POLÍMEROS

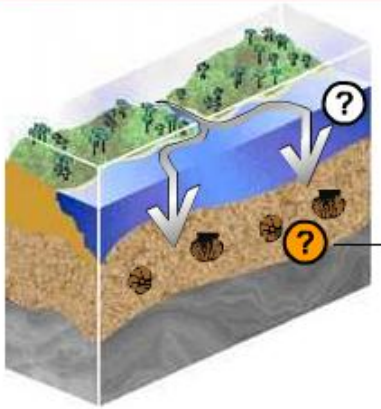
Julio Alberto Aguilar Schafer

Formación geológica del petróleo

Formación del Petróleo

HOW ARE OIL AND GAS FORMED?

Oil and gas (hydrocarbons) are found in sedimentary basins.



Sedimentary rocks with organic material are source rocks. The "source" of hydrocarbons, they can be coal or shale.

HOW ARE OIL AND GAS FORMED?

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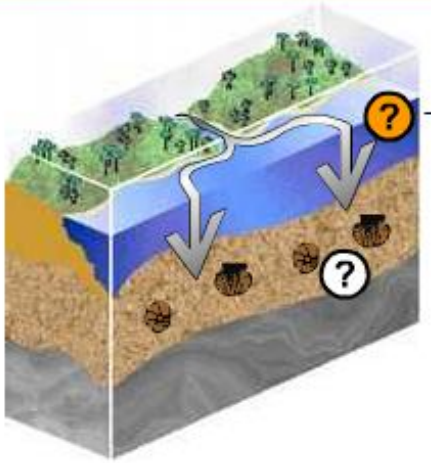
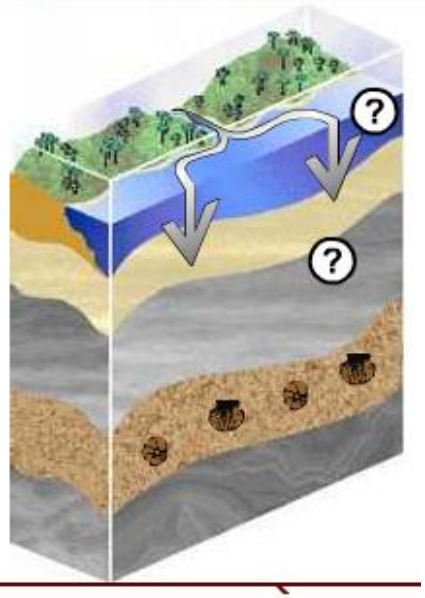


The type of organic material determines whether oil or gas is formed

HOW ARE OIL AND GAS FORMED?

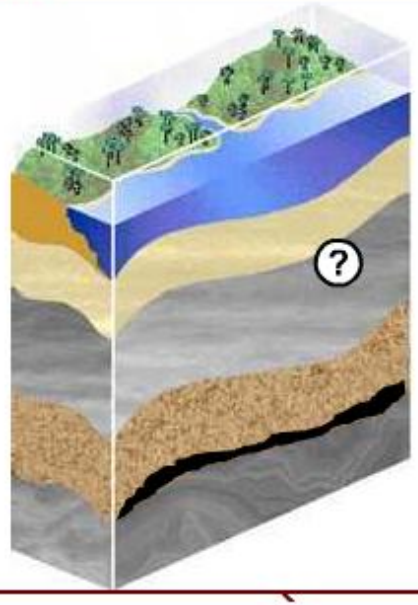
Oil and gas (hydrocarbons) are found in sedimentary basins.

Millions of years ago dead plants and microscopic animals (organic material) were deposited in sedimentary basins with mud, sand and other sediments. Over time the sediments were compacted and transformed into layers of sedimentary rock.



HOW ARE OIL AND GAS FORMED?

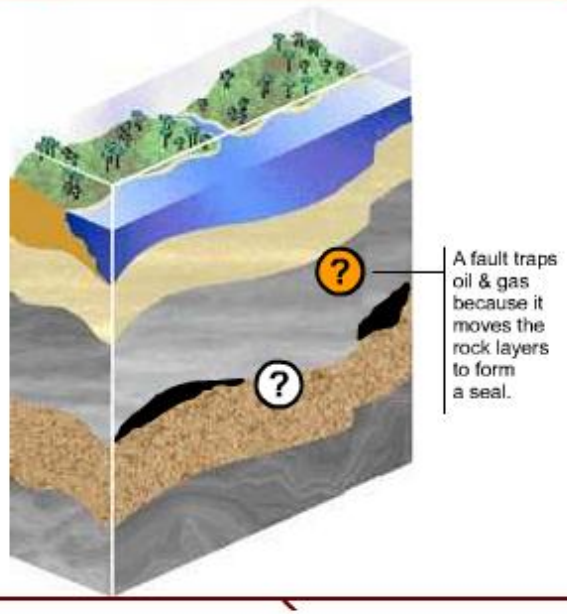
Oil and gas are formed by the thermal conversion of organic matter trapped in source rocks. This happens when source rocks are buried deeper and the temperature rises and pressure increases.



HOW ARE OIL AND GAS FORMED?

To form an oil or gas field, oil and gas must leave the source rocks and move through the pores and spaces of permeable rock or along minor fractures and fault lines.

If oil and gas are not trapped in a reservoir formation they will escape to the earth's surface as a seepage.



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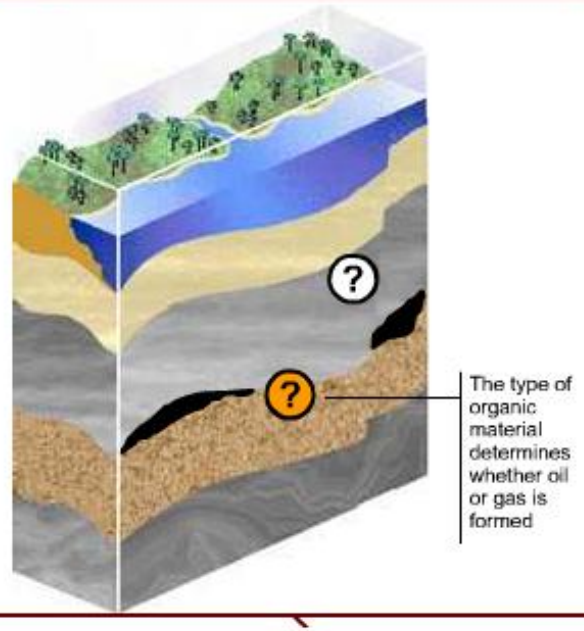
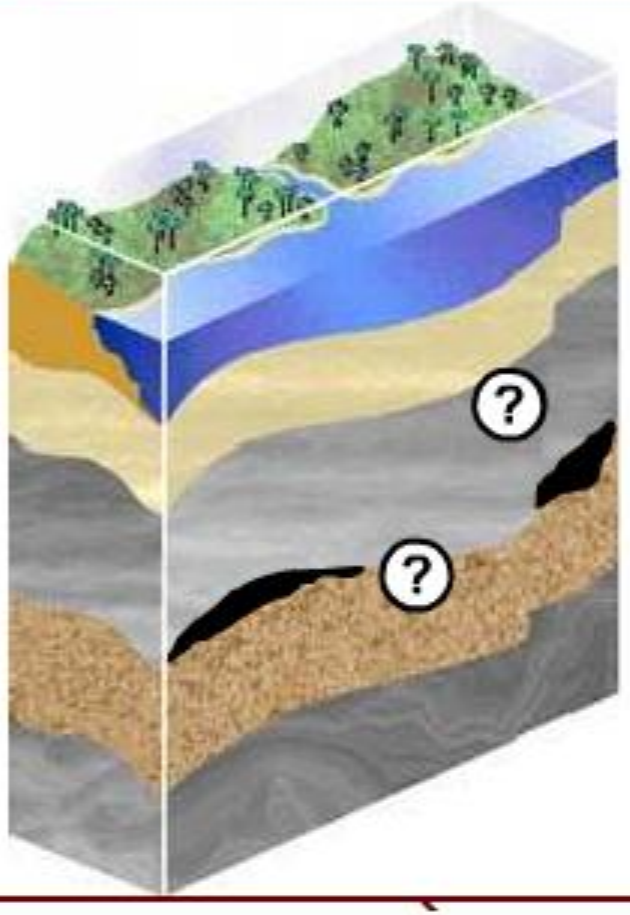


HOW ARE OIL AND GAS FORMED?

Oil or gas fields are found in subsurface geological features called traps. For a trap to be effective it needs reservoir rock to hold the oil and gas and seal rocks to contain it.

Oil and gas are not a liquid lake but are contained in the reservoir rocks' pores.



Localización de Petróleo

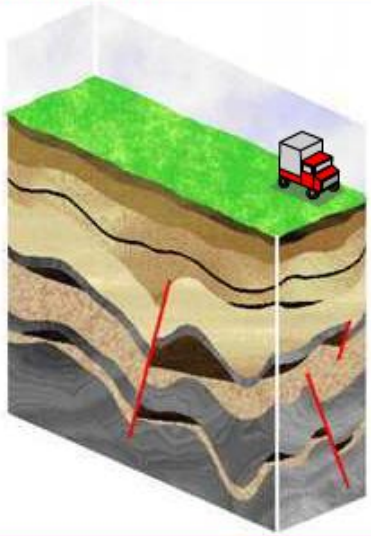
Magnetometría aerea

Localización de Petróleo

HOW ARE OIL AND GAS DEPOSITS LOCATED?

Scientists use geology and geophysics to "see" what is happening beneath the earth.

Seismic surveying is important. It can be performed on land and sea using different equipment. There are always three components:



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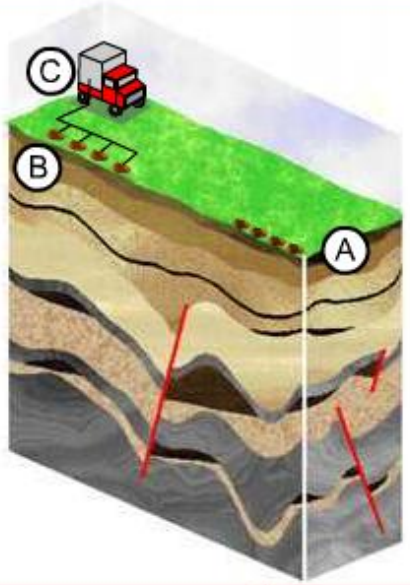
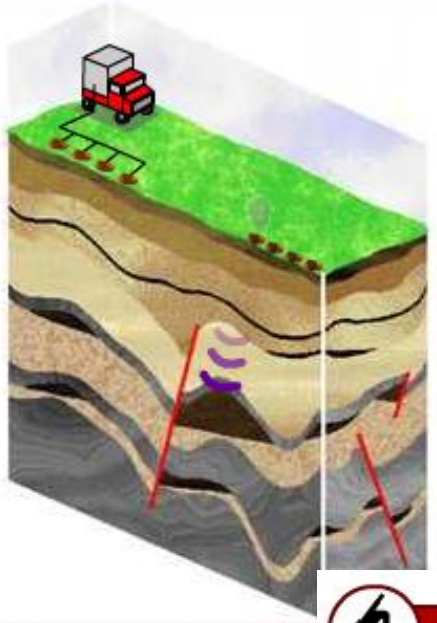
A. **a seismic source**
B. **sensors**
C. **recording equipment**



HOW ARE OIL AND GAS DEPOSITS LOCATED?

Scientists create a "picture" of the structure of the rock layers by measuring the time it takes energy waves to reach the surface.



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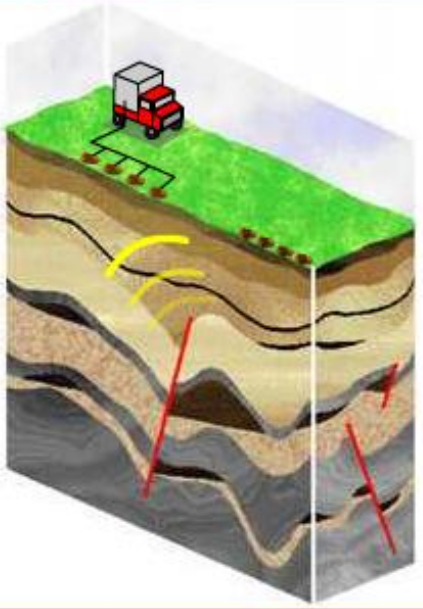

HOW ARE OIL AND GAS DEPOSITS LOCATED?

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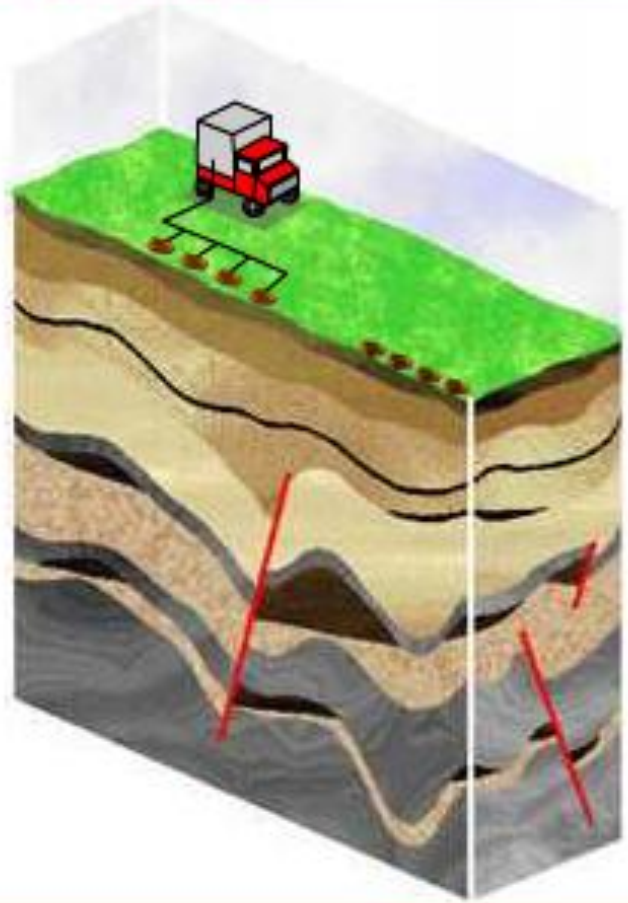
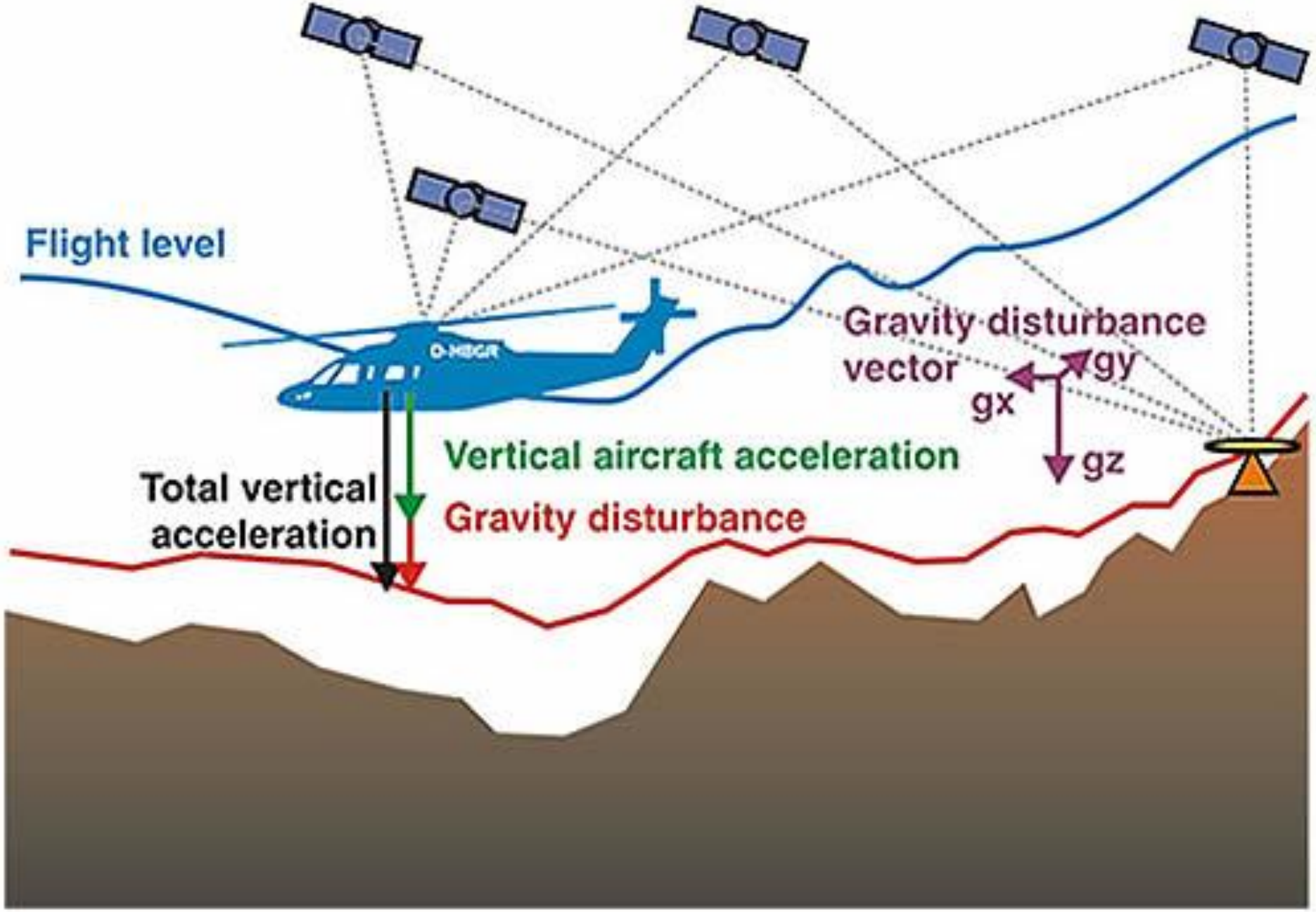
Once the seismic data is collected it must be processed and carefully interpreted to decide whether further testing is needed or if exploration can begin.




Flight level
D-HBGR
Gravity disturbance vector
gy
gx
gz
Vertical aircraft acceleration
Total vertical acceleration
Gravity disturbance

Camión Vibrador

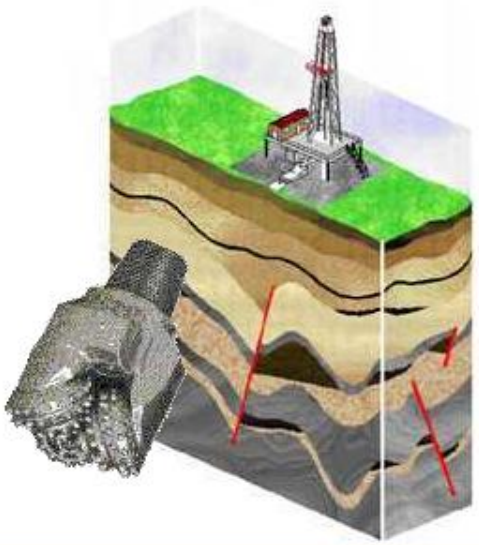
Perforadora de mesa giratoria y brocas

Cómo es descubierto

HOW ARE OIL AND GAS DISCOVERED?

The most common drilling technique is the rotary drilling system - a highly efficient mechanical system used on land and sea.

When seismic surveys and other data indicate that oil and/or gas could be present an exploration or 'wildcat' well will be drilled.



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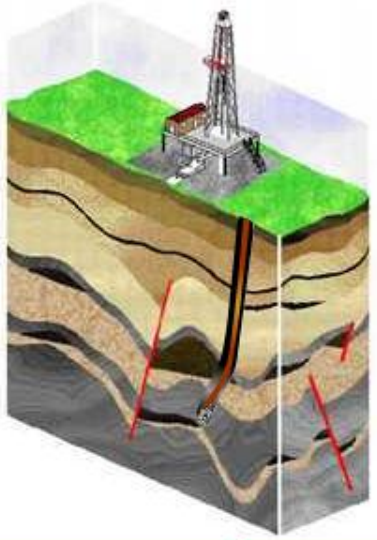
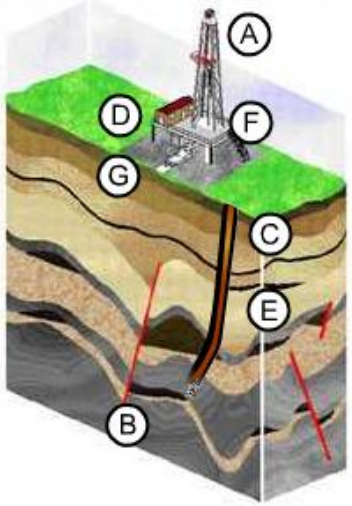


HOW ARE OIL AND GAS DISCOVERED?

A rotary drilling rig is made up of :

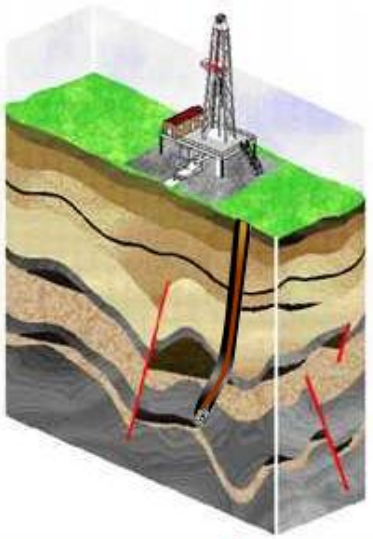
A. Hoisting equipment
B. Drilling bit
C. Drill pipe
D. Rotary equipment
E. Mud circulating treating equipment
F. Blowout prevention system
G. Power source



HOW ARE OIL AND GAS DISCOVERED?

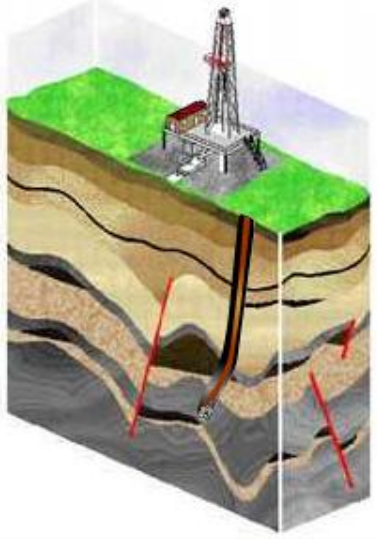
Drilling is a round-the-clock operation. A drilling supervisor leads a team of experts who work in shifts.

Wells are usually drilled vertically but can be drilled at an angle . This technique, called directional drilling, is used for a variety of reasons. A major advancement is horizontal drilling which drills along a reservoir and increases production.

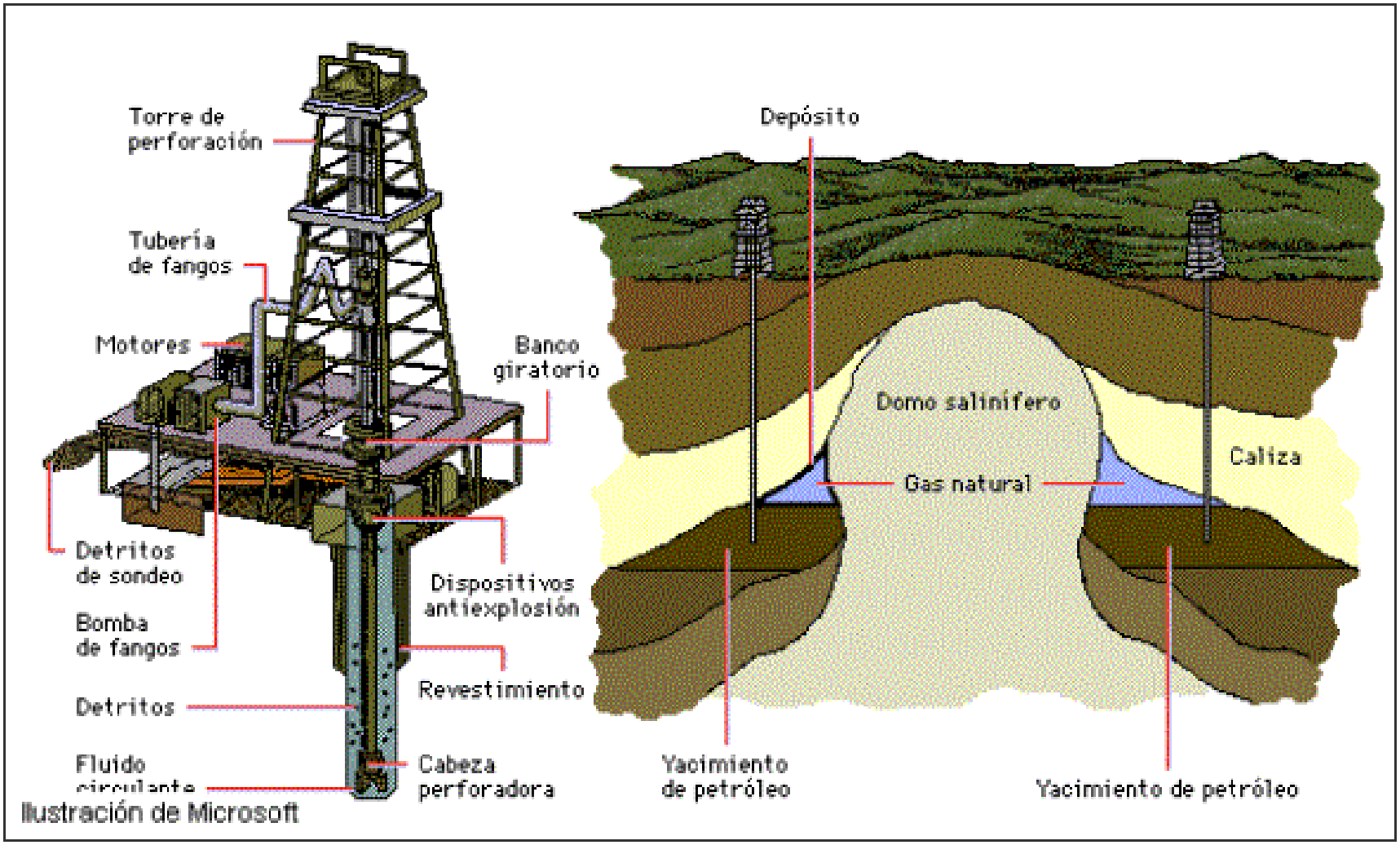


HOW ARE OIL AND GAS DISCOVERED?

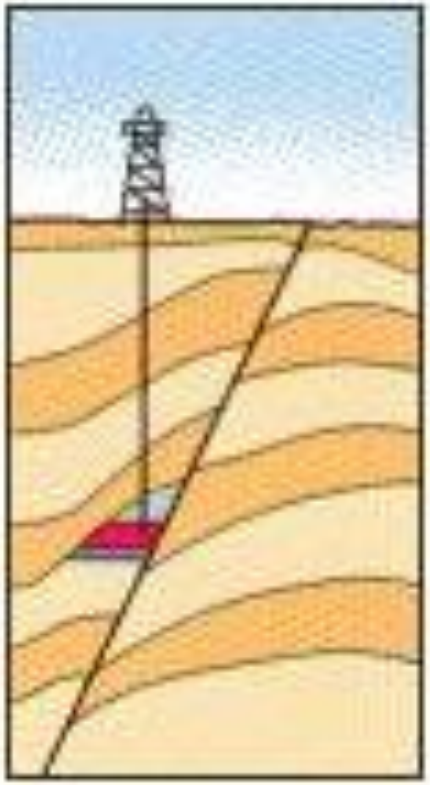
As the drill nears its final depth, engineers, geologists and management have to decide if there is enough oil and gas for the well to be completed or if it should be abandoned as a 'dry hole.'



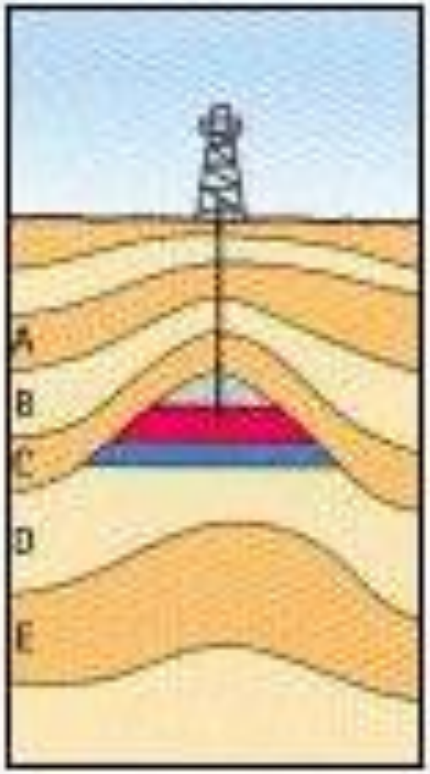
Extracción del petroleo



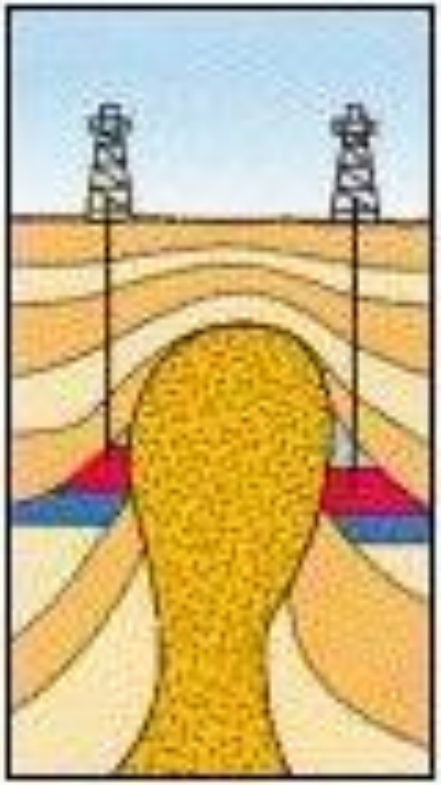
TRAMPAS MAS COMUNES



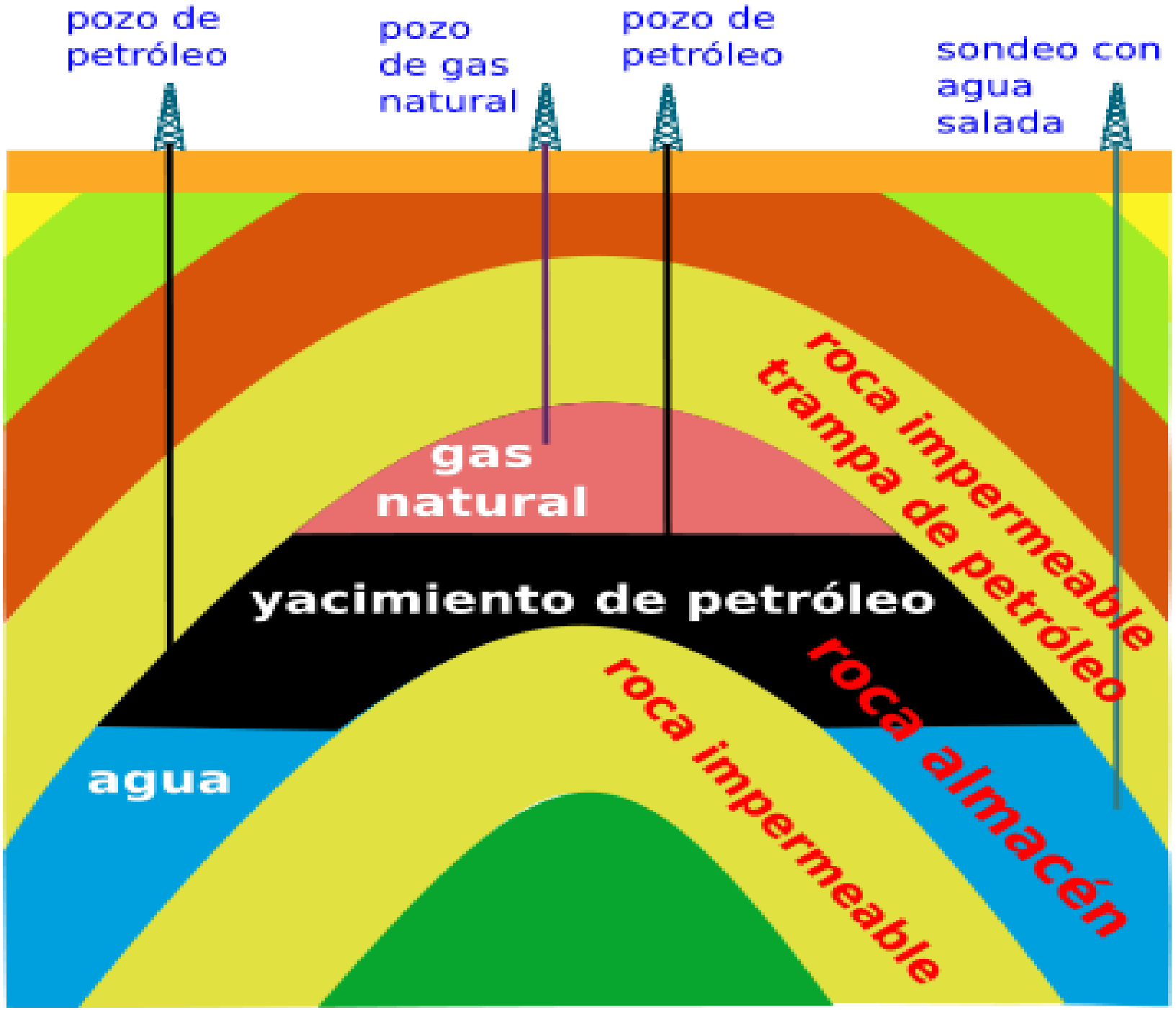
TRAMPA POR FALLA



TRAMPA POR PLEGAMIENTO



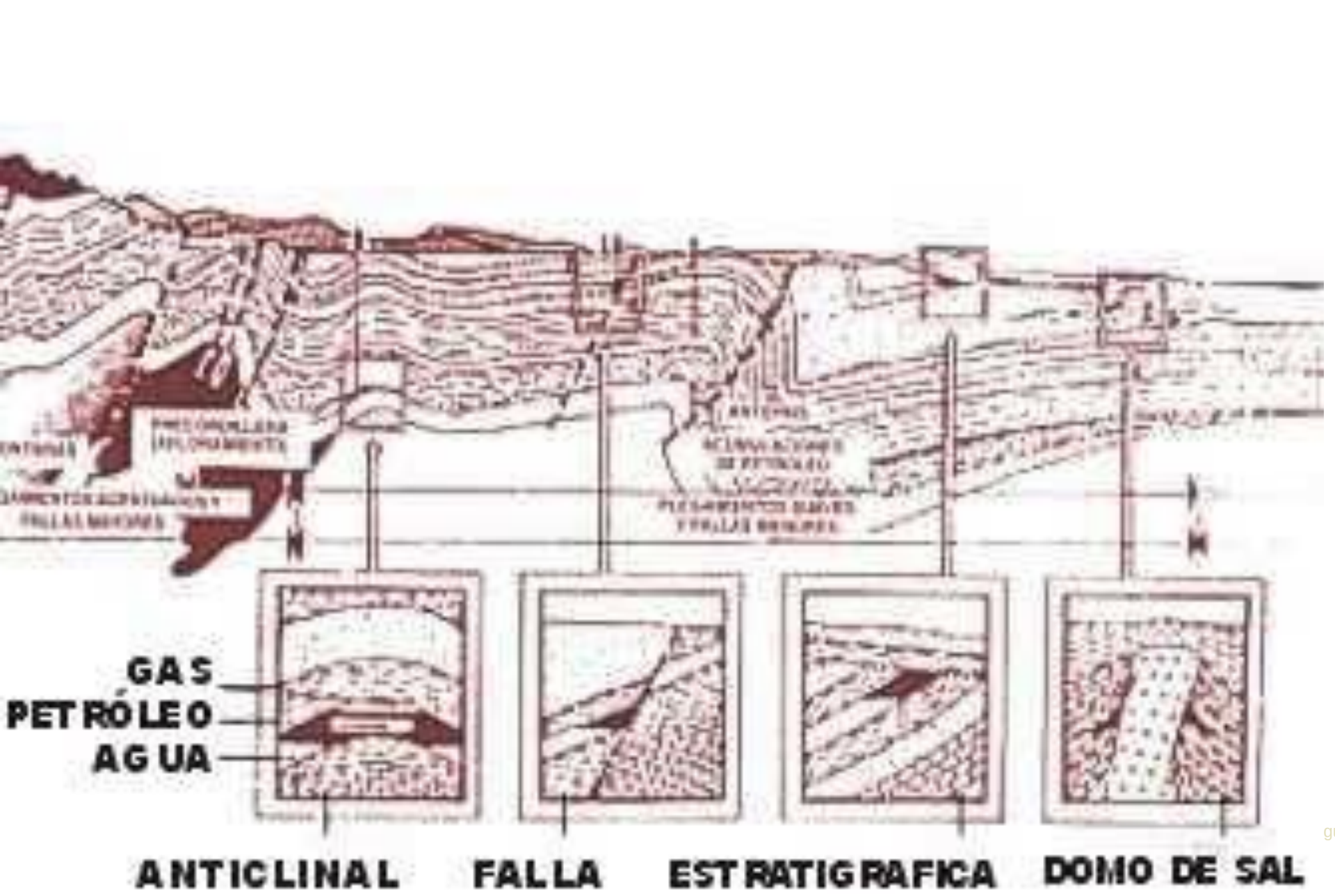
TRAMPA COMBINADA (PLEGAMIENTO, FALLA Y DOMO)

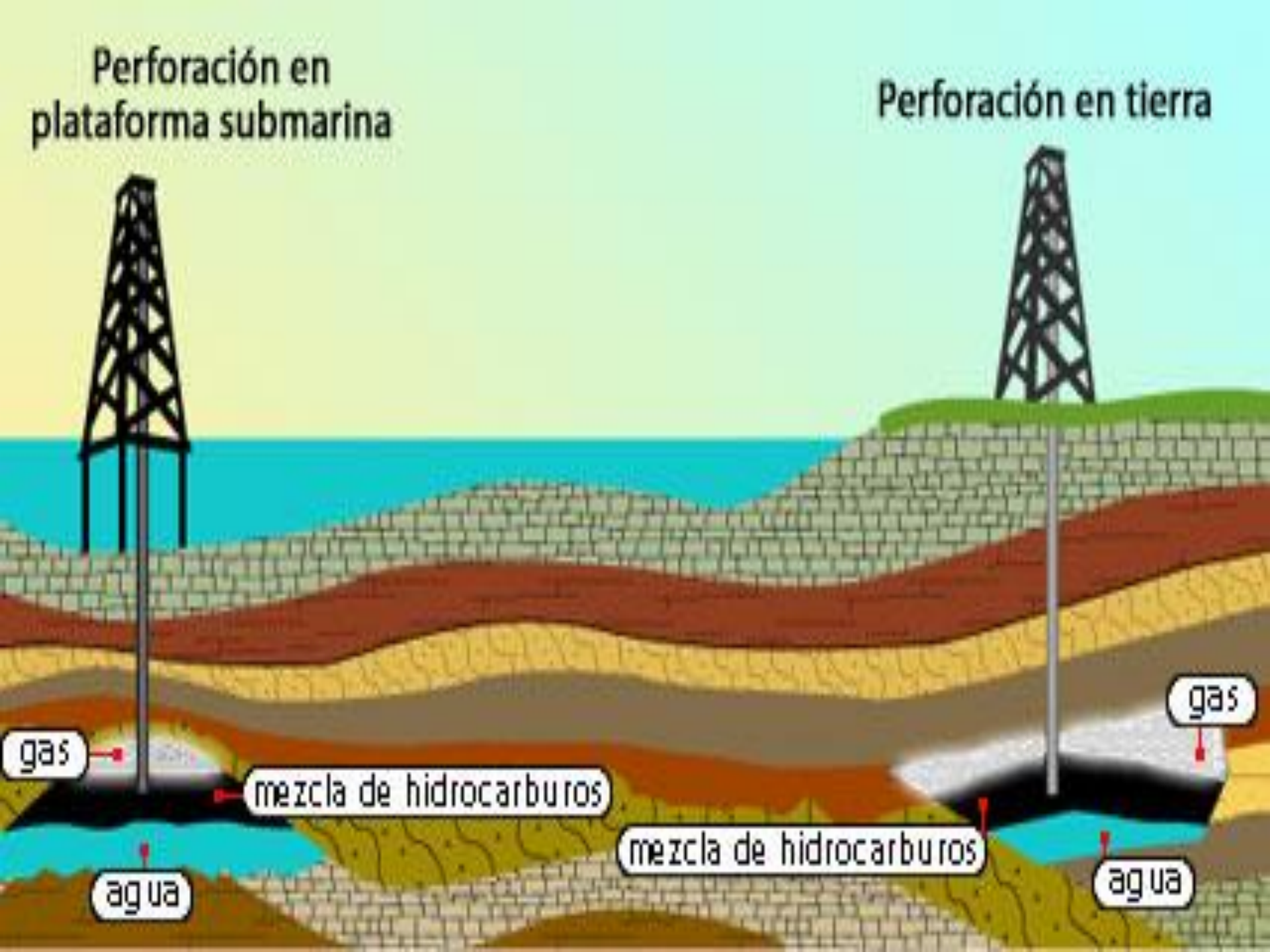

pozo de petróleo
pozo de gas natural
pozo de petróleo
sondeo con agua salada
gas natural
yacimiento de petróleo
agua
roca impermeable trampa de petróleo
roca almacén
roca impermeable

