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FOAM SECTORS

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Montreal Protocol Division
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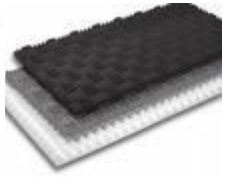
4 May 2016

FOAM SECTORS

What could attract audience attention?

- Foam What the foam is?
- Importance of polymeric foams.
- Importance for UNIDO. Does MP technology conversion projects fit with ISID?
- Environment and human health protection. Energy saving?
- Challenges and way forward. Saving of natural resources?

Foam



Foam is 2-phase colloidal system where a liquid is the dispersing medium and a gas is the dispersed medium.






Foam


FOAM

Foam is 2-phase colloidal system where a liquid is the dispersing medium and a gas is the dispersed medium.

The dispersed gas is separated by a viscous liquid film, which is determining the overall stability of the foam.

POLYMERIC FOAMS

The preparation of a polymeric foam involves:

1. formation of gas bubbles in a liquid system, followed by,
2. the growth and stabilization of these bubbles as the viscosity of the liquid polymer increases, resulting ultimately in the solidification of the cellular resin matrix (viscosity reaches ∞).

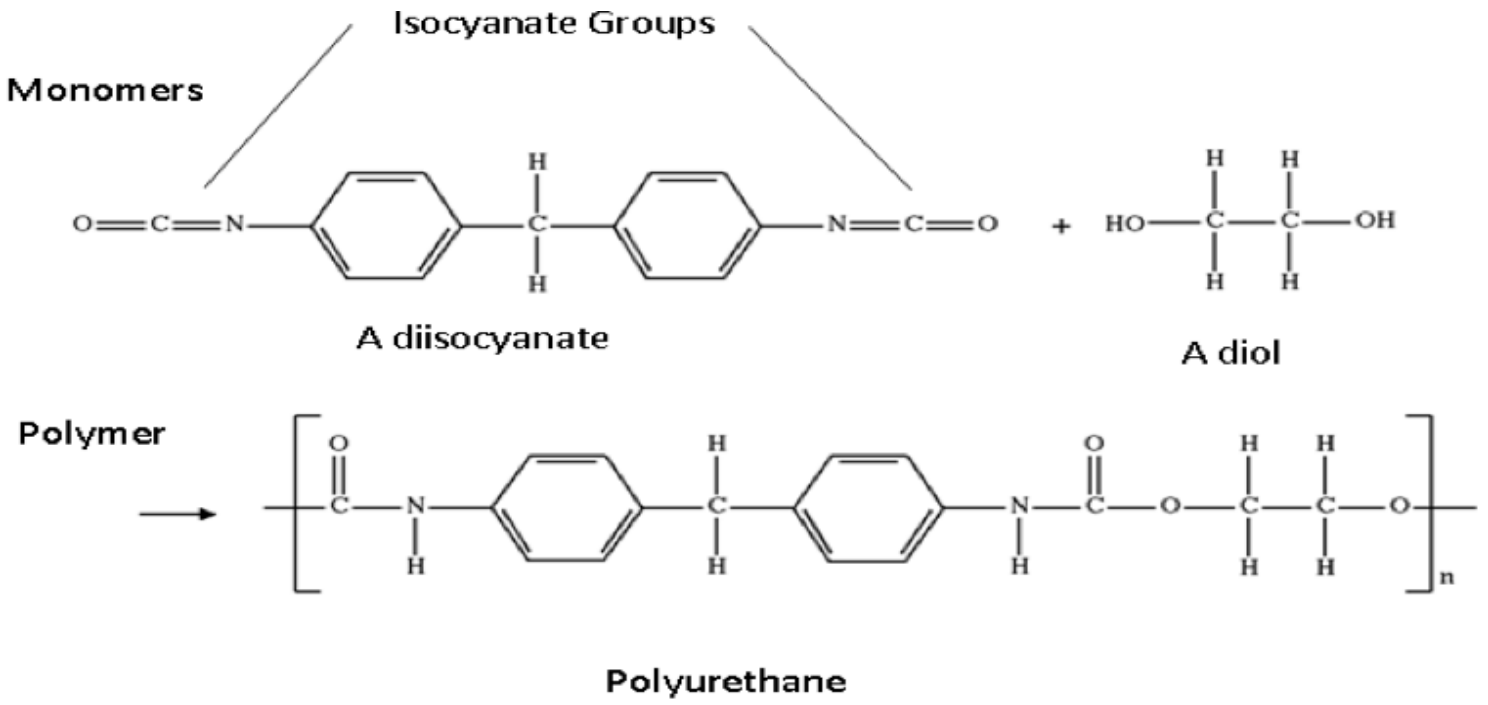
Foams may be prepared by two fundamental methods:

