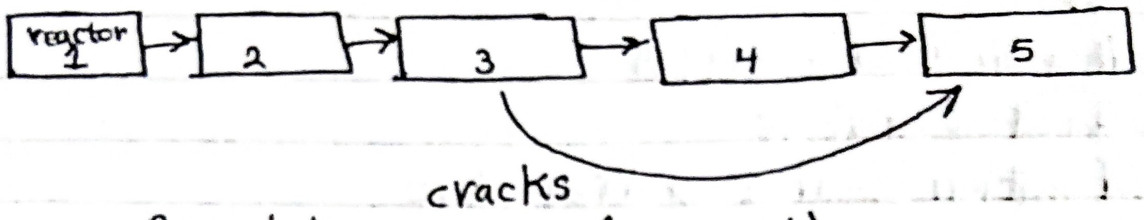
في كمان بس مشيت نعزول اهم اشي هو

chat Gpt

* Disasters كوارث

- Flixborough / England (1974)

  Caprolactum / Nylon



(Cause of incident: selection of material)

* Ch2:- Information required

الانفجار، الحرارة، انتقال للحدوث

ضغط، وجودهم الثلاث لازم يكون ضمن تركيز او معايير للحدوث الحريق. دائما

* combustion → "الإحتراق"

1- fuels:-

- Liquids: Gasoline, acetone, ether, Pentane
- Solids: Plastic, wood dust, fibers, metal Particales.
- Gases: Acetylene, Propane, carbon monooxide, hydrog

→ حسب حالة المادة يختلف نظام لعن ادخير الحريق

2- Oxidizers:- < O_2 > لازم تركيز ال O_2 يكون كافي

- Gases: oxygen, fluorine, chlorine
- Liq: Hydrogen peroxide, nitric acid
- Solids: metal peroxides, ammonum nitrite

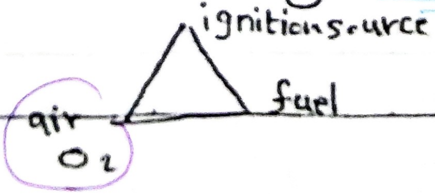
شرار كهرباء ساكنة

3- Ignition sources:- sparks, flames, static electricit

لازم يكون بها ال (energy) الكافية

* five triangle

- fire: when all sides are connected.
- No fire: when any one side is missing → لازم الثلاث يتصلوا مع بعض حتى يتم الاشتعال



يتحكم في عن طريق merting

smile...

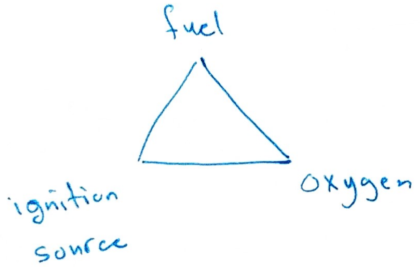
* عند الإحتراق ⇐

١- رح تختفي الـ moisture الخاص بالمادة

٢- المادة رح تطلق vapor وهو يلي بصير الـ احتراق

* طريقة الـ Inerting مشابهة للـ close space
غير هيك طريقة غير ناجحة لمنع الحريق

* بشكل عام صار عندي كتالي ⇐



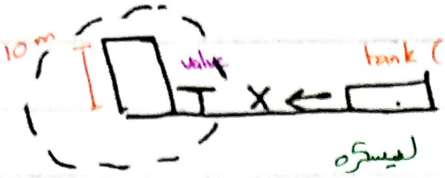
١- الـ fuel لازم يكون ضمن الـ flammable limits
(LEL - UEL)

اذا طلع من هنا الـ range ما رح يصير في إشتعال

٢- الـ ignition source لازم تكون اعلى من (minimum ignition temp)

٣- لازم تركيز الـ O_2 يكون كافي

* Fire Prevention



توصيل fuel من tank الى tower
ليس لها ماء في حريقة ، فهنا لازم توقف ال fuel
فلازم اسكر ال Valve وهنا لازم واحد يدخل جوا الحريق ليسكره

1- Inerting → no oxygen ⇒ O_2 يقلل نسبة , by inerting
2- fuel → shut it
3- Ignition source → Prevent it

* Combustion Theories

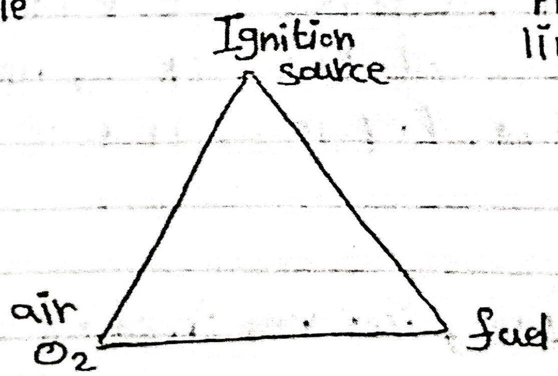
- flammable limits

حيث هاي كمية O_2 قليلة غير قادر على اشتعال هاي الكمية من fuel

ادنى تركيز قابل للاشتعال — min explosible conc — ما في اشتعال — Lower explosible Limit (LEL)

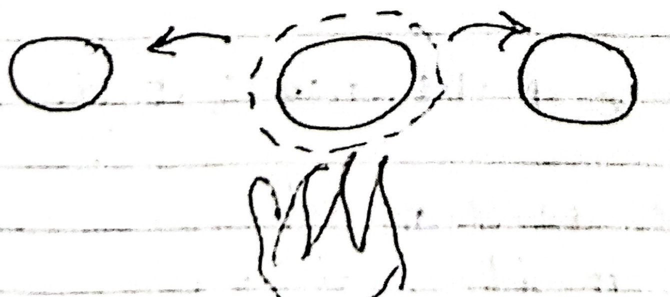
في اشتعال

اعلى تركيز قابل للاشتعال — max explosible con — ما في اشتعال — upper explosible limit (UEL)



* Minimum ignition temp

اقل درجة حرارة قادرة على احداث الاشتعال



min ignition temperature

Propagation of fire
انتشار

شو المعلومات المطلوبة

Table 1.3 Type of Information Required on Hazardous Materials

Flammable Reactive Toxic

Name of chemical; other names
Uses
General description of hazards
General description of precautions
- Firefighting methods
- Regulations
- Sources of advice on precautions

Characteristics: evaluate as appropriate under all process conditions
Formula (chemical structure)
- Purity, physical state, appearance, other relevant information
- Odour, detectable concentration, taste

(1) Physical characteristics:
- Molecular weight
- Vapour density
- Specific gravity
- Melting point
- Boiling point
- Solubility/miscibility
- Viscosity
- Particle size
- Foaming/emulsification characteristics
- Critical temperature/pressure
- Expansion coefficient
- Surface tension
- Joule-Thompson effect
- Caking properties

Corrosivity
Contamination factors (incompatibility), oxidising or reducing agent, dangerous reactions

(2) Flammability information:
- Flashpoint
- Fire point
- Flammable limits (LEL, UEL)
- Ignition temperature
- Spontaneous heating
- Vapour pressure
- Dielectric constant
- Electrical resistivity
- Electrical group (see BS 229)
- Explosion properties of dust (see Palmer, 1973)

(3) Reactivity (instability) information:
- Acceleration rate calorimetry
- Differential thermal analysis (DTA)
- Impact test
- Thermal stability
- Lead block test
- Explosion propagation with detonation
- Drop weight test
- Thermal decomposition test
- Influence test
- Self acceleration temperature
- Card gap test (under confinement)
- JANAF
- Critical diameter
- Pyrophoricity (see Silver, 1967; Stull, 1973)

(4) Toxicity information:
- Toxic hazard rating (see Sax, 1975)
- Threshold limit value (TLV)
- Maximum allowable concentration (MAC)
- Lethal concentration (LC_{50})
- Lethal dose (LD_{50}) (see Dominguez, 1978)

Biological properties
Exposure effects:
- Inhalation
- Respiratory irritation
- Ingestion
- Skin/eye irritation

Radiation information:
- Radiation survey
- Alpha/beta/gamma/[illegible]

materials, collision and other impact blows, stumbling, falling, poisoning and other exposure effects on personnel.

Action to deal with first degree hazards is mainly associated with good engineering, design and layout, maintenance and operating practice. As with other operating procedures, this is outside the scope of this text.

Table 1.2 Some Potential Hazards Catagories

1 **Energy source**	Process chemicals, fuels, nuclear reactors, generators, batteries Source of ignition (Figure 1.1), radio frequency energy sources, activators, radiation sources Rotating machinery, prime movers, pulverisers, grinders, conveyors, belts, cranes Pressure containers, moving objects, falling objects (اقلها جيها energy source)
كيف يمكن تتسرب 2 **Release of material** تسرب المواد	انسكاب Spillage, leakage, vented material كدمات Exposure effects, toxicity, burns, bruises, biological effects (حتى احمرار الجلد) Flammability, reactivity, explosiveness, corrosivity and fire-promoting properties of chemicals (see Table 1:3) Wetted surfaces, reduced visibility, falls, noise, damage Dust formation, mist formation, spray
3 **Fire hazard** عن يؤدي الى explosion	Fire, fire spread, fireballs, radiation Explosion, secondary explosion, domino effects (حتى انفجار قوة يؤدي الى انفجار بحدة قريبة منها) Noise, smoke, toxic fumes, exposure effects Collapse, falling objects, fragmentation
4 **Process state**	High/low/changing temperature and pressure Stress concentrations, stress reversals, vibration, noise Structural damage or failure, falling objects, collapse Electrical shock and thermal effects, inadvertent activation, power source failure Radiation, internal fire, overheated vessel Failure of equipment/utility supply/flame/instrument/component Start-up and shutdown condition Maintenance, construction and inspection condition
5 **Environmental effects**	Effect of plant on surroundings, drainage, pollution, transport, wind and light change, source of ignition/vibration/noise/radio interference/fire spread/explosion Effect of surroundings on plant (as above) Climate, sun, wind, rain, snow, ice, grit, contaminants, humidity, ambient conditions Acts of God, earthquake, arson, flood, typhoon, *force majeure* Site layout factors, groups of people, transport features, space limitations, geology, geography Security

TABLE 6-3 IGNITION SOURCES OF MAJOR FIRES[1]

Electrical (wiring of motors)		23%
Smoking		18%
Friction (bearings or broken parts)		10%
Overheated materials (abnormally high temperatures)		8%
Hot surfaces (heat from boilers, lamps, etc.)		7%
Burner flames (improper use of torches, etc.)		7%
Combustion sparks (sparks and embers)	جمر	5%
Spontaneous ignition (rubbish, etc.)	احتراق ذاتي	4%
Cutting and welding (sparks, arcs, heat, etc.)		4%
Exposure (fires jumping into new areas)		3%
Incendiarism (fires maliciously set)	تتم الحرقة عن قصد	3%
Mechanical sparks (grinders, crushers, etc.)		2%
Molten substances (hot spills)	مواد تنصهر	2%
Chemical action (processes not in control)	powder	1%
Static sparks (release of accumulated energy)	تحدث بالعادة لل	1%
Lightning (where lightning rods are not used)	مانعات الصواعق لا	1%
Miscellaneous	بلمس الكهرباء	1%

[1] *Accident Prevention Manual for Industrial Operations* (Chicago: National Safety Council, 1974).