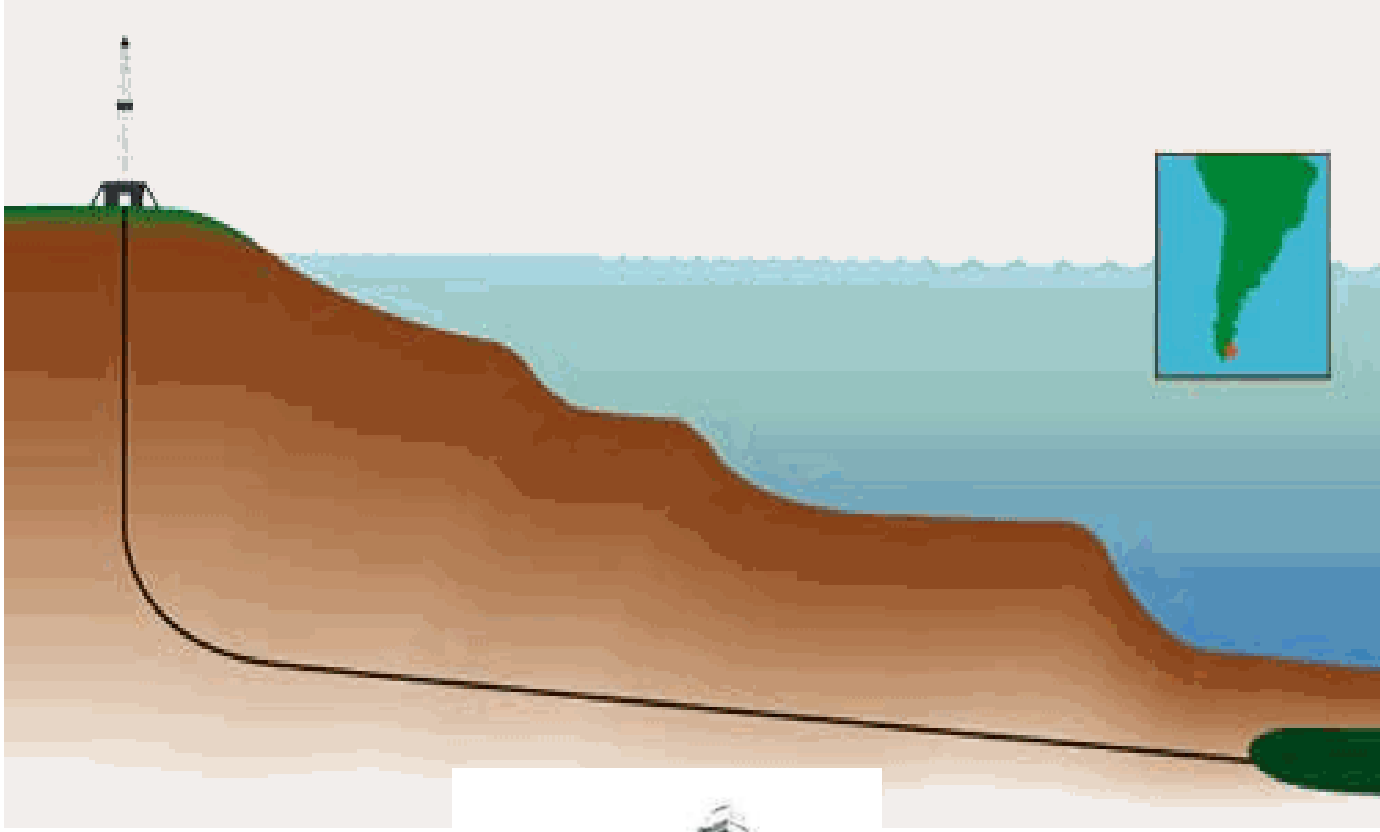
TRAMPAS DEL PETROLEO

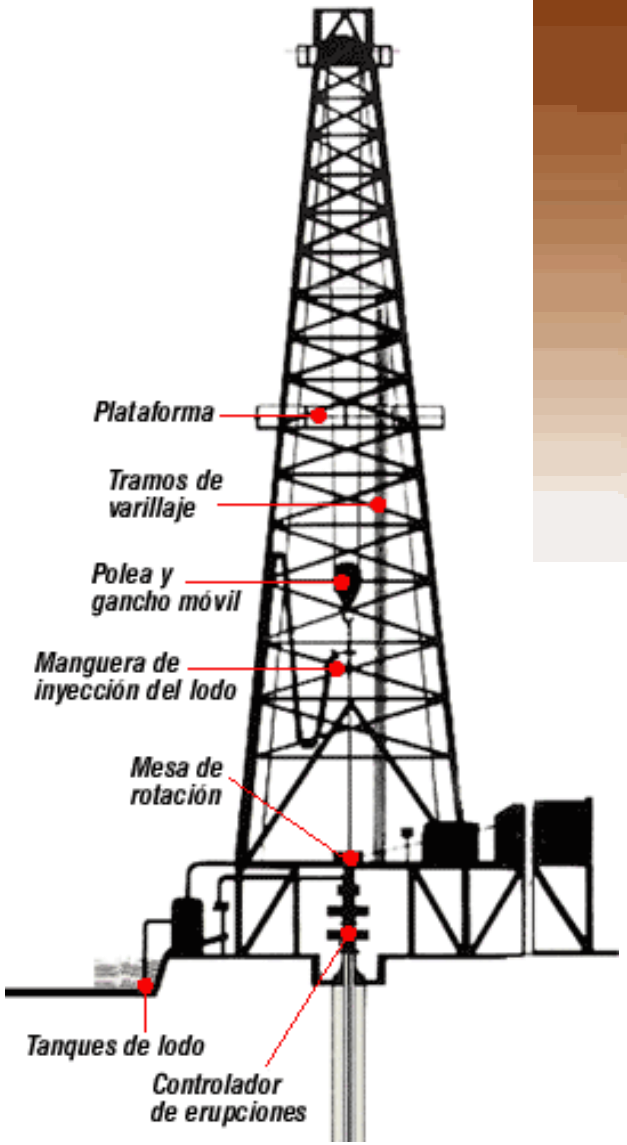
MARGA
CONGLOMERADO
ARENISCA
ARCILLA
CALIZA
DOMO DE SAL
FALLA
LENTES DE ARENA
ROCA ALTERADA
PLIEGUES
PETROLEO - GAS

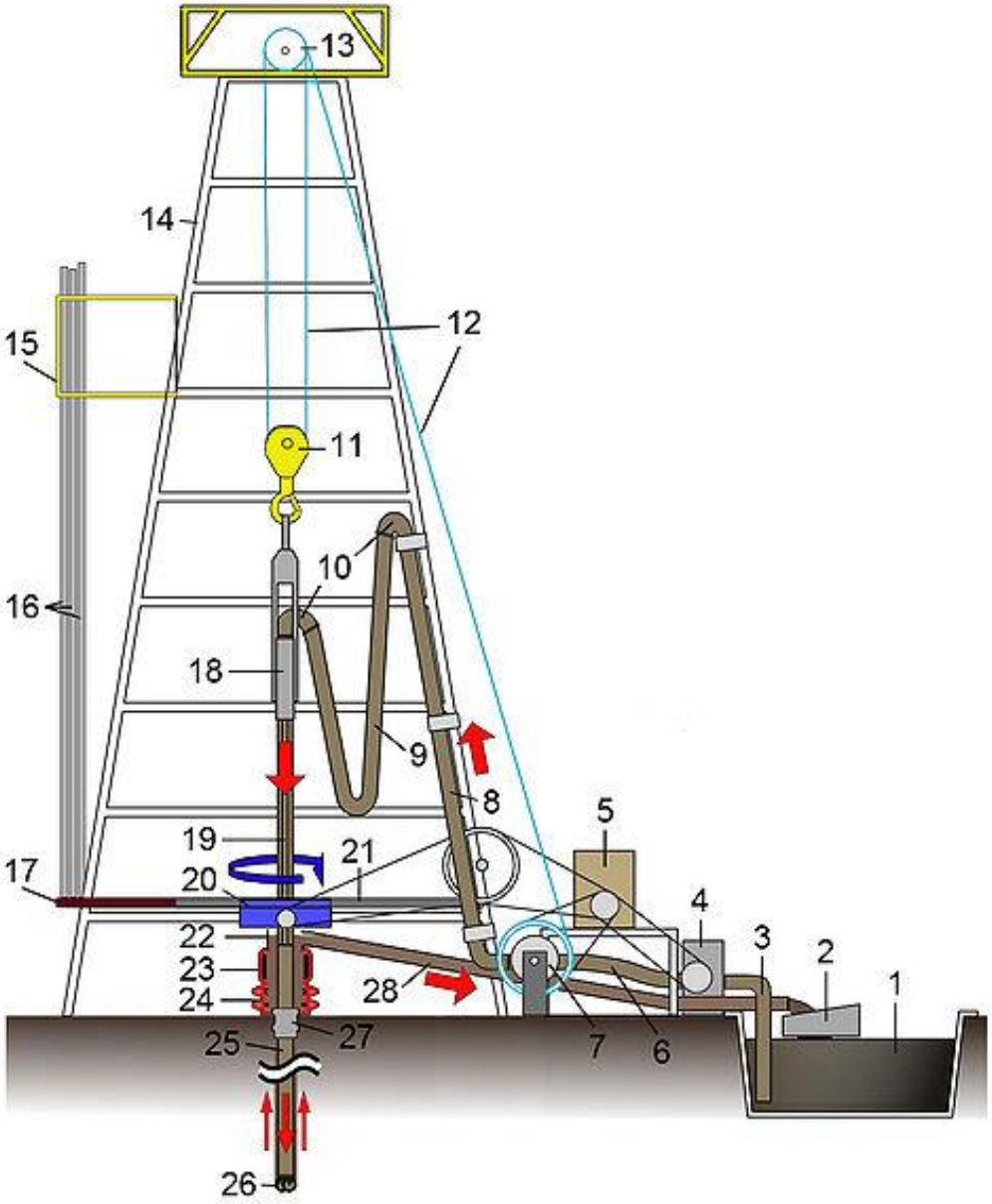
TRAMPAS DE PETRÓLEO


GAS
PETRÓLEO
AGUA
ANTICLINAL
FALLA
ESTRATIGRAFICA
DOMO DE SAL


Perforación en plataforma submarina
Perforación en tierra
gas
mezcla de hidrocarburos
agua
mezcla de hidrocarburos
gas
agua

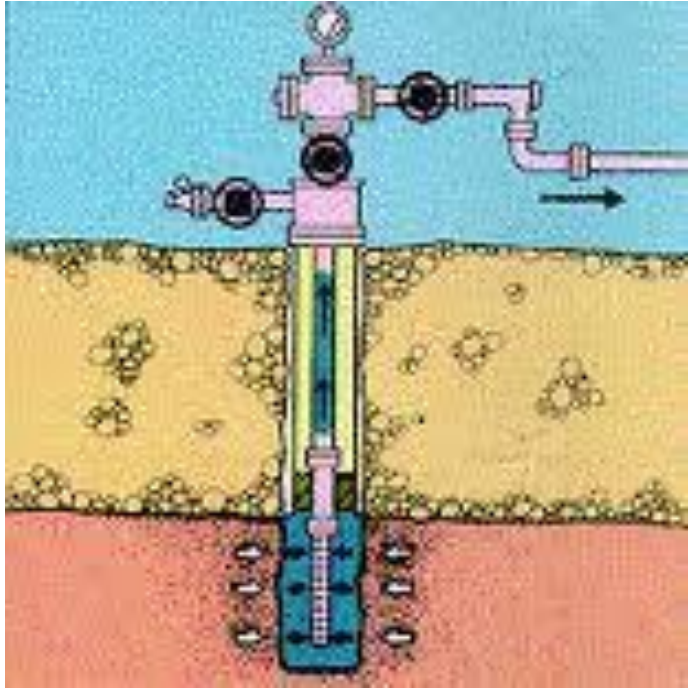


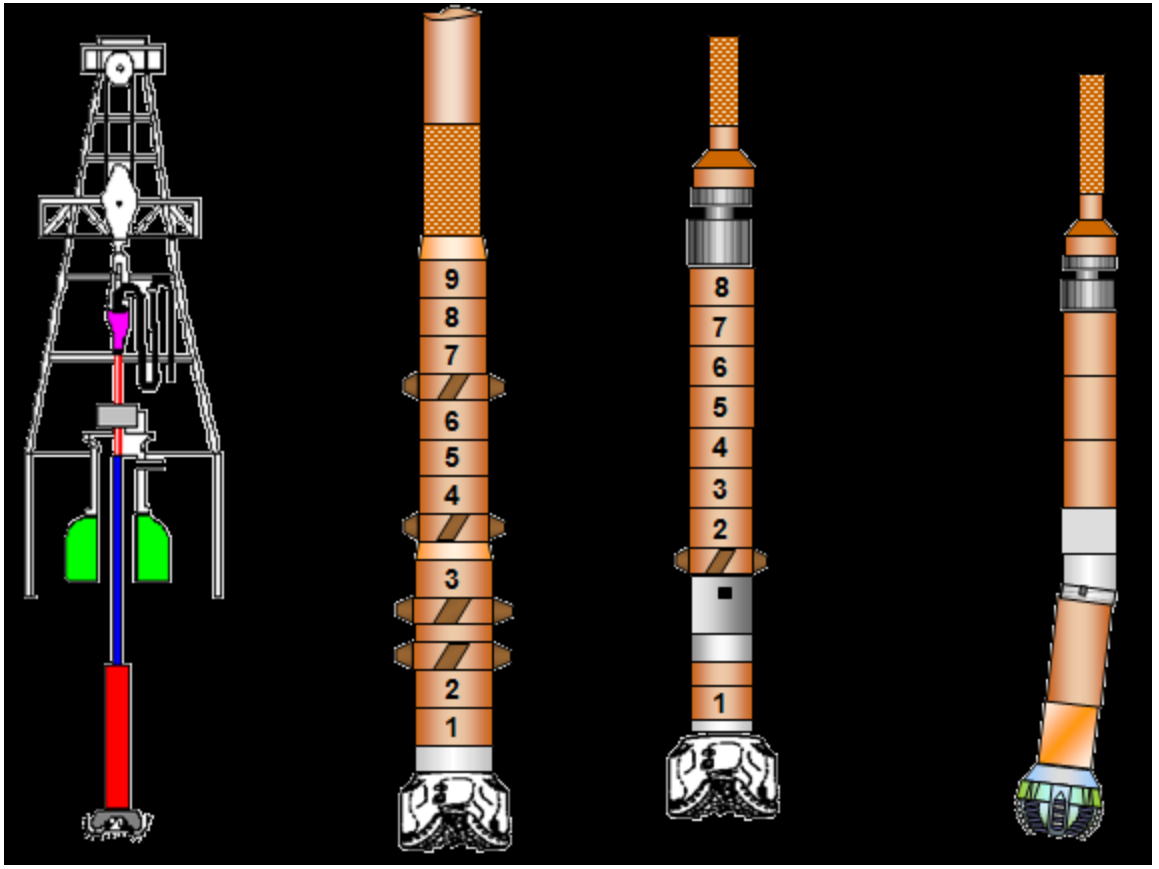

Plataforma
Tramos de varillaje
Polea y gancho móvil
Manguera de inyección del lodo
Mesa de rotación
Tanques de lodo
Controlador de erupciones

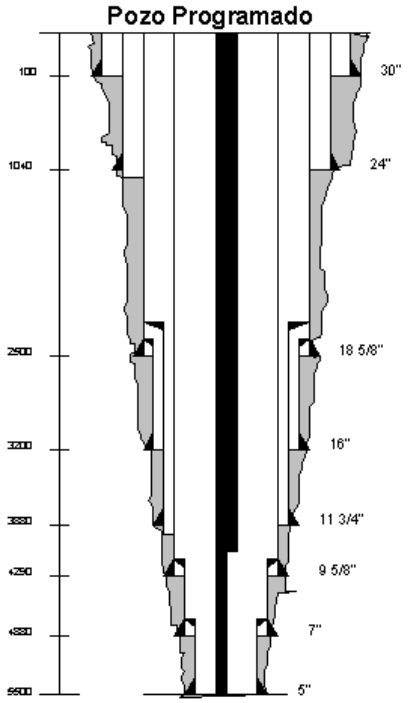


Identificación de la Fig. (Equipos usados en la Perforación de Pozos)

1. Tanque de lodo
2. Agitador de arcilla
3. Succión de lodo.
4. Bomba de lodo
5. Motor
6. Manguera de bomba
7. carrete de aparejo
8. Cañeria de lodo
9. Manguerote
10. Cuello de ganso
11. Aparejo
12. Cable de aparejo
13. Bloque corona
14. Estructura
15. Piso del enganchador
16. Tiros
17. Rack
18. Conexión giratoria de lodo
19. Barra de perforación
20. mesa rotativa
21. Piso de perforación
22. Bell niple
23. Valvula BOP anular
24. Valvula BOP ciega de cañeria
25. Sarta de perforación
26. Trépano
27. Cabeza del casing
28. Linea de retorno del lodo.




9
8
7
6
5
4
3
2
1
8
7
6
5
4
3
2
1


Pozo Programado
100
1040
2500
3200
3680
4250
4680
5600
30"
24"
18 5/8"
16"
11 3/4"
9 5/8"
7"
5"

Para mejorar el porcentaje de extracción (de 25% a 33% promedio) se utilizan dos procesos:

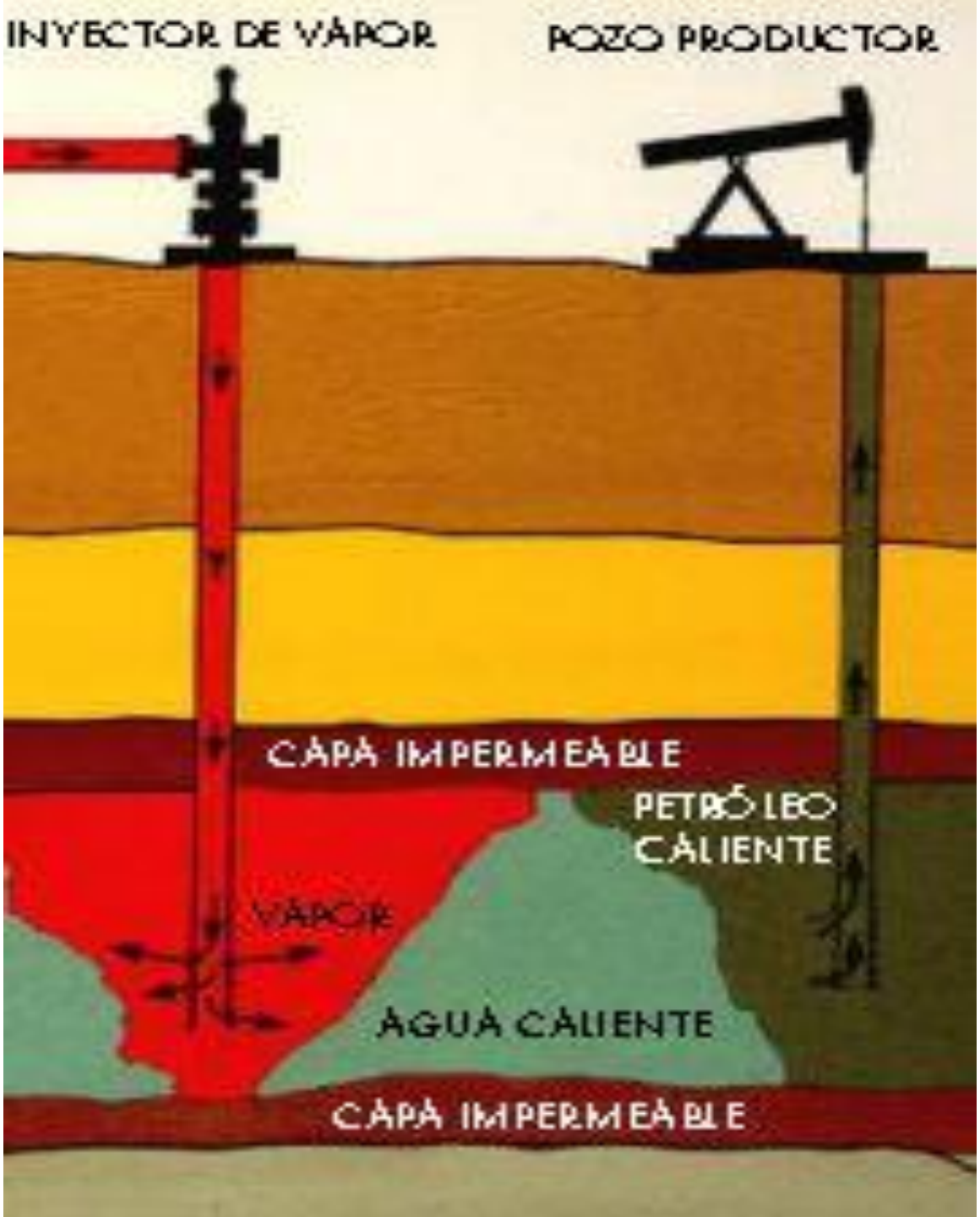
- Inyección de Agua:

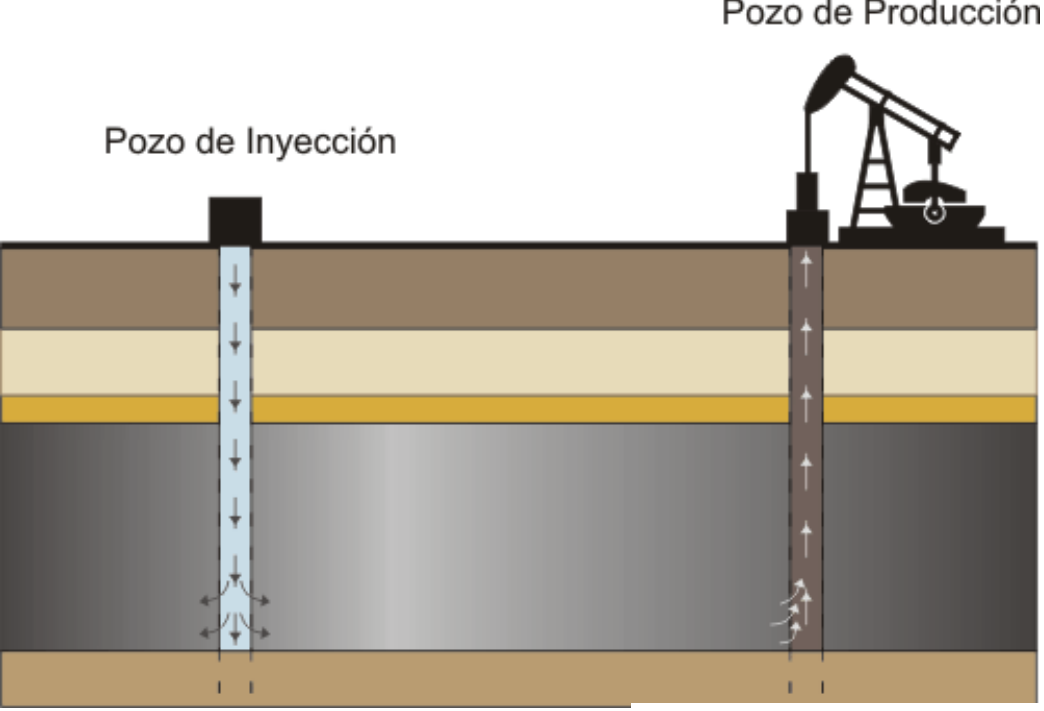
  Se bombea agua hacia el yacimiento para mantener o aumentar la presión. También aumenta el ritmo de producción.

- Inyección de Vapor:

  Se emplea en depósitos de petróleo muy viscoso. Reduce la viscosidad.


mape


INYECTOR DE VAPOR
POZO PRODUCTOR
CAPA IMPERMEABLE
PETRÓLEO CALIENTE
VAPOR
AGUA CALIENTE
CAPA IMPERMEABLE


Pozo de Producción
Pozo de Inyección

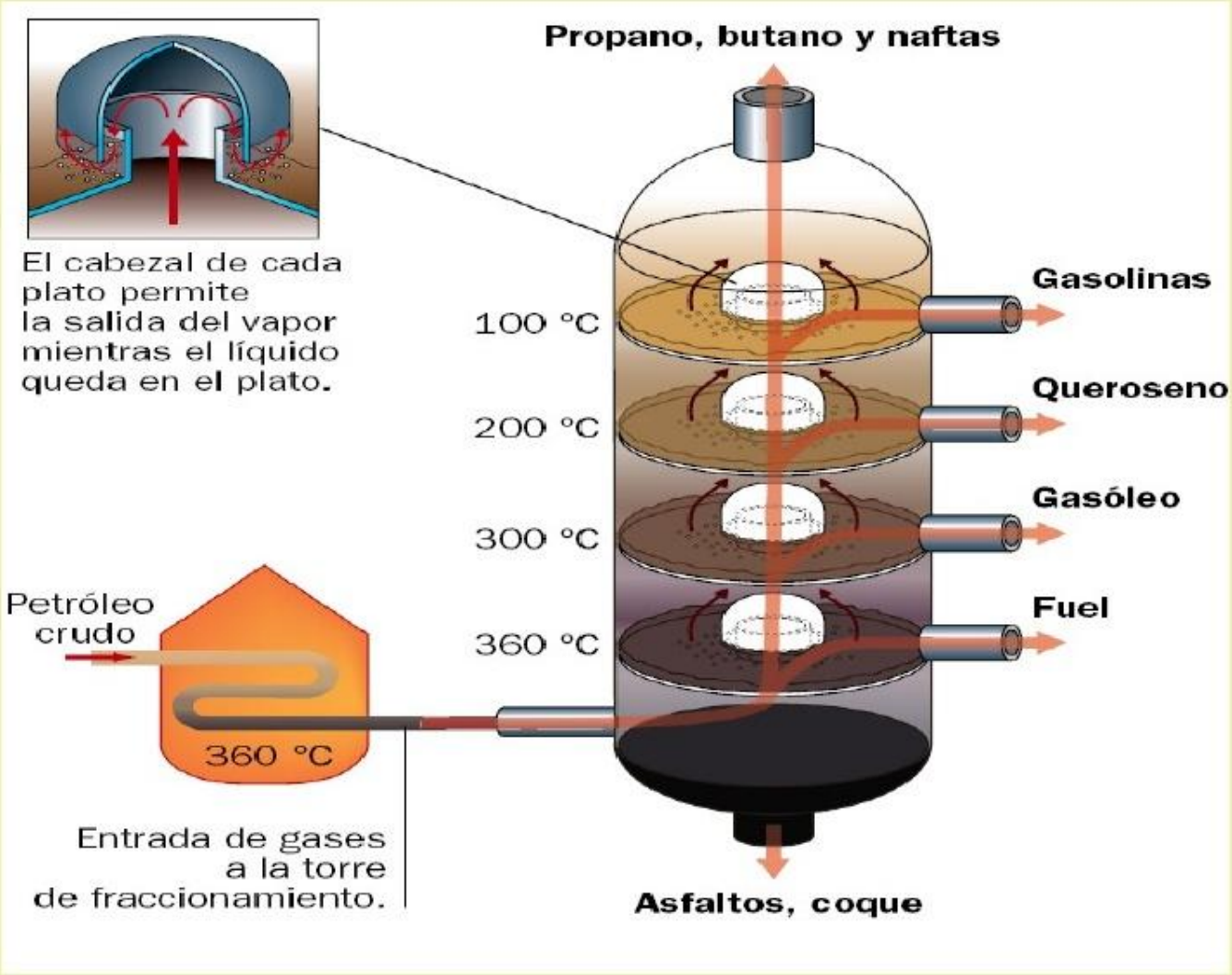

Pozo de Producción
Pozo de Inyección
Dióxido de Carbono
Inyección de Agua
Agua de Conducción
CO_2
Agua
CO_2
Zona Miscible
Banco de Petroleo
Recuperación de Petroleo Adicional

El oleoducto de Alaska (EEUU) transporta petróleo desde el campo de petróleo de la bahía de Prudhoe hasta los petroleros que atracan en el sur de Alaska. El oleoducto recorre 1.270 km de tierras deshabitadas y transporta hasta dos millones de barriles diarios de la costa ártica al golfo de Alaska.

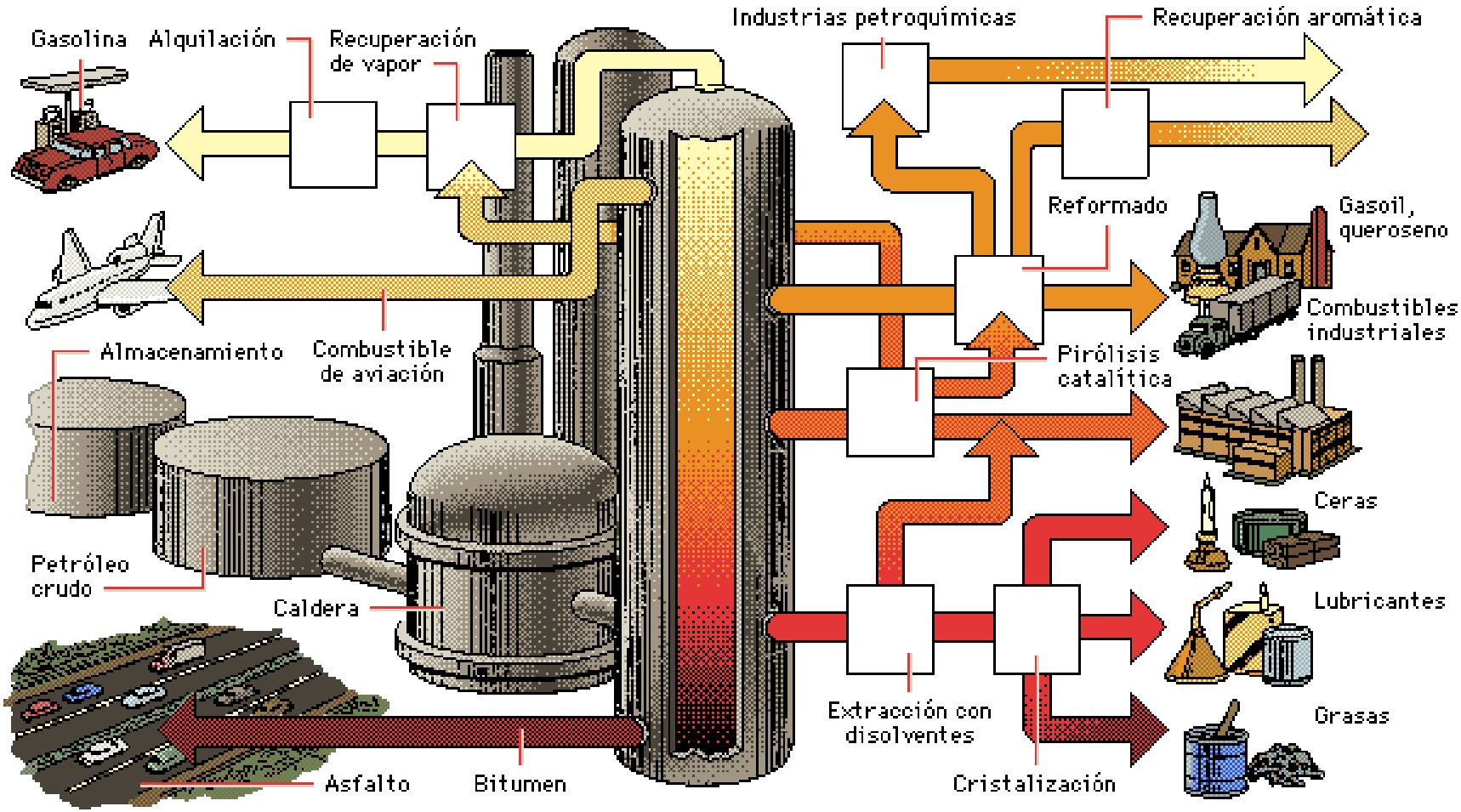
REFINACIÓN

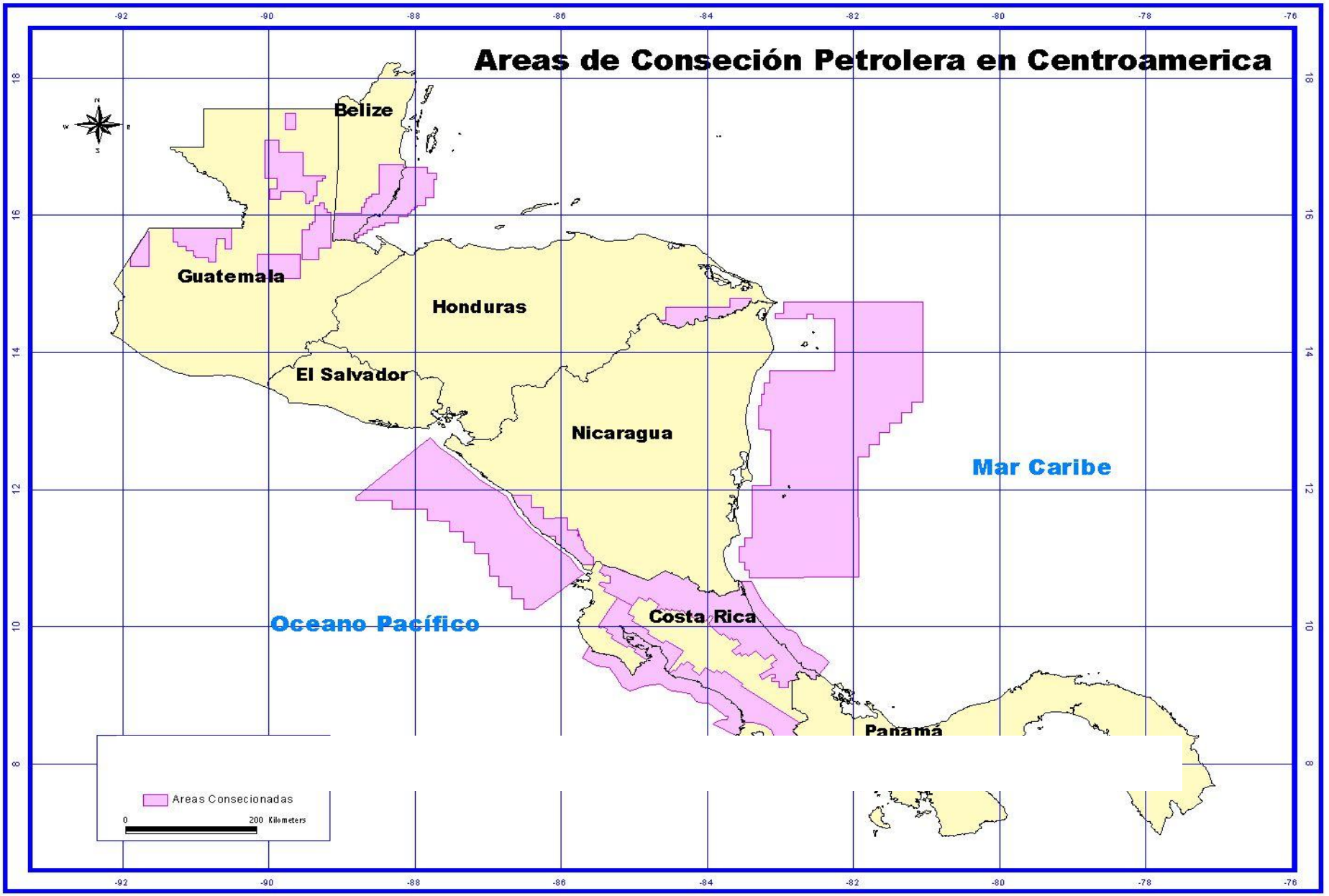
- Esta operación sólo suministra productos en bruto, que deberán ser mejorados para su comercialización.
- Hoy, un barril de crudo produce 79,5 litros de gasolina, 11,5 litros de diesel, 34 litros de gasoil y destilados, 15 litros de lubricantes y 11,5 litros de residuos más pesados.

Destilación fraccionada

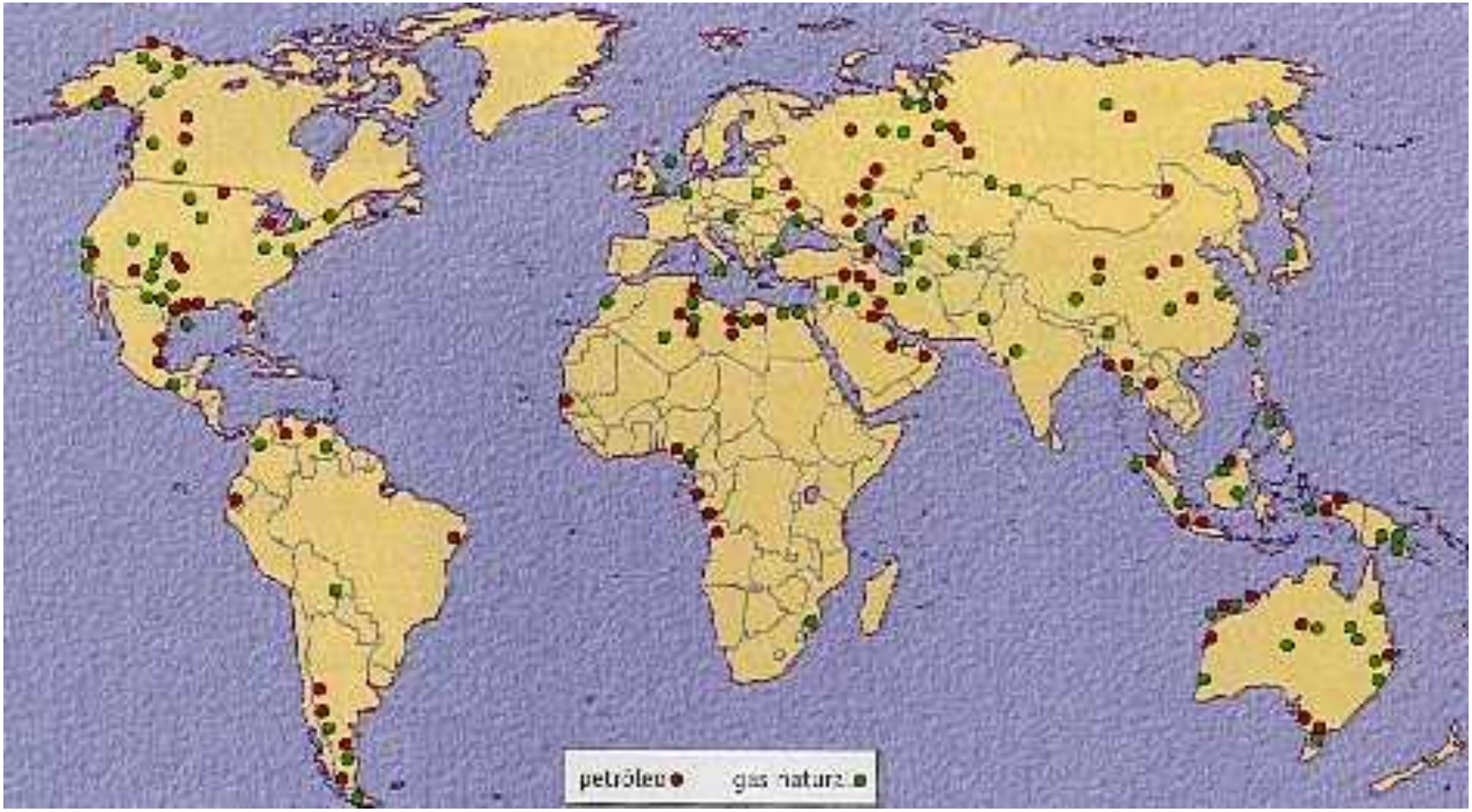


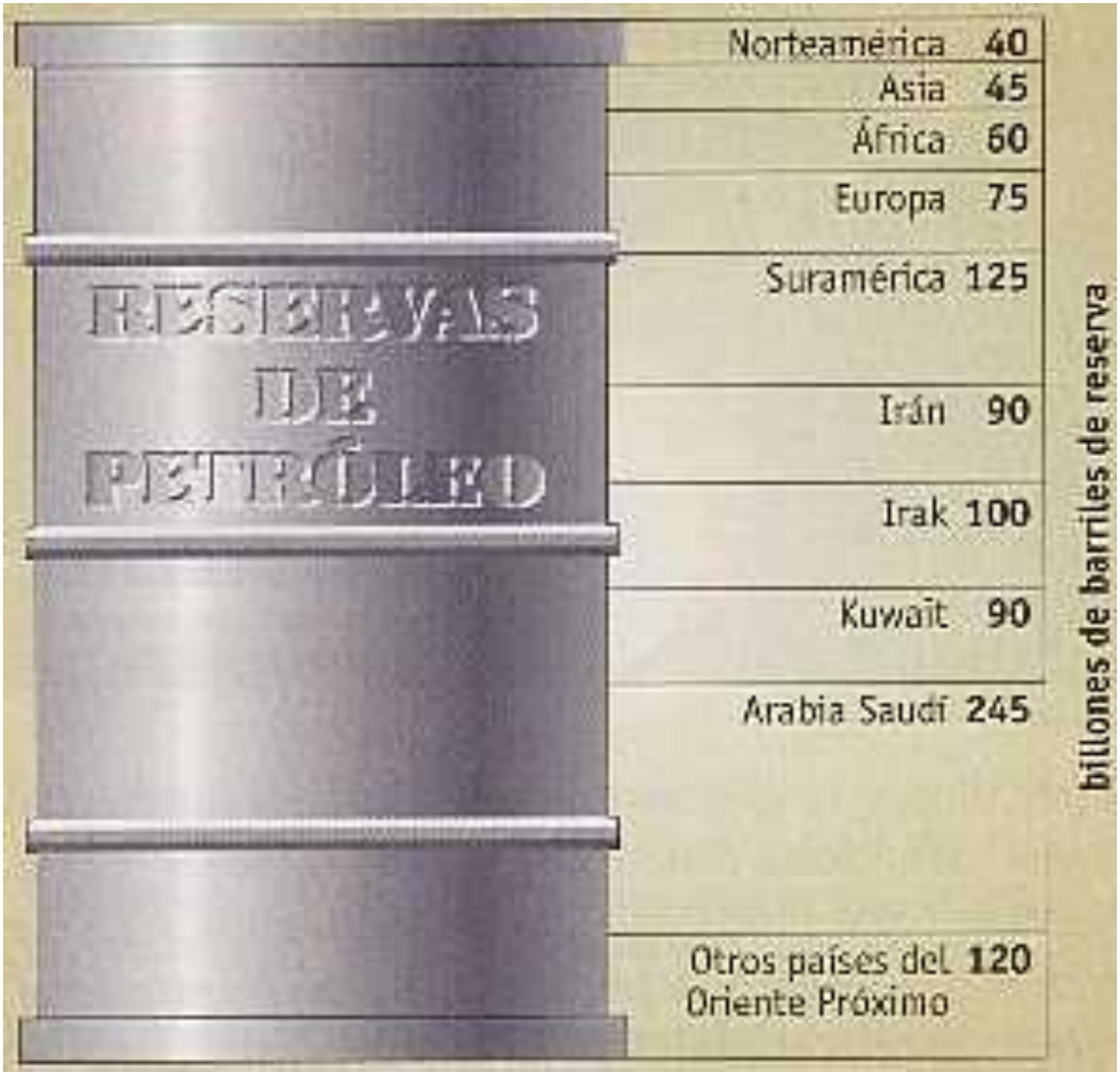
SISTEMA DE DESTILACIÓN DE HIDROCARBUROS



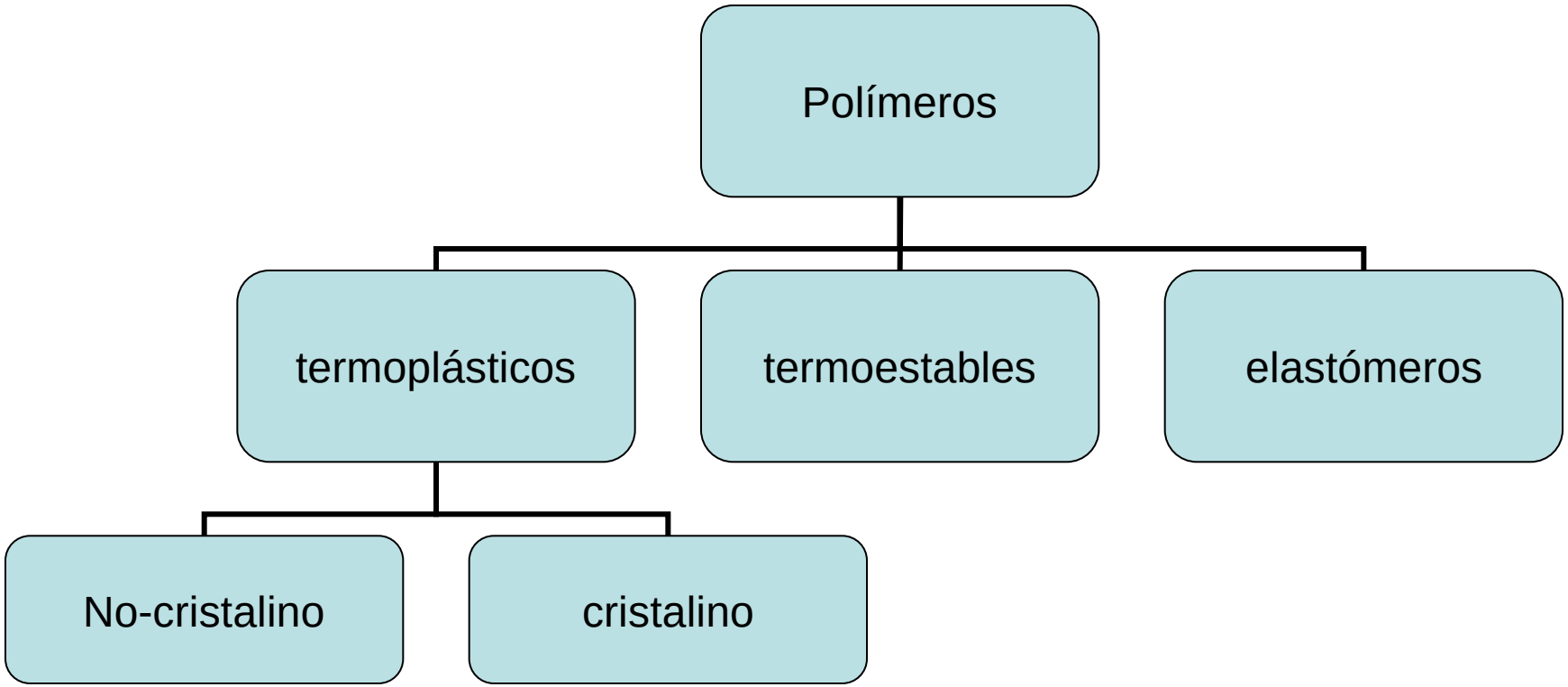

Areas de Conseción Petrolera en Centroamerica
Belize
Guatemala
Honduras
El Salvador
Nicaragua
Costa Rica
Panamá
Mar Caribe
Oceano Pacífico
Areas Consecionadas
0
200 Kilometers
-92
-90
-88
-86
-84
-82
-80
-78
-76
18
16
14
12
10
8