a) gas is dispersed in a continuous liquid phase to yield a colloidal system with the gas as the dispersed phase (physical blowing, auxiliary blowing agent is added).

b) gas is generated within the liquid phase and appears as separate bubbles dispersed in the liquid phase (chemical blowing, blowing agent is generated by chemical reaction).

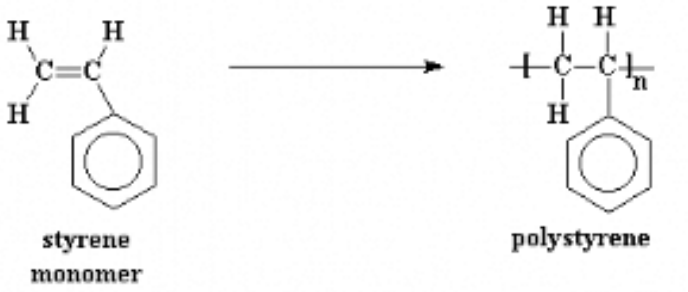
Polymeric foams in the focus of MP/UNIDO

- Polyurethanes

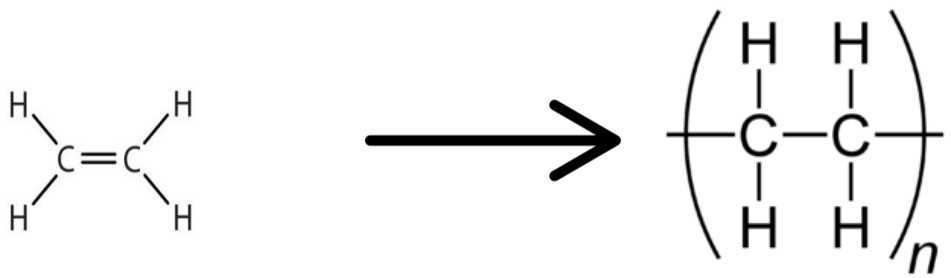


Polymeric foams in the focus of MP/UNIDO

- Polystyrene



- Polyethylene



UNIDO MP programme

Projects - Substance	Approved Funding (US$)	ODP to be Phased Out	ODP phased out	Projects	Disbursement End 2015
Other with ODP impact	240,897,097	1,062.9	1,012.7	862	186,451,840
CFC	30,476,142	9,992.7	9,653.6	38	29,860,870
CFC-11	215,121,215	27,038.3	25,318.3	326	213,554,658
CFC-113	9,797,356	774.1	800.9	22	9,797,776
CFC-12	43,579,776	10,575.3	10,382.9	122	43,499,760
CTC	26,089,585	5,730.5	4,891.1	53	26,090,050
Halon-1211	1,267,835	2,286.7	2,002.8	11	1,267,836
HCFC-141b	39,543,725	910.7	453.5	37	28,680,961
HCFC-142b	1,718,901	47.9	28.9	2	360,694
HCFC-22	68,873,219	502.9	99.7	61	38,865,331
MB	62,192,112	5,176.9	5,238.5	74	61,168,075
TCA	3,006,684	113.7	113.7	20	3,006,684
Other without ODP impac	1,529,107	-	-	17	573,739
Grand Total	**744,092,754**	**64,212.5**	**59,996.4**	**1,645**	**643,178,273**
Sectors	%	%	%	%	%
Foam	**34.46**	**43.6**	**43.0**	**22.2**	**37.7**
Refrigeration	15.11	17.3	17.5	11.1	12.8
MB	8.36	8.1	8.7	4.5	9.5
Solvent	5.23	10.3	9.7	5.8	6.0
Halon-1211	0.17	3.6	3.3	0.7	0.2
CFC, early MP projects	4.10	15.6	16.1	2.3	4.6
Other	32.58	1.7	1.7	52.4	29.0