Table 6
Ignition sources of fires (1996–2004)

Type	Percentage
1. Children carelessness	32.1
2. Arson حرق عن قصد	20.2
3. Smoking	14.7
4. Electrical wiring and equipment	12.5
5. Carelessness إهمال	7.9
6. Gas leak	5.5
7. Heaters	1.7
8. Friction	0.9
9. Car accident	0.8
10. Cutting and welding sparks	0.7
11. Spontaneous ignition	0.2
12. Negligence جهل	0.2
13. Miscellaneous	2.6
	100%

Table 3
Causes of home fires in 2003

Type of ignition source	Percentage of occurrence
Electrical wiring and equipment	21.8
Children carelessness	21.5
Gas leak	17
Arson	14.7
جهل Negligence الغباء	14.5
Heaters	7.2
Smoking	1.6
Others	1.7

* في حال تسرب غاز تجنب إضاءة الأضواء

Compestion →

Explosion → is a rapid expansion of gases resulting in a rapidly moving pressure or shock wave

Mechanical Explosion → An explosion due to sudden failure of a vessel containing high pressure

كل الـ excess pressure 2) يطلع من أضعف نقطة بالـ vessel ويشكل انفجار

type of explosions

Deflagration → An explosion with resulting shock wave moving at a speed less than the speed of sound in the unreacted meduim

Detonation → An

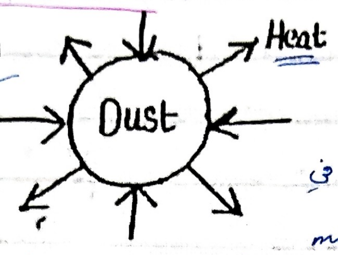
مصنع سماد احدى مكونات مستوردة من هولندا , في حمولة حطوها جوا Hanger
الحكي هذا بشهر <5> فكان طقس حار فال Hanger كان ممتص حرارة لانه معدن
خلال اشهر من تخزين صارت الحمولة تمتص حرارة وهذا سبب إحتراقة لها

* احتراق ذاتي *

No.

*Spontaneous combustion

• Self ignition



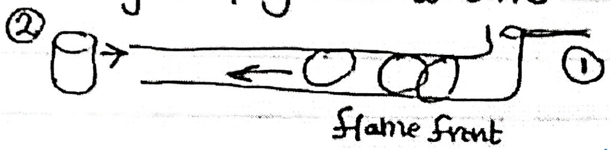
ال Dust رح يمتص ال Heat
بالإضافة انه رح يفقد Heat
لو ال input > loss رح يزيد في
temp ورح يوصل لل minum igntion tem
وقتها رح يصير الحريقة

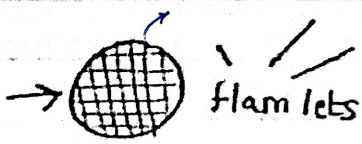
(Input > loss)

Rate of heat input more than of heat loss

فتحات اسمها apetcher

* Preventing Propagation of fire





flam trap ⇐ زي فخ للهب
flame arrester ⇐ مانع اللهب

* Hazards

* ق بين ratio

— first Degree Hazards

• Presence of hazardous material
• Heat
• Pressure
• Reaction
• Energy source

مكونات الخطر موجودة او مسببات الخطر

— Second Degree Hazard
(result of first degree hazard)

شو بنتج من ال first degree hazard

• Fire/spread → حريقة وانتشاره
• Explosion → انفجار
- Primary - secondry
• Release of hazardous material. → انتشار مواد سامة او خطرة

Un confined explosion → Occur in the open, this type of explosion is usually the result of flammable gas spill. the gas is dispersed and mixed with air until it comes in contact with ignition source

→ هاي من أصعب الانفجارات التي تحدث بالمصانع

Dust explosion → results from the rapid combustion of fine solid particle, Many solid materials (Including common metals such as iron and aluminum) become vary flammably when reduced to fine powder

breifly
Flash point → Lowest temp

continue to burn
Fire point =

The flame dissipates energy to the wall of the flame Arrester disc

the narrower the gap, the greater the extinguishing effectivness

the gap size is adjusted in accordance to the flash back Capability of the explosive mixture

← يقوم اللهب بتبديد الطاقة إلى جدار قرص مانع اللهب

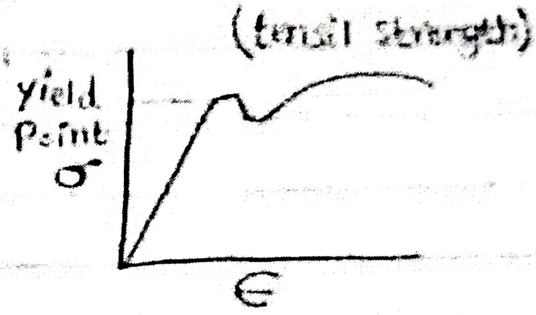
⇐ كل ما كانت الفجوة أضيق، كلما زادت فعالية الإطفاء

← يتم تعديل حجم الفجوة وفقاً "لقدرة" الارتداد للخليط

تفاعل
دينو كيلار

* Dangerous Processes :-

1. Process → explosive reaction (Deflagration or Detonation)
2. " → exothermic reaction
3. " → flammable materials + على حرارة وضغط عاليين قابلين للاشتعال
4. " → High Pressure
5. " → Toxic materials
6. " → Dust / Gas (Explosions)



Domino Effect

4- Unstable compounds

5- Compounds / material operating at limit of explosibility

6- process subject to dust explosion

7- process with large inventory

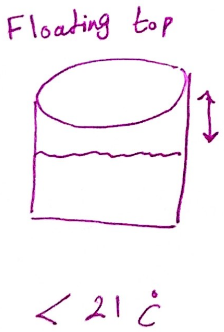
الطاقة الناتجة من fires بتكون slowly

اما ال explosions بتكون very rapidly

كل واحد منهم بؤدي للثاني عكس

لما تعطي شرارة بتكون هاي Flash point

اما لما تمرر الحرارة وتعطي ~~شرارة~~ شعلة وتزيل هاي شعلة موجودة بتكون Fire point



السطح بطلع وبنزل مع مستوى ال liq ⇒ حيث بيمنع ال vapor انه يتشكل

بحيث انه مش space الي يتشكل فيه

كل شو الفرق بينهم او شو الي بميز كل واحد منهم

6-2 DISTINCTION BETWEEN FIRES AND EXPLOSIONS

الفرق الرئيسي بينهم

The major distinction between fires and explosions is the rate of energy release. Fires release energy slowly while explosions release energy very rapidly, typically on the order of microseconds. Fires can also result from explosions and explosions can result from fires.

كل واحد ممكن يسبب حدوث الآخر

A good example of how the energy release rate affects the consequences of an accident is a standard automobile tire. The compressed air within the tire contains energy. If the energy is released slowly through the nozzle, the tire is harmlessly deflated. If the tire ruptures suddenly and all of the energy within the compressed tire releases rapidly, the result is a dangerous explosion.

example

6-3 DEFINITIONS

تعريفات

Some of the commonly used definitions related to fires and explosions are given below.

تفاعل كيميائي يتم في أكسدة للمادة وينتج عنه طاقة , جزء من هاي طاقة يستخدم للحفاظ على تفاعل

Combustion or Fire: Combustion or fire is a chemical reaction in which a substance combines with an oxidant and releases energy. Part of the energy released is used to sustain the reaction.

Ignition: Ignition of a flammable mixture may be caused by a flammable mixture coming in contact with a source of ignition with sufficient energy or the gas reaching a temperature high enough to cause the gas to autoignite.

الحرارة يلي عندها بتقدر المادة هي انها تسبب احتراق ذاتي

[redacted]

**Autoignition temperature (AIT):* A fixed temperature above which a flammable mixture is capable of extracting enough energy from the environment to self-ignite.

زي قداحة بتكون بشكل مؤقت

Flash Point (FP): The flash point of a liquid is the lowest temperature at which it gives off enough vapor to form an ignitable mixture with air. At the flash point, the vapor will burn but only briefly; inadequate vapor is produced to maintain combustion. The flash point generally increases with increasing pressure.

طرق يلي بقيس فيها Flash point

There are several different experimental methods used to determine flash points. Each method produces a somewhat different value. The two most commonly used methods are open cup and closed cup, depending on the physical configuration of the experimental equipment. The open cup flash point is a few degrees higher then the closed cup.

Fire Point: The fire point is the lowest temperature at which a vapor above a liquid will continue to burn once ignited; the fire point temperature is higher than the flash point.

Flammability Limits (LFL and UFL): Vapor-air mixtures will only ignite and burn over a well-specified range of compositions. The mixture will not burn when the composition is lower than the lower flammable limit (LFL); the mixture is too lean for combustion. The mixture is also not combustible when the composition is too

يتم الاحتراق على تراكيز محددة ك range اذا زاد او قل عنه ما رح يتم الاحتراق هنا

Domino effect → اذا صار مشكلة بإش 21
ينتشر للي حواليه ويأثر عليهم

rich; that is, when it is above the upper flammable limit (UFL). A mixture is flammable only when the composition is between the LFL and the UFL. Commonly used units are volume percent fuel (percent of fuel plus air).

Lower explosive limit (LEL) and upper explosive limit (UEL) are used interchangeably with LFL and UFL.

Explosion: An explosion is a rapid expansion of gases resulting in a rapidly moving pressure or shock wave. The expansion can be mechanical (via the sudden rupture of a pressurized vessel) or it can be the result of a rapid chemical reaction. Explosion damage is caused by the pressure or shock wave.

Mechanical explosion: An explosion due to the sudden failure of a vessel containing high pressure, nonreactive gas. tensil strength

(زي انتشار اللهب *Deflagration:* An explosion with a resulting shock wave moving at a speed less then the speed of sound in the unreacted medium.

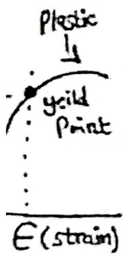
(زي المصانع *Detonation:* An explosion with a resulting shock wave moving at a speed greater than the speed of sound in the unreacted medium.

Confined explosion: An explosion occurring within a vessel or a building. These are most common and usually result in injury to the building inhabitants and extensive damage.

من أصعب الانفجارات في المصانع

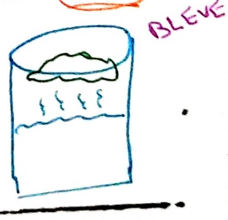
Unconfined explosion: Unconfined explosions occur in the open. This type of explosion is usually the result of a flammable gas spill. The gas is dispersed and mixed with air until it comes in contact with an ignition source. Unconfined explosions are rarer than confined explosions since the explosive material is frequently diluted below the LFL by wind dispersion. These explosions are very destructive since large quantities of gas and large areas are frequently involved. (Flixborough case) مثال عليها

Boiling liquid expanding vapor explosion (BLEVE): A BLEVE occurs if a vessel ruptures which contains a liquid at a temperature above its atmospheric-pressure boiling point. The subsequent BLEVE is the explosive vaporization of a large fraction of the vessel contents; possibly followed by combustion or explosion of the vaporized cloud if it is combustible. This type of explosion occurs when an external fire heats the contents of a tank of volatile material. As the tank contents heat, the vapor pressure of the liquid within the tank increases and the tank's structural integrity is reduced due to the heating. If the tank ruptures the hot liquid volatilizes explosively.



Dust explosion: This explosion results from the rapid combustion of fine solid particles. Many solid materials (including common metals such as iron and aluminum) become very flammable when reduced to a fine powder.