Países productores de petróleo




RESERVAS DE PETRÓLEO
Norteamérica 40
Asia 45
África 60
Europa 75
Suramérica 125
Irán 90
Irak 100
Kuwait 90
Arabia Saudí 245
Otros países del Oriente Próximo 120
billones de barriles de reserva

Clasificación de los polímeros

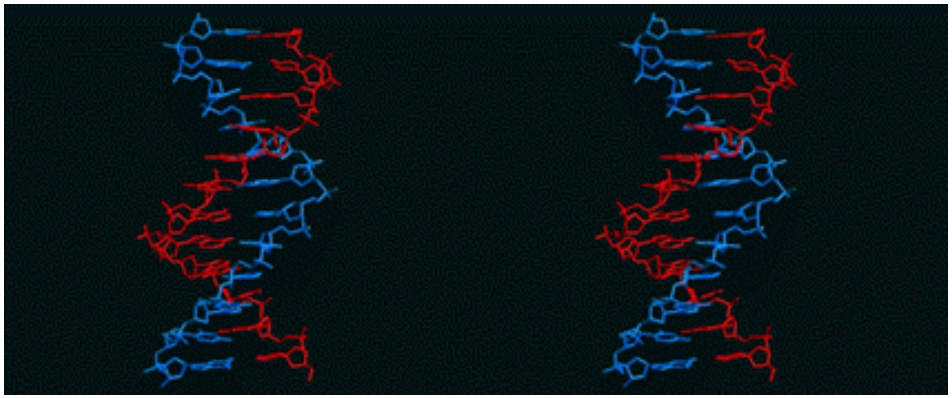


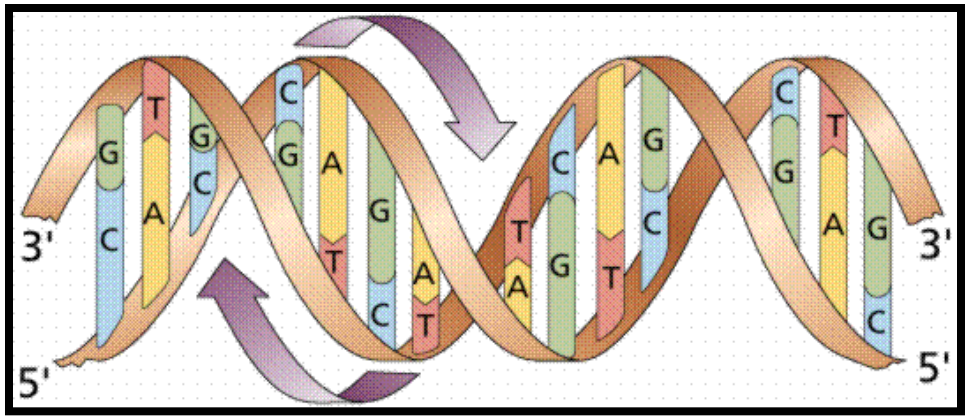
POLIMEROS SINTETICOS

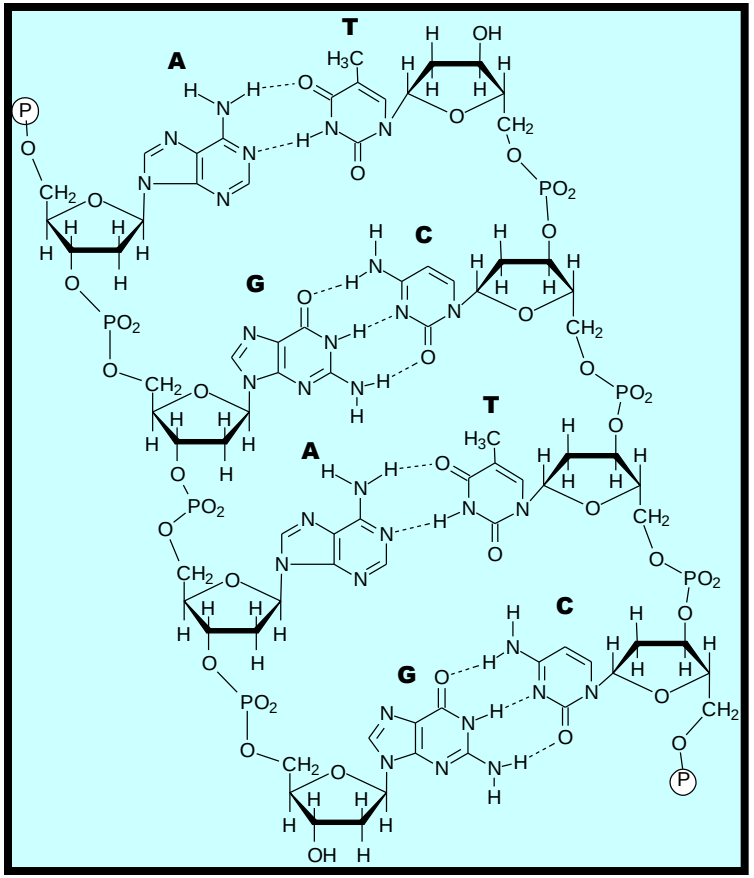
TIPOS DE POLÍMEROS

- **Termoplásticos:** **polietileno**
- **Elastómeros:** **caucho**
- **Termoestables:** **baquelita**
- **Fibras:** **poliéster**

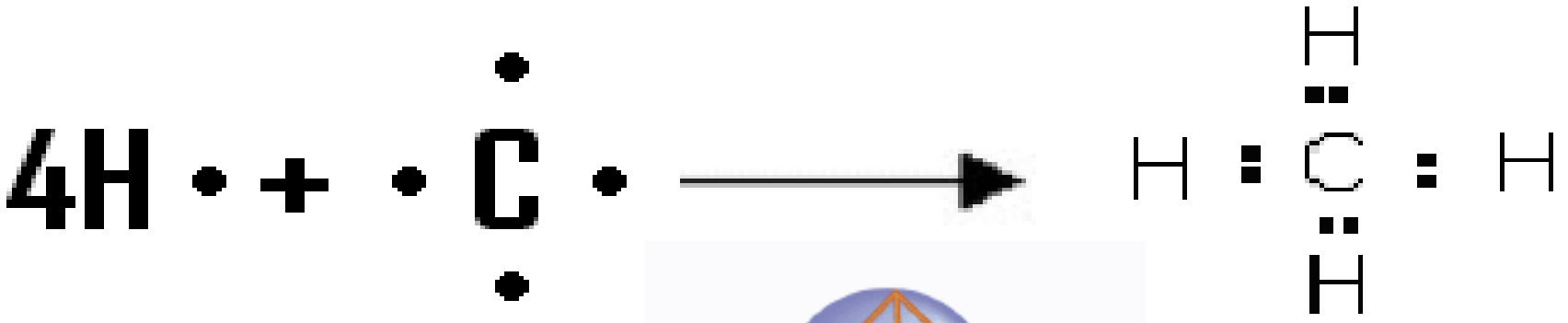
POLIMEROS NATURALES: ADN

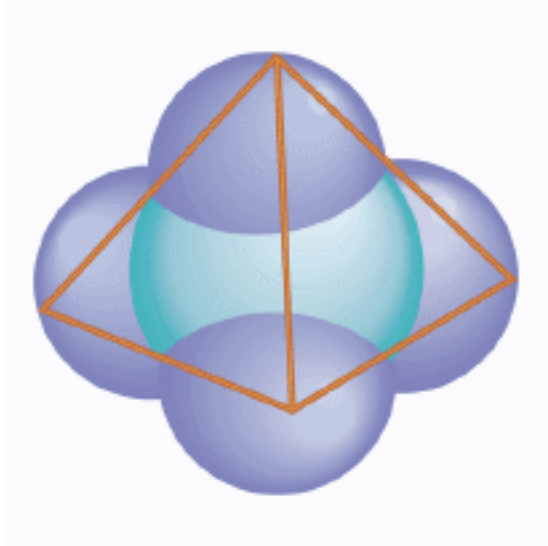






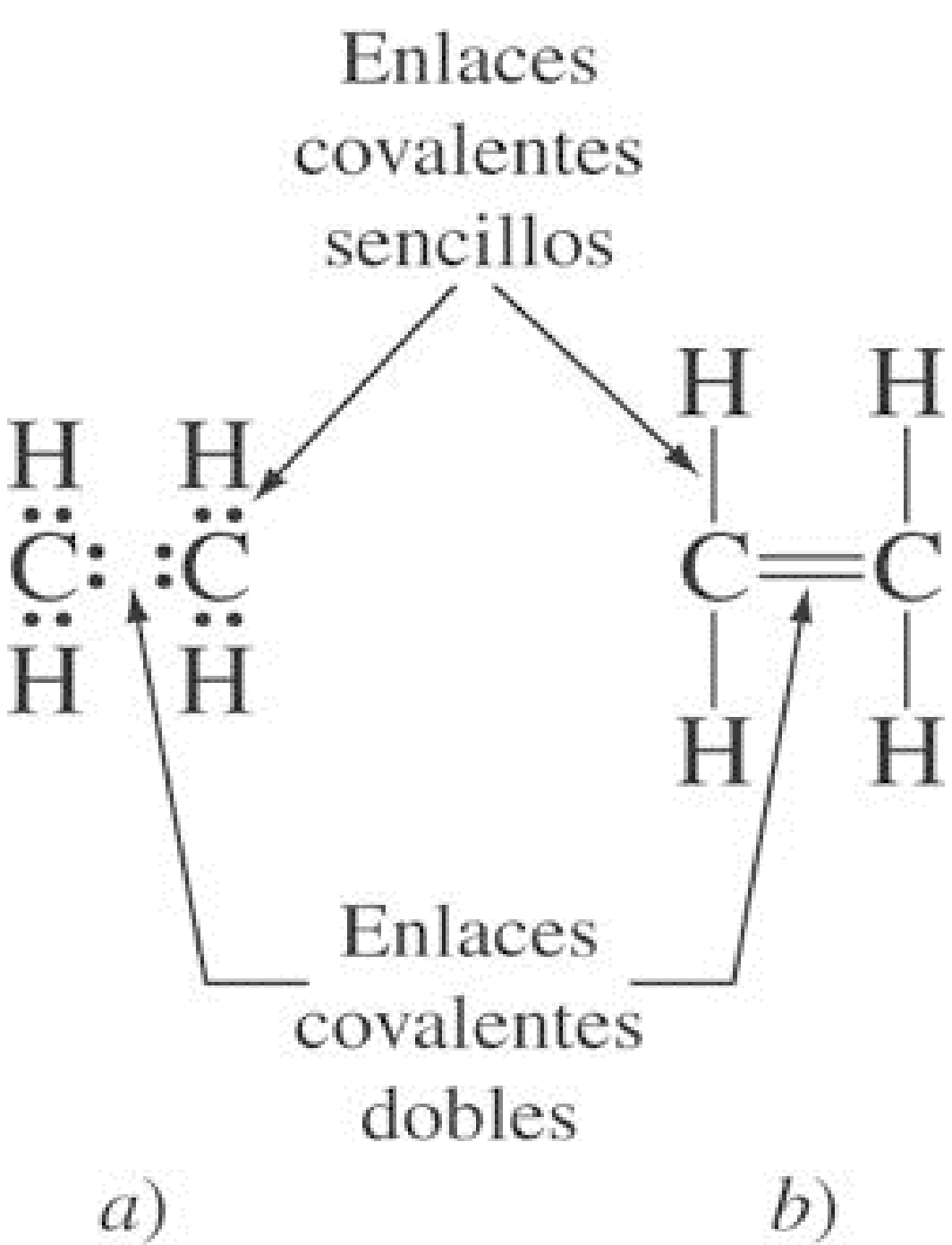
Unión covalente del metano

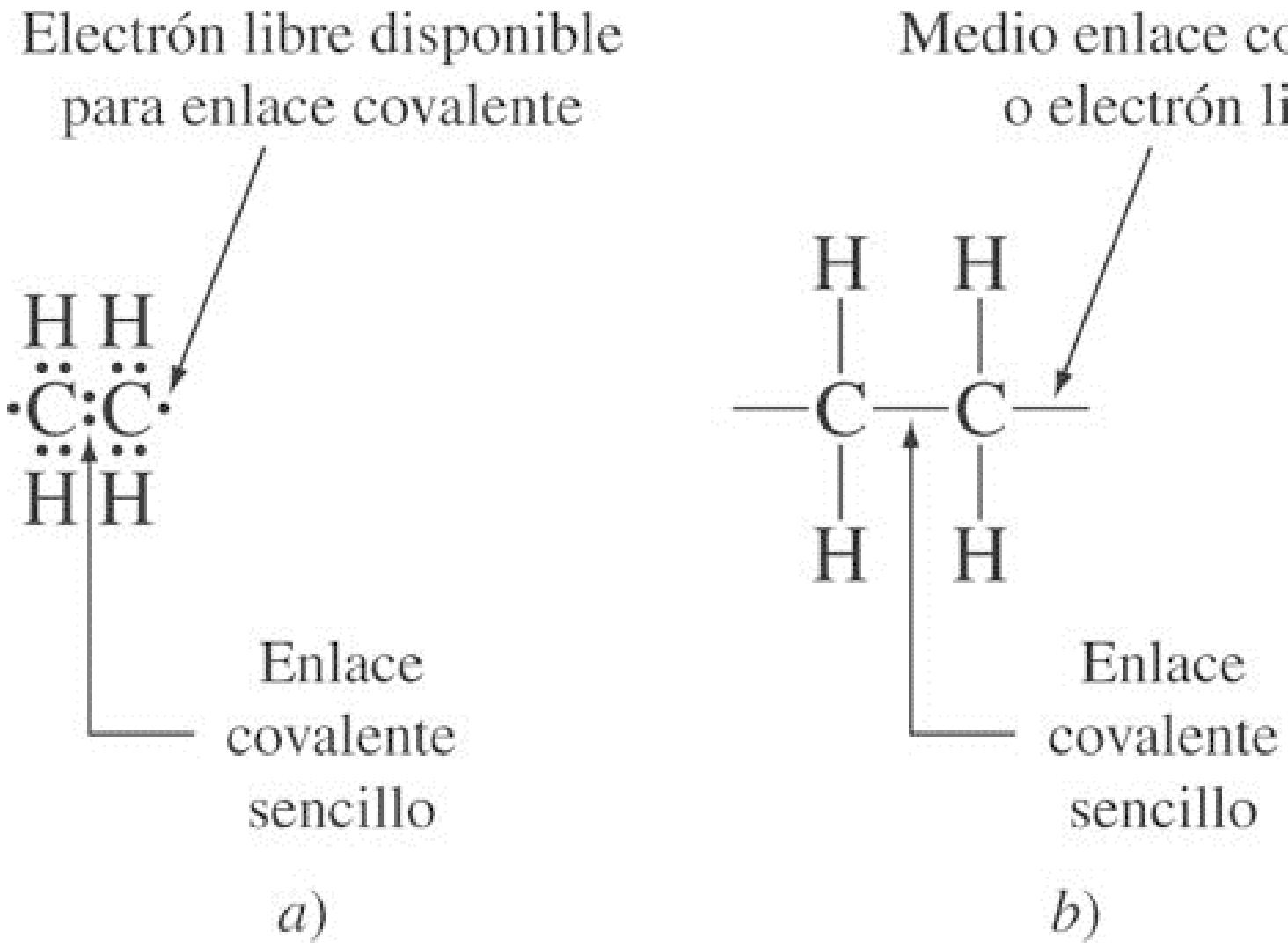




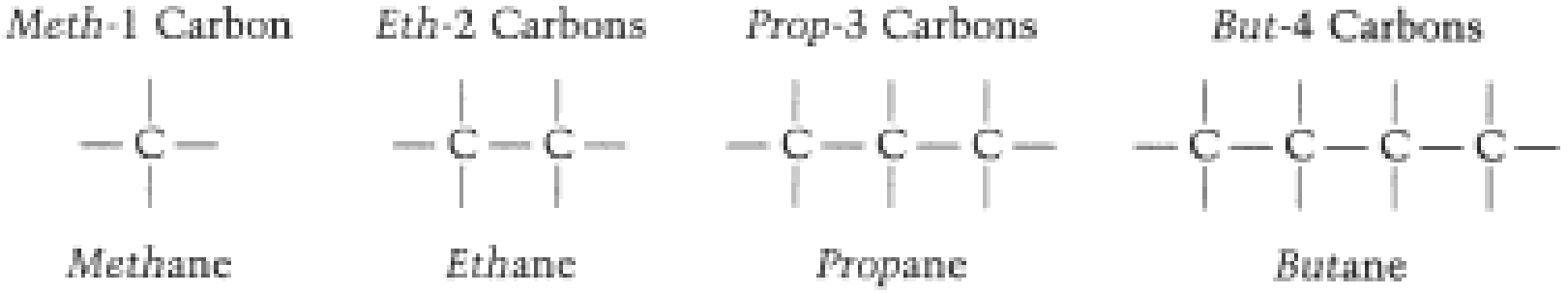
Hidrocarburo	Fórmula	Peso molecular	Densidad	T. de fusión
• Metano	CH_4	16	gas -182 °C	
• Etano	C_2H_6	30	gas	-183 °C
• Propano	C_3H_8	44	gas	-190 °C
• Butano	C_4H_{10}	58	gas	-138 °C
• Pentano	C_5H_{12}	72	0,63	-130 °C
• Hexano	C_6H_{14}	86	0,66	-95 °C
• Heptano	C_7H_{16}	100	0,68	-91 °C
• Octano	C_8H_{18}	114	0,70	-57 °C
• Nonano	C_9H_{20}	128	0,72	-52 °C
• Decano	$C_{10}H_{22}$	142	0,73	-30 °C
• Undecano	$C_{11}H_{24}$	156	0,74	-25 °C
• Dodecano	$C_{12}H_{26}$	170	0,75	-10 °C
• Pentadecano	$C_{15}H_{32}$	212	0,77	10 °C
• Eicosano	$C_{20}H_{42}$	283	0,79	37 °C
• Triacontano	$C_{30}H_{62}$	423	0,78	66 °C
• Polietileno	$C_{2000}H_{4002}$	28000	0,93	100 °C

Densidad y temperatura de fusión de hidrocarburos.

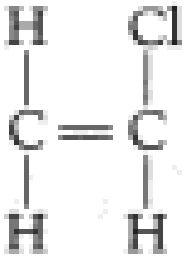

Enlaces
covalentes
sencillos
Enlaces
covalentes
dobles
a)
b)


Electrón libre disponible para enlace covalente
H H
C C
H H
Enlace covalente sencillo
a)
Medio enlace covalente o electrón libre
H H
C C
H H
Enlace covalente sencillo
b)

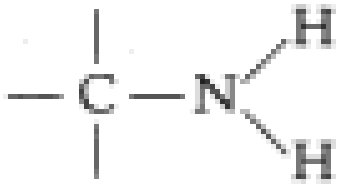
Nomenclatura de los compuestos orgánicos



a) Cadenas saturadas

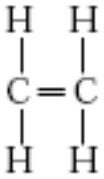


b) Cadena no saturada

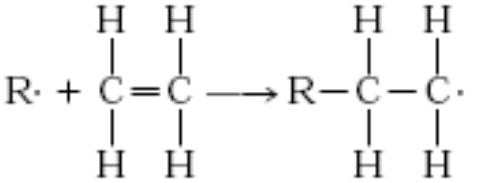


c) radical

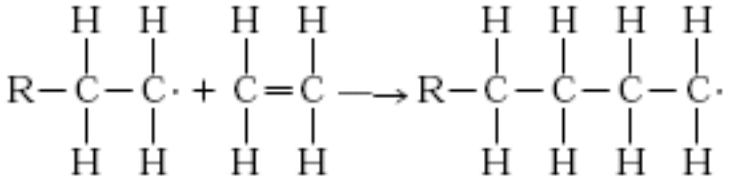
Síntesis del Polietileno (PE)

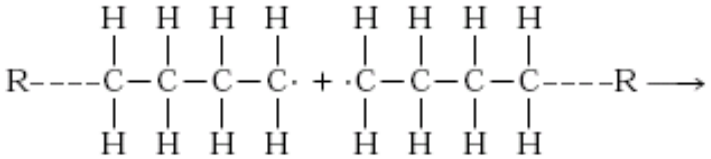


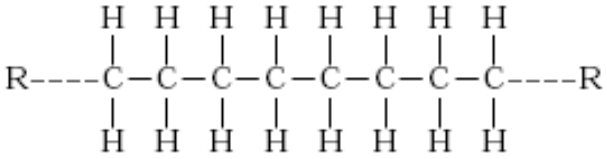
monómero

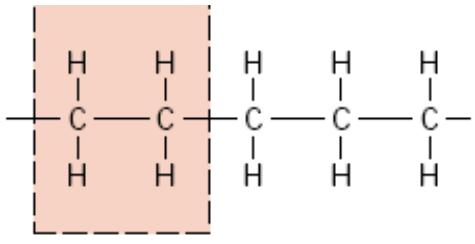


radical

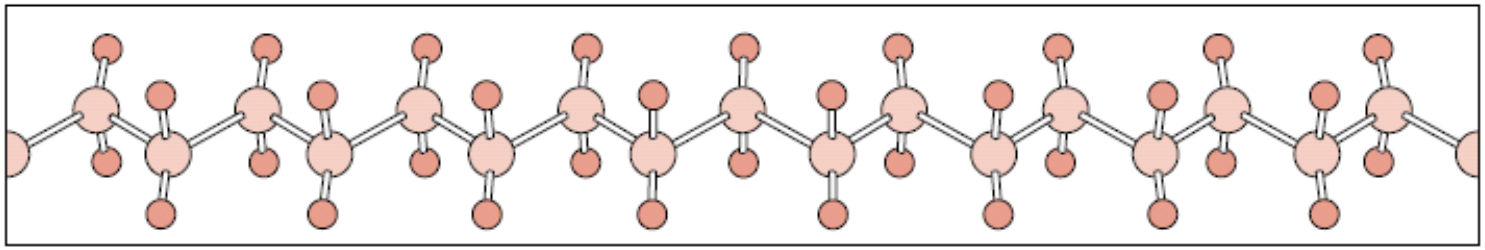


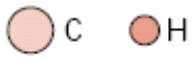


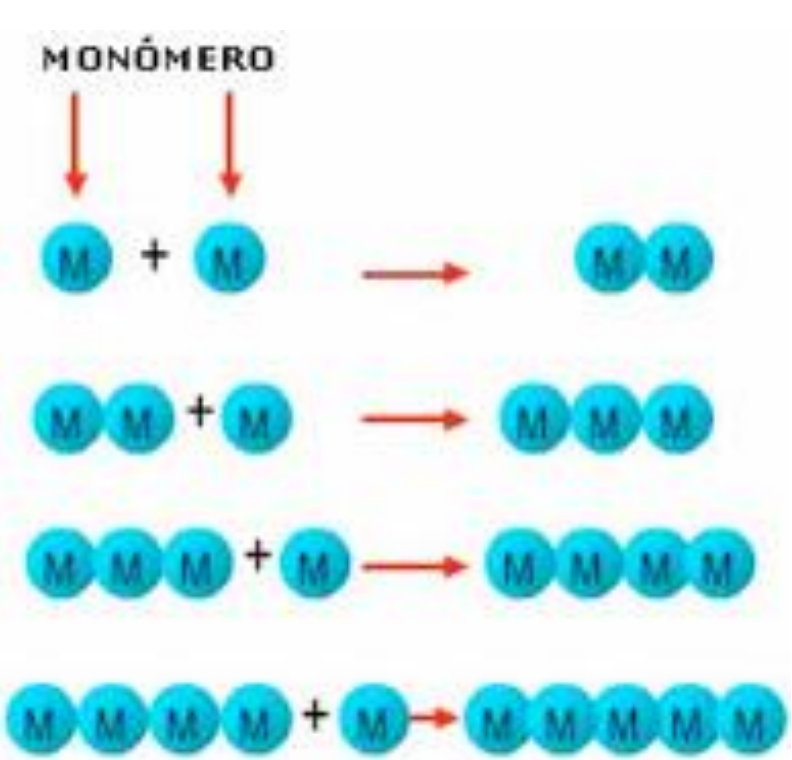




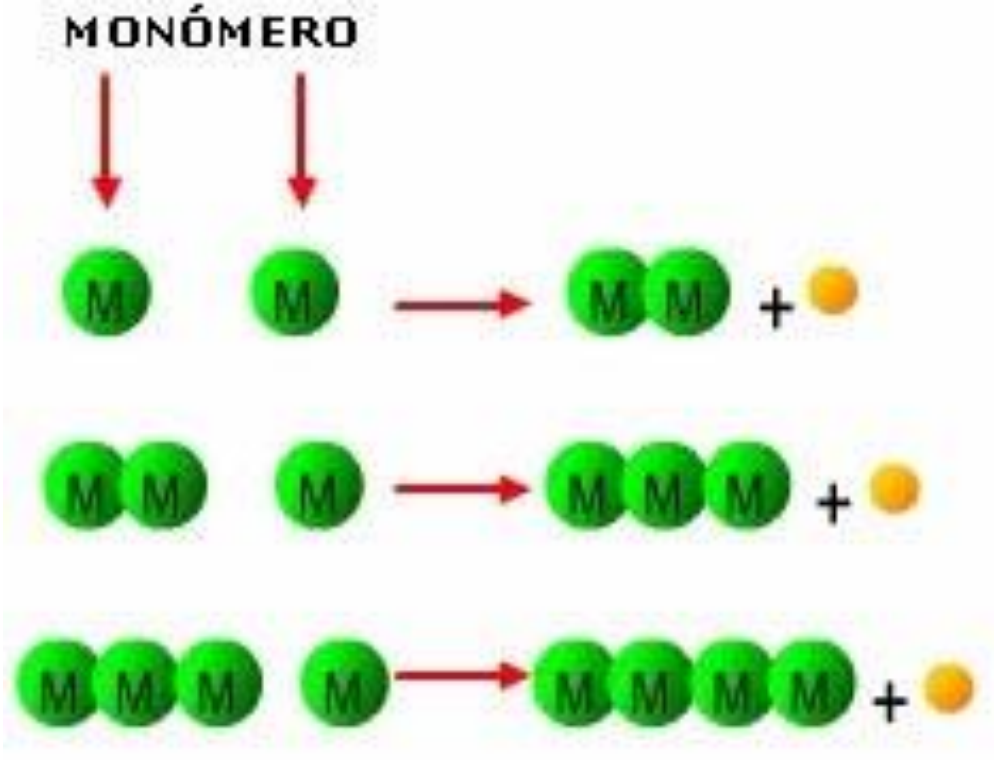
mero



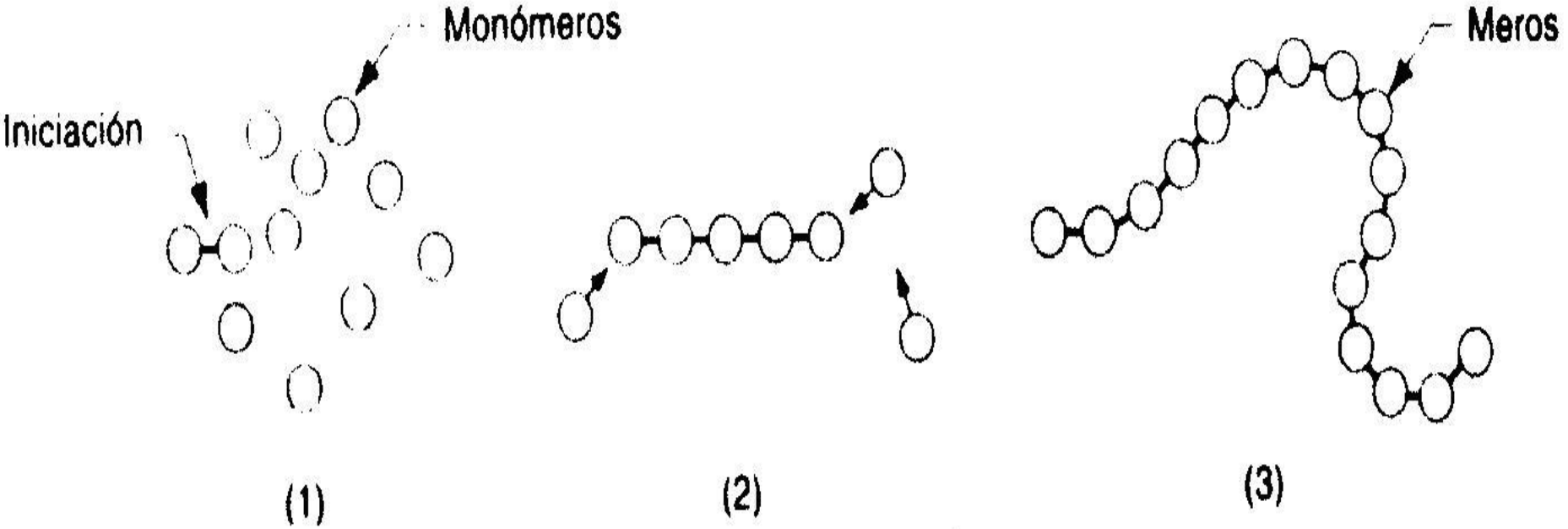




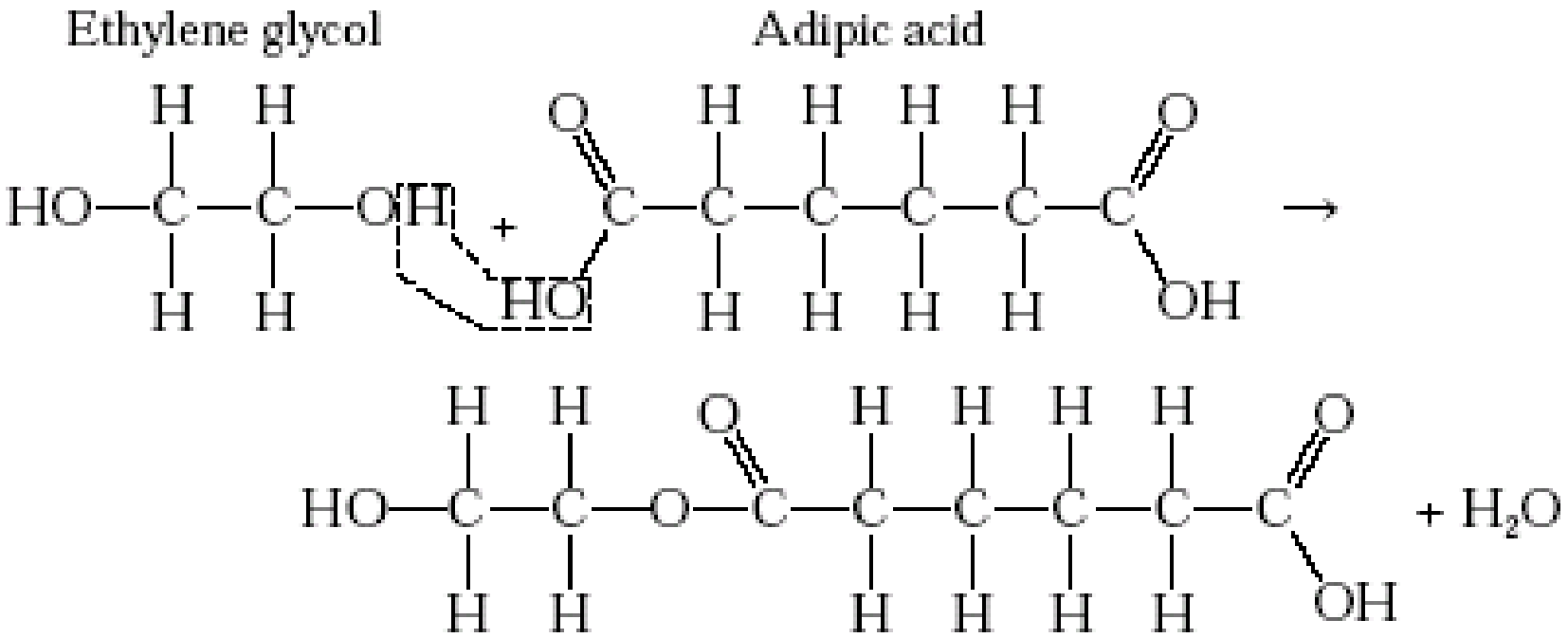
Esquema de polimerización por adición



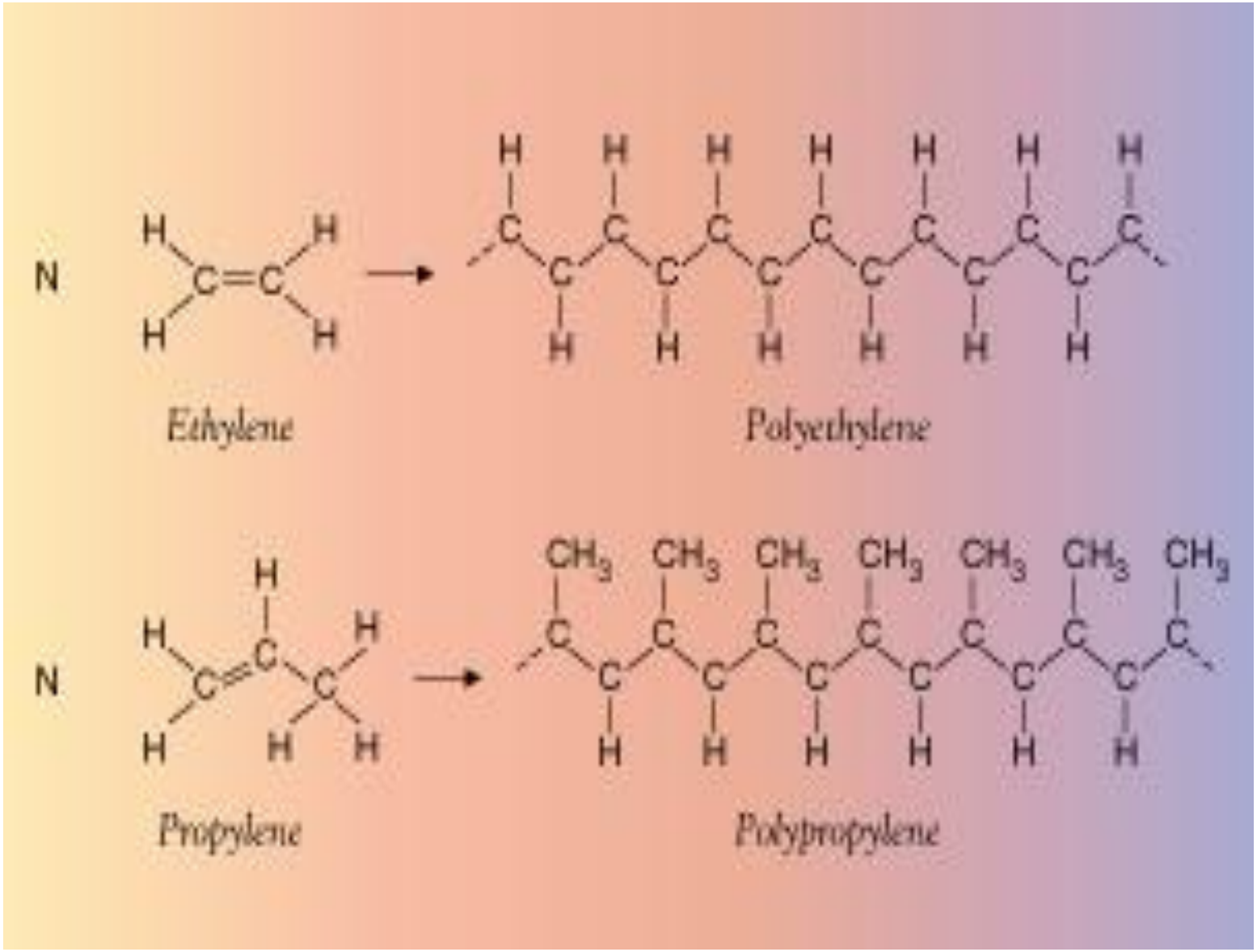
Esquema de polimerización por condensación


Monómeros
Iniciación
Meros
(1)
(2)
(3)

Polimerización por condensación



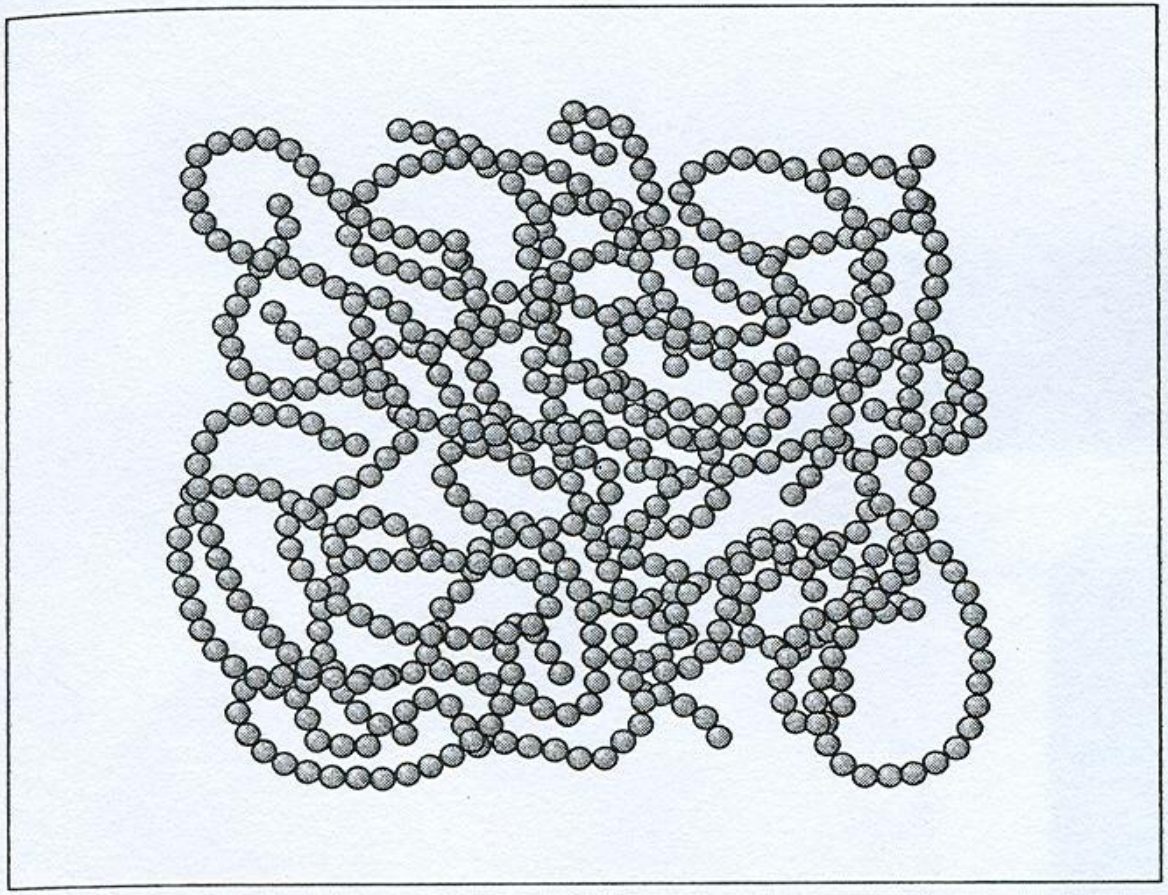
Polimerización del etileno y el propileno para obtener polietileno y polipropileno



Polímeros de adición

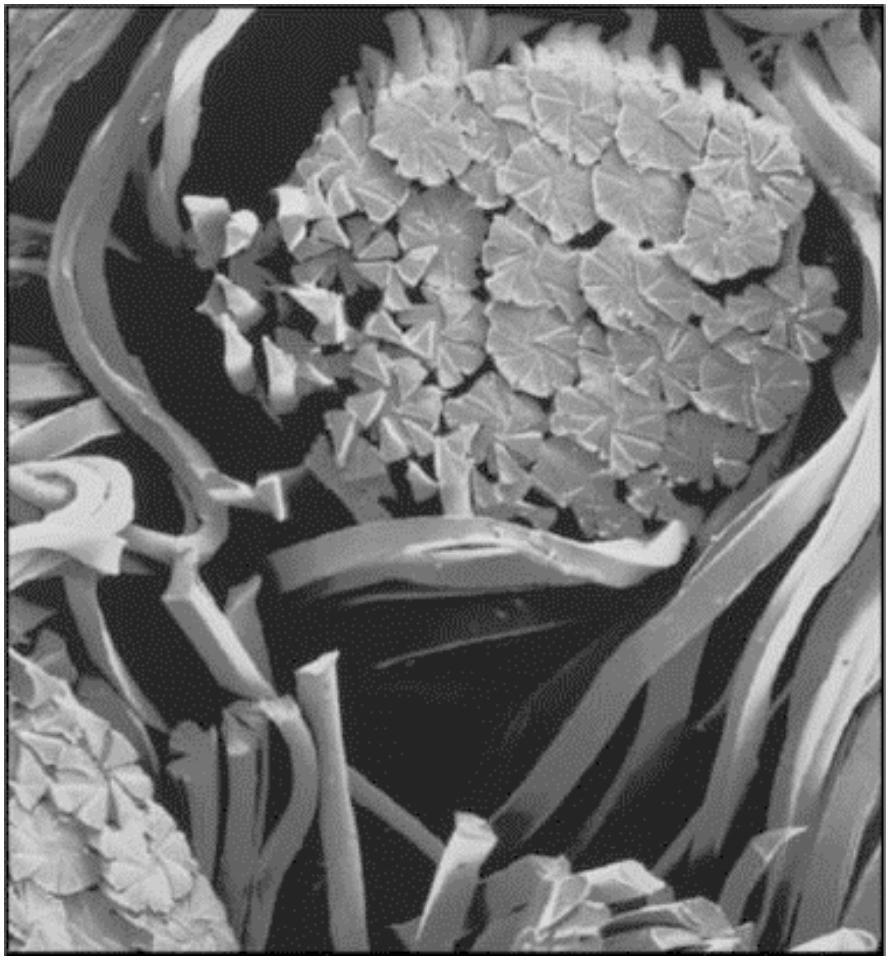
MONÓMEROS		**POLÍMEROS**
– Eteno	⇨	– Polietileno
– Propeno	⇨	– Polipropileno
– cloroeteno	⇨	– policloruro de vinilo
– tetraflúoreteno	⇨	– teflón
– propenonitrilo	⇨	– poliacrilonitrilo
– butadieno	⇨	– polibutadieno
– fenileteno	⇨	– poliestireno
– 2-clorobutadieno	⇨	– neopreno