Insulation is important. Weight,strength,sturdiness too

Material	**Thermal conductivity** [mW/mK @25C]
Cyclopentane	11
Xenon	5
Polyurethane foam	~ 30
Polystyrene foam	30 - 35
Wood	55 - 170
Dense brick brickwork	150 – 1,600
Concrete	100 – 1,800
Carbon steel	54,000
Copper	401,000

Foaming processes and blowing agents

a) Chemical blowing

Water/CO_2 blowing

(1)

$$R'-N=C=O \;+\; HOH \longrightarrow R-NH-COOH \longrightarrow$$

Isocyanate + Water → Carbamic Acid →

$$\text{Heat} \;+\; CO_2\uparrow \;+\; R-NH_2$$

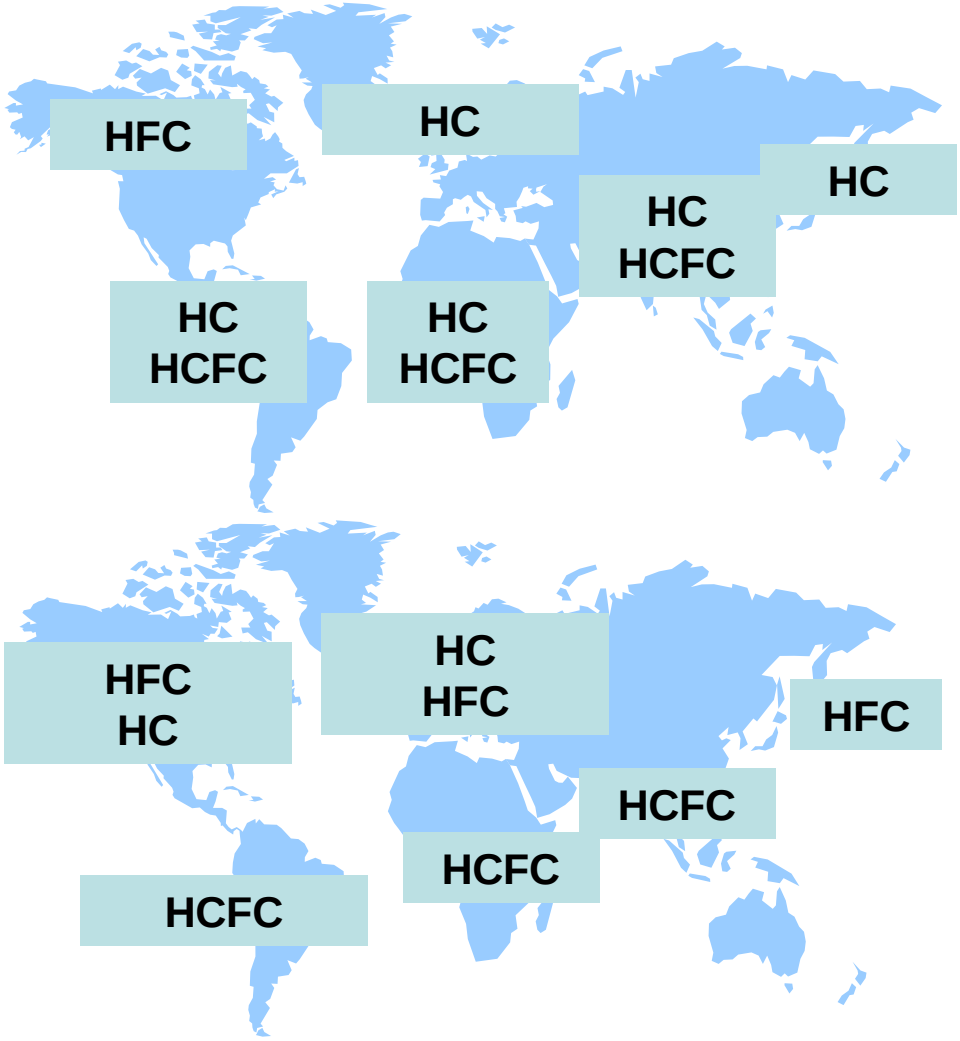
Heat + Carbon Dioxide + Amine

Isocyanate is consumed to generate CO_2

b) Physical blowing

added gas is dispersed in a continuous liquid phase

GLOBAL BLOWING AGENT TECHNOLOGY- APPLIANCES

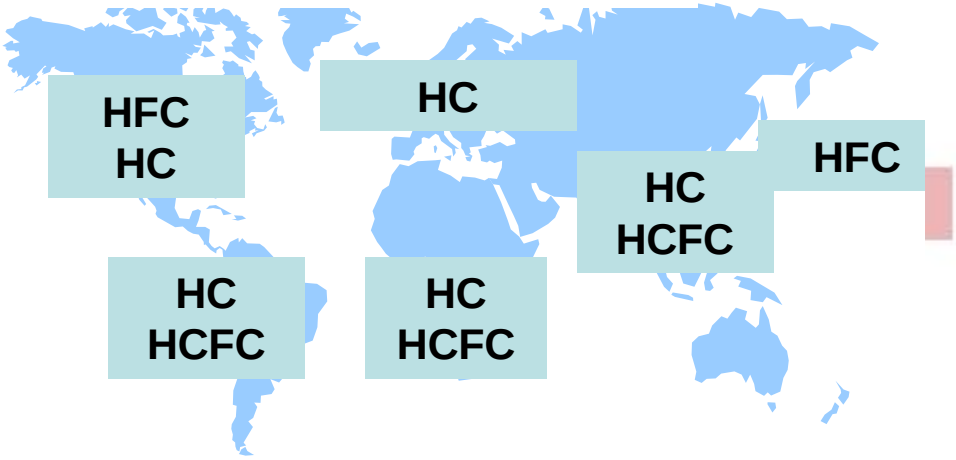


Refrigerators/Freezers

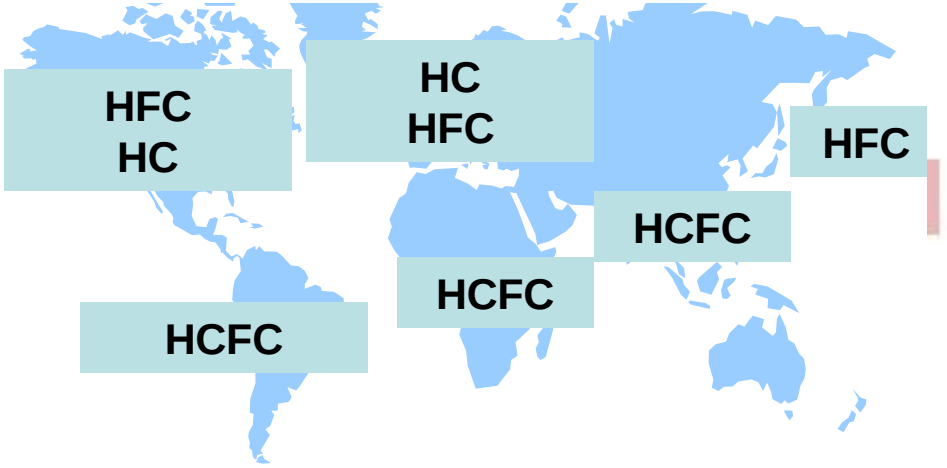
Other Appliances (water heaters, display unit)