Shock wave: A pressure wave moving through a gas. A shock wave in open air is followed by a strong wind; the combined shock wave and wind is called a blast.



هذا ال powder لو كان بالجو وصار في مصدر شعلة رح يسبب explosion

رح يكون في مصدر يسخن هون على جدا ال vessel ويصير في تبخر ~~للسوائل~~ وزيادة للضغط داخل ال tank، هنا هون رح يحاول يبرد ال tank بس الجزء الي مافي هون رح ينضغط ويصير الانفجار

IGnition source of Major fires ⇛

Electrical 23 %

smoking 18 %

Freiction

over heated materials

Hot surfaces (heat from boillers , Lamps)

Burner flames

Combustion sparks

spontaneons igntion

cuting and welding

Exposure

Incendiarism (تم الحرق عن قصد , fires malicously set)

Mechanical sparks

Molten substances (Hot spills)

chemical action (processes not in Control) 1 %

static sparks (تحدث بالعادة لا بإرادة , relase of accumlated energy) 1 %

Lightning (where lightning rods are not used) 1 %

لا مانع صواعق تمتص الكهرباء

Miscellaneous 1 %

< 4 ⇐ 3 ص. >
pages

project <1> ⇛ 3 weeks , about any things in safety

such as an accident ,

← جهد للموضوع في
← عدم نسخ ورقي

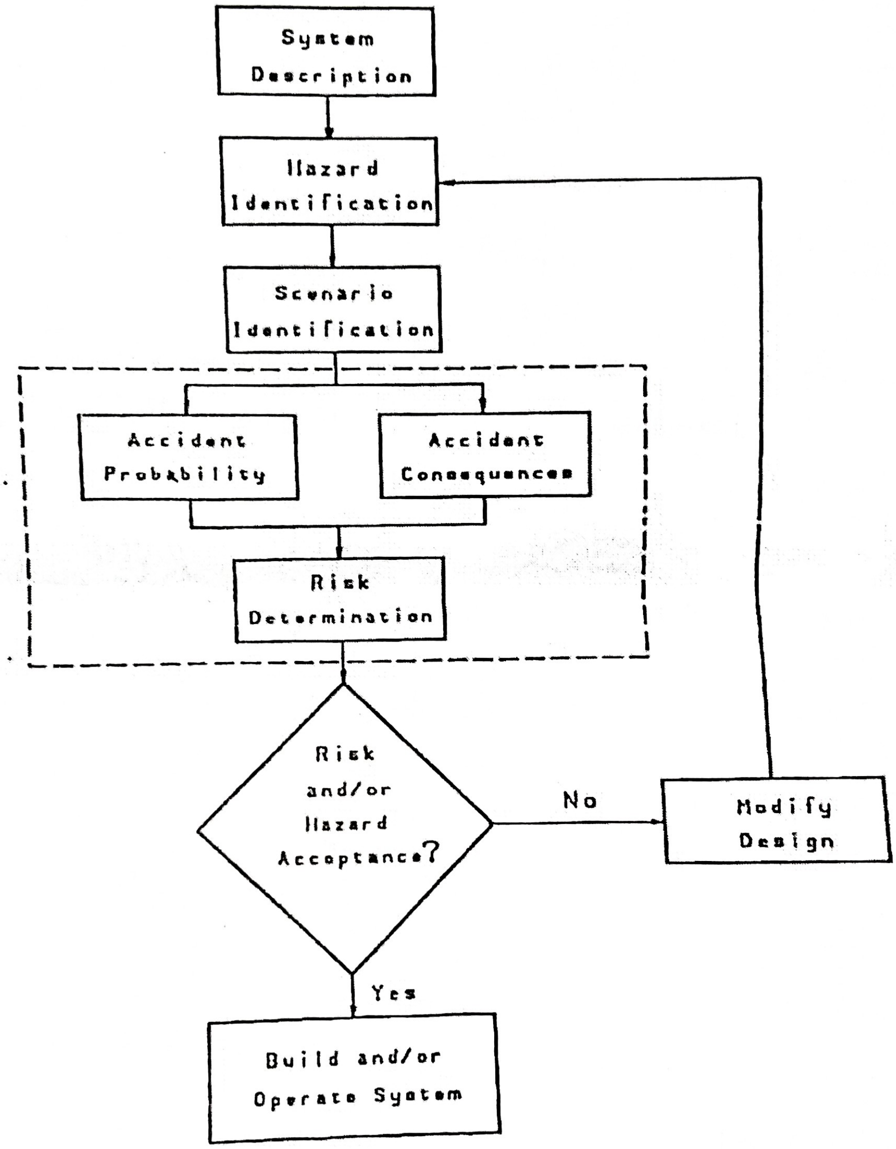


Figure 10-1 The hazards identification and risk assessment procedure. (Adapted from *Guidelines for Hazards Evaluation Procedures*, American Institute of Chemical Engineers, New York, 1985, p. 1-9.)

mined. This is followed by a concurrent study of both the probability and the consequences of an accident. This information is assembled into a final risk assessment. If the risk is acceptable, then the study is complete and the process is operated. If the risk is unacceptable, then the system must be modified and the procedure is restarted.

	Fatalities
Residential homes	138
Industrial plant	3
wild land	5
used tyres and solid waste	2
Motor ~~vicles~~ vehicles and petrolem tankers	165
Commercial stores	5
others (Hotels, restaurant, hospitals, etc)	46

Ignition sources of fires in Jordan

children Carelessnes (عبث الأطفال)	32.1 %
Arson (الحرق عن تعمد)	20.2 %
smoking	14.7 %
Electrical wiring and equipment	12.5 %
Carelessnes	7.9 %
Gas leak	5.5 %
Heaters (زي صوبا)	1.7
Friction	0.9
Car accident	0.8
Cutting and welding sparks	0.7
spontaneous ignition (الإشتعال الذاتي)	0.2
Nigligence (جهل)	0.2
Miscellaneous	2.6

No

*Vapor mixtures: Lower and upper flammable limits calc

$$LFL_{mix} = \frac{1}{\sum_{i=1}^{n} \frac{y_i}{LFL_i}}$$

LFL → Lower flammable limits.

$$UFL = \frac{1}{\sum_{i=1}^{n} \frac{y_i}{UFL_i}}$$

* Lower and upper mixture example:

Gas mixture composed of

0.8 % hexane

2% methane → by Volume

0.5% ethylene

What is the LFL and UFL of the mixture?

	Volume %	mole fraction	LFL %	UFL %
Hexane	0.8	$\frac{0.8}{3.3}$ → 0.24	1.1	7.5
CH_3OH	2	$\frac{2}{3.3}$ → 0.61	5	15
Ethylene	0.5	$\frac{0.5}{3.3}$ → 0.15	2.7	36
Total combustible	3.3			
Air	96.7 → 100 - 3.3			

$$LFL = \frac{1}{\frac{0.24}{1.1} + \frac{0.61}{5} + \frac{0.15}{2.7}} = 2.53\ \%\ \text{by volume}$$

$$UFL = \frac{1}{\frac{0.24}{7.5} + \frac{0.61}{15} + \frac{0.15}{36}} = 13\ \%\ \text{by volume}$$

* Volume % = mole fraction → if we assume ideal gas

smile...

3.3%

LFL

2.53 %

13 % UFL

⇝ It is explosible

* Effect of Temp on flammability limits

كيف نحسب UFL, LFL على حرارات مختلفة

$$LFL_T = LFL_{25}\left[1 - 0.75\,(T-25)/\Delta H_c\right]$$

$$UFL_T = UFL_{25}\left[1 + 0.75\,(T-25)/\Delta H_c\right]$$

$T = °C$

H_2O as vapor

ΔH_c = net heat of combustions or gross

(H_2O vapor as aproduct) — H_2O as السائل

Unit: Kcal/mol

* Effect of Pressure on flammability limits

LFL → No effect on LFL

UFL → $UFL_P = UFL + 20.6(\log P + 1)$

P: in absolute pressure

Ex: UFL for asubstance is 11% by volame at 0.0 ~~mpa~~ MPa gauge, what is the UFL at 6.2 Mpa gauge?

Absolute Pressure = 6.2 + 0.101 = 6.301 mpa

$UFL_P = 11 + 20.6(\log 6.301 + 1)$

UFL = 48 Vol % fuel

* بنلاحظ انه زيادة الضغط زادت من قيمة الـ UFL يتالي بتزيد عندي الـ range

m ← مفروض تكون M

mega not meli

$$LFL = -\frac{3.42}{\Delta H_c} + 0.569\,\Delta H_c + 0.0538\,\Delta H_c^2 + 1.8$$

$$UFL = 6.3\,\Delta H_c + 0.567\,\Delta H^2 + 23.5$$

$$LFL = \frac{0.55\,(100)}{4.76m + 1.19X - 2.38 + 1}$$

$$UFL = \frac{3.5\,(100)}{4.76m + 1.19X - 2.38 + 1}$$

* Estimation of flammability limits :-

$$C_{st} = \frac{\text{moles of fuel}}{\text{moles of fuel} + \text{moles of air}} \times 100\%$$

LFL = 0.55 Cst

1- UFL = 3.5 Cst

where Cst = Volume% fuel in fuel plus air

$\frac{X}{2}$

2- $C_m H_X O_y + ZO_2 \rightarrow m\,CO_2 + X/2\, H_2O$

Z ⇒ No. of moles of oxygen

→ $Z = m + X/4 - y/2$ ⇒ حفظ صيغة

Z = mole O_2 / mole fuel

theory lead to :-

$$LFL = \frac{0.55\,(100)}{4.76m + 1.19X - 1.38y + 1}$$

* قانون عام

لو ا-ز ما كان موجود بنفس نحطه صفر

$$UFL = \frac{3.5\,(100)}{4.76m + 1.19X + 1}$$

Ex:- Estimate the LFL and UFL for hexane

$C_6H_{14} + ZO_2 \rightarrow m_6\, CO_2 + X/2\, H_2O$

$Z = 9.5$, $m = 6$, $X = 14$, $y = 0$ → ما في O بالـ Component

LFL = 0.55 (100) / 4.76(6) + 1.19(14) + 1

= 1.19 vol% X 1.1% actual

اي طلعت معي بالحساب ← → اذا طلعتها من المختبر

UFL = 3.5(100) / 4.76(6) + 1.19(14) + 1

= 7.57 vol% X 7.5% actual

Material	Min Ignition energy
Methane	0.29
Propane	0.26
Heptane	0.25
Hydrogen	0.03
~~Con~~ Cornstrach dust	0.3
Iron dust	0.12

MIE depends on ⇒

1- specific chemical or mixture
2- the concentration
3- pressure → بتقل مع زيادة الضغط
4- temp

★ بالعادة MIE لل hydro carbons بتكون قرابة 0.25 mJ فهو قليل كتير مقارنة

بال Ignition source ← قتال

static discharge = 22 mJ

⇐ كل اشي اله energy بس بقيمة مختلفة

No.