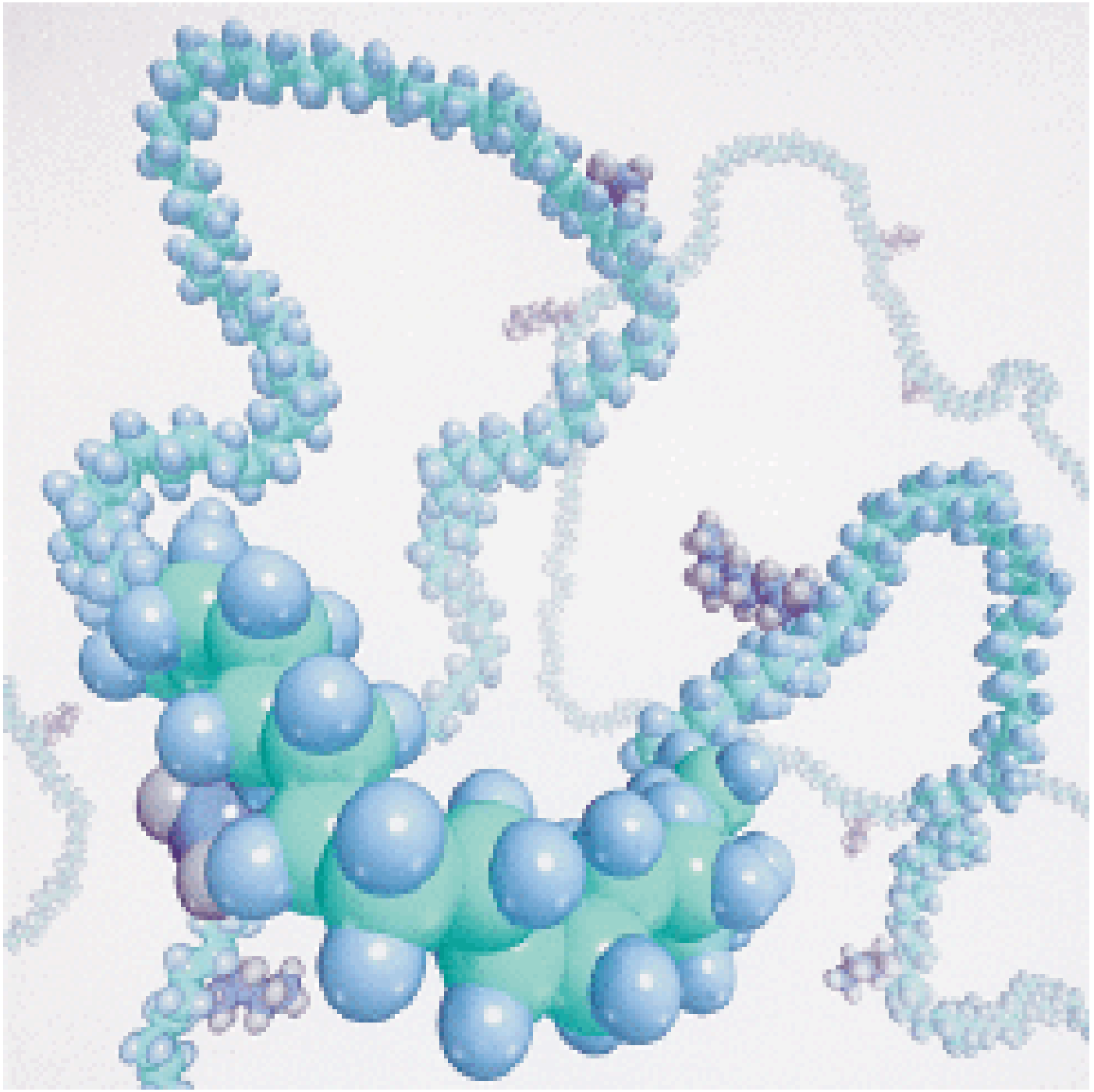
Cadenas de polímeros unidos por fuerzas de Van der Walls



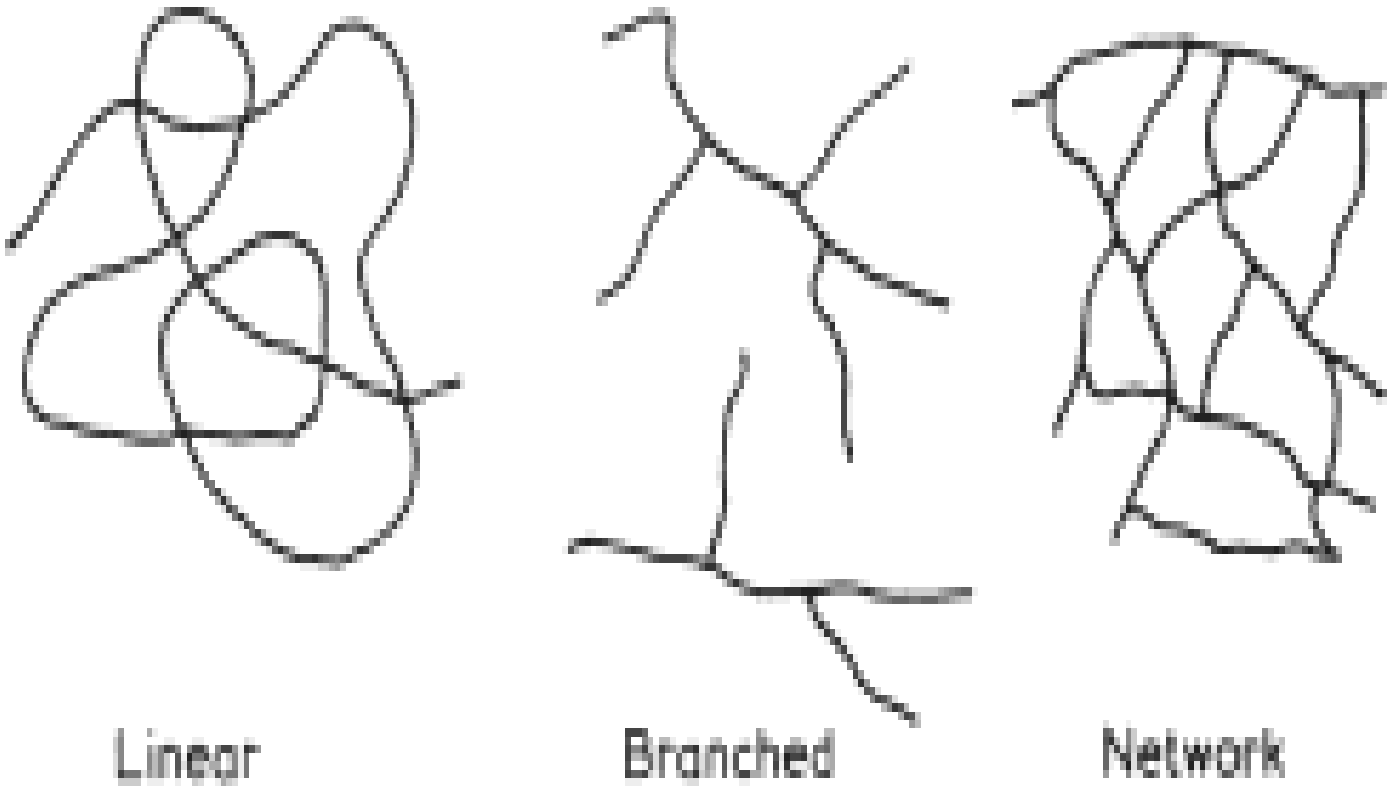
(Según W. G. Moffatt, W. G. Pearsall y J. Wulff, «The Structure and Properties of Materials», vol. I, «Structure», Wiley, 1965, p. 104.)

FIGURA 7.5. Representación esquemática de un polímero. Las esferas representan las unidades de la cadena del polímero de átomos no especificados.

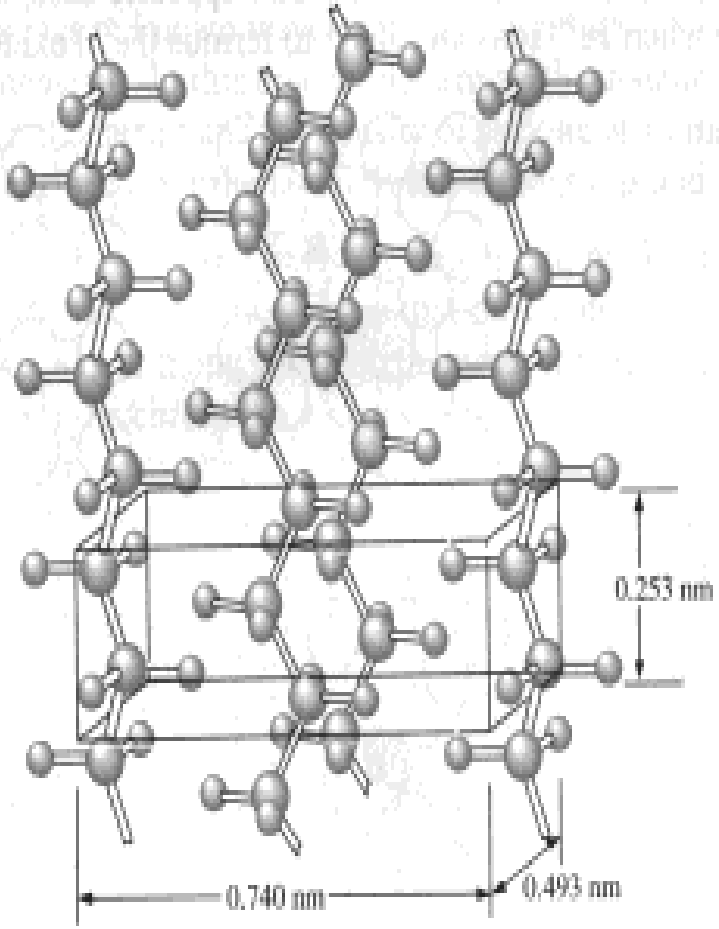




Formas en que se pueden manifestar las cadenas de polímeros

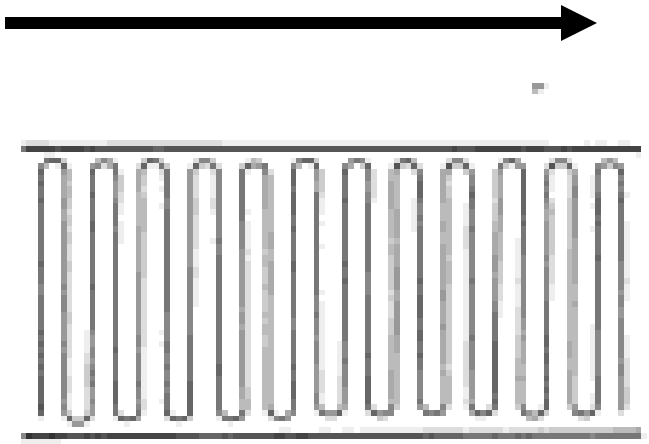


Estructura cristalina del polietileno



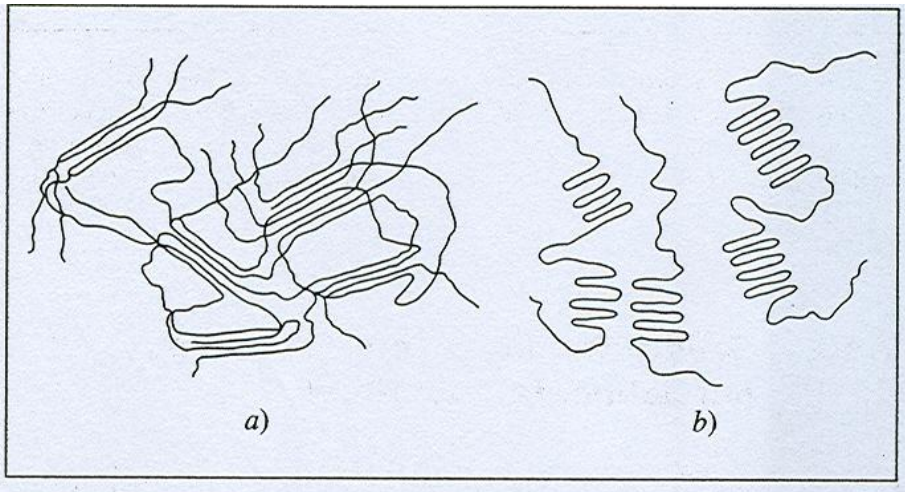
a) Alineación de la cadena cristalina del polietileno

Crecimiento del cristal



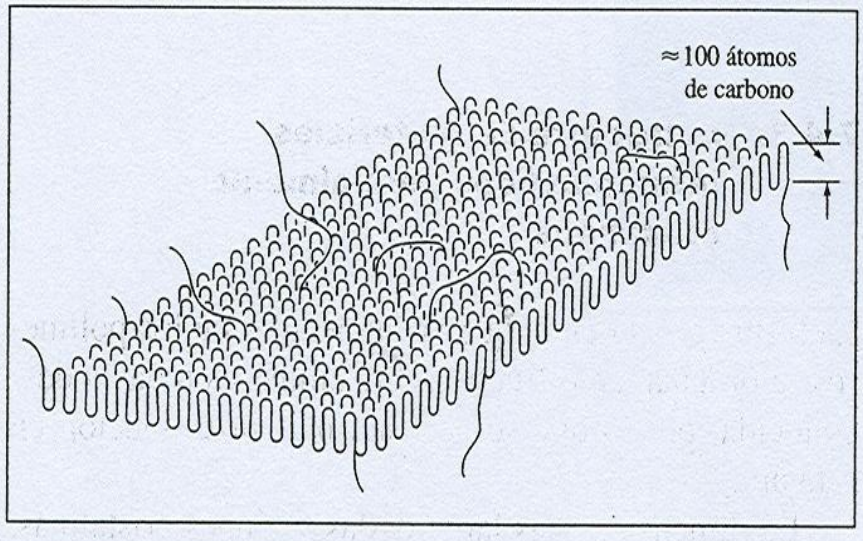
b) Ordenamiento de la cadena

Cadenas de polímeros de ordenaciones cristalinas



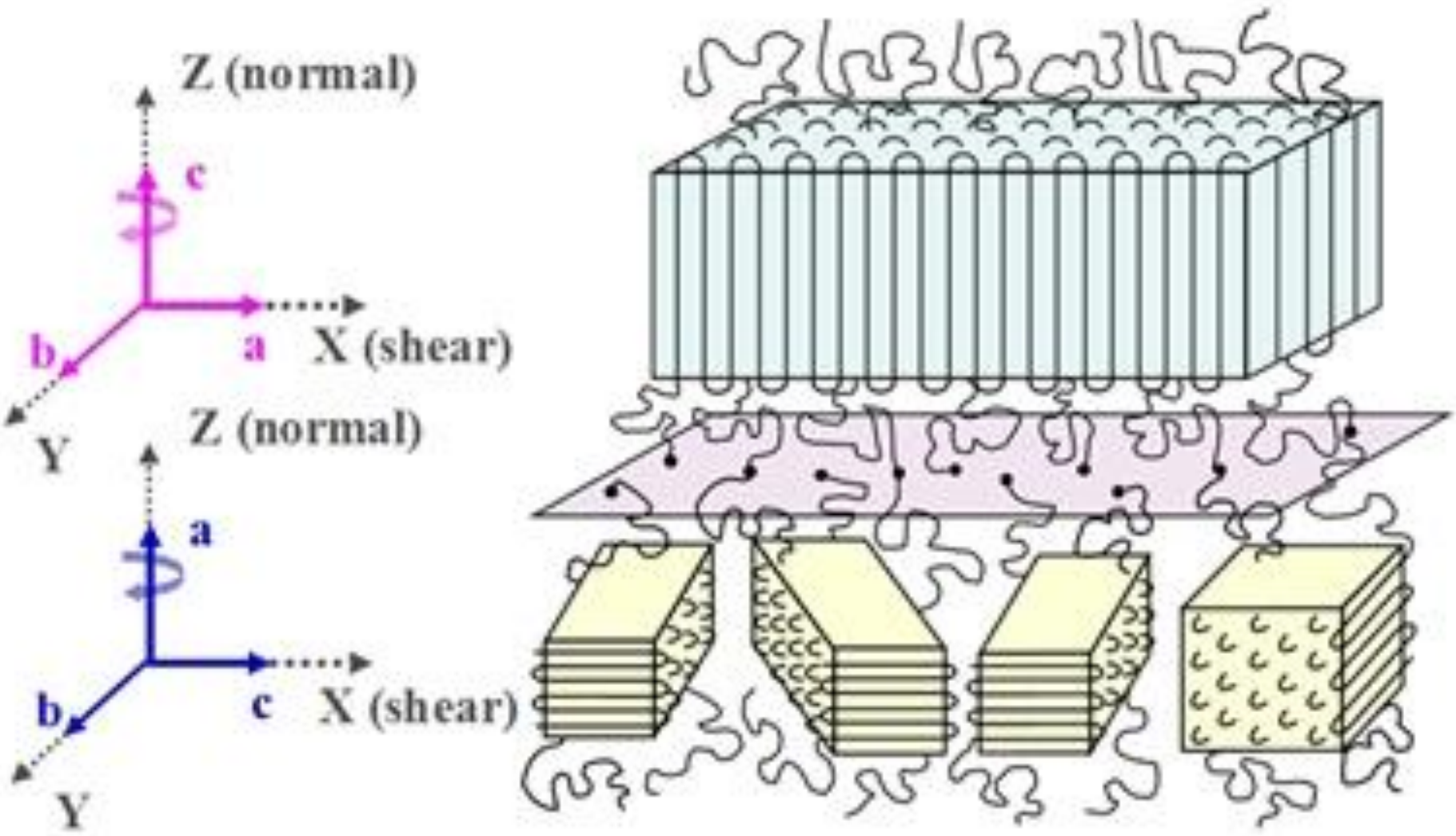
(Según F. Rodríguez, «Principles of Polymer Systems», 2.ª ed., McGraw-Hill, 1982, p. 42.)

FIGURA 7.16. Dos ordenaciones cristalinas sugeridas para materiales termoplásticos parcialmente cristalinos. *a*) Modelo de micela con flecos, y *b*) modelo de cadenas plegadas.



[Según R. L. Boysen, Olefin Polymers (High-Pressure Polyethylene), en «Encyclopedia of Chemical Technology», vol. 16, Wiley, 1981, p. 405.]

FIGURA 7.17. Esquema de la estructura de cadena plegada de una lámina de polietileno de baja densidad.


Z (normal)
c
b
a
X (shear)
Y
Z (normal)
a
b
c
X (shear)
Y

Nivel de consumo de los principales polímeros

	Use % of market
Polyethylene, PE	32
Polypropylene, PP	11
Polystyrene, PS	9
Polyvinylchloride, PVC	15
	67

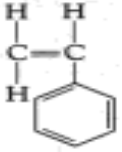
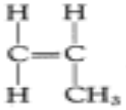
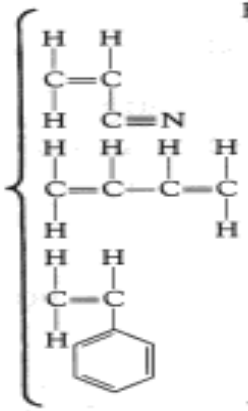
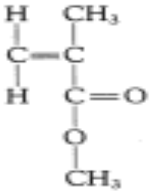
Algunos radicales substitutos del hidrogeno en la cadena

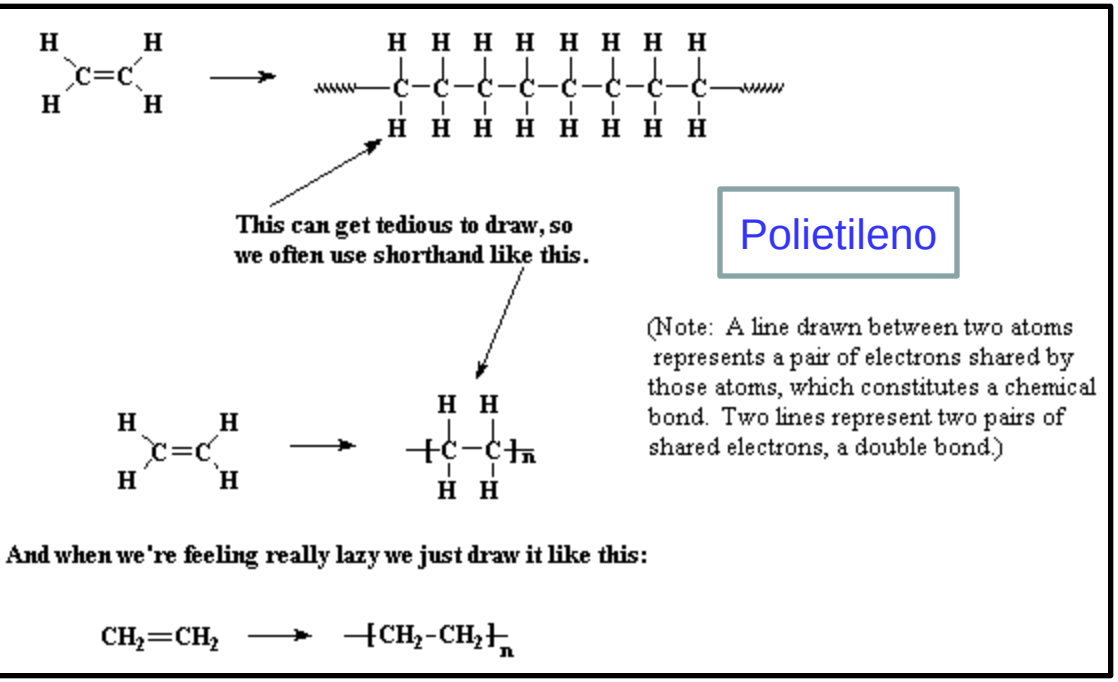
• **H**	**-**
• **F**	**flouro**
• **Cl**	**cloro**
• **Br**	**bromo**
• **I**	**iodo**
• **CH_3**	**methyl**
• **$CH_3(CH_2)n$**	**alkyl**
• **CN**	**cianuro**
• **NH_2**	**amino**
• **$N(CH_3)$**	**dimethylamino**
• **NO_2**	**nitro**

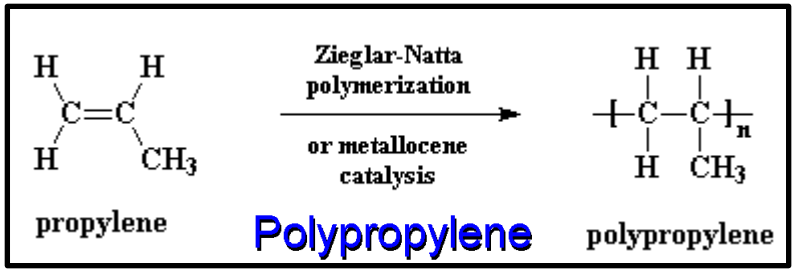
Algunos monomeros para formar polímeros

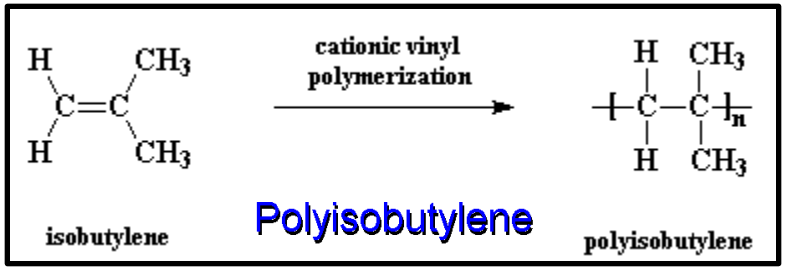
TABLE 13.1 Summary of Important Polymers

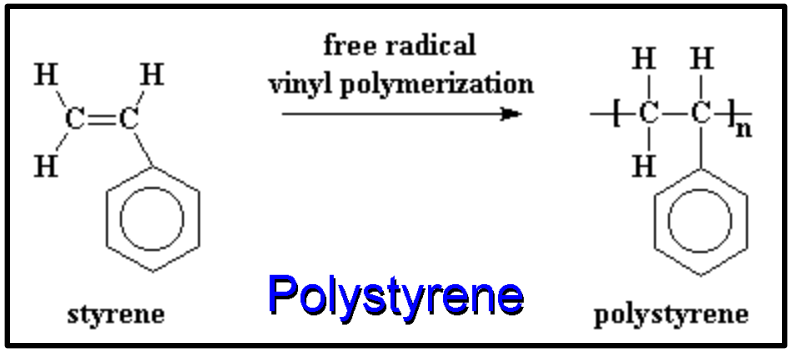
Group I. Thermoplastics

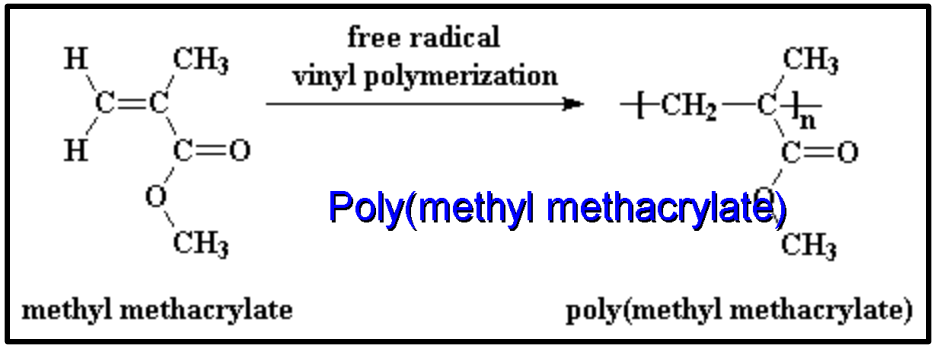
Polymer	*Percentage of Market*	*Monomer(s) Used*
Polyethylene	32	
Polyvinylchloride	15	
Polystyrene	9	 ( is benzene, C_6H_6)
Polypropylene	11	
ABS	3	 Acrylonitrile (graft) Butadiene (chain) Styrene (graft)
Acrylics (examples: polymethyl methacrylate, Lucite)	1	



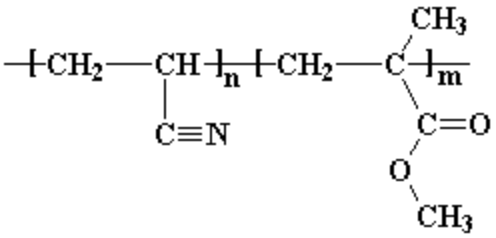




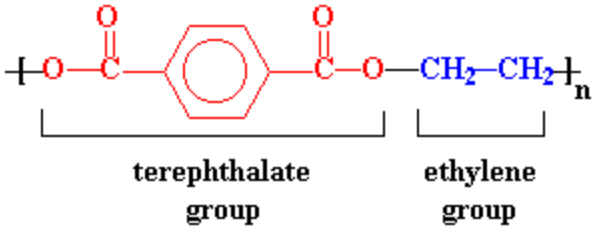




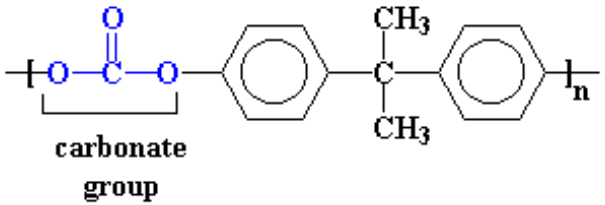
EJEMPLO DE POLIMEROS



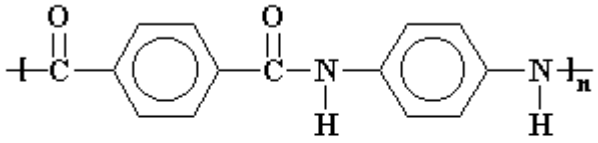
poly(acrylonitrile-*co*-methyl methacrylate)



Polyesters

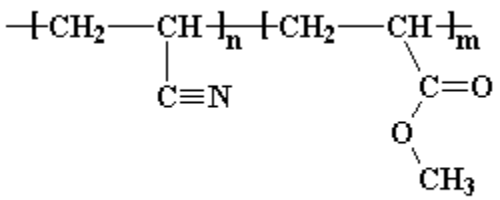


Polycarbonates

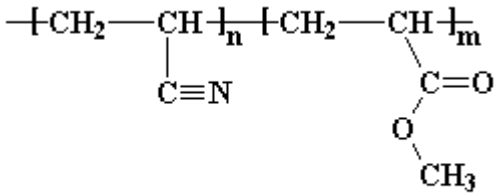


In Kevlar the aromatic groups are all linked into the backbone chain through the 1 and 4 positions. This is called *para-* linkage.

Aramids

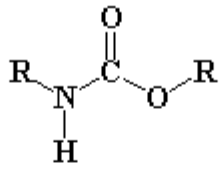


poly(acrylonitrile-*co*-methyl acrylate)

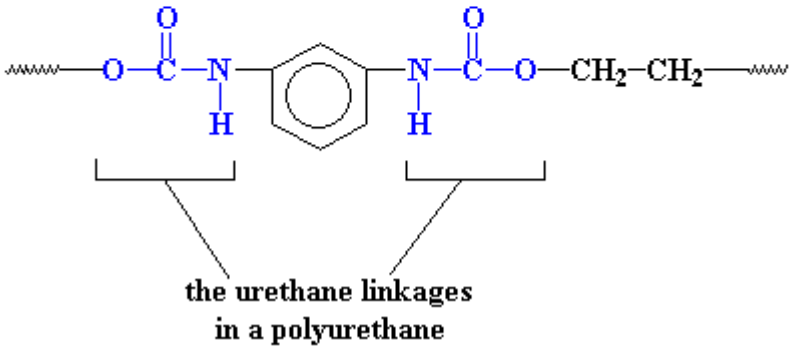


poly(acrylonitrile-*co*-methyl acrylate)

Polyacrylonitrile

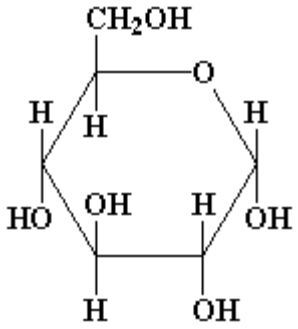


a urethane



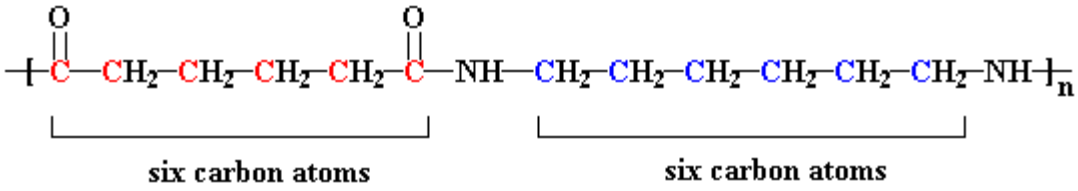
the urethane linkages
in a polyurethane

Polyurethanes



glucose

Cellulose



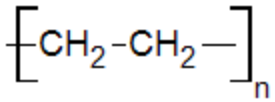
six carbon atoms

six carbon atoms

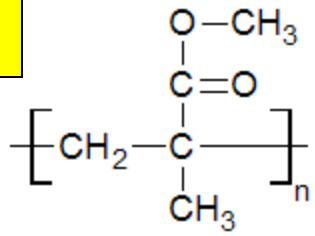
Nylons

EJEMPLO DE POLIMEROS

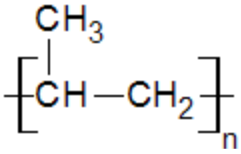
Polietileno



Polimetacrilato de metilo

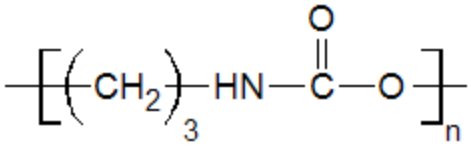


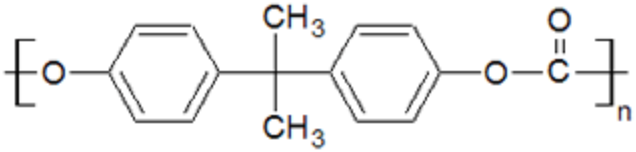
Polipropileno



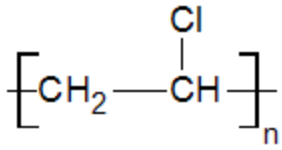
poli(4,4’-isopropilidendifenol carbonato (lexan)

Poliuretano

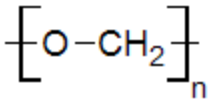




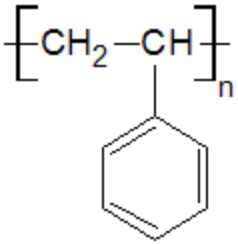
Cloruro de polivinilo
Poli(cloruro de vinilo)
(PVC)



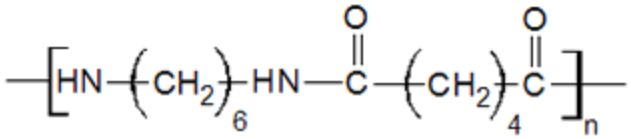
Polioximetileno



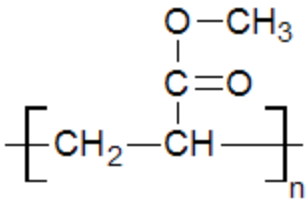
Poliestireno



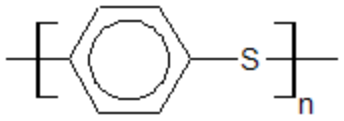
Nylon



Poliacrilato de metilo



Poli(sulfuro de fenileno)



Procesos de fabricación de polipropileno

Aplicaciones del polipropileno

- Autopartes
- Baldes, recipientes, botellas
- Muebles
- Juguetes
- Películas para envases de alimentos
- Fibras y filamentos
- Bolsas y bolsones
- Fondo de alfombras
- Pañales, toallas higiénicas, ropa
- Envases de pared delgada

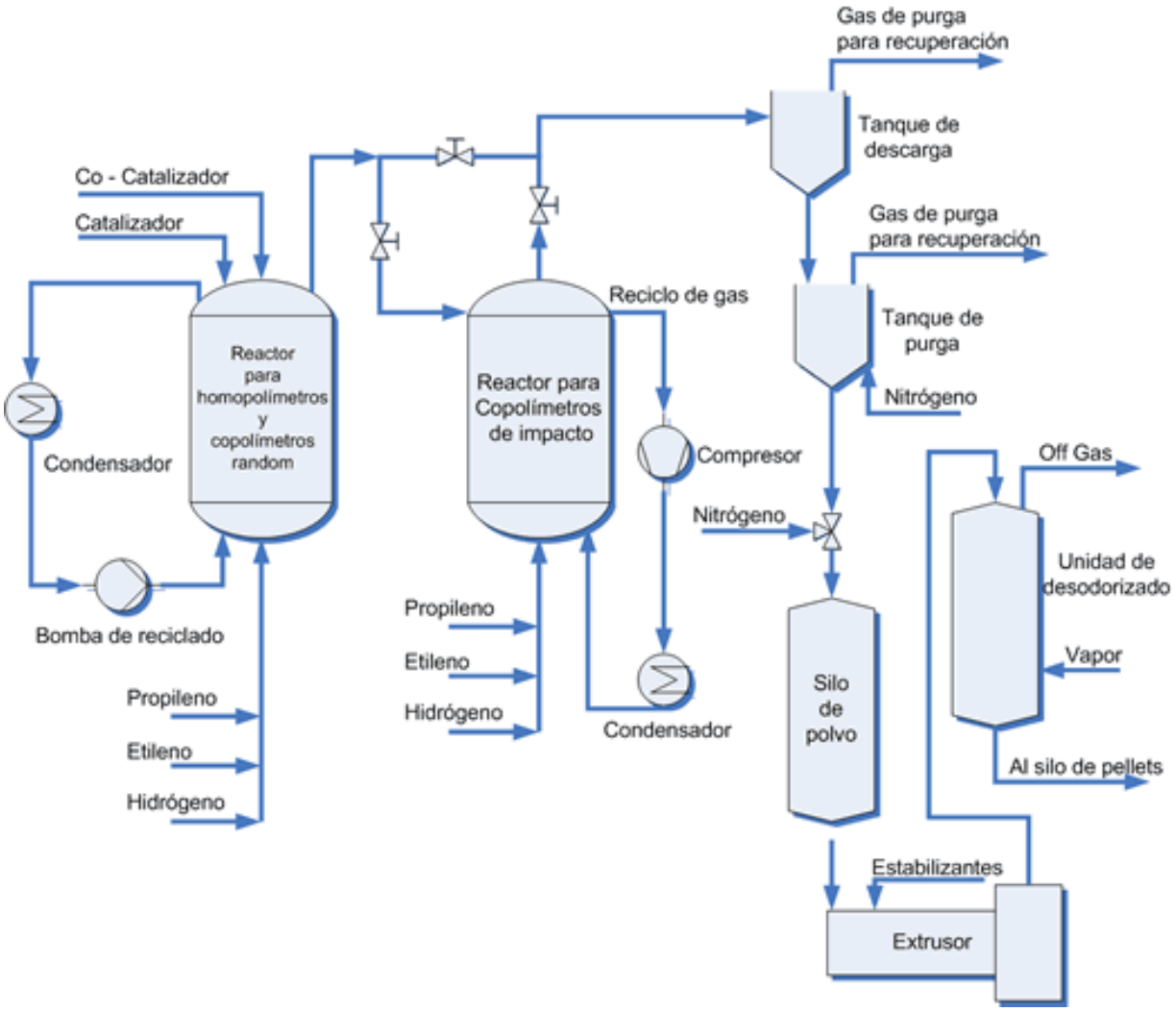
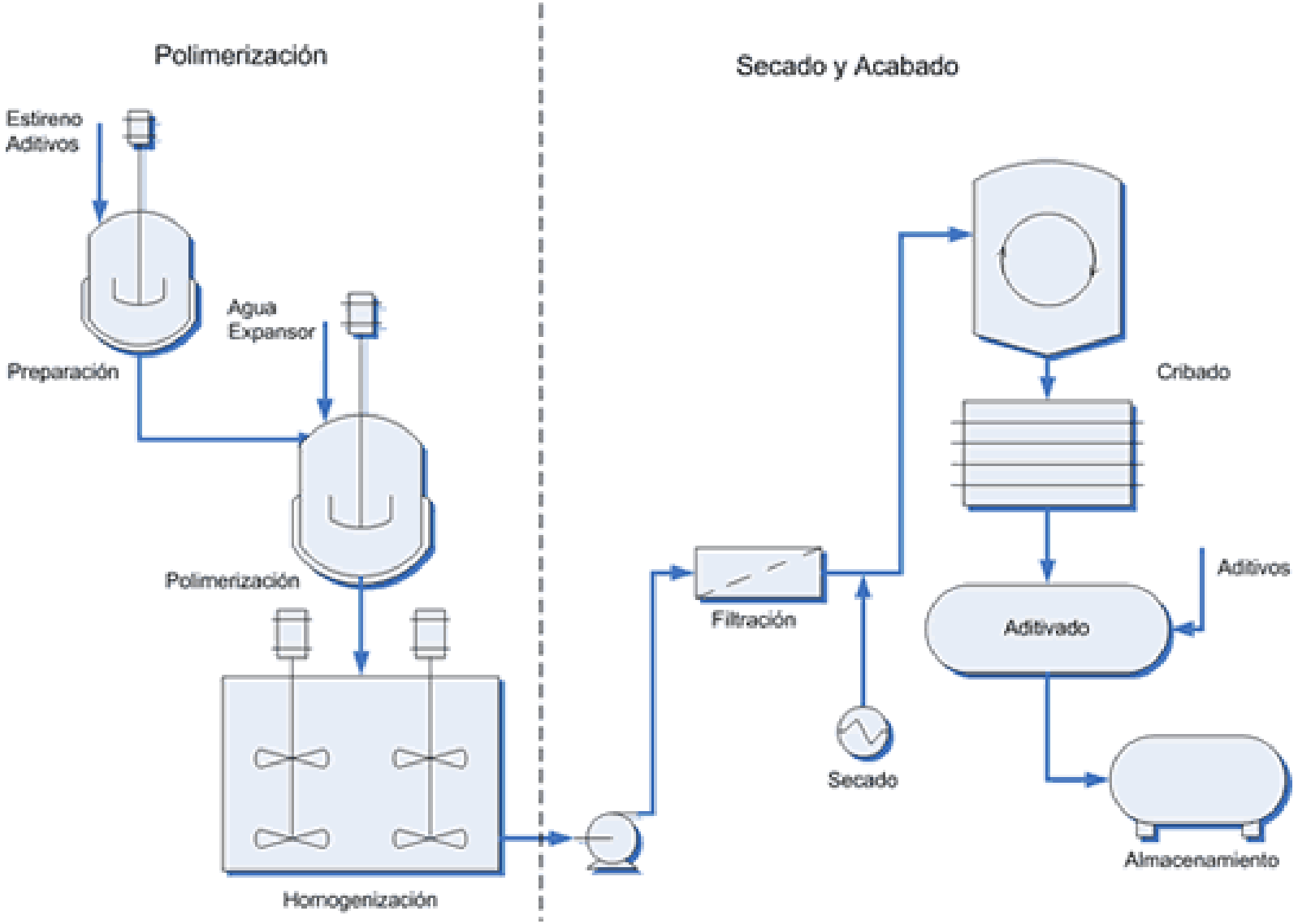
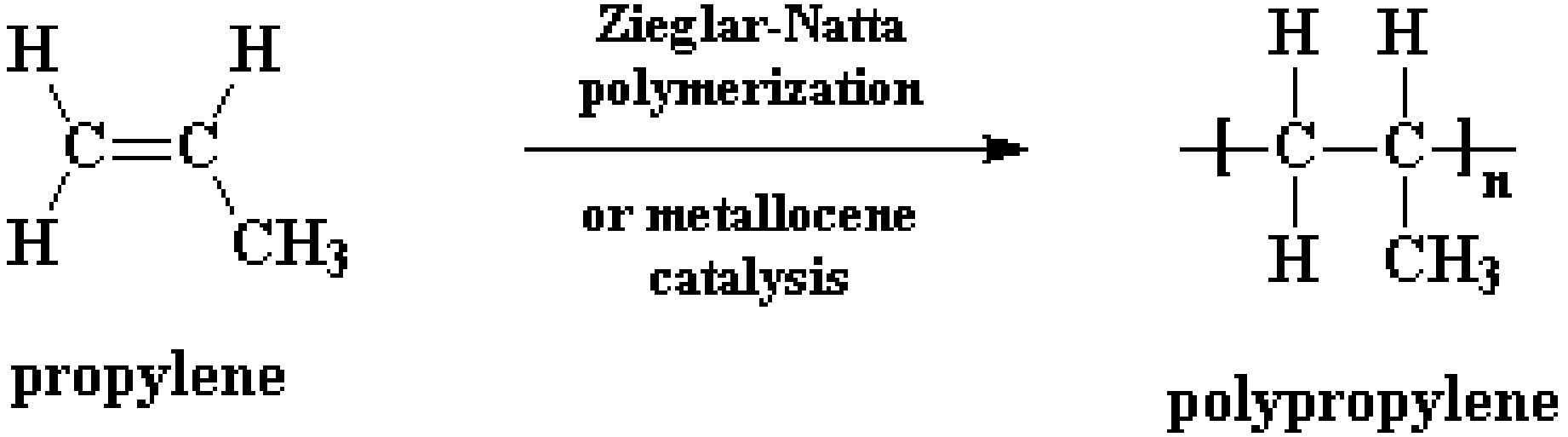