GLOBAL BLOWING AGENT TECHNOLOGY – SANDWICH PANELS

Continuous process

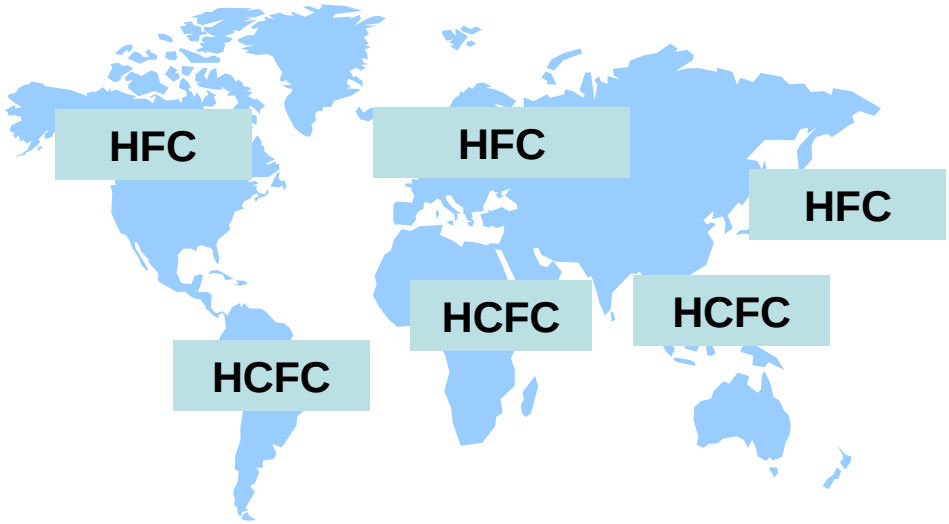


Discontinuous process



Composite panels

GLOBAL BLOWING AGENT TECHNOLOGY – SPRAY FOAM



Spray foam

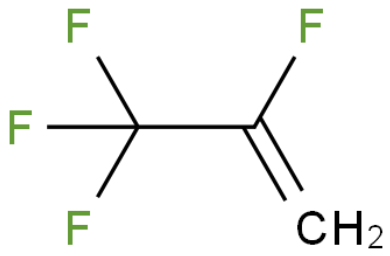
BLOWING AGENT PROPERTIES

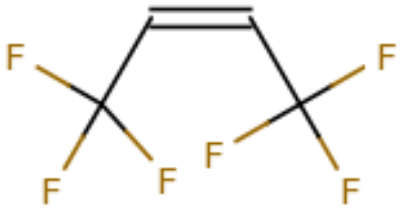
(Past and Present Blowing Agents)

BLOWING AGENT	MW	BP (ºC)	DENSITY (gm/cm3 @ 20C)	GAS λ-VALUE (mW/mK @10C)	GWP (100 year ITH)	FLAMMABLE LIMITS IN AIR (% VOL)
CFC-11	137	24	1.49	7.4	4,680	None
HCFC-141b	117	32	1.25	8.8	713	7.3-16
HCFC-22	86	-41	1.49	9.9	1,780	None
n-pentane	72	36	0.63	14	<25	1.4-8.0
iso-pentane	72	28	0.62	13	<25	1.4-7.6
c-pentane	70	50	0.75	11	<25	1.4-8.0
HFC-152a	66	-27	0.89	14.3	125	3.8-21.8
HFC-227ea	170	-16.5	1.54	11.6	3,140	None
HFC-245fa	134	15	1.32	12.05	1,020	None
HFC-365mfc	148	40	1.25	10.6	780	3.8-13.0
*H_20/CO_2	44	-78		14.6	1	None
Methylformate	60	32	0.97	10.7	<20	LEL/UEL 5/23
HFO FEA 1100 DuPont	164	33	1.36	10.7	8.9	None
HFO 1233zd	130	19	1.27	10.2	<5	None