* Ignition energy — اقل درجة طاقة قادرة لحدوث إشتعال

- min. Ignition energy required to Intiate combustions
(MIE)

	min. ignition energy (m.J)
methan	
Propane	
Heptane	
H.y	

* Adiabatic ~~combustion~~ compiession → ignition نحن اخر لل

Gasoline and air in a car cylinder will ignite if the vapors are compressed to an adiabatic temp, which exceeds the into ignition temp.

$$T_P = T_i \left(\frac{P_P}{P_i} \right)^{(\gamma-1)/\gamma}$$

T_f = fuel absolute T

T_i = initial absolute T

P = absolute Pressure

$\frac{P_P}{P_i}$ = compression ratio

$\gamma = \frac{C_P}{C_V}$

بدل P حط f

$T_f = T_P$

Ex: what is the final temp after compression air Liquid hexane from 14.7 Psia to 500 psia if the initial temp is ~~°~~ 100 °F and $\gamma = 1.4$

→ AIT for hexane is 500 F and lambda for air 15.14

$$T_S = 560\left(\frac{500}{14.7}\right)^{0.4/1.4}$$

in R°

$$= 1533°R = 1073°F$$

$$1073 > 500$$

This exceeds AIT for hexane resulting in an explosion.

psia → p → pound
s → per square
i → Inch
a → asbsolute

1 atm = 14.7 psia

$$\boxed{F° = R° - 460}$$

parameter Affecting Explosions →

1- Ambient Temp and pressure

Compositions of explosive material

physical properties

* Ignition energy
- min. Ignition energy required to Initiate combustions

	min. ignition energy (m.J)
methan	0.29
Propane	0.26
Heptane	0.25
Hydrogen	0.03

* Adiabatic ~~combustion~~ compression

Gasoline and air in a car cylinder will ignite if the vapors are compressed to an adiabatic temp, which exceeds the ~~[illegible]~~ auto ignition temp.

$$T_f = T_i \left(\frac{P_f}{P_i} \right)^{(\gamma-1)/\gamma}$$

T_f = fuel absolute T

T_i = initial absolute T

P = absolute Pressure

$\frac{P_f}{P_i}$ = compression ratio

$$\gamma = \frac{C_p}{C_v}$$

Ex: what is the final temp after compression air over Liquid hexane from 14.7 Psia to 500 psia if the initial temp is 100°F ?

→ AIT for hexane is 500 F and lambda ~~[illegible]~~ $\lambda = 1.4$

$$T_f = 566\left(\frac{500}{14.7}\right)^{0.4/1.4}$$

$$= 1533°R = 1073°F$$

$1073 > 500$

This exceeds AIT for hexane resulting in an explosion.

smile.

* Dust explosions → انفجارات الأغبرة

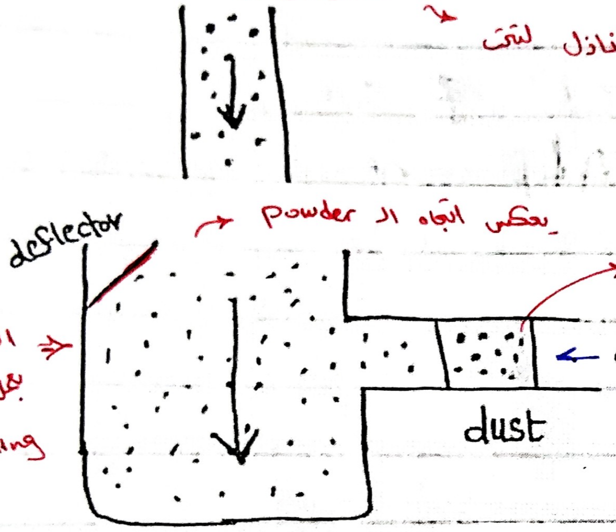
Dust sample
↓
classification tests

* الأغبرة يختلف الـ Dispersion تاعها من Vertical او Horizontal

① vertical , ② horizental , inflammator

او نازل من فوق لتحت او العكس

① Downward desperssion (inflammator) → نازل لتحت



→ powder يعكس اتجاه الـ

بدي اشوف قديش تركيزها

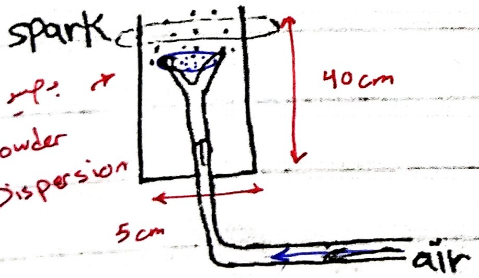
pressurise air

الـ powder بحل settling

spark → مصدر حراري

طالع لفوق

② upward desperssion (vertical)



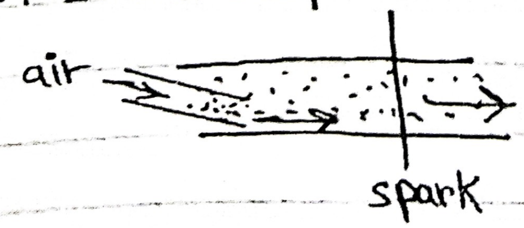
بوصل الـ → powder Dispersion

min Exp conc (g/L)

LFL ✕————✕ UFL

كمية fuel كبيرة مقارنة بالـ air

③ Horizental desperssion



* اي بنختلف هون هو الـ Behavior of dust or powder

* classification tests → * من الثلاث اجهزة اذا جهاز اعطى اشتعال يكون group (A) اذا ولا واحد منهم اعطى يكون group (B) ما صار اشتعال

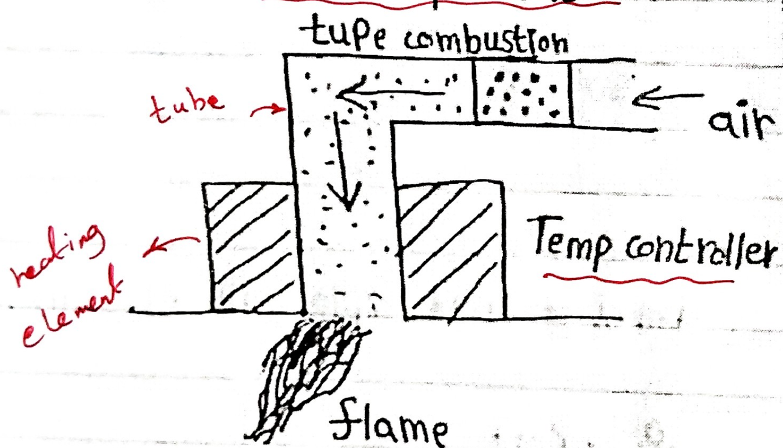
قابل للاشتعال ← explosibile group (a)

Non-explosibile group (b)

شو الخصائص الي لازم اعرفها

Parameters:
- → min explosible concentration → اقل تركيز قابل للاشتعال
- → min ignation temprature → اقل حرارة تعمل اشتعال
- → min ignation energy →
- → explosible pressure at its max rate → الضغط الناتج من اشتعال المادة

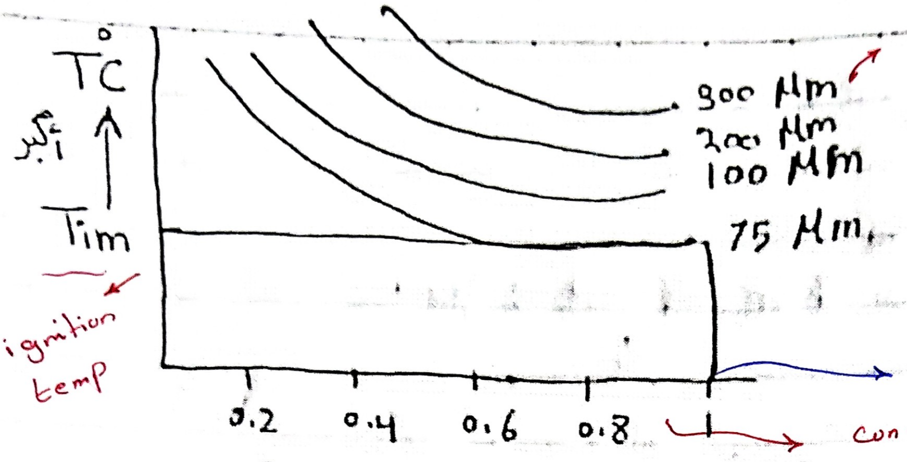
* ~~Shhe~~ furnace aparatus :



بنوجد ← ⇒ Min ignition temp

* بنرفع درجة الحرارة و بنشوف اذا اشتعل عند حرارة معينة ~~بخفف~~ بصير انزل بالحرارة لحد ما يوقف اشتعال

Dust explosion : ignition temp

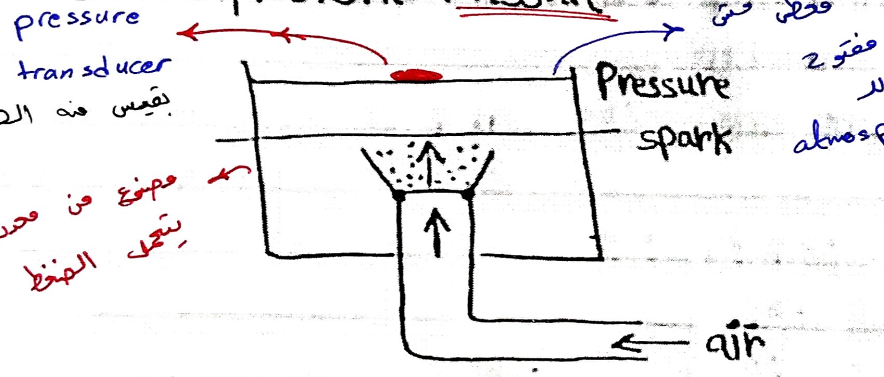


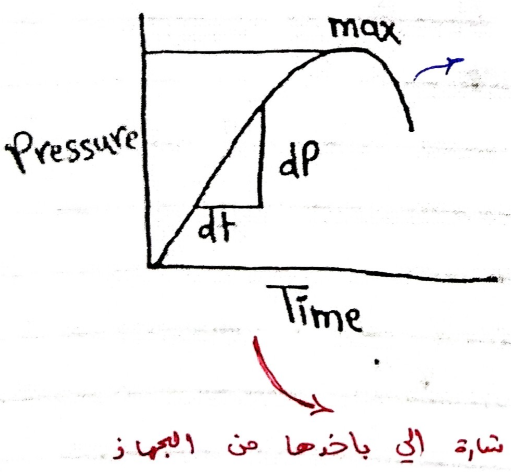
* كل ما زاد ال particle size زادت ⟵ صعوبة الاشتعال
أكبر

لو عندي mixture باخذ عندها concentration

Tim (min ignation temp) is at 1g/L

* Dust explosibrle Pressure





بلش ينزل لانه عكس
خلصت المادة او ال air

P_{max} = max Explosibile Pressure.

$$\frac{dP}{dt} = \text{rate}$$

* **The cubic law** ⇒ سواء غاز أو بودرة

$$\left(\frac{dP}{dt}\right)_{max} V^{1/3} = const$$

$$\frac{bar}{s}\,(m^3)^{1/3} = K_g\,(gas)$$ → for gas

$$\frac{bar.m}{s} = K_{st}\,(dust)$$ → for dust or powder

$$\left[\left(\frac{dP}{dt}\right)_{max} V^{1/3}\right]_{experiment} = \left[\left(\frac{dP}{dt}\right)_{max} V^{1/3}\right]_{vessel}$$

→ scale up يعني هنا

* K_g and K_{st} values

Gas	K_g
methane	55
Propane	25
Hydrogen	550

Dust	K_{st}
PVC	75
sugar	90
wood dust	110
AL	750

K_{st}	st. class
0	st-0
1-200	st-1
200-300	st-2
>300	st-3

هذا تعبير للـ powder فقط

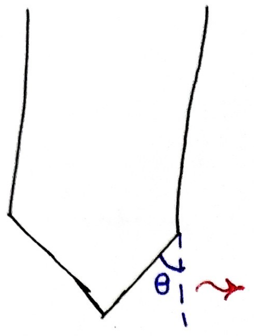
* كل ما زادت الـ Kg بتزيد شدة الانفجار كذلك الأمر مع Kst

Kst , Kg ⇒ deflagration index

مع زيادة قوة الـ نفخ، بتزيد قيمهم

smile..

cyclone or hopper → equipment used for storage solid material



الزاوية هاي
تختلف من مادة
لمادة

* احد أهم اسباب ال ignition لل solid هي ال static charge

* بدخل Hot air على powder من اجل اله تجفيف

No

* Types of explosions

(I) Dust explosion

1- dust (cloud)

2- Partical size (small and uniform)

3- ignition source → fire triangle يكمل في — شرارة أو لهب الخ

energy- duration types — قديش استمرت كوقت

4- explosibility rang (UFL, LFL) — range تكون ضمن ال

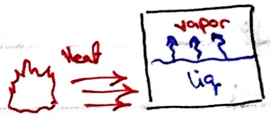
(II) Boiling Liq expanding Vapor explosions (BLEVE)

بصير تسخين لل liquid قد
بصير اله تبخير هذا البخار 21 ...
يسبب في تسخين الجزء العلوي من
الخزان بالإضافة انه 21 يأثر عليها
pressure ب

(III) Vapor cloud explosions (VCE)

*(most dangerous)

"Flixbrough" (law changed)



• Occurs :- كيف صارت

1- sudden release of large quantity of flammable vapor

2- Dispersion of the vapor throughout the plant and surronding area while mixing with air.