Diagrama de flujo de Polimerización

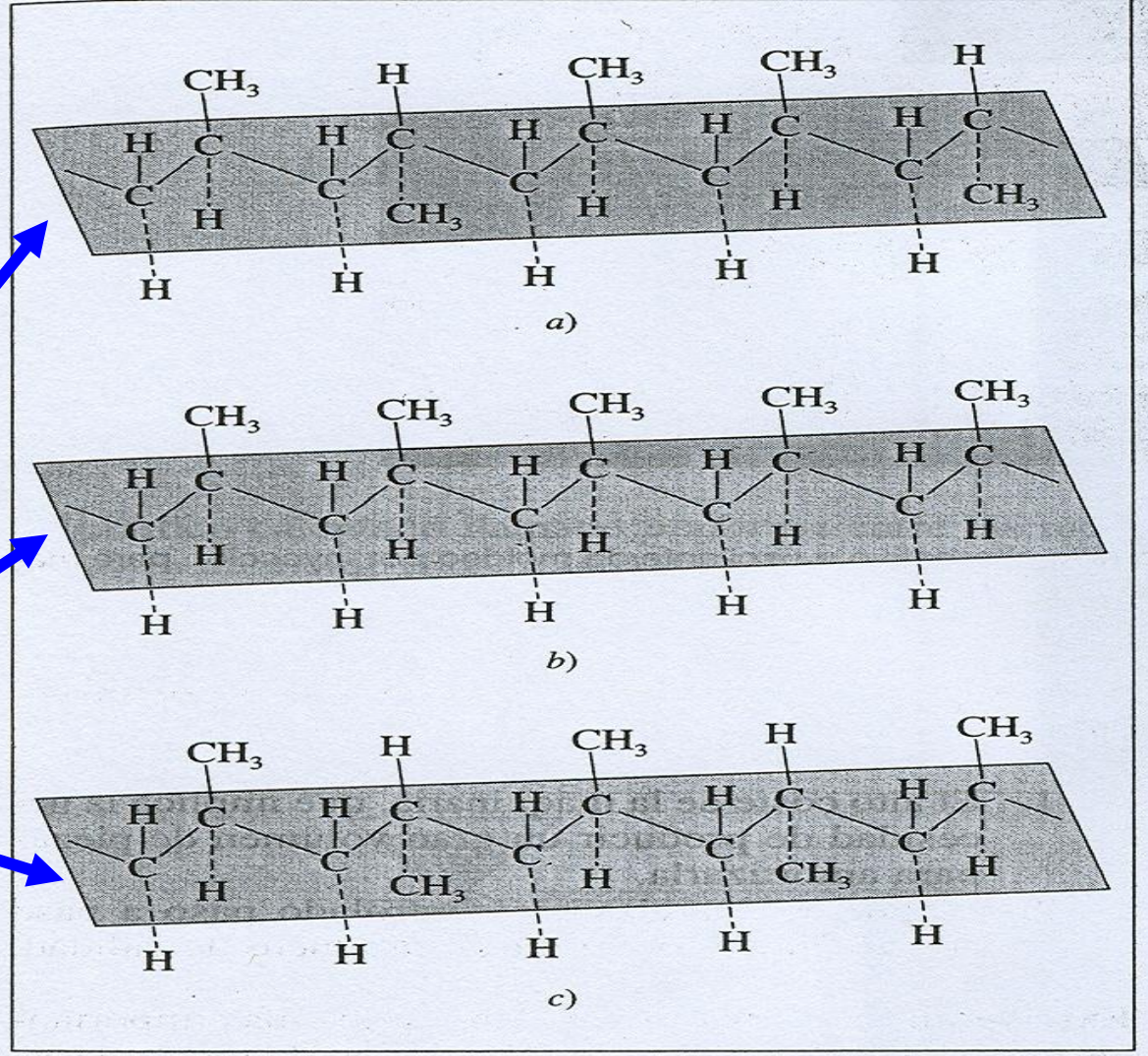


Isómeros del polipropileno

(misma composición química pero diferentes característica física)



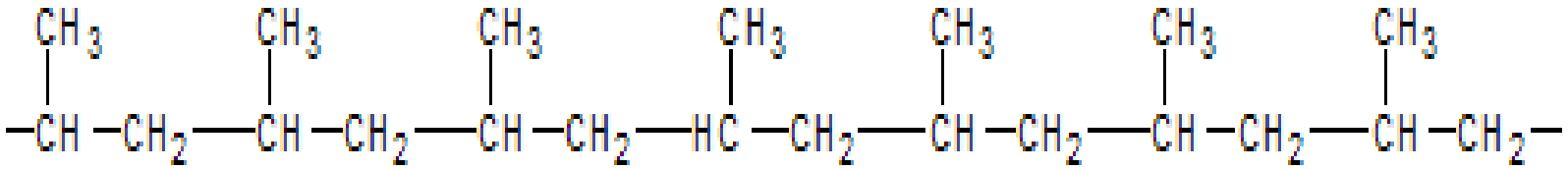
Isómeros:
atáctico
isotáctico
sindiotáctico



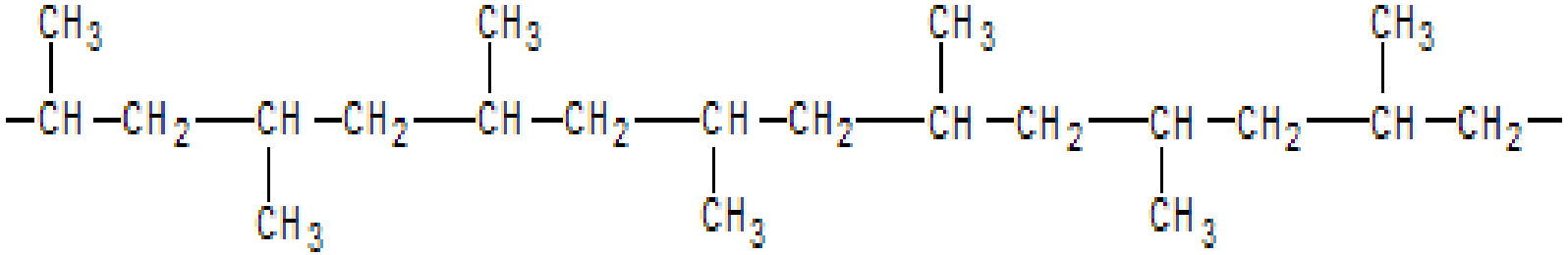
[Según G. Crespi y L. Luciani, Olefin Polymers (Polyethylene), en «Encyclopedia of Chemical Technology», vol. 16, Wiley, 1982, p. 454.]

FIGURA 7.19 Estereoisómeros del polipropileno. *a)* Isómero atáctico en el que los grupos metilo sustituyentes se encuentran dispuestos aleatoriamente a uno u otro lado de la cadena principal; *b)* isómero isotáctico, en el que los grupos CH_3 sustituyentes se encuentran todos del mismo lado de la cadena principal, y *c)* isómero sindiotáctico en el cual los grupos CH_3 están ubicados de modo regular y alternado a uno y otro lado de la cadena principal.

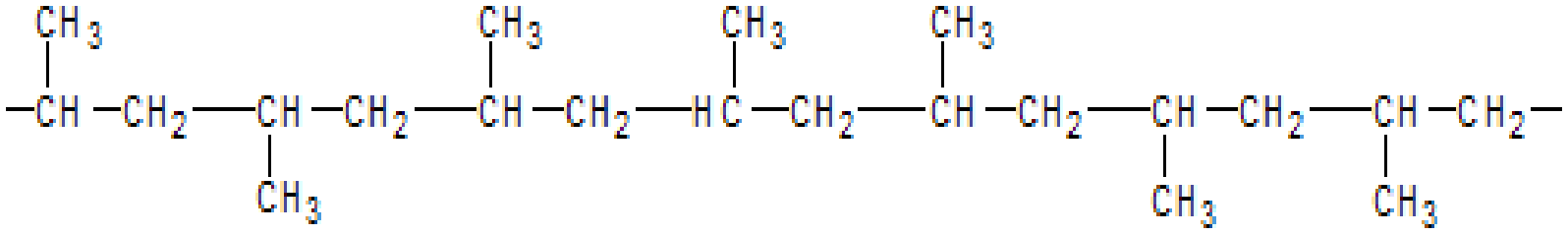
isomeros



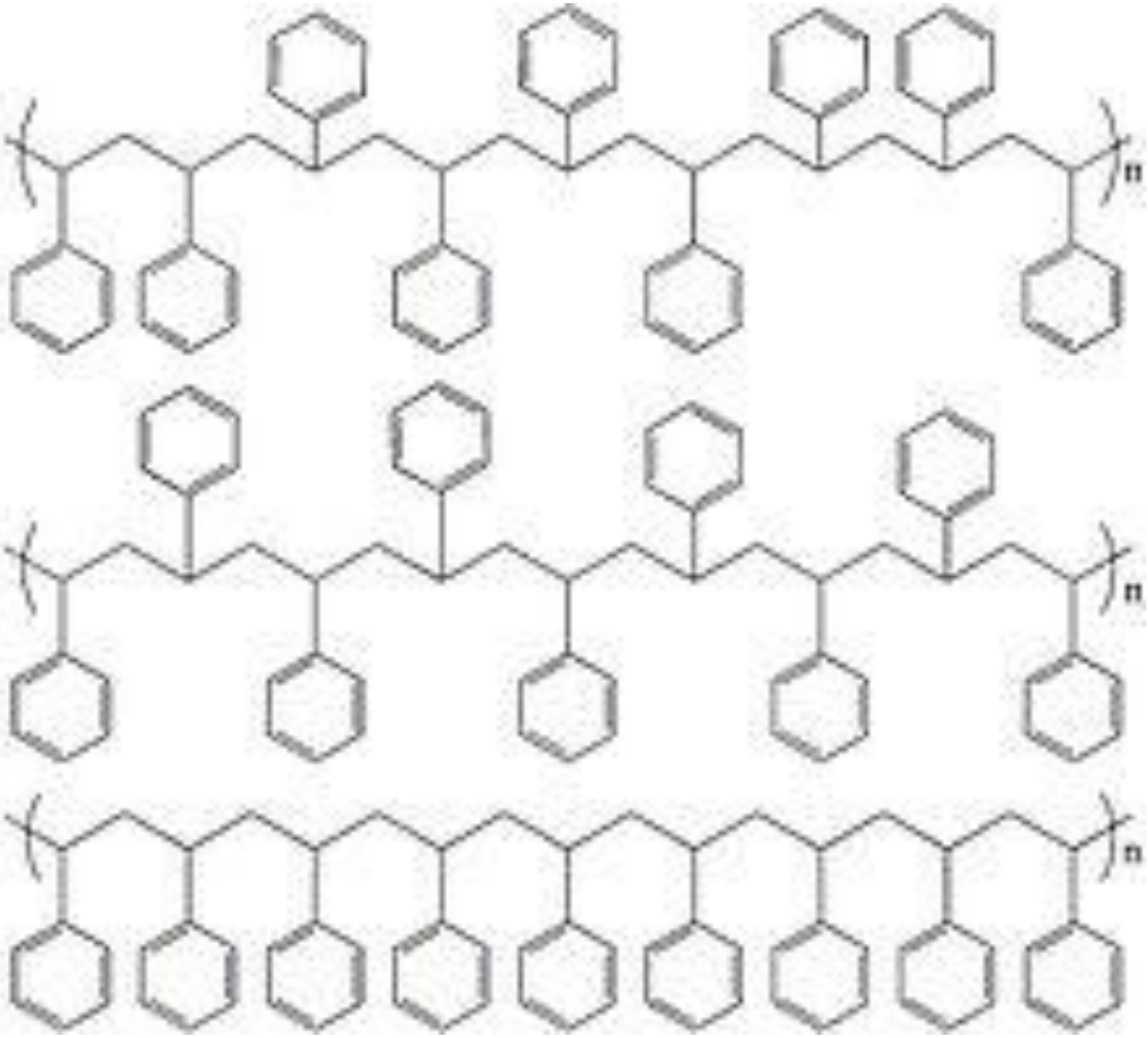
Isotáctica



Sindiotáctica



Atáctica

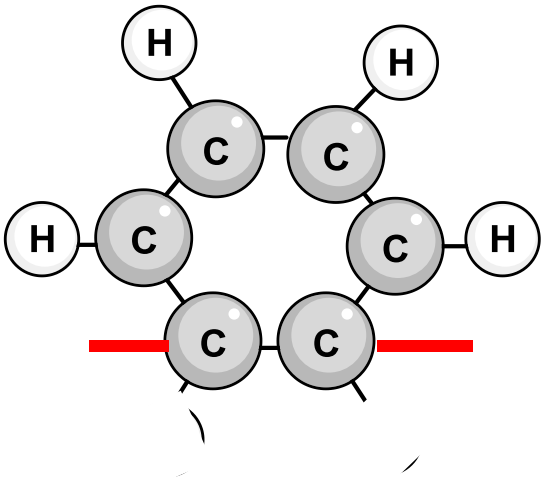


Atáctico

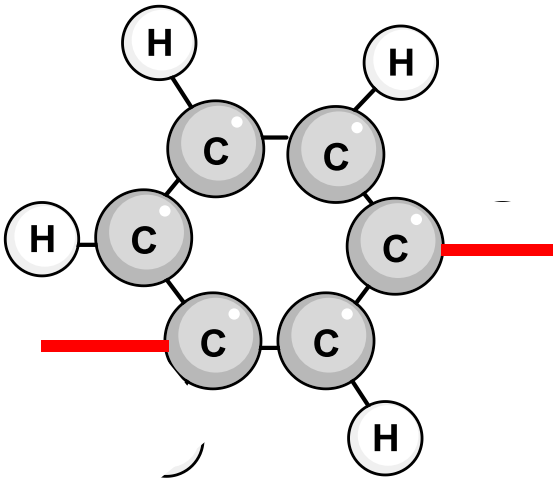
Sindiotáctico

Isotáctico

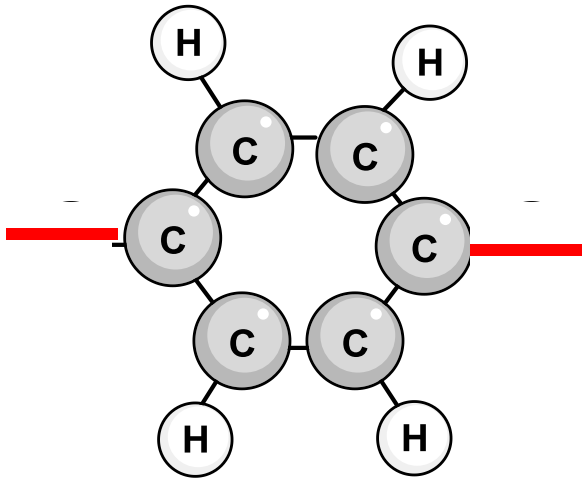
Isómeros de benceno



ORTO



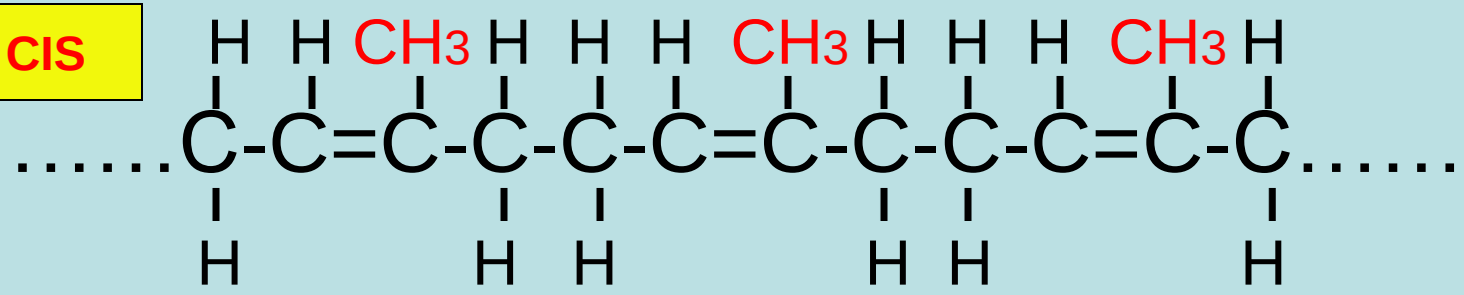
META



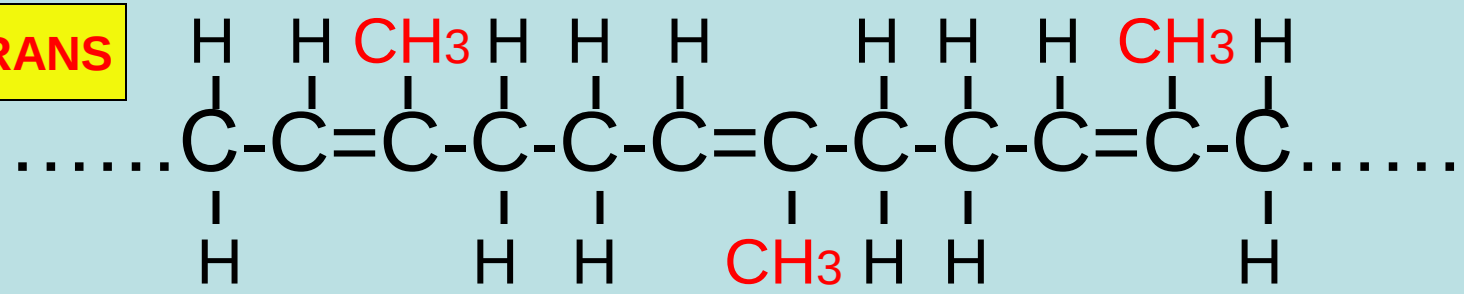
PARA

Isómeros

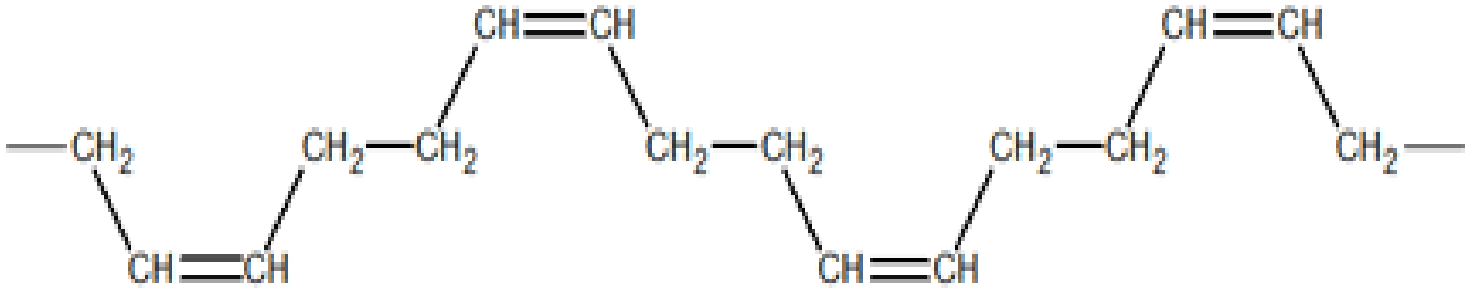
CIS



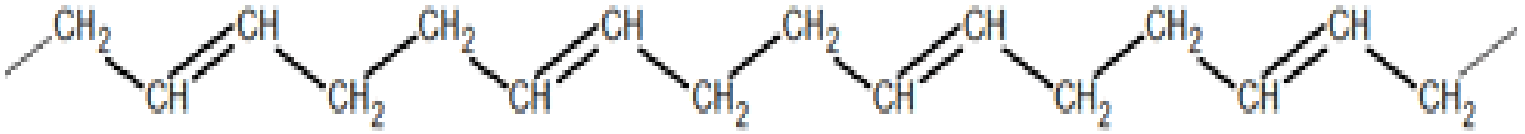
TRANS



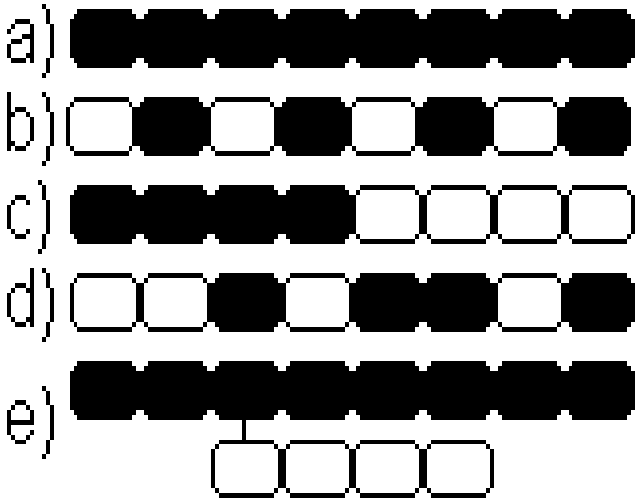
La primera se llama configuración *CIS* y así es el hule de la hevea y el de Guayule que se caracterizan por su flexibilidad y su elasticidad, la cual deben en parte a su estructura CIS, que es irregular y les impide cristalizar.



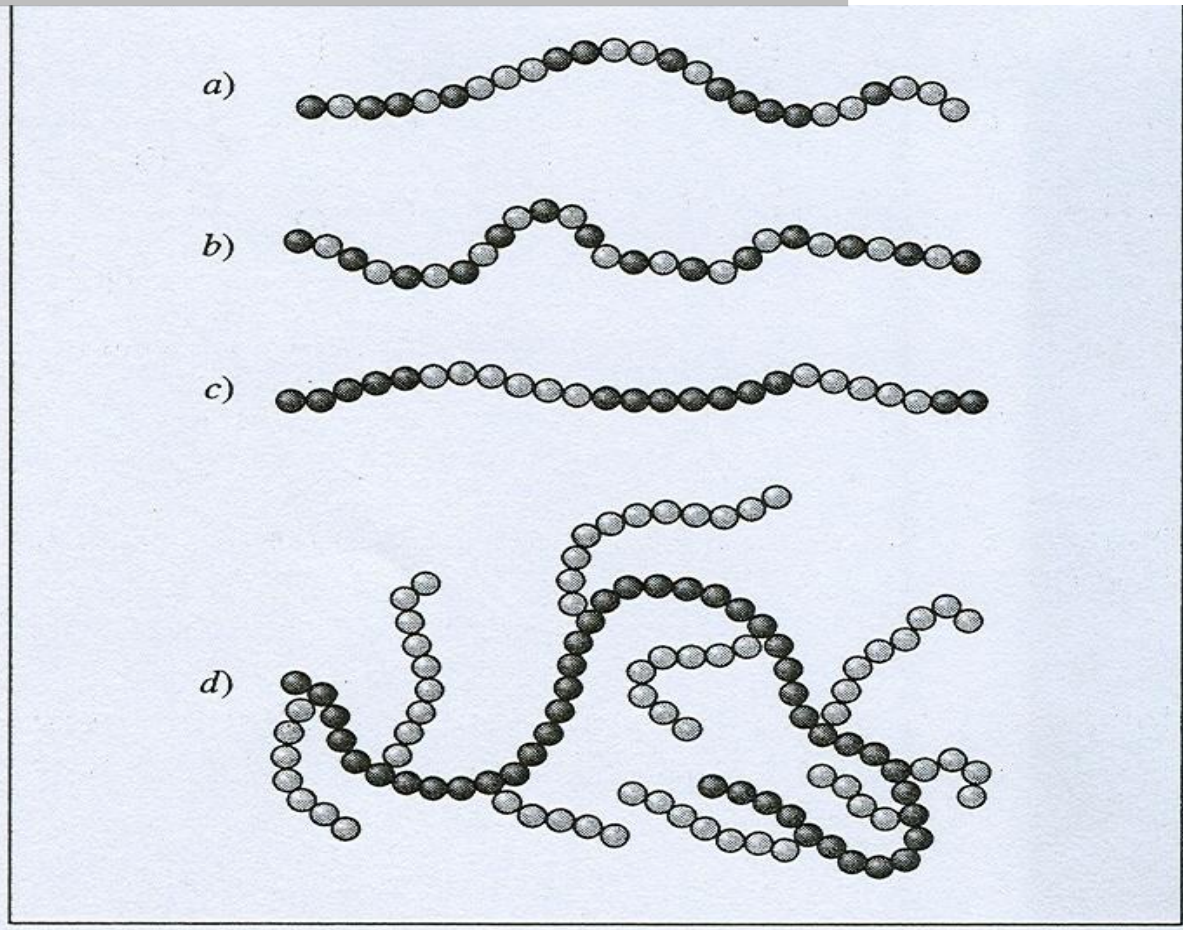
En cambio, la configuración *TRANS*, con gran regularidad estructural, está presente en el hule de gutapercha, que es cristalino, mucho menos elástico, con alta dureza, por lo que se lo emplea como cubierta de pelotas de golf.



Copolímeros

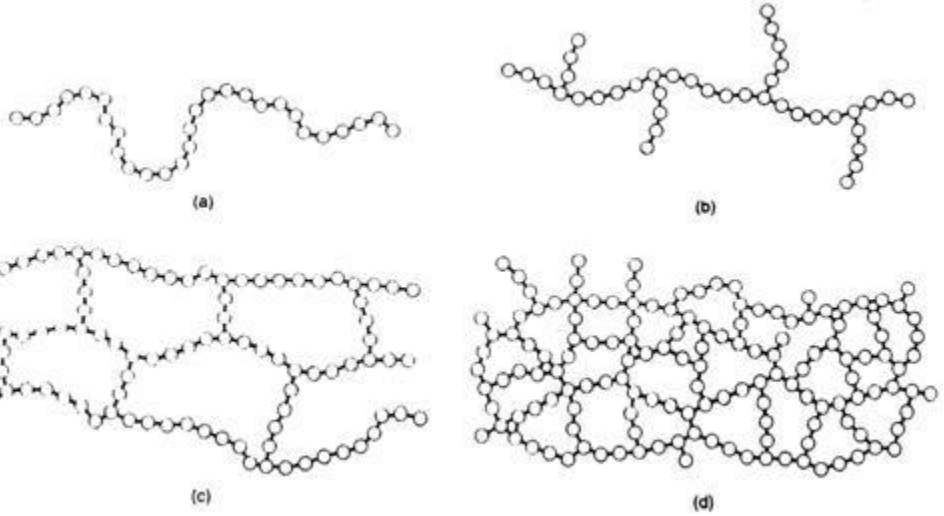


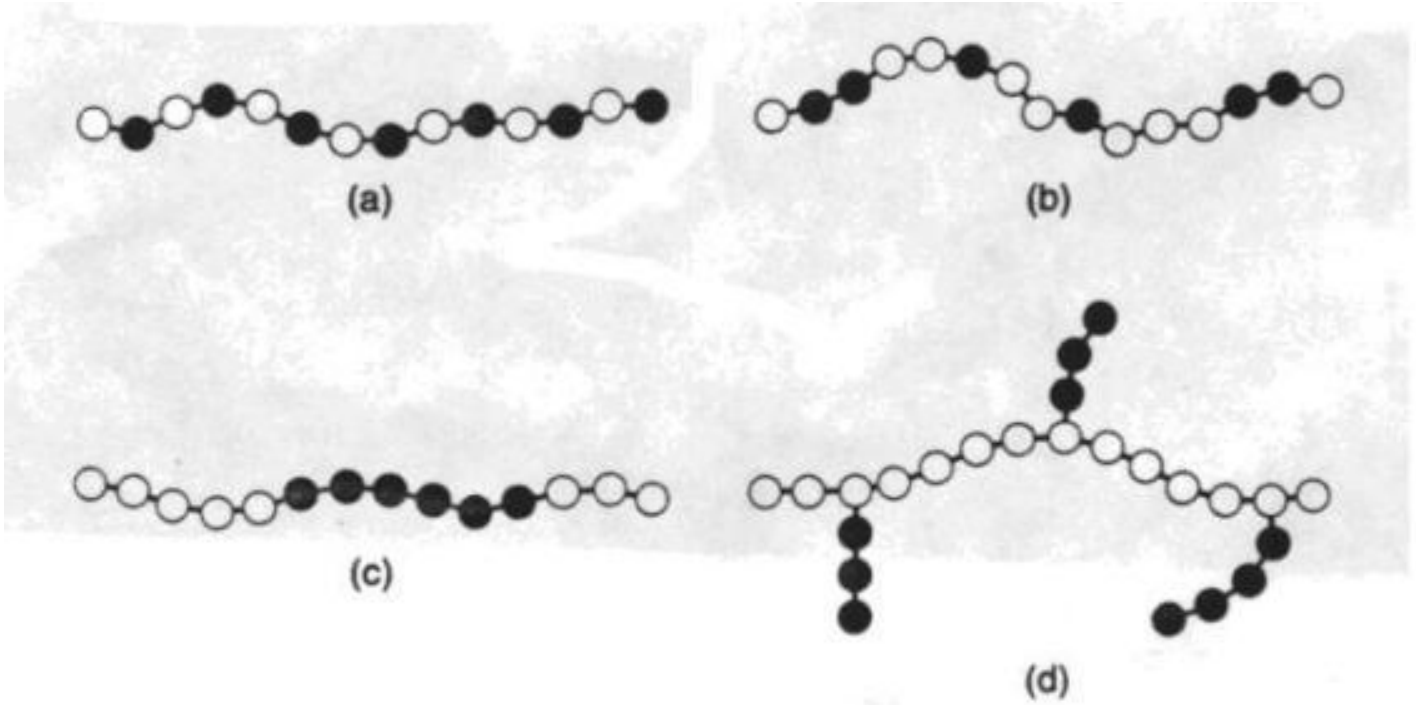
a).Homopolímero
b).Copolímero alternante
c).Copolímero bloque
d).Copolímero aleatorio
e).Copolímero de injerto



(Según W. G. Moffatt, G. W. Pearsall y J. Wulff, «The Structure and Properties of Materials», vol. I, «Structure», Wiley, 1965, p. 108.)

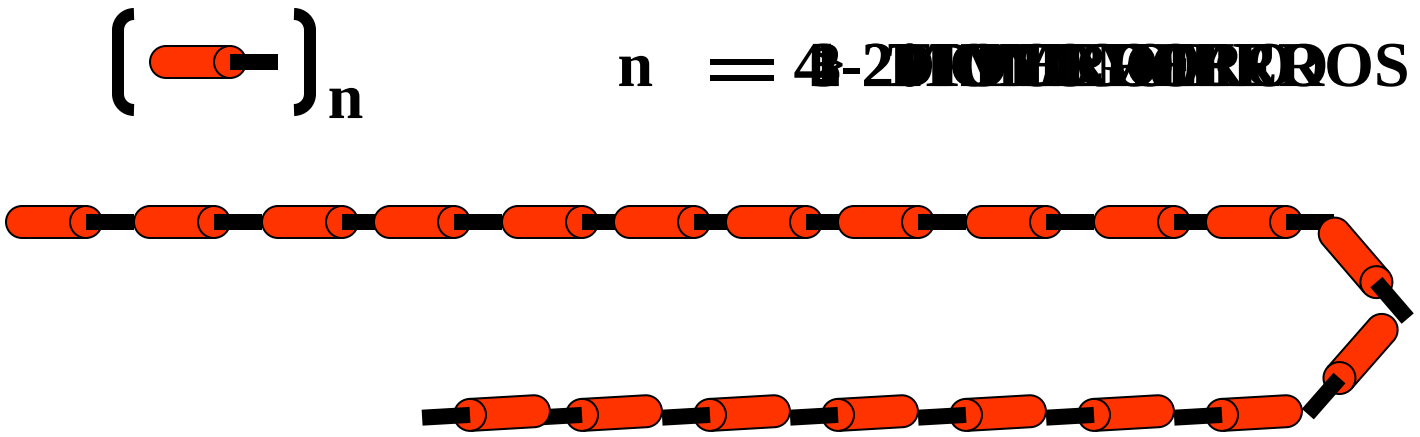
FIGURA 7.8. Ordenaciones de copolímeros. *a*) Copolímero en donde las distintas unidades están distribuidas al azar a lo largo de la cadena; *b*) las unidades están alternadas regularmente; *c*) un copolímero en bloque, y *d*) un copolímero de injerto.

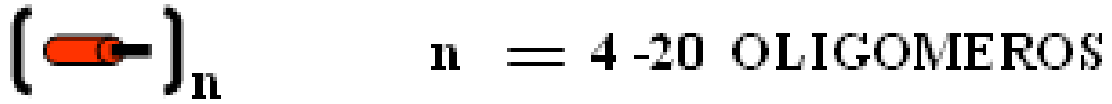

(a)
(b)
(c)
(d)

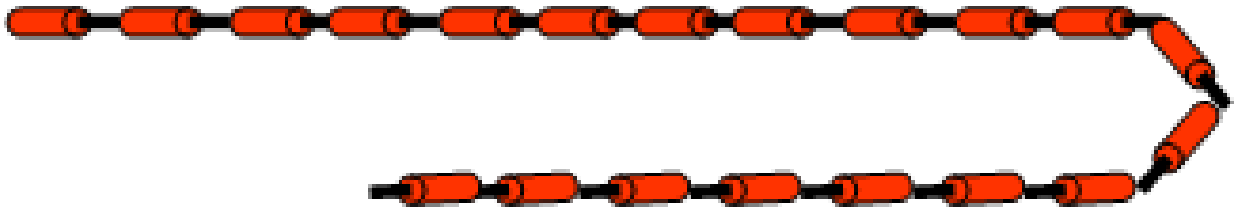

(a)
(b)
(c)
(d)

POLIMEROS:
¿Que es un polímero?

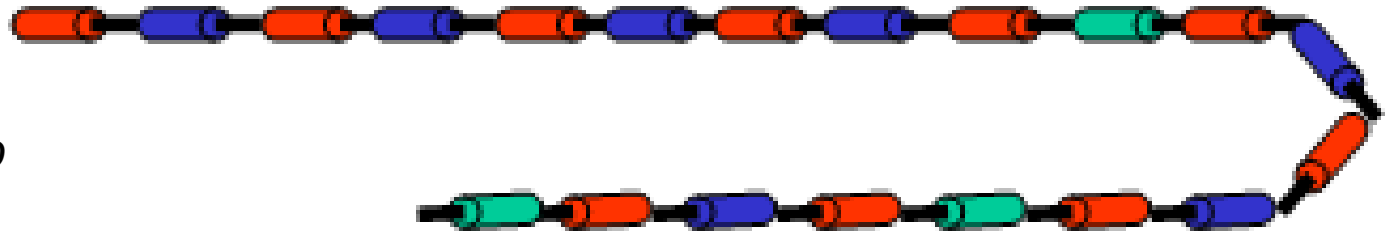
Es una macromolécula formada por la unión de moléculas de menor tamaño que se conocen como monómeros.





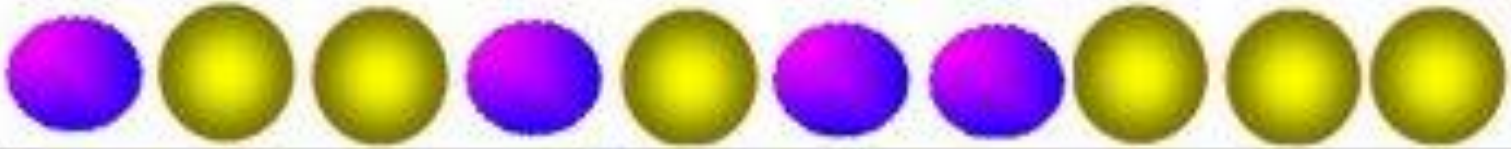


Homopolímero

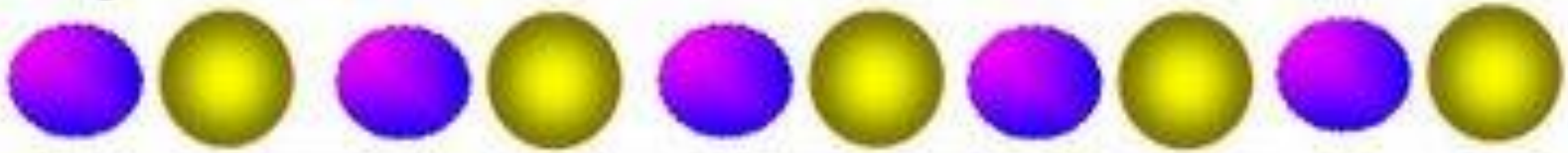


Copolímero

Copolímero al azar

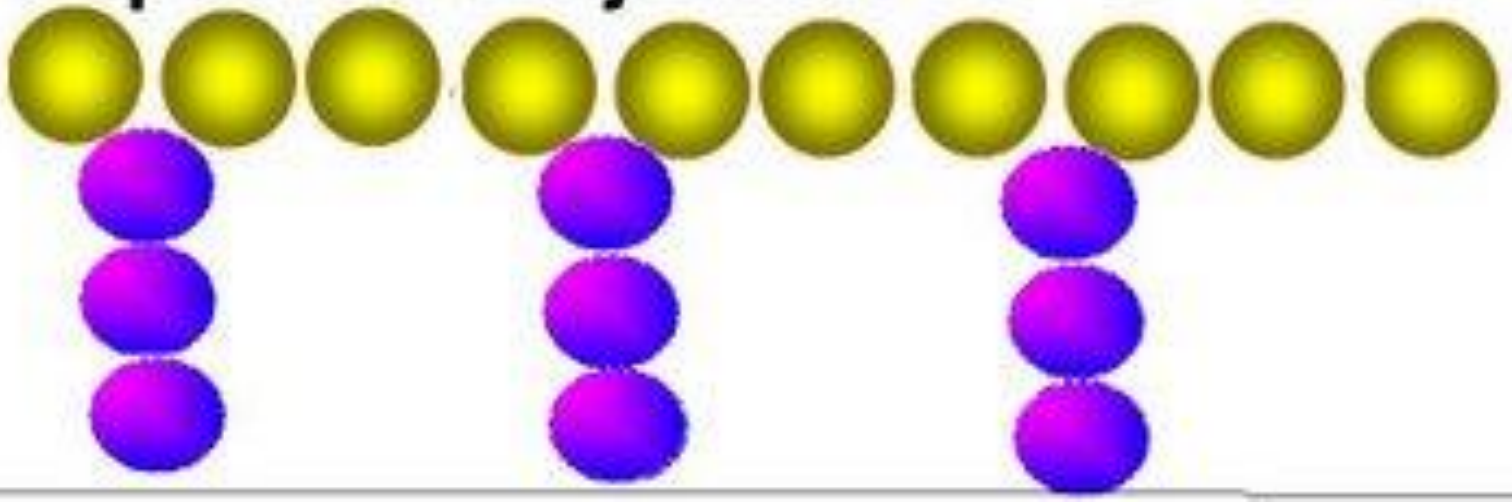


Copolímero alternado

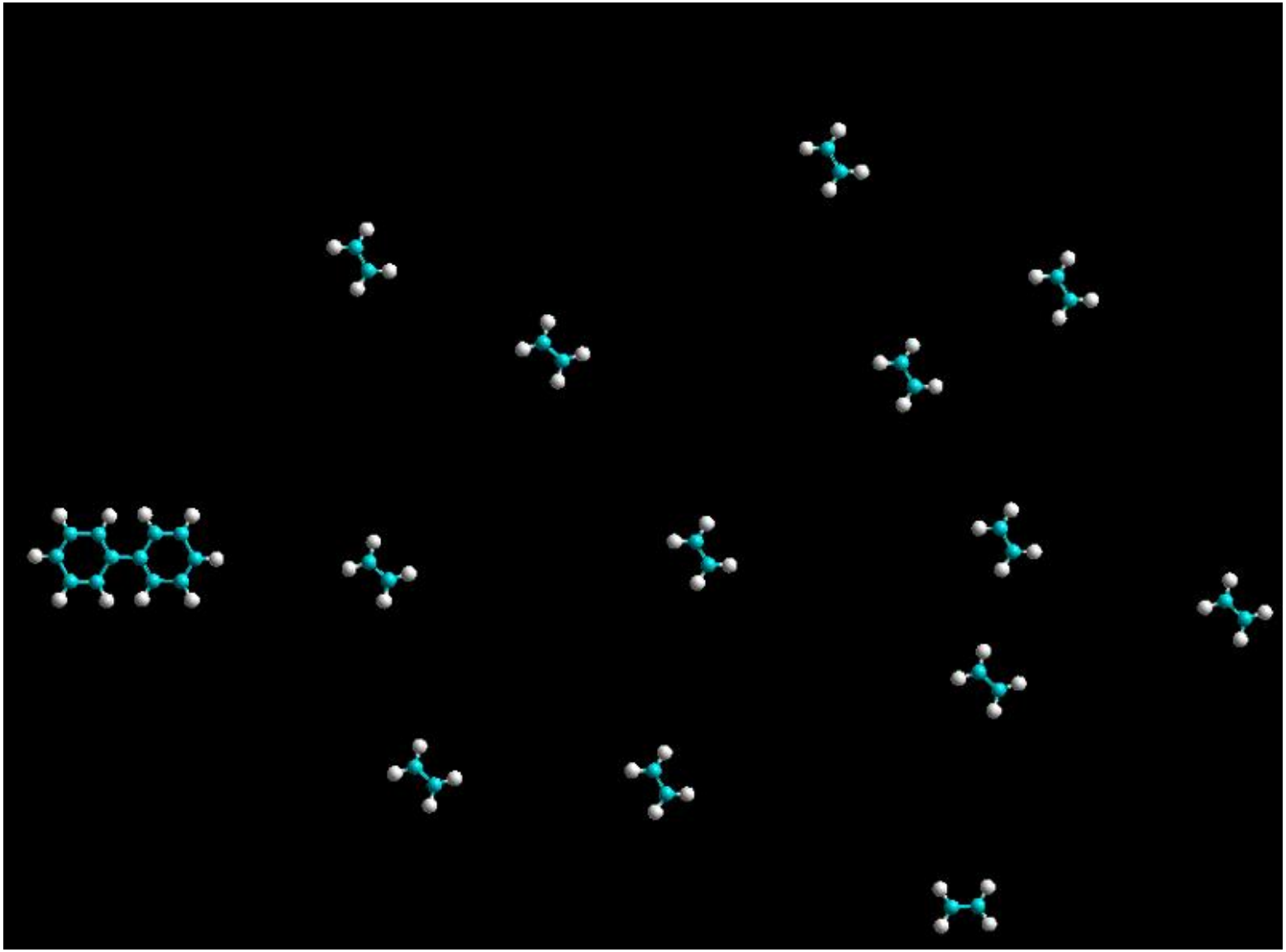


Copolímero en bloque

Copolímero injertado



POLIMERIZACIÓN



Copolímero

policloruro de vinilo-poliacetato de vinilo

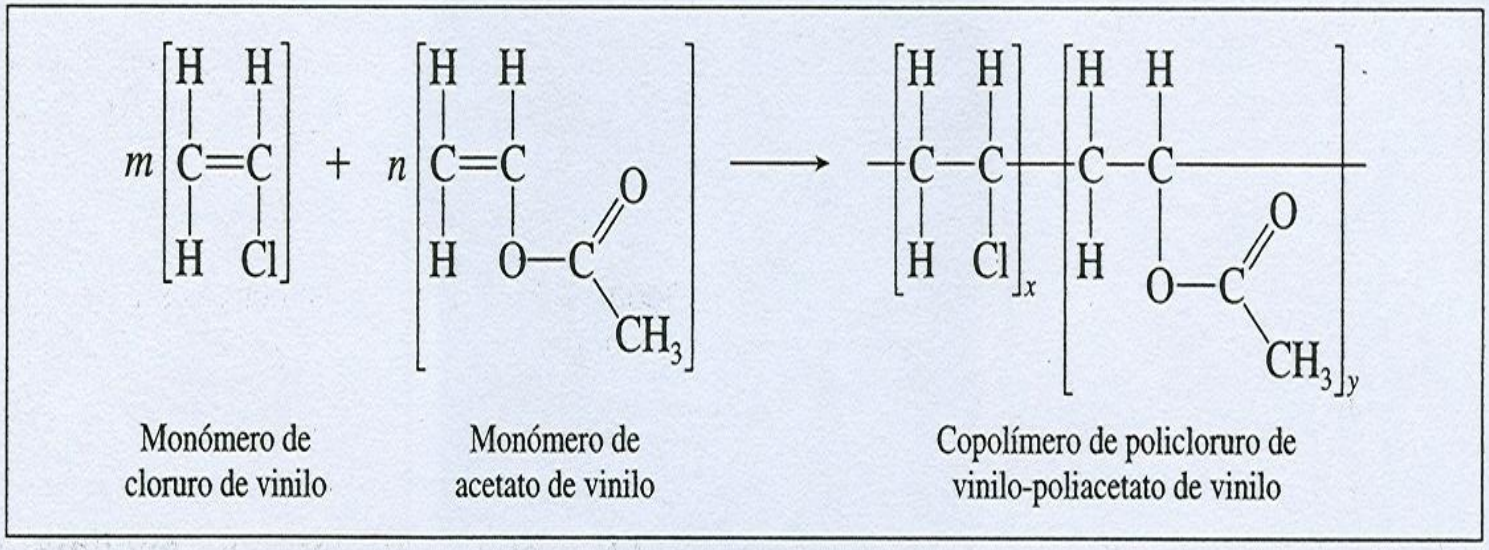
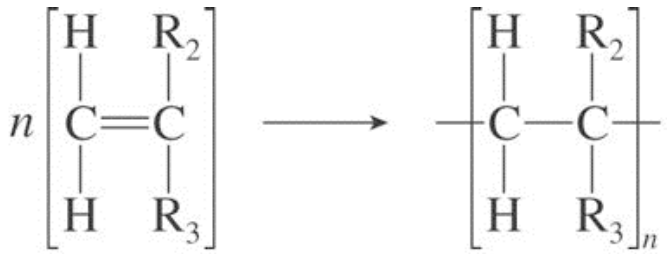
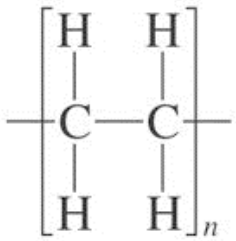
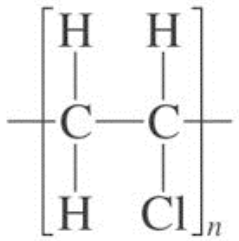


FIGURA 7.9. Reacción de polimerización generalizada de monómeros de cloruro de vinilo y acetato de vinilo para producir un copolímero de policloruro de vinilo-poliacetato de vinilo.