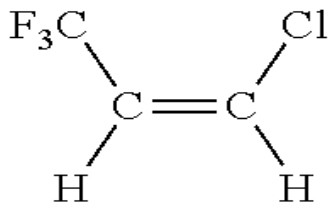
* Properties of CO_2

Hydrofluoroolefins: HFO-1234yf (2,3,3,3-tetrafluoroprop-1-ene); FEA 1100 (1,1,1-4,4,4-hexafluorobut-2-ene) etc.etc. including Trans- 1-chloro-3,3,3-trifluoropropene (very small ODP! Admitted)

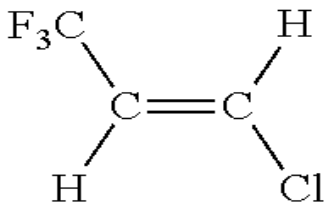




[Chem. 1]



Cis (Z) isomer
normal boiling point:
39.0° C.



Trans (E) isomer
normal boiling point:
21.0° C.

Hydrofluoroolefins; HFOs; u-HFCs

FEA 1100 (1,1,1-4,4,4-hexafluorobut-2-ene)

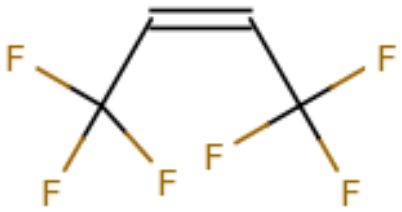
DuPont, Formacel® 1100

ODP = 0

GWP_{100y} = 8.9

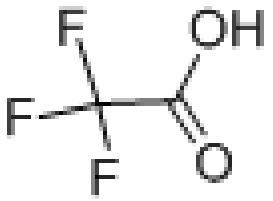
Hazard code F in Chemical Book http://www.chemicalbook.com/ChemicalProductProperty_EN_CB8467094.htm

Atmospheric life = 22 days



Photolysis + O_2 →

?

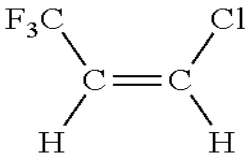


Hydrofluoroolefins HFOs; u-HFCs

Trans- 1-chloro-3,3,3-trifluoropropene
Honeywel, ®Solstice LBA

ODP ~ 0 small ODP admitted
GWP = <5
Atmospheric life = 26 days
Possibility of hazardous reactions: Polymerization can occur
Specific hazards during fire fighting: Decomposition products may be produced, such as: hydrogen fluoride, hydrogen chloride, carbonyl halides

[Chem. 1]



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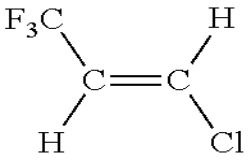

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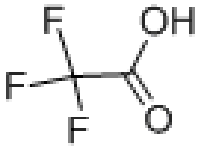
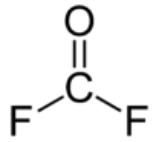
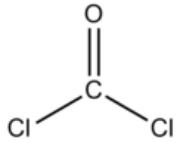


Fire

?





Barriers for uptake of natural substances

- Awareness.
- Technology & Standards
- Regulations policy framework
- Financial incentives e.g. MP Decision 74/56 has allowed funding up to a maximum of 25% above cost effective threshold to introduce low GWP alternatives and 40% for SMEs consuming less than 20 MT

Challenges

- maintain Awareness.
- Technology & Standards research and develop
- maintain Regulations policy framework rational
- Financial incentives value for money, for sustainability

Thank you

Q&A

"Don't worry, I welcome stupid questions because I have plenty of stupid answers."