3- Ignition the resulting vapor cloud.

• Parameters of VCE :-

1- Quantity of material released → الكمية قديش هل هي كبيرة ؟!

2- Probability of ignition → شو نوع ال ignition و duration تاعه

3- Distance travelled → قديش قطع مسافة اذا كثير بصير اله dillution

كمية من ال vapor القابل للاشتعال طلع للجو و بدأ يتشتت و يتوزع على المنطقة المجاورة

وخلال انتشاره كان يختلط مع Air حتى وصل لل flammable concentration range ووقع صدوم

وصار ignition حدثة الكارثة

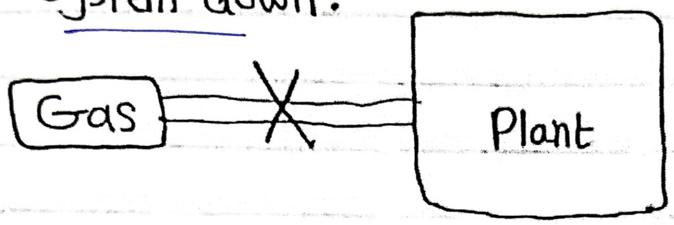
smile...

- Method for Preventing (VCE):- كيف امنعه

1- Keeping low inventories of volatile, flammable materials لا تخزن كميات كبيرة عندك

2- using process conditions which minimize flashing if rupture occurs. dispersion اقل ال

3- installing automated block valves to shut the system down.



على temp او flow او الخ
بزود. ال valve بطفي تدفق
من container لمصدر الإشتعال

4- using analyzers to detect leaks at very low concentrations

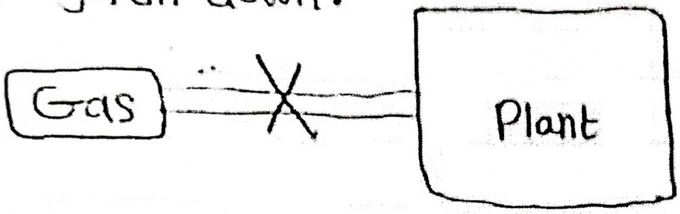
عندي حساسات اول ما يصير تهريب يعطيني تنبيه

- Method for Preventing (VCE):-

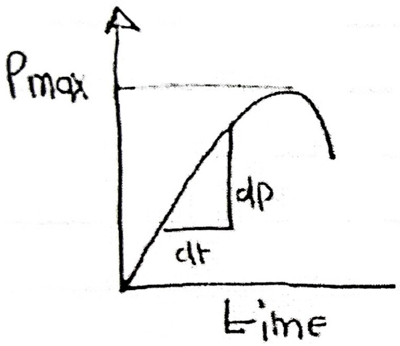
1- Keeping low inventories of volatile, flammable materials

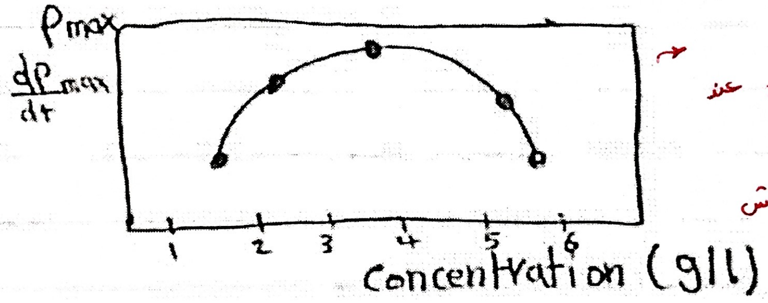
2- using process conditions which minimize flashing if rupture occurs.

3- installing automated block valves to shut the system down.

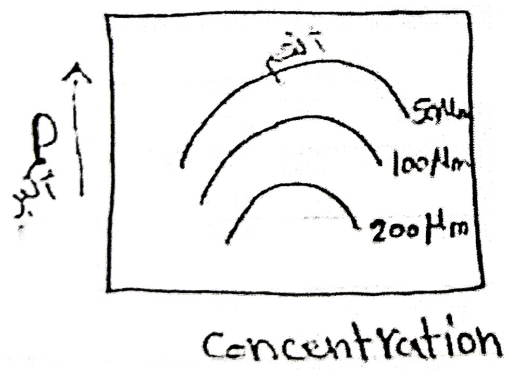


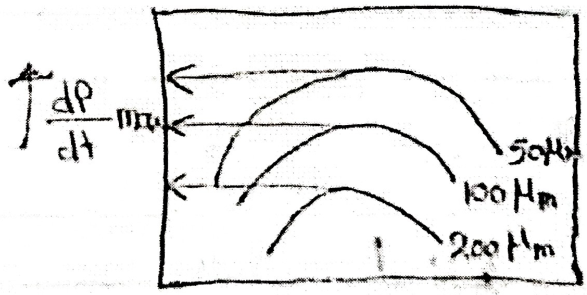
4- using analyzers to detect leaks at very low concentrations.





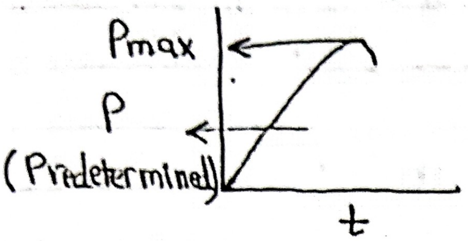
اذا بدي اعرف
للمادة كذا .بروح عند
اعلى قيمة
اما لو تحدد قديش
تركيز .بروح
عتركيز مباشرة وبكون
هاي اكثر دقة

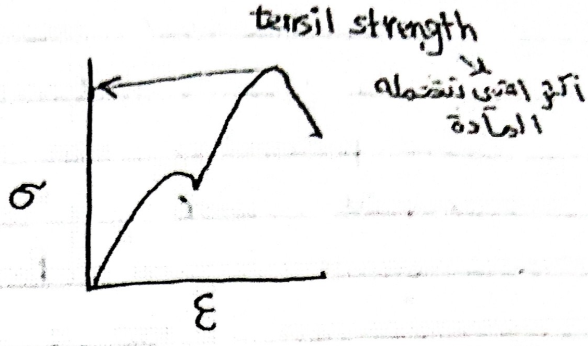


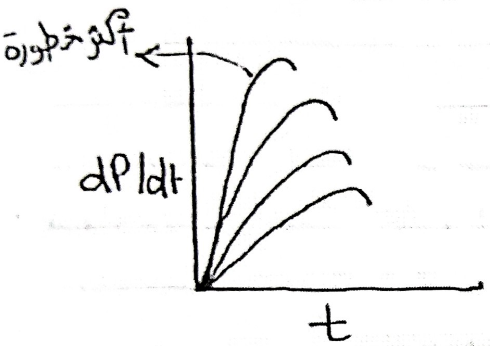


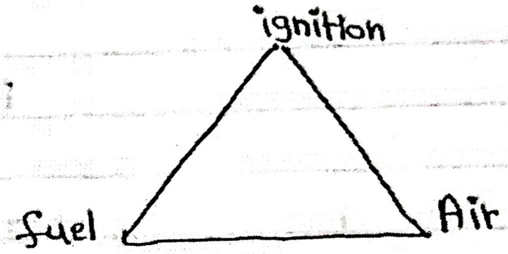
$$\left[\left(\frac{dP}{dt}\right)_{max} V^{1/3}\right]_{exp} = \left[\left(\frac{dP}{dt}\right)_{max} V^{1/3}\right]_{vessel}$$

* Predetermined value





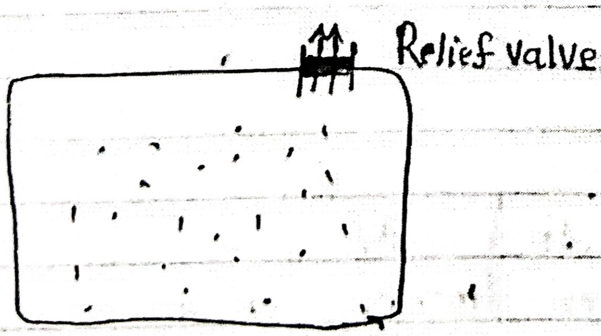




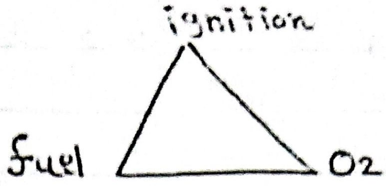
Prevention (triangle عابدي الـ
تكتمل فنقلل O_2)

Protection (triangle الـ أكتملت عناصر)
وبعرين بس اتحكم فيها

* Relief vents



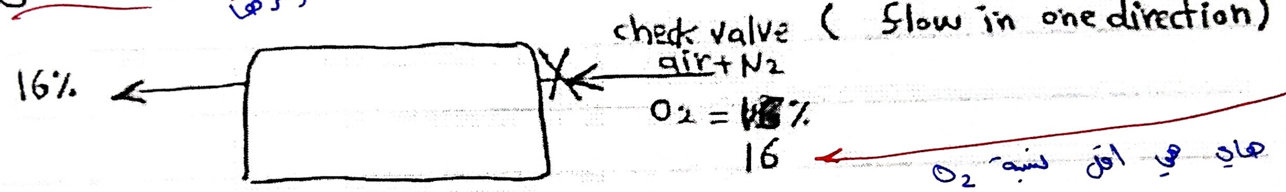
1- Protection
2- Prevention



* Inerting with gas:
Advantages: explosion is avoided rather than controlled.