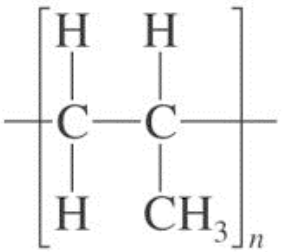




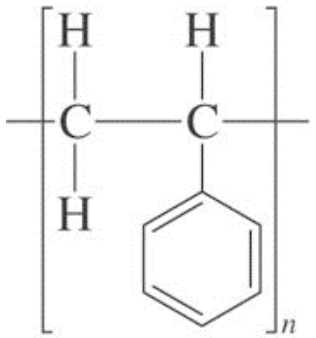
Polietileno
pf: 110-137°C
(230-278°F)



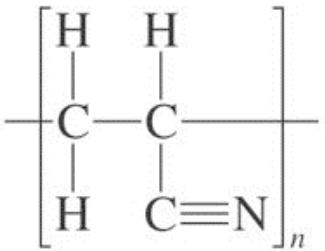
Policloruro de vinilo
pf: ~204°C
(~400°F)



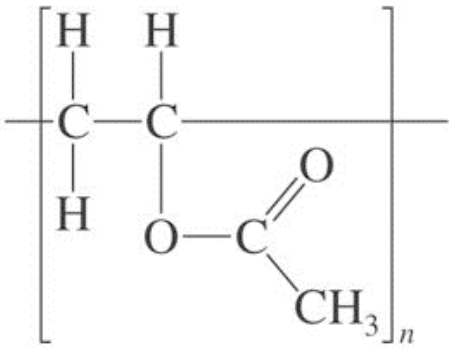
Polipropileno
pf: 165-177°C
(330-350°F)



Poliestireno
pf: 150-243°C
(330-470°F)

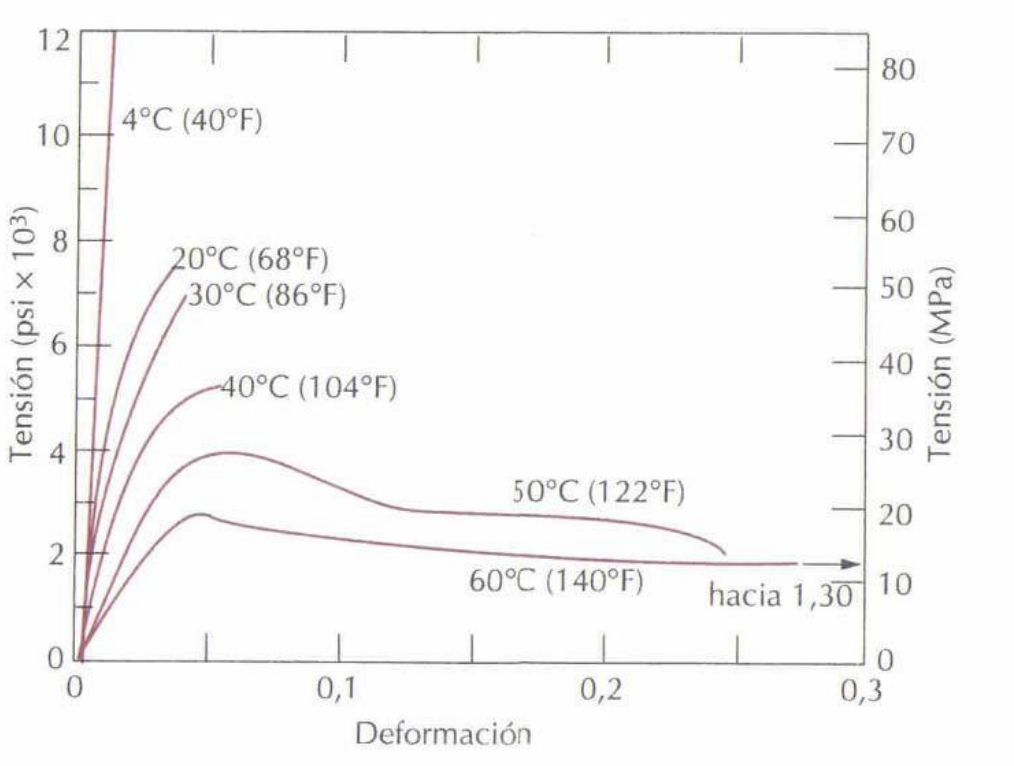


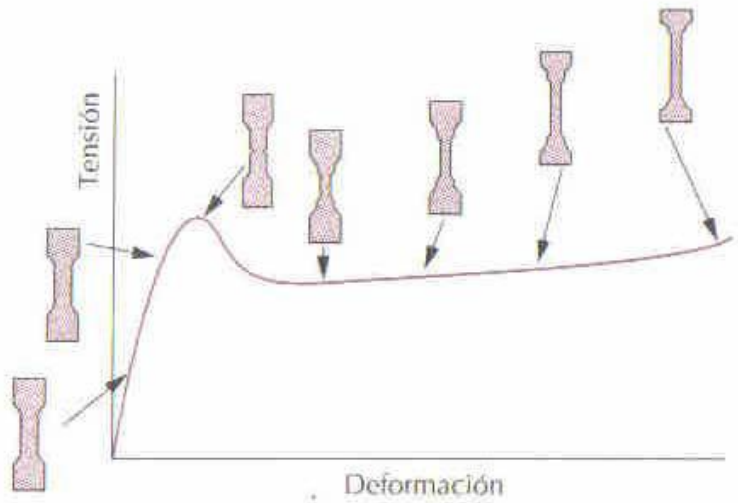
Poliacrilonitrilo
(no se funde)

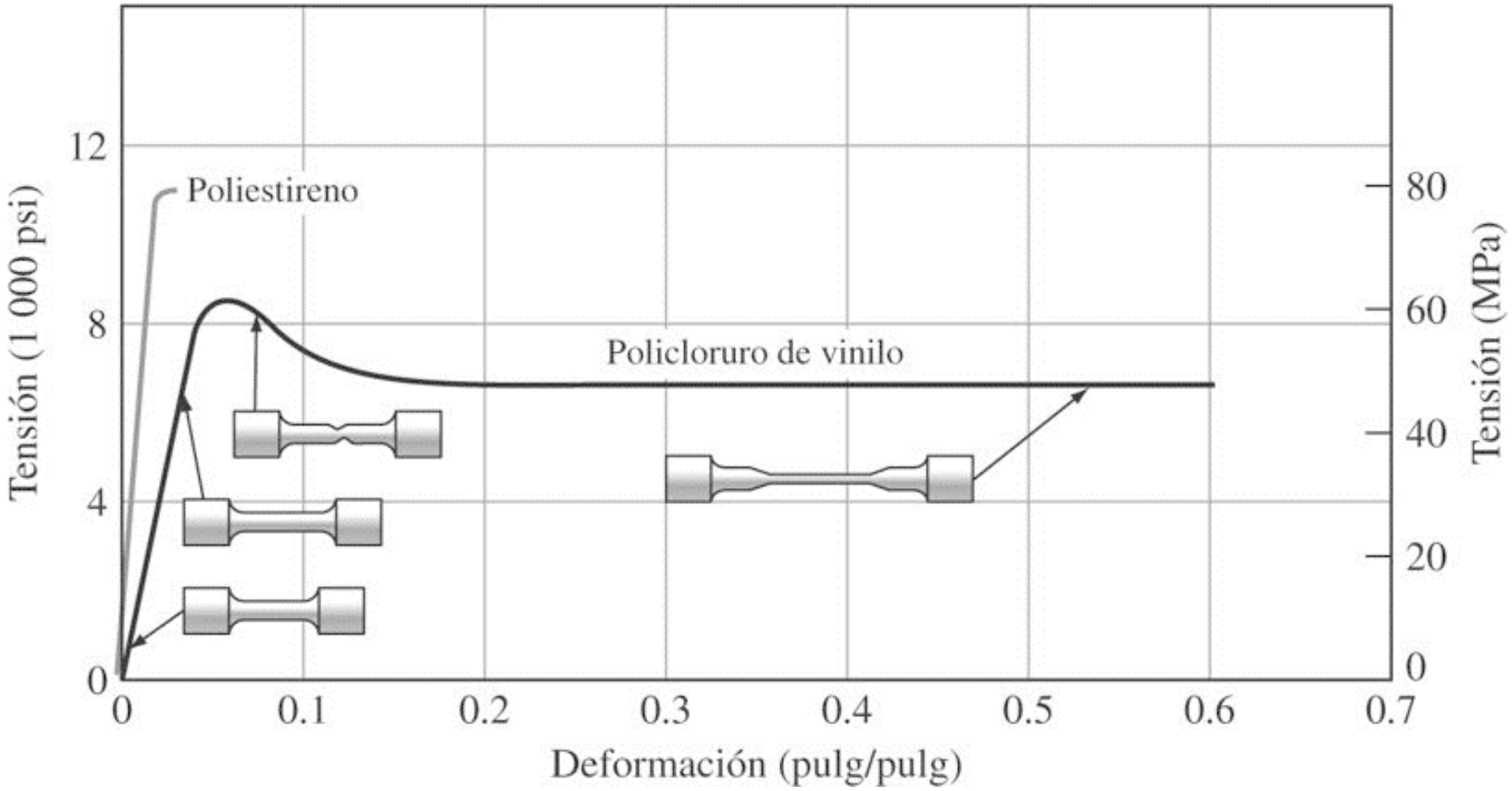


Poliacetato de vinilo
pf: 177°C (350°F)

Tensión–deformación de polímeros







Datos de tensión-deformación para el termoplástico amorfo policloruro de vinilo (PVC) y el poliestireno (PS). Los dibujos presentan diversos modos de deformación de la muestra en varios puntos sobre la curva de esfuerzo-deformación.

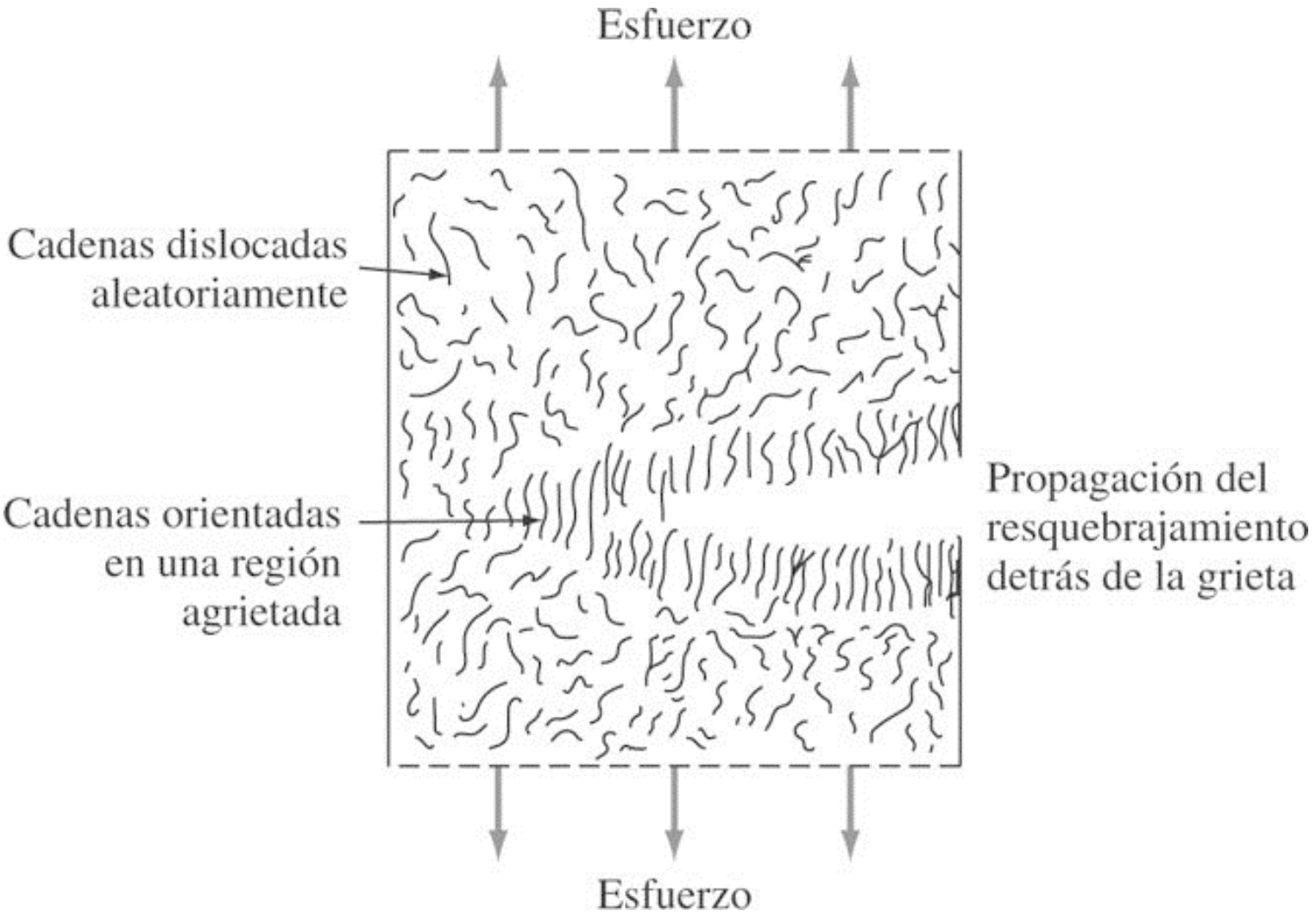
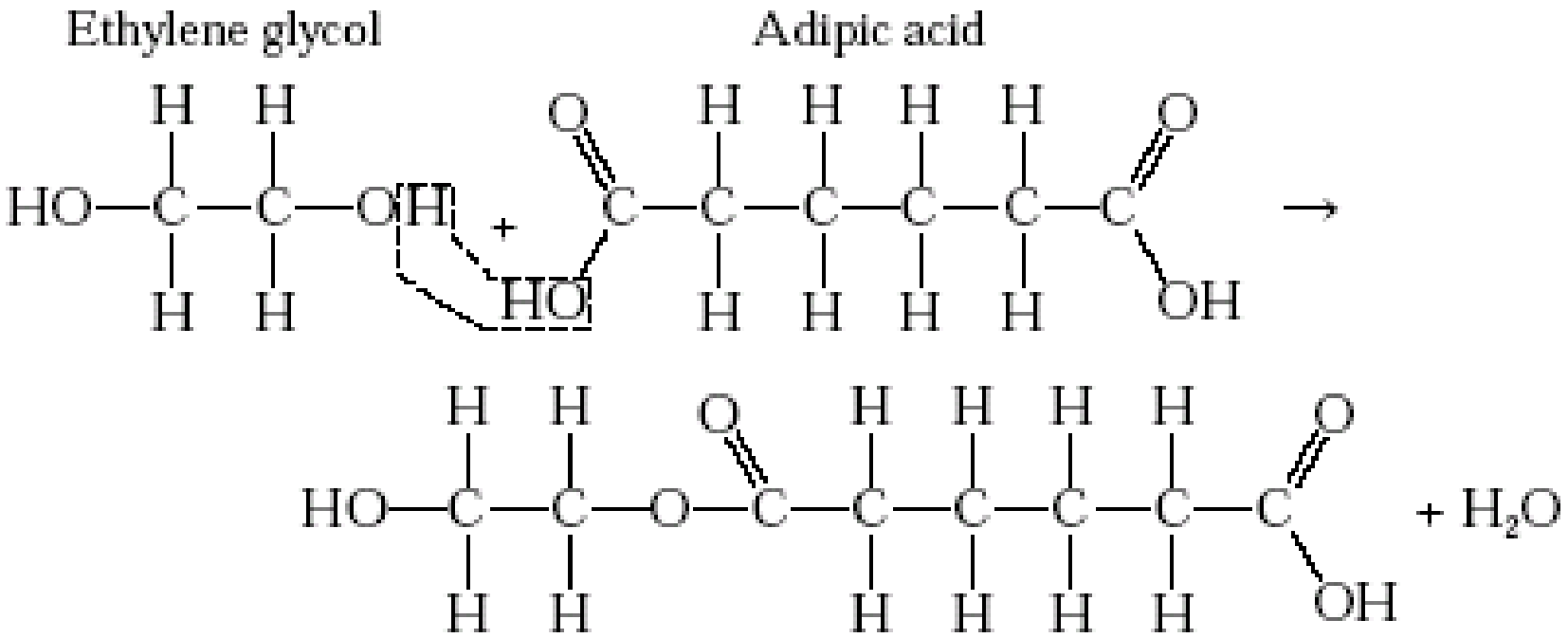
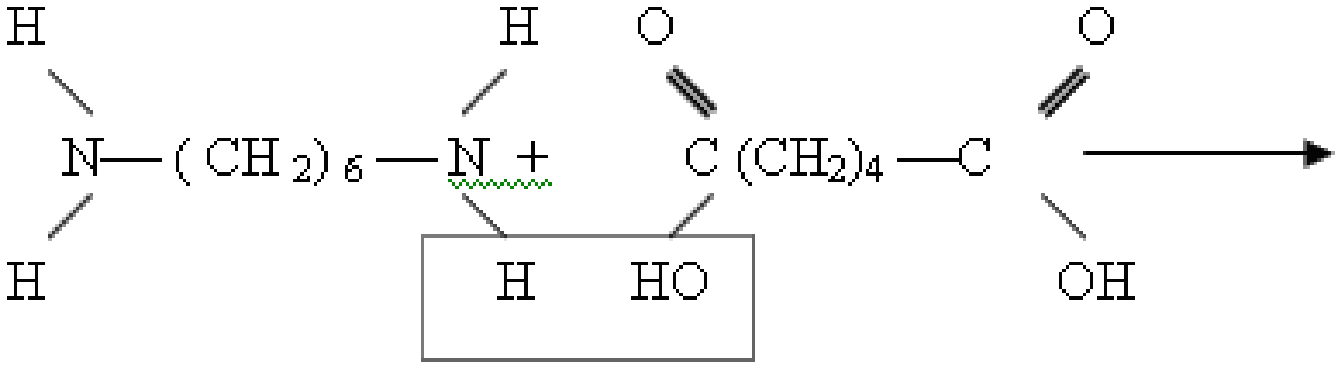


Ilustración esquemática de la estructura de un agrietamiento cercano al extremo de una fisura en un termoplástico vidriado.

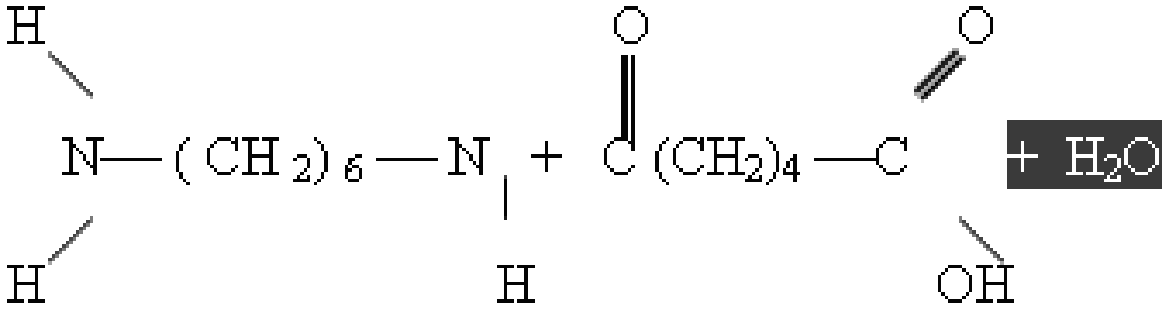
COPOLÍMEROS

Polimerización por condensación



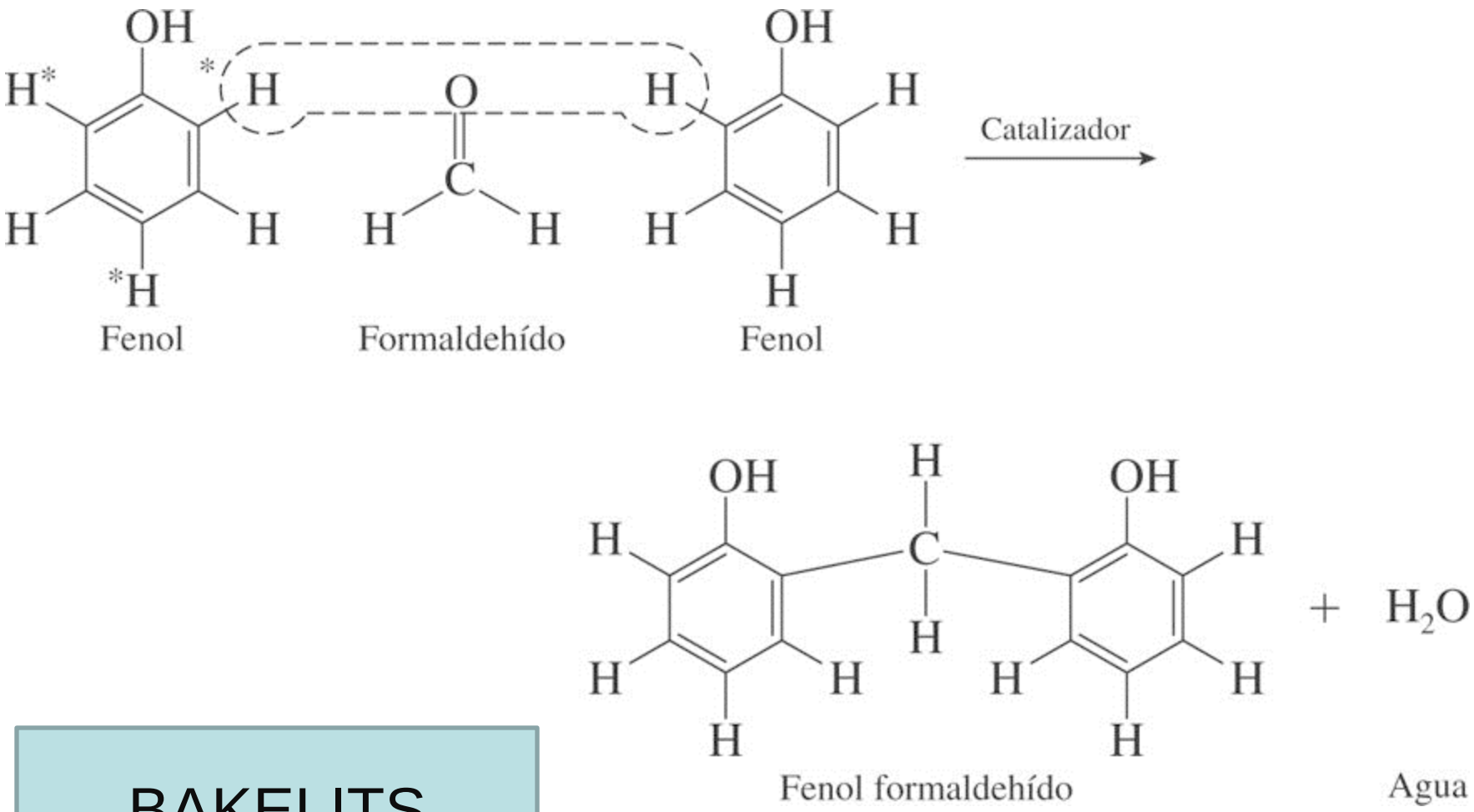


Hexametiolendiamina Ácido adípico



Hexametiolendiamina Agua

La correspondiente poliamida es el nylon 6,6


OH
H*
*
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O
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OH
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H
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H
H
H
H
*H
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H
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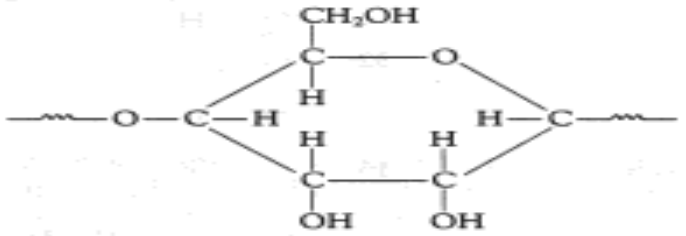
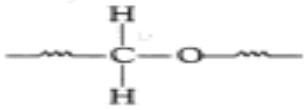
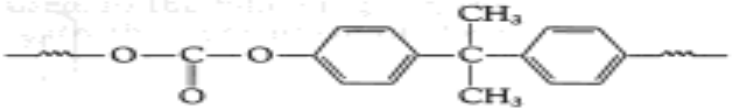
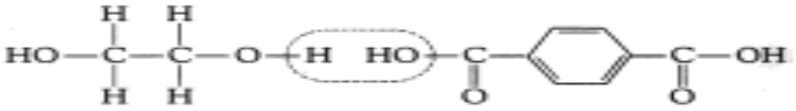
Catalizador
Fenol
Formaldehído
Fenol
OH
H
OH
H
H
C
H
H
H
H
H
H
H
H
+
H_2O
Fenol formaldehído
Agua

BAKELITS

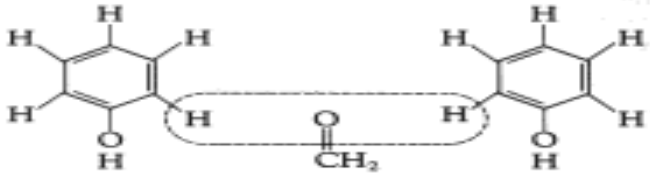
COPOLÍMEROS

TABLE 13.1 Summary of Important Polymers (*Continued*)

Group I. Thermoplastics (Continued)

Polymer	*Percentage of Market*	*Monomer(s) Used*
Cellulosics	<1	 (mer of cellulose)
Acetals	<1	 (mer)
Nylons	1	
Polycarbonates	<1	 (mer)
Fluoroplastics (example: polytetrafluoroethylene)	<1	
Polyester, thermoplastic type (example: polyethylene-terephthalate (dacron))	2	

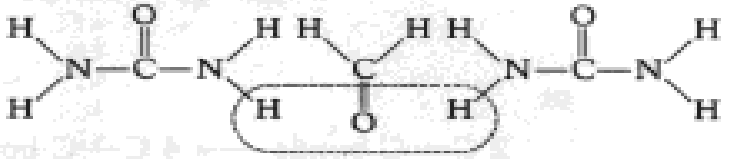
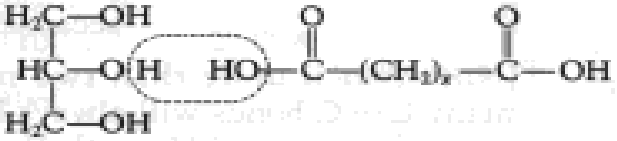
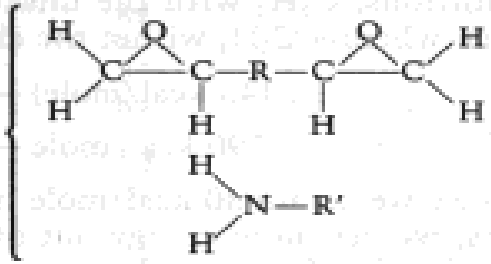
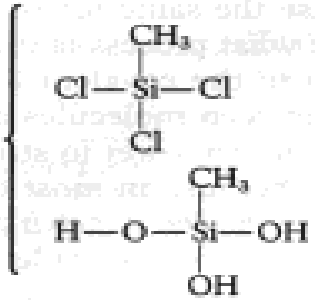
Group II. Thermosetting Polymers

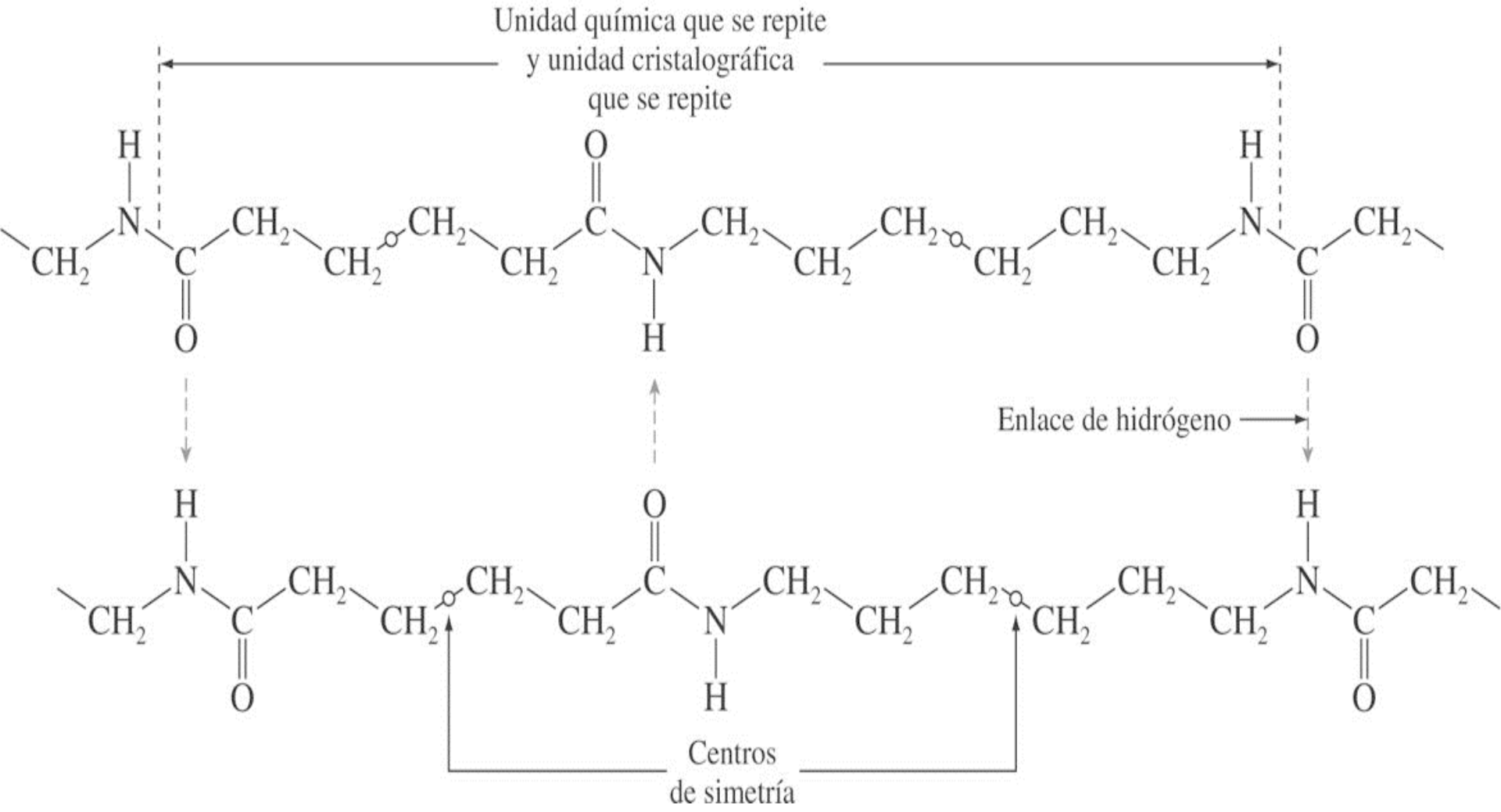
Phenolics (example: phenol formaldehyde)	6	

COPOLÍMEROS

TABLE 13.1 Summary of Important Polymers (*Continued*)

Group II. Thermosetting Polymers (Continued)

Polymer	*Percentage of Market*	*Monomer(s) Used*
Amino resins (example: urea formaldehyde)	4	
Polyesters, thermoset type	3	
Epoxies	1	 (R and R′ are complex polyfunctional molecules)
Polyurethane, also thermoplastic	4	 (diisocyanate) (R and R′ are complex polyfunctional molecules)
Silicones	1	 Trichlorosilane; Trihydroxy silane


Unidad química que se repite
y unidad cristalográfica
que se repite
Enlace de hidrógeno
Centros
de simetría

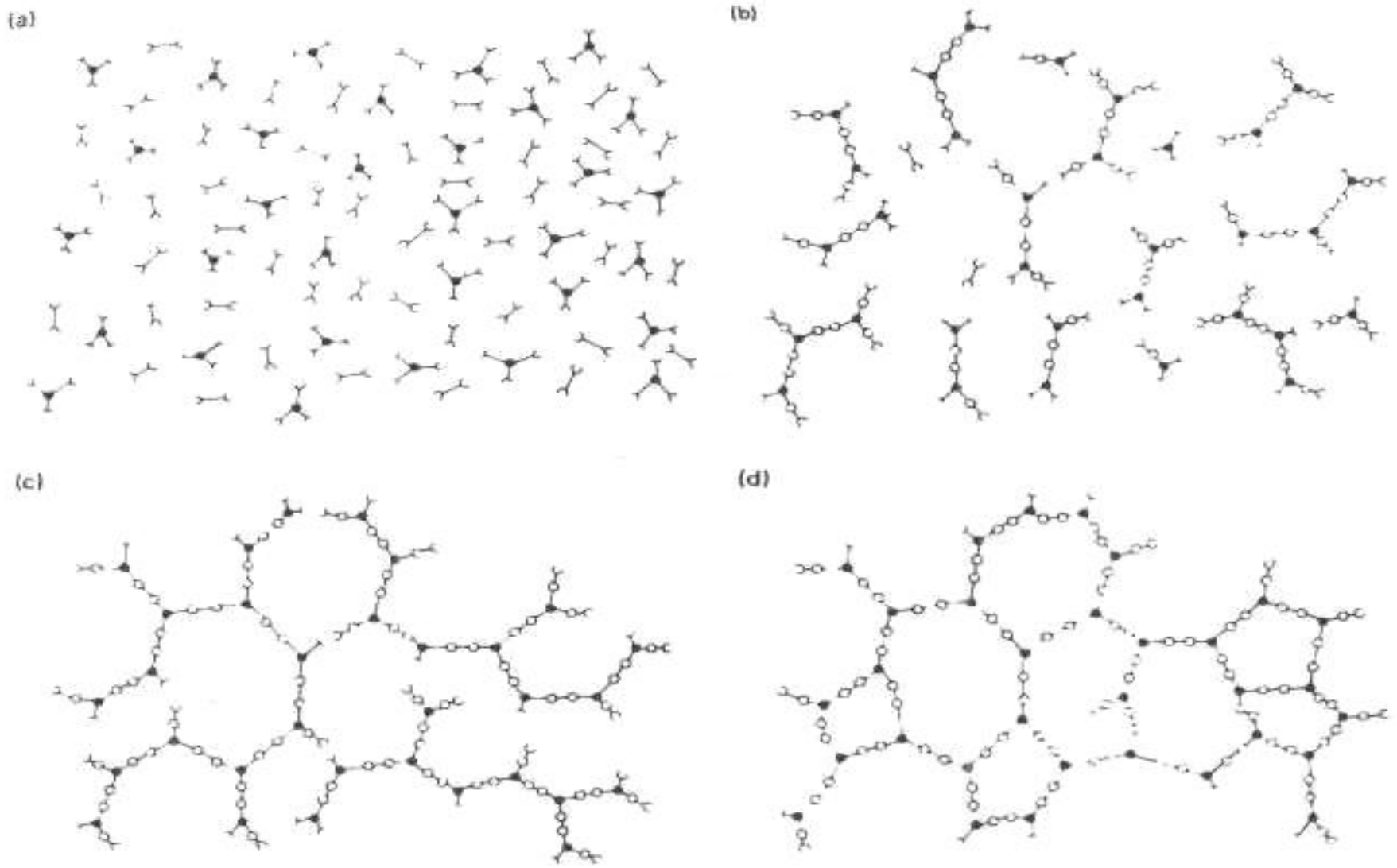
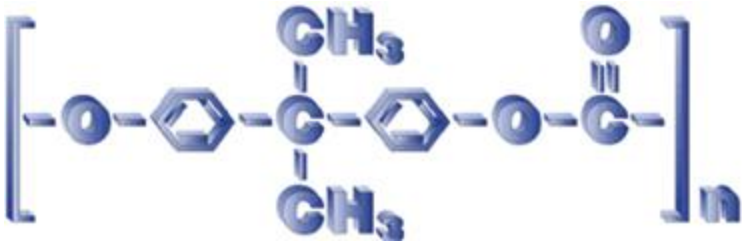
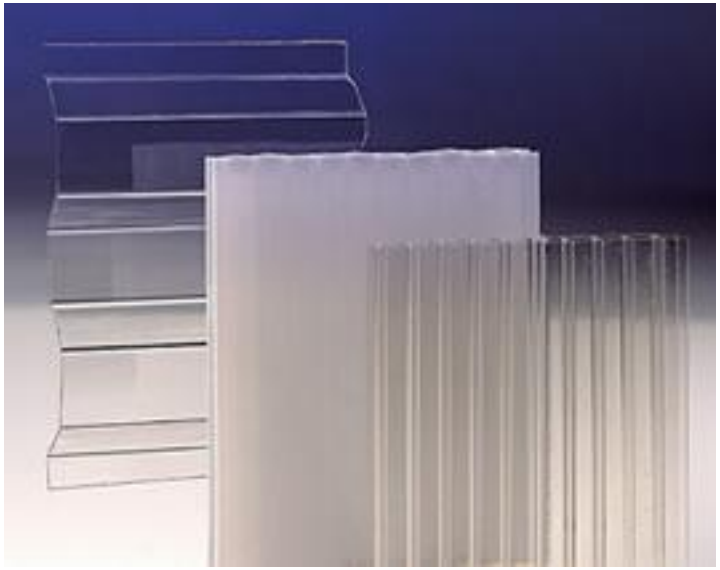


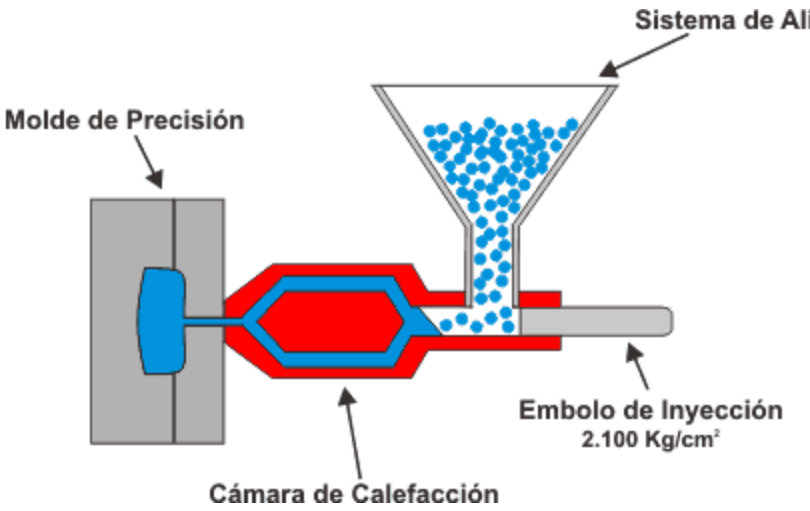
Figura 1.1 Representación en dos dimensiones del curado de un termoestable. (a) Monómeros. (b) Crecimiento lineal y ramificación por debajo del punto de gel. (c) Formación de un gel, reticulación incompleta. (d) Termoestable, curado total. (de Turi, 1981).

POLICARBONATO

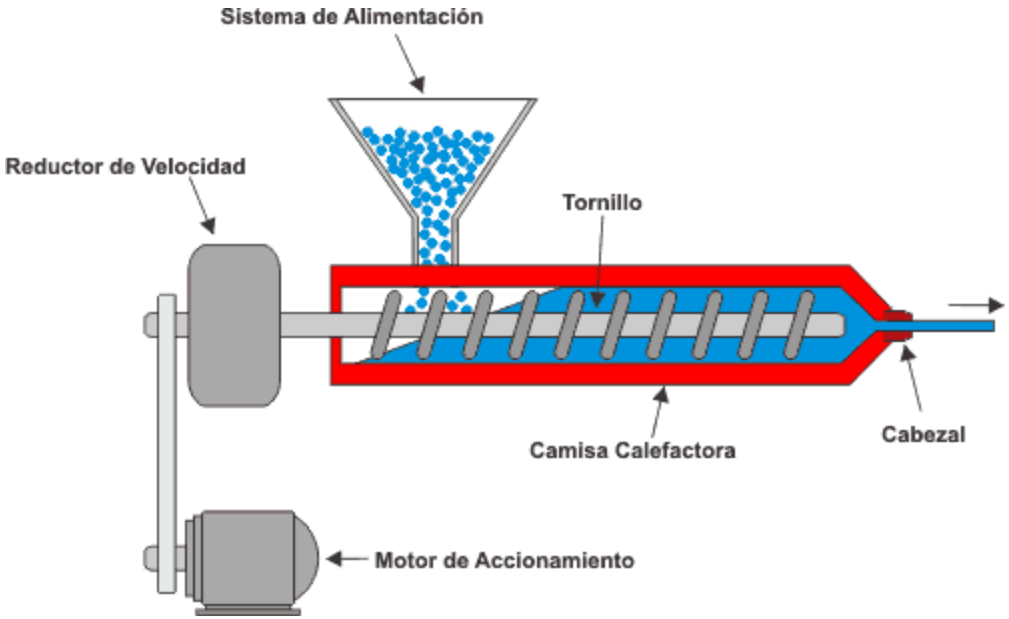
200 veces más resistente que el vidrio al impacto



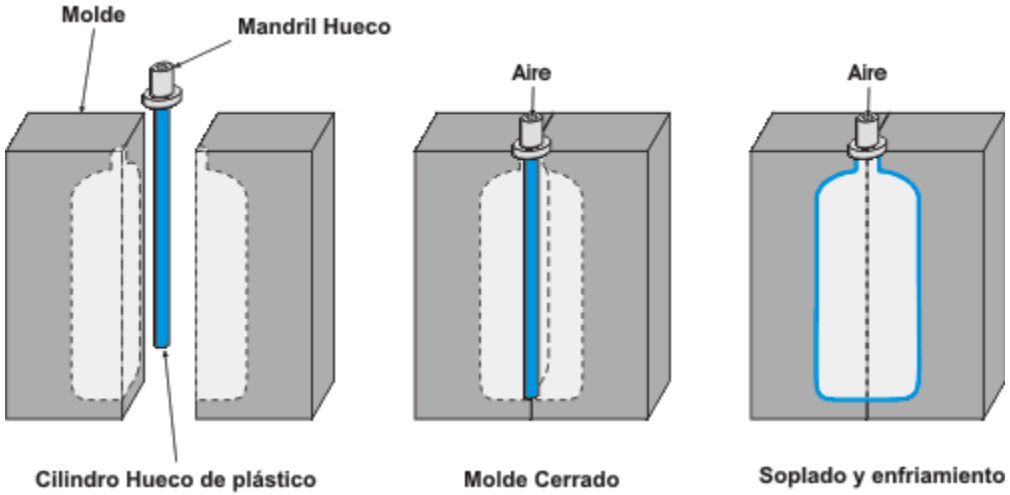




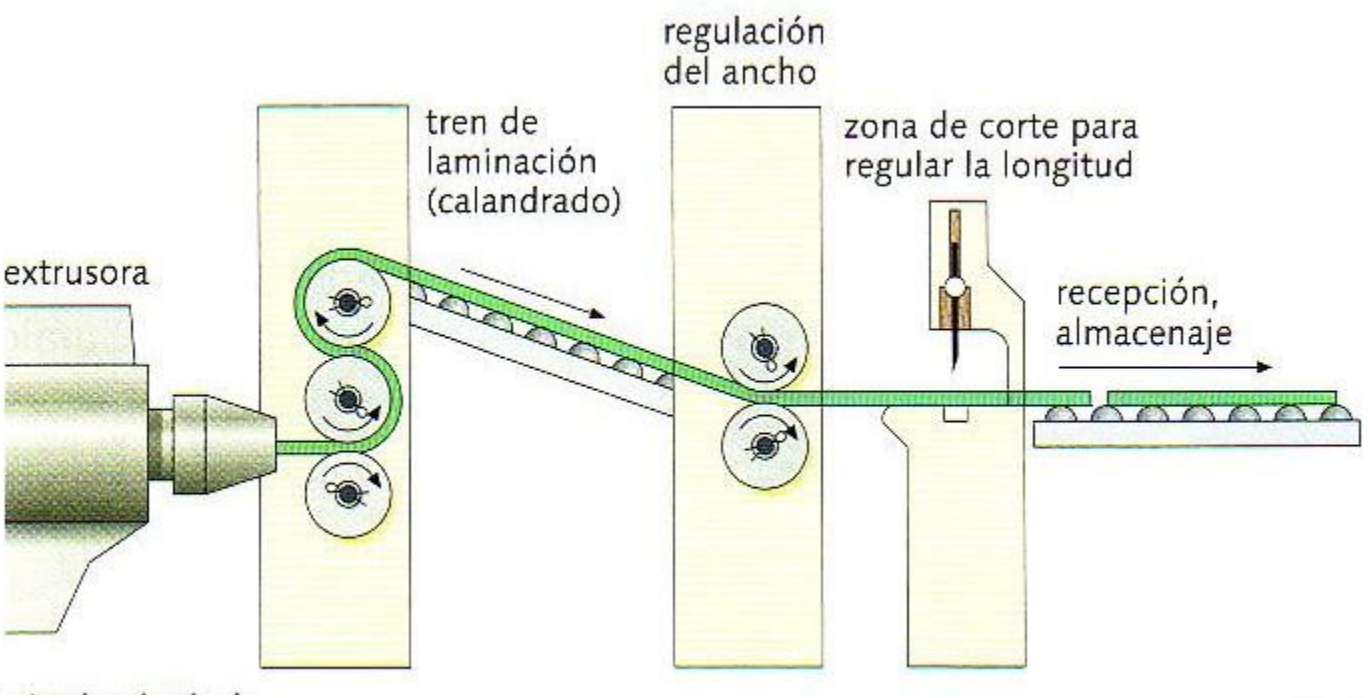
Moldeo por inyección

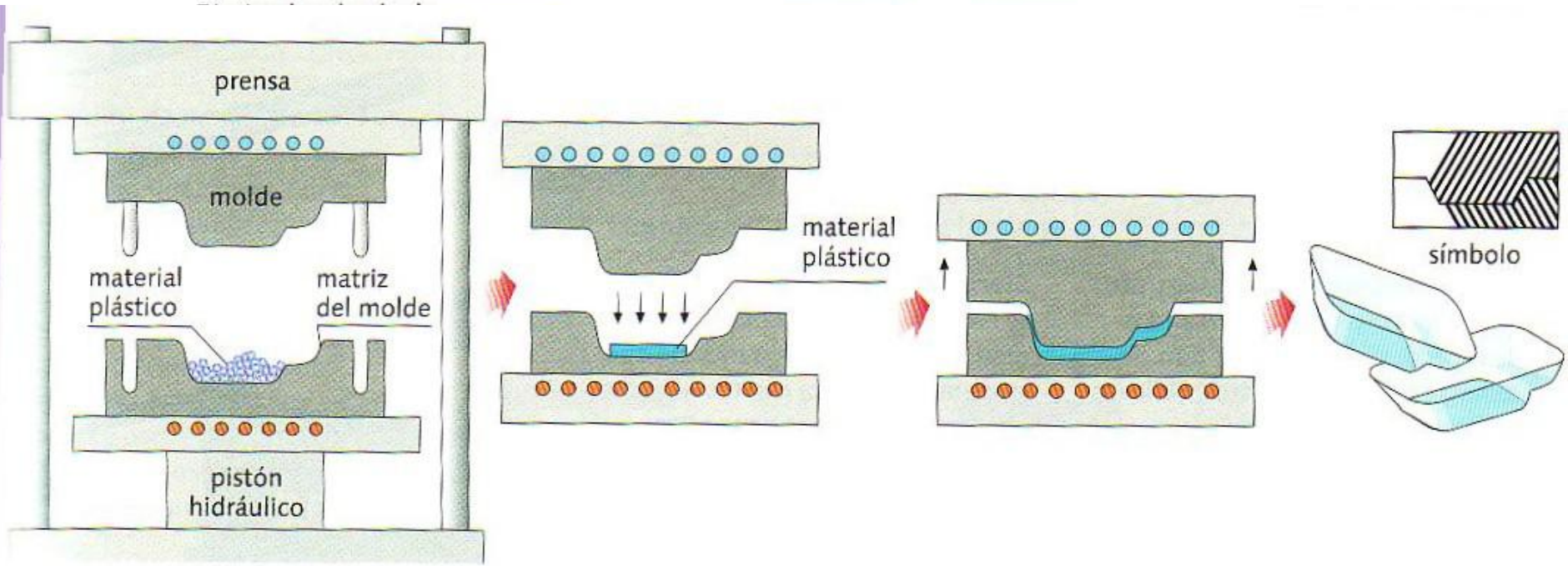


Moldeo por extrusión

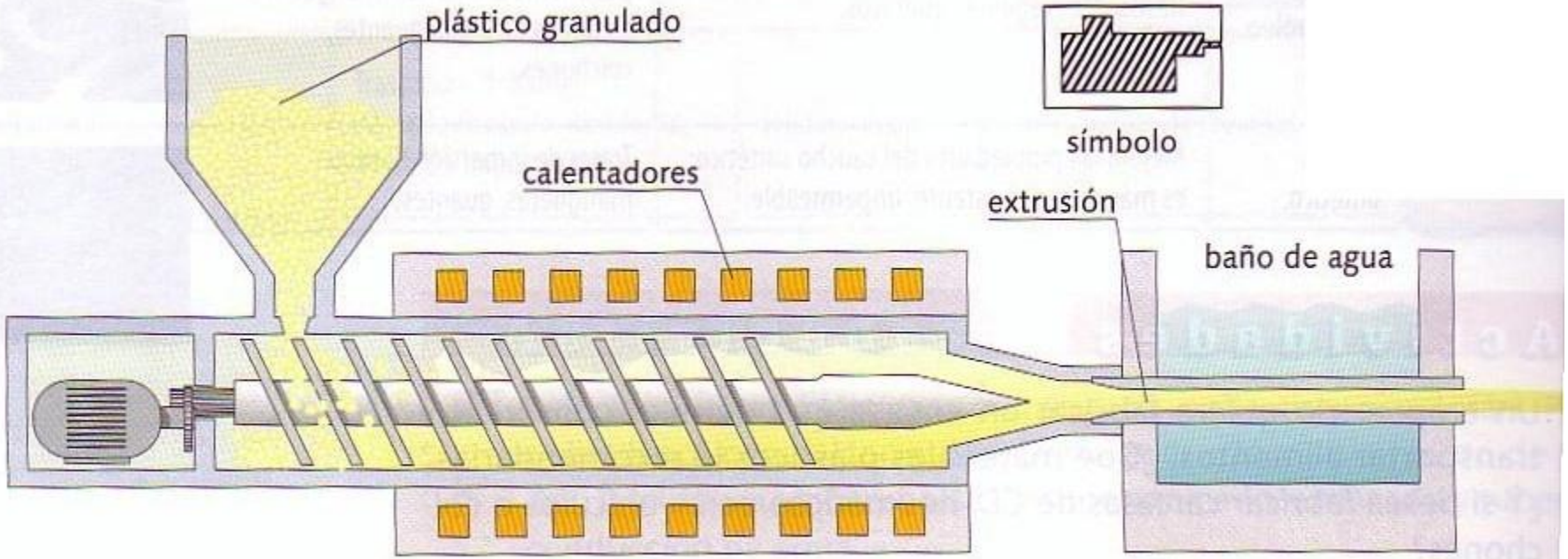


Moldeo por insuflación de aire

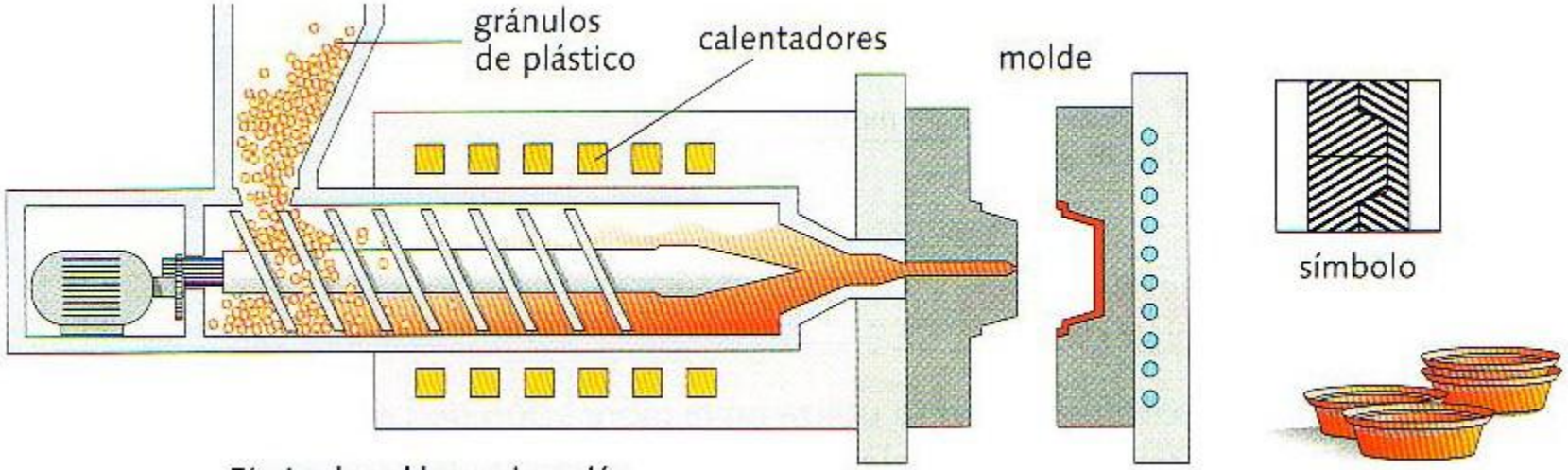




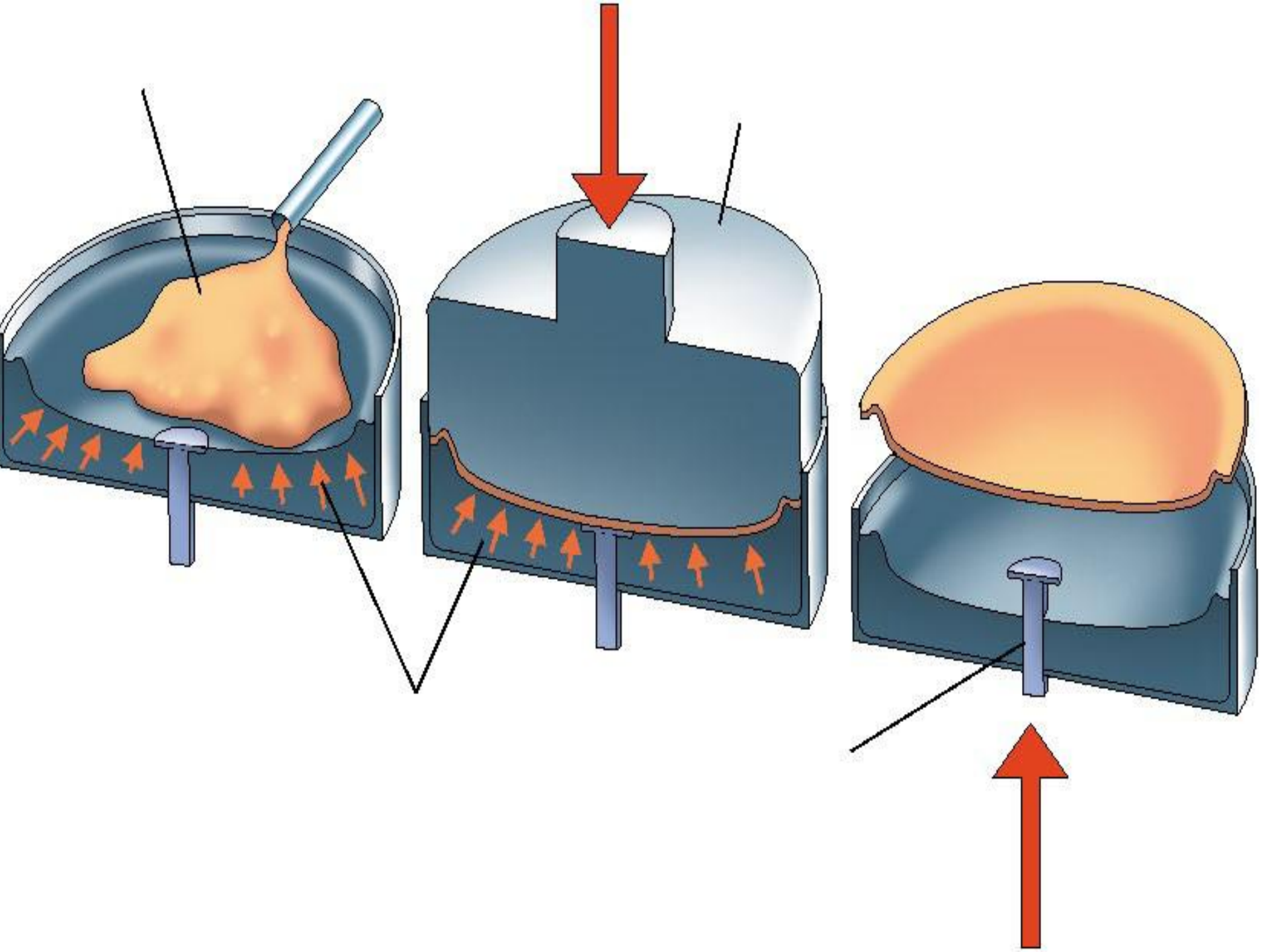
El moldeo por compresión se realiza en una máquina llamada prensa.

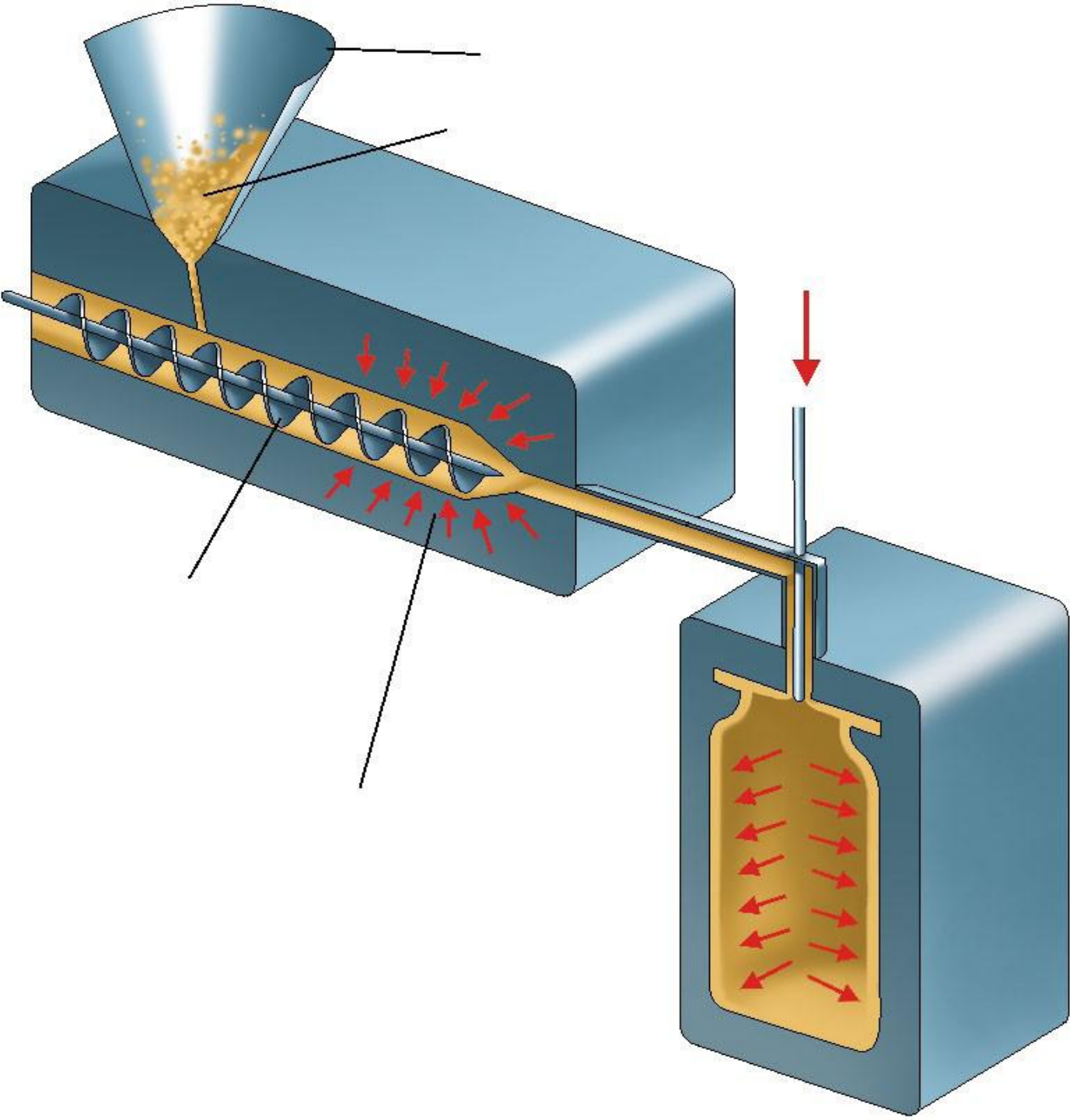


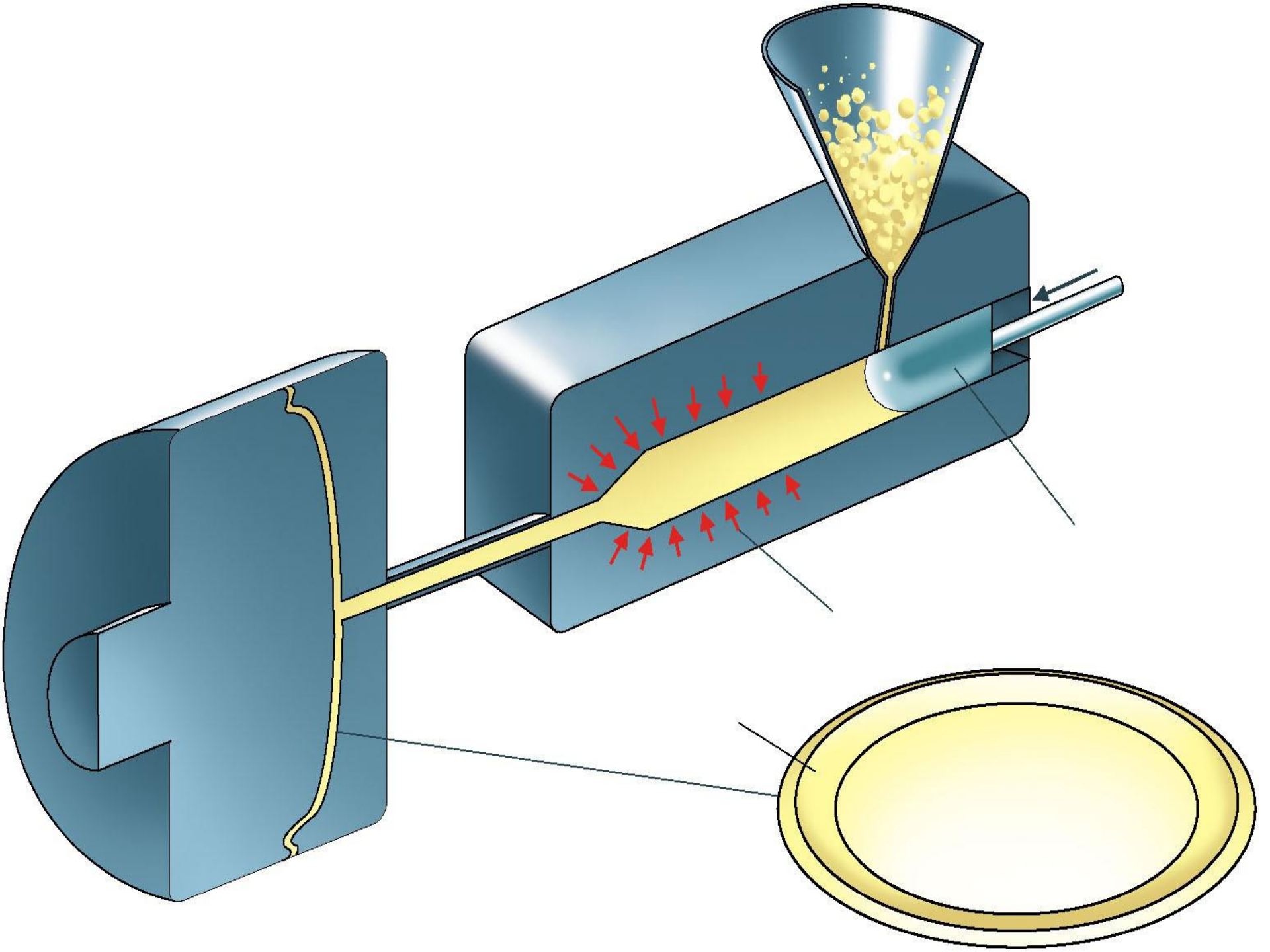
Técnica de extrusión.

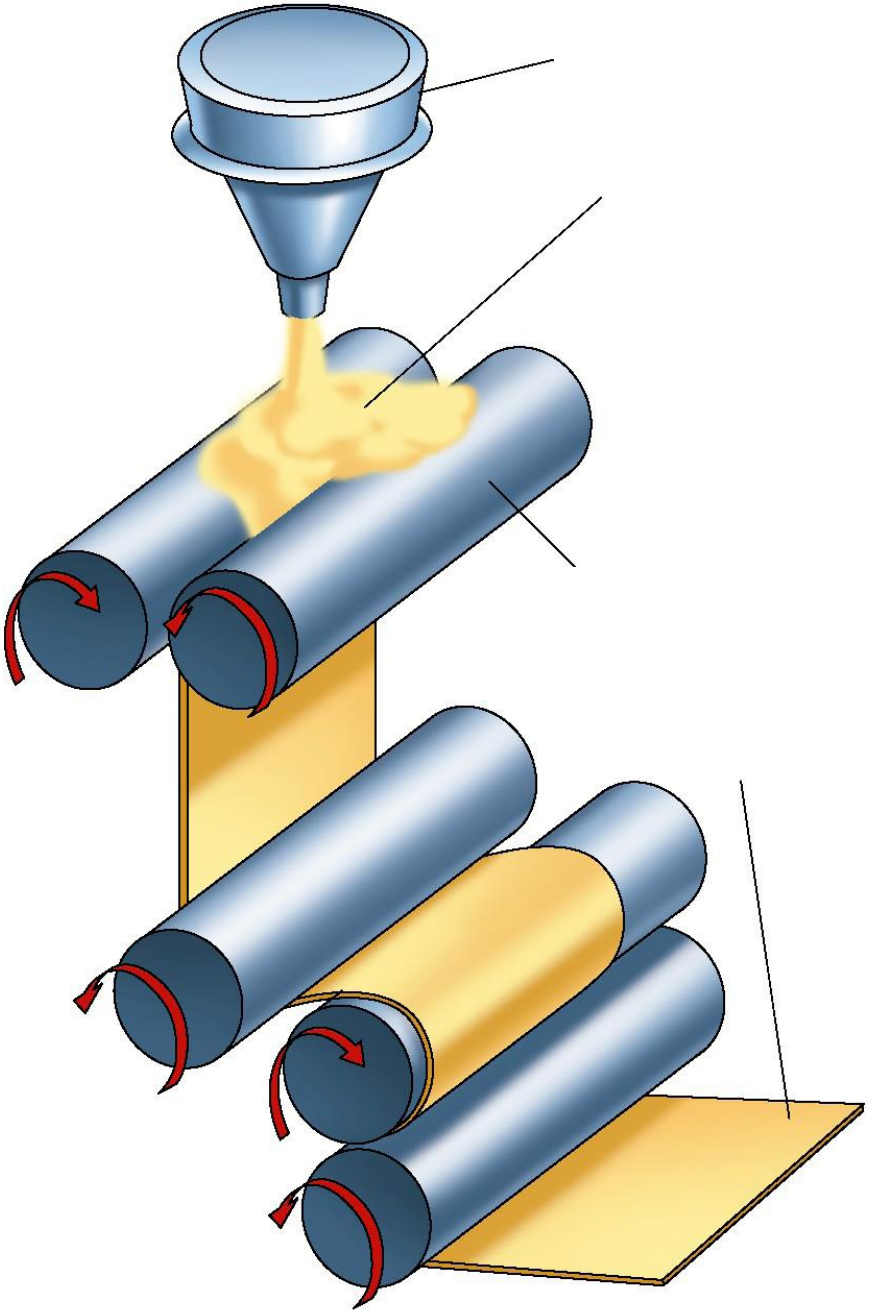


Técnica de moldeo por inyección.



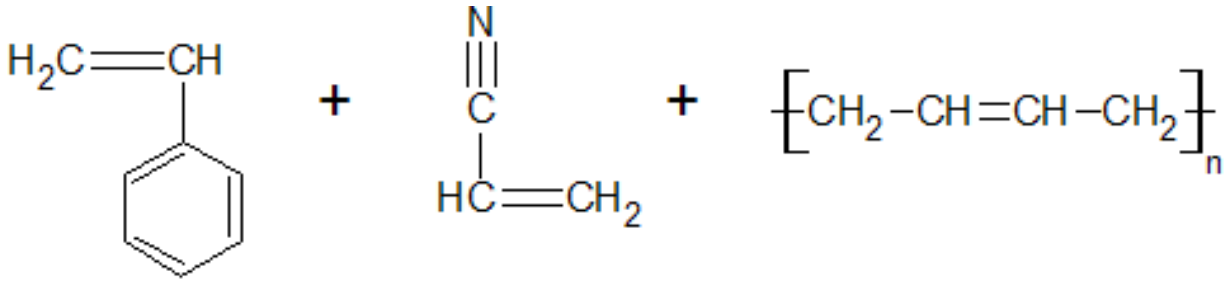


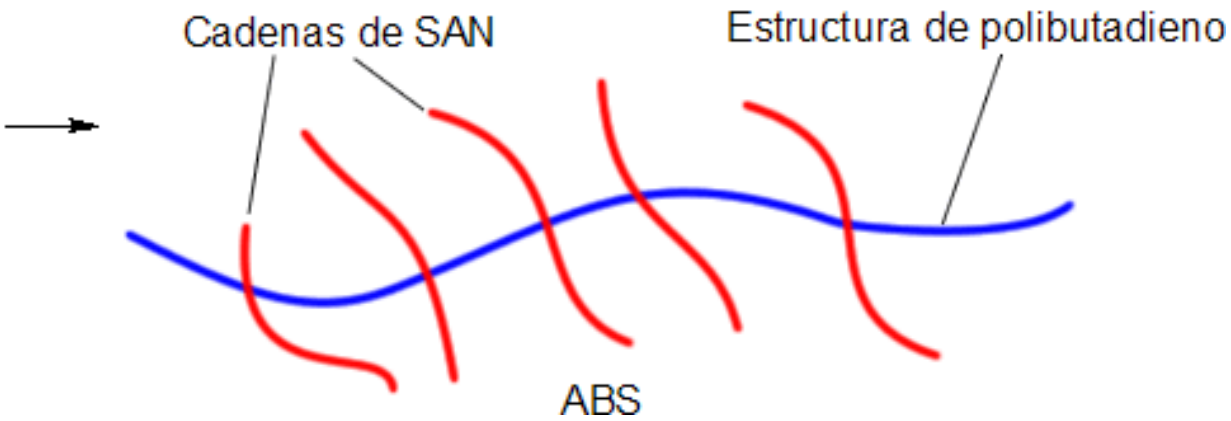




Estructura del ABS

La estructura del ABS es una mezcla de un copolímero vítreo (estireno – acrilonitrilo) y un compuesto elástico principalmente el polímero de butadieno. La estructura con la fase elastómera del polibutadieno (forma de burbujas) inmersa en una dura y rígida matriz SAN.



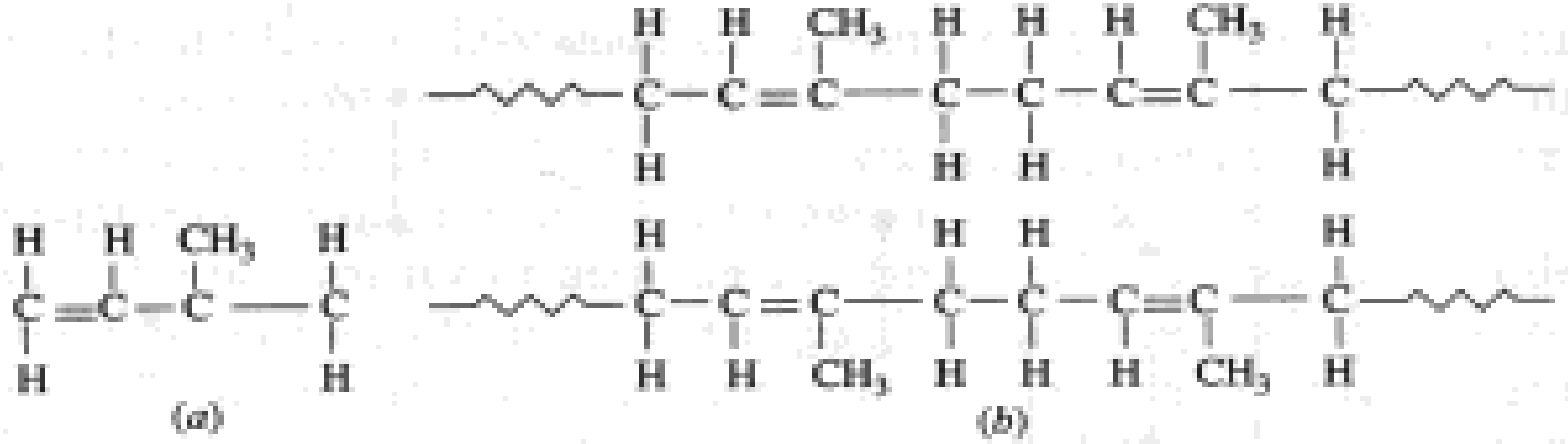


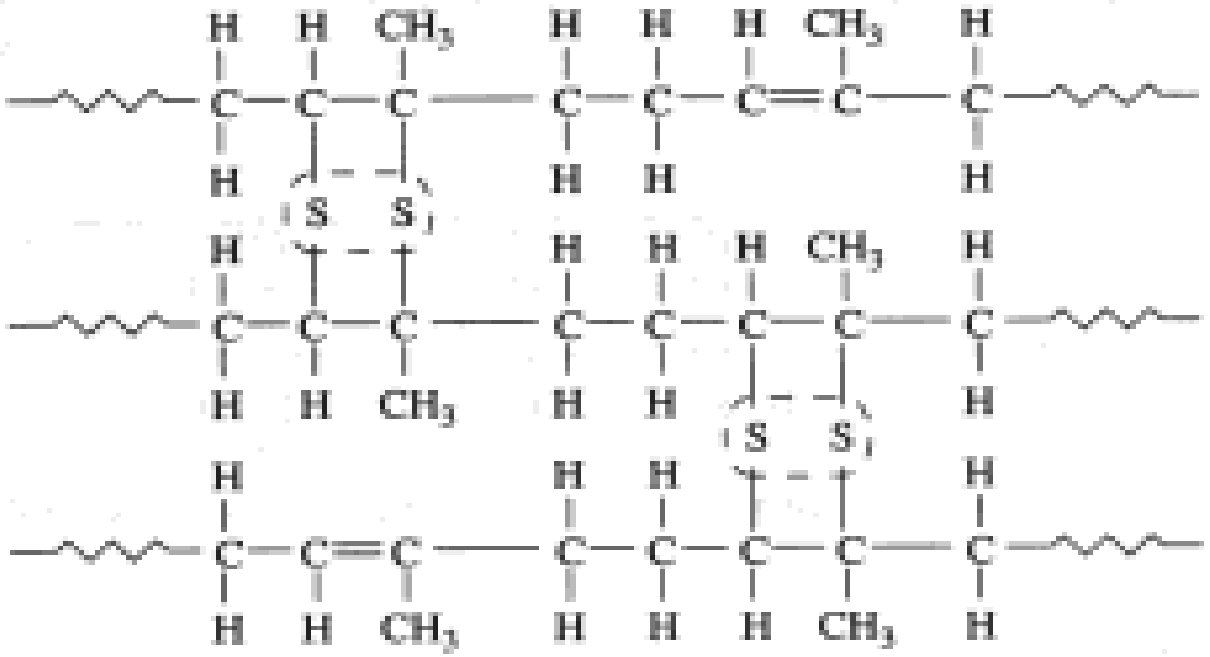
ELASTOMEROS

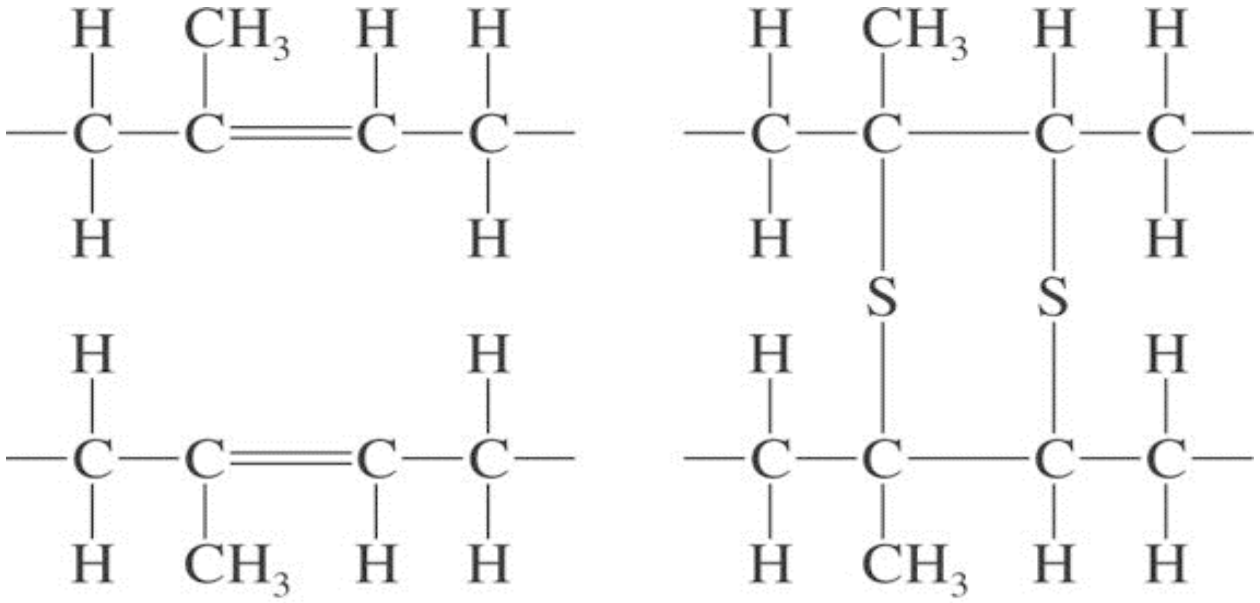
Vulcanisado de hule polisopreno (hule natural)

Extracción de látex de un árbol; El látex se emplea en la producción de goma

Vulcanisado de hule polisopreno (hule natural)






H
CH3
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CH3
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CH3
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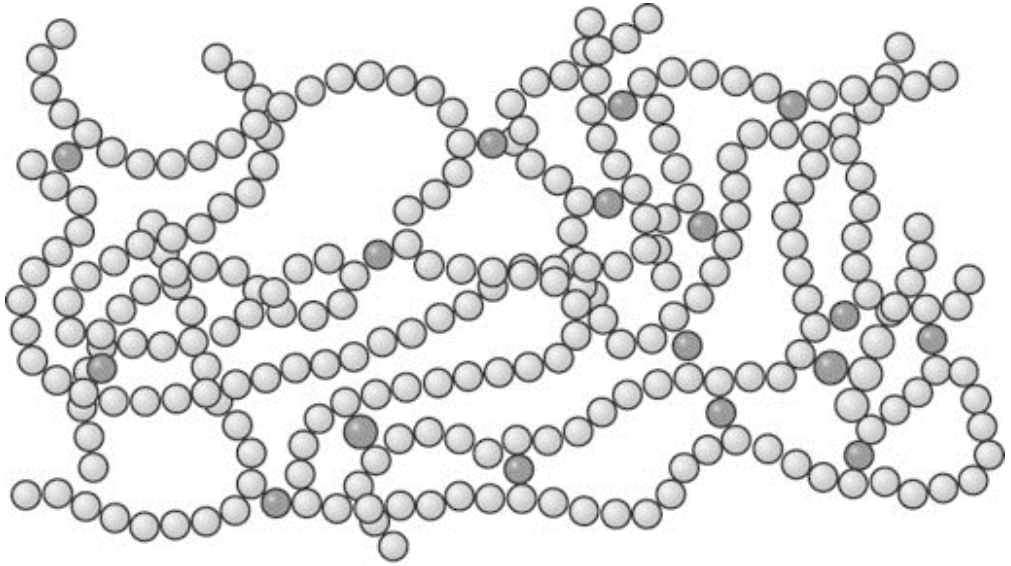
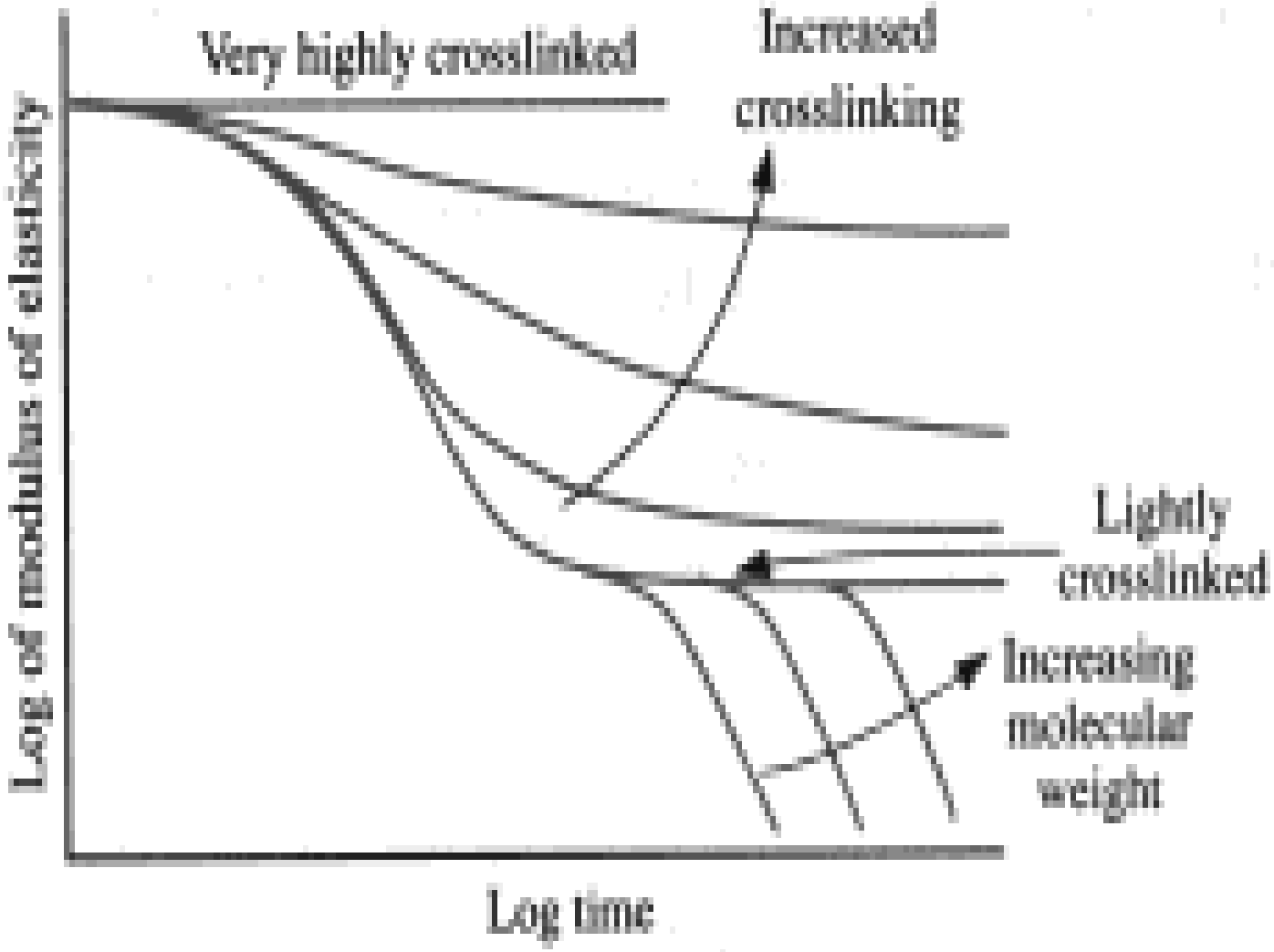
H