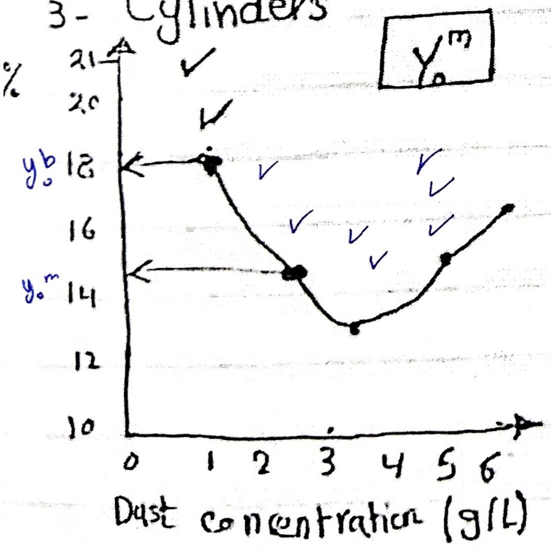
* Basic Requirements for inerting :-

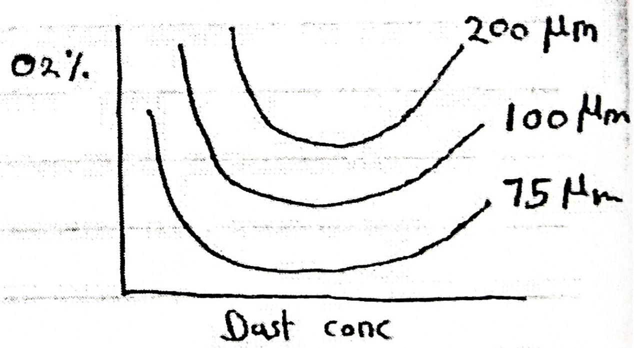
1- A Permanent supply of inert gas.
2- closed system
3- Continuous and reliable monitoring of the atm.
4- A knowledge of the min O_2 concentration to Prevent ignition (Y_o^m)
رمزها



هاي هي أقل نسبة O_2 لتجنب الإشتعال (قادرة على منع الإشتعال)

* Permanent supply of inert gas:
1- By Product: another Part of the Plant
2- Generators: commerical
3- Cylinders





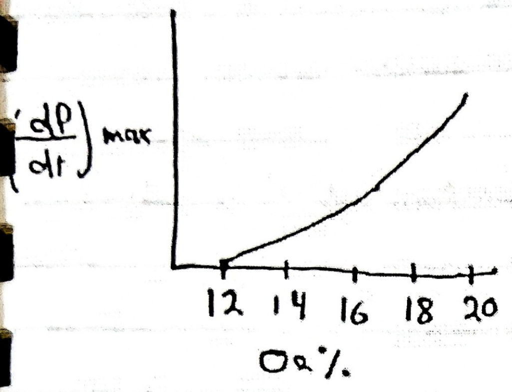
تحت المنحنى ما بصير عندي اشتعال

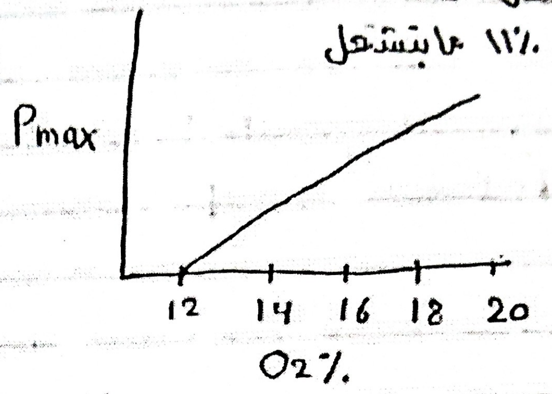
فوق المنحنى بصير عندي اشتعال

كل ما قلت حجم الجزيئات تشتغل على نسبة أقل

smile

* P_{max} , $(dP/dt)_{max}$ with O_2 %.





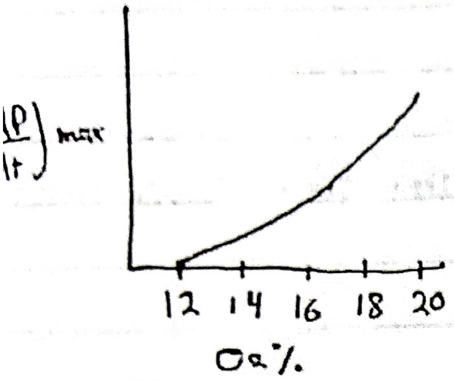
بيتشتعل على 12%
على 11% مابيشتعل

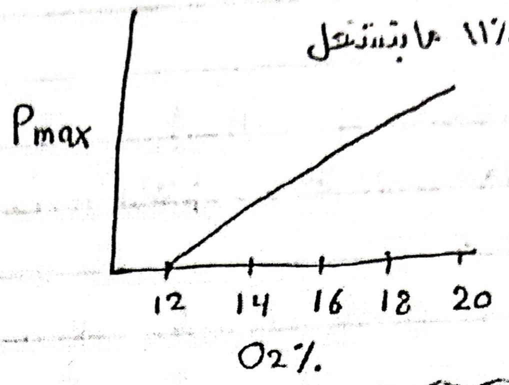
كل ما قلت نسبة O_2 بتقل شدة قابلية الاشتعال

* P_{max} , $(dP/dt)_{max}$ with O_2 %

يشتعل على 12%

على 11% ما بتشتعل





كل ما قلت نسبة O_2 بتقل شدة
لحتى يوصلوا للاشتعال

* Inerting

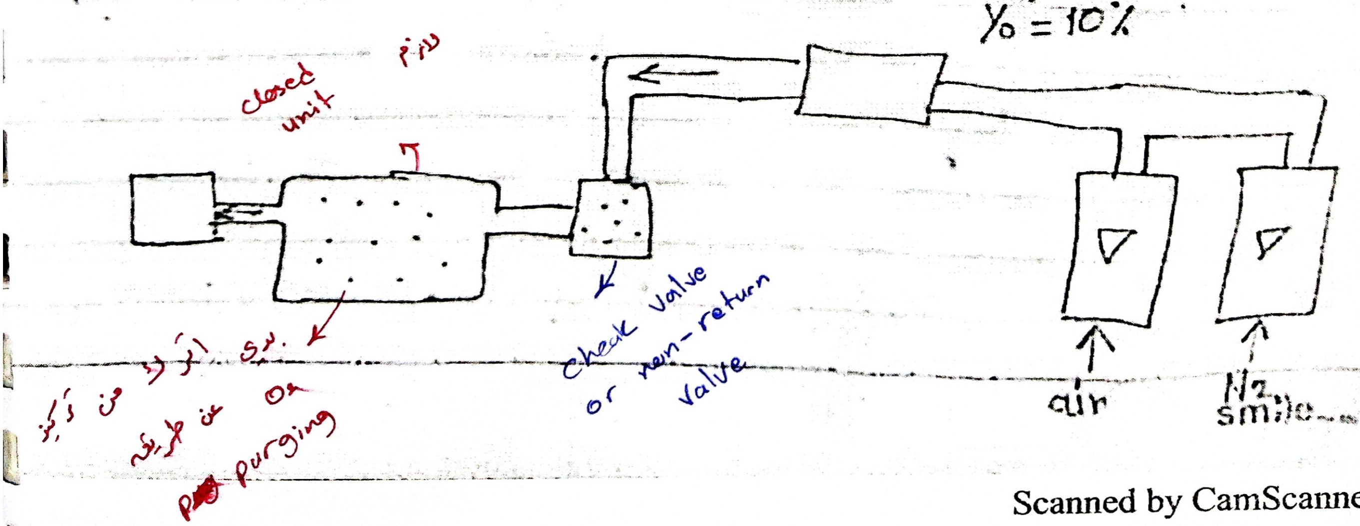
1- inerting with gas N_2, CO_2 ... inert gases
2- inerting with dust
   oil shale
   [clay, sand, stone dust] inert dust
3- Mines
   [gas , coal] Fire triangle.

* inerting with gas

1. initial Purge of the vessel with inert gas
2. flammable material introduce
3. maintain conditions

بعد ما اكون من purge

$Y_O^m = 10\%$



* Vaccum Purging

1- Draw a vaccum on the vessel until the desired vaccum is reached

2- Relieve the vaccum with N_2/ Air mixture

3- Repeat steps 1 and 2 until the desired concentraction reached

بعض اعيد اول خطوتين حتى اوصل للتركيز الي بدي ياه

Use a vacüm purging technique →

To reduce the O_2 within a 1000 gal vessel to 1 ppm, calculate the number of purges required & the total N_2 used

A vacum pump used which reaches ~~20 mm Hg ab~~ 20 mmHg abs

Scanned by CamScanner

ACE Scanner

1 atm = 760 mm Hg = 14.7 psia

1 ft^3 = 7.48 gal

$$\frac{\ln\left(\frac{y_i}{y_o}\right)}{\ln\left(\frac{P_L}{P_H}\right)} = j$$

* Vaccum Purging

1- Draw a vaccum on the vessel until the desired vaccum is reached

2- Relieve the Vaccume with N_2 / Air mixture

3- Repeat steps 1 and 2 until the desired concentraction reached

* Inerting

- Vacuum Purging

Use vacume Purging to reduce the O_2 within a 1000 gal vessel to 1 PPm

$T = 75°C$ vaccume Pump = 20 mmHg abs. vacume relieved with y_o^{m} until

final or low pressure

y_o (initial) = $\dfrac{0.21 \text{ lbmole } O_2}{\text{total moles}}$

* the initial pressure is the atmosphere pressure which equal 1 atm = 760 mmHg

y_f (final) = 1 PPm = 1×10^{-6} $\dfrac{\text{lb mole } O_2}{\text{total mol}}$

$$y_j = y_o \left(\frac{P_L}{P_H} \right)^j$$

حفظ يوجد عدد cycles

$y_j \rightarrow$ concn after j cy

$y_o \rightarrow$ initial concn

$P_L \rightarrow$ initial (low) Pressure

$P_H \rightarrow$ " (high) "

j = # of Purje cycles

No

$$\ln\left(\frac{y_i}{y_o}\right) = j\ln\left(\frac{P_L}{P_H}\right)$$

$$j = \frac{\ln(10^{-6}/0.21)}{\ln(20\,mmHg/760\,mmHg)} = 3.37 \approx 4$$

$$P_L = \left(\frac{20\,mmHg}{760\,mmHg}\right)(14.7\,Psia) = 0.387\,Psia$$

$$\Delta n_{N_2} = j(P_H - P_L)\frac{V}{R_g T}$$

$$= 4(\underset{\text{initial P}}{14.7} - \underset{\text{final P}}{0.387})\,Psia * \frac{1000\,gal\,(1\,ft^3/7.48\,gal)}{\left(\frac{10.73\,Psia \cdot ft^3}{1\,lbmoles\,R^\circ}\right)(75+460)}$$

تحويل من $F^\circ \rightarrow R^\circ$

$$= 1.33\ lb\,moles$$

$* M_w = 1.33\ lb\ moles * \frac{28\ lb}{lb\,mole}$

$= 38\ lb$ of N_2

~~sprinklers~~

* sprinklers

① closed head area system → activites the head indivually
→ storage, lab

② open head area system
(activites the entries sprinklers (Plant area))

Scanned by CamScanner

TABLE 7-8 FIRE PROTECTION FOR CHEMICAL PLANTS[1]

Closed Head Area Systems for small storage areas, laboratories, control rooms, and small pilot plants.