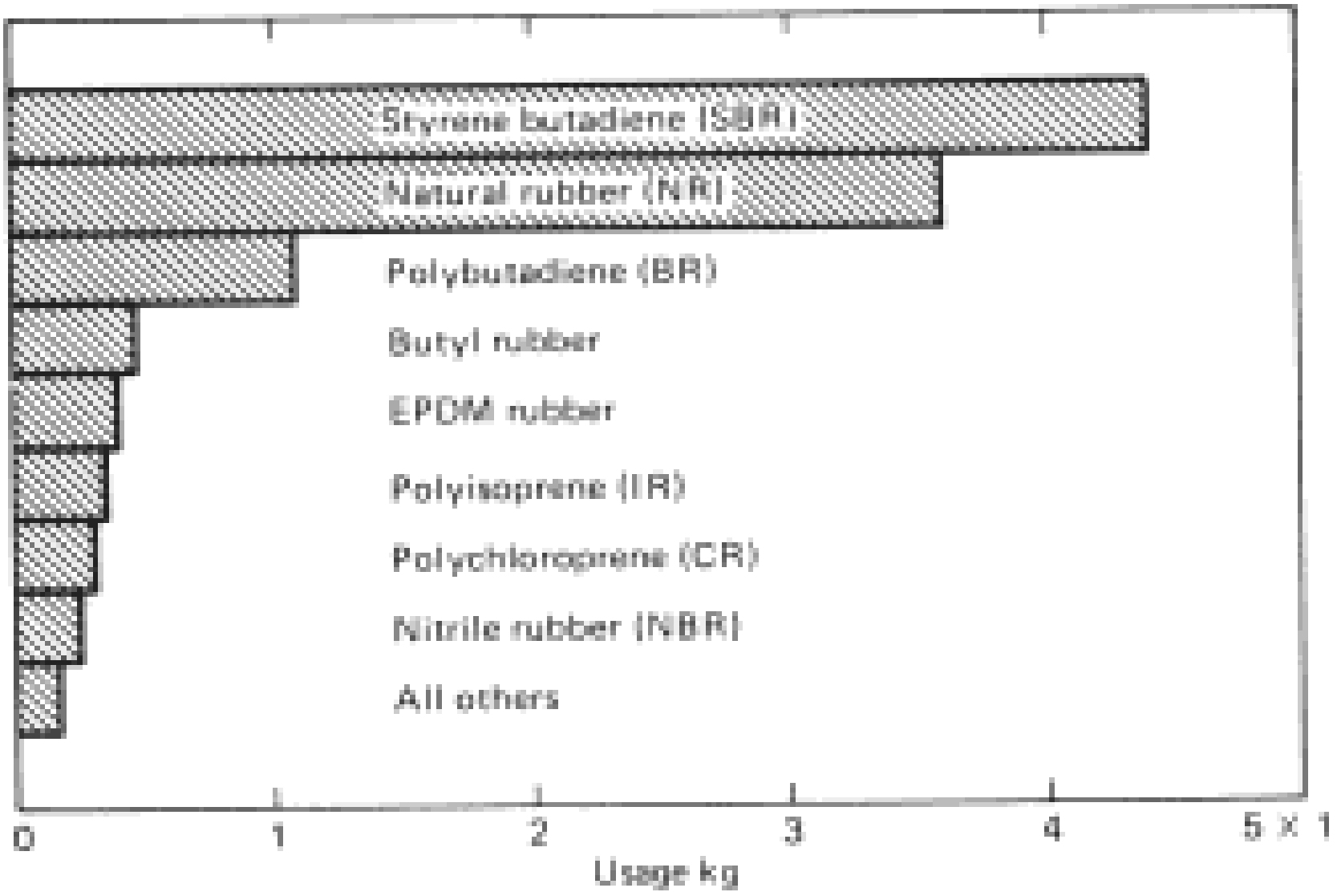
a) *b*)



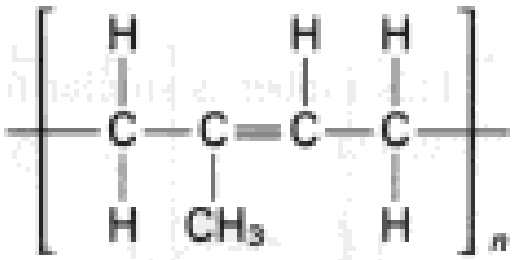
Efectos de elasticidad en modulos de hule



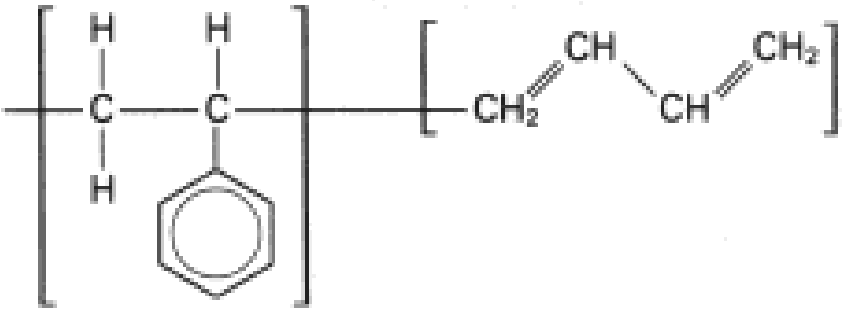
Consumo mundial de elastomeros



Monomeros elastoméricos más comunes



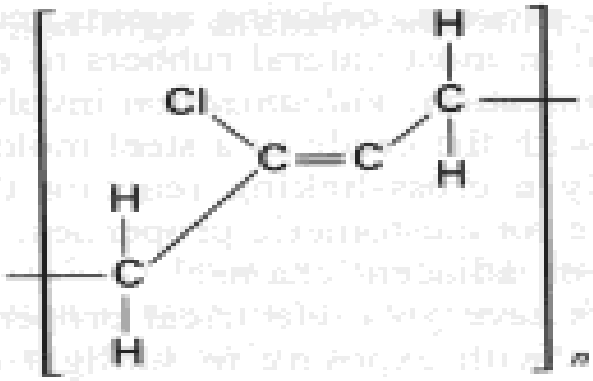
Polyisoprene (IR)



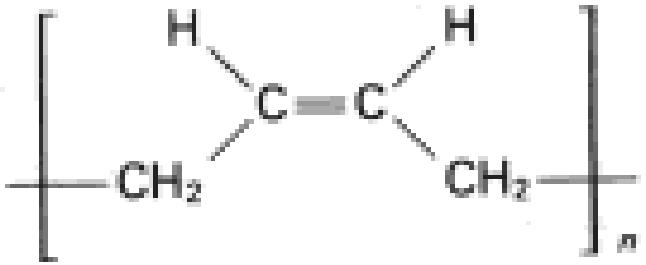
Polystyrene-1 part

Butadiene-3 parts

(SBR)

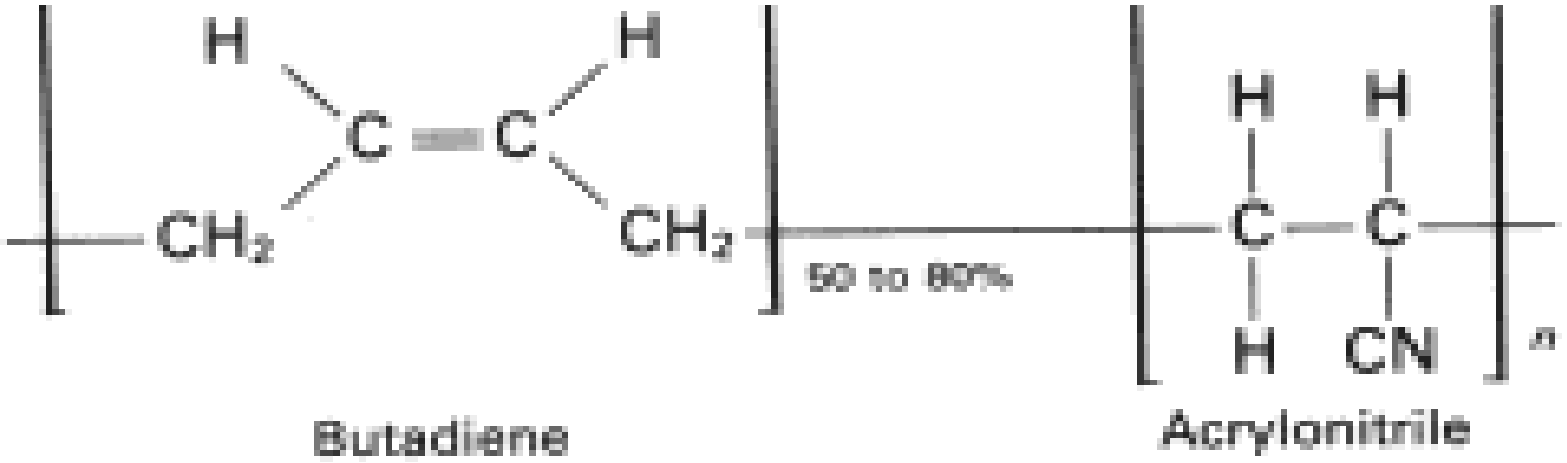


Polychloroprene (CR)

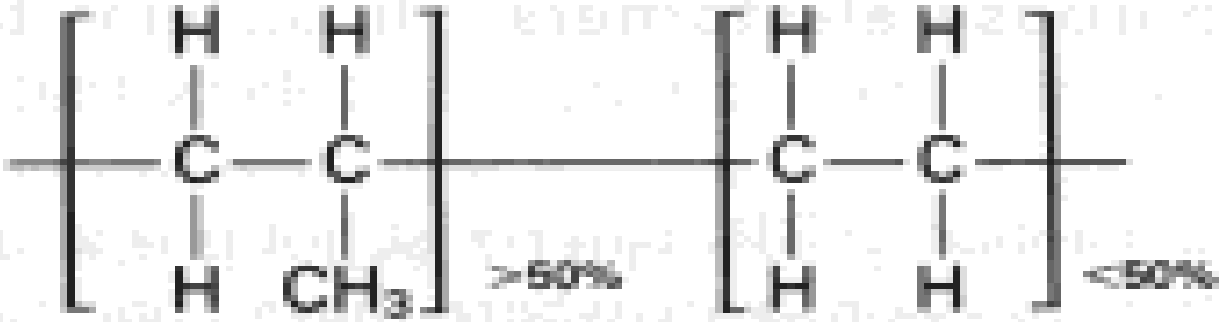


Polybutadiene (BR)

Monomeros elastoméricos más comunes

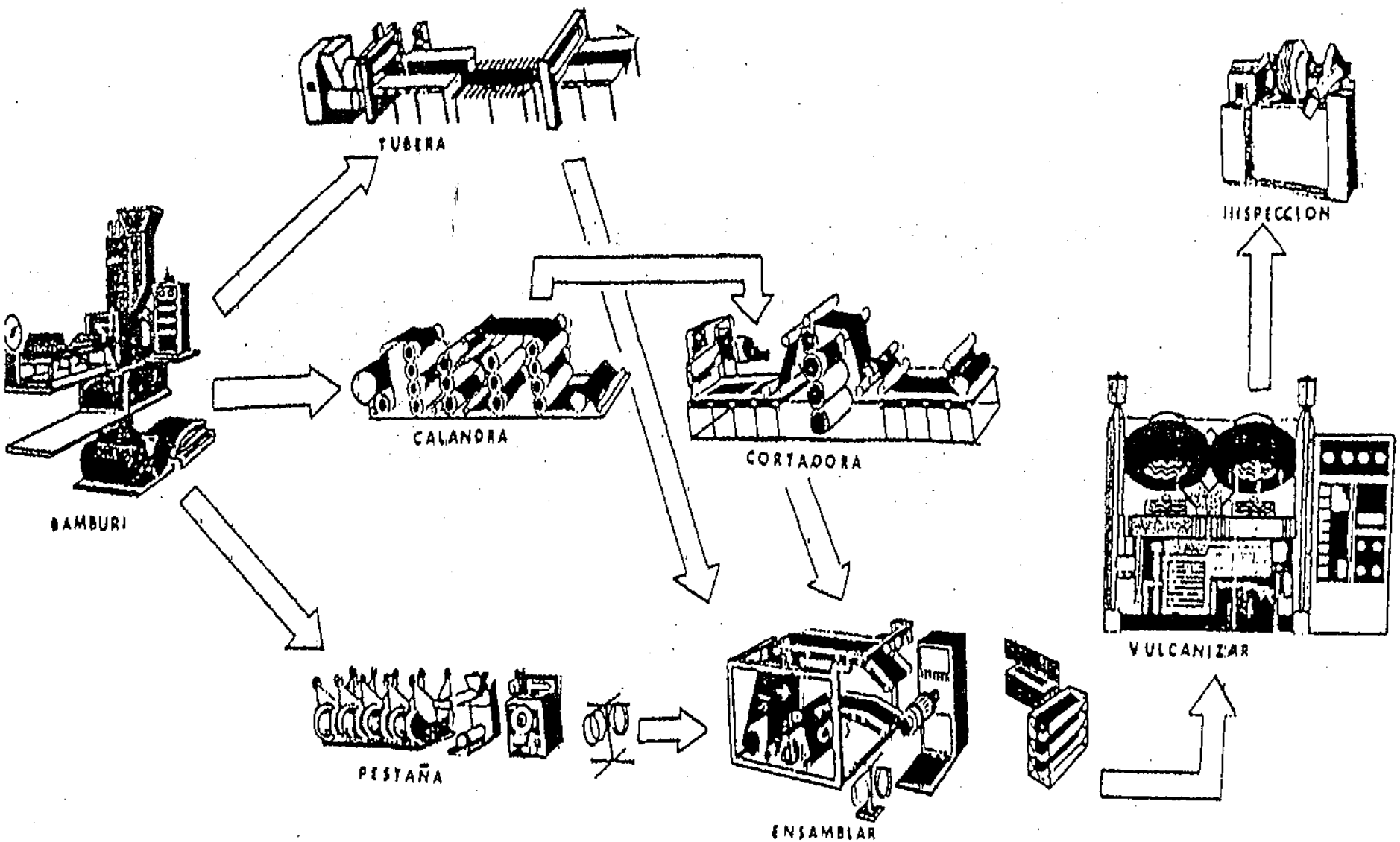


Nitrile rubber (NBR)



EPM rubber

PROCESO DE FABRICACIÓN DE NEUMÁTICOS



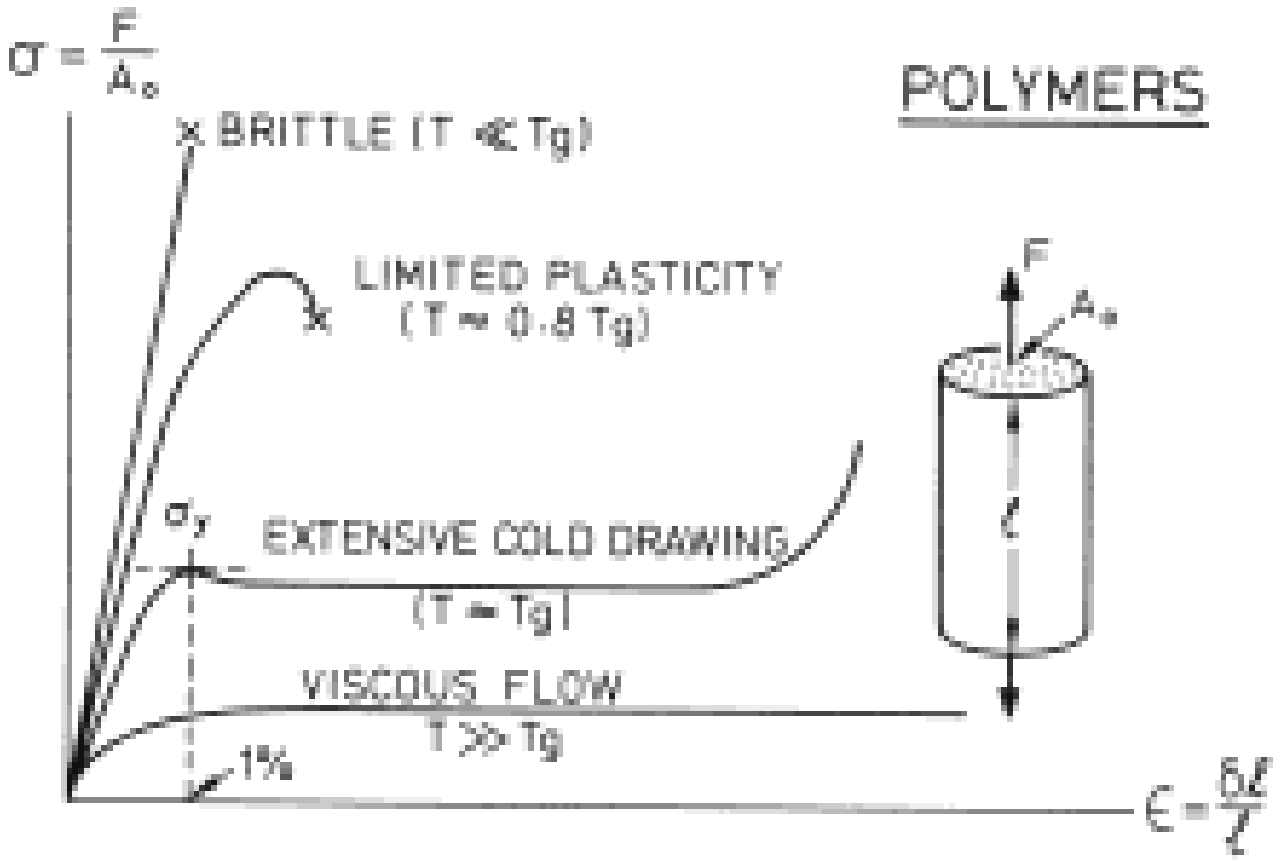
Datos de materiales elastomeros

TABLE 13.5 Properties of Different Rubbers (Elastomers)

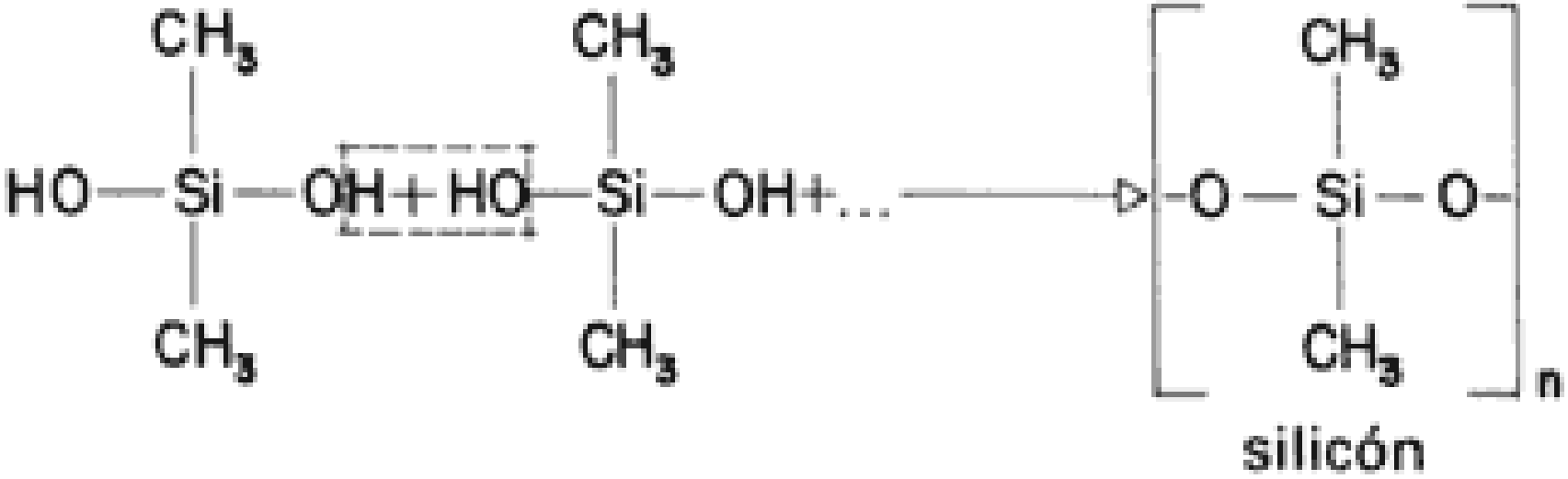
Common Name	*Chemical Name*	*Tensile, Strength,* psi*	*Percent Elongation*	*Resistance to Oil, Gas*	*Useful Temperature Range, °F (°C)*
Natural rubber	*cis*-Polyisoprene	3,000	800	Poor	−60 to 180 (−51 to 82)
GR-S or Buna S	Butadiene-styrene copolymer	250	3,000	Poor	−60 to 180 (−51 to 82)
Isoprene	Polyisoprene	3,000	400	Poor	−60 to 180 (−51 to 82)
Nitrile or Buna N	Butadiene-acrylonitrile copolymer	700	400	Excellent	−60 to 300 (−51 to 149)
Neoprene (GR-M)	Polychloroprene	3,500	800	Good	−40 to 200 (−40 to 93)
Silicone	Polysiloxane	700	300	Poor	−178 to 600 (−117 to 315)
Urethane	Diisocyanate polyester	5,000	600	Excellent	−65 to 240 (−54 to 115)

*Multiply psi by 6.9×10^{-3} to obtain Mn/m^2 (MPa) or by 7.03×10^{-4} to obtain kg/mm^2.

Curva de carga-deformación de los polímeros

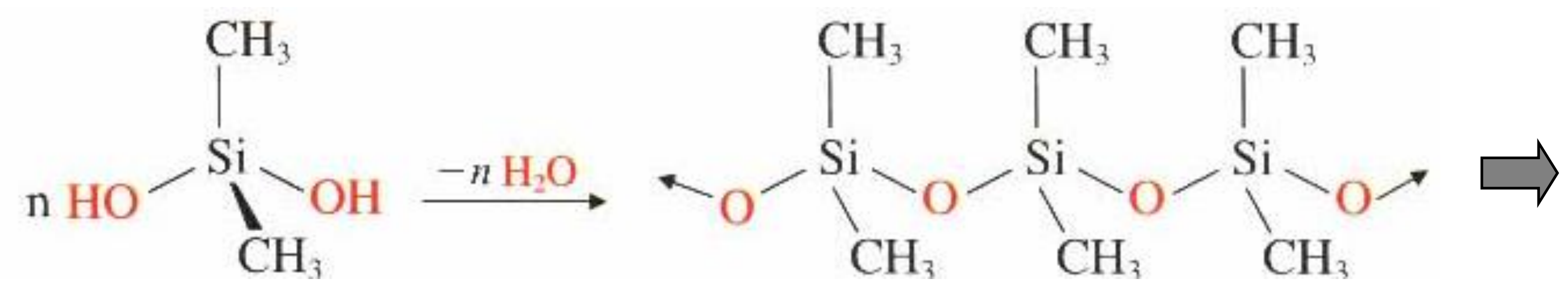


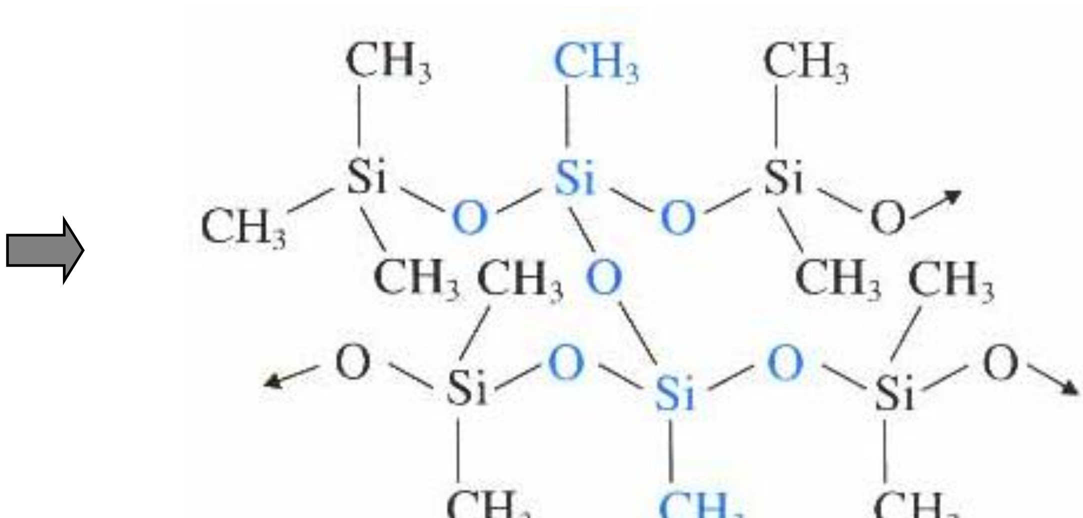
SILICONES

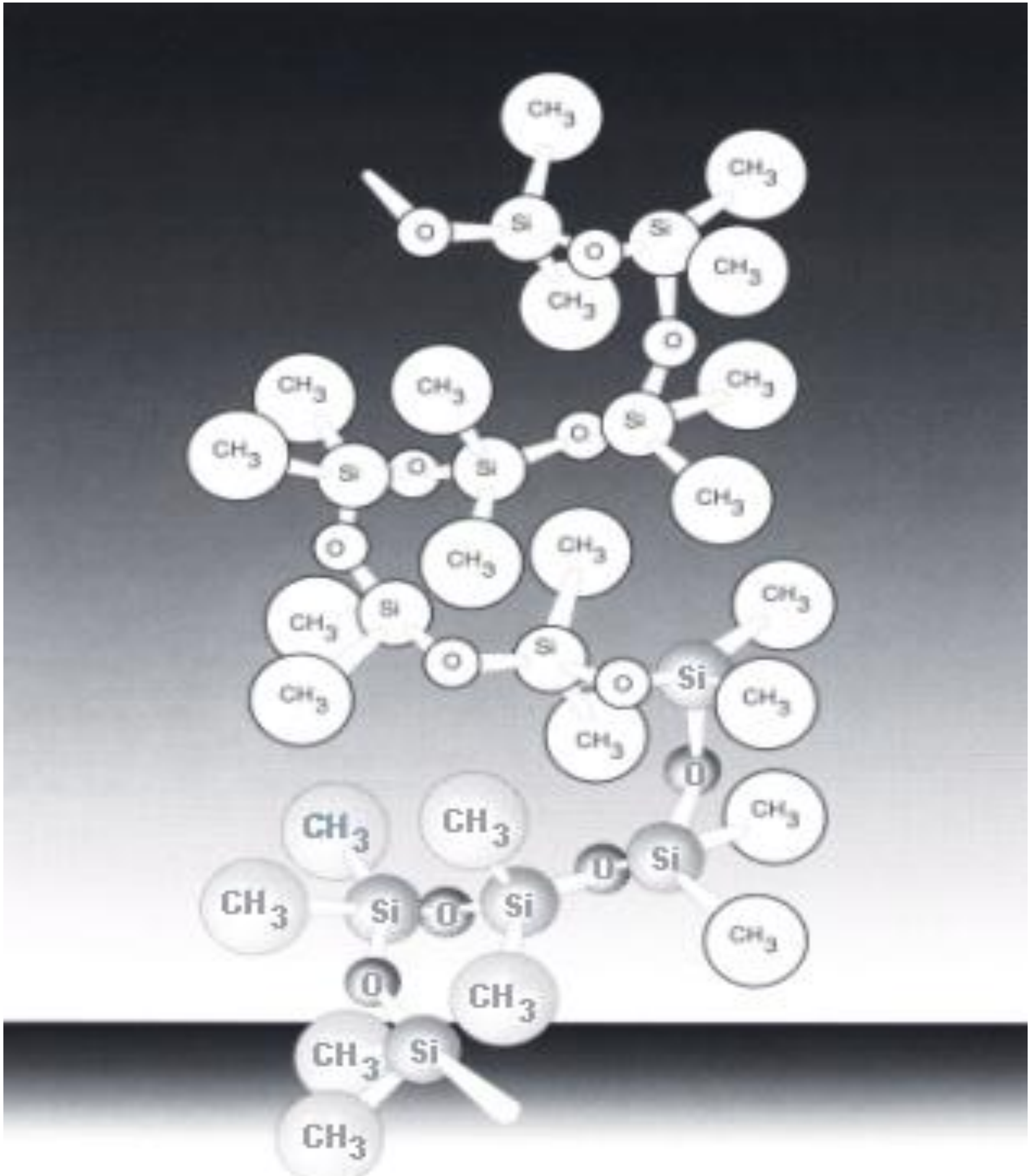


Polímeros de condensación: Siliconas

- Proceden de monómeros del tipo $R_2Si(OH)_2$
- Se utiliza para sellar juntas debido a su carácter hidrofóbico.



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CH3

SILICATOS Y SILICONAS

El silicio forma una variedad de polímeros naturales inorgánicos, los *silicatos*, que contienen unidades SiO_4

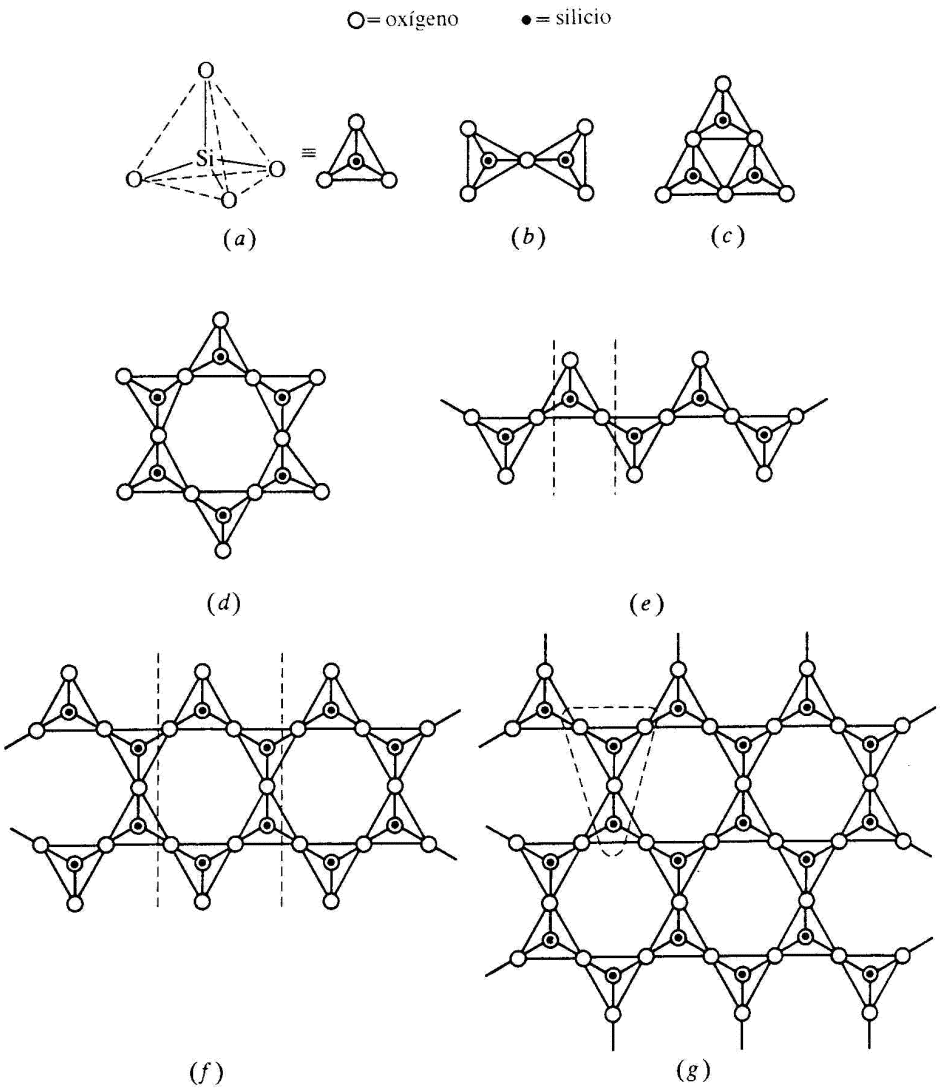
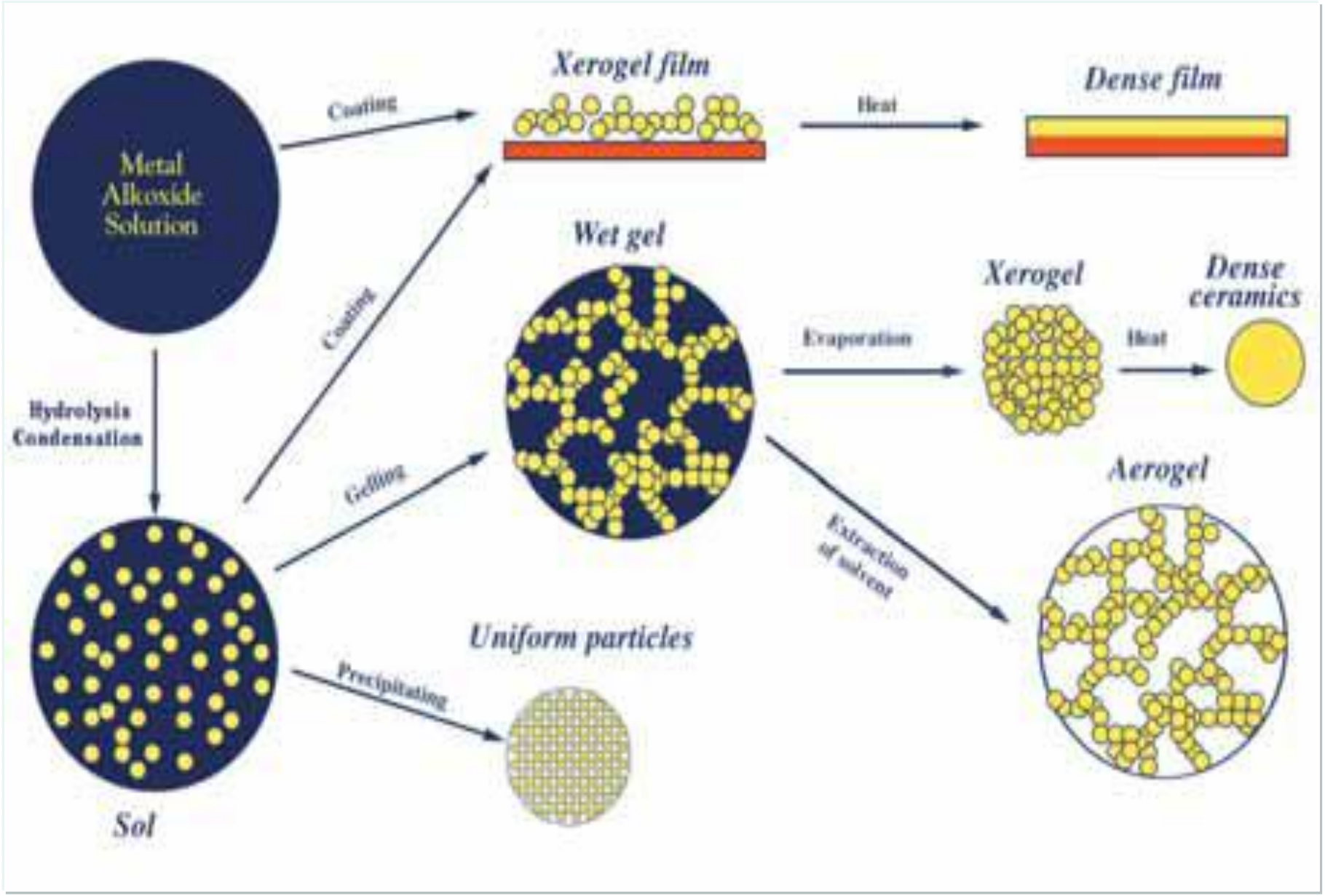
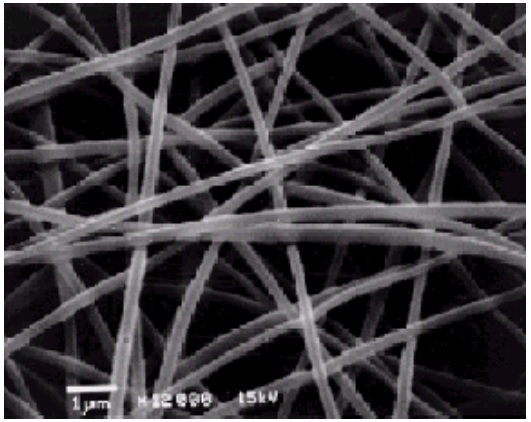


Figura 15.8. Estructuras de los silicatos: (*a*) orto SiO_4^{4-}, (*b*) piro $Si_2O_7^{6-}$, (*c*) cíclico $Si_3O_9^{6-}$, (*d*) cíclico $Si_6O_{18}^{12-}$, (*e*) cadena sencilla SiO_3^{2-}, (*f*) cadena doble $Si_4O_{11}^{6-}$ y (*g*) laminar $Si_2O_5^{2-}$.

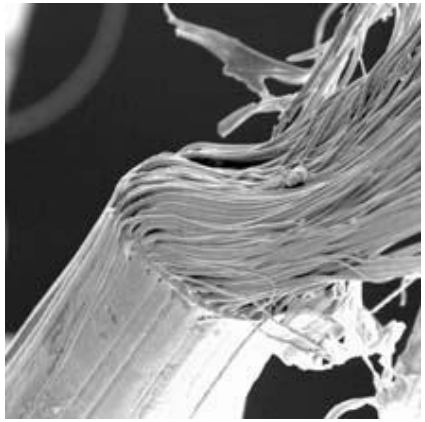

Metal Alkoxide Solution
Coating
Xerogel film
Heat
Dense film
Hydrolysis Condensation
Coating
Wet gel
Evaporation
Xerogel
Heat
Dense ceramics
Gelling
Extraction of solvent
Aerogel
Uniform particles
Precipitating
Sol

FIBRAS NATURALES

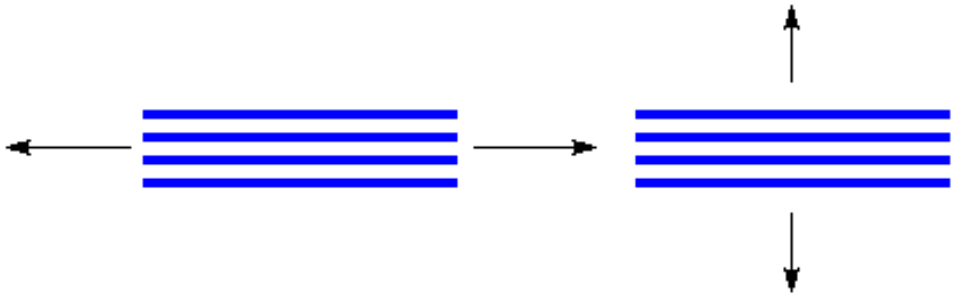
FIBRAS ARTIFICIALES



POLIACRILONITRILO



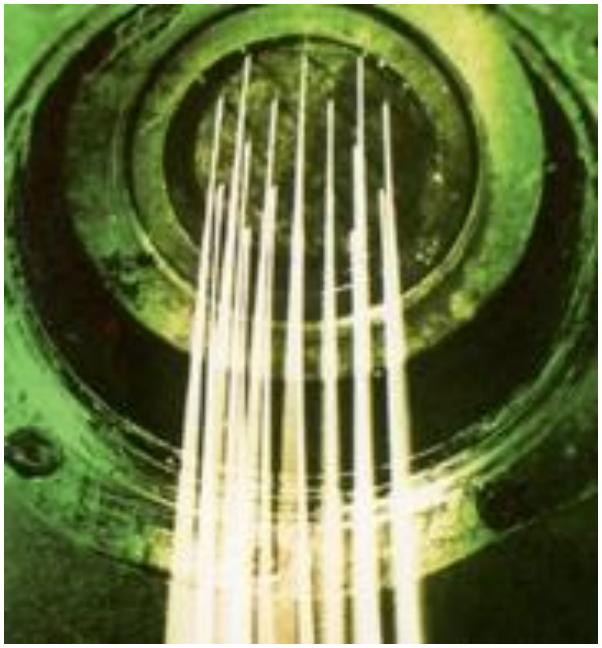
POLIPROPILENO



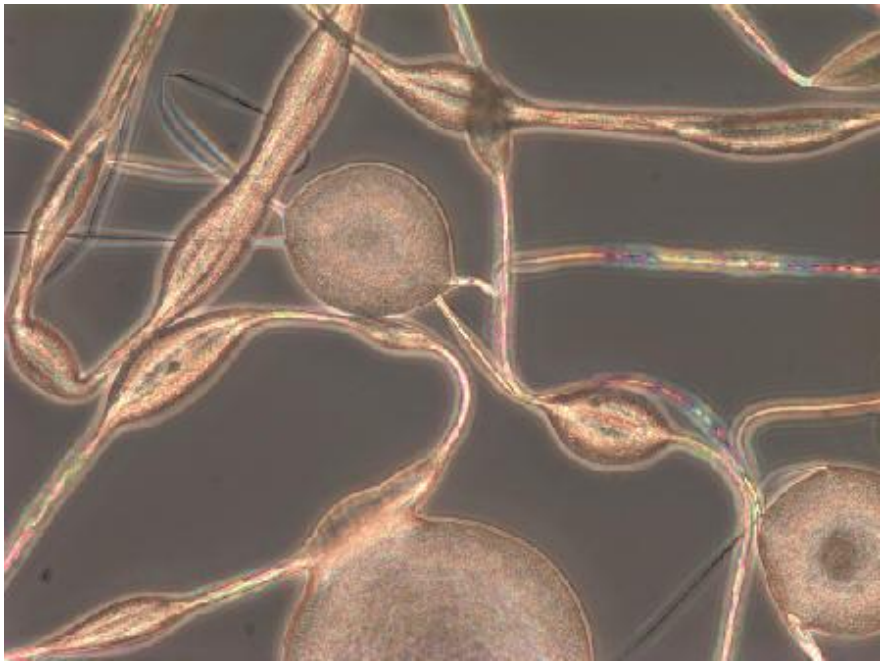
Las fibras orientadas son resistentes cuando usted estira en la dirección de las fibras.

Pero son débiles en ángulos rectos a la dirección de las fibras.

SPINNING (HILADO)



Spinning por fusión o en solución



Electrospinning

Las soluciones de polímero se rotan en un campo eléctrico de alto voltaje. La gota suspendida de polímero se carga y colapsa formando “chorros”.