(a) 0.25 gpm/ft² of floor area over an area of 3000 ft² for normal hydrocarbons such as, hexane, ethanol, toluene, etc.
(b) 0.35 gpm/ft² of floor area over an area of 3000 ft² for reactive hydrocarbons, such as styrene, butadiene, ethylene oxide, etc.
(c) For areas greater than 3000 ft² the system is designed for the most hydraulically remote 3000 ft² of the system. For example, if a warehouse area is 10,000 ft², the total water requirement is usually based on the most distant 3000 ft² area.

Open Head Area Systems for process areas including larger pilot plants.

(a) 0.25 gpm/ft² of floor area for normal hydrocarbons such as, hexane, ethanol, toluene, etc.
(b) 0.35 gpm/ft² of floor area for reactive hydrocarbons, such as styrene, butadiene, ethylene oxide, etc.
(c) An area covered is based on a particular hazard or potential spill which could include several vessels.

Deluge Water Spray Systems for vessels, heat exchangers, etc. These systems are similiar to open head area systems.

(a) Same as open head area system above, except area is based on surface area of the vessels covered.
(b) Maximum spacing around perimeter of vessel is 8 feet.
(c) Maximum distance from vessel surface is 2 feet.

Nominal Discharge Capacities of approved sprinklers having a nominal 1/2 inch orifice.

Gpm:	18	25	34	50	58
Psi:	10	20	35	75	100

Fire Monitors (usually fixed)

(a) Rate is 500 to 2000 gpm.
(b) Area coverage is 150 ft radius.

Spacings between Nozzles are based on vendors' specifications.

Piping sizes are based on nozzle specifications, nozzle layout, and conventional hydraulic calculations.

[1] *National Fire Codes*, Vol. I, (Quincy, MA: National Fire Protection Association, 1986); *NFPA Fire Protection Handbook*, 16th ed. (Boston: National Fire Protection Association, 1986); and *SFPE Handbook of Fire Protection Engineering*, 1st ed. (Quincy, MA: National Fire Protection Association / Society of Fire Protection Engineering, 1988).

3- Minimization of dust cloud (MoDC)

4- separation of plant

5- Venting

Containment ⇒ بدي اخلي P محاصر داخل ال Unit

بدي اعرف tensile strength ويكون اكبر من

P_{max} ⇒ حتى تتحمل المادة الإشتعال اذا صار

(MoDC) ⇒

يقسموا الحجرات كل حجرة يكون فيها فتحات

* Protection and Prevention

1- inerting → prevention   الباقي كله protection

2- Containment → احتواء الانفجار

* Sprinkler systems

1- Closed

Activates the head individually

Labs

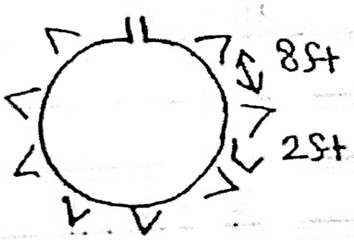
Control room

Storage area

2- Open

Activates

* Deluge system



1- to Keep the Vessel cool

2- Flush away hazardous spills

3- To Knock down gas clouds

4- Enough time to transfer the material to another Place sprinkler

- Determine sprinkler requirements for chemical:
- building Plant 100ft X 30 ft
- Reactive solvents

# of sprinklers?

Pump specefecation

total water requirement

$$= \left(35\ \frac{gpm}{ft^2}\right)(100\,ft \times 30\,ft) = 1050\ gpm$$

$$\#\ \text{of sprinklers} = \frac{1050\ gpm}{34\ gpm/nozzel} = 31\ \text{nozzel} \approx 32$$

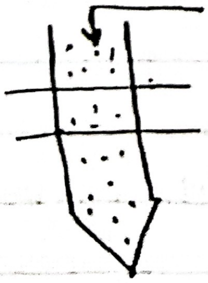
$$\Sigma P = 52\ Psi$$

$$\frac{ft.lbf}{sec} = 52\frac{lb}{in^2} \times \frac{144\ in^2}{ft^2} \times \frac{1050\,gal}{min} \times \frac{min}{60s} \times \frac{ft^3}{7.48\,gal}$$

$$= 17520$$

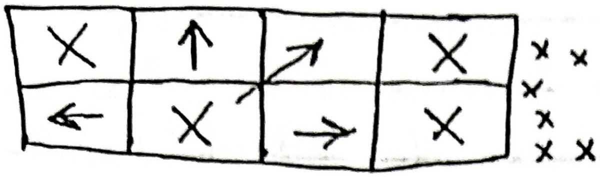
$$HP = 17520\ \frac{ft.lbf}{s} \times \frac{HP}{550\ \frac{ft.lbf}{s}} \approx 32\ HP$$

* minimization of dust cloud

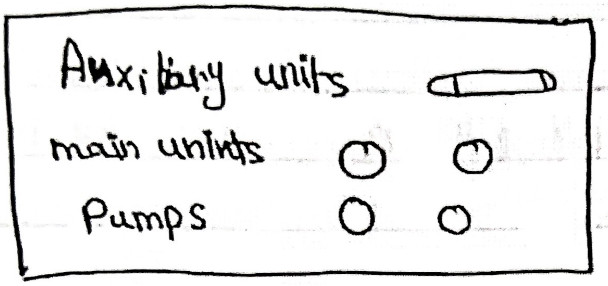


No.

* seperation of Plant



Layout



* Explosion Protection

- These methods are acuated at apre-determined level of explosion severity, ~~Their~~ Techniques of this types include:-

1- explosion relief venting   بطلع ال excess pressure بره
2- explosion suppression
3- isolation   ..ابعد الشاشة... زي
4- contaminated   الوحدات الخطيرة افصلها

ضغط قدر يتحمله المعدن

Explosion prevention

These methods do not Provide the necessary enviroment for the initiation of explosion They include :-

1- inerting by gas /   * ما بدي يكتمل ال fire triangle
2- use of wet Process
3- Elemination of sources of ignition
4- Avoidance of the ~~set~~ suspensions of flammable dust

ال powder يلي بتعامل معه كيف ما اخلي يتطاير

Q1. What happens with loss of cooling, heating or mixing?

Q2. What happens if the Process is contaminated?

Q3. " " if the units is ~~xy~~ engulfed in a fire?

Q4. " " " " operators makes an error?

* Location of reliefs or vent

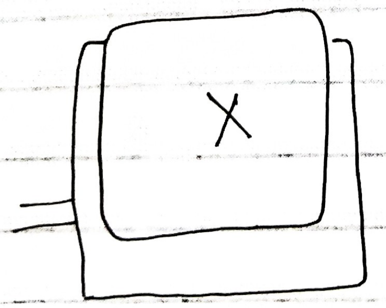
1. All vessel reactors, storagetank, towers, drums
2. Pump/ discharge turbines, line compressors.
3. storage vessels
4. ~~vessel~~ used steam Jackets

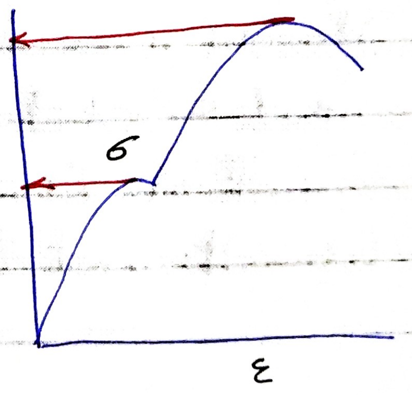
الاساس

* Vent ratio = $\dfrac{\text{Area of Vent } (m^2)}{\text{Volume of Vessel } (m^3)}$

كتابي

* Palmer recommended that the vent ratio should be related to $\left[\frac{dP}{dt}\right]_{max}$ obtained from the hartman test as follows taking into account the diffrences in the ~~explosion~~ explosibility of diffrent dusts





up to $1000\ ft^3$ ($30 m^3$) ~~vent~~

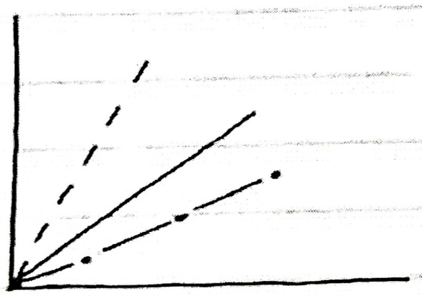
For dusts with diffrent maximum rates of Pressure rise

maximum rate of Presser rise		vent ratio	
lb/in² s	bar/s	ft²/ft³	m²/m³
< 5000	< 345	1/20	1/1.6
5000 - 10000	345 - 690	1/13	1/4.6
> 10000	> 690	1/10	1/3.1

$> 1000\ ft^3$ ($30 m^3$) for dust with max rates of $P < 5000\ lb/in^2$.

Volume range	modification
30 - 300	Vent ratio linearly from ~~1/6~~ 1/6.1 to 1/25
300 - 600	half area of top
> 700	full area of top

vent area (m^2)



Vessel volume (m^3)

$\left(\frac{dP}{dt}\right)_{max}$

--- < 345 bar/s

—— 345.6 bar/s

—·—· > 696 bar/s

(sizing the relief vent area by vent ratio method)

* maximum allowable working Pressure (MAWP)
The maximum gauge pressure at the top of avessel.
(design Pressure)

* operating Pressure
the gauge Pressure during normal services (usually 10% below the MAWP)

* Overpressure
the Pressure increase in the vessel over the set Pressure during the relieving Process.

* Back Pressure :- the Pressure at the outlet of relief device dering the relief Process ~~thr~~ to Pin the dischange system.

* Relief sizing
  - vent area calculation depends upon:

1- types of flow liq, vapor
2- " " relief device spring, rupture disc.

* Steps

Locate reliefs (on the top)

↓

choose relief types

↓

Relief scenarios

↓

Data

↙ ↘

Single Phase | Two Phase

choose worst case scenario مهم اختار اصعب سيناريو

↓

Design relief system

* Relief concepts

1. to Protect Personal
2. to minimize chemical losses
3. to Prevent damage to equipment
4. to " " " ~~adjoining Property~~ adjoining Property
5. to reduce insurance Premiums
6. to comply with local regulations.

* set Pressure : The Pressure at which the relief device begins to activate (10% above operating pressure)

* The vent area
Based on the cubic law

$$A_2 = \frac{A_1 V_2^{2/3}}{V_1^{2/3}}$$

for both Gas and dust

$V_1 \rightarrow$ Volume of the test Vessel (m^3)
$V_2 \rightarrow$ " " " vessel to be Protected (m^3)
$A_1 \rightarrow$ Vent area of the test vessel required to Prevent the Pressure from exceeding a pre-determined Value (m^2)
$A_2 \rightarrow$ Vent area of the Vessel to be Protected which will

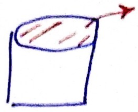
* The Kst classification

* Vents
- Pressure rise too high
- May exceed the max strength of vessel/Pipelines
- Results in rupturing the Process equipment. → تسبب في شرخ
- Causing release of toxic / flammable chemicals.

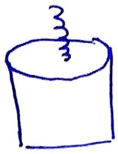
1- (First line of defense)
Prevent accident → امنع الحادث انه يحصل
Better Process control → تحكم بال conditions و بغيرها

2- (Second line of defense)
- install relief systems (vents) befor Pressure are developed
اركب ال vents من قبل ما يزيد الضغط اذا يخرجه لل atmosphere

rupture disc ⇒



اذا زاد ضغطا
تتمزق ويخرج
ضغط الزائد



→ spring operated

* اذا زاد ضغط برتفع ال
spring وبتم تنفيس
الضغط الزائد وبعدها
برجع مكانه

Convential spring operated relief in liq service

conversion factor

$$A = \frac{Q_v}{C_o \sqrt{2 g_c}} \sqrt{\frac{\rho}{\Delta P}}$$

$C_o \rightarrow$ discharge coefficint

تختلف حسب عدة عوامل
لو انت مش عارف عوضها
0.61

velocity

$Q_v = uA$

conversion factor

$$A = \left[\frac{in^2 (Psi)^{1/2}}{38\ gPm}\right] \frac{Q_v}{C_o} \sqrt{\frac{\rho / \rho_{Ref}}{\Delta P}}$$

reference

للحالات دي
spring operated
+ rupture disc

$$A = \left[\frac{in^2 (Psi)^{1/2}}{38\ gPm}\right] \frac{Q_v}{C_o K_v K_P K_b} \sqrt{\frac{\rho / \rho_{Ref}}{1.25 P_s - P_b}}$$

correction

$A \rightarrow$ computed relief area (in^2) — تختلفوا من liq لـ liq او vapor

$K_v \rightarrow$ viscosity correction

$K_P \rightarrow$ overpressure "

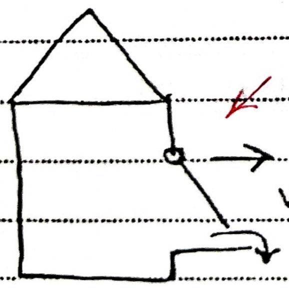
$K_b \rightarrow$ backPressure "

$P_s \rightarrow$ gauge set Pressure

$P_b \rightarrow$ " back "

$Q_v \rightarrow$ volumatric flow through the relief.

* Blowout Panels



جزء من الجدار بيحولو
ك vent
لما يزيد الضغط
بيفتح الـ vent

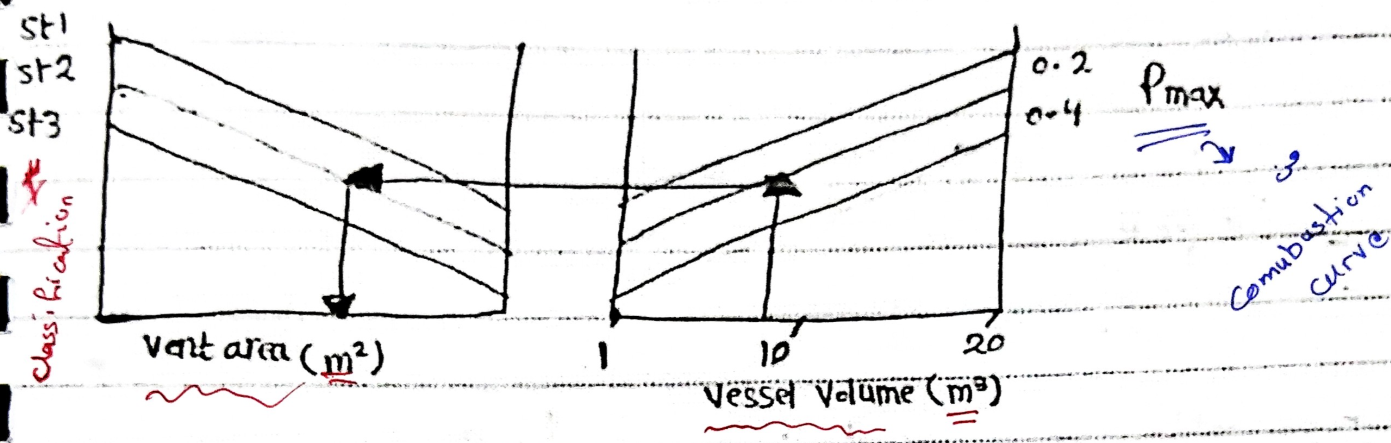
→ بطبقها هنا المثال
كتير في صوامع القمح

walls + Bottom + top

$A = \frac{C_{vent} A_s}{\sqrt{P}}$, A_s → inside surface area of enclosure

C_{vent} → constant ($\sqrt{Psi}$)

* Vessel Volume and Vent area



* Relief Types   * بدك تدور على + thick + type of material + ع منفذ بفتح

• Basis   لازم قبل ما تستخدم إسالة

1- details of relief system → من وين ولوين

2- Process condition → T, P, بدك تطلعه

3- Physical Properties of relief fluid → شو ال fluid إذا طالع هل هو رذاذ ولا powder

• two categories (types)

1- spring operated

2- Rupture ~~discs~~ discs → معدن أو ورقة مقوى

* spring operated

1- Conventional (back Pressure) Minimal. → صغير

2- Balanced bellows: (back Pressure) substantial → كبير

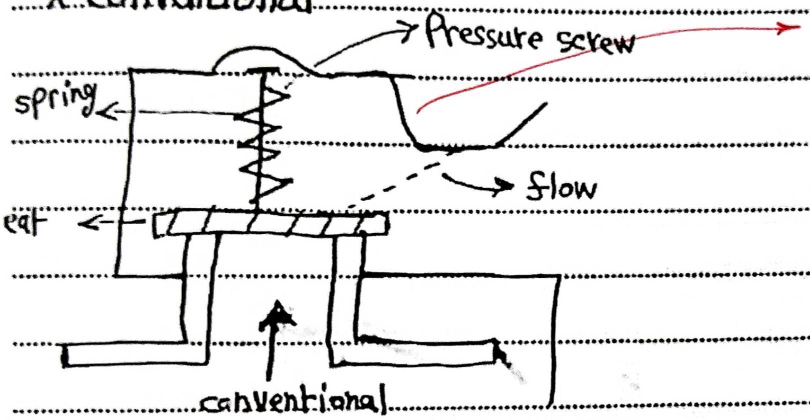
الفروقة حسب ال Back pressure

Subject: for spring just

* Pressure relief

1- Relief valve → for liq service
2- Safty " → " steam, gas, vapor service
3- Safty relief valve → for liq and vapor service

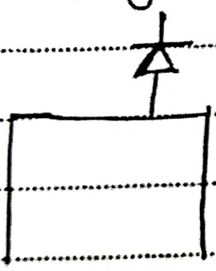
* Conventional



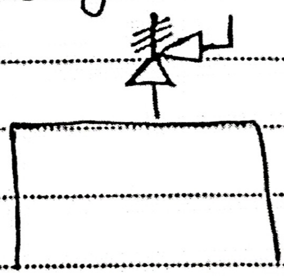
هذا الغطاء ما حدا يغير في اعداداتة
يعني ما حدا يلعب فيه
إلا اذا تغيرت ال Condition يلي جوا

* Drawing

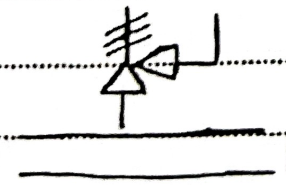
- Piping and instrumentation diagrame:



Rupture disc



spring relief system



Pipe

* يستخدم لل dust explosion

TABLE 7-9 MISCELLANEOUS DESIGNS FOR PREVENTING FIRES AND EXPLOSIONS[1]

Feature	Explanation
Maintenance Programs	The best way to prevent fires and explosions is to stop the release of flammables. Preventative maintenance programs are designed to up-grade system before failures occur
Fireproofing	Insulate vessels, pipes, and structures to minimize damage due to fires. Add deluge systems and design to withstand some damage due to fires and explosions; e.g. use multiple deluge systems with separate shut-offs.
Control Rooms	Design control rooms to withstand explosions.
Water Supplies	Provide supply for maximum demand. Consider many deluge systems running simultaneously. Diesel-engine pumps are recommended.
Control Valves for Deluge	Place shut-offs well away from process areas.
Manual Fire Protection	Install hydrants, monitors, and deluge systems. Add good drainage.
Separate Units	Separate(space) plants on a site, and units within plants. Provide access from two sides.
Utilities	Design steam, water, electricity, and air supplies to be available during emergencies. Place substations away from process areas.
Personnel Areas	Locate personnel areas away from hazardous process and storage areas.
Group Units	Group units in rows. Design for safe operation and maintenance. Create islands of risk by concentrating hazardous process units in one area. Space units so "hot work" can be performed on one group while another is operating.
Isolation Valves	Install isolation valves for safe shutdowns. Install in safe and accessible locations at edge of unit or group.
Railroads and Flares	Process equipment should be separated from flares and railroads.
Compressors	Place gas compressors downwind and separated from fired heaters.
Dikes	Locate flammable storage vessels at periphery of unit. Dike vessels to contain and carry away spills.
Block Valves	Automated block valves should be placed to stop and/or control flows during emergencies. Ability to transfer hazardous materials from one area to another should be considered.
On-line Analyzers	Add appropriate on-line analyzers to (a) monitor the status of the process, (b) detect problems at the incipient stage, and (c) take appropriate action to minimize effects of problems while still in initial phase of development.
Fail Safe Designs	All controls need to be designed to fail safely. Add safeguards for automated and safe shut-downs during emergencies.

[1]John A. Davenport, "Prevent Vapor Cloud Explosions," *Hydrocarbon Processing*, March 1977, pp. 205-214, and Orville M. Slye, "Loss Prevention Fundamentals for Process Industry," *AIChE Loss Prevention Symposium*, New Orleans, LA, March 6-10, 1988.

TABLE 6.1

ESSENTIAL REQUIREMENTS OF A PERMIT TO WORK PROFORMA

ESSENTIAL REQUIREMENTS	EXPANATION OF REQUIREMENTS	REASON/COMMENT
Owner's Identity	Company's name and address in full	The form fulfills a legal requirement and may be required as evidence
Explanatory Title	Name of form	For the purpose of 'in house' identification
Proforma identity	Form serial number/book number etc. 1, 2, 3, 4, 5, 6 etc.	There must be positive identification without repetition
Allowed time	Date work to be done and time from and upto:	This is a simple control requirement
Location of Work	Building, plant area, vessel or equipment identification	It must be positive: avoid colloquial references
Description of Work	What is required to be done, why it is required and how it is to be achieved	Simple statement of requirement and method to be used
Safety requirements	Those precautions which will ensure the safety of persons, plant and product	Must be listed specifically avoid general statements
Authority to start	The signature of a person properly qualified to initiate work	Persons should be specifically identified: not by rank alone
Acceptance of conditions	The signature of the person responsible for the work undertaken.	They are then responsible for others
Acknowledgement of completion	The signature of the persons responsible for (8) above	Restoration of normal functions

TABLE 6.2

DESIRABLE FEATURES OF A PERMIT TO WORK PROFORMA.

DESIRABLE FEATURES OF PROFORMA	EXPLANATION OF REQUIREMENTS	REASON/COMMENT
Cautionary statement	This is a positive reminder to the initiator of the importance to be attached to the document	It is a legally binding document
Advisory statement	This reminds the initiator that the responsibility for introducing effective safety requirements is his/hers	The initiator may delegate this work to others but cannot then delegate responsibility
Recognition of hazard level	This is a positive method of making the initiator aware of high risk situations	Relates to both place of work and nature of work
Acknowledgement of high hazard risk	High risk situations often require and warrant more than a single viewpoint	Consideration by and input from, other disciplines warranted
Indication of work progress	Commencement of work may often reveal a far greater job content than was originally envisaged	Provides an opportunity for job close down and re-appraisal
Location of completed form	It is desirable to indicate where permits should be displayed	Pockets, files etc. do not provide for simple references to the stated requirements. Less possibility of inter-action between 2 jobs going on unrecognised.